SECTION 6B

COOLING AND RADIATOR

CAUTION: This vehicle has a Supplemental Inflatable Restraint (SIR) System. Refer to the SIR Component and Wiring Location view in order to determine whether you are performing service on or near the SIR components or the SIR wiring. When you are performing service on or near the SIR components or the SIR wiring, refer to the SIR On-Vehicle Service information. Failure to follow the CAUTIONS could cause air bag deployment, personal injury, or unnecessary SIR system repairs.

NOTICE: ***When adding coolant, it is important that you use GM Goodwrench DEX-COOL ™ coolant. If coolant other than DEX-COOL ™ is added to the system the engine coolant will require change sooner - at 50,000km (30,000 miles) or 24 months.***

NOTICE: ***Always use the correct fastener in the proper location. When you replace a fastener, use ONLY the exact part number for that application. General Motors will call out those fasteners that require a replacement after removal. General Motors will also call out the fasteners that require thread lockers or thread sealant. UNLESS OTHERWISE SPECIFIED, do not use supplemental coatings (paints, greases, or other corrosion inhibitors) on threaded fasteners or fastener joint interfaces. Generally, such coatings adversely affect the fastener torque and joint clamping force, and may damage the fastener. When you install fasteners, use the correct tightening sequence and specifications. Following these instructions can help you avoid damage to parts and systems.***

CONTENTS

CONTENTS (cont'd)

GENERAL DESCRIPTION

COOLING SYSTEM

This vehicle has a pressure-type engine cooling system with thermostatic control of coolant circulation. The cooling system is sealed by a pressure-type radiator cap that causes the system to operate at higher than atmospheric pressure. The high-pressure operation raises the boiling point of the coolant, thereby increasing the cooling efficiency of the radiator. The 103 kPa (15 psi) pressure cap raises the boiling point of the coolant to about 128°C (262°F) at sea level.

The pressure-vacuum valve radiator cap allows the coolant to expand through the pressure valve in the center of the cap without building unnecessary pressure. The expanding coolant flows into the coolant recovery reservoir. The vent valve closes due to expansion and coolant flow. The nominal 103kPa (15 psi) pressure will not be reached until the system is working

at maximum capacity. Any air in the cooling system will be forced into the coolant reservoir and out the vent tube at the top of the reservoir. As the system cools, the coolant in the reservoir is drawn back into the radiator through the vent valve. Through this process, the radiator remains full at all times.

ENGINE COOLANT

This vehicle was manufactured with GM Goodwrench DEX-COOL ™. DEX-COOL ™ was developed to last for 240,000km (150,000 miles) or 5 years whichever occurs first. Make sure only GM Goodwrench DEX-COOL ™ is used when coolant is added or changed. Follow the instructions in "Draining and Refilling" in this section.

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

- Freezing protection down to -37°C (-34°F).
- Boiling protection up to 129°C (265°F).
- Help keep the proper engine temperature.
- Rust and corrosion protection.
- Allow the sensors and switches to operate as designed.

NOTICE: ***Do not use a solution stronger than 70 percent antifreeze. Pure anti-freeze will freeze at -22°C (-8°F).***

RADIATOR

The radiator is a crossflow, tube and center type, utilizing an aluminum core with plastic side tanks (Figure 1).

Shrouds direct air flow through the radiator core and also serve as a fan guard. Provision for coolant expansion is achieved with a coolant recovery reservoir that prevents coolant overflow and reduces frequent refills. A transmission oil cooler is built into the right tank of the radiator, with inlet and outlet fittings for transmission fluid circulation. There is an optional engine oil cooler available that is built into the left tank, with inlet and outlet fittings for engine oil circulation.

RADIATOR CAP

The pressure-vent radiator cap allows a build-up of 103 kPa (15 psi) in the cooling system. This pressure raises the boiling point of the coolant to about 129°C (265°F) at sea level. Do not remove the radiator cap to check the engine coolant level; check the coolant visually at the see-through coolant recovery reservoir. Add coolant to the reservoir when the system cools.

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 radiator cap while the engine is hot and the pressure is high will cause the solution to boil instantaneously and possibly with explosive force, spewing the solution over the engine, fenders, and person removing the cap. Under some conditions, the engine coolant is combustible.

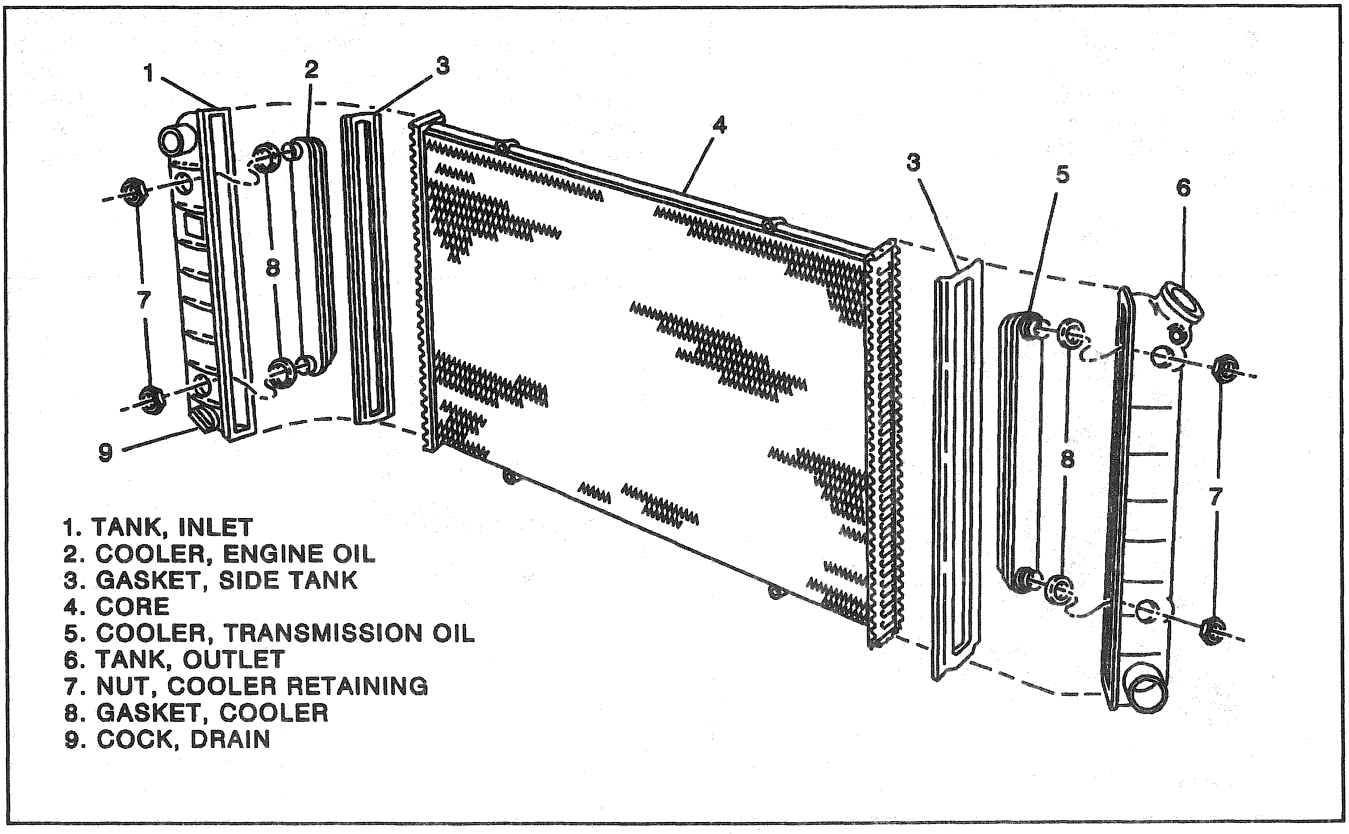
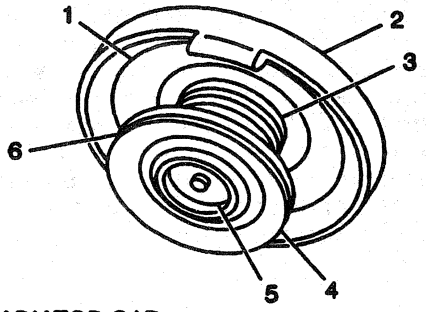


Figure 1—Radiator Components

The radiator cap contains a blow off or pressure valve and a vacuum or atmospheric valve. The pressure valve is held against its seat by a spring of predetermined strength. This protects the radiator by relieving internal pressure when it exceeds cooling system design limits. The vacuum valve is held against its seat by a light spring which permits opening of the valve to relieve vacuum created in the system when it cools (Figure 2).

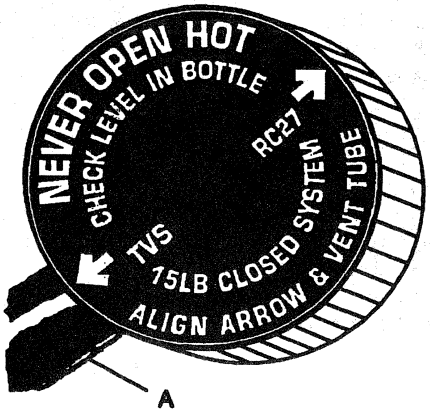
The radiator cap is designed to discourage inadvertent removal. To safely remove the cap from the radiator, rotate the cap slowly counterclockwise (do not press down) to the detent. Allow any pressure to release from the radiator. Press down on the cap, continue to rotate counterclockwise and lift off the radiator.

Under the diaphragm spring at the top of the cap is a gasket. Embossed on the cap is a caution against its being opened and arrows indicating the proper closed position (Figure 3).



1. SEAL, RADIATOR CAP
2. CAP, RADIATOR
3. SPRING, PRESSURE VALVE
4. SEAL, PRESSURE VALVE
5. VALVE, VACUUM
6. VALVE, PRESSURE RELIEF

Figure 2—Radiator Pressure Cap Pressure and Vacuum Valves



A. TO RECOVERY TANK

Figure 3—Radiator Cap Alignment Arrows

The seal of the filler cap and the operation of the pressure relief valve can be checked using a conventional cooling system testing kit (Figure 4).

COOLANT RECOVERY RESERVOIR

A "see-through" plastic reservoir is connected to the radiator by an overflow hose. As the vehicle is driven, the coolant is heated and expands. The portion of the fluid displaced by this expansion flows from the radiator into the coolant recovery reservoir. When the vehicle is stopped and the coolant cools and contracts, vacuum draws the displaced coolant back into the radiator. Thus, the radiator is kept filled with coolant to the desired level at all times, resulting in increased cooling efficiency.

Keep the coolant level between the "ADD" and "FULL" marks on the recovery reservoir. These marks are about one liter (one quart) apart. Use a 50/50 mixture of ethylene glycol antifreeze and water (distilled water preferred) to keep the system at the "FULL" mark when hot.

NOTICE: ***When adding coolant, it is important that you use GM Goodwrench DEX-COOL™ coolant. If coolant other than DEX-COOL is added to the system the engine coolant will require change sooner - at 50,000km (30,000 miles) or 24 months.***

DIESEL SURGE TANK

The diesel engine uses a cooling system with a surge tank. The pressure cap for the diesel engine is different than the gasoline engine pressure cap and is located on the surge tank. The surge tank used with the diesel engine cooling system is pressurized. Coolant circulates through the surge tank to allow any air that is in the system to be removed and to provide room for the coolant to expand when the coolant is hot.

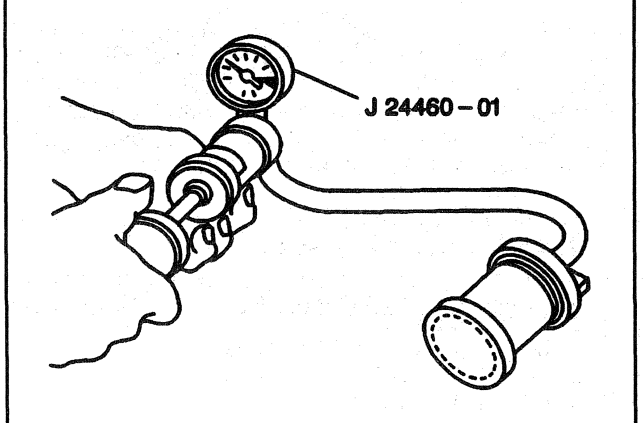


Figure 4—Testing the Radiator Pressure Cap

THERMOSTAT

A pellet-type thermostat in the coolant outlet passage controls the flow of engine coolant to allow proper engine warm up and to regulate coolant temperatures. A wax pellet element in the thermostat expands when heated and contracts when cooled. The pellet is connected through a piston to a valve. When the pellet is heated, the valve opens. As the pellet cools, the contraction allows a spring to close the valve. The valve remains closed while the coolant is cold, preventing circulation of coolant through the radiator. When the engine warms and the thermostat valve opens, coolant flows through the radiator where heat is exchanged through the radiator into the surrounding air. This opening and closing of the thermostat permits enough coolant to enter the radiator to keep the engine within operating limits.

WATER PUMP

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

The pump inlet is connected to the bottom of the radiator by means of a rubber hose. From the pump, coolant passes through the engine front cover into the coolant passages in the block to absorb excess engine heat.

INSPECTION/MAINTENANCE RECOMMENDATIONS

CAUTION: Never spray water on a hot radiator. The resulting steam could cause personal injury.

NOTICE: ***Compressed air or water can be used to clean radiator fins. Do not exceed 138 kPa (20 psi). Pressures over 138 kPa (20 psi) will damage the radiator.***

Check the outside of the radiator for bent fins or signs of leakage.

Do not attempt to temporarily seal the cooling system with a sealer type antifreeze or coolant additive. Remove any stones from between the fins. Clean loose debris and road film from the radiator core with a quality grease solvent and compressed air. Direct the stream of solvent at the front of the core for more efficient cleaning.

Remove the grille, fan guard, and fan shroud, to ensure a thorough cleaning.

Remove the radiator cap and look for plugging and scale on the inside of the tank. Replace a badly plugged radiator. Test the radiator and system as described in this section.

1. Check the coolant level. If low, add recommended coolant as required.

NOTICE: ***When adding coolant, it is important that you use GM Goodwrench DEX-COOL ™ coolant. If coolant other than DEX-COOL is added to the system the engine coolant will require change sooner - at 50,000km (30,000 miles) or 24 months.***

2. Check the hose conditions and the clamps. Replace cracked or corroded clamps.
3. Check the coolant hoses for spongy or cracked appearance. Replace deteriorated hoses or bursting could occur that would result in coolant loss and extensive damage due to overheating.
4. Check the radiator core for leaks and for accumulation of dirt which may obstruct the air passages and reduce heat transfer.
5. Check the coolant recovery tank for leaks.
6. Inspect the radiator rubber mountings and bumpers for deterioration and replace as necessary. Check the mounting bolts, supports and braces. Also check for damage to the radiator core, side flanges, and supporting components.
7. Check for clearance between the fan blades, core, and shroud. Check the fan attaching bolts for tightness and make sure none are missing. Replace the fan if any blade is bent, broken, or cracked. The distance between the blades and shroud should be approximately equal around the entire perimeter of the shroud. Adjust as necessary.
8. Inspect the filler cap seal for evidence of cracking, separation, or deterioration. Replace as required.
9. To assist in maintaining efficient heat dissipation, an occasional external flushing with water will remove the majority of dirt accumulation and foreign matter from between the core fins. Direct water under moderate pressure from behind the core to force debris out in the opposite direction of its entry. Direct the water stream in line with the fins to reduce the possibility of bending fins.
10. A radiator with a dirty, obstructed, or leaking core will cause the engine to overheat. A scale deposit inside the radiator is a result of using hard, high mineral content water in the cooling system. The effect of heat on the minerals in the water causes the formation of scale, or hard coating, on metal surfaces within the radiator, thereby reducing the transfer of heat. Some hard water will produce a silt-like deposit that restricts the flow of water. Replace a radiator that is plugged or has a heavy scale in the core.

DIAGNOSIS

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 radiator cap while the engine is hot and the pressure is high will cause the solution to boil instantaneously and possibly with explosive force, spewing the solution over the engine, fenders, and person removing the cap. Under some conditions, the engine coolant is combustible.

Refer to the "Overheating Diagnosis" and "Coolant Loss Diagnosis" charts in this section for detailed cooling system diagnostic procedures.

TESTING PROCEDURES

Leak Testing

Some core leaks can be detected by adding water to the radiator. Clean the core so that the damaged area can be found.

1. Remove dirt and insects from the fins with a common water hose without a nozzle. Excessive water pressure could damage the fins.
2. Scrub the core with a soft-bristle brush using clean, hot water or hot water with a mild detergent.

NOTICE: ***Pressure above 138 kPa (20 psi) should not be used when pressure testing the cooling system. Pressures over 138 kPa (20 psi) will damage the radiator.***

On-Vehicle Pressure Testing

Pressure-test the aluminum-plastic radiator with J 24460-01 (Figure 5). With the system at a cool temperature, remove the radiator cap, connect the gage, and apply normal system operating pressure. Do not exceed 138 kPa (20 psi). Watch the gage needle for an indication of a leak, and examine the radiator and other cooling system parts for escaping coolant.

Repair hose and hose connections as required. Check the radiator cap to ensure that it will maintain the correct pressure.

If the radiator leaks during the pressure test, mark the leak area.

SYSTEM CHECKS

Exhaust Leaks

To check for exhaust leaking into the cooling system, drain the system until the coolant level stands just above the top of the cylinder heads, then disconnect the radiator upper hose and remove the thermostat and fan belt. Start the engine and accelerate several times. At the same time, note any appreciable coolant rise or the appearance of bubbles which may indicate that exhaust gases are leaking into the cooling system.

NOTICE: ***A worn head gasket may allow exhaust gases to leak into the cooling system. This can damage the cooling system as the gases combine with the water to form acids which are harmful to the radiator and engine.***

Water Pump

Check water pump operation by running the engine while squeezing the upper radiator hose. When the engine warms, a pressure surge should be felt. Check for a plugged vent hole in the pump.

Radiator

Test for restrictions in the radiator by warming the engine up and then turning the engine off and feeling the radiator. The radiator should be hot along the left side and warm along the right side, with an even temperature rise from right to left. Cold spots in the radiator indicate clogged sections.

DIAGNOSIS OF RADIATOR

PROBLEM	POSSIBLE CAUSE	CORRECTION
Engine Overheats	1. Cooling area obstructed. 2. Radiator fins plugged. 3. Leaking radiator. 4. Bent fins.	1. Remove or relocate the add on parts that may block air to the radiator. 2. Remove any debris (bugs, leaves, etc.) from the radiator fins. 3. Repair the leaks or replace the seals. 4. Repair or replace.
Radiator Loose	1. Loose screws. 2. Missing insulators.	1. Tighten the screws. 2. Replace the insulators.
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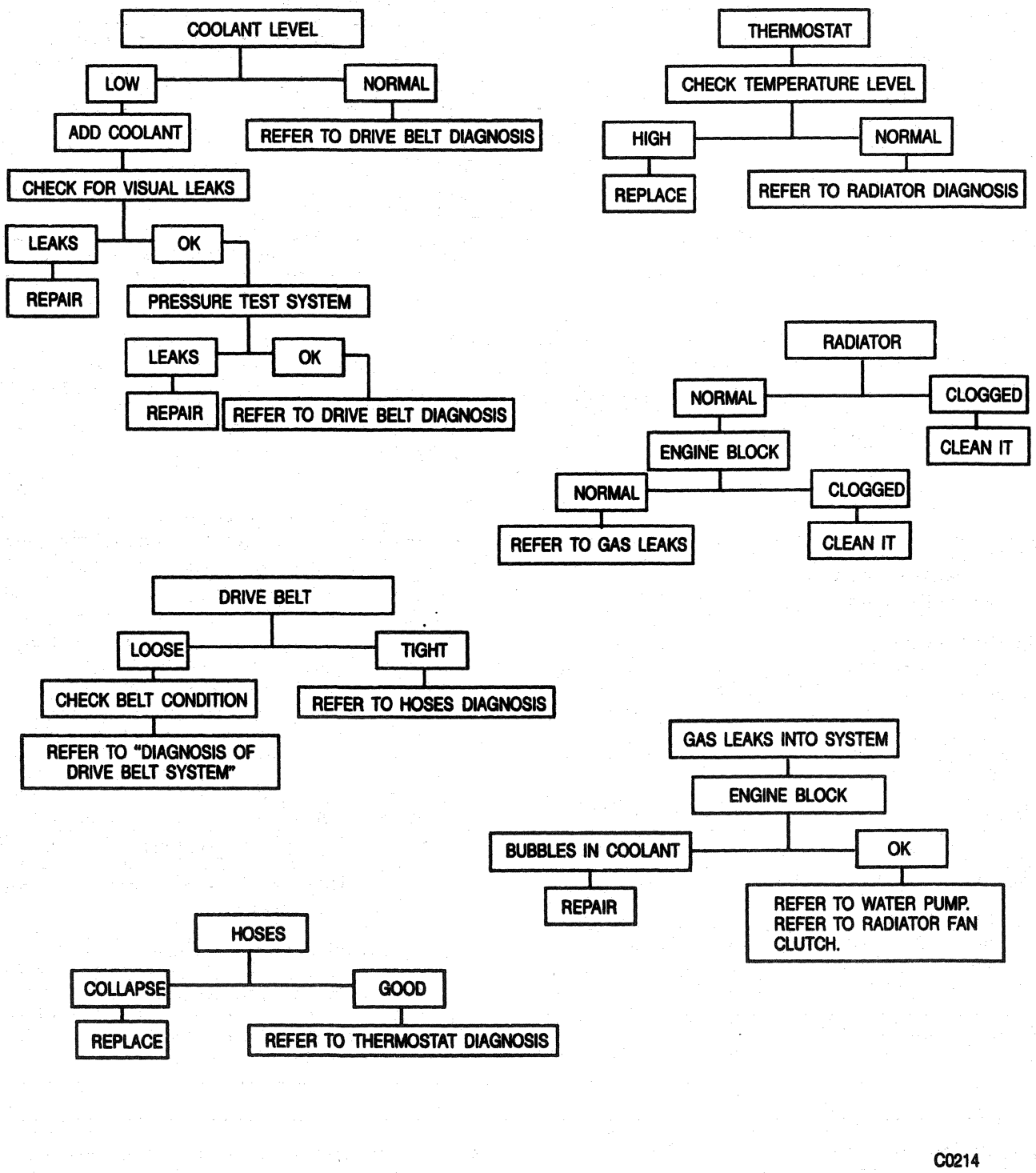
Overheat and/or Noise

Restrictions in the cooling system can cause engine overheating and/or cooling system noise. Components prone to this condition are the cylinder head, water pump, block, thermostat housing, and inlet manifold. Symptoms are:

- Engine may make snapping/cracking noises.
- Heater core may gurgle or surge.
- Radiator hoses may collapse and expand.

OVERHEATING DIAGNOSIS
(HOT LIGHT ON, HISSING, RUMBLE, STEAM, POWER LOSS)



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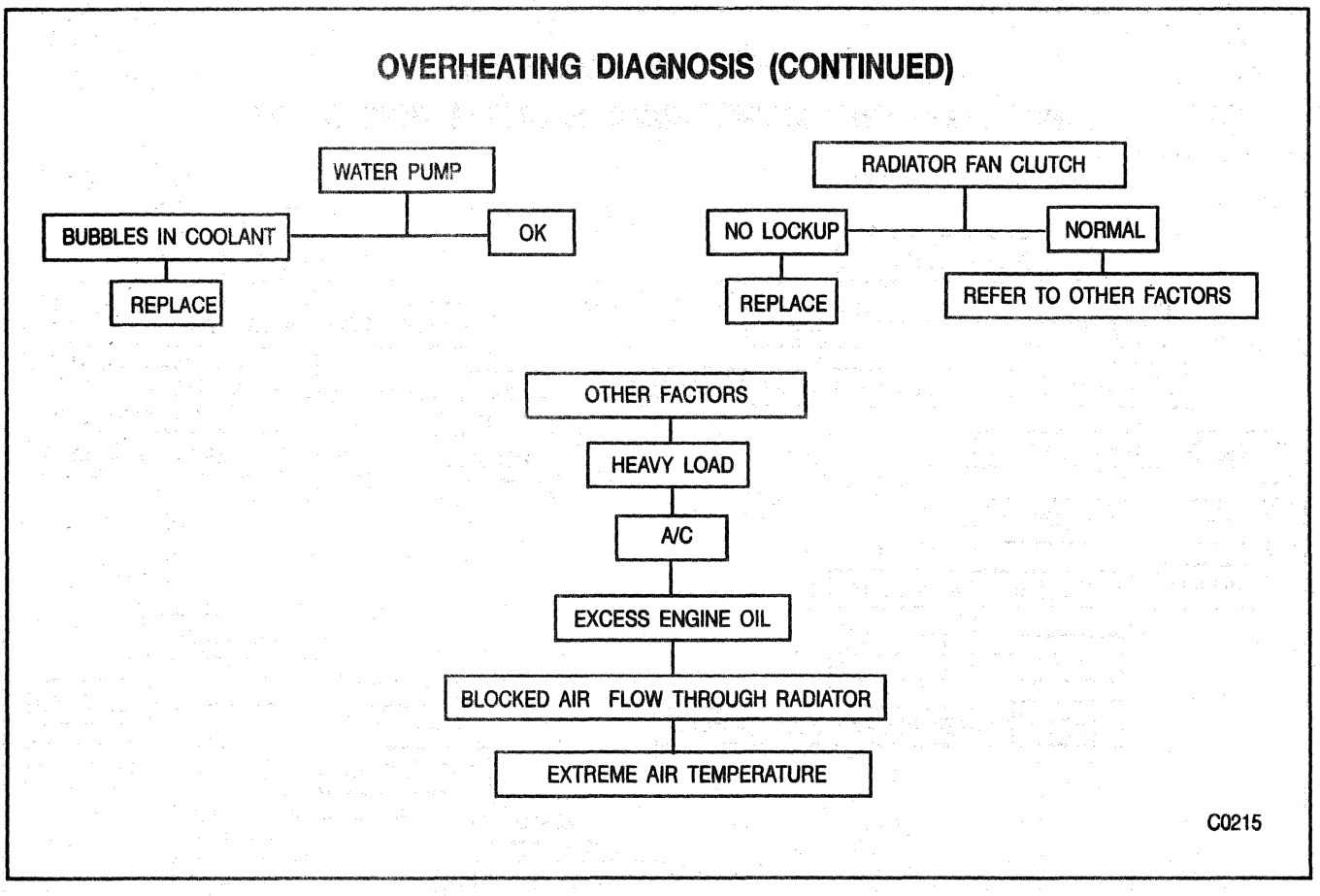


- Heater hoses may vibrate and thump.
- Overheat lamp may or may not come on.

Diagnosis/Inspection

1. Isolate the area by probing the engine with a sounding bar (large screwdriver).

CAUTION: The radiator cap should be removed from a cool engine only. If the radiator cap is removed from a hot cooling system, serious personal injury may result.

2. With the radiator cap removed, observe the coolant being circulated in the radiator. Feel the front area of the radiator for cold spots which indicate blockage. Blocked radiators generally occur on vehicles with higher mileage and not on newer vehicles.
3. Inspect the thermostat to see if it opens.
4. Inspect the thermostat housing to make sure it is free of obstructions.
5. Remove the water pump from the vehicle and remove the back cover on the pump. Inspect all internal passages using a flashlight.
6. Inspect the crossover at the front of the inlet manifold. This entire passage can be seen only with the thermostat removed.
7. Remove the cylinder heads and check the block with a pen light flashlight. Never replace a block unless the restricted area can be seen.
8. Inspect the cylinder heads if the problem is not found. Cylinder heads with blocked coolant passages generally have more than one area that is blocked. Look for signs of overheat discoloration (a dark blue or black area). If none are found, look in the coolant passages for blockage and probe all accessible passages. The cylinder head cooling passages are intricate, and all the passages may not be reached. Use a substantial wire to go through or around a partially blocked area. If nothing is found by visual inspection and probing, inspect the passages for a rough, ragged appearance. The roughest internal passages are probably the ones that are blocked. Replace a blocked or suspect cylinder head and inspect the replacement head before installation.

FAN BLADE CLUTCH

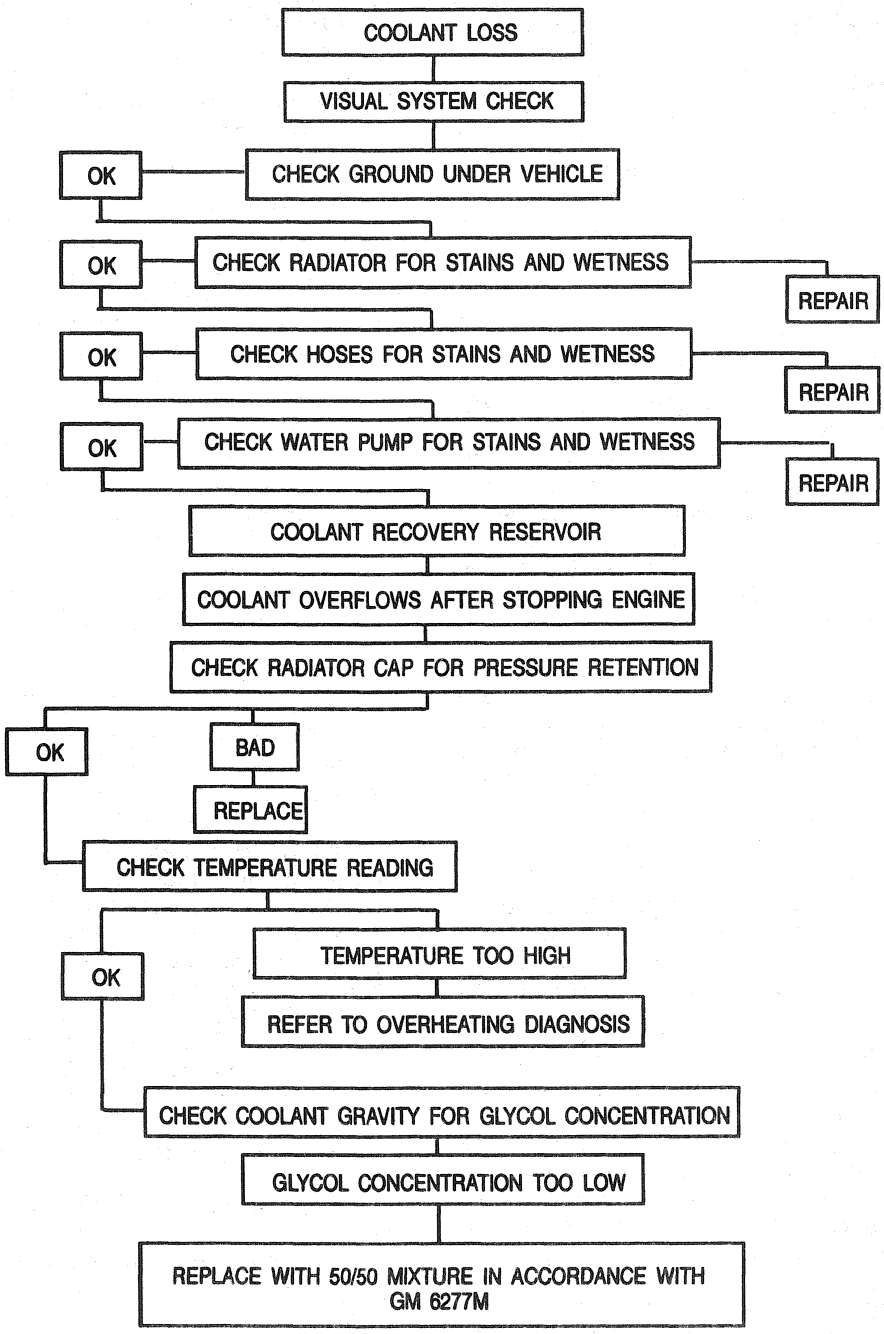
CAUTION: To help avoid personal injury or damage to the vehicle, a bent, cracked, or damaged fan blade should always be replaced.

Noise

Fan noise is sometimes evident under the following normal conditions.

- When the clutch is fully engaged for maximum cooling.
- During the first 15 seconds to one minute after start-up until the clutch can re-distribute the silicone

COOLANT LOSS DIAGNOSIS



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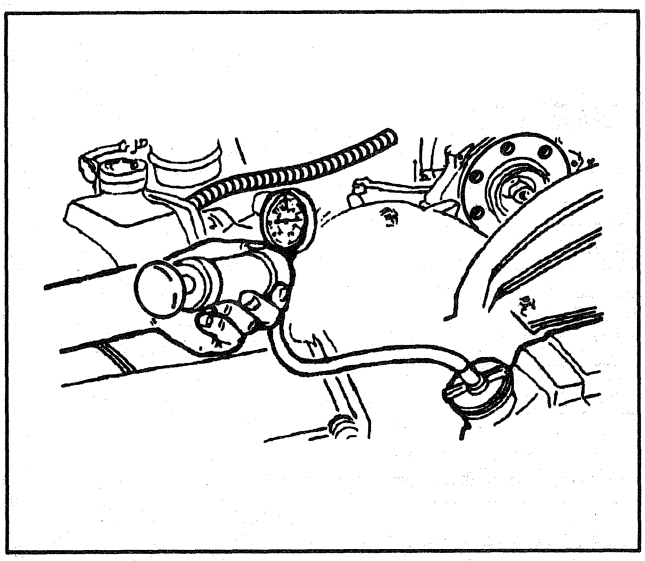


Figure 5—Pressure Testing

fluid back to its normal disengaged operating condition (after overnight settling).

Fan noise or an excessive roar will generally occur continuously under all high engine speed conditions (2500 RPM and up) if the clutch assembly is locked up due to an internal failure. If the fan cannot be rotated by hand or there is a rough grating feel as the fan is turned, replace the clutch. Refer to "Fan and Fan Blade Clutch Replacement" in this section.

Looseness

Check the fan assembly for wear and replace as necessary. Under various temperature conditions, there is a visible lateral movement at the tip of the fan blade. Approximately 6.5 mm (1/4 inch) maximum lateral movement measured at the fan tip is allowable. This is not cause for replacement of the clutch.

Silicone Fluid Leaks

The fan blade clutch operation is not affected by small fluid leaks which may occur in the area around the bearing assembly. If leakage appears excessive, replace the fan blade clutch. Refer to "Fan and Fan Blade Clutch Replacement" in this section.

Engine Overheating

A. Start with a cool engine to ensure complete fan blade clutch disengagement.
B. If the fan and clutch assembly free-wheels with no drag (revolves more than five times when spun by hand), replace the clutch. Refer to "Fan and Fan Blade Clutch Replacement" in this section. If the clutch performs properly with a slight drag, go to step C.
   - Testing a fan blade clutch by holding the small hub with one hand and rotating the aluminum housing in a clockwise/counterclockwise motion will cause the clutch to free-wheel, which is a normal condition when operated in this manner. This should not be considered a test by which replacement is determined.
C. Position a thermometer so it is located between the fan blades and the radiator. This can be achieved by inserting the thermometer sensor through one of the existing holes in the fan shroud or by placing it between the radiator and the shroud. On some models, it may be necessary to drill a 5 mm (3/16 inch) hole in the fan shroud to insert the thermometer.

NOTICE: ***Check for adequate clearance between fan blades and the thermometer sensor before starting engine, as damage could occur.***

D. With the thermometer in position, cover the radiator grille sufficiently to induce a high engine temperature, start the engine, turn air conditioning on, and operate at 2000 RPM.
E. Observe thermometer reading when the clutch engages. It will take approximately 5 to 10 minutes for the temperature to become high enough to allow engagement of 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 approximately 3°C to 10°C (5°F to 15°F).
   - If the clutch did not engage between 65°C to 90°C (150°F to 205°F) the unit should be replaced. Be sure the fan blade clutch was disengaged at the beginning of the test. Do not continue the test past a thermometer reading of 90°C (205°F) to prevent engine overheating.
F. As soon as the clutch engages, remove the radiator grille cover and turn the air conditioning off to assist in engine cooling. Run the engine at approximately 1500 RPM.
G. 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, it should be replaced.

THERMOSTAT

Perform an operational check of the thermostat by hanging the thermostat on a hook in a 33 percent glycol solution, -12° C (10° F) below the temperature indicated on the valve. With the valve submerged and the coolant agitated, the valve should close. Refer to the thermostat diagnosis chart for detailed thermostat diagnostic procedures (Figure 6).

COOLANT DIAGNOSIS

Hydrometer

Due to changes in commercially available antifreeze, the use of a hydrometer may give an incorrect reading. The hydrometer should be used to test ethylene glycol based antifreeze only. Ethylene glycol based antifreeze is recommended for year round use.

Coolant Tester

Coolant testers J 26568 (Centigrade Scale) and J 23688 (Fahrenheit Scale) can be used to check the antifreeze protection of the coolant. Make sure the hydrometer markings are correct. Unless J 26568 or J 23688 has a provision for temperature correction, test the temperature at which J 26568 or J 23688 is calibrated. If the coolant is warmer or cooler, the reading may be incorrect. Follow the manufacturer's directions for using J 26568 or J 23688.

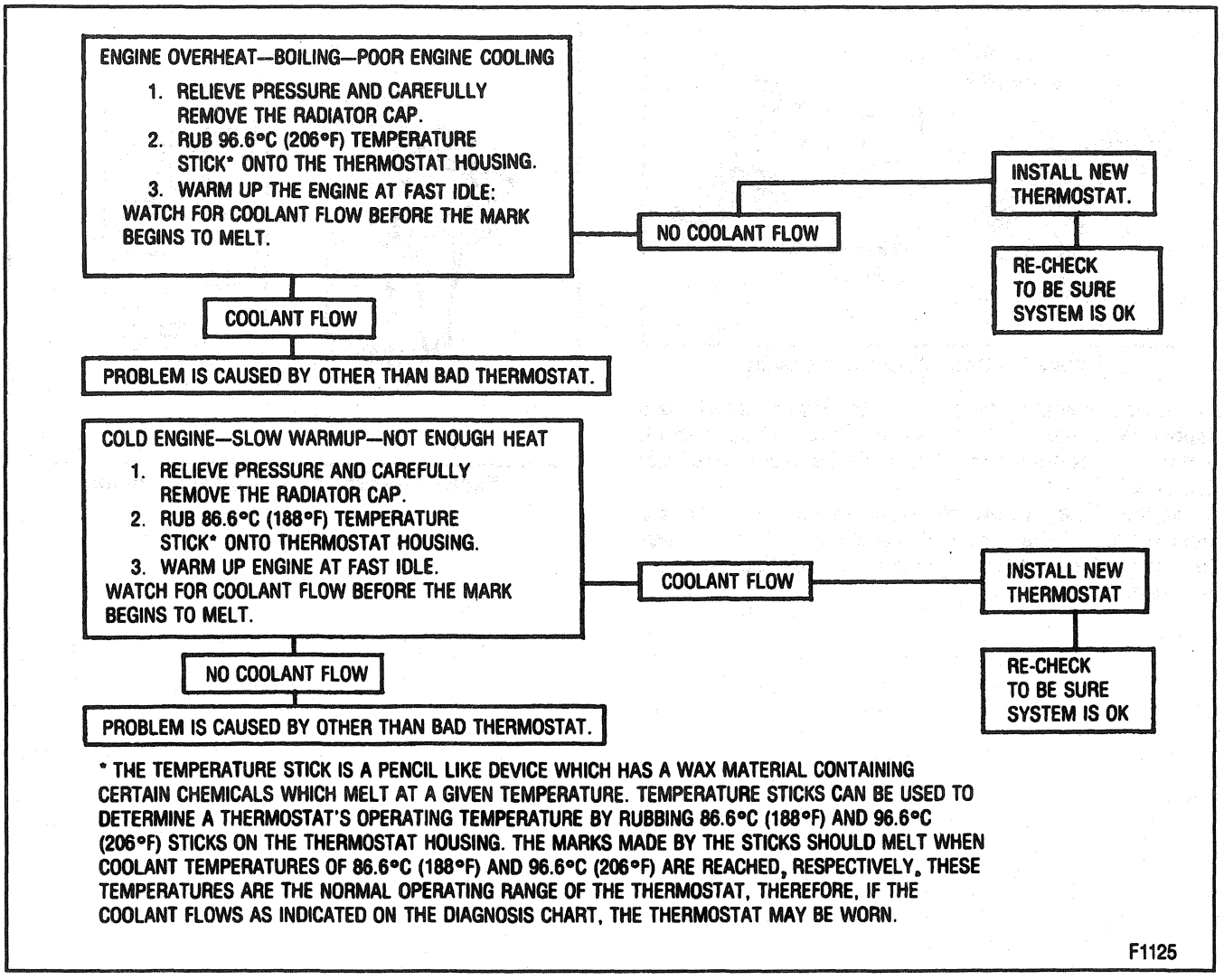


Figure 6—Thermostat Diagnosis

Clean

- Before each use, swing back the plastic cover at the slanted end of the tester, exposing the measuring window and the bottom of the plastic cover (Figure 7).
- Wipe dry with a tissue or a clean soft cloth.
- Close the plastic cover.

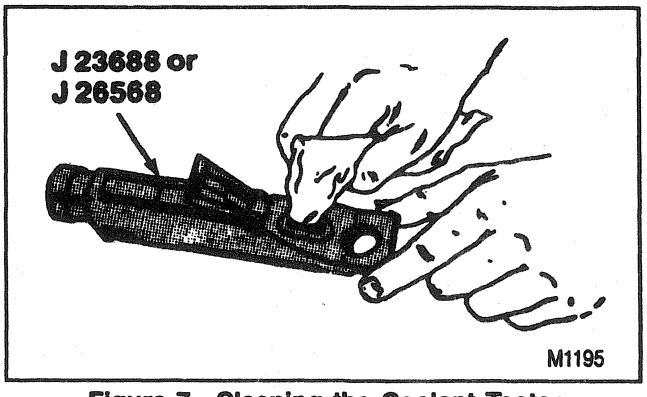


Figure 7—Cleaning the Coolant Tester

Testing

Do not remove the clear plastic pump from the tester. Release the tip of the pump from the tester housing and insert the tip into the radiator filler neck. Insert the tip below the level of the coolant (Figure 8).

Press and release the bulb to draw a sample. Bend the plastic tube around and insert the tip into the cover plate opening. Press the bulb and inject a few drops of coolant onto the measuring surface. Do not open the plastic cover when taking the readings because water evaporation can change the reading.

Reading

Point the tester toward any light source and look into the eyepiece (Figure 9).

The antifreeze protection reading is at the point where the dividing line between light and dark (edge of the shadow) crosses the scale: the antifreeze protection is the right scale, battery charge is on the left.

The tester temperature scale is reversed from a standard thermometer scale; below zero readings are on the

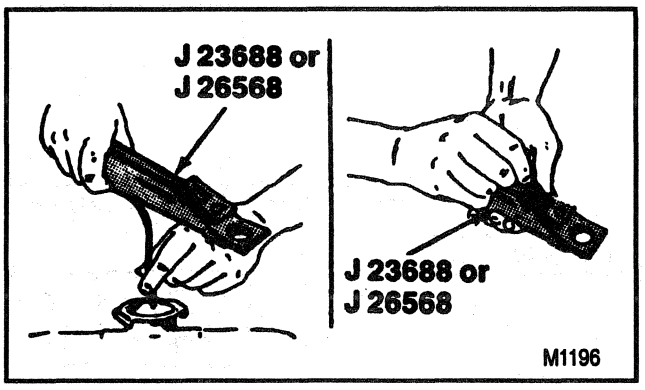


Figure 8—Collecting the Coolant

upper half of scale. Readings on the lower half of scale (above zero readings) indicate solutions without enough antifreeze concentration to provide adequate rust protection.

Tilt the tester toward the light source to obtain the best results. If the "edge of the shadow" is not sharp, the measuring surfaces were not clean or dry. Wipe dry and re-test.

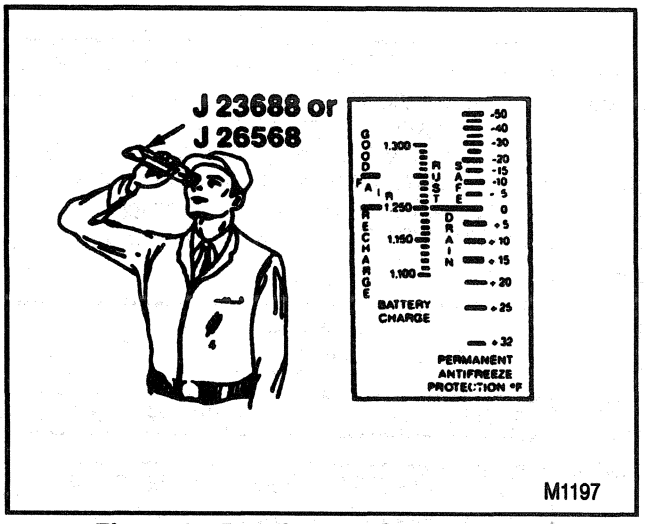


Figure 9—Reading the Coolant Tester

DIAGNOSIS of DRIVE BELT SYSTEM

Drive belts and pulleys wear evenly with use. Unusual signs of wear indicate some correction is needed. The following diagnostic chart will aid in diagnosing multiple ribbed belt system problems.

DEFINITIONS:

Chirping: A high pitched noise that is usually heard once per revolution of a pulley or belt. It is also usually heard at idle and is most common on cold damp mornings. By squirting water onto a chirping belt, the noise will momentarily go away.

Squeal: A loud screeching noise that is usually caused by a slipping belt. The noise usually occurs when a heavy load is applied to the belt, such as compressor engagement, accelerating the engine, or the belt slipping on seized pulley.

Whine: A high pitched continuous noise that may be caused by a failed bearing.

Faint Cyclic Rumbling: A deep low frequency noise (once per revolution of the belt).

Pilling: The random accumulation of rubber dust in the bottom of the multi-ribbed belt grooves. A small amount of pilling is normal. Operation of the drive belt system will not be affected unless buildup exceeds 1/3 of the belt groove depth.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Chirp	1. Misalignment of pulleys. A. Power steering pump pulley. B. Bent or cracked brackets. C. Loose or missing fasteners. 2. Bent pulley flange. 3. Severe pilling, exceeding 1/3 of belt groove depth.	1. Check the pulley alignment. A. Refer to SECTION 3B. B. Replace as necessary. C. Check and re-torque. Replace as necessary. 2. Replace as necessary. 3. Replace the belt.
Squeal	1. Seized bearings. 2. Insufficient tension. A. Incorrect belt length. B. Incorrect pulley size. C. Malfunctioning tensioner. D. Incorrect drive belt routing.	1. Replace as necessary. 2. Tighten as needed. A. Replace the belt. B. Replace the pulley. C. Replace the tensioner. D. Refer to "Drive Belt Routing" in this section.
Whine	1. Worn bearings.	1. Replace as necessary.
Faint Cyclic Rumbling	1. Severe pilling.	1. Replace the belt.
Belt Falls Off	1. Misalignment of pulleys. A. Bent or cracked brackets. B. Loose or missing fasteners. C. Misaligned power steering pump pulley. 2. Damaged belt. 3. Malfunctioning tensioner. 4. Worn idler or tensioner pulley bearings.	1. Check pulley alignment. A. Replace as necessary. B. Check and re-torque, replace as necessary. C. Refer to SECTION 3B. 2. Replace as necessary. 3. Replace as necessary. 4. Replace as necessary.
Vibration	1. Bent or cracked brackets. 2. Loose or missing fasteners. 3. Damaged fan blades. 4. Bent fan clutch or water pump shaft.	1. Replace as necessary. 2. Check and re-torque, replace as necessary. 3. Replace as necessary. 4. Replace as necessary.
Excessive Wear in Either Outside Groove of Drive Belt	1. Ribs in the drive belt do not match the grooves in the pulley.	1. Replace damaged belt as necessary. Refer to "Drive Belt Replacement" in this section.
		D0270

Check the drive belt for looseness, damage, or fabric delamination. If the belt is loose, check the belt tensioner for proper operation. The belt tensioner is not adjustable. If it is not working properly, it must be replaced. If the belt is delaminated or damaged, replace it.

Important

- Cracks across the rib material are a normal part of the belt aging process. Cracks do not affect belt operation, and do not indicate a need to replace it.

Check the belt length scale on the tensioner. If it reads outside the "acceptable" range, check for proper routing as shown on the belt routing label and in this section. Also check for proper tracking of belt ribs in the pulley grooves, correct pulley sizes (including idlers), and correct belt length.

Important

- Multiple rib belts stretch and wear very little. Normal stretch and wear rarely exceeds 10 mm (3/8 inch) on the belt length scale.

UNCOMMON COOLING SYSTEM PROBLEMS

Problems Not Requiring Disassembly of the Cooling System

1. Remove large obstructions blocking the radiator or condenser.
   - Auxiliary oil cooler.
   - License plates.
   - Spare tires.
   - Ice, mud, or snow obstructing the grille.
2. Engine oil is overfilled.
3. Incorrect radiator for the application.
   - Check the part number.
4. Loose, damaged, or missing air seals.
5. Missing or damaged lower air baffle.
6. Incorrect ignition timing.

Problems Requiring Disassembly of the Cooling System

1. Incorrect or damaged radiator fan.
2. Worn or damaged emission system components.
   - Could cause overheating at idle.
   - Damaged positive crankcase ventilation (PCV) valve, thermal vacuum valve (TVV), or engine coolant temperature (ECT)sensor.
3. Pressure check the cooling system with the pressure cap installed.
   - Shows if the pressure cap leaks because of radiator filler neck damage.
4. Worn or damaged water pump.
   - Impeller vanes eroded or broken.
   - Worn or damaged bearing and/or seal. Check for shaft or bearing play.
5. Plugged radiator tubes.
   - Perform a flow check.
6. Internal system leaks.
   - Cylinder head gasket.
   - Cracked block.
   - Timing chain cover.
   - Intake manifold gasket.
7. Plugged coolant passages in the cylinder heads.
   - Visual check.

ON-VEHICLE SERVICE

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 radiator cap while the engine is hot and the pressure is high will cause the solution to boil instantaneously and possibly with explosive force, spewing the solution over the engine, fenders, and person removing the cap. Under some conditions, the engine coolant is combustible.

NOTICE: ***When adding coolant, it is important that you use GM Goodwrench DEX-COOL™ coolant. If coolant other than DEX-COOL is added to the system the engine coolant will require change sooner - at 50,000km (30,000 miles) or 24 months.***

DRAINING AND REFILLING THE COOLING SYSTEM

Draining the Cooling System:

1. Place a drain pan under the radiator drain cock.
2. Install a tube on the drain cock.
3. Place the end of the tube in the drain pan.

CAUTION: The radiator cap should be removed from a cool engine only. If the radiator cap is removed from a hot cooling system, serious personal injury may result.

4. Make sure the cooling system is cool. Then remove the radiator cap.
5. Open the drain cock completely.
6. Let the cooling system drain until the flow stops.

7. Place a drain pan under the engine.
8. Remove the drain plug from the engine block.
9. Let the engine block drain until the flow stops. There may be some more drainage from the radiator at this time.
10. Replace the engine block drain plug.
11. Close the radiator drain cock.

Refilling the Cooling System:

NOTICE: ***Two sealant pellets GMSPO P/N 3634621 must be added to the radiator whenever the coolant system is drained and refilled with fresh coolant. Failure to use the correct sealant pellets may result in premature water pump leakage. Do not add the pellets to the coolant recovery bottle since this may prevent the coolant system from operating properly.***

1. Check the radiator drain cock to be sure that it is closed.
2. Check the engine drain plug to be sure that it is tight.
3. Premix the antifreeze with clear water (distilled water preferred) in a 50/50 ratio.
   - If the old coolant is being used, check it for 50/50 glycol/water mix and make sure that it is clean and clear.
4. Place a large top funnel in the radiator fill hole.
5. Slowly pour in the coolant. Refer to "Specifications" in this section for the cooling system capacity. The filling may be slowed because of the thermostat being closed.
6. After the cooling system is filled to 13 mm (1/2 inch) below the fill hole, 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 until the level is up to the fill hole.
7. Replace the radiator cap.
8. Check the coolant level in the recovery reservoir. Add coolant if needed.

FLUSHING THE COOLING SYSTEM

Various methods and equipment can be used to flush the cooling system. If special equipment such as a back flusher is used, follow the equipment manufacturer's instructions.

NOTICE: ***If the engine is damaged internally and a new engine assembly is installed in the vehicle, make sure all foreign material is completely flushed out of the cooling system. The oil cooler system should also be flushed out (if equipped). Failure to rid the oil or cooling system of debris can result in damage to the replacement engine.***

Important

- Remove the thermostat before flushing the cooling system.

SCALE REMOVAL

To remove the hardened scale, a direct chemical action is necessary. A flushing compound at the specified rate of 30 grams per liter (4 oz. per gallon) of radiator capacity, should be added to the coolant water in the form of a dissolved solution while the engine is running. Operate the engine for 15 minutes, then drain and flush the system with clean water.

There are various types of flushing compounds commercially available, but they should be obtained from a reliable source. Most compounds attack metals and should not remain in the engine for more than a few minutes. Use a neutralizer in the cooling system immediately after a descaling solvent is used.

For extremely hard, stubborn coatings, such as lime scale, use a stronger solution. The corrosive action of a stronger solution will affect the thin metals of the radiator, thereby reducing its operating life. A complete flushing and rinsing is mandatory.

After the solvent and neutralizer have been used and the cooling system is flushed, drain the entire system and fill it with clean, soft water plus a rust inhibitor or high boiling type antifreeze. After filling the cooling system, check for radiator, hose and engine coolant leaks.

DRAIN COCK REPLACEMENT

CAUTION: To help avoid the danger of being burned, do not remove the radiator cap or diesel surge tank cap while the engine and radiator are still hot. Scalding fluid and steam can be blown out under pressure if the cap is taken off too soon. Remove the radiator cap before draining the coolant, so the coolant is not forced out under pressure.

Remove or Disconnect (Figure 10)

1. Drain cooling system. Refer to "Draining and Refilling the Cooling System" in this section.
2. Drain cock stem.
   - Seal will usually come out attached to stem.
3. Drain cock body.
   - Squeeze sides of body with fingers or needle-nose pliers to disengage body locking tangs from side tank.

Install or Connect (Figure 10)

1. Drain cock body.
   - Make sure body is fully seated in side tank and that locking tangs are engaged.
2. Seal to stem.
3. Stem into body. Turn to lock in place.
4. Fill cooling system.
   - Start engine and check for leaks.

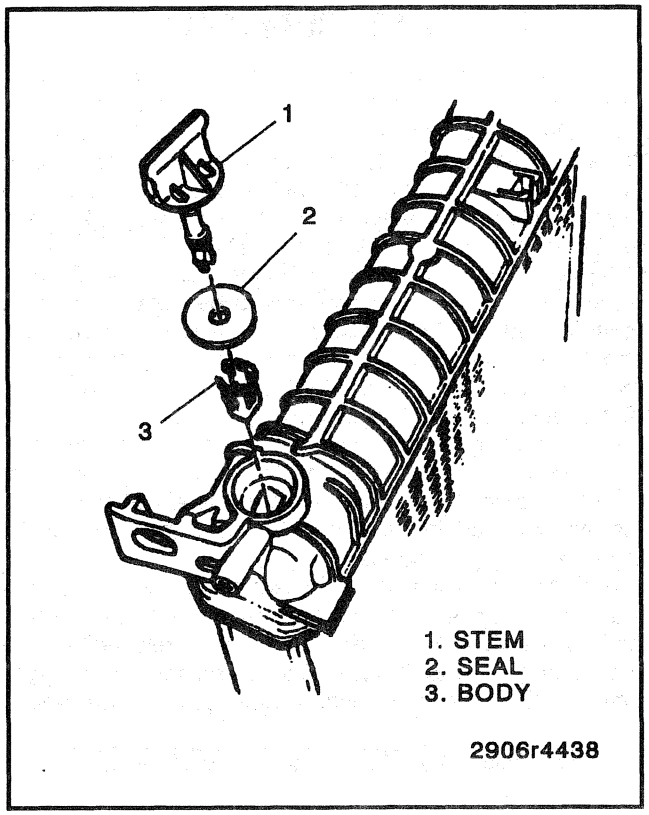


Figure 10—Radiator Drain Cock

FAN SHROUD REPLACEMENT

Upper Fan Shroud

Remove or Disconnect (Figures 11 and 12)

1. Upper radiator hose from the radiator. Refer to "Radiator Hose Replacement" in this section.
2. Negative battery cable (dual batteries only). Refer to SECTION 6D1.
3. Upper fan shroud bolts and upper shroud.

Inspect

- Upper fan shroud for signs of damage. Replace if necessary.

Install or Connect (Figures 11 and 12)

1. Upper fan shroud and upper fan shroud bolts.

Tighten

- Bolts (4) to 9 N·m (71 lb in).

2. Upper radiator hose to the radiator.
3. Negative battery cable (dual batteries only).

Lower Fan Shroud

Remove or Disconnect (Figures 11 and 12)

1. Upper fan shroud. Refer to "Fan Shroud Replacement" in this section.
   - Raise the vehicle.
2. Front differential carrier shield (if equipped). Refer to SECTION 4C.
3. Lower fan shroud bolts and lower fan shroud.

Inspect

- Lower fan shroud for signs of damage. Replace if necessary.

Install or Connect (Figures 11 and 12)

1. Lower fan shroud and lower fan shroud bolts.

Tighten

- Bolts to 9 N·m (71 lb in).

2. Front differential carrier shield (if equipped).
   - Lower the vehicle.
3. Upper fan shroud.

RADIATOR REPLACEMENT

Remove or Disconnect (Figures 11 through 13)

1. Drain cooling system. Refer to "Draining and Refilling the Cooling System" in this section.
2. Upper fan shroud. Refer to "Fan Shroud Replacement" in this section.
3. Upper insulators and brackets.
4. Upper and lower radiator hoses. Refer to "Radiator Hose Replacement" in this section.
5. Transmission fluid cooler pipes.
6. Engine oil cooler pipes.
7. Lower fan shroud bolts and lower fan shroud. Refer to "Fan Shroud Replacement" in this section.
8. Coolant recovery reservoir hose.
9. Radiator from the lower insulators and brackets.

Inspect

- All parts and connections for leaks and wear. Replace if necessary.

Install or Connect (Figures 11 through 13)

1. Radiator on the lower insulators.
2. Coolant recovery reservoir hose.
3. Lower fan shroud bolts and lower fan shroud.

Tighten

- Bolts to 9 N·m (71 lb in).

4. Engine oil cooler pipes.

Tighten

- Fittings to 24 N·m (18 lb ft).

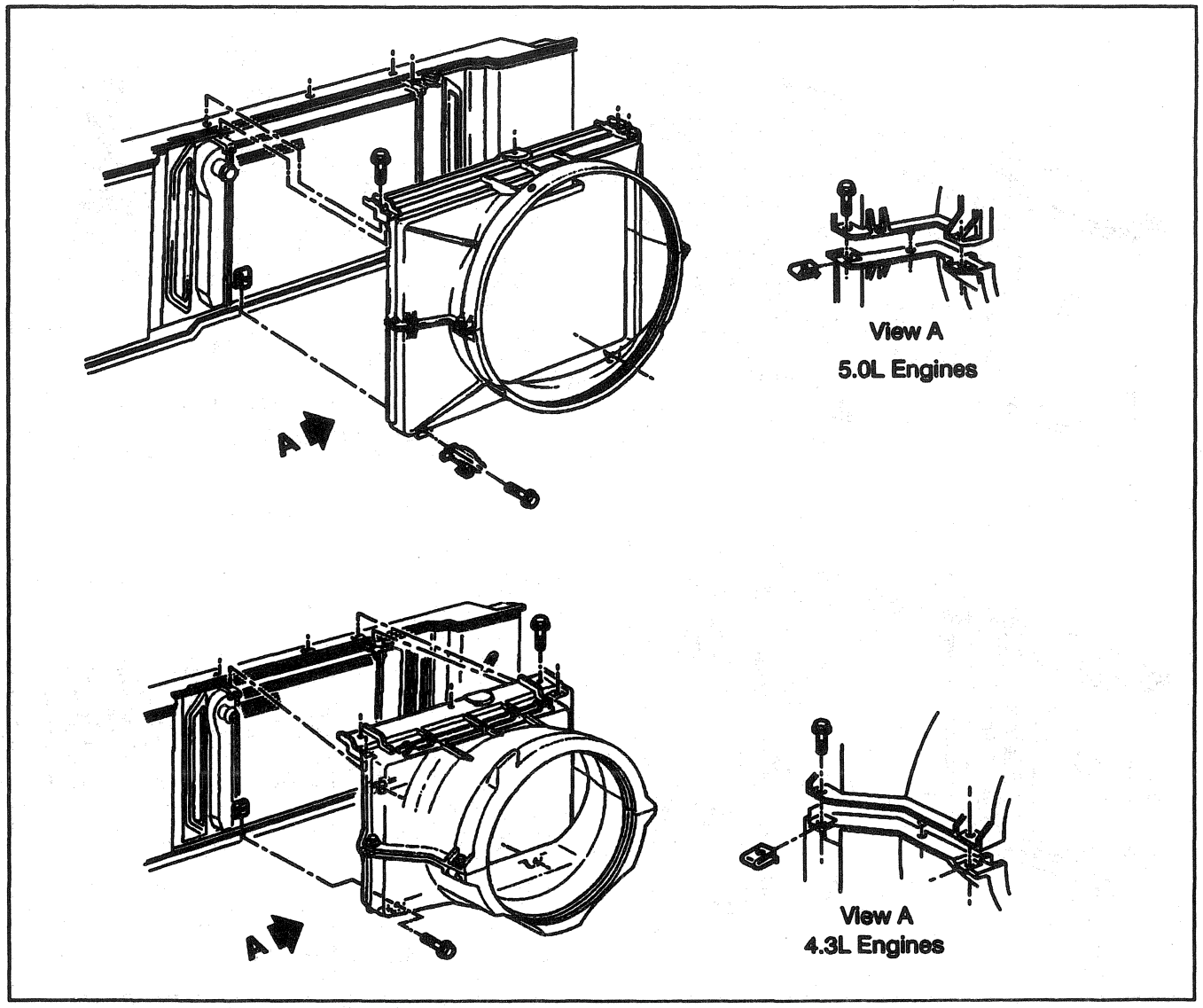


Figure 11—Fan Shroud and Components (4.3L and 5.0L Engines)

5. Transmission fluid cooler pipes.

Tighten

- Fittings to 26 N·m (19 lb ft).

6. Upper and lower radiator hoses.
7. Upper insulators.
8. Upper fan shroud and upper fan shroud bolts.

Tighten

- Bolts to 9 N·m (71 lb in).

9. Fill cooling system.
   - Leak test.

COOLANT RECOVERY RESERVOIR/SURGE TANK REPLACEMENT

Remove or Disconnect (Figures 14 and 15)

1. Coolant from the reservoir or tank.
2. Clamps.
3. Coolant recovery hose from the reservoir or tank.
4. Overflow hose.
5. Bolts.
6. Reservoir or tank from vehicle.

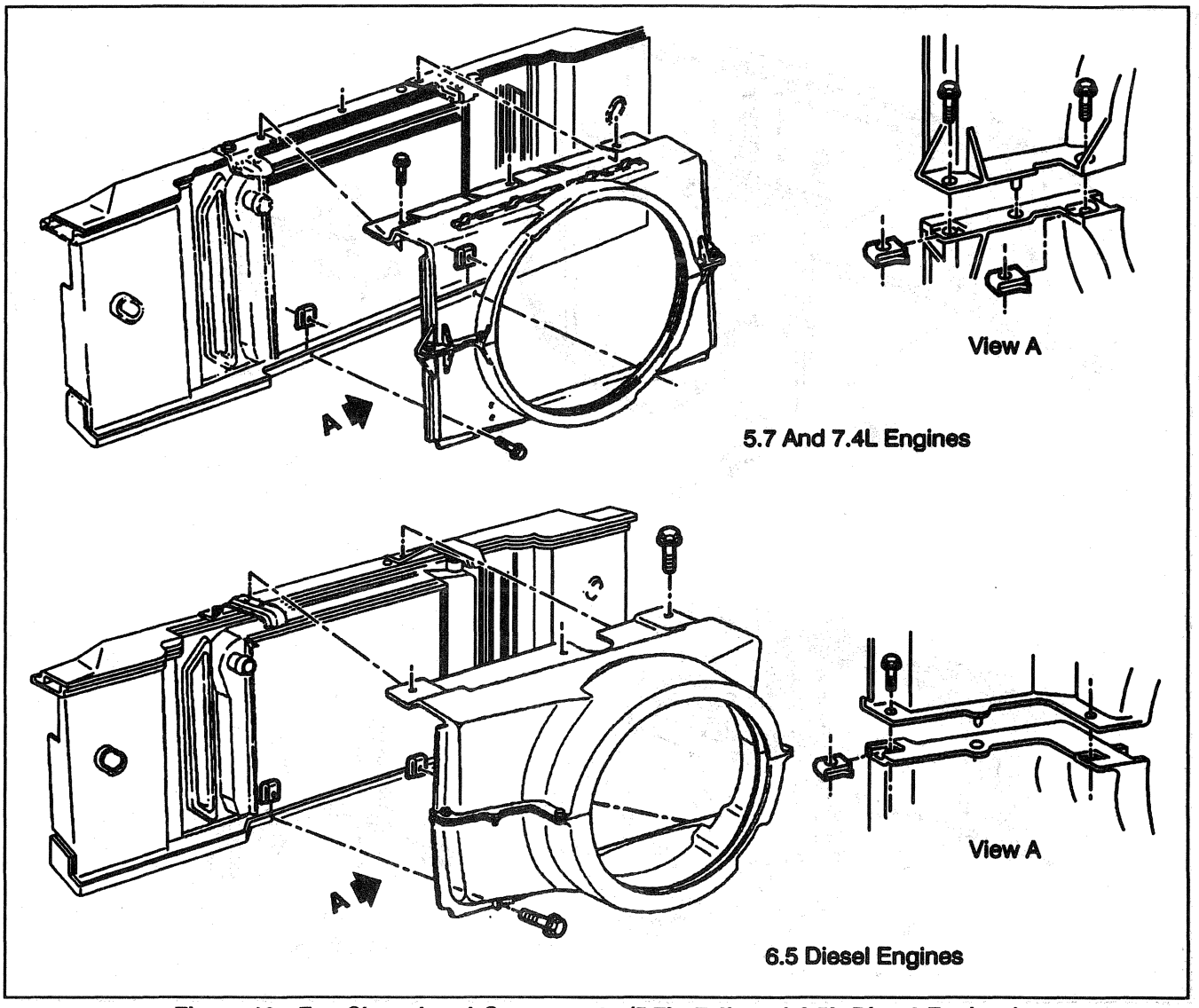


Figure 12—Fan Shroud and Components (5.7L, 7.4L and 6.5L Diesel Engines)

Install or Connect (Figures 14 and 15)

1. Reservoir or tank to vehicle.
2. Bolts.

Tighten

- Bolts to 10 N·m (89 lb in).

3. Coolant overflow hose to reservoir or tank.
4. Coolant recovery hose to reservoir or tank.
5. Clamps.
6. Coolant in reservoir tank.

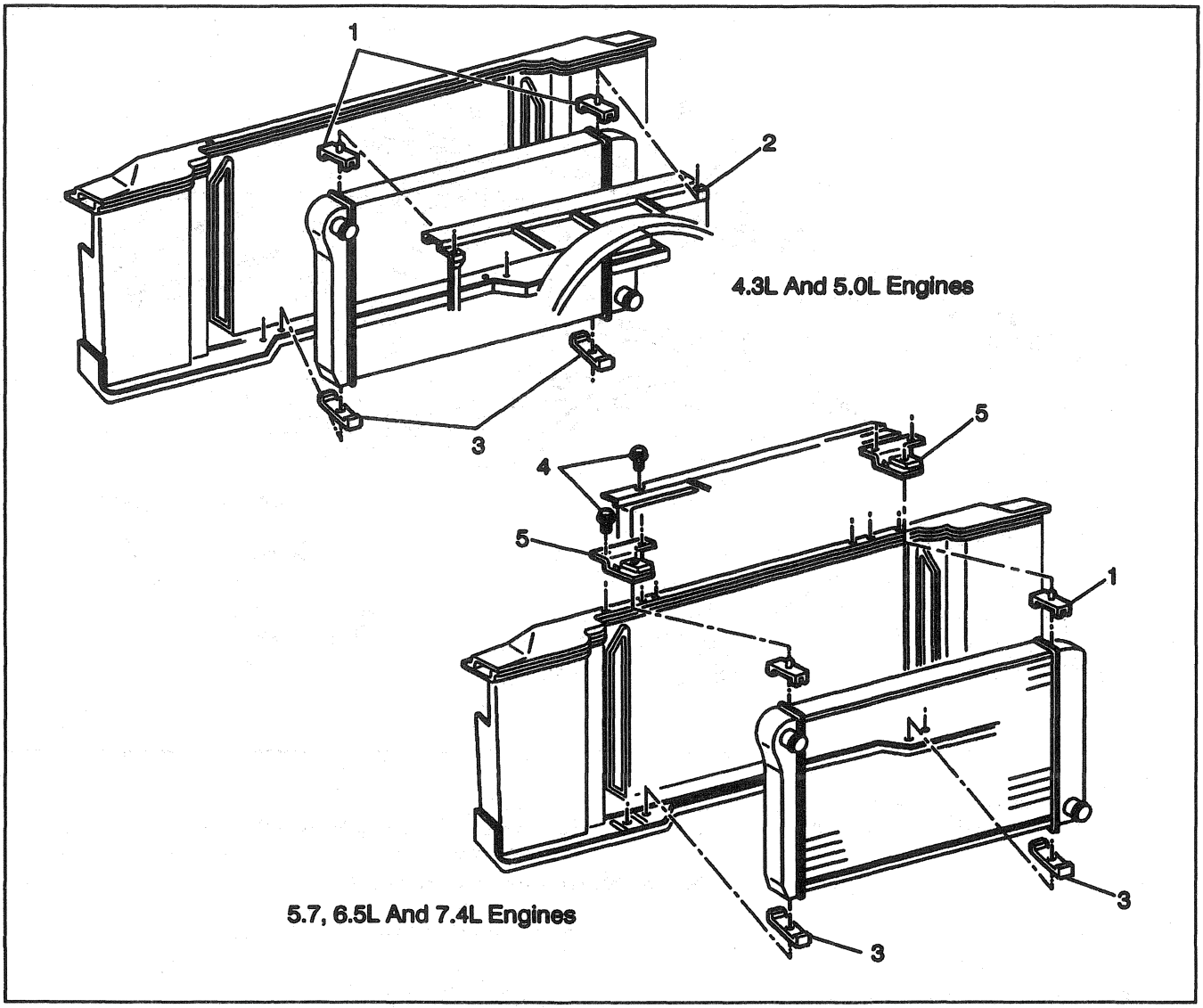


Figure 13—Radiator Mounting Components

RADIATOR HOSE REPLACEMENT

Most C/K-Models use a spring-type clamp at the radiator hose connections. When this type of clamp is used, the radiator hoses should be installed on dry, non-painted surfaces to ensure proper sealing.

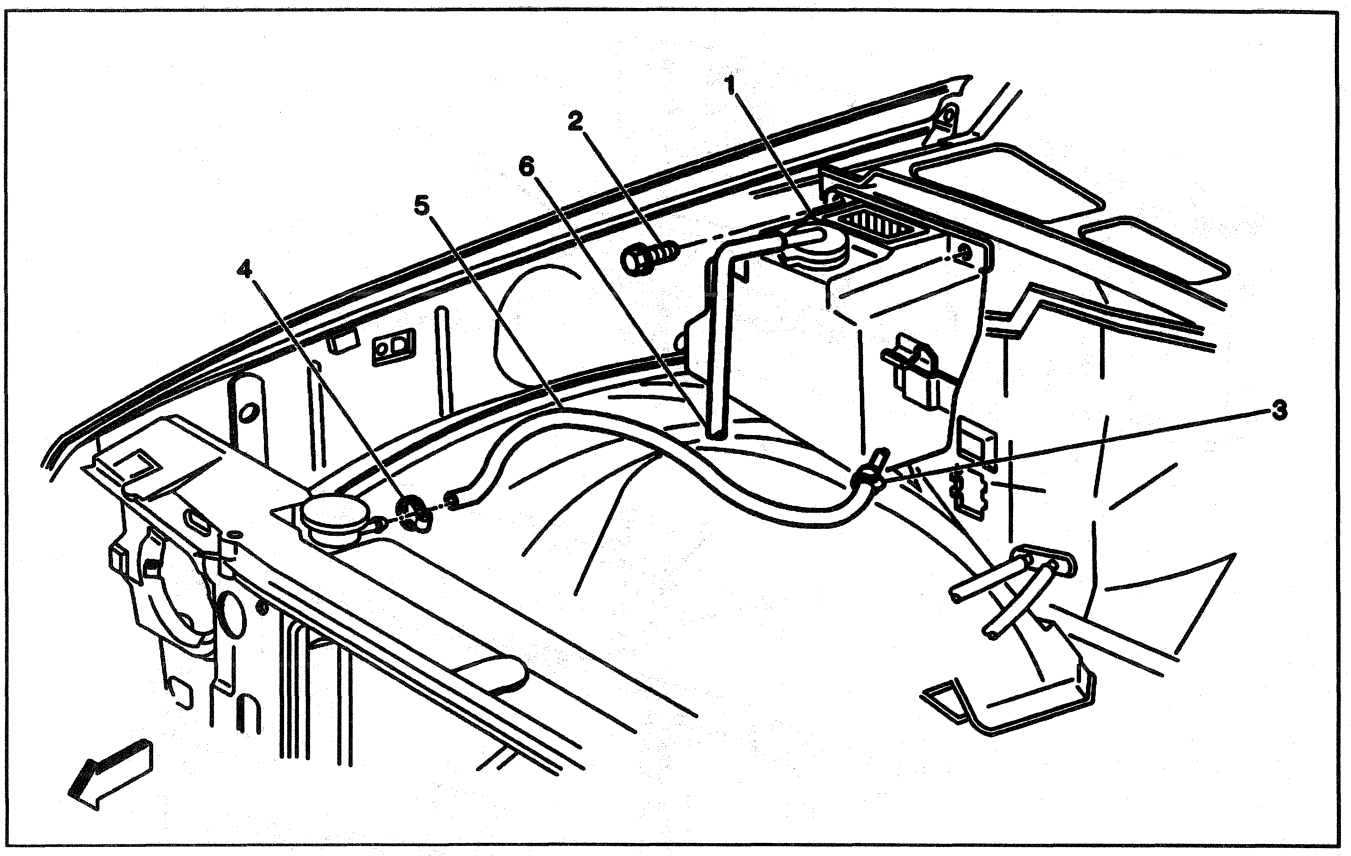
4.3L and 5.0L Engines

Remove or Disconnect (Figures 16 and 17)

1. Drain cooling system. Refer to "Draining and Refilling the Cooling System" in this section.
2. Clamps from the inlet and outlet radiator hoses.
3. Radiator inlet hose.
4. Radiator outlet hose.

Install or Connect (Figures 16 and 17)

1. Radiator outlet hose.
2. Radiator inlet hose.
3. Clamps to the inlet and outlet radiator hoses.
4. Fill cooling system.
   - Check for leaks.



Legend

(1) Coolant Recovery Reservoir
(2) Coolant Recovery Reservoir Bolt
(3) Clamp
(4) Clamp
(5) Coolant Recovery Reservoir Hose
(6) Overflow Hose

Figure 14 - Coolant Recovery Reservoir (Gasoline)

5.7L Engine

Remove or Disconnect (Figure 16)

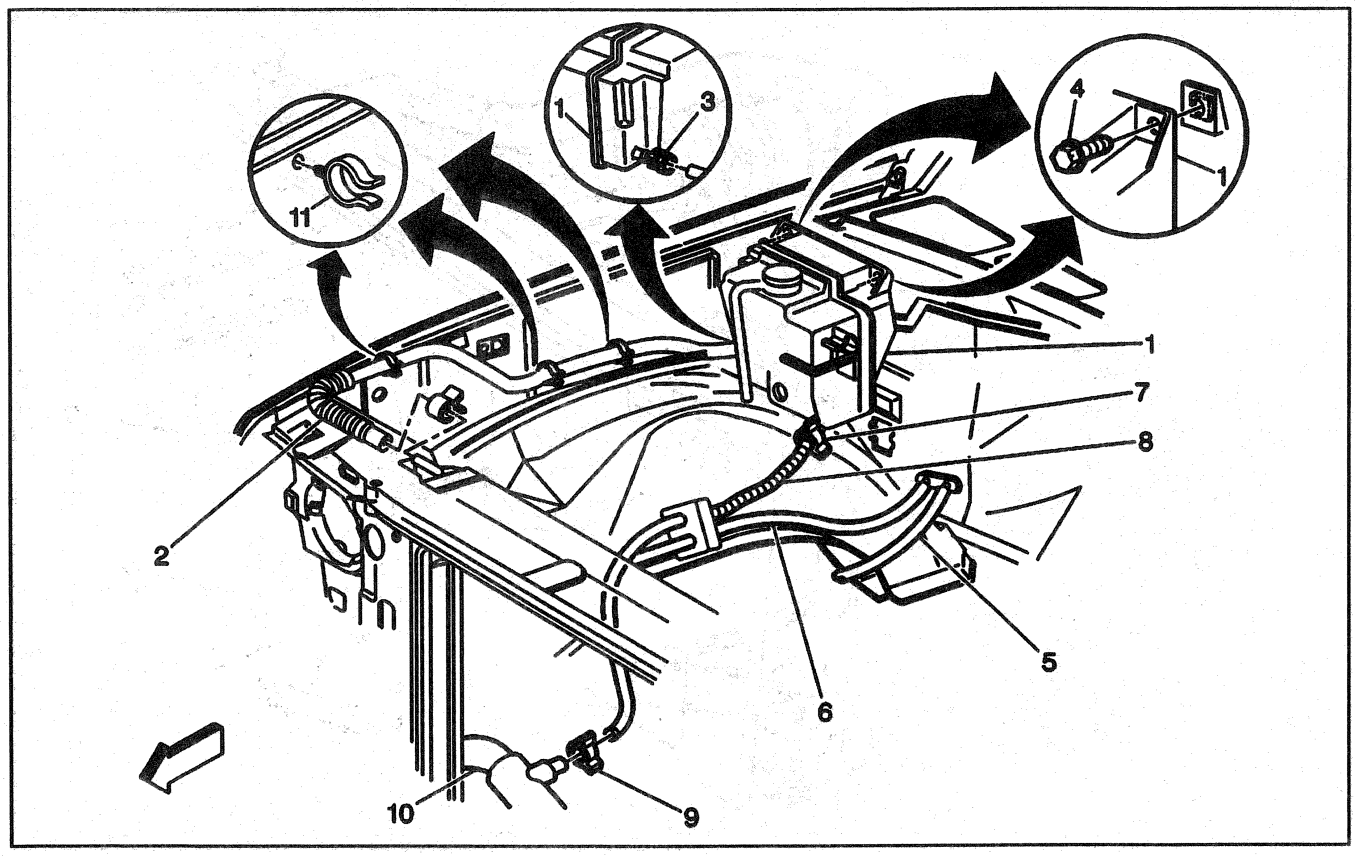
1. Drain cooling system. Refer to "Draining and Refilling the Cooling System" in this section.
2. Bolt from the hose support.
3. Hose support.
4. Hose clamps from the inlet and outlet hoses.
5. Radiator inlet hose.
6. Radiator outlet hose.

Install or Connect (Figure 16)

1. Radiator outlet hose.
2. Radiator inlet hose.
3. Clamps to the radiator inlet and outlet hoses.
4. Hose support to inlet hose.
5. Bolt.

Tighten

- Bolt to 15 N.m (11 lb ft).



Legend

(1) Surge Tank
(2) Hose
(3) Clamp
(4) Bolt
(5) Heater Hose
(6) Heater Hose
(7) Clamp
(8) Surge Tank Hose/Shield
(9) Clamp
(10) Lower Radiator Hose
(11) Clip

Figure 15 - Coolant Surge Tank (Diesel)

6. Fill cooling system.
   - Check for leaks.

7.4L Engine

Remove or Disconnect (Figure 18)

1. Drain cooling system. Refer to "Draining and Refilling the Cooling System" in this section.
2. Bolt from the hose support.
3. Hose support.
4. Hose clamps from the inlet and outlet hoses.
5. Radiator inlet hose.
6. Radiator outlet hose.

Install or Connect (Figure 18)

1. Radiator outlet hose.
2. Radiator inlet hose.
3. Clamps to the radiator inlet and outlet hoses.
4. Hose support to inlet hose.
5. Bolt.

Tighten

- Bolt to 15 N·m (11 lb ft).

6. Fill cooling system.
   - Check for leaks.

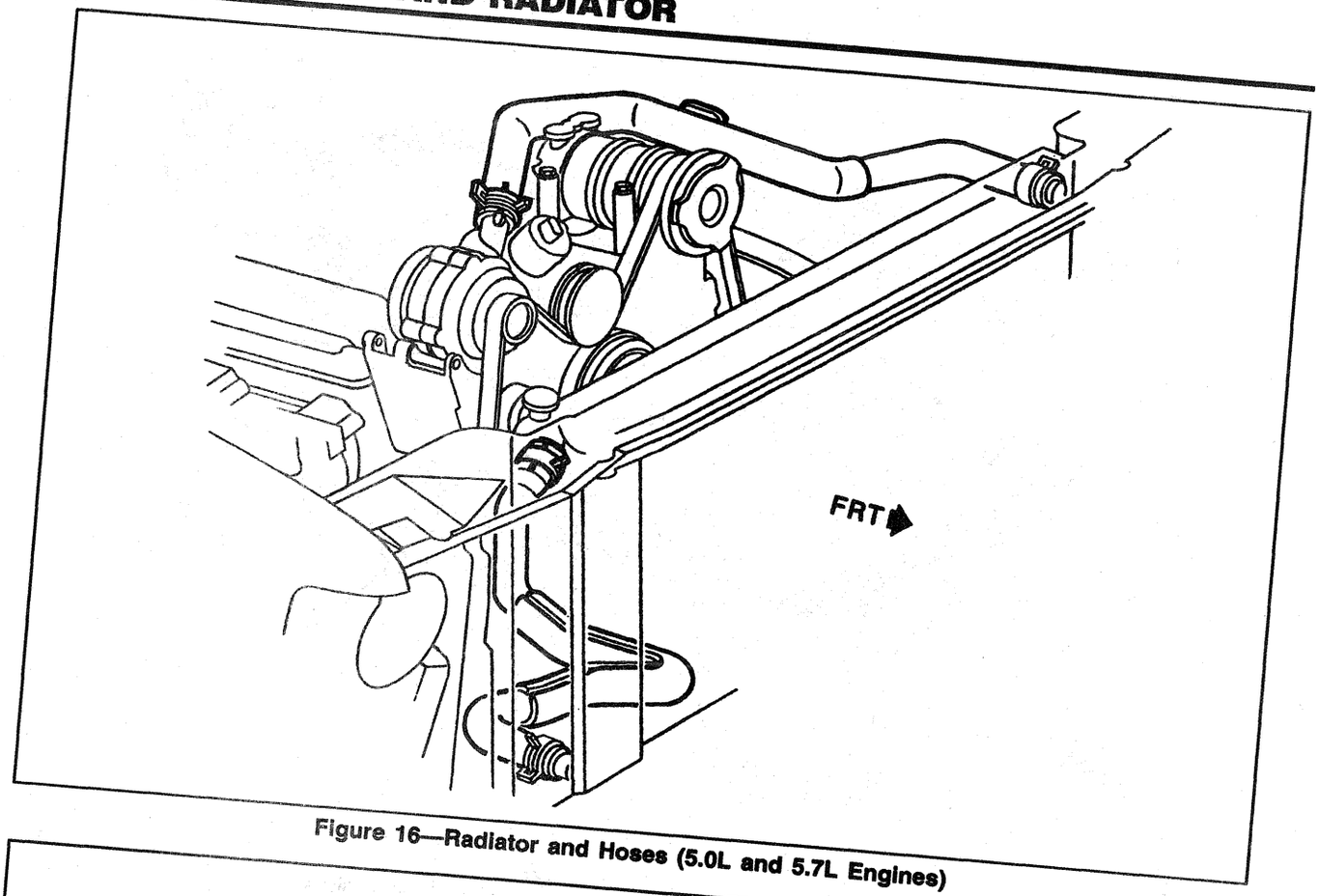


Figure 16—Radiator and Hoses (5.0L and 5.7L Engines)

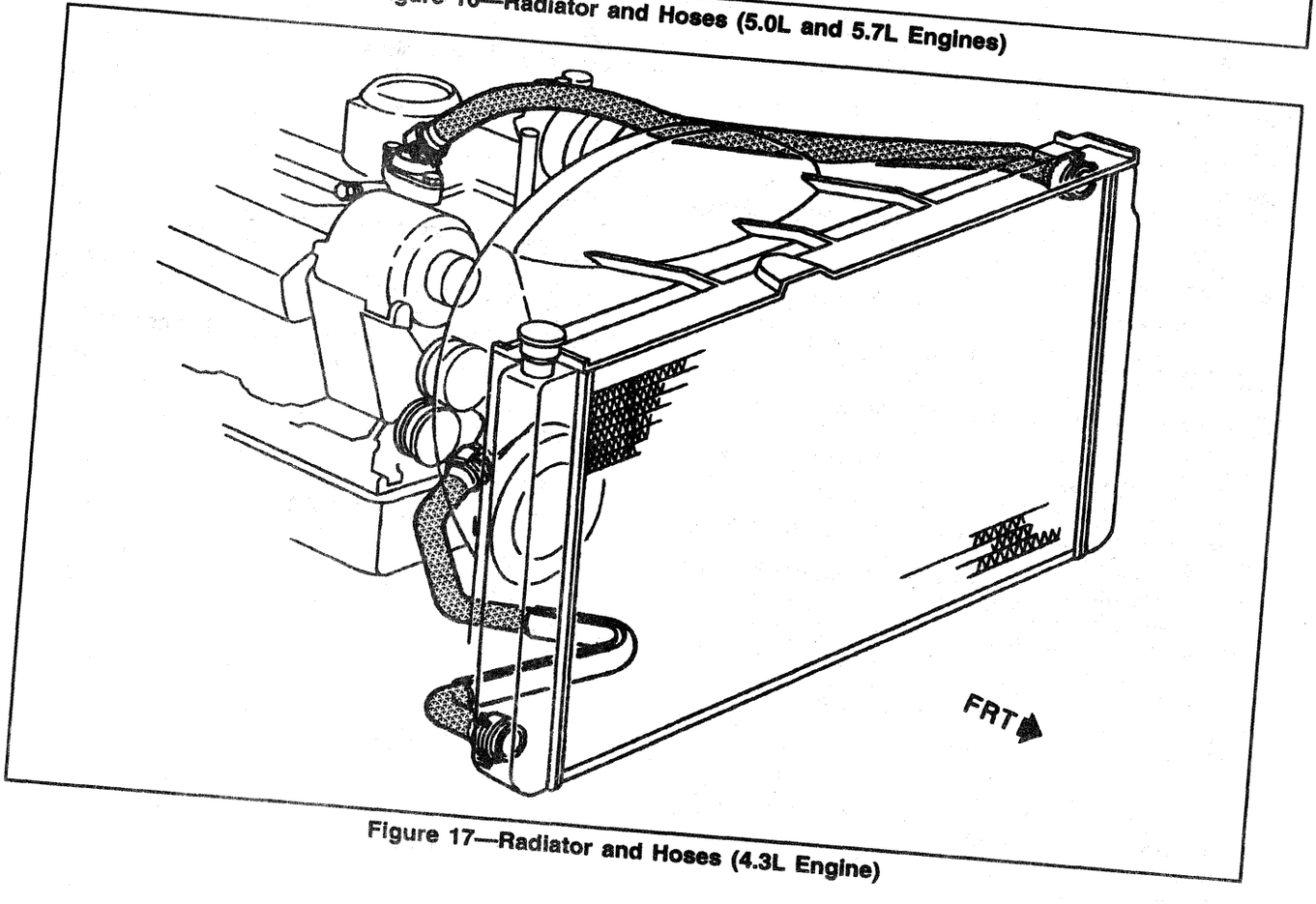


Figure 17—Radiator and Hoses (4.3L Engine)

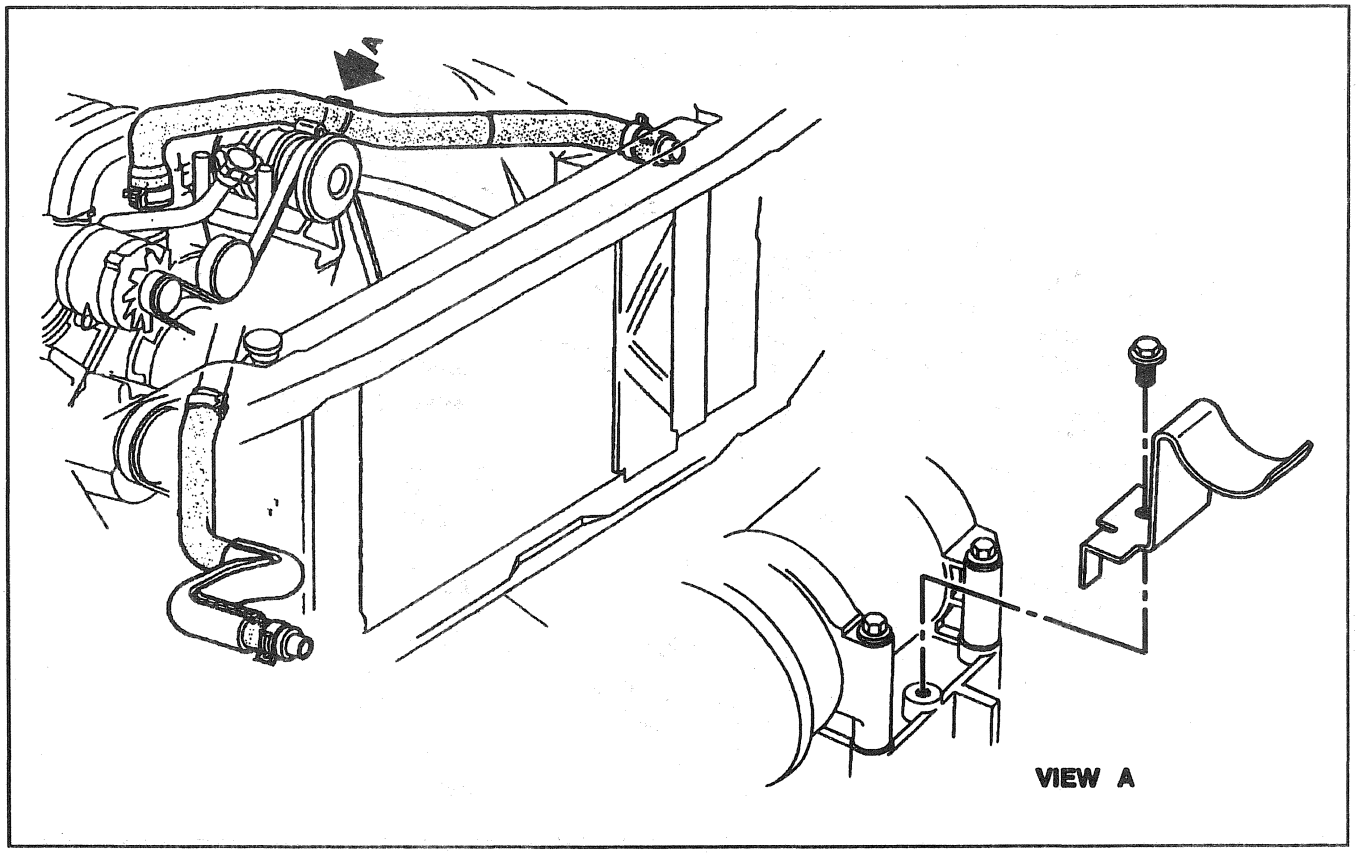


Figure 18—Radiator and Hoses (7.4L Engine)

Diesel Engines

Remove or Disconnect (Figure 19)

1. Drain the cooling system. Refer to "Draining and Refilling the Cooling System" in this section.
2. Clamps.
3. Radiator inlet hose.
4. Radiator outlet hose.

Install or Connect (Figure 19)

1. Radiator outlet hose.
2. Radiator inlet hose.
3. Clamps.
4. Fill cooling system.
   - Check for leaks.

RADIATOR FAN and FAN BLADE CLUTCH REPLACEMENT

4.3L, 5.0L and 5.7L Engines

Tools Required:
J 41240 Fan Clutch Wrench

Remove or Disconnect (Figure 20)

CAUTION: To help avoid personal injury or damage to the vehicle, a bent, cracked, or damaged fan blade or housing should always be replaced.

1. Upper fan shroud. Refer to "Fan Shroud Replacement," in this Section.
2. Drive belt. Refer to "Drive Belt Replacement" in this section.
3. Fan and clutch using J 41240.
4. Fan blade from clutch.

CAUTION: Do not use or repair a damaged fan assembly. An unbalanced fan assembly could fly apart and cause personal injury and/or property damage. Replace damaged assemblies with new assemblies.

Install or Connect (Figure 20)

NOTICE: ***Refer to "Notice" on page 6B-1.***

1. Fan blade to clutch.

Tighten

   - Bolts to 23 N·m (17 lb ft).

2. Fan and clutch using J 41240.
   - Fan clutch nut to 56 N·m (41 lb ft).
3. Drive belt.
4. Upper fan shroud.

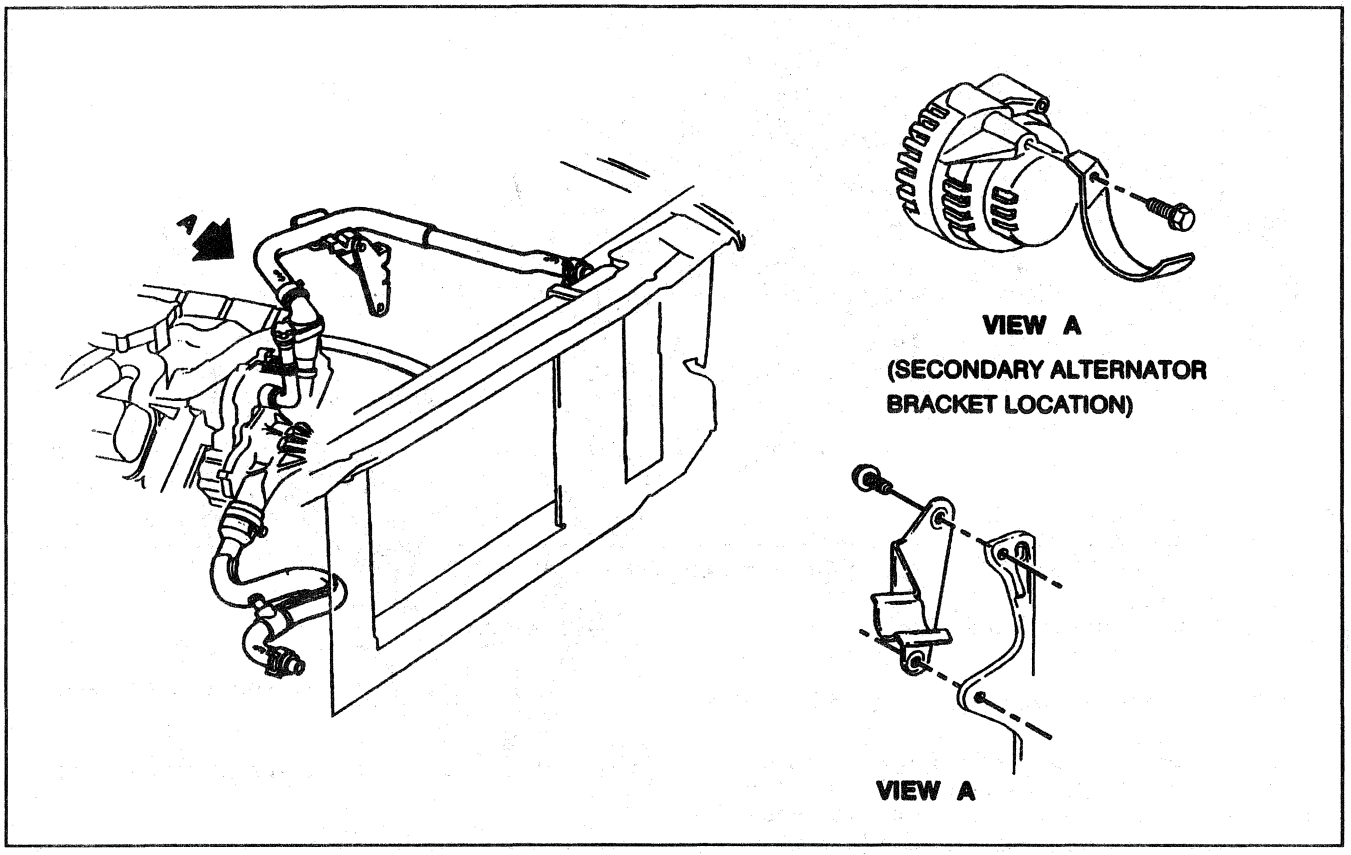


Figure 19—Radiator and Hoses (Diesel Engines)

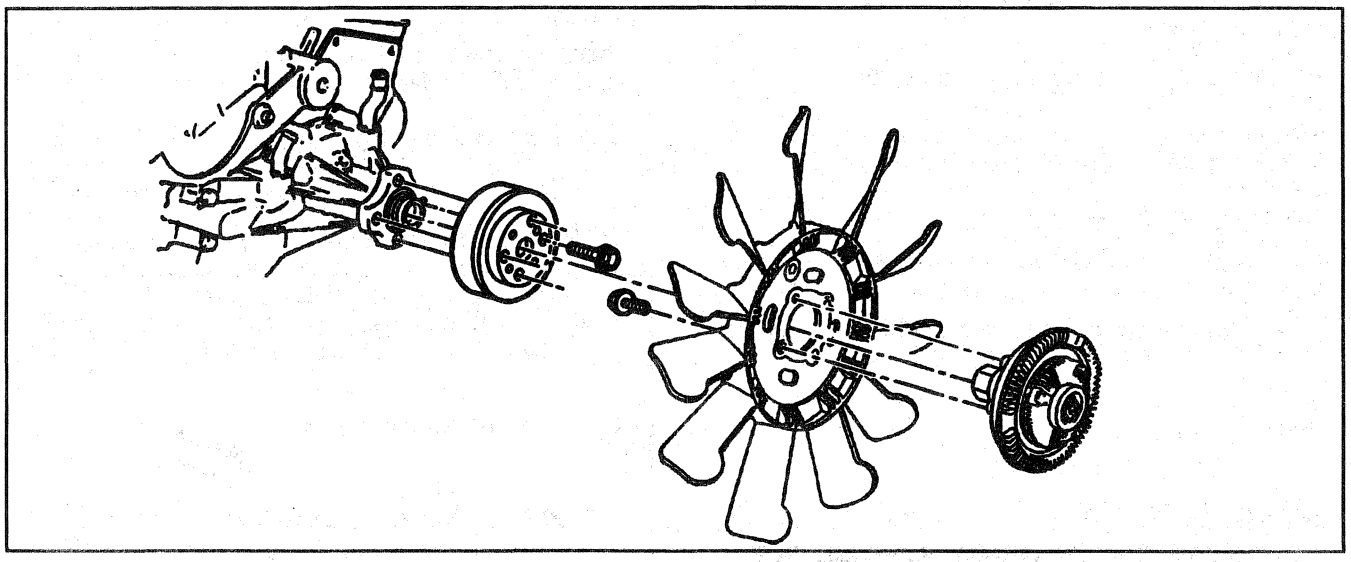


Figure 20—Radiator Fan and Fan Clutch (4.3L, 5.0L and 5.7L Engines)

7.4L and Diesel Engines

Remove or Disconnect (Figure 21)

1. Upper fan shroud. Refer to "Fan Shroud Replacement" in this section.
   - Locate the yellow dot on the fan clutch hub and mark the water pump pulley.
2. Nuts.
3. Fan and fan clutch from the coolant pump pulley.
4. Bolts.
5. Radiator fan from the fan clutch.

Inspect

- Inspect the mating surfaces (the coolant pump hub and the fan clutch hub) for smoothness. Rework as necessary to eliminate any burrs or other imperfections.

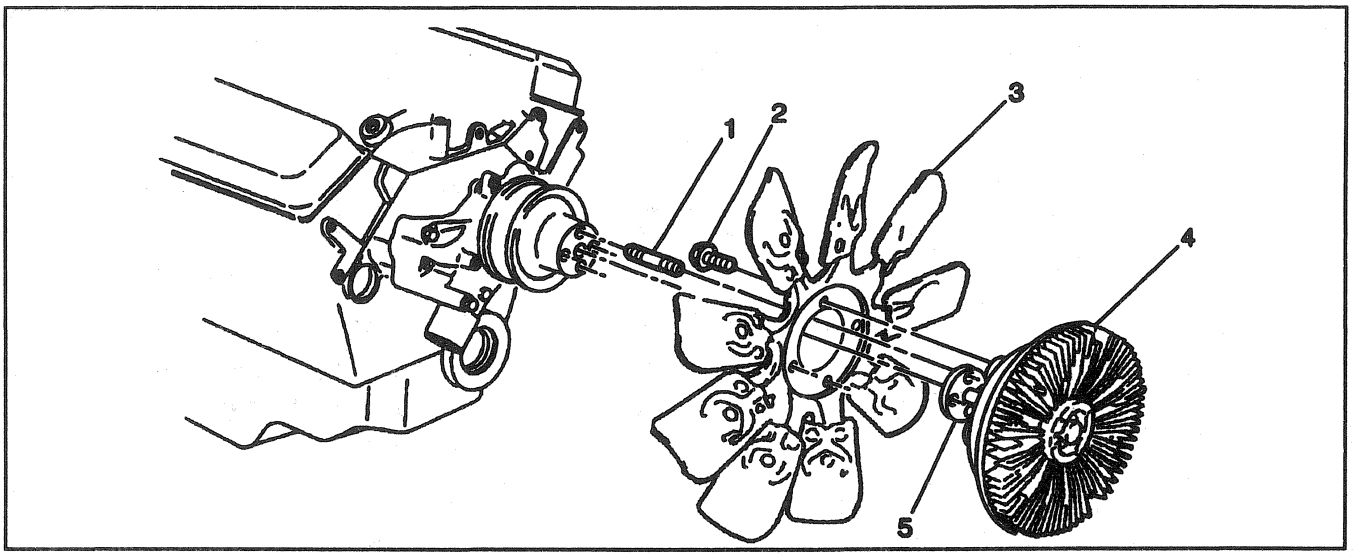


Figure 21—Radiator Fan and Fan Clutch (7.4L and Diesel Engines)

Install or Connect (Figure 21)

NOTICE: *Refer to "Notice" on page 6B-1.*

CAUTION: Do not repair and reuse a fan with a bent, cracked, or damaged blade. Replace the fan as an assembly. A damaged blade can change the balance of a fan. A fan out of balance or cracked could fly apart during use and cause personal injury or damage to the vehicle.

1. Radiator fan to the fan clutch.
2. Bolts.

Tighten

- Bolts to 24 N·m (18 lb ft).

3. Fan and clutch assembly to the water pump pulley.
4. Nuts.
   - Align the yellow reference marks on the water pump pulley and the fan clutch hub.

Tighten

- Nuts to 24 N·m (18 lb ft).

5. Upper fan shroud.

THERMOSTAT REPLACEMENT

Gasoline Engines

Remove or Disconnect (Figures 22 through 24)

1. Drain the cooling system until the radiator coolant level is below the thermostat.
2. Bolts or studs.
3. Coolant outlet.
4. Thermostat from its housing.
5. Gasket (if necessary).

Clean

- Thermostat housing and coolant sealing surfaces.

Install or Connect (Figures 22 through 24)

1. Thermostat in its housing.
2. New gasket into position (if necessary).
3. Coolant outlet.
4. Bolts and studs.

Tighten

- Bolts and studs to 28 N·m (21 lb ft) on 4.3L, 5.0L, and 5.7L engines.
- Studs to 37 N·m (27 lb ft) on 7.4L engines.

5. Fill the cooling system.

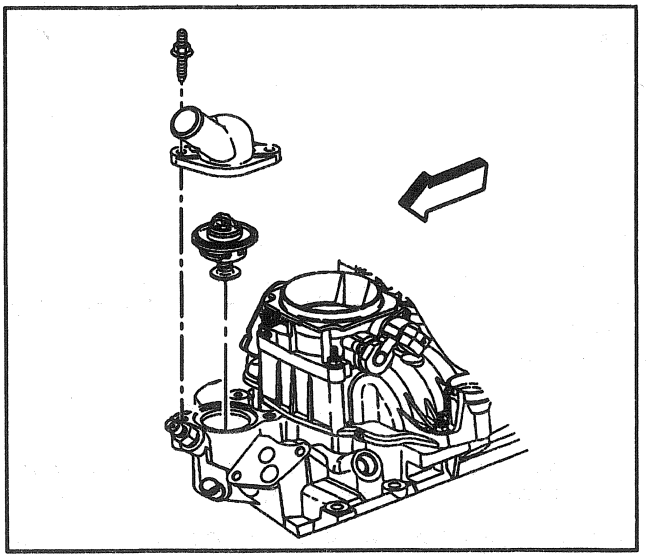


Figure 22—Thermostat and Components (4.3L Engine)

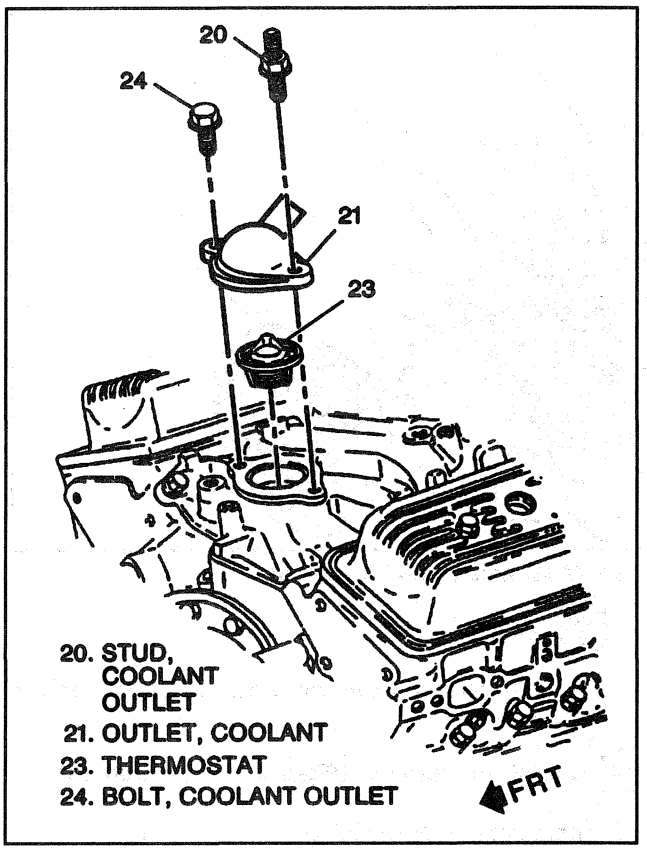


Figure 23—Thermostat and Components (5.0L and 5.7L Engines)

6. Start the engine and run with the radiator cap removed until the upper hose becomes hot (thermostat is open).
7. With the engine idling, add coolant to the radiator until the coolant level reaches the bottom of the filler neck.
8. Radiator cap to the radiator, making sure the arrows line up with the overflow tube.
9. Check for leaks.

Diesel Engines

Remove or Disconnect (Figure 25)

1. Drain the cooling system until the radiator coolant level is below the thermostat.
2. Upper radiator (inlet) hose.
3. Bolt, stud, and the coolant outlet.
4. Gasket.
5. Thermostat from its housing.

Clean

- Thermostat housing and coolant outlet sealing surfaces.

Install or Connect (Figure 25)

1. Thermostat into its housing.
2. Gasket into position.
3. Coolant outlet.

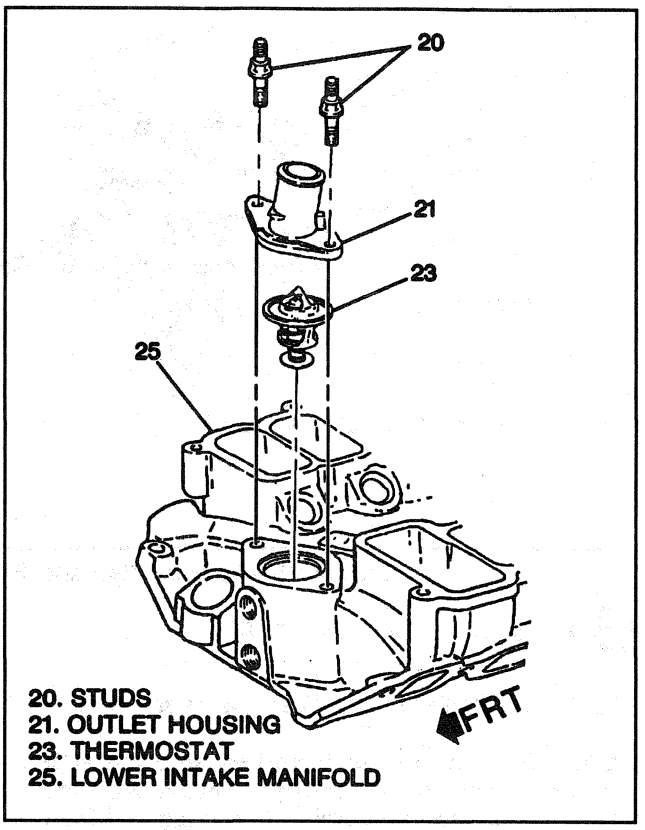


Figure 24—Thermostat and Components (7.4L Engine)

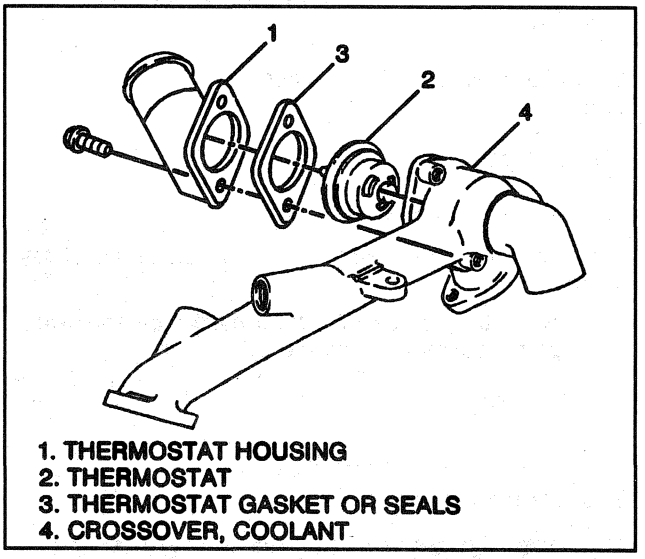


Figure 25—Thermostat and Components (Diesel Engines)

4. Bolt and stud.

Tighten

- Bolt and stud to 42 N·m (31 lb ft).

5. Upper radiator (inlet) hose.
6. Fill the cooling system.

7. Start the engine and run with the radiator cap removed, until the upper radiator hose becomes hot (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. Radiator cap to the radiator, making sure the arrows line up with the overflow tube.
10. Check for leaks.

WATER PUMP REPLACEMENT

Gasoline Engines

Remove or Disconnect (Figures 26 through 28)

1. Coolant from the radiator.
2. Upper fan shroud. Refer to "Fan Shroud Replacement" in this section.
3. Drive belt. Refer to "Drive Belt Replacement" in this section.
4. Fan, fan clutch, and pulley from the coolant pump. Refer to "Fan and Fan Clutch Replacement" in this section.
5. Lower radiator (outlet) hose and heater hose from the coolant pump.
   - On the 7.4L engine, remove the bypass hose.
6. Bolts.
7. Water pump from the engine block.

Clean

- Mating surfaces on the water pump and the engine block.

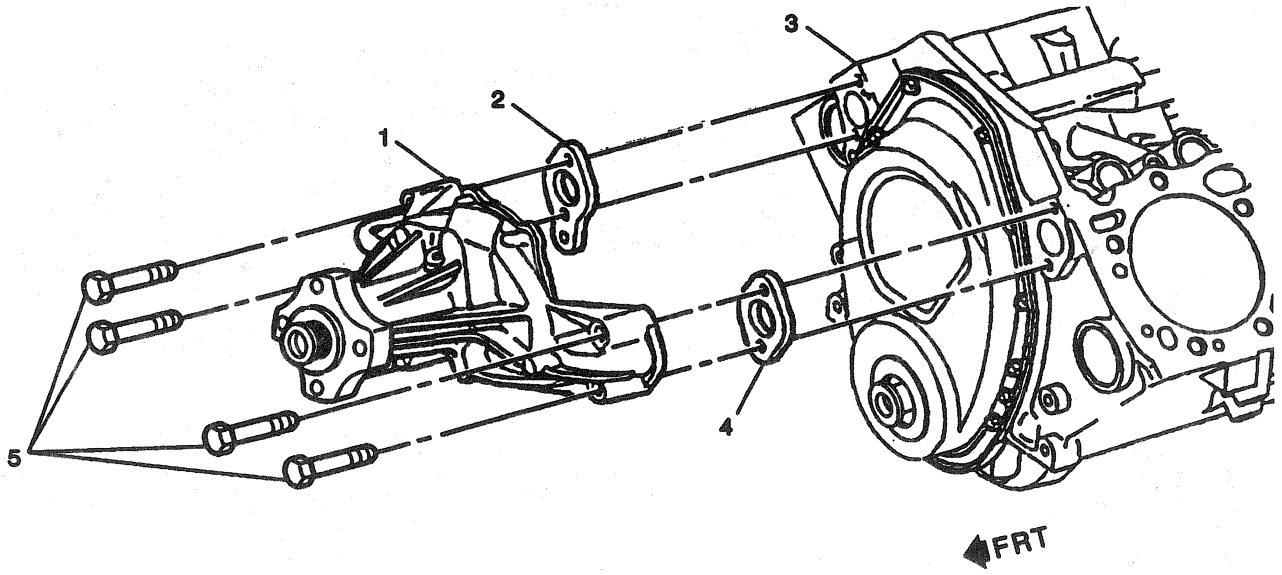
Install or Connect (Figures 26 through 28)

1. Water pump to the engine block.
2. New gaskets.
3. Bolts.

Tighten

- Bolts to 41 N.m (30 lb ft).

4. Lower radiator (outlet) hose and heater hose to the water pump.
   - Bypass hose on the 7.4L engine.
5. Water pump pulley, fan, and fan clutch to the coolant pump hub. Refer to "Fan and Fan Clutch Replacement" in this section.
6. Drive belt. Refer to "Drive Belt Replacement" in this section.
7. Upper fan shroud. Refer to "Fan Shroud Replacement" in this section.
8. Start the engine and run, with the radiator cap removed, until the upper radiator hose becomes hot (thermostat is open).
9. Add coolant to the radiator until the level reaches the bottom of the filler neck.
   - Engine must be running at idle speed.



1. PUMP, WATER
2. GASKET
3. BLOCK, ENGINE
4. GASKET
5. BOLT

Figure 26—Water Pump and Components (4.3L Engine)

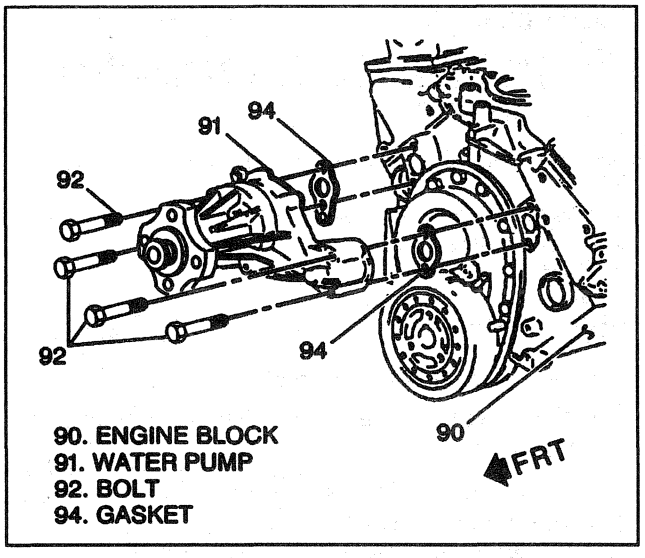


Figure 27—Water Pump and Components (5.0L and 5.7L Engines)

10. Radiator cap, making sure the arrows line up with the overflow tube.
11. Check for leaks.

Diesel Engines

Remove or Disconnect (Figure 29)

1. Negative battery cable. Refer to SECTION 6D1.
2. Coolant from the radiator.

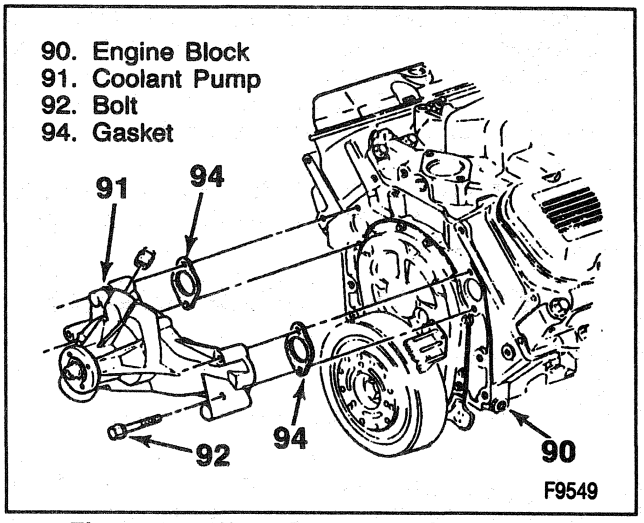


Figure 28—Water Pump and Components (7.4L Engine)

3. Fan shroud. Refer to "Fan Shroud Replacement" in this section.
4. Fan. Refer to "Fan and Fan Clutch Replacement" in this section.
5. Drive belt. Refer to "Drive Belt Replacement" in this section.
6. Raise vehicle. Support with safety stands.
7. Vacuum pump mounting bracket nuts.
8. Bolt holding vacuum pump bracket and generator.
9. Vacuum pump with bracket.

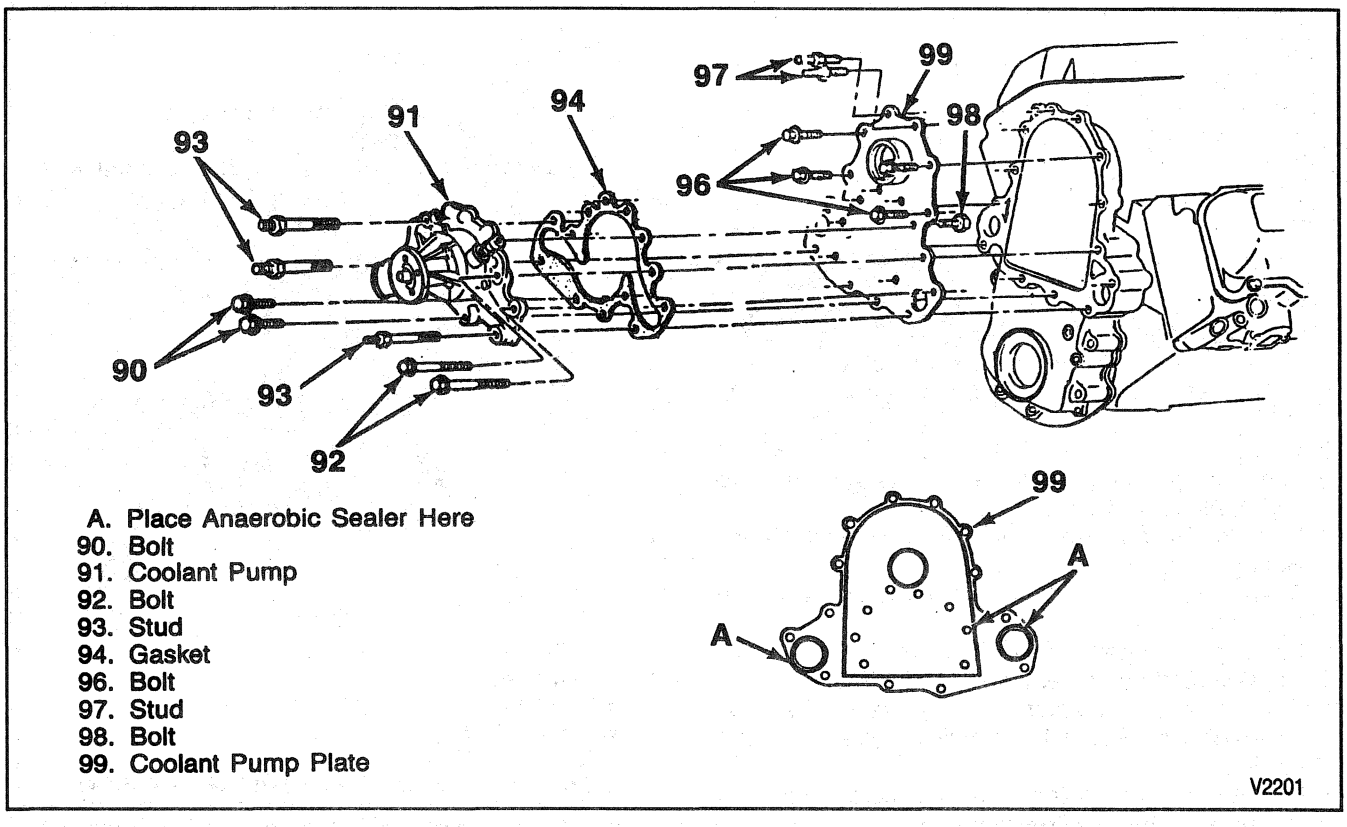


Figure 29—Water Pump and Components (Diesel Engines)

10. Power steering pump (lay aside). Refer to SECTION 3B1.
11. Power steering pump mounting bracket. Refer to SECTION 3B1.
12. Lower radiator hose from pump.
13. Bypass hose from pump.
14. Bolts (90, 92, and 96), studs (93 and 97), water pump plate (99), and the water pump (91) (Figure 27).
15. Bolt (98) from the rear of the water pump plate.
16. Water pump (91) and gasket (94) from the plate (99).

Clean

- All flanges must be free of oil. Clean the mating surfaces on the coolant pump, both sides of the water pump plate, and the engine block.

Install or Connect (Figure 29)

1. Gasket (94).
2. Water pump (91) to the water pump plate (99).
3. Bolt (98).

Tighten

- Bolt (98) to 23 N·m (17 lb ft).

4. Water pump (91) and water pump plate (99) to the engine.
   - Apply anaerobic sealer GM P/N 1052357 or equivalent.
   - The sealer must be wet to the touch when the bolts are tightened.
5. Bolts (90, 92, and 96) and studs (93 and 97).

Tighten

- Bolts (90 and 96) and studs (97) to 42 N·m (31 lb ft).
- Bolts (92) and studs (93) to 42 N·m (31 lb ft).

6. Bypass hose and lower radiator hose.
7. Power steering bracket and pump. Refer to SECTION 3B1.
8. Vacuum pump and bracket.
9. Bolt holding vacuum pump and generator. Refer to SECTION 6H.
10. Fan and pulley. Refer to "Radiator Fan Clutch Replacement" in this section.
11. Drive belt. Refer to "Drive Belt Replacement" in this section.
12. Fan shroud. Refer to SECTION 6B2.
13. Negative battery cable. Refer to SECTION 6D1.
14. Coolant in the radiator or surge tank. Refer to "Draining and Filling the Cooling System" in this section.
15. Radiator or surge tank cap, making sure the arrows line up with the overflow tube.
16. Check for leaks.

THERMOSTAT HOUSING CROSSOVER REPLACEMENT

Diesel Engines

Remove or Disconnect (Figure 30)

1. Coolant from the radiator.
2. Compressor. Refer to SECTION 1B.
3. Crankcase depression regulator valve.
4. Generator upper bracket.
5. Bypass hose, upper radiator (inlet) hose, and heater hose.
6. Studs and bolts.
7. Coolant crossover housing assembly from the vehicle.
   - The thermostat and coolant outlet are attached to the crossover housing assembly along with the thermal bypass nipple.

Clean

- Coolant crossover housing sealing surfaces.

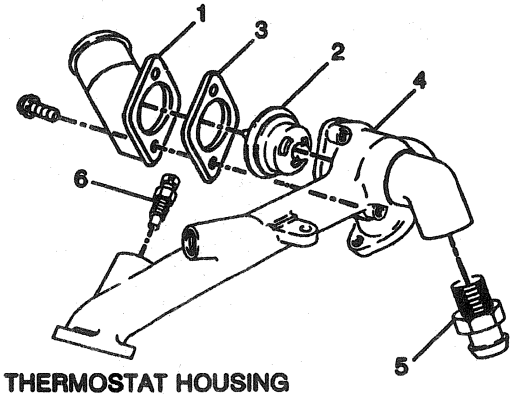
Install or Connect (Figure 30)

1. New gaskets.
2. Coolant crossover housing assembly.
3. Studs and bolts.

Tighten

- Studs and bolts to 42 N·m (31 lb ft).

4. Heater hose, upper radiator (inlet) hose, and bypass hose.
5. Generator upper bracket.
6. Compressor.
7. Crankcase depression regulator valve.
8. Coolant in the radiator.
9. Start the engine and run, with the radiator cap removed, until the upper radiator hose becomes hot (thermostat is open).



1. THERMOSTAT HOUSING
2. THERMOSTAT
3. THERMOSTAT GASKET OR SEALS
4. CROSSOVER, COOLANT
5. BYPASS FITTING
6. ENGINE COOLANT TEMPERATURE SENSOR

Figure 30—Coolant Crossover and Components (Diesel Engines)

10. With the engine idling, add coolant to the radiator until the coolant level reaches the bottom of the filler neck.
11. Radiator cap to the radiator, making sure the arrows line up with the overflow tube.
12. Check for leaks.

AUXILIARY COOLING FAN REPLACEMENT

The auxiliary cooling fan, if equipped, provides additional cooling for low-speed vehicle operations, extended idle, and stop-and-go conditions. The fan will also run after engine shutdown in cases of extreme coolant temperatures. The auxiliary cooling fan is located behind the grille on the right side of the vehicle (Figure 31).

The auxiliary cooling fan circuit consists of the auxiliary fan, relay, and vehicle control module (VCM). When the VCM determines that 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 fan operation is no longer required, the relay is de-energized and voltage is no longer applied to the fan. Refer to Engine Controls Section 6E for circuit schematic and diagnostic procedures.

Remove or Disconnect (Figure 31)

1. Negative battery cable Refer to SECTION 6D1.
2. Radiator grille assembly. Refer to SECTION 2B.
3. Connector from auxiliary fan.
4. Auxiliary fan.

Install or Connect (Figure 31)

1. Auxiliary fan
2. Connector to auxiliary fan.
3. Radiator grill. Refer to SECTION 2B.
4. Negative battery cable. Refer to SECTION 6D1.

FAN RELAY REPLACEMENT

Remove or Disconnect

1. Negative battery cable. Refer to SECTION 6D1.
2. Fan relay from underhood fuse/relay center.

Install or Connect

1. Fan relay to underhood fuse/relay center.
2. Negative battery cable. Refer to SECTION 6D1.

DRIVE BELT TENSIONER INSPECTION

Remove or Disconnect

1. Negative battery cable. Refer to SECTION 6D1.
2. Multiple ribbed drive belt. Refer to "Drive Belt Replacement" in this section.
   - Move the drive belt tensioner through its full travel. Refer to "Drive Belt Replacement" in this section.

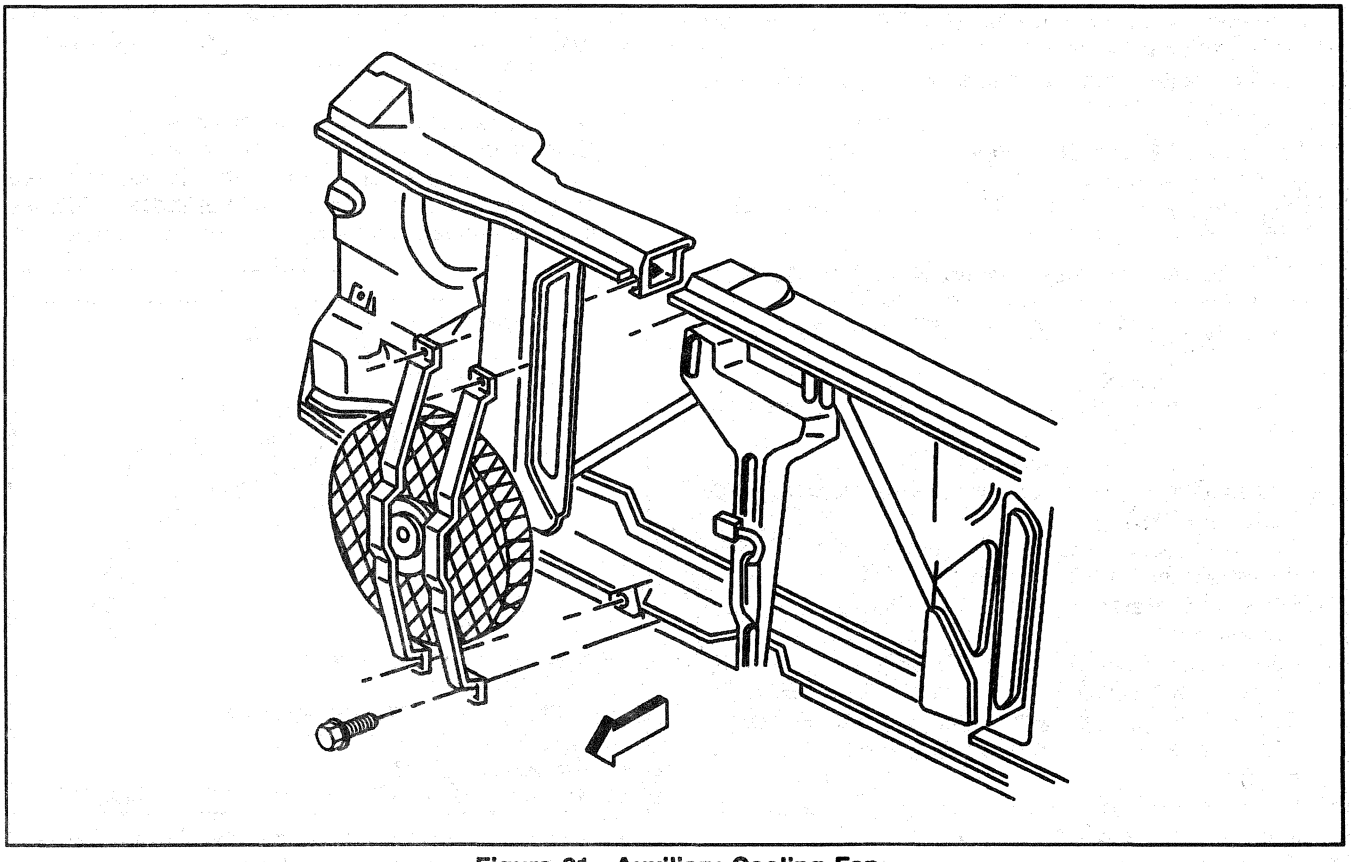


Figure 31—Auxiliary Cooling Fan

NOTICE: ***Do not allow the drive belt tensioner to snap into the "free" position. This may result in damage to the tensioner.***

- Movement should feel smooth and return freely without any binding. If any binding is observed, replace the tensioner.

Install or Connect

1. Multiple ribbed drive belt. Refer to "Drive Belt Replacement" in this section.
2. Negative battery cable. Refer to SECTION 6D1.

DRIVE BELT TENSIONER REPLACEMENT

4.3L, 5.0L, and 5.7L Engines

Remove or Disconnect (Figure 32)

1. Negative battery cable. Refer to SECTION 6D1.
2. Multiple ribbed drive belt. Refer to "Drive Belt Replacement" in this section.
3. Bolt.
4. Tensioner.

Install or Connect (Figure 32)

1. Tensioner to mounting bracket.
2. Bolt.

Tighten

- Bolt to 50 N·m (37 lb ft).

3. Multiple ribbed drive belt.
4. Negative battery cable.

C/K 2 and 3 with 7.4L Engine and A/C

Remove or Disconnect (Figure 33)

1. Negative battery cable. Refer to SECTION 6D1.
2. Multiple ribbed drive belt. Refer to "Drive Belt Replacement" in this section.
3. Bolt.
4. Tensioner.

Install or Connect (Figure 33)

1. Tensioner.
2. Bolt.

Tighten

- Bolt to 50 N·m (37 lb ft).

3. Multiple ribbed drive belt.
4. Negative battery cable.

Diesel Engines

Remove or Disconnect (Figure 34)

1. Negative battery cable. Refer to SECTION 6D1.
2. Multiple ribbed drive belt. Refer to "Drive Belt Replacement" in this section.
3. Bolt.
4. Tensioner.

Install or Connect (Figure 34)

1. Tensioner.
2. Bolt.

Tighten

- Bolt to 50 N·m (37 lb ft).

3. Multiple ribbed drive belt.
4. Negative battery cable.

IDLER PULLEY REPLACEMENT

4.3L, 5.0L, and 5.7L Engines

Remove or Disconnect (Figure 35)

1. Negative battery cable. Refer to SECTION 6D1.
2. Multiple ribbed drive belt. Refer to "Drive Belt Replacement" in this section.

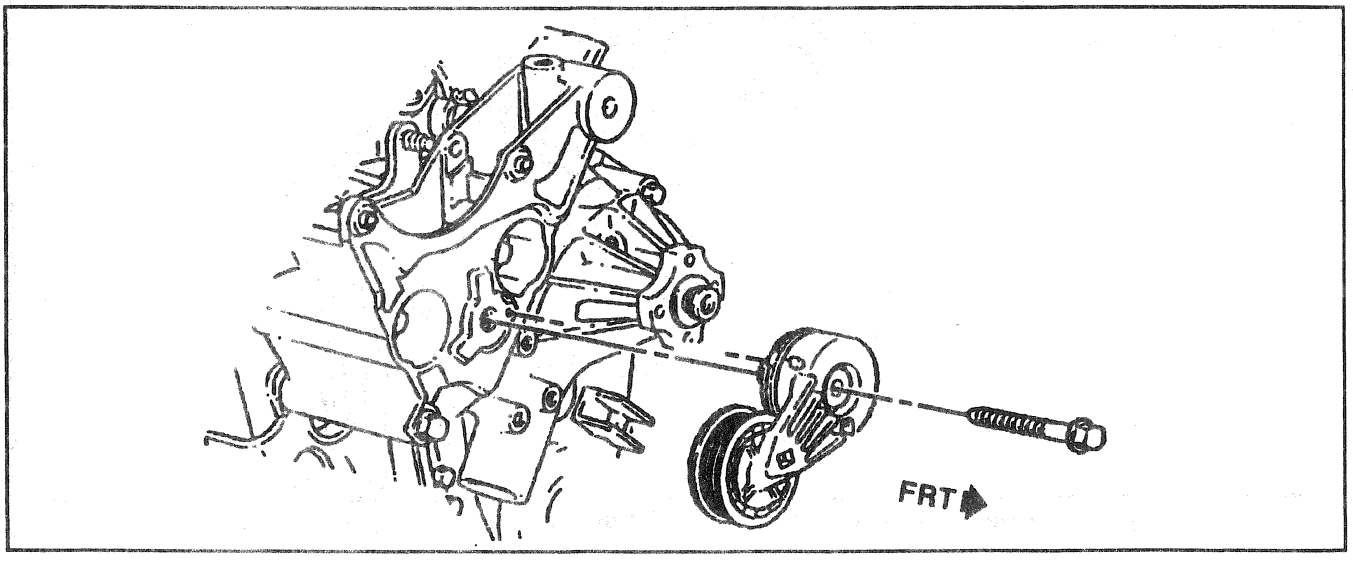
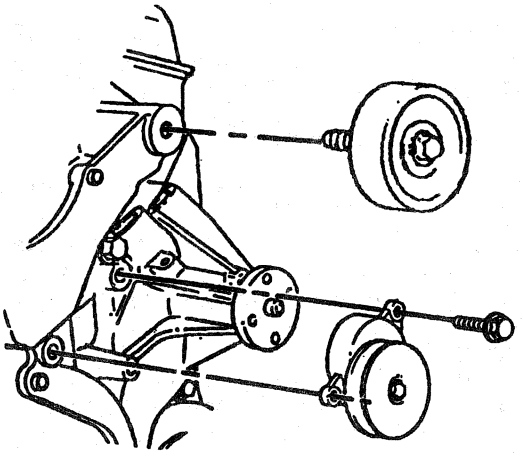
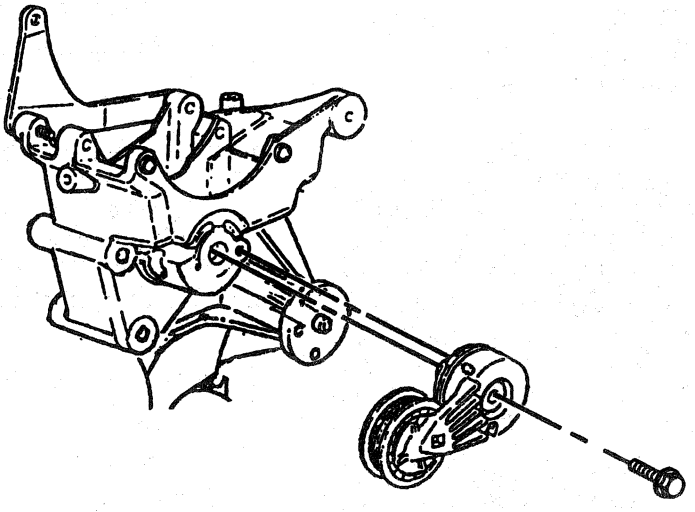


Figure 32—Belt Tensioner Assembly (4.3L, 5.0L, and 5.7L Engines)



WITH K19



WITHOUT K19

Figure 33—Belt Tensioner Assembly (C/K 2 and 3 with 7.4L Engine and A/C)

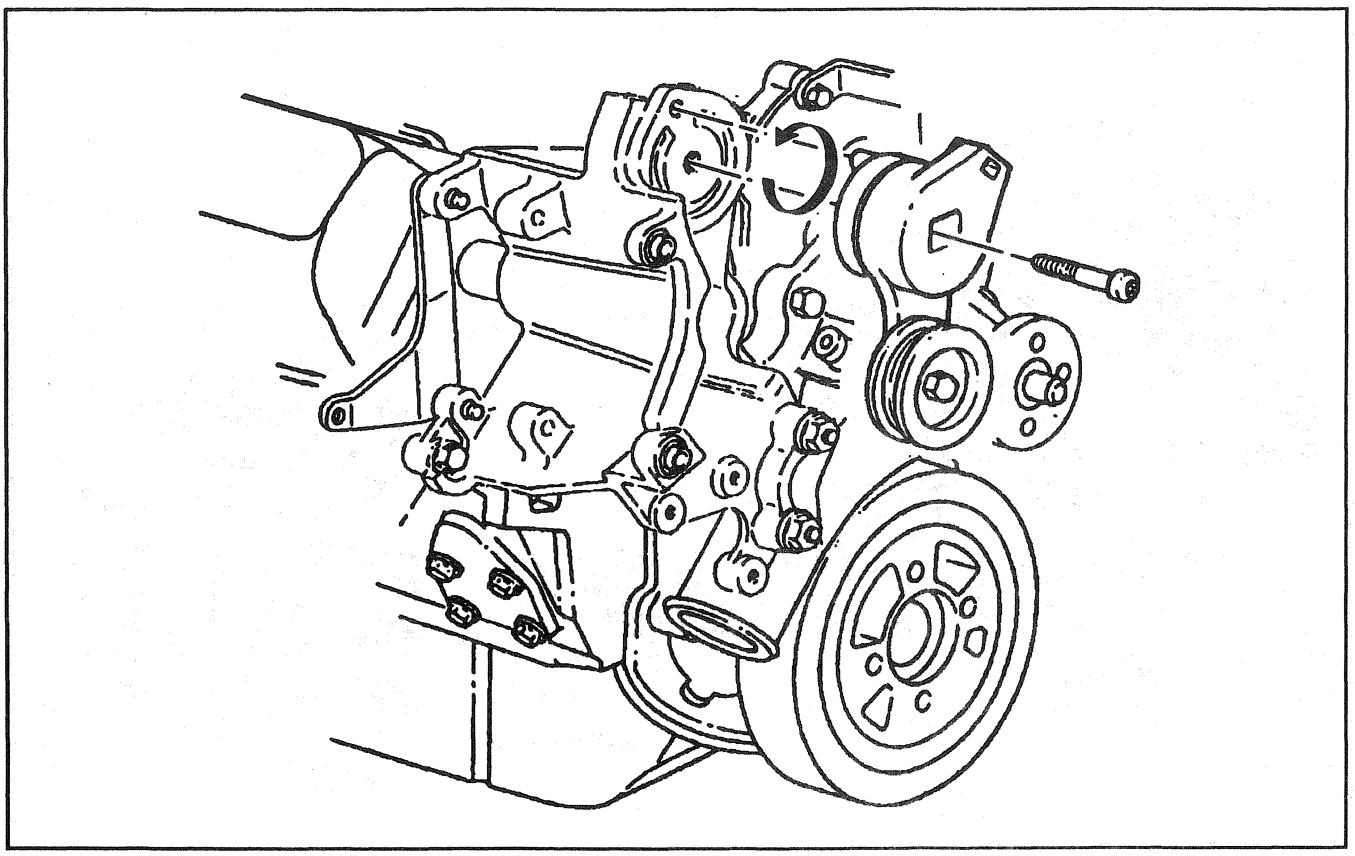


Figure 34—Belt Tensioner Assembly (Diesel Engines)

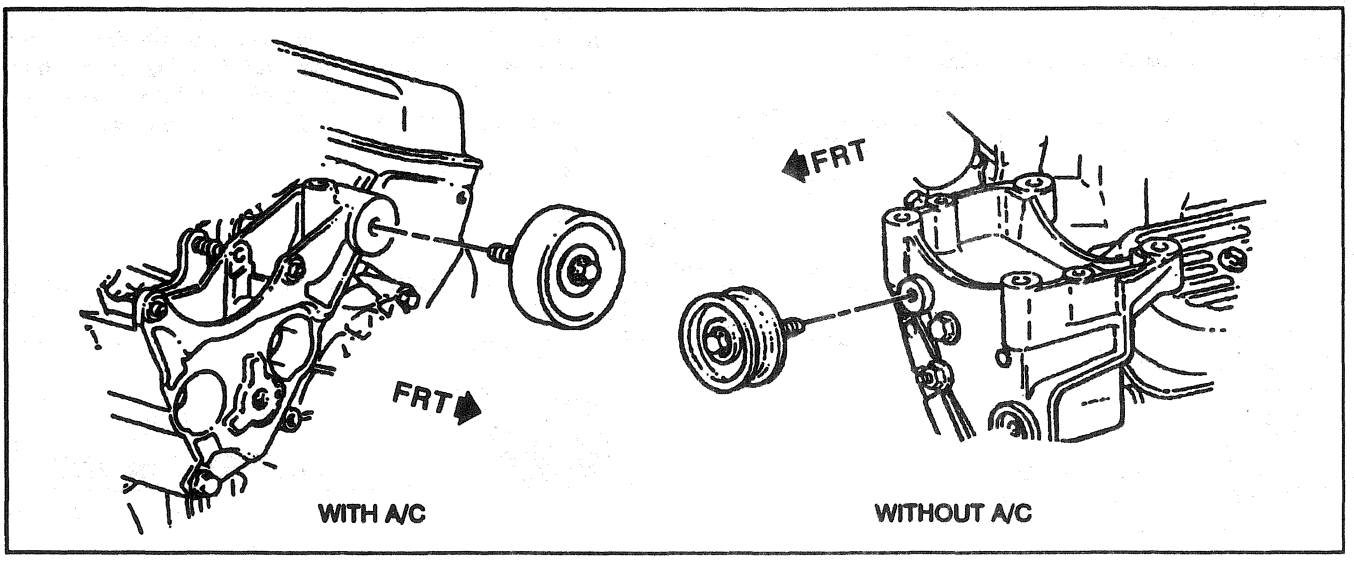


Figure 35—Idler Pulley (4.3L, 5.0L, and 5.7L Engines)

3. Idler pulley bolt.
4. Idler pulley.

Install or Connect (Figure 35)

1. Idler pulley.
2. Idler pulley bolt.

Tighten

- Bolt to 50 N·m (37 lb ft).

3. Multiple ribbed drive belt.
4. Negative battery cable.

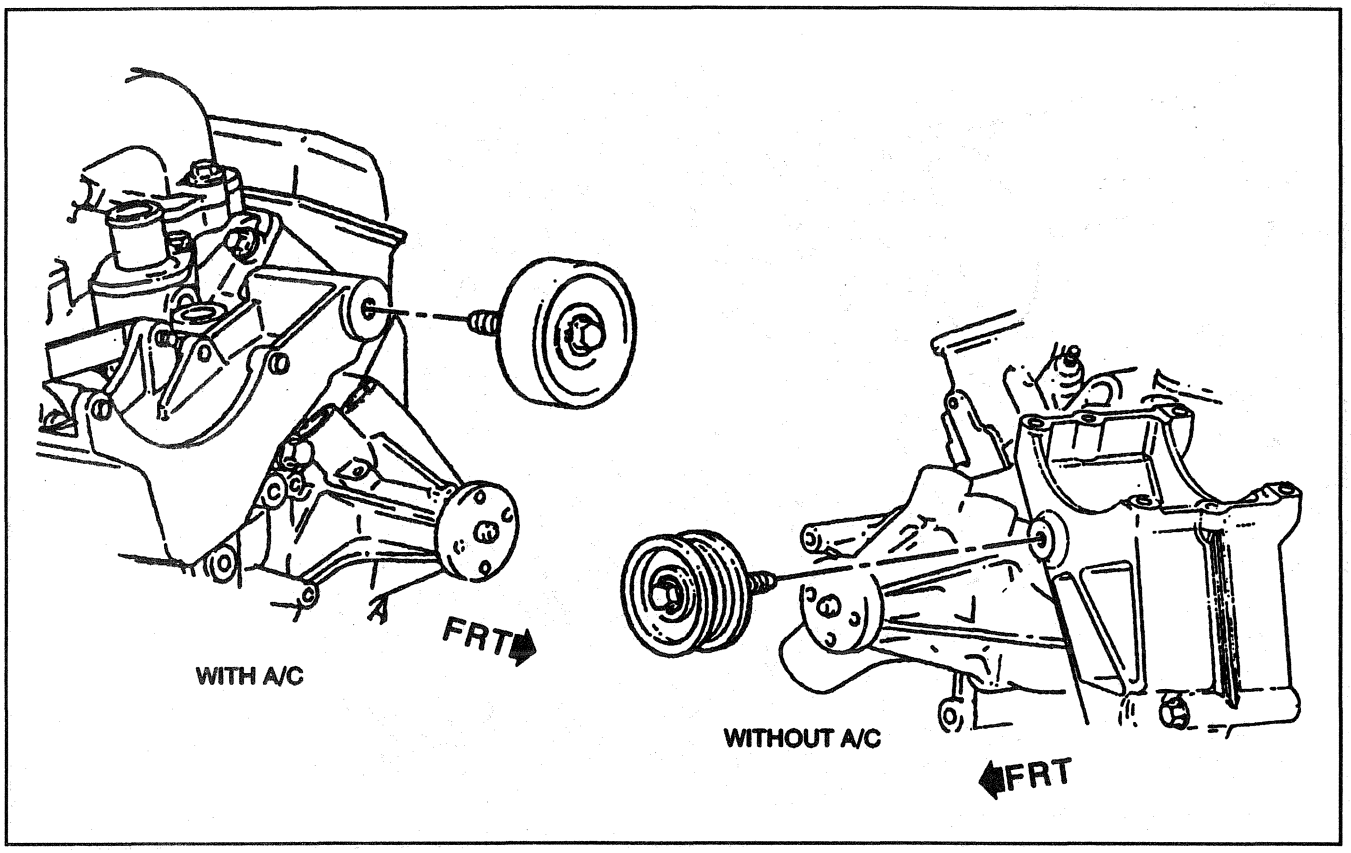


Figure 36—Idler Pulley (7.4L Engine)

7.4L Engine

Remove or Disconnect (Figure 36)

1. Negative battery cable. Refer to SECTION 6D1.
2. Multiple ribbed drive belt. Refer to "Drive Belt Replacement" in this section.
3. Idler pulley bolt.
4. Idler pulley.

Install or Connect (Figure 36)

1. Idler pulley.
2. Idler pulley bolt.

Tighten

- Bolt to 50 N·m (37 lb ft).

3. Multiple ribbed drive belt.
4. Negative battery cable.

DRIVE BELT SERVICE

Maintaining the multiple ribbed drive belt and pulleys can extend the normal life of a drive belt.

Pulley Inspection

Examine the pulleys for chips, nicks, tool marks, cracks, bent sidewalls, corrosion, or other damage.

1. Place a straightedge or position a cord across the two pulleys so they touch at all points (Figure 37).
2. Turn each pulley one half revolution and recheck with a straightedge or cord. Full contact at all points must be made. If contact is not made at all points, the pulley may be warped or its shaft could be bent. Replace any parts found to be damaged.
3. If the belt becomes loose and squeals or the belt comes off the engine drive pulleys, refer to "Diagnosis of Drive Belt System" in this section.

Drive Belt Inspection

Important

- Routine inspection of the belt may reveal cracks in the belt ribs. These cracks will not impair belt per-

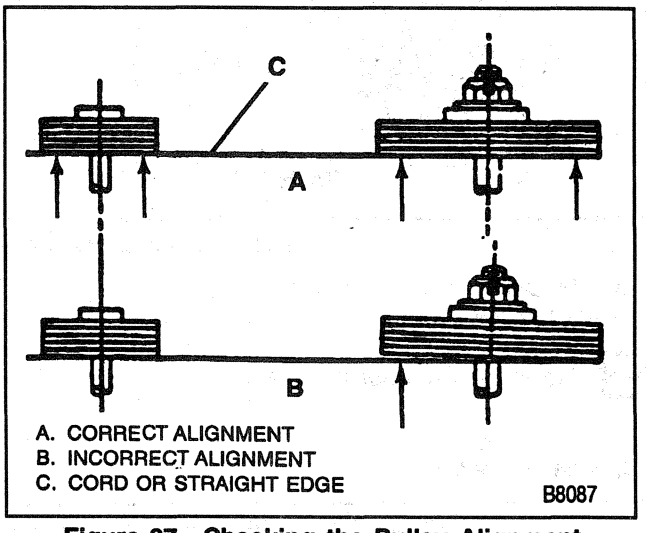


Figure 37—Checking the Pulley Alignment

formance and are not a basis for belt replacement. If sections of the belt are missing, the belt should be replaced.

- Do not use drive belt dressings to extend belt life. Use of belt dressing will soften the belts and cause deterioration. Oil or grease contamination on the belt or pulleys will also deteriorate the belt.

Drive Belt Installation

Install a multiple ribbed belt following the belt routings shown in Figures 38, 39, and 40. The grooves in the belt must match the grooves in the pulleys. The tensioner is spring loaded. After removing the belt, the tensioner will return to the tension position.

Drive Belt Replacement

Remove or Disconnect (Figures 38 through 40)

1. Release belt tension.
   - Use a 1/2 inch breaker bar in the square hole provided in the belt tensioner to rotate tensioner counterclockwise and release tension on all models, except 7.4L engines with A.I.R. pump (California emissions control only).
   - On models with 7.4L engines and A.I.R pump, use a wrench on the pulley axis bolt to rotate the tensioner clockwise and release tension.

NOTICE: ***Do not rotate the tensioner except as noted bove. Also, do not allow the tensioner to snap into the "free" position. Either of these conditions could damage the belt and/or tensioner.***

2. Belt.

Install or Connect

1. Route belt over all of the pulleys except the belt tensioner.
2. Release belt tensioner.
   - Use a 1/2 inch breaker bar in the square hole provided in the belt tensioner to rotate tensioner counterclockwise and release tension on all models, except 7.4L engines with A.I.R. pump (California emissions control only).
   - On models with 7.4L engines and A.I.R pump, use a wrench on the pulley axis bolt to rotate the tensioner clockwise and release tension.
3. Belt over tensioner pulley. Slowly allow tensioner to move back into installed position.
4. Check the belt for correct "V" groove tracking into each pulley.

ENGINE OIL COOLER LINE REPLACEMENT

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

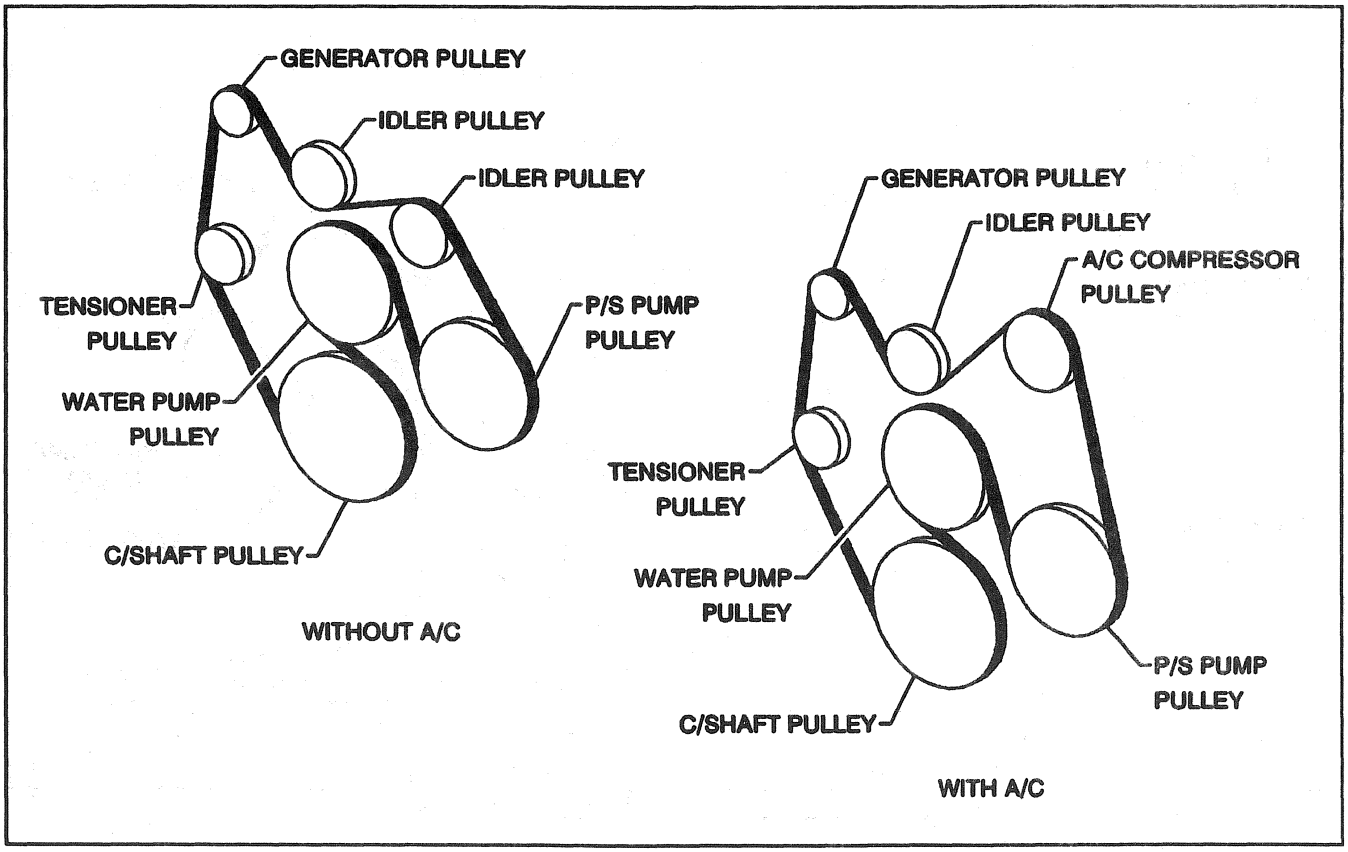


Figure 38—Multiple Rib Drive Belt Routing (4.3L, 5.0L, and 5.7L Engines)

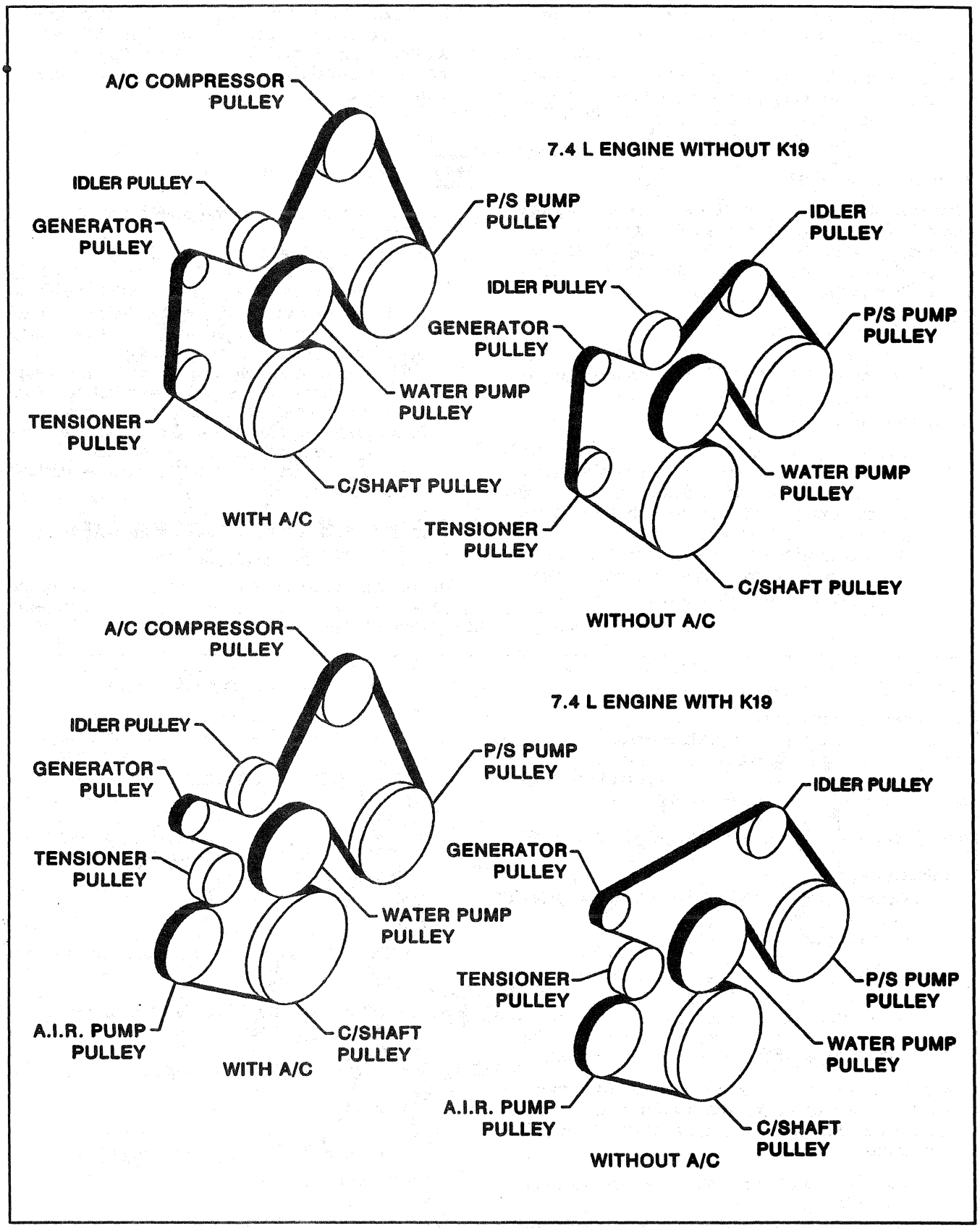


Figure 39—Multiple Rib Drive Belt Routing (7.4L Engines)

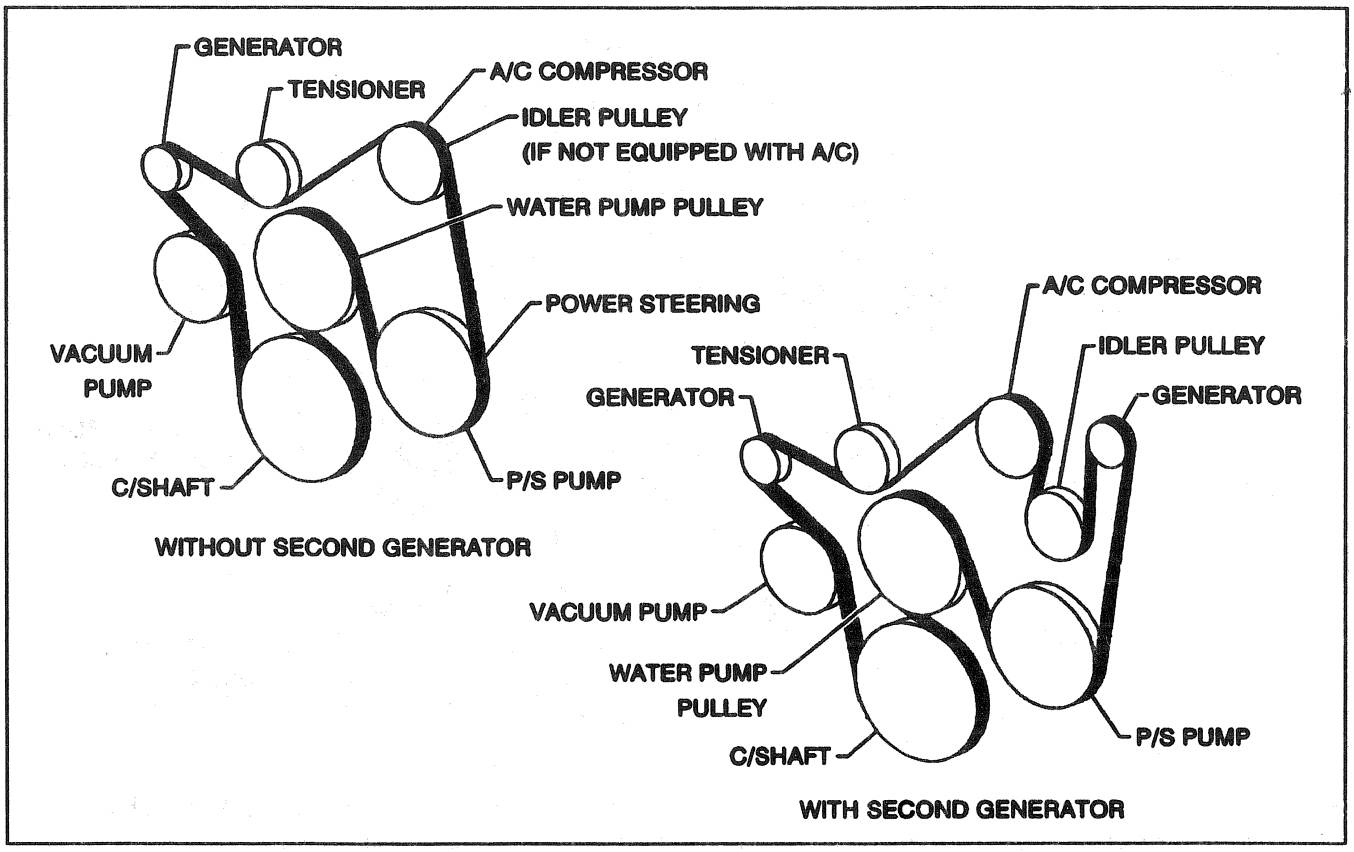


Figure 40—Multiple Rib Drive Belt Routing (Diesel Engines)

Figures 43 through 49 for the applicable engine being serviced.

Oil Cooler System Service

If foreign material has entered the oil cooler or if the engine has been damaged internally, flush the oil cooler, connecting lines, and filter adapter assembly in the following manner.

Remove or Disconnect (Figures 41 through 47)

- Set the parking brake.

1. Remove plastic cap from connector by pulling back along the pipe.
2. Oil cooler lines from the connector.
   - Use a small pick-type tool or screwdriver to release one of the open ends of the retaining ring from the connector fitting (A in Figure 46).
3. Rotate the retaining ring out of position on the connector fitting and remove completely. Discard the retaining ring clip (B in Figure 46).

NOTICE: ***Do not use more than 690 kPa (100 psi) air to clean the cooler and lines. Exceeding 690 kPa (100 psi) could damage the cooler or lines.***

4. Pull outward on the pipe to remove from connector fitting.

A. Using clean solvent and compressed air, back-flush the oil cooler and lines.
B. Using compressed air, remove the cleaning solvent.
C. Flush the system using the same type of oil normally circulated through the cooler.

5. Bolt and clamp from bracket.
6. Bolt from clip (7.4L and 6.5L engines only).
7. Oil cooler lines from the oil cooler fittings.
8. Oil filter and discard.

Clean

- All components in a suitable solvent and dry with compressed air.

Inspect

- All fittings, connectors, and cooler lines for damage or distortion.

Install or Connect (Figures 41 through 47)

1. Oil filter.
2. Oil cooler lines to oil cooler fittings.

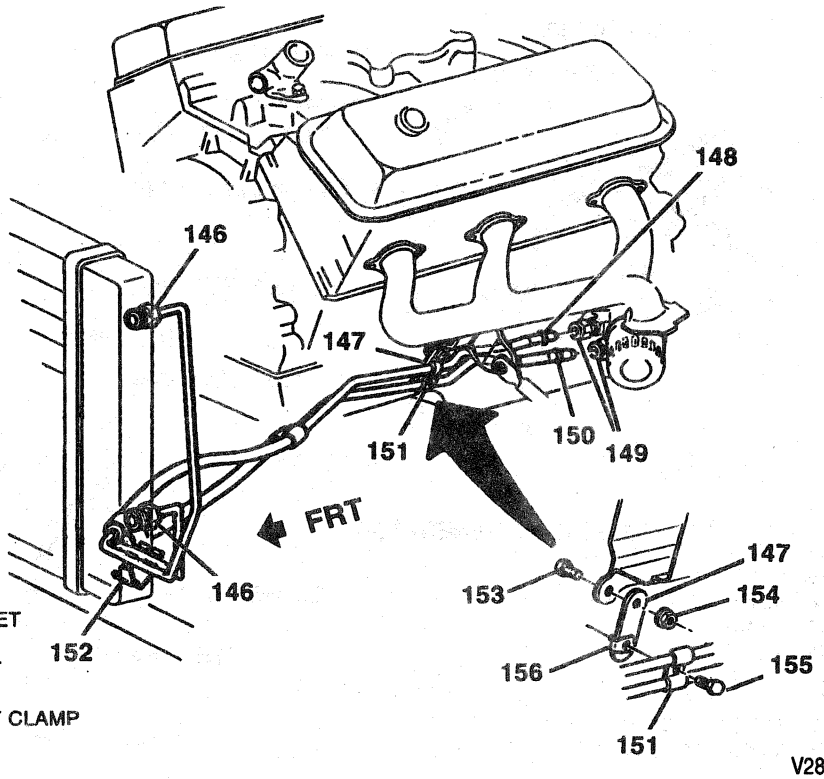
Tighten

- Oil cooler line fittings to 24 N·m (18 lb ft).

3. Oil cooler lines to clip.
4. Bolt to clip.

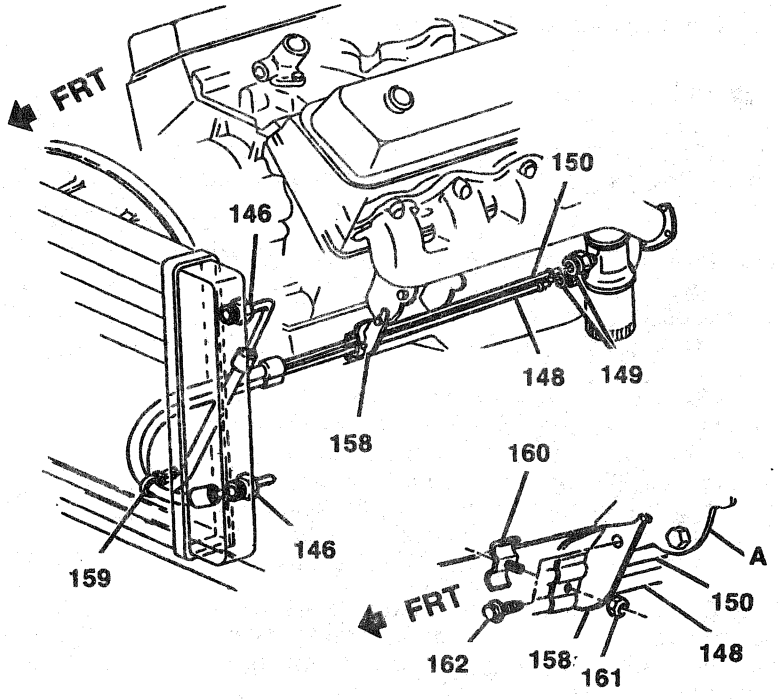
Tighten

- Bolt to 6 N·m (53 lb in).



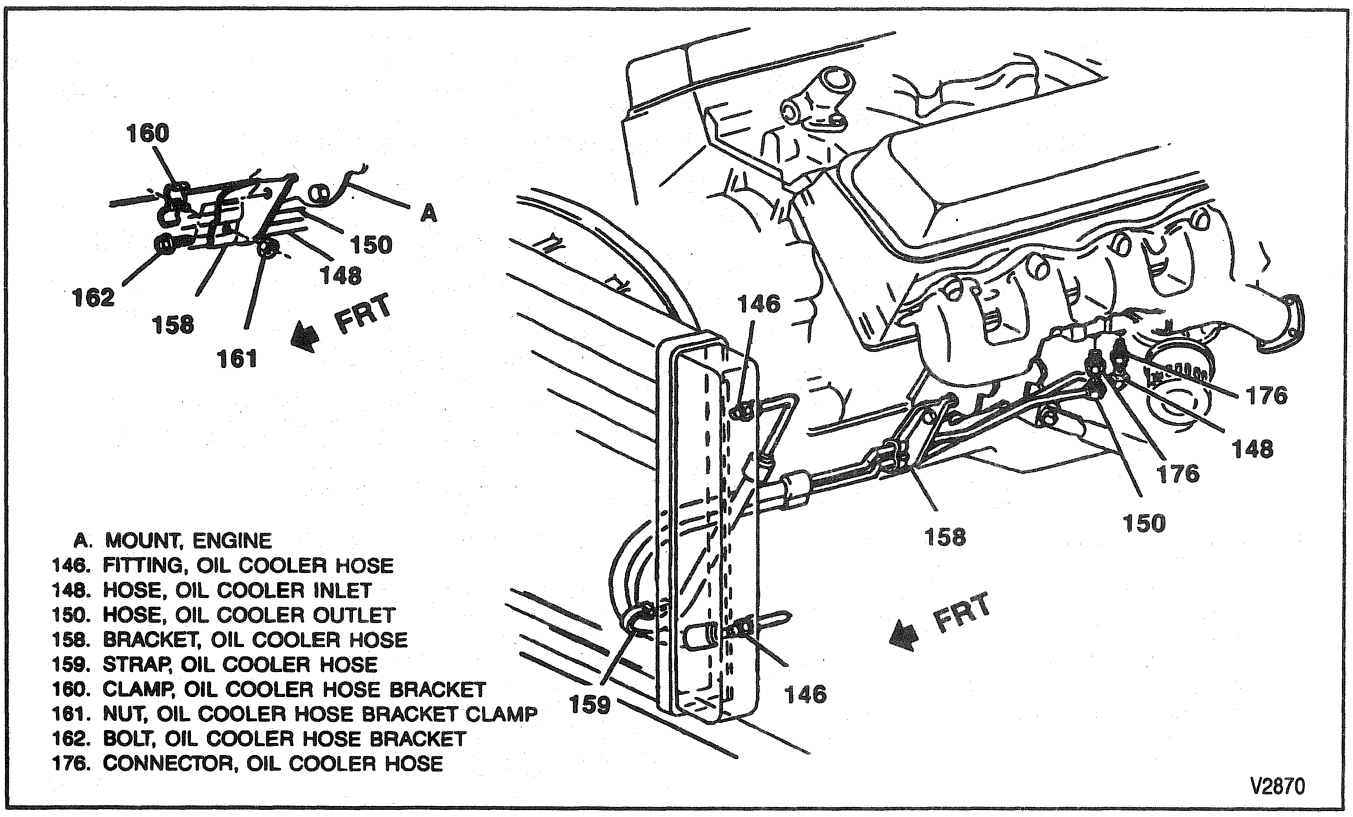
146. FITTING, OIL COOLER HOSE
147. BRACKET, OIL COOLER HOSE
148. HOSE, OIL COOLER INLET
149. CONNECTOR, OIL FILTER ADAPTER
150. HOSE, OIL COOLER OUTLET
151. CLAMP, OIL COOLER HOSE BRACKET
152. CLIP, OIL COOLER HOSE
153. BOLT, OIL COOLER HOSE BRACKET
154. NUT, OIL COOLER HOSE BRACKET
155. BOLT, OIL COOLER HOSE BRACKET CLAMP
156. NUT, SPRING

Figure 41—Engine Oil Cooler Lines and Components (4.3L Engine with Engine Oil Cooler)



A. MOUNT, ENGINE
146. FITTING, OIL COOLER HOSE
148. HOSE, OIL COOLER INLET
149. CONNECTOR, OIL FILTER ADAPTER
150. HOSE, OIL COOLER OUTLET
158. BRACKET, OIL COOLER HOSE
159. STRAP, OIL COOLER HOSE
160. CLAMP, OIL COOLER HOSE BRACKET
161. NUT, OIL COOLER HOSE BRACKET CLAMP
162. BOLT, OIL COOLER HOSE BRACKET

Figure 42—Engine Oil Cooler Lines and Components (5.0L and 5.7L Engines with Engine Oil Cooler)



A. MOUNT, ENGINE
146. FITTING, OIL COOLER HOSE
148. HOSE, OIL COOLER INLET
150. HOSE, OIL COOLER OUTLET
158. BRACKET, OIL COOLER HOSE
159. STRAP, OIL COOLER HOSE
160. CLAMP, OIL COOLER HOSE BRACKET
161. NUT, OIL COOLER HOSE BRACKET CLAMP
162. BOLT, OIL COOLER HOSE BRACKET
176. CONNECTOR, OIL COOLER HOSE

Figure 43—Engine Oil Cooler Lines and Components (7.4L Engine)

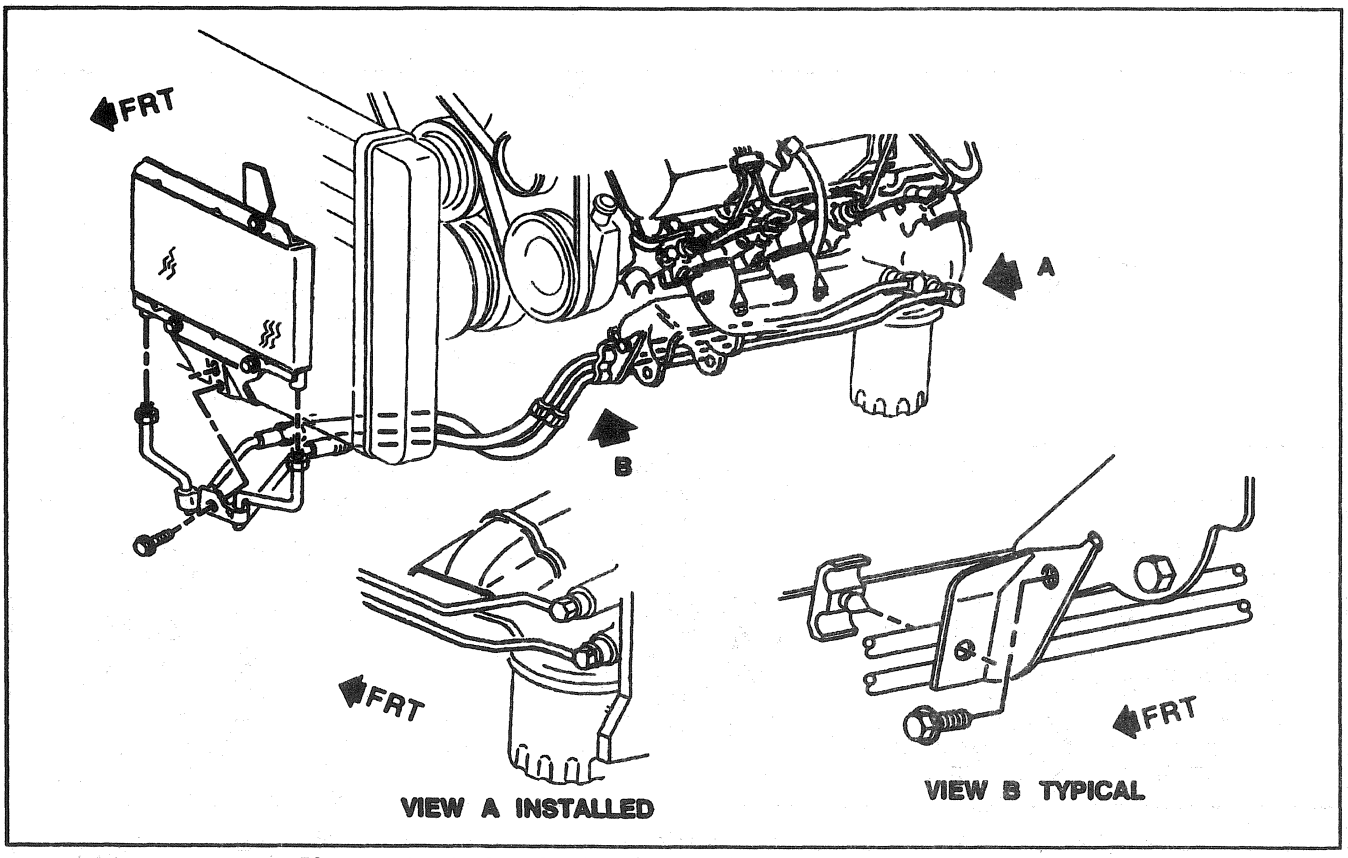


Figure 44—Engine Oil Cooler Lines and Components (Diesel)

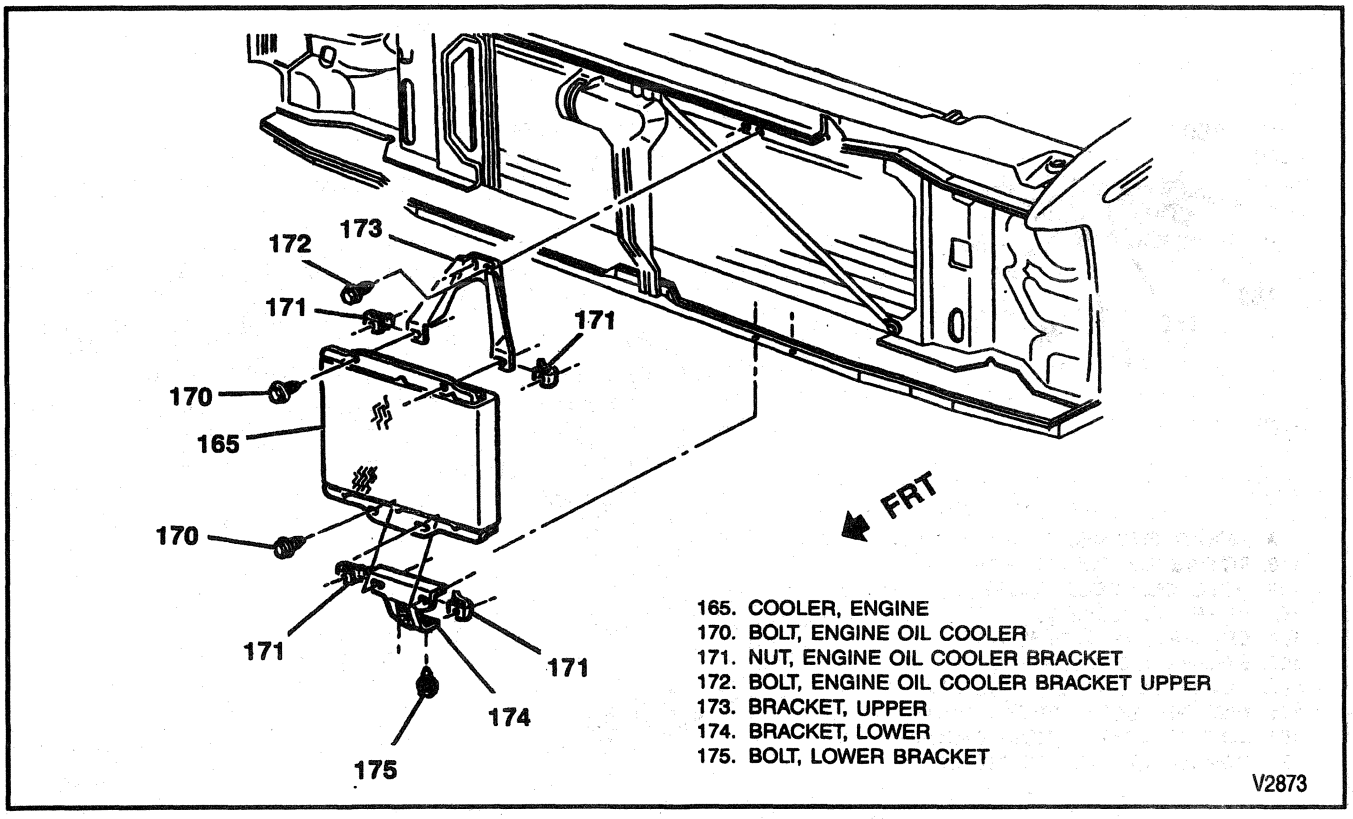


Figure 45—Engine Oil Cooler Assembly (Diesel Engines)

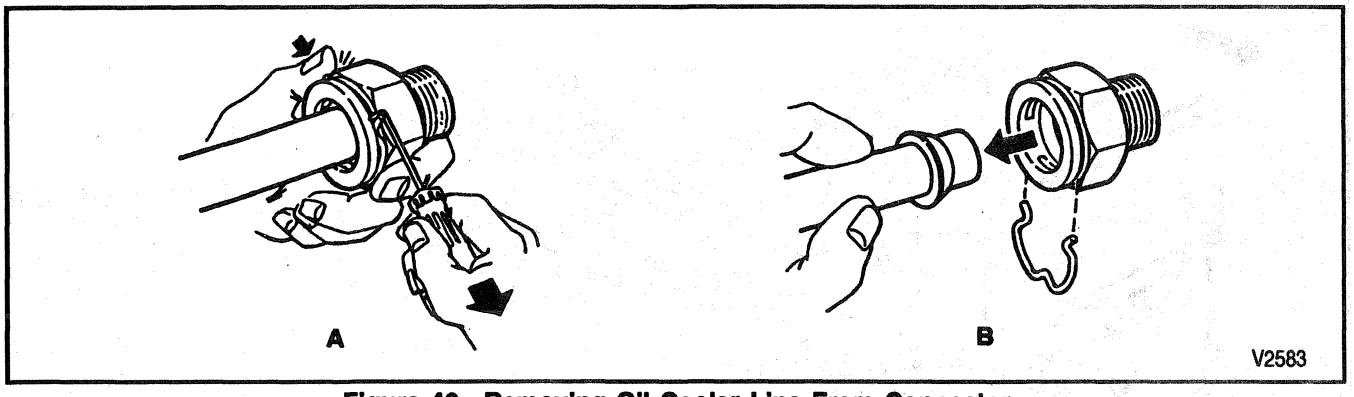


Figure 46—Removing Oil Cooler Line From Connector

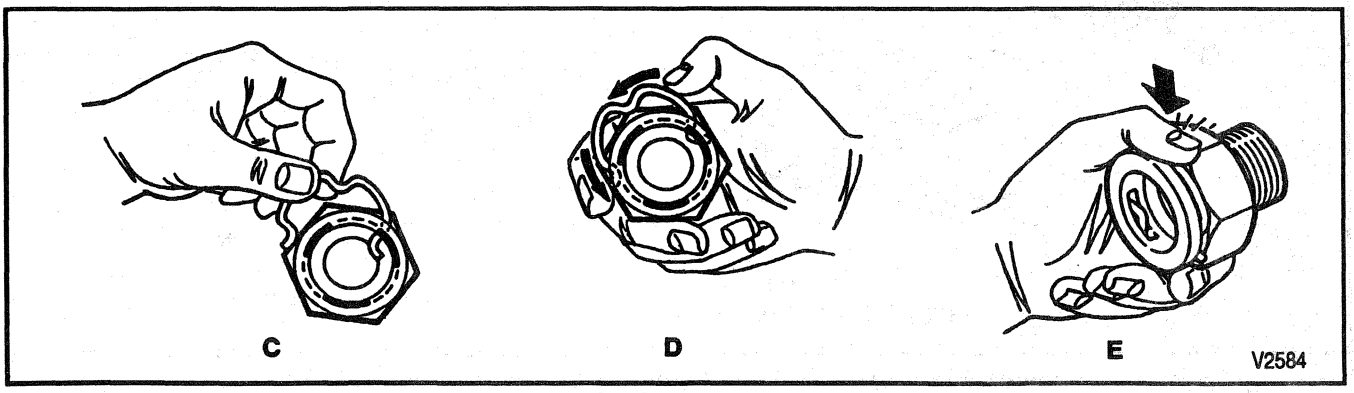


Figure 47—Installing Oil Cooler Line Clip Into Connector

5. Bolt and clamp to bracket.

Tighten

- Bolt to 9 N.m (80 lb in).

NOTICE: ***Do not reuse the existing retaining clips removed from the engine oil cooler line connector fittings. The two retaining clips being put into the engine oil cooler connector fittings must be new.***

NOTICE: ***Make sure the connector clip engages all three slots in the connector fitting. Failure to properly install the connector clip could cause the oil cooler line to come loose and cause damage to the engine.***

6. Retaining clip into connector fittings.
   - Using your thumb and forefinger, insert a new retaining clip into one of the three recesses in the connector fitting (C in Figure 47). With one end of the retaining clip engaged in the connector fitting slot, use your thumb and rotate the retaining clip around the connector fitting until it snaps into place (D and E in Figure 47).
7. Oil cooler lines to the connector fittings.
   - Test the flow of oil through the cooler before connecting the lines.
   - If the flow is not restricted, connect oil lines to the connector fitting.
   - If the flow is restricted, replace the radiator. Refer to "Radiator Replacement" in this section.
8. Line to connector fitting.
   - Ensure a click is either heard or felt and yellow identification on the end is hidden within the connector fitting.
9. Pull back sharply on the pipe to assure the pipe is fastened into the connector fitting.
10. Snap the plastic cap into connector fitting by sliding forward along the pipe.
    - Plastic cap must be seated against connector fitting hex.

Important

- If the plastic cap will not snap into place on the connector fitting, repeat procedure from Step 8.

11. Run engine and check for leaks.

SPECIFICATIONS

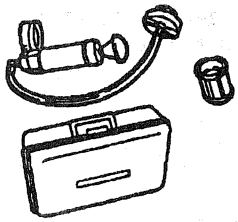
FASTENER TIGHTENING SPECIFICATIONS

Application	N.m	Lb ft	Lb in
Coolant Crossover Housing to Cylinder Head Bolt or Stud (Diesel Engines)	42	31	—
Coolant Outlet to Crossover Housing Bolt or Stud (Diesel Engines)	42	31	—
Coolant Outlet to Intake Manifold Bolt or Stud (4.3L, 5.0L, and 5.7L Engines)	28	21	—
Coolant Outlet to Intake Manifold Stud (7.4L Engines)	37	27	—
Water Pump Bolts (Gasoline Engines)	41	30	—
Water Pump Plate to Block Bolts (Diesel Engines)	23	17	—
Water Pump Plate to Block Studs (Diesel Engines)	23	17	—
Water Pump Plate to Water Pump Bolt (Diesel Engines)	23	17	—
Water Pump to Block Bolts (Diesel Engines)	23	17	—
Water Pump to Block Bolts (Diesel Engines)	42	31	—
Water Pump to Block Stud (Diesel Engines)	42	31	—
Coolant Recovery Reservoir Bolts	10	—	89
Coolant Temperature Sensor	23	17	—
Drive Belt Tensioner Bolt	50	37	—
Fan Clutch to Water Pump Stud (7.4L and 6.5L Engines)	8	—	71
Fan Clutch to Water Pump Stud Nuts(7.4L and 6.5L Engines)	24	18	—
Fan to Fan Clutch Bolts and Nuts (7.4L and 6.5L Engines)	24	18	—
Fan to Fan Clutch Bolts (4.3L, 5.0L, and 5.7L Engines)	23	17	—
Fan Clutch Nut to Water Pump Stud (4.3L, 5.0L, and 5.7L Engines)	56	41	—
Hose Support Bolt (5.7L Engines)	15	11	—
Idler Pulley Bolt	50	37	—
Lower Fan Shroud Bolts	9	—	71

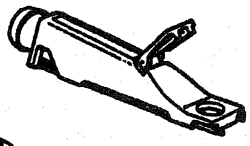
Application	N·m	Lb ft	Lb in
Oil Cooler Line Bracket Bolt	9	—	71
Oil Cooler Line Clamp Nut	13	—	115
Oil Cooler Line Clip Nut	6	—	53
Oil Cooler Line Fittings	24	18	—
Radiator Hose Clamps (Diesel Engines)	3	—	27
Radiator Inlet Hose Support Bolt (5.7L and 7.4L Engines)	3	—	27
Radiator Inlet Hose Support Bolt (Diesel Engines)	9	—	71
Upper Fan Shroud Bolts	9	—	71

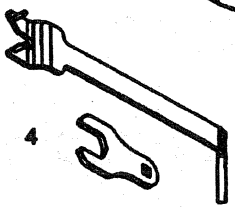
SPECIAL TOOLS

1  J 23699

2  J 24460-01

1. OVERFLOW TUBE PRESSURE TEST ADAPTER
2. COOLING SYSTEM TESTER
3. COOLANT TESTER
4. FAN CLUTCH WRENCH
5. BELT TENSION GAGE

3  J 23688 (FAHRENHEIT SCALE)
J 26568 (CENTIGRADE SCALE)

4  J 41240

5  J 23600-B
(V-BELT)
BT-33-97 M
(MULTIPLE RIBBED BELT)

10-10-95
3006T3237

SECTION 6D

ENGINE ELECTRICAL

CONTENTS

GENERAL DESCRIPTION

BATTERY

This section contains information on the maintenance, diagnosis, storage, charging and jump starting of batteries. Battery cable and ground strap routing also appear in this section.

CRANKING SYSTEM

This section covers the diagnosis, on-vehicle servicing and specifications of the cranking circuit and starter.

SD STARTER MOTOR

This section covers the disassembly, repair procedures, assembly and specifications of the SD-255 starter motor.

28-MT STARTER MOTOR

This section covers the disassembly, repair procedures, assembly and specifications of the 28-MT starter motor.

CHARGING SYSTEM

Generator diagnosis, on-vehicle servicing and specifications are covered in this section.

CS-144 GENERATOR

This section covers the disassembly, repair procedures, assembly and specifications of the CS-144 generator.

IGNITION SYSTEM

This vehicle is equipped with a distributor ignition (DI) system. On-vehicle service is limited to distributor and ignition coil testing. Procedures to replace the spark plugs, ignition coil and distributor are also located in this section. Refer to the Engine Controls, Transmission Diagnosis, and Electrical Diagnosis Manual for ignition timing instructions, diagnosis and servicing.

DISTRIBUTORS

This section covers the unit repair or bench repairing of distributors. Disassembly, repair procedures and assembly of distributors are covered in this section.

ENGINE WIRING

Engine wiring views are shown in SECTION 6D5. Refer to the Engine Controls, Transmission Diagnosis, and Electrical Diagnosis Manual for engine wiring schematics and diagnosis.

Important

Where a driveability complaint exists, or a Diagnostic Trouble Code is set, refer to the Engine Controls, Transmission Diagnosis, and Electrical Diagnosis Manual. Wiring diagrams, component locations, and system checks are located in the Engine Controls, Transmission Diagnosis, and Electrical Diagnosis Manual.

DIESEL GLOW PLUG ELECTRICAL SYSTEM

Diesel engines with electronic throttle controls have a glow plug electrical system that is controlled by the Powertrain Control Module (PCM). Information, including diagnosis on the PCM controlled system is in the Engine Controls, Transmission Diagnosis, and Electrical Diagnosis Manual.

SECTION 6D1

BATTERY

CAUTION: This vehicle has a Supplemental Inflatable Restraint (SIR) System. Refer to the SIR Component and Wiring Location view in order to determine whether you are performing service on or near the SIR components or the SIR wiring. When you are performing service on or near the SIR components or the SIR wiring, refer to the SIR On-Vehicle Service information. Failure to follow the CAUTIONS could cause air bag deployment, personal injury, or unnecessary SIR system repairs.

CAUTION: Before removing or installing any electrical unit, or when a tool or equipment could easily come in contact with "live" exposed electrical terminals, disconnect the negative battery cable to help prevent personal injury and/or damage to the vehicle or components. Unless instructed otherwise, the ignition switch must be in the "OFF" or "LOCK" position.

NOTICE: ***Always use the correct fastener in the proper location. When you replace a fastener, use ONLY the exact part number for that application. General Motors will call out those fasteners that require a replacement after removal. General Motors will also call out the fasteners that require thread lockers or thread sealant. UNLESS OTHERWISE SPECIFIED, do not use supplemental coatings (paints, greases, or other corrosion inhibitors) on threaded fasteners or fastener joint interfaces. Generally, such coatings adversely affect the fastener torque and joint clamping force, and may damage the fastener. When you install fasteners, use the correct sequence and tightening specifications. Following these instructions can help you avoid damage to parts and systems.***

CONTENTS

GENERAL DESCRIPTION

BATTERY

The maintenance-free battery is standard in all vehicles (Figure 1). Refer to "Specifications" later in this section for specific applications. These vehicles may be equipped with one or more batteries, 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 the small amount of gas produced in the battery to escape.

The battery has three functions in the electrical system: first, it provides a source of energy for cranking the engine; second, it acts as a voltage stabilizer for the electrical system; and third, it can, for a limited time, provide energy when the electrical load exceeds the output of the generator.

The battery specification label, as shown in Figure 2, contains information pertinent to the servicing of the battery. This information includes test ratings and both original equipment and recommended replacement part numbers. This information is also included in the "Specifications" at the end of this section.

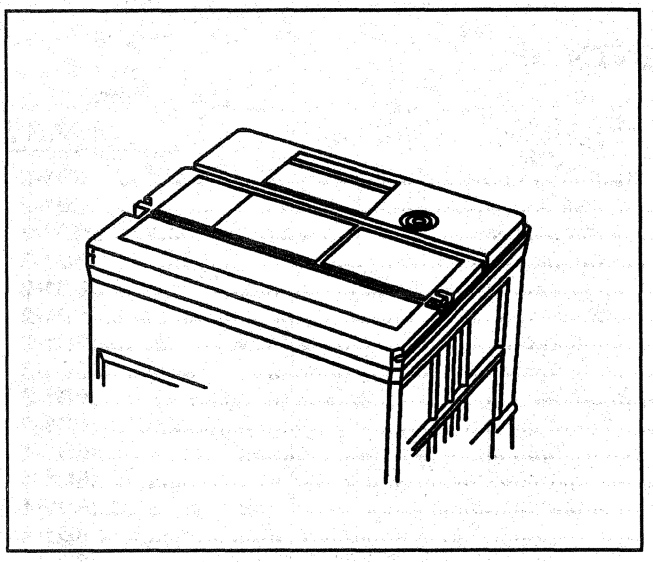


Figure 1—Maintenance-Free Battery (Side Terminals)

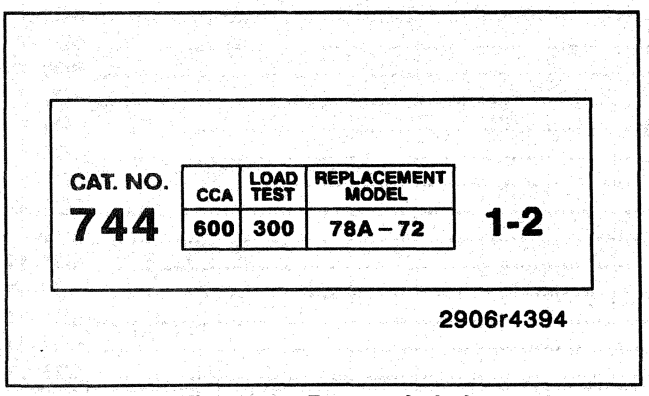


Figure 2—Battery Label

BATTERY RATINGS

A battery has two ratings: reserve capacity and cold cranking amperage.

Reserve Capacity

Reserve capacity is an estimate of how long the vehicle can be driven with no generator output, the headlamps turned on, and minimum electrical load (most 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 temperatures or current draws, the state of charge, the condition of the battery, etc., will affect how long the battery will actually last when the vehicle is being driven and there is no 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 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, etc.

COMMON CAUSES OF FAILURE

The battery is not designed to last indefinitely; however, with proper care, it will provide many years of service.

If the battery tests good, but fails to perform satisfactorily in service for no apparent reason, the following are some important factors that may point to the cause of trouble:

1. Vehicle accessories left on overnight.
2. Slow average driving speeds for long periods, or short trips, as the battery may not have sufficient time to recharge.
3. The vehicle's electrical load is more than generator output, particularly with the addition of aftermarket equipment.
4. Conditions in the charging system such as poor ground circuits, electrical shorts, slipping drive belt, or a faulty generator.

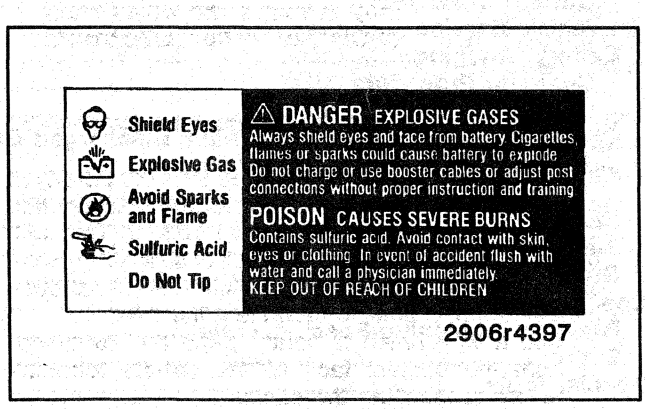


Figure 3—Safety Precautions

5. Battery abuse, including failure to keep battery cable terminals clean and tight or operating with a loose battery hold-down.
6. Mechanical conditions in the electrical system, such as shorted or pinched wires or a damaged battery case resulting from a collision.

The outside of the battery should be checked periodically for damage, such as a cracked cover or case.

ELECTROLYTE FREEZING

The freezing point of electrolyte depends on its specific gravity. Since freezing may ruin a battery, protect it against freezing by keeping it in a charged condition. 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).

CARRIER AND HOLD-DOWN

The battery carrier and hold-down clamp should be clean and free from corrosion before installing the battery.

The carrier should be in sound condition so it will hold the battery securely and keep it level. Make sure there are no parts in the carrier before installing the battery.

To prevent the battery from shaking in its carrier, the hold-down bolts should be tightened to the specifications given at the end of this section.

BATTERY PROTECTION DURING VEHICLE STORAGE

CAUTION: Follow all safety precautions. Refer to Figure 3.

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" in this section.

NOTICE: *Always turn off the ignition switch 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.*

To help keep the battery in a charged state while storing the vehicle:

- If the vehicle is likely to be stored for over 30 days, make sure the green dot is visible, then disconnect the negative battery cable at the battery. This will protect the battery from being discharged by parasitic current drains from the vehicle's electrical system. When it is time to reconnect the battery:
  - A. Use a wire brush to lightly clean any oxidation from the contact face of the battery terminal before reattaching the cable.
  - B. Tighten the cable bolt to 15 N.m (11 lb ft).
  - C. Reset the clock, pushbutton radio tuning, etc., before the vehicle is put back in service.
- If the battery cannot be disconnected, establish a regular schedule of recharging the battery every 20-45 days to maintain a high state of charge. Any time a battery is found with the green dot not visible in the hydrometer, promptly recharge the battery.
- To keep charge time low, use a battery charger that is capable of providing a charging voltage of at least 16 volts. Original equipment maintenance free batteries will not be damaged by charge rates of 50 amperes or more, as long as the battery does not spew electrolyte from the vents, or get too hot - over 52°C (125°F). Every 45-60 minutes, inspect the battery being charged and stop or reduce the charge if necessary. To avoid overcharging, be sure to stop charging within one hour after the green dot appears in the hydrometer.
- Allow ample charging time. Refer to "Battery Charging" in this section.
- A battery that is allowed to remain in a discharged state for a long period of time will be difficult to recharge, and permanent damage to the battery may occur if it is allowed to stay discharged.

BUILT-IN HYDROMETER

Molded into the top of the maintenance-free battery is a built-in temperature compensated hydrometer (Figure 4). Use this hydrometer with the following diagnostic procedure.

When observing the hydrometer, make sure the battery has a clean top. A light may be required in some poorly-lit areas.

Under normal operation, one of three indications can be observed:

1. GREEN DOT VISIBLE
   - Any green appearance in the hydrometer is interpreted as a "green dot." This means the battery is ready for testing.
2. DARK DOT, GREEN DOT NOT VISIBLE
   - If the green dot cannot be seen and there is a cranking complaint, proceed to "Diagnosis of the Battery" in this section for further testing. The charging system should be tested for output and the electrical system should be tested for excessive draws.

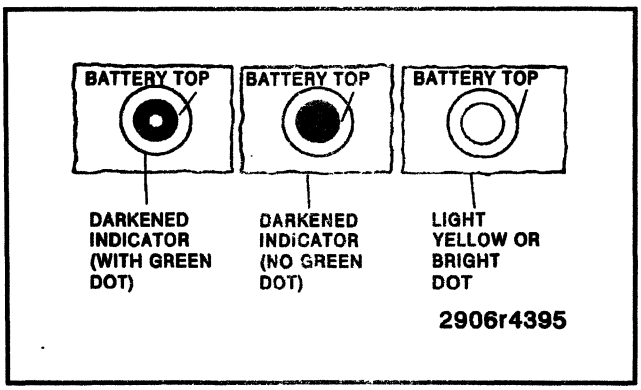


Figure 4—Built-In Hydrometer

3. CLEAR OR LIGHT YELLOW DOT
   - This means the electrolyte level is below the bottom of the hydrometer and is too low for diagnosis. This may have been caused by excessive or prolonged charging, a broken case, or excessive tipping. When finding a battery in this condition it may indicate high charging voltages caused by a faulty charging system. Therefore, the charging and electrical systems must be tested. The battery should be replaced if a cranking complaint exists and the battery has a yellow or clear hydrometer.

AUXILIARY CAMPER BATTERY (GAS ENGINE VEHICLES)

Description

An auxiliary battery is available for pickup models.

The auxiliary battery mounts to the left front of the engine compartment and is connected through a relay on the left wheelwell to the battery junction block on the right side of the cowl in the engine compartment. The relay is activated and grounded through the convenience center located on the left side of the cab behind the instrument panel.

Circuit Operation

Circuit operation is shown in Figure 6. Constant voltage is supplied from the main battery through the junction block and the black/red wire to the relay. Constant voltage is also supplied by the auxiliary battery to the relay and through the red feed wire to the camper. When the ignition switch is turned to RUN, current flows through the heater/air conditioning fuse in the fuse block, through the convenience center, and across the coil in the relay. The relay energizes and the contacts close. The auxiliary battery can now be charged by the vehicle's charging system.

If voltage is not reaching the camper unit feed wire, check the following:

1. Auxiliary battery state of charge.
2. Battery and convenience center ground wires.
3. Heater fuse by operating the heater or A/C with the engine running.
4. Fusible links.
5. Feed wire in-line fuse.

DIAGNOSIS OF THE BATTERY

BATTERY TESTING

Tools Required:

GM P/N 12303040 (or equivalent) Battery Terminal Adapters

J 39200 Digital Multimeter

The following procedure should be used for testing batteries (Figure 3):

1. VISUAL INSPECTION
   - Check for obvious damage, such as a cracked or broken case or cover, that could permit loss of electrolyte. If obvious damage is noted, replace the battery. Determine the cause of the damage and correct as needed. If not, proceed to Step 2.
2. HYDROMETER CHECK (Figure 4)
   A. GREEN DOT VISIBLE - Go to Step 3
   B. DARK; GREEN DOT NOT VISIBLE
      - Charge the battery as outlined under "Battery Charging" in this section, then proceed to Step 3.
   C. CLEAR OR YELLOW
      - If the hydrometer is clear or light yellow, the battery is low on electrolyte and should be replaced.
3. LOAD TEST
   - Load testing requires the use of battery side terminal adapters (Figure 5), GM P/N 12303040 or equivalent to ensure good connections. Do not load test a frozen battery. Replace it.

   A. Use J 39200 to measure voltage across the terminals. With all loads off, and the green dot showing in the hydrometer, voltage should be 12 volts or higher. Unless the battery has just been discharged (such as by load test or cranking the engine), replace the battery if the voltage is below 12 volts.
   B. With J 39200 still attached, connect a battery load tester across the battery terminals.
   C. If the battery has been charging, apply a 300 ampere load for 15 seconds to remove the surface charge from the battery. Remove load. (Do not complete this step if the battery has not been recently charged.)
   D. Wait 15 seconds to let the battery recover. Apply the specified load located on the battery label or listed in "Specifications" in this section. Read the voltage after 15 seconds, then remove the load.

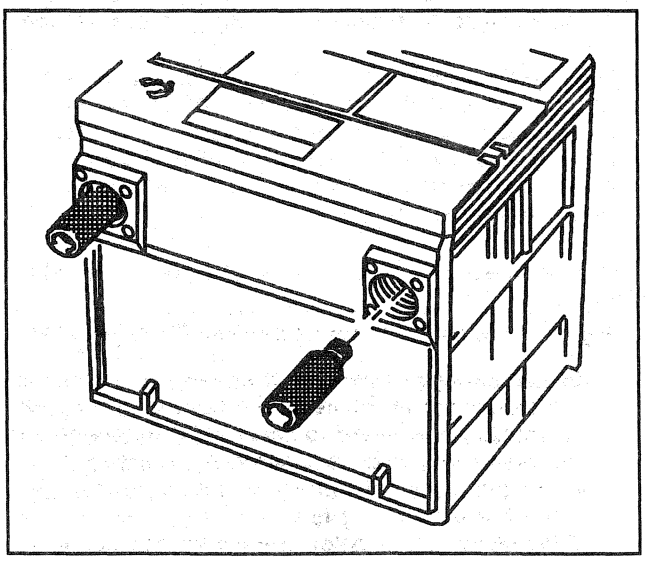
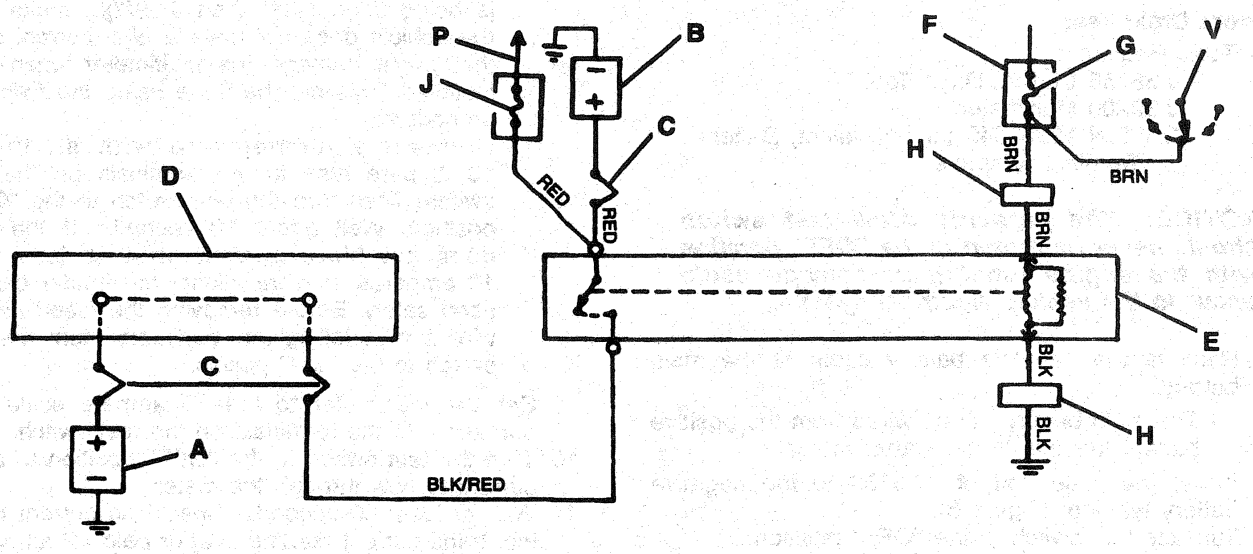


Figure 5—Battery Terminal Adapters



A. BATTERY
B. BATTERY, AUXILIARY
C. LINK, FUSIBLE
D. BLOCK, JUNCTION (HOT AT ALL TIMES)
E. RELAY, AUXILIARY
F. BLOCK, FUSE
G. FUSE, A/C HEATER — HOT IN RUN
H. CENTER, CONVENIENCE
J. FUSE, IN-LINE
P. WIRE, CAMPER FEED
V. SWITCH, IGNITION — RUN POSITION

F6923

Figure 6—Auxiliary Battery Schematic

ESTIMATED TEMPERATURE	MINIMUM VOLTAGE
70° F. (21° C.)	9.6
50° F. (10° C.)	9.4
30° F. (0° C.)	9.1
15° F. (−10° C.)	8.8
0° F. (−18° C.)	8.5
0° F. (BELOW −18° C.)	8.0

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Figure 7—Battery Temperature vs. Voltage Drop

E. If the voltage does not drop below the minimum value listed in Figure 7, the battery is good and should be returned to service. (The battery temperature must be estimated by feel and by the temperature the battery has been exposed to for the preceeding few hours.)
F. If voltage drops below the minimum value listed, replace the battery.

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 tested for an excessive electrical drain. This is referred to as "parasitic current drain."

If a battery needs recharging and no cause is evident, test 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 circuit continuity is restored. Even though cycling the ignition key to the RUN and then to the OFF position may at times 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, make sure the ignition switch is in the "LOCK" position, all electrical accessories are turned off, and the doors are closed.

Current Drain Test

Tools Required:
- J 38758 Currant Drain Tool
- J 39200 Multimeter
- GM P/N 12303040 (or equivalent) Battery Terminal Adapters

NOTICE: ***The parasitic draw test switch should never be turned to the "OFF" position with the engine running or damage could occur to the vehicle electrical system.***

1. Remove the negative battery cable at the main battery.
   - The main battery will be wired from the positive battery terminal to the starter motor.
2. Install the male end of J 38758 to the negative battery terminal (Figure 8).
3. Turn the test switch to the "OFF" position.
4. Install the negative battery cable to the female end of the test switch.
5. Turn the test switch to the "ON" position.
6. Road test the vehicle while activating all accessories, such as the radio and air conditioning.
7. Turn the ignition switch to the "OFF" position and remove the key.

Important

- From this point on, electrical continuity must be maintained in the ground circuit to the battery, either through the J 38758 (in the "ON" position) or through the ammeter.

8. Some components, such as PCM's, have timers that draw several amperes 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.

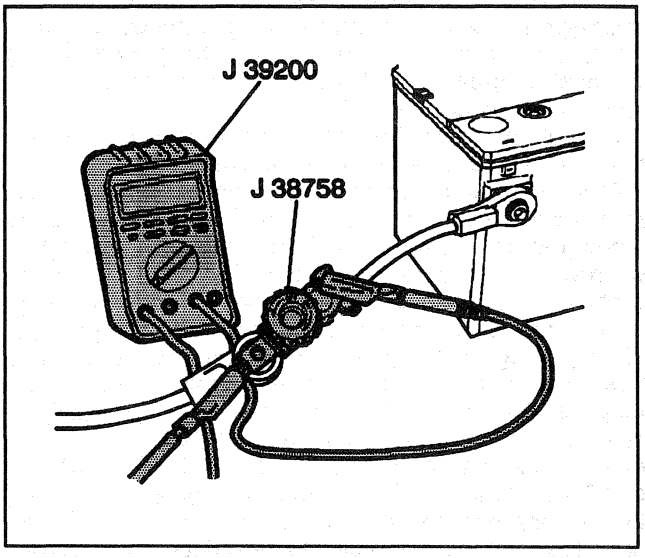


Figure 8—Parasitic Draw Test Switch Installed

Important

- Before performing Step 9, if a digital multimeter is being used other than J 39200, make sure the vehicle does not have a high current drain that might damage the multimeter when it is installed. This can be done using the following procedure.
- Connect a jumper wire with an in-line 10 ampere fuse to the terminals on the test switch. Then turn the test switch to the "OFF" position. Wait about 10 seconds. If the fuse does not blow, current draw is less than 10 amperes, and the digital multimeter can be used safely. Before removing the fused jumper wire and installing the multimeter, turn the test switch to the "ON" position.

9. Set the multimeter to the 10 ampere scale and connect it to the terminals on the test switch.
10. Turn the test switch to the "OFF" position to allow current to flow through the meter.
11. Wait at least 60 seconds. Check the current reading. If the current reading is at or below 2 amperes, turn the test switch to the "ON" position (to maintain continuity in the electrical system) and switch down to the 2 ampere scale for a more accurate reading when the test switch is reopened.
12. Take the reading in milliamperes.
13. Find the reserve capacity of the battery in "Specifications" in this section. Divide this number by 4. Compare this to the digital multimeter reading. The current drain reading should not exceed this number. (Example: If a battery has a reserve capacity of 100 minutes, the current drain should not exceed 25 milliamperes). If the vehicle has a diesel engine with 2 batteries, add the reserve capacities together and divide this total by four. If a vehicle is equipped with an auxiliary battery, use only the reserve capacity of the main battery.

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.***

14. If current draw is too high, remove system fuses one at a time until the draw returns to a value less than or equal to the specifications. Start with fuses that are hot at all times. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual. To remove the fuse, the door must be opened. This may cause a high enough current draw to damage the multimeter. To protect the meter without disrupting electrical continuity, turn the test tool to the "ON" position before opening the door. Then remove the courtesy lamp fuse. Note the meter reading. If the parasitic load is still excessive, start removing the other fuses, one at a time. Leave the courtesy lamp fuse out during diagnosis so the vehicle door can be left open.

    Perform Steps 10 through 12 each time a fuse is removed.

15. Removing the PCM fuse should cause a drop of less than 10 milliamperes.
    - If the drop is more than 10 milliamperes, check the orange wires for a short to ground. Also check the components connected to the orange wires. Refer to the Engine Controls, Transmission Diagnosis and Electrical Diagnosis Manual.
    - If there is no drop in the milliampere reading, the PCM is not drawing current. Refer to the Engine Controls, Transmission Diagnosis and Electrical Diagnosis Manual.
16. Repeat the parasitic current drain procedure after any repair has been completed.
17. When the cause of excessive current draw has been located and repaired, remove the meter, test switch, and terminal adapters and connect the negative battery cable to the negative battery terminal.

Tighten

- Negative battery cable bolt to 15 N·m (11 lb ft).

ON-VEHICLE SERVICE

BATTERY CHARGING

(Figures 2 through 5)

When it is necessary to charge the battery, the following basic rules must be followed (Figure 3):

1. Use a charger with an end of charge voltage of 16.0 volts and equipped with a voltmeter that is accurate within 1 percent.
2. Ambient (surrounding) temperature should be 15°C to 38°C (60°F to 100°F). A battery that is extremely cold may not accept measurable current for several hours after starting the charger.
3. Charging area should be well ventilated.
4. Do not charge the battery if the built-in hydrometer is clear or light yellow. If cranking problems exist, replace the battery.
5. Do not charge a battery if it seems to be frozen. Replace it.
6. Batteries with a green dot showing in the hydrometer do not require charging unless they have just been discharged (such as cranking the vehicle).

Charging Procedure

CAUTION: Always turn off the ignition switch when connecting or disconnecting battery cables, battery chargers, or jumper cables. Failure to do so may result in personal injury and damage to the powertrain control module or other electronic components.

When charging the battery in the vehicle, proceed to Step 1. If charging side terminal batteries out of the vehicle, install an adapter kit GM P/N 12303040 or equivalent (Figure 5).

The adapters should be tightened against the lead terminals of the battery to keep resistance between the adapter and the battery terminals to a minimum.

1. Make sure all charger connections are clean and tight.
2. Charge the battery using the charger setting for 12-volt batteries that gives the highest charge rate to the battery until the green dot appears. (Do not use charger settings for jump-starting vehicles to charge the battery. Refer to the charger manufacturer's instructions). The battery should be checked periodically while charging. Tap the hydrometer lightly on the top to dislodge any air bubbles that may prevent a correct indication.
3. If the battery feels hot 52°C (125°F), or if violent gassing or spewing of electrolyte through the vent holes occurs, discontinue charging or reduce the charging rate.
4. After charging, the battery should be tested as outlined in "Diagnosis of the Battery" in this section.

Charging Time Required

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

A. Size of the Battery - A completely discharged heavy-duty battery requires more than twice the recharging time as a completely discharged light-duty battery.
B. Temperature - The colder the battery, the more time it takes to recharge. When a fast charger is connected to a cold battery, the current accepted by the battery will be very low at first. In time the battery will accept a higher rate as the battery warms.
C. Charger Capacity - The higher the charger amperage, the less time it will take to charge the battery.
D. State-of-Charge - A completely discharged battery requires more than twice as much charge as a one-half charged battery. Because the electrolyte is nearly pure water and a poor conductor in a completely discharged battery, the current accepted by the battery is very low at first. Later, as the charging current causes the electrolyte acid content to increase, charging current will also increase.

Any battery discharged by parasitic current drain, and then allowed to stand in this condition for a period of time, may not accept a charge readily. However, if recharged long enough, many batteries will return to a usable condition.

If the battery remains in an extremely discharged condition for a prolonged period, it can become permanently damaged. This damage can be accelerated by changes in temperatures. Batteries that are extremely discharged can freeze at temperatures as high as -7°C (20°F) and be permanently damaged.

To prevent battery damage and recharge problems, vehicles that are not going to be in service within a 30 day period should have the negative battery cable disconnected to remove the constant drain on the battery. If this is not possible, recharge the battery periodically every 30-45 days until the green dot is visible.

CHARGING A VERY LOW OR COMPLETELY DISCHARGED BATTERY

The following procedure should be used to recharge a very low or completely discharged battery. Unless the procedure is properly followed, a perfectly good battery may be needlessly replaced.

1. Measure voltage at battery terminals with J 39200. If voltage is below 11 volts, charge current will be very low and it could take some time before it accepts current in excess of a few milliamperes.
2. Set the battery charger on the high setting.
3. Some chargers feature polarity protection circuitry that prevents charging unless the charger leads are connected to the battery terminals correctly. A completely discharged battery may not have enough voltage to activate this circuitry, even though the leads are connected properly, making it appear that the battery will not accept charging current. Therefore, follow the specific charger manufacturer's instructions telling how to bypass or override the circuitry so the charger will turn on and charge a low-voltage battery.
4. Battery chargers vary in the amount of voltage and current they provide. The time required for the battery to accept measurable charger current at various voltages may be as follows:
   - 16.0 volts or more up to 4 hours
   - 14.0 to 15.9 volts up to 8 hours
   - 13.9 volts or less up to 16 hours

Important

   - If the charge current IS NOT measurable at the end of the above charging times, replace the battery. If the charge current IS measurable during the charging time, the battery is considered to be good. Complete the charging in the normal manner.

5. It is critical to remember that a completely discharged battery must be recharged for a sufficient number of ampere hours (AH) to restore it to a useable state. As a rule of thumb, use the reserve capacity rating of the battery to determine how long it will take to completely recharge the battery. For capacity ratings, refer to "Specifications" in this section. Divide the reserve capacity rating by the amount of ampere charge to determine how many hours of charging are needed. (Rating divided by amperes = hours.)
   - For example: a battery with a reserve capacity rating of 75, charged at a rate of 10 amperes, will take 7.5 hours to fully recharge (75 divided by 10 = 7.5). The same battery, charged at a rate of 25 amperes, will take 3 hours to fully recharge (75 divided by 25 = 3).
6. Any battery recharged by this procedure should be load tested to determine serviceability. Refer to "Diagnosis of the Battery" in this section.

JUMP STARTING IN CASE OF EMERGENCY

Do not try to jump start a vehicle if you are unsure of the other vehicle's voltage or ground, or if the other vehicle's voltage and ground are different.

Diesel engine vehicles have more than one battery. Should the vehicle have an optional diesel engine or an auxiliary battery option, use only the battery on the passenger side of the vehicle.

This procedure can be used to start a single-battery vehicle from any of the diesel engine vehicle's batteries. However, at low temperatures, it may not be possible to start a diesel engine vehicle from a single battery in another vehicle.

The booster battery and discharged battery should be treated carefully when using jumper cables. Follow the procedure outlined below, being careful not to cause sparks.

CAUTION: Batteries produce explosive gasses, contain corrosive acid, and supply levels of electrical current high enough to cause burns. Therefore, to reduce the risk of personal injury when working near a battery:
- **Always shield your eyes and avoid leaning over the battery whenever possible.**
- **Do not expose the battery to open flames or sparks.**
- **Do not allow battery acid to contact the eyes or skin. Flush any contacted areas with water immediately and thoroughly, and get medical help.**
- **Follow each step in the jump starting instructions.**

NOTICE: ***Do not push or tow the vehicle to start it. Under some conditions this may damage the catalytic converter or other parts of the vehicle. Also, since this vehicle has a 12-volt negative ground electrical system, make sure the vehicle or equipment used to jump start the engine has a 12-volt negative ground electrical system. Use of any other type system may damage the vehicle's electrical components.***

Jump Starting Procedure

1. Position the vehicle with the good (charged) battery so that the jumper cables will reach, but NEVER let the vehicles touch. Also, make sure the jumper cables do not have loose or missing insulation.
2. Set the parking brake and place the transmission in neutral. Block the wheels. Turn off the ignition switch, lights, and all other electrical loads that aren't needed except for the hazard flasher or any lamps needed for the work area.
3. Check the built-in hydrometer. If it is clear or light yellow, do not attempt to jump start the battery. Replace it.
4. Attach the end of one jumper cable to the positive terminal of the booster battery and the other end of the same cable to the positive terminal of the discharged battery (Figure 9). A is the charged battery, B is the dead battery.

5. Attach one end of the remaining negative jumper cable to the negative terminal of the booster battery.
6. Make the final connection of the negative cable to a solid ground (such as an A/C compressor bracket), at least 450 mm (18 inches) from the battery of the vehicle being started (Figure 9).
7. Start the engine of the vehicle that is providing the jump start and turn off all electrical accessories. Then start the engine in the vehicle with the discharged battery.
8. Reverse Steps 4, 5, and 6 exactly when removing the jumper cables. The negative cable must be disconnected from the engine that was jump started first (Figure 10).

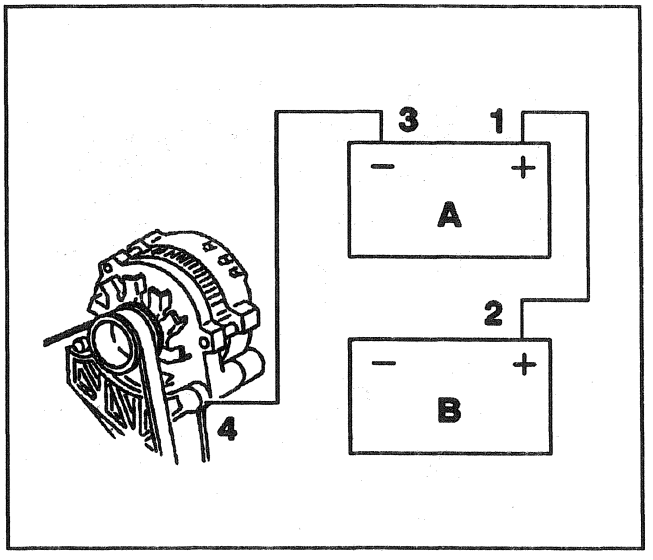


Figure 9—Installing Jumper Cables

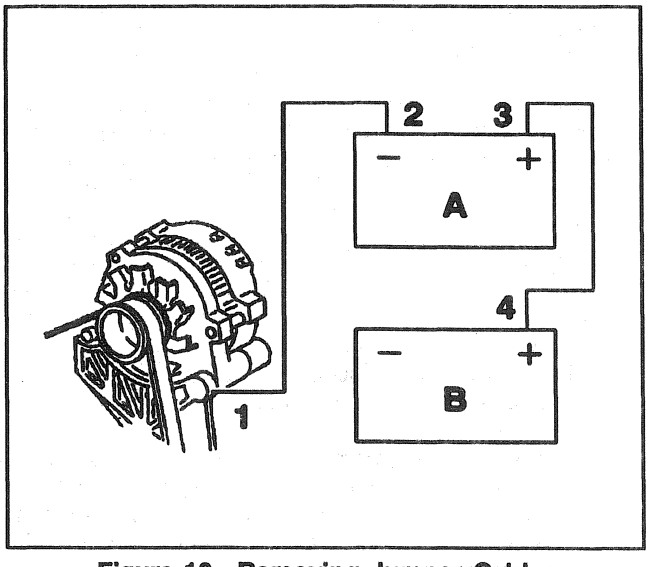


Figure 10—Removing Jumper Cables

BATTERY REPLACEMENT

Remove or Disconnect (Figure 12)

1. Negative cable from the negative battery terminal.
2. Positive cable from the positive battery terminal.
3. Battery hold-down retainer.
4. Battery.

Inspect

- Battery for damage.
- Cables and connectors for corrosion or wear.
- Carrier for damage or foreign objects.

- If damage is noted, find and correct the cause.

Clean

- Corrosion from cables and connectors.
- Battery tray of any foreign objects.

Install or Connect (Figure 12)

NOTICE: ***Refer to "Notice" on page 6D1-1.***

1. Battery into carrier.

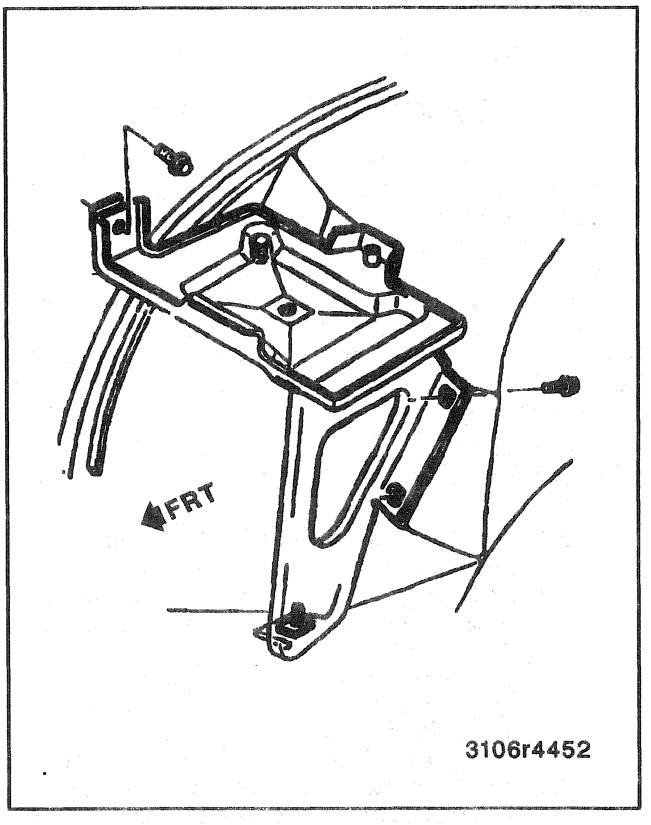


Figure 11—Battery Tray

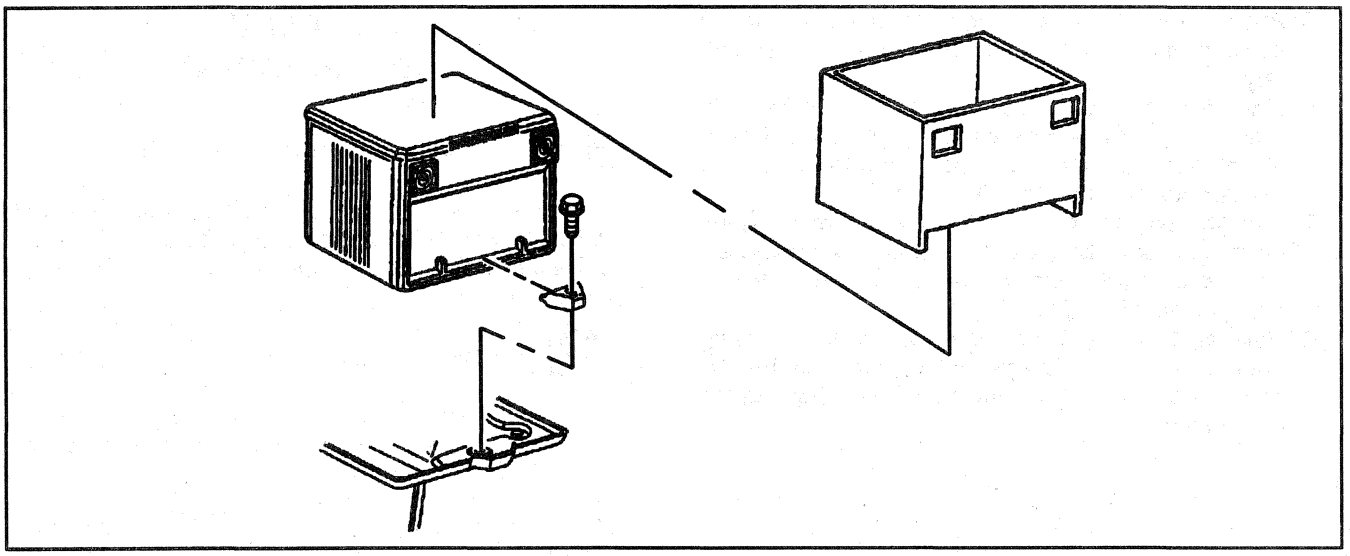


Figure 12—Battery Retainer

2. Hold-down retainer.

Tighten

- Retainer bolt to 15 N·m (11 lb ft).

3. Positive cable and positive battery terminal to the battery.
4. Negative cable and negative battery terminal to the battery.

Tighten

- Side terminals to 15 N·m (11 lb ft).

BATTERY CABLES

Excessive resistance caused by poor terminal connection 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 normal starter operation and cause hard starting.

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

Always be certain when replacing a battery cable to route it the same as the original cable.

CAUTION: To prevent possible personal injury from a moving vehicle or operating engine, do the following before performing the tests:

1. **Engage the parking brakes and block the wheels.**
2. **Place the manual transmission in the Neutral position or the automatic transmission in Park.**
3. **On gas engines, disconnect the battery feed at the distributor. On diesel engines, disconnect the battery feed at the engine shutoff (ESO) solenoid.**

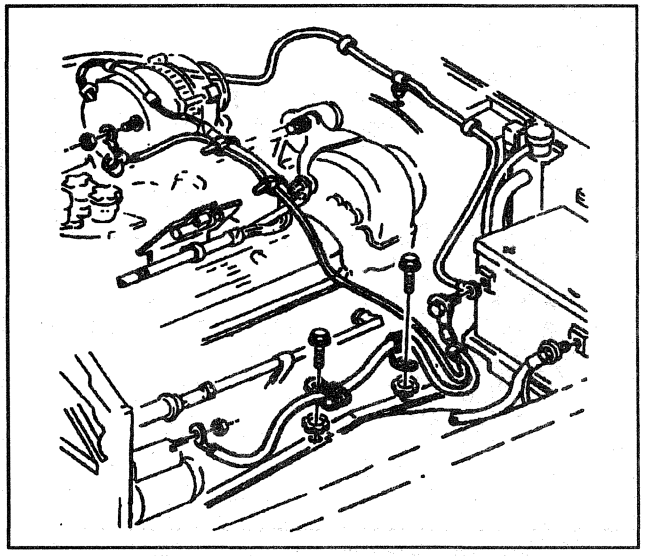


Figure 13—Battery Cable Routing (Gas Engines)

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 other leads are installed. Failure to do so may result in solenoid terminal and/or solenoid damage.***

1. Test the voltage drop between ground (negative battery terminal) and the vehicle frame. Place one probe of 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. Test the voltage drop between the positive battery terminal and starter terminal stud with the starter operating.
3. Test 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 volt, there is excessive resistance in the circuit. To eliminate resistance, the cables should be dis-

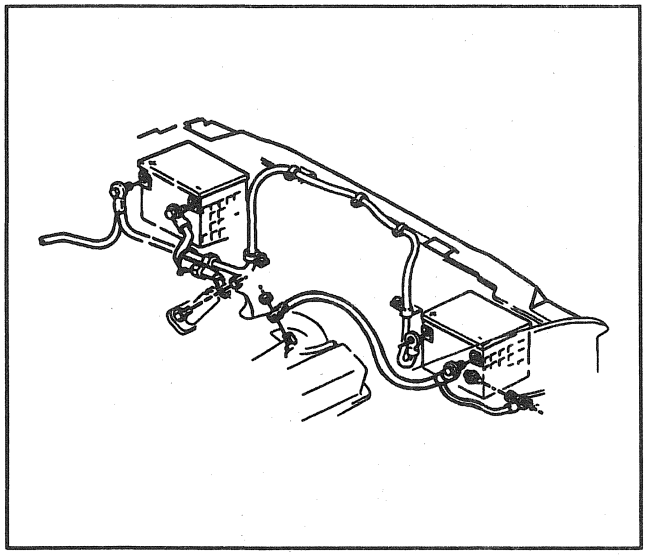
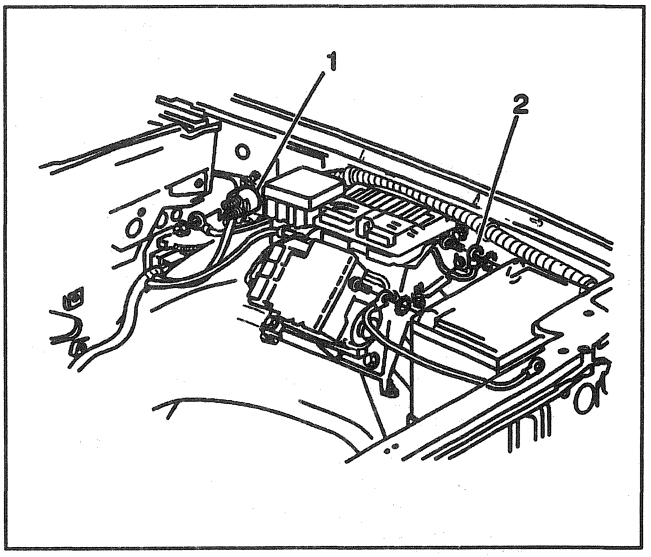


Figure 14—Battery Cable Routing (6.5L Diesel)

connected and connections cleaned. If cables are frayed or the clamps corroded, the cables should be replaced. When selecting new cables, be sure they are the same length and diameter as the ones being replaced. Battery cable routing is shown in Figures 13 through 15.

GROUND STRAPS

Additional ground straps are used to connect the body and frame to the engine and transmission. Always connect all ground straps to ensure a good ground path to the battery from all electrical components. For illustrations and ground strap locations, refer to SECTION 6D5.



Legend
(1) Auxiliary Battery Relay
(2) Auxiliary Battery Cable

Figure 15—Auxiliary Battery, Relay, and Wiring

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

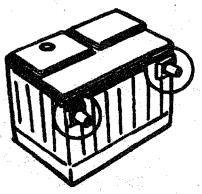
Application	N·m	Lb ft	Lb in
Retainer Bolt	23	17	—
Battery Cable Bolts	15	11	—

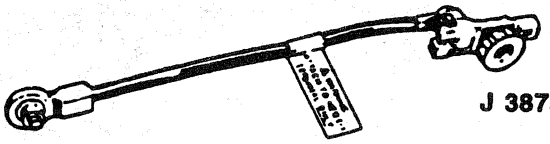
BATTERY

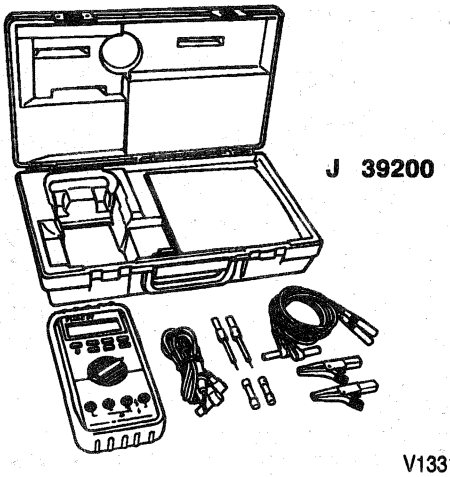
Catalog Number	Application	Catalog Replacement Number	Volts	Cold Cranking Amperes Rating @ -18° (0°F)	Reserve Capacity (Minutes at 25 Amps)	Load Test (Amperes)
1900676	All	78A-72	12	600	115	300
1900678	All	78A-84	12	690	115	340

T2080

SPECIAL TOOLS

1.  S/T ADAPTERS

2.  J 38758

3.  J 39200

1. BATTERY TERMINAL ADAPTERS—GM P/N 12303040
2. CURRENT DRAIN TOOL
3. MULTIMETER

V1331

SECTION 6D2

CRANKING SYSTEM

CAUTION: This vehicle has a Supplemental Inflatable Restraint (SIR) System. Refer to the SIR Component and Wiring Location view in order to determine whether you are performing service on or near the SIR components or the SIR wiring. When you are performing service on or near the SIR components or the SIR wiring, refer to the SIR On-Vehicle Service information. Failure to follow the CAUTIONS could cause air bag deployment, personal injury, or unnecessary SIR system repairs.

CAUTION: Before removing or installing any electrical unit, or when a tool or equipment could easily come in contact with "live" exposed electrical terminals, disconnect the negative battery cable to help prevent personal injury and/or damage to the vehicle or components. Unless instructed otherwise, the ignition switch must be in the "OFF" or "LOCK" position.

NOTICE: ***Always use the correct fastener in the proper location. When you replace a fastener, use ONLY the exact part number for that application. General Motors will call out those fasteners that require a replacement after removal. General Motors will also call out the fasteners that require thread lockers or thread sealant. UNLESS OTHERWISE SPECIFIED, do not use supplemental coatings (paints, greases, or other corrosion inhibitors) on threaded fasteners or fastener joint interfaces. Generally, such coatings adversely affect the fastener torque and joint clamping force, and may damage the fastener. When you install fasteners, use the correct sequence and tightening specifications. Following these instructions can help you avoid damage to parts and systems.***

CONTENTS

GENERAL DESCRIPTION

CRANKING CIRCUIT

The cranking circuit consists of the battery, starter motor, ignition switch (gasoline engines), engine control switch (diesel engines), neutral-start switch (manual transmission), and related electrical wiring (Figures 1 and 2).

For detailed schematics of the cranking system, refer to the Engine Controls, Transmission Diagnosis and Electrical Diagnosis Manual.

STARTER MOTOR

Three starter motors are used on these engines.

The SD-255 and 260 is a straight drive starter with the pinion driven directly by the armature shaft. Pole pieces are arranged around the armature that is energized by wound field coils (Figure 3). This type is used on gas engines.

The PG-260 achieves gear reduction at a ratio of 5:1 through planetary gears. Its relatively small size and light weight offers improved cranking performance and reduced current requirements for larger gasoline engines (Figures 4 and 5).

The 28-MT, used on diesel engines, is a gear reduction starter with an overrunning roller type clutch and an enclosed shift lever (Figures 6 and 7).

Enclosed shift lever cranking motors have the shift lever mechanism and the solenoid plunger enclosed in the drive housing, protecting them from exposure to dirt, icing conditions, and splash.

Solenoid windings are energized when the ignition switch is in the start position. The resulting plunger and shift lever movement causes the pinion to engage the engine flywheel ring gear, the solenoid main contacts to close, and cranking takes place. When the engine starts, the pinion overrunning clutch protects the armature from excessive speed until the ignition switch is released. At this time the plunger return spring causes

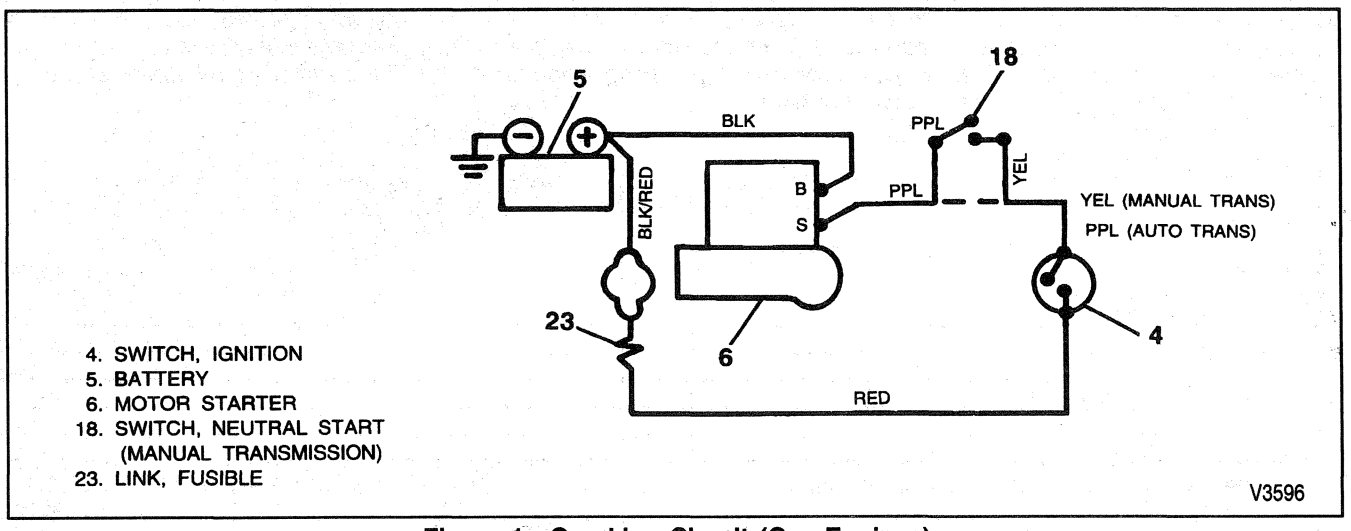


Figure 1—Cranking Circuit (Gas Engines)

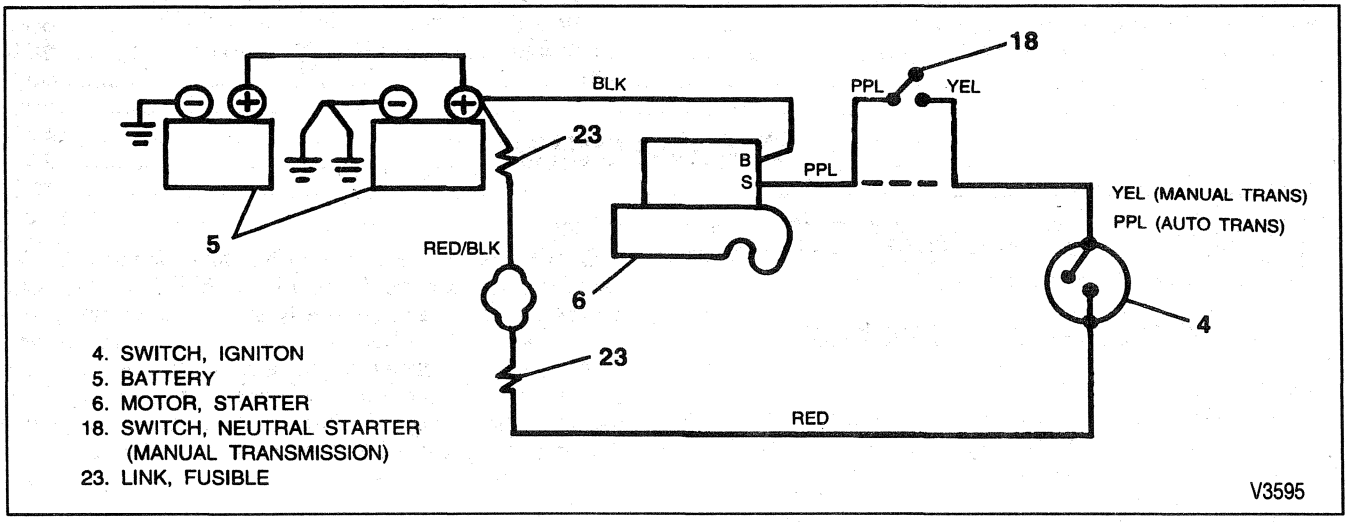


Figure 2—Cranking Circuit (Diesel Engine)

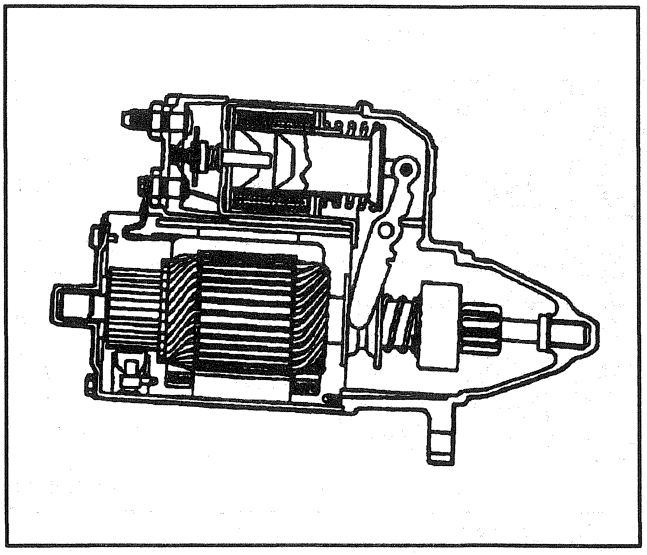


Figure 3—SD Series Starter Motor (Typical)

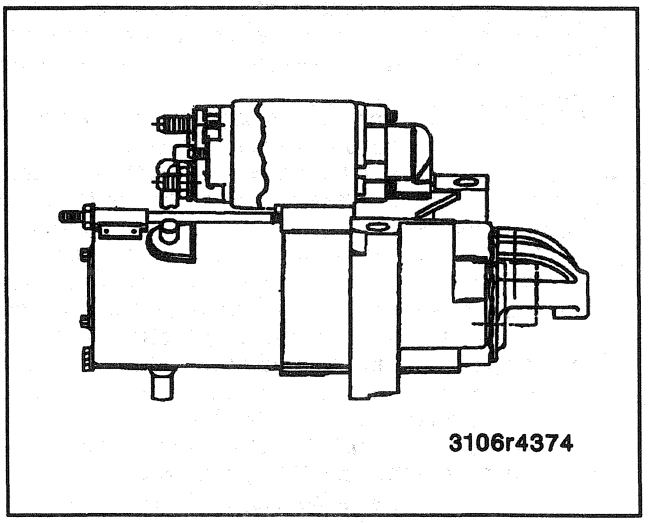


Figure 4—PG-260 Starter Motor

the pinion to disengage. To prevent excessive overrunning, release the switch from the crank position as soon as the engine starts.

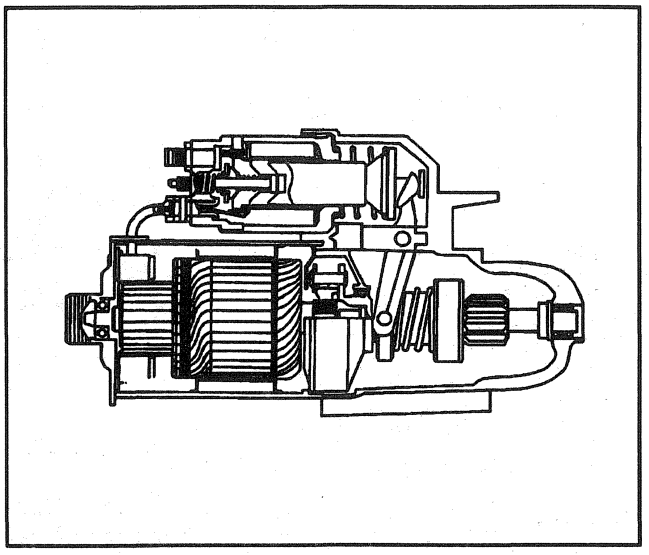


Figure 5—PG Series Components (Typical)

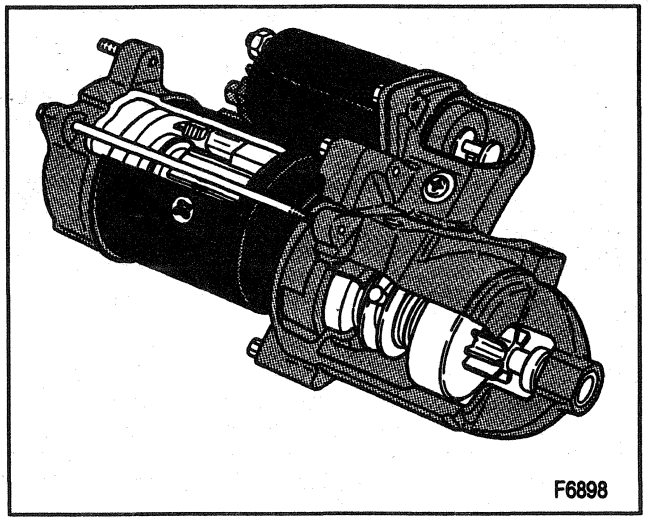


Figure 6—28-MT Starter Motor

Unit Repair Information

For bench repair of the SD-255 and 260, or 28-MT starter motors, Refer to SECTION 6D2B.

PG-260 model starters are serviced by replacement only.

DIAGNOSIS

Refer to Figures 8 and 9 for diagnosis of the cranking system. Before removing any component in the system for repair, make the following checks.

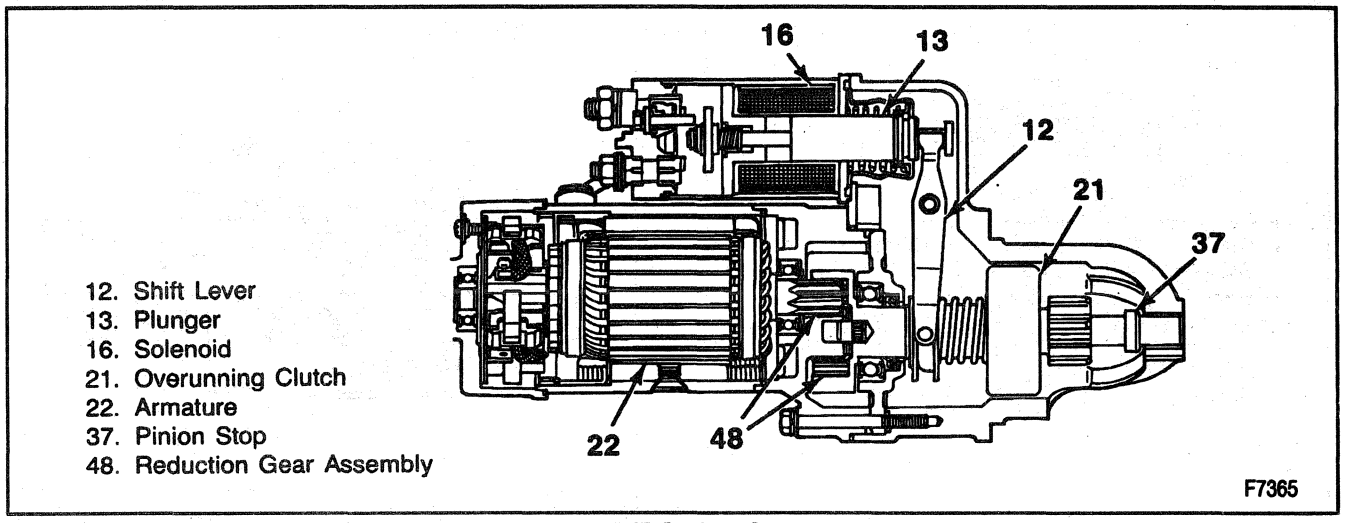
CRANKING CIRCUIT

Battery

Determine the condition of the battery. Refer to SECTION 6D1 for battery diagnosis and testing.

Wiring

Check the 10 ampere CRANK fuse. Inspect the system for open circuits, loose terminals inside connectors, corrosion, and damage. Verify that no wires are pierced by screws and no harnesses are missing insulation by rubbing on components. Inspect all connections to the starter motor, solenoid, ignition (or engine control) switch, and battery, including all ground connections. Clean and tighten all connections as required.



12. Shift Lever
13. Plunger
16. Solenoid
21. Overunning Clutch
22. Armature
37. Pinion Stop
48. Reduction Gear Assembly

Figure 7—28-MT Series Components

Solenoid and Control Switches

Inspect all switches to determine their condition.

Vehicles equipped with manual transmissions have a neutral-start switch attached to the clutch pedal that closes when the pedal is depressed. Vehicles with automatic transmissions have a mechanical interlock in the steering column that does not allow the ignition switch to turn to START unless the transmission is in PARK or NEUTRAL.

STARTER MOTOR NOISE

Refer to "Diagnosis of Starter Motor Noise" in this section.

Pinion Clearance (Gas Engines)

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. If the flywheel needs replacing, refer to SECTION 6.
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.
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 (Figure 10). Normal clearance is 0.5 to 1.5 mm (0.02 to 0.06 inch).
   - 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.
   - 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.
7. 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.
   - Add 0.33 mm (0.013 inch) shims between the outboard starter mounting pad and the engine mount until the noise stops. Do not add more than 4 shims total.
8. When shimming is done, tighten the mounting bolts (Figure 11).

Tighten

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

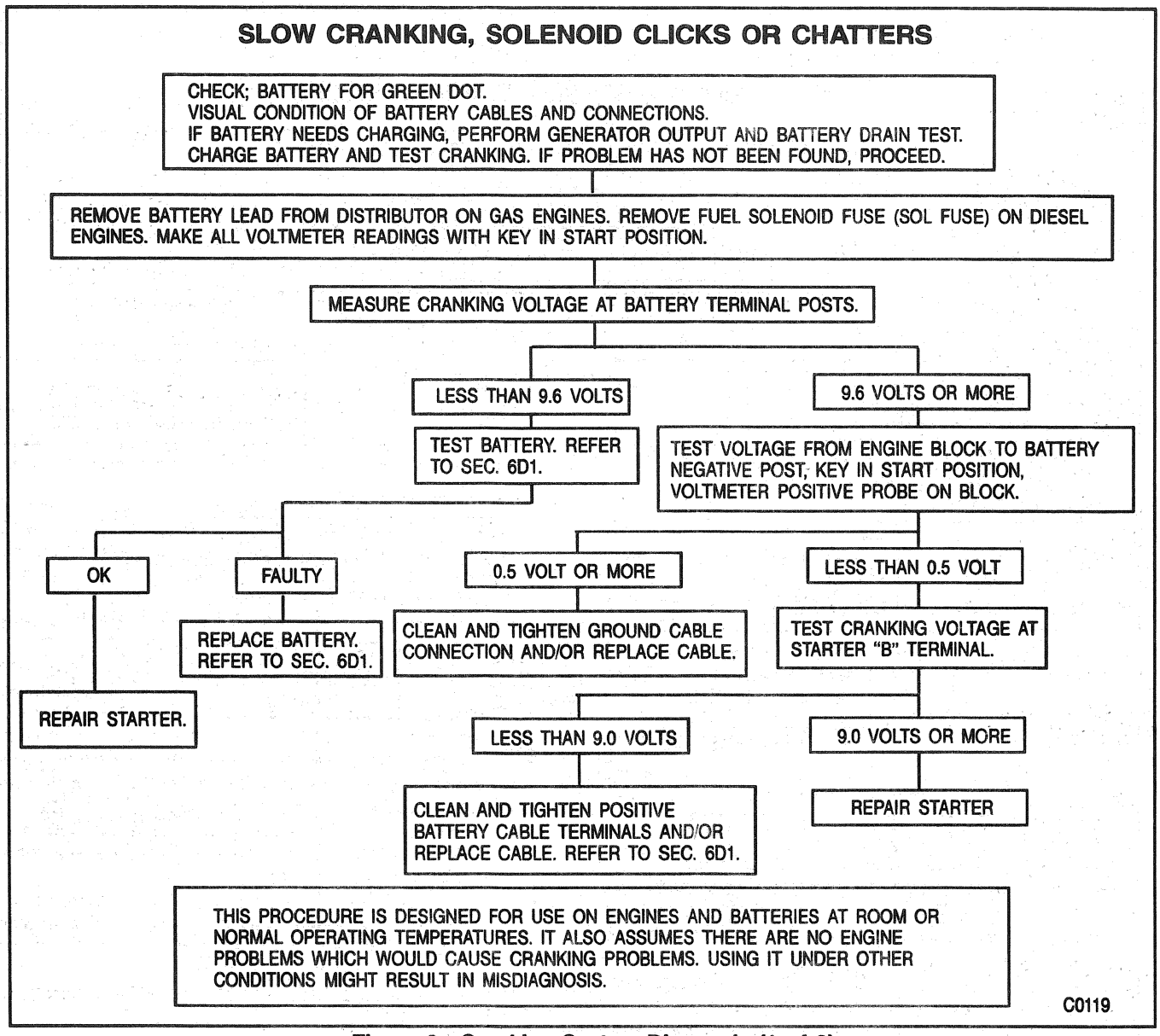


Figure 8—Cranking System Diagnosis (1 of 2)

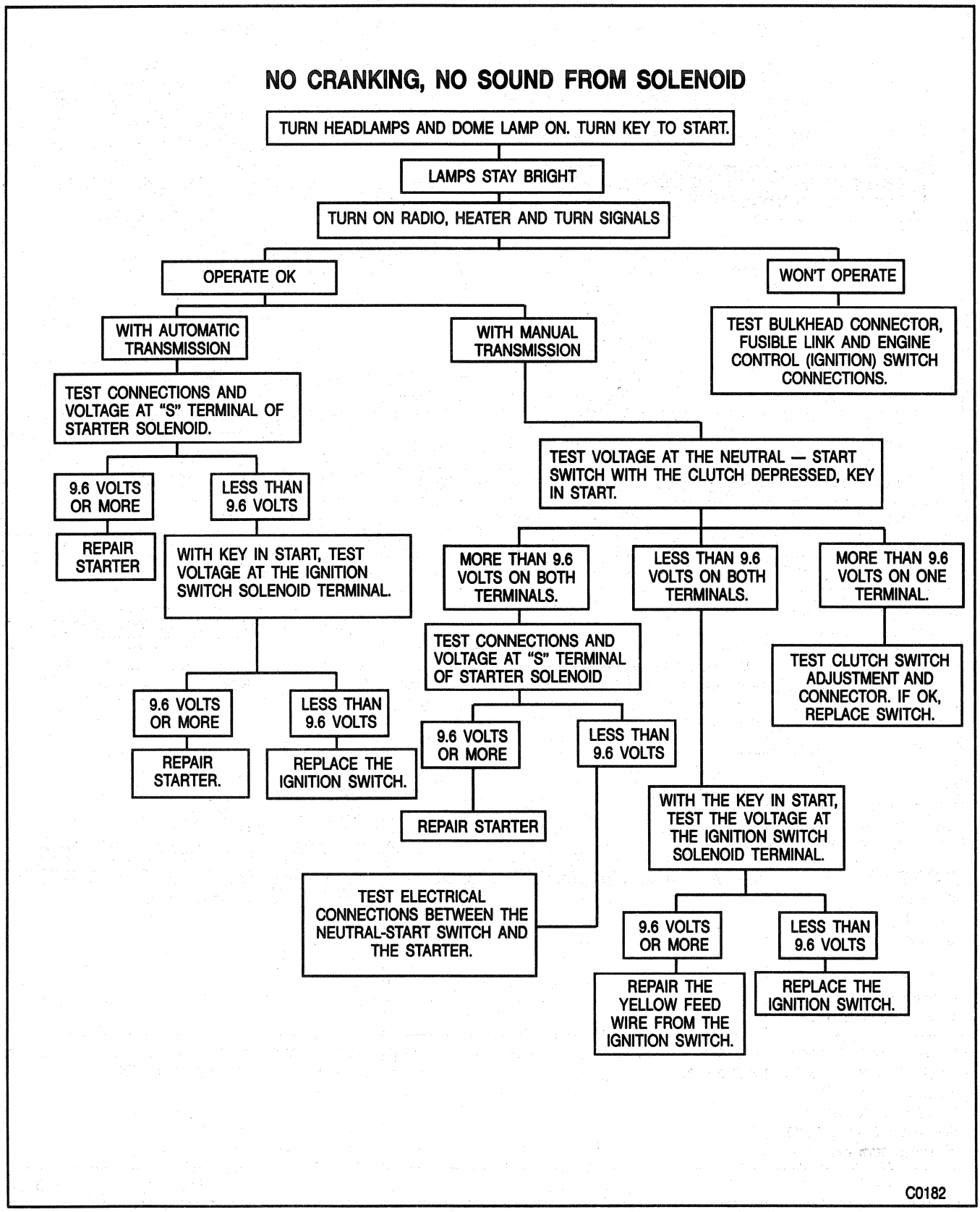


Figure 9—Cranking System Diagnosis (2 of 2)

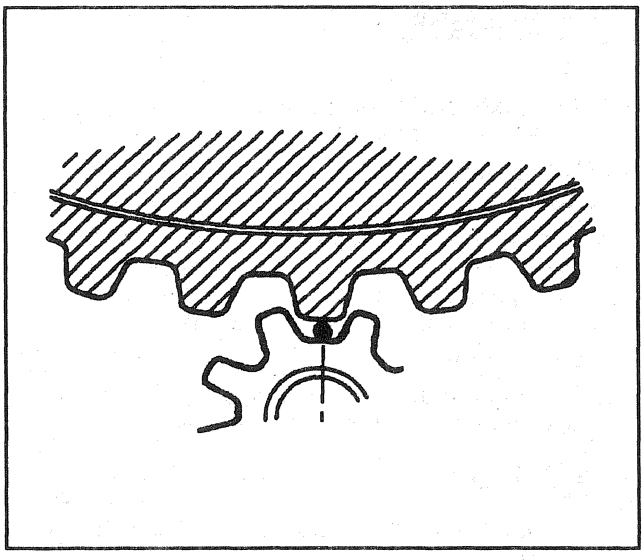


Figure 10—Flywheel to Pinion Clearance

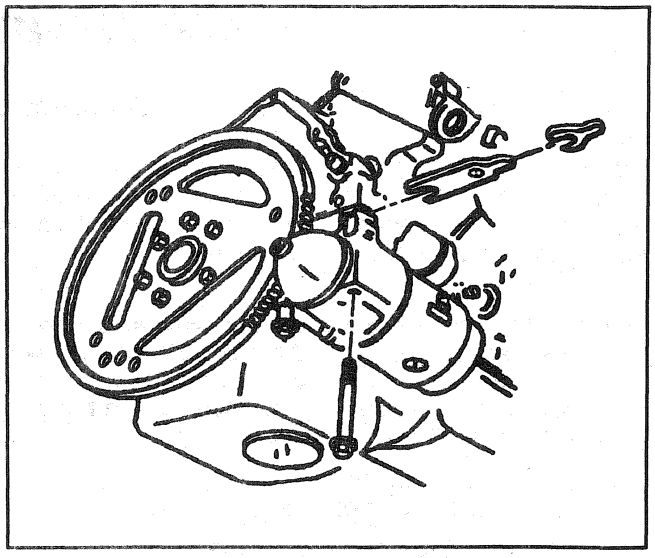


Figure 11—Shimming Gas Engine Starter Motors

DIAGNOSIS OF STARTER MOTOR NOISE

PROBLEM	POSSIBLE CAUSE	CORRECTION
High-pitched whine during cranking (before engine fires) but engine cranks and fires normally.	Distance too great between the starter pinion and the flywheel.	Remove shims at the starter mount. Refer to "Starter Motor Noise" in this section.
High-pitched whine after the engine fires as key is being released. The engine cranks and fires normally. This complaint is often diagnosed as "starter hang-in" or "solenoid weak."	Distance too small between the starter pinion and the flywheel. Flywheel runout contributes to the intermittent nature of the problem.	Add shims at the starter mount. Refer to "Starter Motor Noise" in this section.
A loud "whoop" after the engine fires but while the starter is still held engaged. Sounds like a siren if the engine is revved while the starter is engaged.	Usually due to a worn starter motor clutch.	Remove the starter motor and check the clutch. Refer to section 6D2A.
A "rumble," "growl" or (in severe cases) a "knock" as the starter is coasting down to a stop after starting the engine.	Usually due to a bent or unbalanced starter armature.	Remove the starter motor and check the armature. Refer to section 6D2A.
		D0134

ON-VEHICLE SERVICE

Starter motors do not require lubrication except during overhaul.

If the battery, wiring, and switches are in good condition, and the engine is functioning properly, but cranking problems remain, remove the starter motor. Refer to SECTION 6D2B for repair procedures.

NOTICE: ***Never operate the starter motor more than 15 seconds at a time without pausing to allow it to cool for at least 2 minutes. Overheating, caused by excessive cranking, will damage the starter motor.***

STARTER MOTOR REPLACEMENT

Remove or Disconnect (Figures 12 through 15)

1. Negative battery cable. Refer to CAUTION on page 6D2-1.
2. Starter brackets and/or shields, if equipped.
3. Wires from the starter solenoid.
   - Raise the vehicle and support with safety stands.
4. Two bolts and washers (where present) holding the starter to the engine.
5. Starter from the engine.

Install or Connect (Figures 12 through 15)

NOTICE: *Refer to "Notice" on page 6D2-1.*

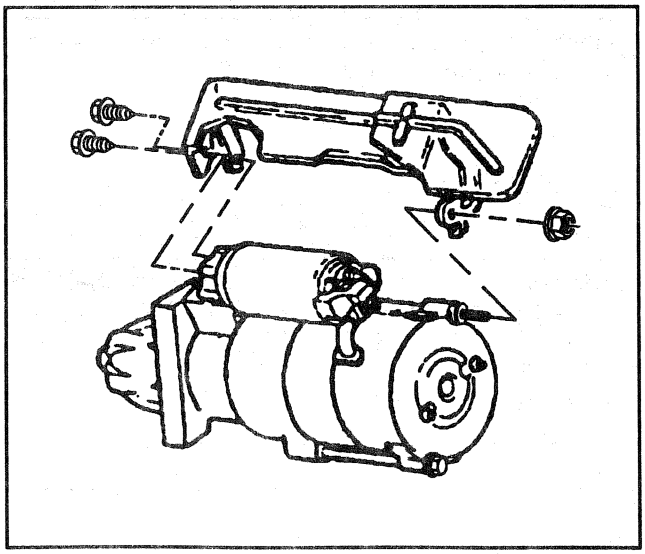


Figure 12—Gas Engine Starter Motors and Heat Shield (5.7 - 7.4L)

1. Two bolts and washers (where used) through the starter to the engine.

Tighten

- Mounting bolts (diesel) to 40 N·m (30 lb ft).
- Mounting bolts (gas) to 45 N·m (33 lb ft).
- Bracket Nut (diesel) to 8 N·m (75 lb in).
- Nut (diesel) to 8 N·m (75 lb in).

- Lower the vehicle.

2. Wires to the solenoid terminals.
3. Brackets and/or shields, if equipped.

Tighten

- Heat Shield bolts (diesel) to 17 N·m (13 lb ft).

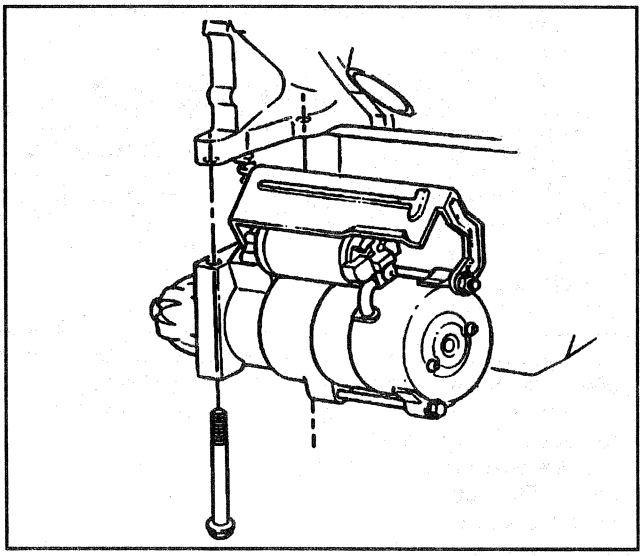


Figure 13—Gas Engine Starter Motors and Heat Shield

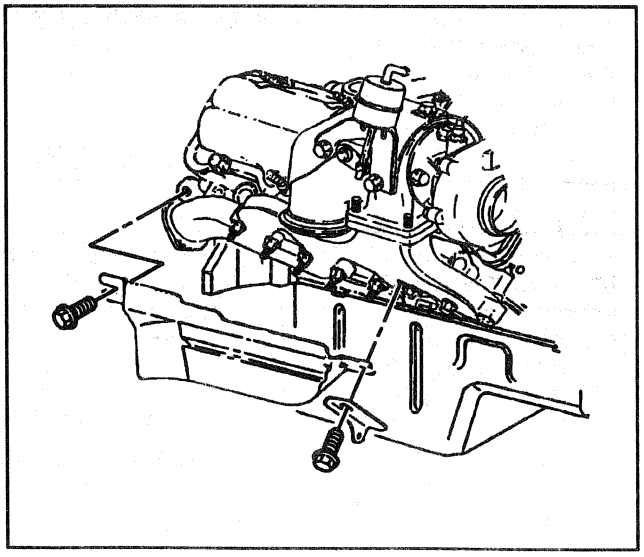


Figure 14—Diesel Engine Starter Motor Shield

- Heat Shield bolts (gas) to 12 N·m (9 lb ft).

4. Negative battery cable.

STARTER DRAW TEST

Tools Required:
J 39200 Digital Multimeter
J 35590 Adapter, or equivalent.

Important

Verify that both batteries are in good condition. Refer to SECTION 6D1.

NOTICE: ***Never operate the starter motor more than 15 seconds at a time without pausing to allow it to cool for at least 2 minutes. Overheating, caused by excessive cranking, will damage the starter motor.***

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 tool to the negative battery cable.
4. Crank the engine and observe the meter readings. The reading should be 330 to 360 amperes. If the amperage is over 360 amperes, an internal starter failure may be the cause. If the amperage is under 330 amperes, a battery cable or connection may be the cause.

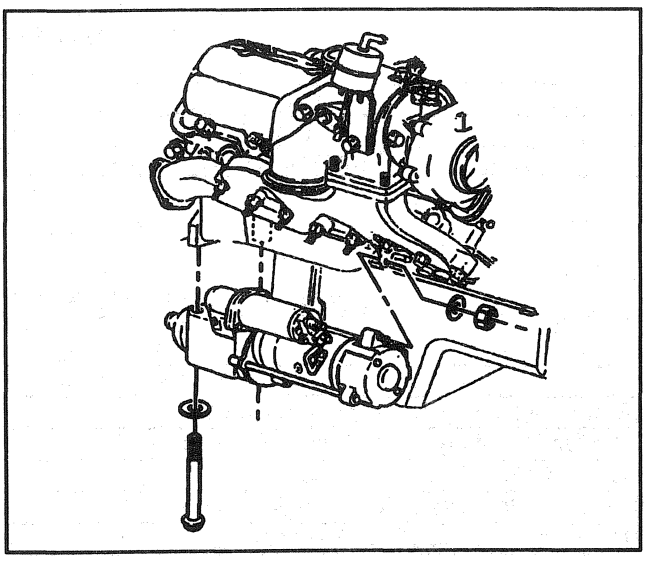


Figure 15—Diesel Engine Starter Motor

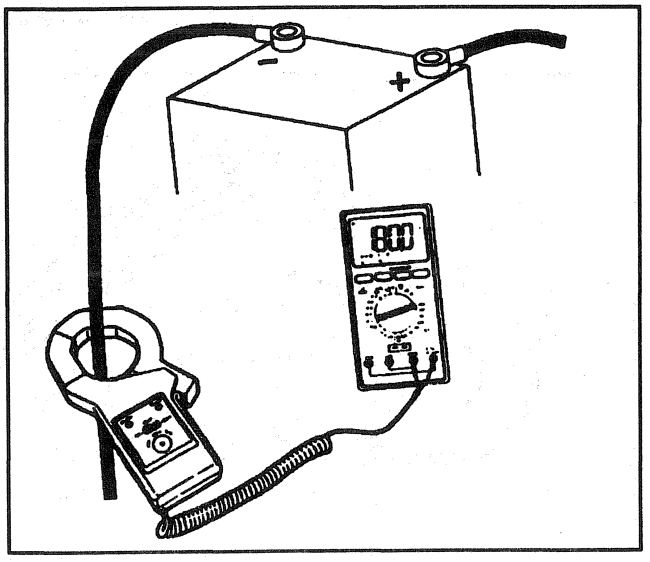


Figure 16—Starter Draw Test

SPECIFICATIONS

STARTER SPECIFICATIONS

Engine Application			Load Test @ 10 Volts			
			AMPS		RPM	
	Part No.	Series	Minimum	Maximum	Minimum	Maximum
4.3L, 5.7L, 7.4L	9000786	PG-260	65	95	2825	3275
Diesel	1113296	28MT	130	190	2300	5600

T2135

STARTER SHIMS

Gas Engines

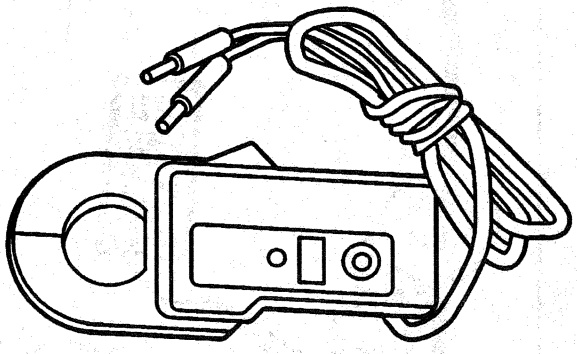
Shim	Part No.
0.33 mm (0.013-inch)	12456249
1.0 mm (0.04-inch)	14036090

T2937

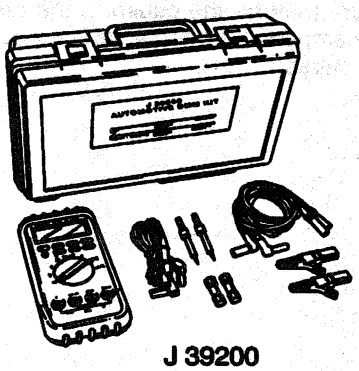
FASTENER TIGHTENING SPECIFICATIONS

Application	N·m	Lb ft	Lb in
Starter Mounting Bolts (Gas Engines)	40	30	—
Starter Mounting Bolts (Diesel Engines)	45	33	—
Bracket Nut (Diesel Engines)	8	—	75
Heat Shield Bolts (Diesel Engines)	17	13	—
Heat Shield Bolts (Gas Engines)	12	9	—

SPECIAL TOOLS



J 35590



J 39200

SECTION 6D2A

SD STARTER MOTOR

CAUTION: This vehicle has a Supplemental Inflatable Restraint (SIR). Refer to the SIR Component Location View in order to determine whether you are performing service on or near the SIR wiring. When you are performing service on or near the SIR components or the SIR wiring, refer to the SIR On-Vehicle Service information. Failure to follow CAUTIONS could result in possible air bag deployment, personal injury, or otherwise unneeded SIR system repairs.

NOTICE: ***Always use the correct fastener in the proper location. When you replace a fastener, use ONLY the exact part number for that application. General Motors will call out those fasteners that require a replacement after removal. General Motors will also call out the fasteners that require thread lockers or thread sealant. UNLESS OTHERWISE SPECIFIED, do not use supplemental coatings (paints, greases, or other corrosion inhibitors) on threaded fasteners or fastener joint interfaces. Generally, such coatings adversely affect the fastener torque and joint clamping force, and may damage the fastener. When you install fasteners, use the correct tightening sequence and specifications. Following these instructions can help you avoid damage to parts and systems.***

CONTENTS

GENERAL DESCRIPTION

SD-255 STARTER MOTOR

The SD-255 straight-drive type starter motor covered in this section has enclosed shift levers (Figure 1).

The starter motor has the drive end housing extended to enclose the shift lever and solenoid plunger. The solenoid flange mounts to the extension of the drive end housing with sealing compound between the flange and the field frame.

The starter motor bearings are lubricated during motor assembly and do not require service except during motor repair.

Identification

The part number can be found either stamped on the outside of the closed end frame or on an identification tag attached by a through-bolt.

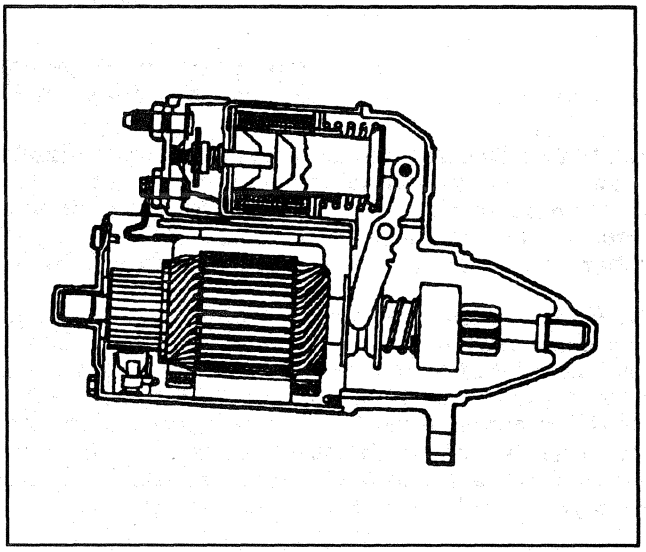


Figure 1—SD-255 Starter Motor

DIAGNOSIS

STARTER MOTOR TEST

Before disassembling the starter motor for repair, the following test should be made.

NOTICE: ***Never operate the starter motor more than 30 seconds at a time without pausing to allow it to cool for at least two minutes. Overheating caused by too much cranking, will damage the starter motor.***

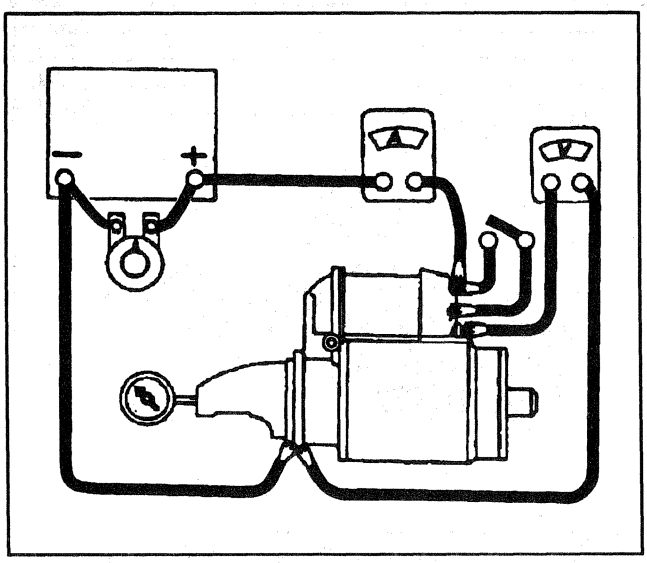


Figure 2—No-Load Test

NO-LOAD TEST

Connect a voltmeter from the motor terminal to the motor frame and an optical tachometer to measure armature speed (Figure 2). Connect the motor and an ammeter in series with a fully charged battery of the specified voltage, and a switch in the open position to the switch terminal. Close the switch and compare the RPM, current, and voltage readings with the specifications, refer to "SD 255 Starter Motor Specifications" in this section. It is not necessary to obtain the exact voltage. If the voltage is slightly higher, the RPM will be slightly higher, with the current remaining basically unchanged. However, if the exact voltage is desired, a carbon pile connected across the battery can be used to reduce the voltage to the specified value. Compare the test results as follows:

1. Rated current draw and no-load speed indicates normal condition of the starter motor.
2. Low free speed and high current draw indicates:
   - **Too much friction.** Tight, dirty, or worn bearings or a bent armature shaft allowing the armature to drag.
   - **Shorted armature.** This can be further checked on a growler after disassembly.
   - **Grounded armature or fields.** Check further after disassembly.
3. Failure to operate with high current draw indicates:
   - **A direct ground** in the terminal or fields.
   - **Seized bearings.** This should have been noted by turning the armature by hand.

4. Failure to operate with no current draw indicates:
   - **Open field circuit.** This can be checked after disassembly by inspecting internal connections and tracing the circuit with a test lamp.
   - **Open armature coils.** Inspect the commutator for badly burned bars after disassembly.
   - **Broken brush springs or worn brushes.**
   - **High insulation** between the commutator bars or other causes which would prevent good contact between the brushes and commutator.
5. Low no-load speed and low current draw indicates a higher internal resistance due to poor connections, defective leads, dirty commutator and causes listed under Step 4.
6. High free speed and high current draw indicates shorted fields. If shorted fields are suspected, replace the field coil assembly and check for improved performance.

DISASSEMBLY

If the motor does not perform to specifications, it may need to be disassembled for further testing of the components. Normally, the starter motor should be disassembled only so far as is necessary to make repair or replacement of parts. As a precaution, it is suggested that safety glasses be worn when disassembling or assembling the starter motor.

Before disassembly, perform the electrical tests on the solenoid described under "Inspection and Repair" in this section.

SOLENOID

Disassemble (Figure 3)

A. Clean the outside of the starter housing.
B. Make scribe marks to show the relationship of the drive end frame, frame and field assembly, and the end frame to aid in assembly.
C. Note the position of the through-bolts.

Models with Solenoid Shield:

1. Solenoid shield nuts from the solenoid clamp screws.
2. Shield from the solenoid.
3. Motor lead attaching nut and lead from the solenoid.
4. Solenoid clamp attaching screws, clamp and solenoid from the frame assembly.

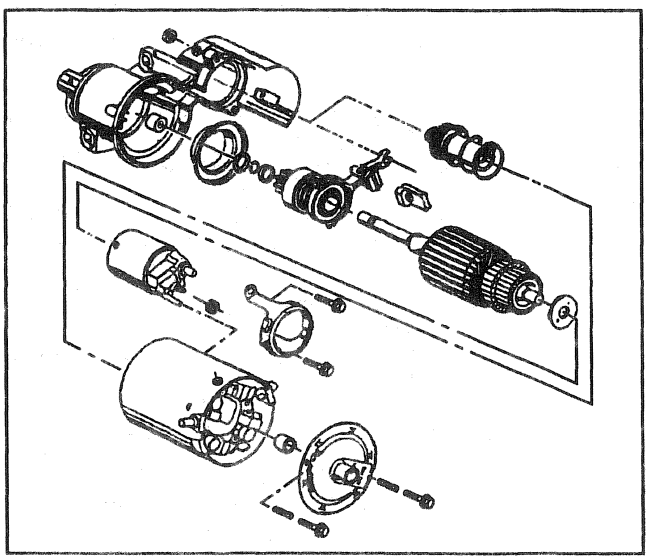


Figure 3—SD-255 Components

FRAME AND FIELD ASSEMBLY

Disassemble (Figure 3)

1. Through-bolts from the end frame.
2. End frame.
3. Brake washer from the armature assembly.
4. Frame and field assembly from the armature/drive end frame assembly.

DRIVE END FRAME ASSEMBLY

Disassemble (Figures 3 and 4)

1. Plug from the drive end frame assembly.
2. Armature with the drive assembly, shift lever, plunger and return spring from the drive end frame.
3. Return spring from the plunger.
4. Plunger from the shift lever.
5. Shift lever from the drive assembly by spreading the lever arms slightly to snap them off the mating buttons on the drive collar.

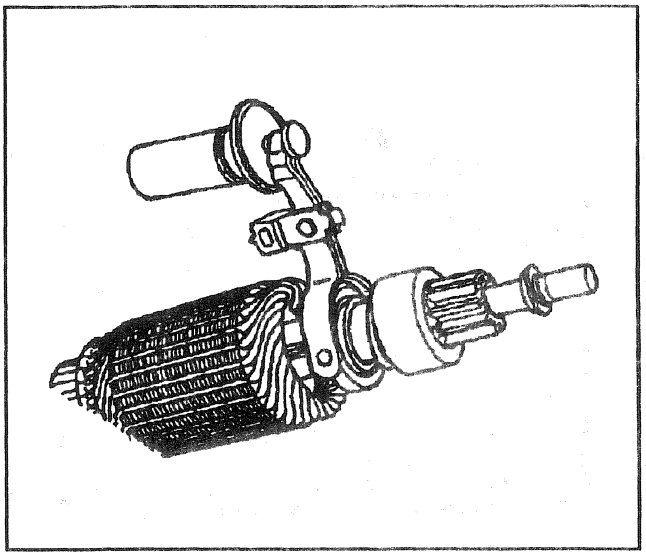


Figure 4—Armature, Drive, and Shift Lever Assembly

6. Drive assembly from the armature shaft as follows:
   A. Remove the thrust collar from the armature shaft.
   B. Drive the pinion stop collar away from the pinion stop retainer ring by sliding a metal cylinder onto the armature shaft and with a hammer, strike the metal cylinder against the stop collar.
   C. 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.
   D. Slide the stop collar and drive assembly off the armature shaft.

INSPECTION

CLEANING, INSPECTION, AND ELECTRICAL TESTS

Clean

NOTICE: ***Do not clean the starter motor parts in a degreasing tank. Immersing parts in a cleaning solution will dissolve permanent lubrication and may damage electrical insulation, causing shortened motor life.***

- All parts by wiping with a clean cloth.

Inspect (Figures 5 through 8)

1. Bushing or armature bearing fit in the end frame, lever housing and 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 roller bearings. They are permanently lubricated at time of manufacture.
2. Armature shaft for runout or scoring. Replace the armature assembly if the condition of the armature shaft is questionable.
3. 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.
4. Armature for short circuits (Figure 5).
   - Rotate the armature in a growler with a steel strip, such as a hacksaw blade, held on the armature parallel to the shaft. The steel strip will vibrate on the area of the short circuit.
   - Shorts between the commutator bars are sometimes produced by brush dust or copper dust.
5. Armature for opens.
   - Look for loose connections where the conductors join the commutator bars. Poor connections cause arcing and burning of the commutator.
6. Armature for grounds using a self-powered test lamp (Figure 6).
   - If the test lamp lights when one test probe is placed on the commutator and the other test probe is placed on the armature core or shaft, the armature is grounded.
7. Brushes for wear. If the brushes are worn to half the size of a new brush, replace the brush assembly.
8. Brush holders for dirt or damage.
   - Make sure that the brushes are not binding in the holders.

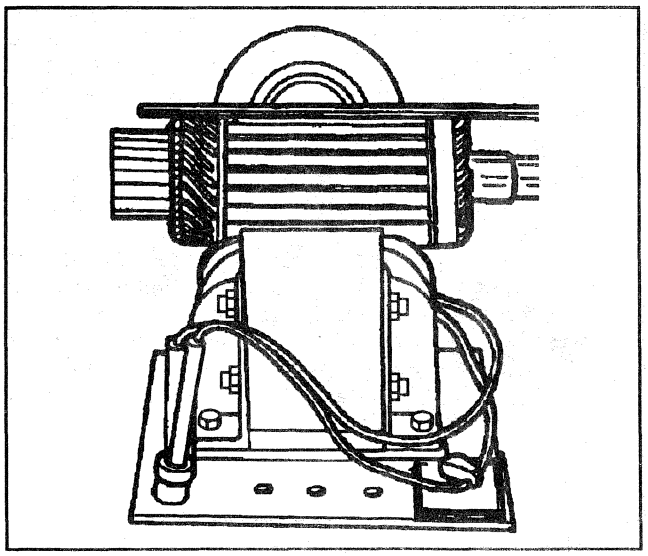


Figure 5—Testing the Armature for Short Circuits

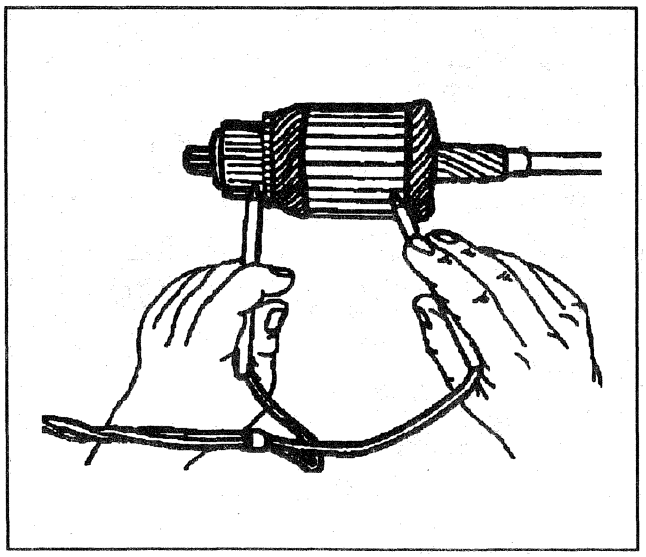


Figure 6—Testing the Armature for Grounds

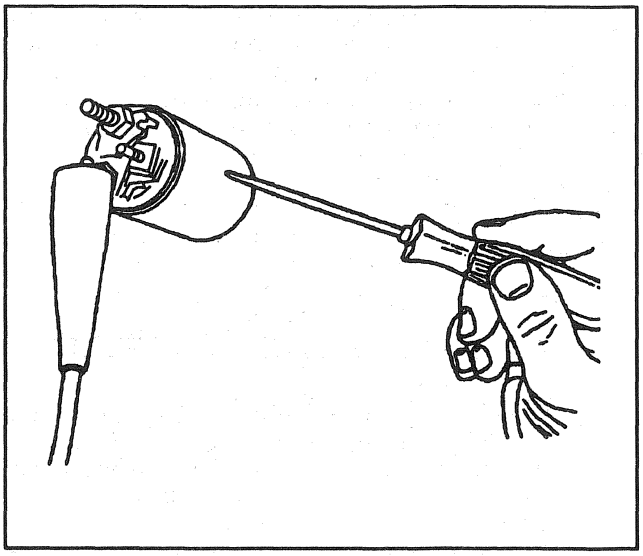


Figure 7—Checking the Solenoid for Opens or Grounds

9. Brush springs for distortion or discoloring. If the springs are weak, bent, or discolored, replace the frame and field assembly.
10. Field coils.
    - Look for burned or damaged insulation, damaged connections or loose poles. If the condition of the coils is doubtful, replace the field and frame assembly.
11. 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.
12. Field coils for opens.
    - Connect a self-powered test lamp between the field connector and each of the positive brushes.
      — If the test lamp does not light at both brushes, the field coils are open.
13. 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.
14. Drive assembly (clutch) by turning the drive pinion in the cranking direction.
    - If the drive pinion turns roughly or slips in the cranking direction, replace the complete over-running clutch assembly.
15. Solenoid for grounds using a self-powered 12 volt test lamp (Figure 7).
    A. Connect the test lamp between the BAT terminal and the case. The lamp should not light (terminal should not be grounded).

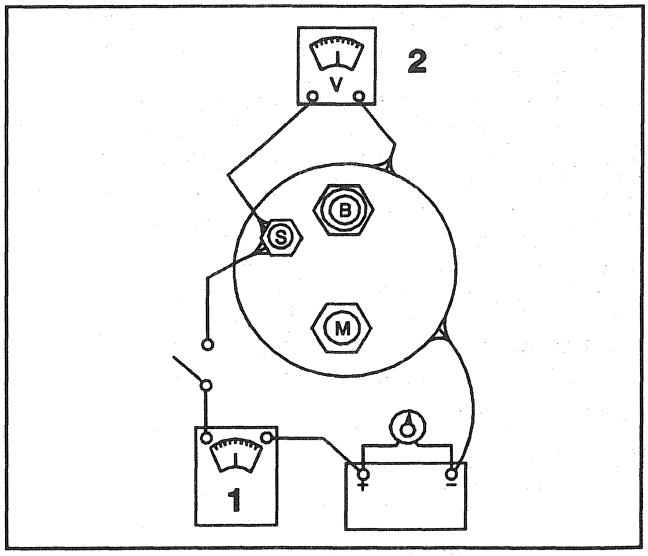


Figure 8—Solenoid Test Connections

    B. Connect the test lamp between the "S" terminal and the case. Then connect the test lamp between the "M" terminal and "S" terminal or "M" terminal and the case. The lamp should illuminate.
    C. If the solenoid does not pass these checks, replace it.
16. Hold-in winding and pull-in winding.
    A. If solenoid is not removed from starter motor, the field lead must be removed from the terminal on the solenoid before making these tests. Make test connections as shown in Figure 8.

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

    B. To check both windings, connect an ammeter in series with a 12 volt battery and the "switch" terminal on the solenoid. Connect a voltmeter to the "switch" terminal and to ground. 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 55 to 85 amperes.
    C. 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) listed in "SD Starter Motor Specifications" at the end of this section.

ASSEMBLY

DRIVE END

Assemble (Figures 4, 9, and 10)

- Wipe the armature shaft clean and lubricate the area that will be under the drive assembly. Use Lubricant GM P/N 1960954 or equivalent.
- Wipe the drive assembly clean.

1. Drive assembly onto the armature shaft.
2. Pinion stop collar with the flat side of the collar toward the drive pinion.
3. New retaining ring onto the armature shaft.
   - Slide the ring down the shaft until it seats in the shaft groove.
4. Thrust collar onto the shaft with the small flange toward the retaining ring.
   - Using two sets of pliers, push the pinion stop collar and thrust collar together to snap the stop collar onto the retaining ring (Figure 10).

Inspect

- Drive end bearing. If no lubrication is visible, replace the bearing. Do not lubricate the bearing.

5. New drive end bearing by pressing it in until it is recessed 1.6 mm (0.06 in) into the casing. It is prelubricated, so do not add lubricant.
6. Shift lever to the drive assembly by spreading the arms slightly to snap it onto the buttons on the drive collar.
7. Plunger to the lever by snapping into place. Note which side of the lever is up (Figure 4).
8. Armature shaft into the drive end bearing while sliding the shift lever retainer into the slot on the drive end housing.
9. Spring onto the plunger.
10. Plug.
11. Solenoid and clamp onto the drive end frame, aligning the "M" terminal with the field connector.
12. Clamp retaining screws.

Tighten

- Solenoid clamp retaining screws to 11 N.m (95 lb in).

FRAME AND FIELD ASSEMBLY

Assemble (Figure 3)

1. Frame and field assembly onto the armature.
   A. Clean the contact faces of the brushes and the commutator with a soft cloth.
   B. Push the brushes into the brush holders and hold them in place while installing the frame.
   C. Align the scribe mark on the frame with the scribe mark on the drive end frame.
   D. Release the brushes onto the commutator, making sure all four brushes move freely and contact the commutator.
2. Brake washer to the armature assembly.
3. Drain tube to the frame, if it was removed.
4. End frame to the field frame.
   - If the 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 lubricant.
5. Identification tag over the hole in the end frame with the fluted end around the bearing well.
6. Through-bolts in their original locations.

Tighten

- Through-bolts to 8.5 N.m (75 lb in).

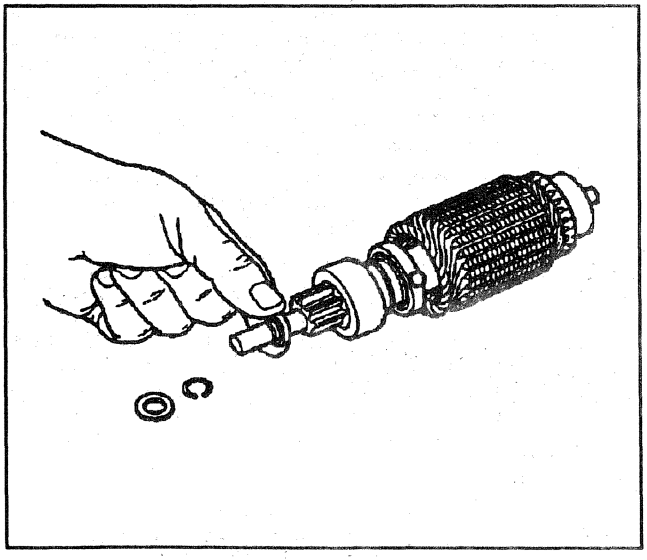


Figure 9—Replacing the Pinion Stop Collar

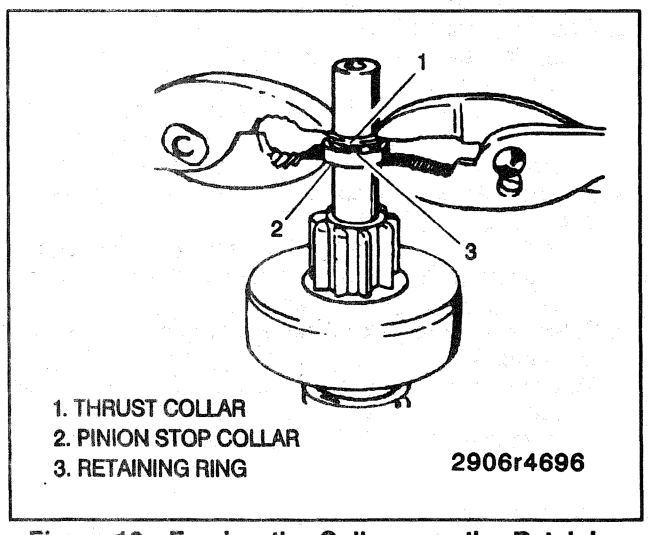


Figure 10—Forcing the Collar over the Retaining Ring

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

Tighten

- Field lead attaching nut to 11 N·m (95 lb in).

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

Tighten

- Shield attaching nuts to 8 N·m (70 lb in).

PINION CLEARANCE CHECK

The pinion clearance should be checked after reassembly of the motor. It cannot be adjusted. Improper clearance is an indication of worn parts.

To check pinion clearance, perform the following steps (Figures 11 and 12).

1. Disconnect the motor field connector from the solenoid "M" terminal and **insulate it carefully.**
2. Connect a battery of the same voltage as the solenoid from the solenoid switch terminal to the solenoid frame.
3. **Momentarily** flash a jumper lead from the solenoid motor terminal to the solenoid frame. This will shift the pinion into cranking position and it will remain so until the battery is disconnected (Figure 11).
4. Push the pinion back toward the commutator end to eliminate stack movement.
5. Measure the distance between pinion and pinion stop collar (Figure 12).

- Clearance should be 0.25 mm to 4.06 mm (0.010 in to 0.160 in).

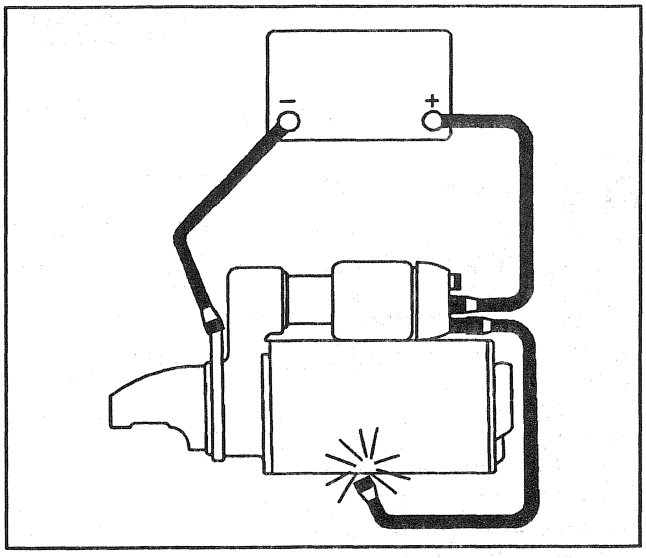


Figure 11—Pinion Clearance Check

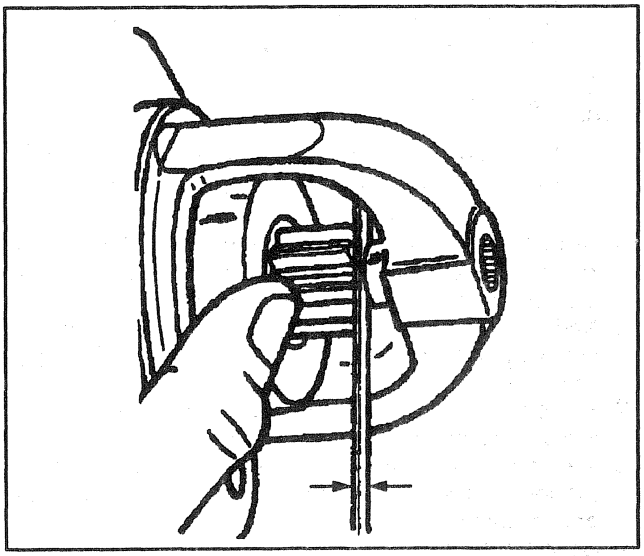


Figure 12—Measuring Pinion Clearance

SPECIFICATIONS

SD 255 STARTER MOTOR SPECIFICATIONS

Part No.	Type	Minimum Amps	Maximum Amps	Minimum RPM	Maximum RPM
10455065	121	55	85	7000	12000

Starter No.	Solenoid	Pull-In Amps	Pull-In Volts	Hold-In Amps	Hold-In Volts
10455065	1115618	24-29	5	16-20	10

FASTENER TIGHTENING SPECIFICATIONS

Application	N.m	Lb ft	Lb in
Field Lead Attaching Nut	11	—	95
Shield Attaching Nuts	8	—	70
Solenoid Clamp Retaining Screw	11	—	95
Through Bolts	8.5	—	75

SECTION 6D2B

28-MT STARTER MOTOR

CAUTION: This vehicle has a Supplemental Inflatable Restraint (SIR). Refer to the SIR Component Location View in order to determine whether you are performing service on or near the SIR wiring. When you are performing service on or near the SIR components or the SIR wiring, refer to the SIR On-Vehicle Service information. Failure to follow CAUTIONS could result in possible air bag deployment, personal injury, or otherwise unneeded SIR system repairs.

NOTICE: ***Always use the correct fastener in the proper location. When you replace a fastener, use ONLY the exact part number for that application. General Motors will call out those fasteners that require a replacement after removal. General Motors will also call out the fasteners that require thread lockers or thread sealant. UNLESS OTHERWISE SPECIFIED, do not use supplemental coatings (paints, greases, or other corrosion inhibitors) on threaded fasteners or fastener joint interfaces. Generally, such coatings adversely affect the fastener torque and joint clamping force, and may damage the fastener. When you install fasteners, use the correct tightening sequence and specifications. Following these instructions can help you avoid damage to parts and systems.***

CONTENTS

GENERAL DESCRIPTION

28-MT STARTER MOTOR

The 28-MT is a gear reduction starter. An internal gear at the gear-reduction end of the driveshaft is driven by the armature shaft gear at a speed of one driveshaft revolution for each 3.9 revolutions of the armature.

The starter has an over-running roller-type clutch and an enclosed shift lever. The solenoid is sealed to prevent entry of foreign material.

Identification

The part number is stamped on a label and attached to the field frame (Figure 1).

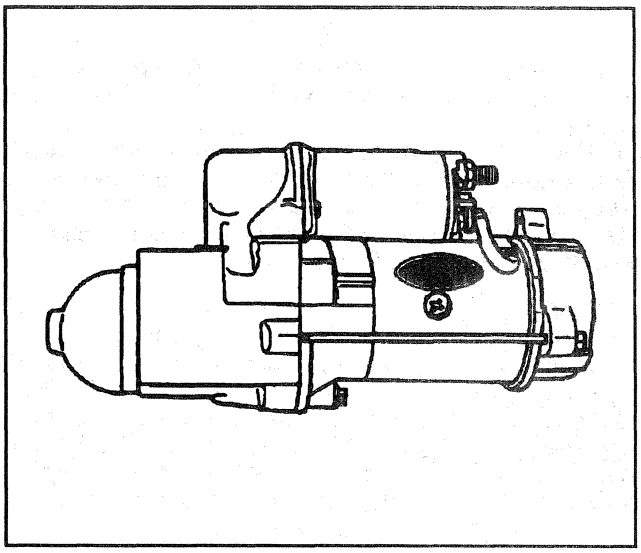


Figure 1—28-MT Starter Motor

DIAGNOSIS

STARTER DRAW TEST

Tools Required:
J 39200 Digital Multimeter
J 35590 Current Clamp

Important

- Verify that both batteries are in good condition, refer to SECTION 6D1.

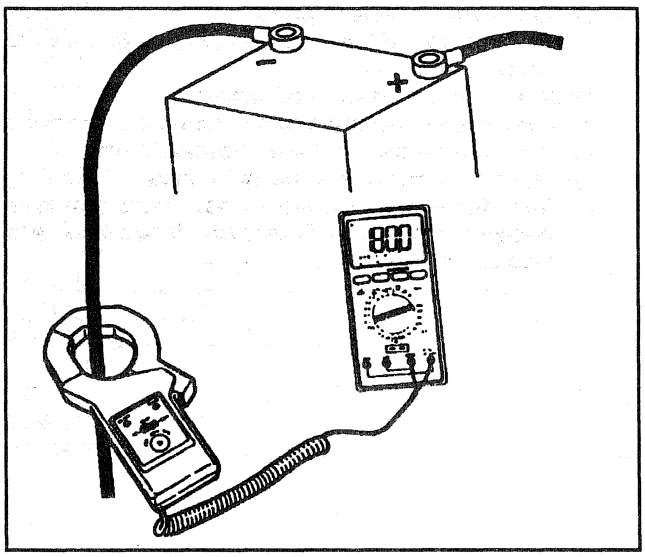


Figure 2—Starter Draw Test

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

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 tool to the negative battery cable.
4. Crank the engine and observe the meter readings. The reading should be 330 to 360 A. If the amperage is over 360 A, an internal starter failure may be the cause. If the amperage is under 330 A, a battery cable or connection may be the cause.

DISASSEMBLY

INTRODUCTION

If the motor does not perform to specifications, it may need to be disassembled for further testing of the components. Normally, the starter motor should be disassembled only so far as is necessary to make repair or replacement of parts. The 28-MT components are shown in Figure 3.

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

- Solenoid assembly (19)
- Clutch drive assembly (34)
- Brush holder assembly (7)
- Armature assembly (13)
- Frame and field assembly (15)

As a precaution, it is suggested that safety glasses be worn when disassembling or assembling the starter motor.

UNIT DISASSEMBLY

Disassemble (Figure 4)

- Scribe marks completely down one side of the starter motor to ensure proper alignment of all components during assembly. Use a colored pencil or marker that will show on all parts.

1. Motor lead on the frame assembly from the solenoid assembly.
   - Remove the nut from the motor terminal, slip off the motor lead, and reinstall the nut.
2. Two through-bolts.
3. Two brush plate screws.
4. Commutator end frame and O-ring seal.

Important

- In the following Step, take care not to lose the small dowel pin installed between the frame assembly and the gear reduction and drive group. The dowel pin is needed for assembly and must be saved. If it is lost, it must be replaced with a 2 mm x 10 mm (0.079 in x 0.394 in) long pin obtained or manufactured locally.

5. Frame, field, and brush holder group, dowel pin, and O-ring seal.
   - The armature assembly may come off with the frame, field, and brush holder group or may be retained by the gear reduction and drive group.
6. Armature assembly with bearings.
   - Do not remove the bearings from the armature assembly unless replacement is required, refer to "Cleaning, Inspection, and Repair" in this section.
7. Solenoid screws.
8. Solenoid assembly.
   - Pivot the inside end of the solenoid assembly out of engagement shift lever drive group to withdraw it.

FRAME, FIELD, AND BRUSH HOLDER GROUP

Disassemble (Figure 5)

1. Insulated brush screws.
   - Move the brush holder assembly with brushes slightly away from the frame and field assembly to reach across with a screwdriver and remove the screws.
2. Frame and field assembly.
3. Grounded brush screws.
4. Brushes if they need replacement.
5. Brush springs if they need replacement.
   - Grasp the brush end of each brush spring with needle-nose pliers. Twist the spring end away from the brush and remove the brush.

All electrical components should be inspected and tested, refer to "Cleaning, Inspection, and Repair" in this section.

GEAR REDUCTION AND DRIVE GROUP

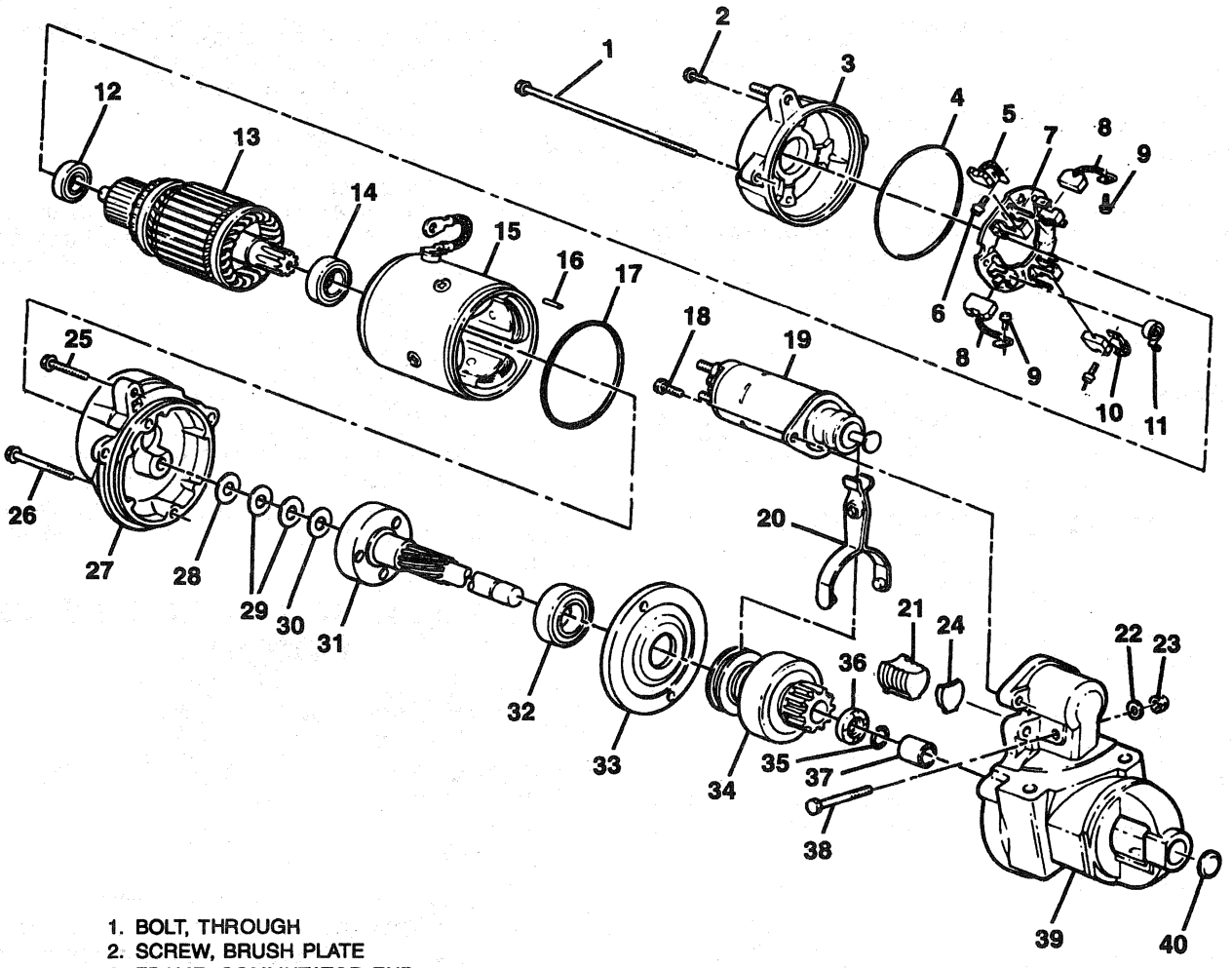
Disassemble (Figure 6)

1. Housing bolts.
2. Armature support bracket.

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 these washers.

3. Washers.
   - Save the washers to be installed in the same position and number at assembly.
4. Drive housing plug and plate.
   - Pry out the drive housing plug with a large screwdriver.
5. Shift lever nut, washer, and screw.
6. Shift lever and driveshaft and clutch group from the drive housing together, then separate them.
   - Do not remove the bushing plug or bushing from the drive housing unless replacement is necessary, refer to "Cleaning, Inspection, and Repair" in this section.



1. BOLT, THROUGH
2. SCREW, BRUSH PLATE
3. FRAME, COMMUTATOR END
4. SEAL, O-RING (C.E. END)
5. BRUSH (GROUNDED)
6. SCREW, GROUNDED BRUSH
7. ASSEMBLY, BRUSH HOLDER
8. BRUSH (INSULATED)
9. SCREW, INSULATED BRUSH
10. BRUSH (GROUNDED)
11. SPRING, BRUSH
12. BEARING, C.E. ARMATURE
13. ARMATURE
14. BEARING, D.E. ARMATURE
15. ASSEMBLY, FRAME AND FIELD
16. PIN, DOWEL
17. SEAL, O-RING (FIELD FRAME)
18. SCREW, SOLENOID
19. ASSEMBLY, SOLENOID
20. LEVER, SHIFT
21. PLUG, DRIVE HOUSING
22. WASHER, SHIFT LEVER
23. NUT, SHIFT LEVER
24. PLATE (IF USED)
25. BOLT, DRIVE HOUSING (SHORT ON SOME MODELS)
26. BOLT, DRIVE HOUSING (LONG)
27. BRACKET, ARMATURE SUPPORT
28. WASHER, (FIBER)
29. WASHER, THIN (ONE OR TWO MAY BE USED)
30. WASHER, THICK
31. SHAFT, DRIVE
32. BEARING, CENTER SUPPORT
33. SUPPORT, DRIVE SHAFT
34. ASSEMBLY, CLUTCH DRIVE
35. RING, STOP
36. STOP, PINION
37. BUSHING, D.E. HOUSING
38. SCREW, SHIFT LEVER
40. PLUG, BUSHING (IF USED)

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Figure 3—28-MT Components

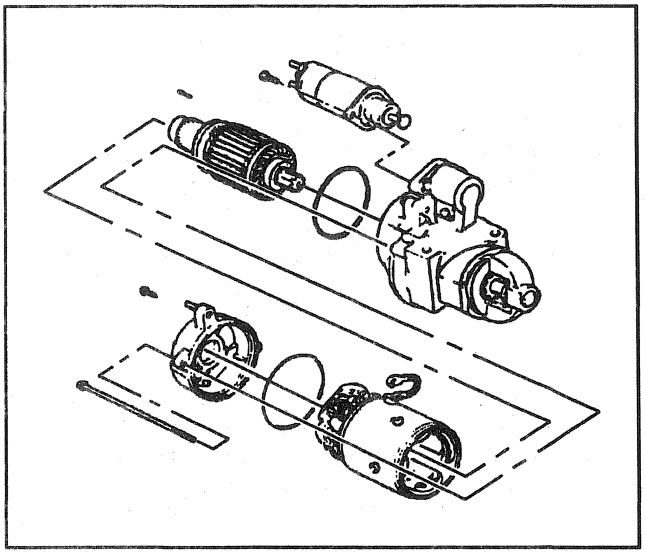

Figure 4—Electrical Group

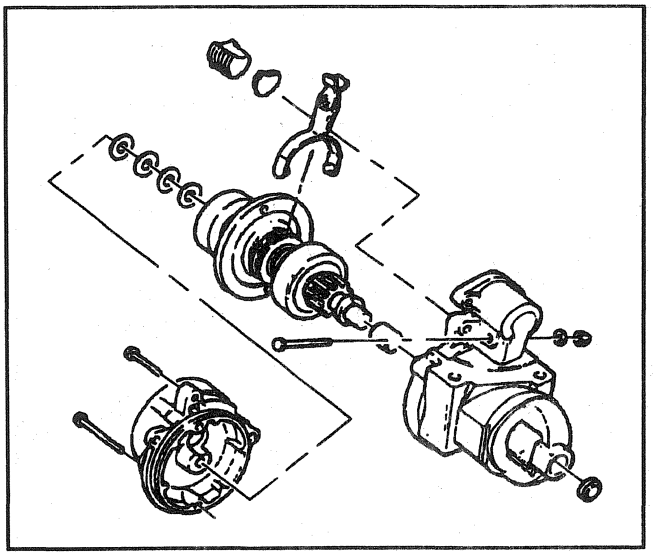

Figure 6—Gear Reduction and Drive Group

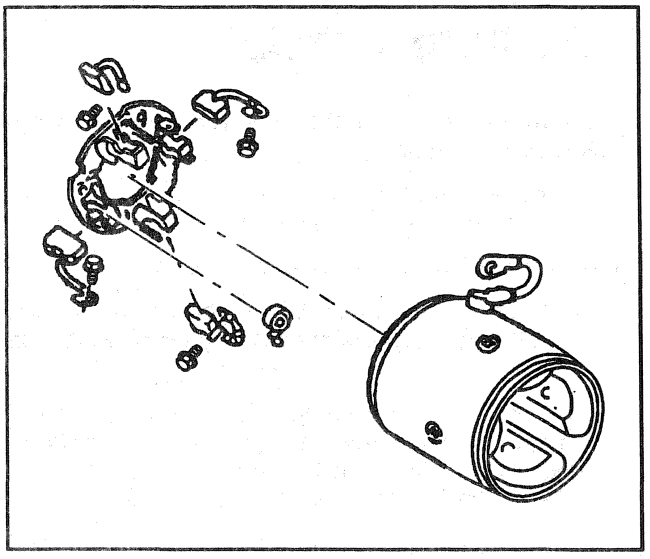

Figure 5—Frame, Field, and Brush Holder Group

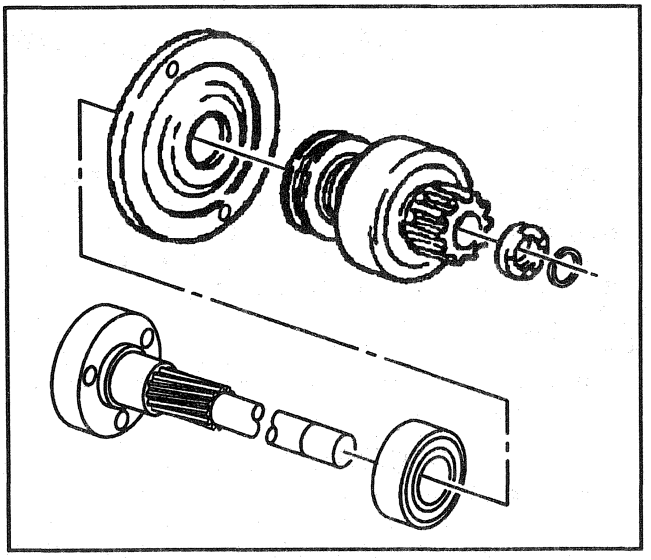

Figure 7—Drive Shaft and Clutch Group

DRIVESHAFT AND CLUTCH GROUP

Disassembly of the driveshaft and clutch group is not required unless it is necessary to clean, inspect, or replace one or more parts of the group separately.

Disassemble (Figures 7 and 8)

1. Stop rings and pinion stop.
   A. Position the driveshaft and clutch group on a work bench with the internal gear end down.
   B. Using an open tube #2 (22 mm diameter) slightly larger than the shaft #1 (14.2 mm diameter), drive the pinion stop toward the clutch drive assembly until it clears the stop rings (Figure 8).
   C. Pry the stop rings out of the driveshaft groove and slide them off the end of the shaft, being careful not to scratch the driveshaft.
   D. Inspect the edges of the shaft groove for burrs that may have been formed through repeated cranking cycles. Such burrs may make removal of the pinion stop and clutch drive assembly difficult.
      - If burrs are found, use a file to carefully remove burrs only, not the base metal. Thoroughly clean away metal filings.
   E. Slide the pinion stop off the driveshaft. Discard the old pinion stop and stop rings. New parts must be used at assembly.
2. Clutch drive assembly from the driveshaft.
3. Driveshaft support from the driveshaft.
   - Do not remove the bearing from the driveshaft unless replacement is required, refer to "Cleaning, Inspection, and Repair" in this section.

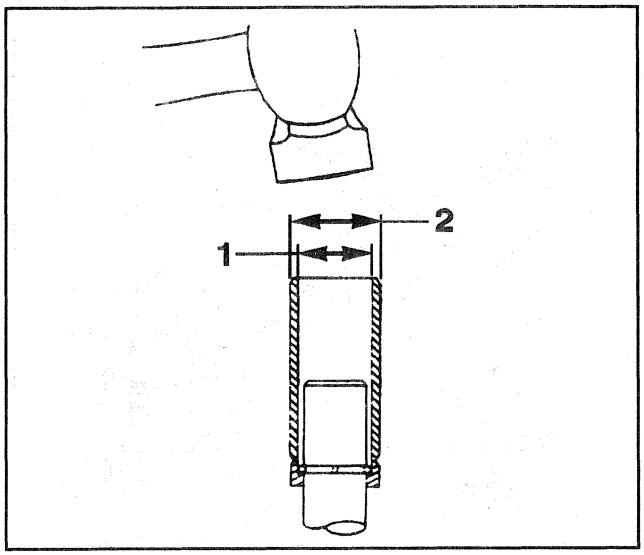

Figure 8—Removing the Pinion Stop

CLEANING, INSPECTION, AND REPAIR

CLEANING

NOTICE: ***Do not clean or immerse the starter motor parts in grease-dissolving solvents. Solvents will dissolve the grease packed in the drive assembly and may damage the armature or field coil insulation.***

Clean

- All starter motor parts with a clean soft cloth prior to testing.

INSPECTION

Inspection in the following steps refers to visual inspection of the starter motor parts and assemblies to determine their serviceability. Electrical tests for certain assemblies are described in "Component Electrical Testing," in this section.

Inspect (Figure 3)

1. All parts for cracks, distortion, or other structural damage. Replace parts or assemblies that are cracked, bent, or otherwise damaged.
2. 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 hardware items that have damaged threads.
3. Solenoid assembly (19) for cut or torn boot. If the boot is damaged, replace the solenoid assembly.
4. Clutch drive assembly (34) for the following and replace the clutch drive assembly if damaged.
   - Pinion gear turns roughly or turns in both directions.
   - Pinion gear teeth are broken or show evidence of step wear.
   - The shift lever collar shows deep scoring or other damage.
5. Brush holder assembly (7) for the following. Replace if damaged:
   - Loose riveted joints.
   - Cracked or broken insulation.
6. Brushes (5 and 8) for excessive wear.
   - Minimum allowable brush length is 12 mm (0.472 in). Replace excessively worn brushes in sets.
7. Drive end housing bushing (37) for scoring or other damage. Replace the damaged bushing, refer to "Repair Procedures" in this section.
8. Ball bearings (12, 14, and 32) as follows:
   A. Hold the armature (13) or driveshaft (31) and slowly rotate the outer bearing race by hand.
   B. Check that the bearing turns freely without binding or the feel of flat spots.
   C. Replace damaged bearings, refer to "Repair Procedures" in this section.
9. Armature assembly (13) for the following:
   - Gear teeth that are broken, or that show evidence of step wear or root interference.
   - Rough commutator surface. Polish with 400 grit polishing cloth if necessary. Thoroughly clean metal dust 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.
   - Worn commutator. Replace the armature assembly if the commutator outer diameter is less than 36 mm (1.378 in) or if the undercut depth at any point is less than 0.2 mm (0.008 in). Do not undercut the insulation.

10. Driveshaft (31) for the following. Replace the drive shaft if damaged:
    - Scored or damaged shaft where it turns in the bushing (37).
    - Internal gear with teeth broken or showing evidence of step wear.
    - Damaged spline. The clutch drive assembly must slide smoothly and easily over the full length of the spline.

COMPONENT ELECTRICAL TESTING

Perform the following electrical tests on the solenoid, armature, and frame and field assemblies to determine their serviceability.

1. Using an ohmmeter, check the windings of the solenoid assembly for continuity as follows:
    - Check the resistance of the solenoid pull-in and hold-in windings in series by measuring the resistance between the motor terminal and the solenoid case (Figure 9). Resistance should be about 1.95 ohms.
    - An extremely high resistance reading indicates a break or fault in the winding continuity. A very low resistance reading indicates a short or ground in the winding circuit. Either condition is cause for replacement of the solenoid assembly.
2. Check the armature assembly as follows for shorts, opens, or grounds.
    - Rotate the armature in a growler holding a steel strip such as a hacksaw blade against the armature. If a short circuit is present, the steel strip will vibrate in that area.
    - Check the armature for grounds using a self-powered test lamp or ohmmeter. There should not be any continuity between the armature shaft and any point on the commutator.
    - Check for opens by visually inspecting the points where the armature conductors join the commutator. A poor connection often will be indicated by signs of arcing or burning of the commutator.
    - Replace armatures that are shorted, grounded, or show evidence of opens.
3. Check the frame and field assembly for grounds or opens (Figure 10).
    A. Visually inspect the field coil connections for opens between the field terminal and the connection points for insulated brushes on the field coil straps.
    B. Using a self-powered test lamp or ohmmeter, check that there is no continuity (no grounds) between the frame and the field terminal.
    C. Replace the frame and field assemblies that have grounds or opens.

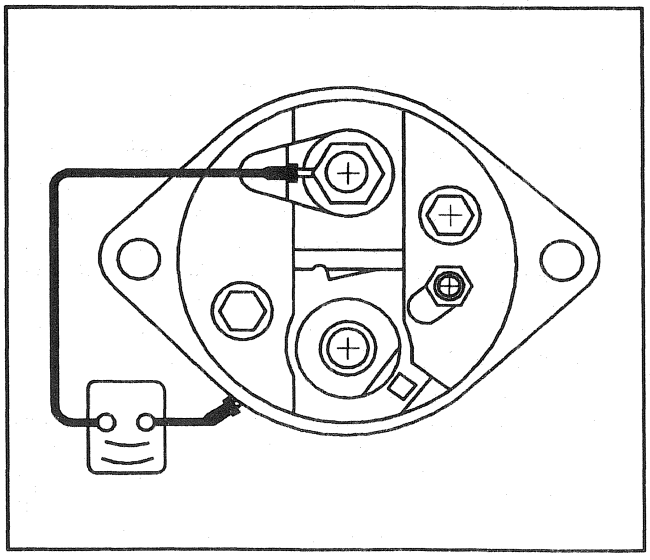

Figure 9—Solenoid Terminals

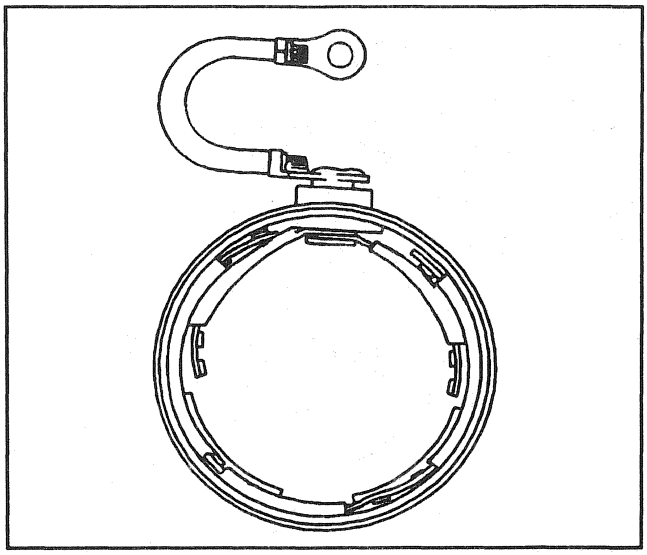

Figure 10—Frame and Field Assembly

REPAIR PROCEDURES

Armature Bearing Replacement

If necessary, replace the bearings (12 and 14) or armature assembly (13).

Remove or Disconnect (Figures 3 and 11 through 13)

NOTICE: ***Ball bearings that are removed from the armature must be replaced with new bearings. The removal procedure causes internal damage to the bearings.***

- Commutator end and/or drive end bearings (12 and 14) from the shaft of the armature assembly (13) using a suitable bearing puller.

Install or Connect (Figures 3 and 11 through 13)

- New commutator end and/or drive end bearings (12 and 14) to the armature assembly (13) using a tube that bears on the bearing inner race only. Press on the bearing until the inner race bottoms out against the shoulder on the armature shaft.

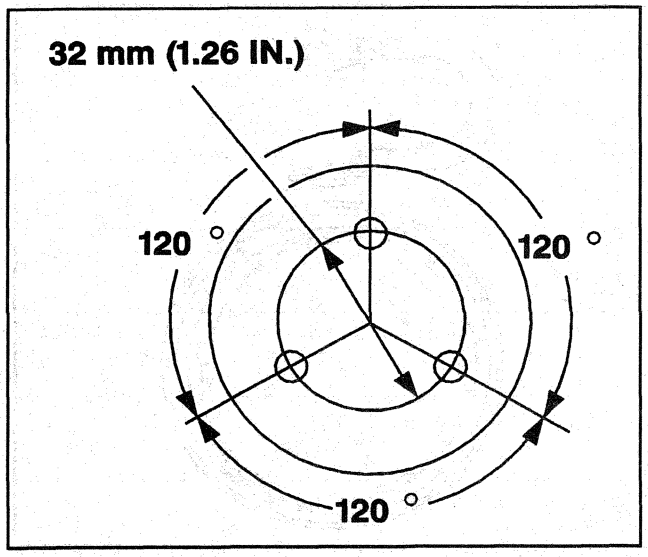

Figure 11—Tool for Removing Center Support Bearing (Top View)

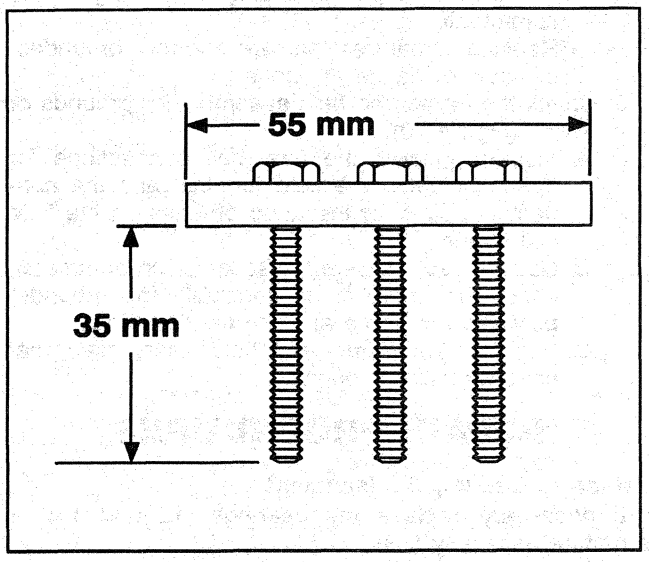

Figure 12—Tool for Removing Center Support Bearing (Side View)

Center Support Bearing

If necessary, replace the center support bearing (32) on the driveshaft (31).

Remove or Disconnect (Figures 3 and 11 through 13)

NOTICE: ***Ball bearings that are removed from the armature must be replaced with new bearings. The removal procedure causes internal damage to the bearings.***

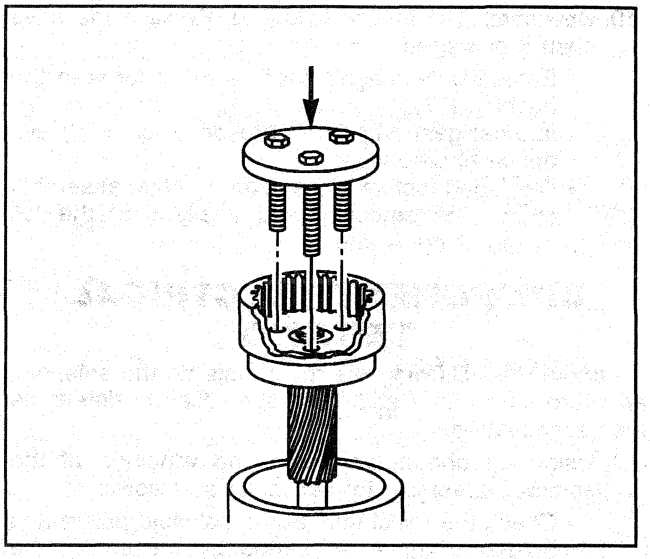

Figure 13—Tool for Removing Center Support Bearing (Installation View)

- Center support bearing (32) from the driveshaft (31) using a locally fabricated tool as shown in Figures 11 through 13. With the driveshaft in a suitable support fixture, place the tool bolt ends through the access holes in the wide end of the driveshaft. Squarely press the bearing off of the surface on the center shaft.

Install or Connect (Figures 3 and 11 through 13)

- New bearing (32) to the driveshaft (31), using a locally fabricated tool (open tube) that bears on the bearing inner race only. Press on the bearing until the inner race bottoms out against the shoulder on the driveshaft.

Drive End Housing Bushing

If necessary, replace the bushing (37) in the drive housing (39).

Remove or Disconnect (Figure 3)

1. Plug (40), if present, from inside the drive housing (39) by driving it out. Use a file to clean away remnants of the old stake to allow installation of a new plug. Clean away any metal shavings.
2. Bushing (37) by pressing it out using a suitable tool.

Install or Connect (Figure 3)

1. New bushing into the drive housing (39) by pressing it in using a suitable tool.
   - Press the bushing in until it is flush with the inside of the housing.

2. New plug (40), if used, to drive housing.
   - Stake the housing material over the plug at three places, equally spaced.

LUBRICATION

Armature bearings and the driveshaft support bearing are permanently lubricated. Do not add lubricant to these bearings. Using GM P/N 1960954 grease lubricant or equivalent, lubricate the following areas during assembly. Avoid using excessive grease.

- Drive end housing bushing in the drive housing.
- Pivot hole and working surface on the ends of the shift lever.
- Internal gear, shaft, and spline on the driveshaft.

ASSEMBLY

DRIVESHAFT AND CLUTCH GROUP

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

Important

- If the center support bearing (32) is being replaced, install it on the driveshaft (31). Refer to "Center Support Bearing" in this section before proceeding with assembly.

Install or Connect (Figures 3 and 14)

1. Driveshaft support (33) to the driveshaft (31), seating the bearing (32) in the support.
2. Clutch drive assembly (34) to the driveshaft (31).
3. New pinion stop (36) and stop rings (35).
   A. Slide the pinion stop (36) onto the driveshaft (31). End with the recess for the stop rings facing up.
   B. Install the stop rings (35) into the groove in the driveshaft.
   C. Pick the assembly up and support it under the pinion stop (36). 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 (Figure 14).

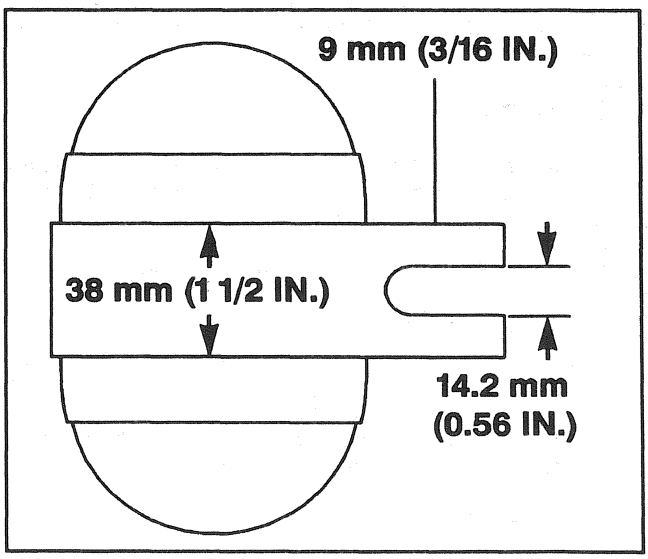

Figure 14—Pinion Stop Support Block

   D. Make sure the stop rings (35) (in the driveshaft groove) are fully seated in the pinion stop recess and stake the upper edge of the pinion stop (36) over the stop ring (35) at four places, equally spaced. Do not allow the staked metal to contact the driveshaft (31).

GEAR REDUCTION AND DRIVE GROUP

Important (Figure 6)

- If the drive end bushing and plug are being replaced, install them in the drive housing. Before proceeding with assembly, refer to "Drive End Housing Bushing" in this section.
- Lubricate the drive end housing bushing, shift lever, and driveshaft, refer to "Lubrication" in this section.

Install or Connect (Figures 6 and 7)

1. Arms on the shift lever with the shift collar onto the driveshaft and clutch group.
2. Assembled shift lever and driveshaft and clutch group into the drive housing.
   A. Align the holes in the driveshaft support with those in the drive housing (Figure 7).
   B. Make sure that the driveshaft support is fully seated in the drive housing and that the driveshaft bearing remains fully seated in the driveshaft support.
3. Shift lever screw, washer, and nut.

Tighten

- Shift lever nut to 4.5 N·m (40 lb in).

4. Plate, if used, and drive housing plug to the drive housing.
5. Washers in the same number and position as noted at disassembly.
6. Armature support bracket to the drive housing.
   - Align the mark made prior to disassembly with that on the drive housing.
7. Drive housing bolts.

Tighten

- Drive housing bolts to 8.5 N·m (75 lb in).

FRAME, FIELD, AND BRUSH HOLDER GROUP

Install or Connect (Figures 5, 15, and 16)

1. Brush springs if removed.
   A. Start each brush spring onto the post on the brush holder assembly just enough to hold the inside end of spring from turning as shown in Figure 15.
   B. Grasp the free end of the spring with needle-nose pliers and twist it to the right over the top of the brush socket.
   C. Push the spring fully onto the post and release the free end to engage the notch in the brush socket.

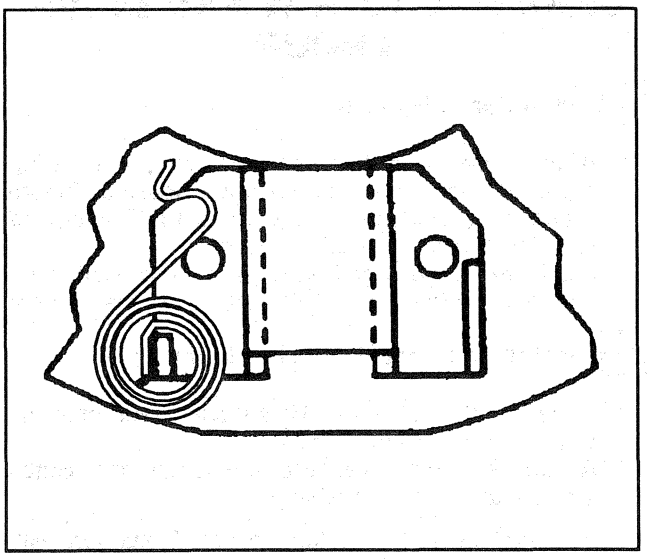

Figure 15—Brush Spring on the Post

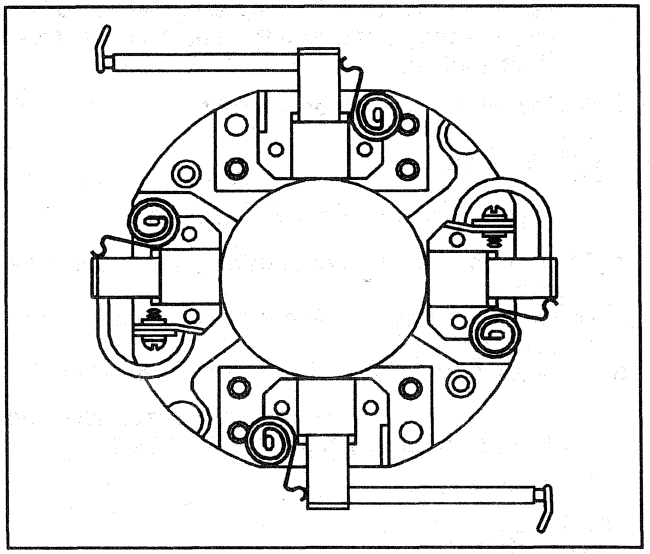

Figure 16—Springs and Brushes on the Brush Holder

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

2. Brushes if removed.
   A. Refer to Figure 16 for proper installed position of all brushes. Make sure the insulated brushes go into the brush sockets of the brush holder assembly that mounts on the insulation.
   B. To install each brush, grasp the free end of the brush spring with needle-nose pliers, twist it to the right to clear the brush socket, and insert the brush partly into the brush socket.
   C. Gradually release the spring so that its end contacts the side (not end) of the brush (Figure 16). This will hold the brushes retracted until after the brush holder is installed over the armature commutator.
3. Grounded brush screws.
   A. Position the terminals of the grounded brush leads behind the terminal tabs on the brush holder (Figure 16).
   B. Insert the brush screws through the terminal tabs on the brush holder and thread into the brush lead terminals.

Tighten

- Grounded brush screws to 1.5 N.m (13 lb in).

4. Frame and field assembly to the brush holder assembly (Figure 5).
   A. Position the brush holder assembly (with installed brushes) over the terminal end of the frame and field assembly.
   B. Attach the terminals of the insulated brush leads to the conductors in the frame and field assembly with insulated brush screws.

Tighten

- Insulated brush screws to 1.5 N.m (13 lb in).

UNIT ASSEMBLY

Support the gear reduction and drive group with the pinion gear end down (Figures 4 and 17) and proceed as follows:

Important

- If the armature bearings are being replaced, install them on the armature, refer to "Armature Bearing Replacement" in this section.

Install or Connect (Figures 4, 5, and 17)

1. Solenoid assembly.
   A. Pivot the plunger of the solenoid assembly into engagement with the shift lever in the gear reduction and drive group.
   B. Position the solenoid assembly mounting flange and install the solenoid mounting screws.

Tighten

- Solenoid screws to 2.8 N.m (25 lb in).

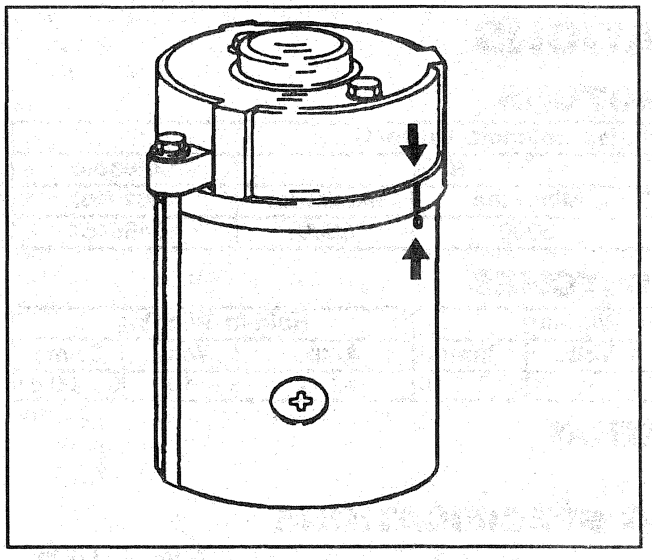

Figure 17—Aligning Timing Marks

2. Frame seal.
3. Armature assembly with bearings into the gear reduction and drive group.
   - Make sure the gear teeth are aligned, then seat the bearing on the armature shaft fully into the housing recess.
4. Frame, field, and brush holder group.
   A. Place the dowel pin in the hole in the armature support bracket of the gear reduction and drive group.
   B. Position the frame, field, and brush holder group over the armature assembly, align the hole for the dowel pin and marks made prior to disassembly, and seat in the gear reduction and drive group.
   C. Twist the brush springs away from the brushes, slide the brushes in to contact the commutator on the armature, and release the brush springs to contact the ends of the brushes (Figure 5).
      - Brush spring tension should be 44.5 to 49 N (10 to 11 lbs). If not, replace the springs before proceeding.
5. O-ring seal.

Important

- The O-ring seal can easily be damaged during installation of the commutator end frame. To prevent such damage, install the O-ring seal as described in the following steps.

   A. Install the O-ring seal on the frame, field, and brush holder group so that it is against the shoulder on the field frame. The O-ring seal will abut the commutator end frame when installed. This is the normal-installed position of the O-ring seal.
   B. Carefully roll the O-ring seal out of its normal-installed position up onto the major outer diameter of the field frame. Allow the seal to remain in this position until the commutator end frame is partially installed.
6. Commutator end frame.
   A. Align the marks on the commutator end frame and frame and field assembly made prior to disassembly (Figure 17).
   B. Start the commutator end frame onto the frame and field assembly, leaving a gap just slightly larger than the thickness of the O-ring seal.
7. Brush plate screws.
   - 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 (Figure 5).

Tighten

- Brush plate screws to 2.8 N·m (25 lb in).

8. Through-bolts.
   A. Install the through-bolts and tighten by hand, but do not close the gap between the commutator end frame and frame and field assembly where the O-ring seal goes.
   B. Roll the O-ring seal back down into its installed position between the commutator end frame and the frame and field assembly.
   C. Align the timing ribs on the edge of the commutator end frame with the timing spots on the frame and field assembly to ensure proper brush alignment (Figure 17). Marks are located in two places on the motor, but will only match one way.

Tighten

- Through-bolts to 8.5 N·m (75 lb in).

9. Motor lead onto the frame and field assembly (Figure 5).
   - Remove the nut from the terminal on the solenoid, install the motor lead terminal, and reinstall the nut.

Tighten

- Solenoid motor terminal nut to 11 N·m (100 lb in).

TESTING AFTER OVERHAUL

After overhaul of the starter motor, perform the "Starter Draw Test" in this section.

SPECIFICATIONS

STARTER MOTORS

No Load Test @ 10 Volts (Includes Solenoid Current)						
Starter		AMPS		RPM		Solenoid
Part No.	Series	Minimum	Maximum	Minimum	Maximum	Part No.
1113296	28-MT	125	190	3000	5600	10456454

SOLENOID SWITCHES

Switch		Pull-In Winding			Hold-In Winding		
Part No.	Volts	Amps	Volts	Ohms	Amps	Volts	Ohms
10456454	12	52-59	10	0.17-0.19	12-14	10	0.76-0.81

LUBRICATION

Use GM P/N 1960954 Grease Lubricant or equivalent.

FASTENER TIGHTENING SPECIFICATIONS

Item	N·m	Lb In
Brush Plate Screws	2.8	25
Drive Housing Bolts	8.5	75
Grounded Brush Screws	1.5	13
Insulated Brush Screws	1.5	13
Shift Lever Nut	4.5	40
Solenoid Screws	2.8	25
Solenoid Motor Terminal Nut	11	100
Through Bolts	8.5	75

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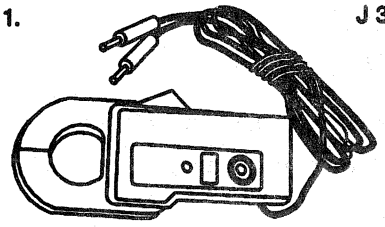
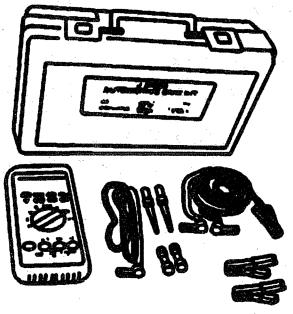
SPECIAL TOOLS

1. J 35590



2. J 39200



1. CURRENT CLAMP
2. DIGITAL MULTIMETER

SECTION 6D3

CHARGING SYSTEM

CAUTION: This vehicle has a Supplemental Inflatable Restraint (SIR) System. Refer to the SIR Component and Wiring Location view in order to determine whether you are performing service on or near the SIR components or the SIR wiring. When you are performing service on or near the SIR components or the SIR wiring, refer to the SIR On-Vehicle Service information. Failure to follow the CAUTIONS could cause air bag deployment, personal injury, or unnecessary SIR system repairs.

CAUTION: Before removing or installing any electrical unit, or when a tool or equipment could easily come in contact with "live" exposed electrical terminals, disconnect the negative battery cable to help prevent personal injury and/or damage to the vehicle or components.

NOTICE: ***Always use the correct fastener in the proper location. When you replace a fastener, use ONLY the exact part number for that application. General Motors will call out those fasteners that require a replacement after removal. General Motors will also call out the fasteners that require thread lockers or thread sealant. UNLESS OTHERWISE SPECIFIED, do not use supplemental coatings (paints, greases, or other corrosion inhibitors) on threaded fasteners or fastener joint interfaces. Generally, such coatings adversely affect the fastener torque and joint clamping force, and may damage the fastener. When you install fasteners, use the correct sequence and tightening specifications. Following these instructions can help you avoid damage to parts and systems.***

CONTENTS

GENERAL DESCRIPTION

The charging system consists of the battery, the generator, the regulator, and the charging system indicator lamp circuitry. The generator supplies electrical power for charging the battery and operating accessories.

CS-130 GENERATOR

The CS-130 generator (Figure 1) features a high ampere output per pound of weight. CS stands for Charging System and 130 is the measurement in millimeters of the outside diameter of the stator laminations.

This generator with integral regulator does not have a diode trio. The delta stator, rectifier bridge, and rotor with slip rings and brushes are electrically similar to those in other CS-series generators. A conventional fan and pulley is used and an internal fan cools the slip rings, end frame, rectifier bridge, and regulator.

The charging system indicator, that appears on the instrument panel as a battery symbol, turns on when the ignition switch is closed and turns off when the engine is running. If the charging system indicator is on with the engine running, a charging system problem is indicated. This indicator will glow at full brilliance, not half lit, if any charging problem occurs or the system voltage is too high or low.

The regulator voltage setting varies with temperature and limits system voltage by controlling rotor field current. When the field current is "ON," the regulator actually switches the rotor field current 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 obtained. At high speeds, the on-time may be 10 percent and the off-time 90 percent. At low speeds, with high electrical loads, on-off time may be 90 percent and 10 percent respectively.

The regulator has four terminals: "P," "L," "I," and "S." The regulator and/or the connector may be stamped "PLI/FS," or "PLFS."

Either the "L" or "I" terminal (or both) turns the regulator on and allows field current to flow when the switch is closed. The "L" terminal must be connected through an indicator lamp or a suitable resistor. The "I" terminal may be connected either directly to battery positive or through a resistor. These two terminals are often used in parallel, connected to two different vehicle circuits. The "P" terminal is connected 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 uses an internal voltage sense for control. Refer to the Engine Controls, Transmission Diagnosis and Electrical Diagnosis Manual.

The generator is not serviceable and no periodic maintenance is required. It should not be disassembled for any reason.

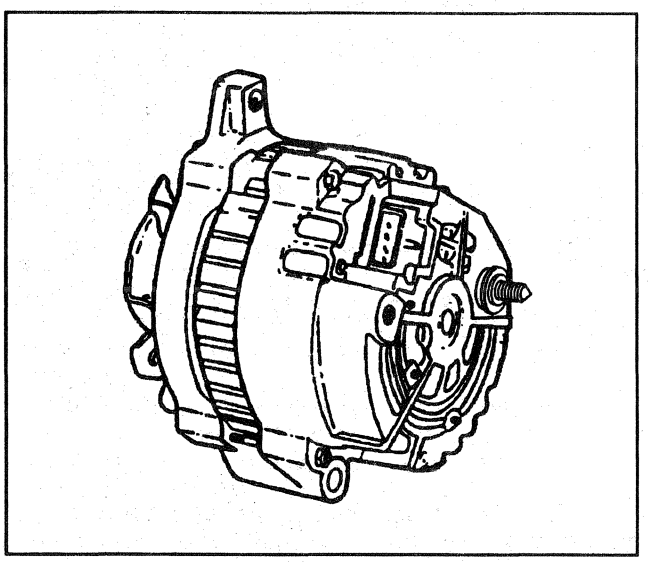


Figure 1—CS-130 Generator

DIAGNOSIS

NOISY GENERATOR

Noise from a generator may be caused by a loose drive pulley, loose mounting bolts, worn or dirty bearings, worn stator, or worn rectifier bridge. If the pulley and mounting bolts are snug and the noise continues, replace the generator. Refer to "Generator Replacement" in this section.

Do not disassemble the generator. Separating the end frames will damage the slip ring end bearing. This generator is serviceable by complete replacement only.

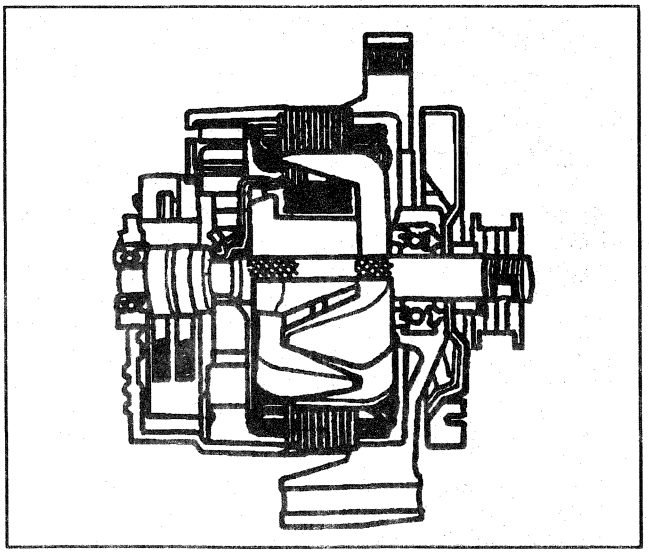


Figure 2—Generator Components

ELECTRICAL TESTS

Before performing the diagnosis procedures on the vehicle, make sure the system wiring is good and the belt is not slipping. Also, the battery must be fully charged for a valid test of the charging system.

NOTICE: ***To avoid damage to the vehicle electrical system, observe the following precautions:***

- ***Do not polarize the generator.***
- ***Do not short across or ground any of the terminals in the charging circuit except as specifically instructed herein.***
- ***NEVER disconnect the output terminal while the generator is operating.***
- ***Make sure the generator and battery have the same ground polarity.***
- ***When connecting a charger or booster battery to the vehicle battery, connect negative to negative and positive to positive.***

CIRCUIT DIAGNOSIS

Trouble in the charging system will show up as one or more of the following conditions:

- Abnormal indicator lamp operation.
- A high or low voltage indication with the engine running and all accessories off.
- An undercharged battery as evidenced by slow cranking or a dark hydrometer.
- An overcharged battery as evidenced by excessive spewing of electrolyte from the vents.

A basic wiring diagram for the charging system is shown in Figure 3. When the system is operating normally, the indicator lamp will turn on when the ignition switch is turned on and turn off when the engine starts. If the lamp operates abnormally or an undercharged or overcharged battery condition occurs, the"Diagnostic Test for CS-130" in this section may be used to diagnose the charging system. Remember that an undercharged battery is often caused by accessories being left on overnight or by a switch stuck closed that allows a lamp, such as an instrument panel compartment lamp, to stay on.

This generator does not have a test hole.

DIAGNOSTIC TEST FOR CS-130

Tool Required:
J 39200 Digital Multimeter

1. Check the belt for wear and tension. Refer to SECTION 6B for belt diagnosis. Check the wiring.

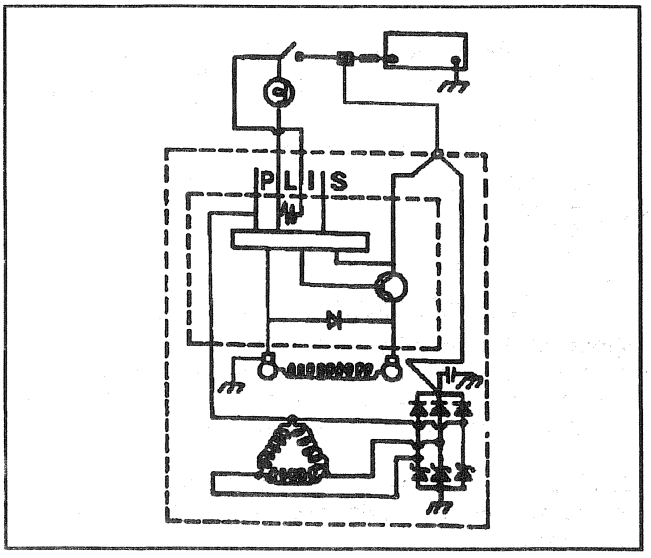


Figure 3—CS-130 Generator Schematic

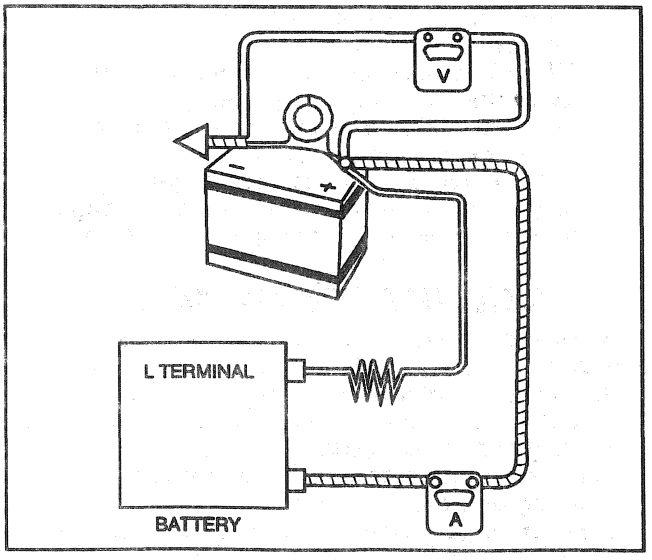


Figure 4—Connections for Generator Output Test

2. With the ignition switch on and the engine off, the lamp should be on. If not, detach the wiring harness at the generator and use a fused jumper wire (J 36169 or equivalent with a 5 ampere fuse) to ground the "L" terminal lead in the wiring harness (Figure 3).
   - If the lamp lights, replace the generator.
   - If the lamp does not light, locate the open circuit between the grounding lead and the ignition switch. The lamp may be open.
3. With the ignition switch on and the engine running at moderate speed, the lamp should be off. If not, stop the engine, turn the ignition switch on, and disconnect the wiring harness at the generator.
   - If the lamp goes out, replace the generator.
   - If the lamp stays on, check for a grounded "L" terminal wire in the harness.
4. If the battery is undercharged or overcharged or the vehicle's voltmeter shows high or low voltage with the engine running:
   A. Disconnect the wiring harness connector from the generator.
   B. With the ignition switch on and the engine not running, connect J 39200, set on DC voltage scale, from ground to the "L" terminal in the wiring harness. Voltage should be B+, other readings indicate an open, high resistance or grounded circuit between the terminal and the battery. Correct as required.
   C. Connect the harness connector to the generator and run the engine at 2500 RPM with accessories off.
   D. Measure the voltage across the battery. If it is above 16 volts, replace the generator.
   E. With the engine off, connect an ammeter at the generator output terminal. The ammeter must have the capability to measure 115 amperes of current. Connect J 39200 across the generator and a carbon pile across the battery.
      - Run the engine at 2500 RPM, turn on the accessories, and load the battery with a carbon pile to obtain maximum amperage. Maintain voltage at 13 volts or above.
      - If the output in amperes is within 15 amperes of the rated output, the generator is OK. Refer to "Generator Specifications" in this section.
      - If the output is not within 15 amperes of the rated output, replace the generator.

GENERATOR BENCH TEST

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

1. Make connections as shown in Figure 4, 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 to 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 within 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.

ON-VEHICLE SERVICE

GENERATOR REPLACEMENT

The removal and installation instructions serve only as a guide. Additional operations may be required on some vehicles to remove other equipment to gain access to the generator, drive belt, and brackets.

CAUTION: Failure to observe Step 1 in this procedure may result in an injury from the hot battery lead at the generator.

Remove or Disconnect (Figures 5 and 6)

1. Negative battery cable. Refer to SECTION 6D1.
2. Terminal plug and battery lead from the back of the generator.
3. Drive belt. Refer to SECTION 6A.
4. Two mounting bolts.
5. Generator from the mounting bracket.

Install or Connect (Figures 5 and 6)

NOTICE: *Refer to "Notice" on page 6D3-1.*

1. Loosely install generator to the bracket with two bolts.

Tighten

A. Top mounting bolt to 25 N·m (18 lb ft).
B. Bottom mounting bolt to 50 N·m (37 lb ft).
C. Bolt through the bracket and back of the generator to 25 N·m (18 lb ft).

Diesel Engines:

2. Generator to the mounting bracket with bolts.

Tighten

A. Top mounting bolt to 25 N·m (18 lb ft).
B. Bottom mounting nut to 23 N·m (17 lb ft).
C. Bolt at the back of the generator to 25 N·m (18 lb ft).

3. Drive belt. Refer to SECTION 6A.
4. Terminal plug and battery lead to the back of the generator.

Tighten

- Battery terminal nut to 8 N·m (71 lb in).

5. Negative battery cable.

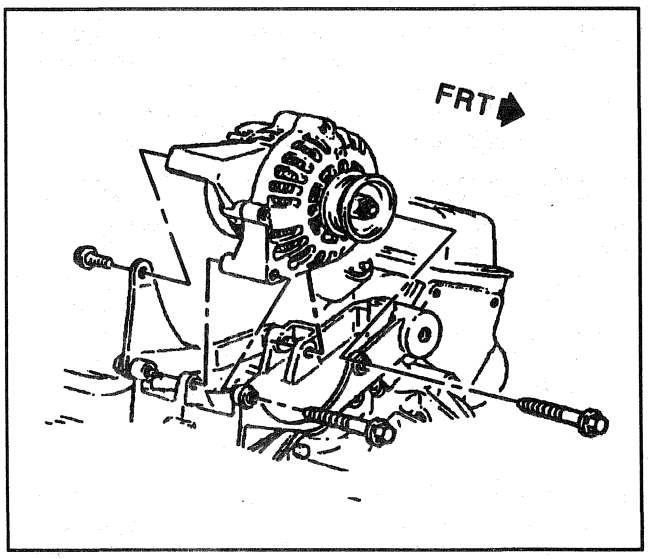


Figure 5—Generator Mounting (Gasoline Engines)

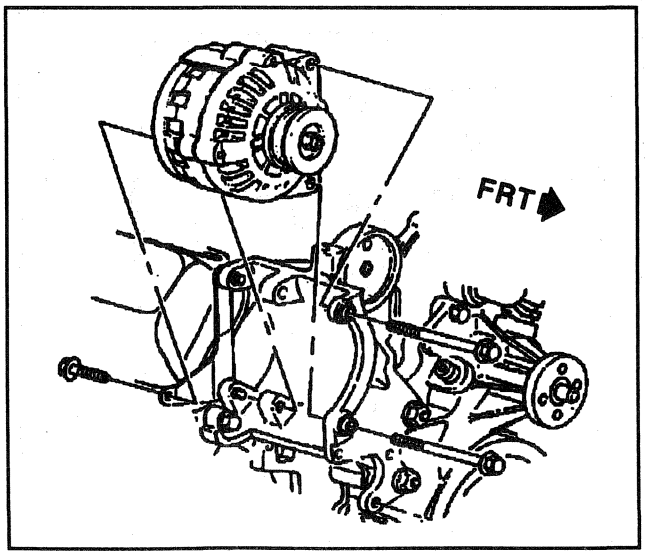


Figure 6—Generator Mounting (Diesel Engines)

SPECIFICATIONS

GENERATOR SPECIFICATIONS

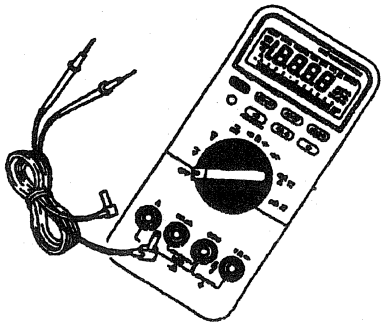
Part No.	Series (Type 100)	Rotation Viewing Drive End	Cold Output AMPS
10480094	CS130	CW	100
10480084	CS130	CW	105
10480086	CS130	CW	100
10480099	CS130	CW	105

T3094

FASTENER TIGHTENING SPECIFICATIONS

Application	N·m	Lb ft	Lb in
Battery Terminal Nut	8	—	71
Top Bracket Bolts (4.3L, 5.0L, 5.7L, 6.5L Engines)	25	18	—
Top Bracket Bolts (7.4L Engines)	50	37	—
Bottom Bracket Bolts (4.3L, 5.0L, 5.7L Engines)	50	37	—
Bottom Bracket Bolts (7.4L Engines)	25	18	—
Bottom Bracket Nuts (6.5L Engines)	23	17	—

SPECIAL TOOLS

1.  J 39200

1. J 39200 DIGITAL MULTMETER

2906r5350

SECTION 6D3A

CS-144 GENERATOR

CAUTION: This vehicle has a Supplemental Inflatable Restraint (SIR). Refer to the SIR Component Location View in order to determine whether you are performing service on or near the SIR wiring. When you are performing service on or near the SIR components or the SIR wiring, refer to the SIR On-Vehicle Service information. Failure to follow CAUTIONS could result in possible air bag deployment, personal injury, or otherwise unneeded SIR system repairs.

NOTICE: ***Always use the correct fastener in the proper location. When you replace a fastener, use ONLY the exact part number for that application. General Motors will call out those fasteners that require a replacement after removal. General Motors will also call out the fasteners that require thread lockers or thread sealant. UNLESS OTHERWISE SPECIFIED, do not use supplemental coatings (paints, greases, or other corrosion inhibitors) on threaded fasteners or fastener joint interfaces. Generally, such coatings adversely affect the fastener torque and joint clamping force, and may damage the fastener. When you install fasteners, use the correct tightening sequence and specifications. Following these instructions can help you avoid damage to parts and systems.***

CONTENTS

GENERAL DESCRIPTION

CS-144 GENERATOR

The CS-144 generator with integral regulator shown in Figure 1, features a high ampere output per pound of weight. It does not use a diode trio. The delta stator, rectifier bridge, and rotor with slip rings and brushes, are electrically similar to other CS-series generators. CS stands for Charging System, and 144 indicates the outside diameter of the stator laminations in millimeters. The bearings are sealed with lifetime lubrication in both end frames. No periodic maintenance is required.

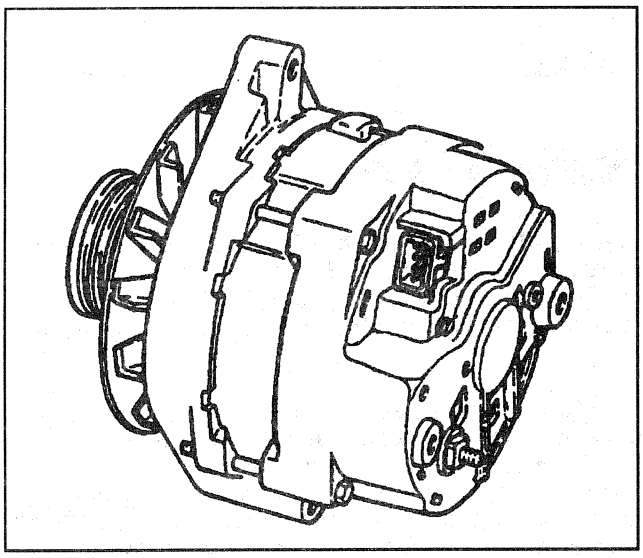


Figure 1—CS-144 Generator

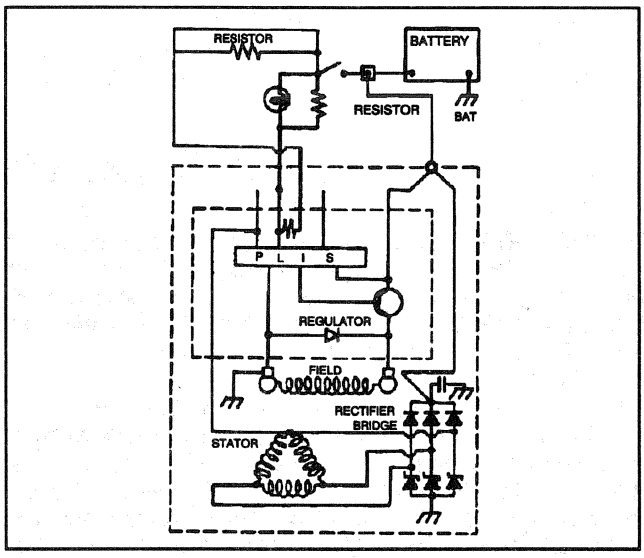


Figure 2—Generator Schematic

Operating Principles

Regulator voltage setting varies with temperature and limits system voltage by controlling rotor field current. When the field current is on, the regulator actually switches rotor field current on and off at a fixed frequency of about 400 cycles per second to help control radio noise. By varying on-off time, correct average field current for proper system voltage control is obtained. At high speeds, the on-time may be 10 percent and the off-time 90 percent. At low speeds, with high electrical loads, on-off time may be 90 percent and 10 percent respectively.

A basic wiring circuit for the "PLIS" regulator is shown in Figure 2. The "P" terminal connects to the stator. The "S" terminal may be connected externally to the battery to monitor voltage and make sure the regulator maintains an adequate voltage level to charge the battery. If the "S" terminal is not connected externally, integrated circuits in the regulator are used for sensing voltage.

Both the "L" and "I" terminals serve to turn on the regulator and allow field current to flow when the switch is closed. The "I" terminal may be connected either directly to the switch, or through a resistor. The "I" circuit may be used with or without anything connected to the "L" circuit and with or without anything connected to the "L" terminal. When used, the "L" terminal must be connected through an external resistor, such as the charging system indicator lamp. When a generator fault is detected (voltage too high or too low, or no rotation), the regulator grounds the "L" terminal and activates the indicator lamp.

DIAGNOSIS

GENERATOR OUTPUT TEST

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

1. Install and connect the generator to the test stand as shown in Figure 3. The ground polarity of the generator and the battery must be the same. The carbon pile must be turned off to begin the test. Be sure that the generator BAT terminal is connected to the battery positive terminal (through the ammeter) and that the battery and generator are properly grounded.
2. Connect a 30 to 500 ohm resistor between the positive battery terminal and the "L" terminal on the generator.
3. Operate the generator through the test stand, increasing speed slowly, and observe the voltage.
4. If the voltage is uncontrolled and increases above 16 volts, the rotor field coil is shorted, the regulator is not working properly, or both. A shorted rotor field coil can cause problems in the regulator.

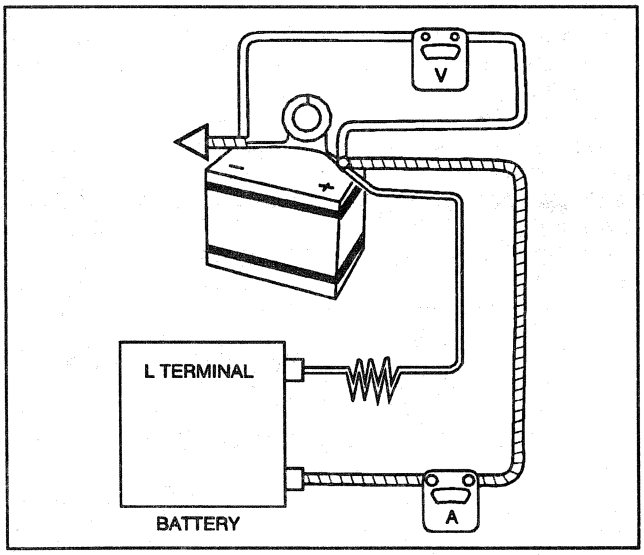


Figure 3—Connections for Generator Output Test

5. If the voltage is below 16 volts, increase speed and adjust the carbon pile to obtain maximum amperage output. Maintain the voltage above 13 volts.
6. If the output is within 15 amperes of the rated output, the generator is good.
7. If the output is not within 15 amperes of the rated output, replace the generator.

DISASSEMBLY

DRIVE END FRAME

Remove or Disconnect (Figures 4 through 7)

Tool Required:
J 28509-A Bearing Remover

- Scribe a mark to help locate the frame end parts in the same position during assembly.

1. Four through-bolts.
2. Rotor and drive end frame assembly from the Slip Ring End (SRE) frame assembly.

NOTICE: ***On models with a slip ring end ball bearing on the rotor shaft, this bearing must be replaced with a new bearing any time the two halves of the generator are separated. If not replaced, the bearing may bind and fail due to distortion of its outer tolerance rings. This does not apply to roller-type slip ring end frame bearings.***

- Place the rotor in a vise and tighten only enough to permit removal of the pulley nut.

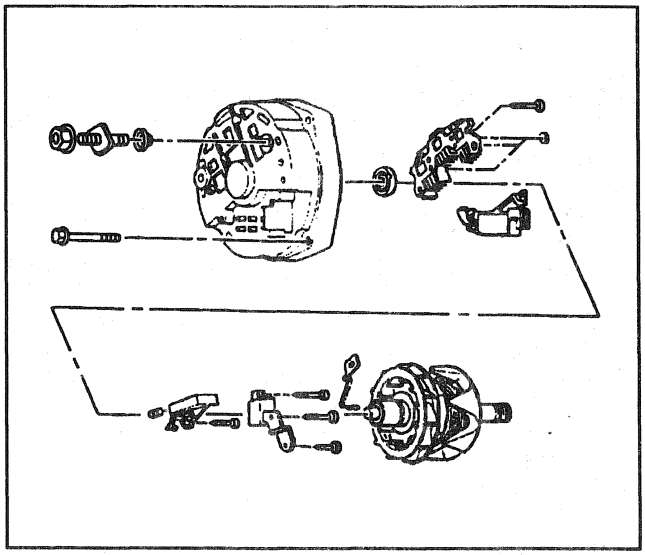


Figure 4—CS-144 Components (1 of 2)

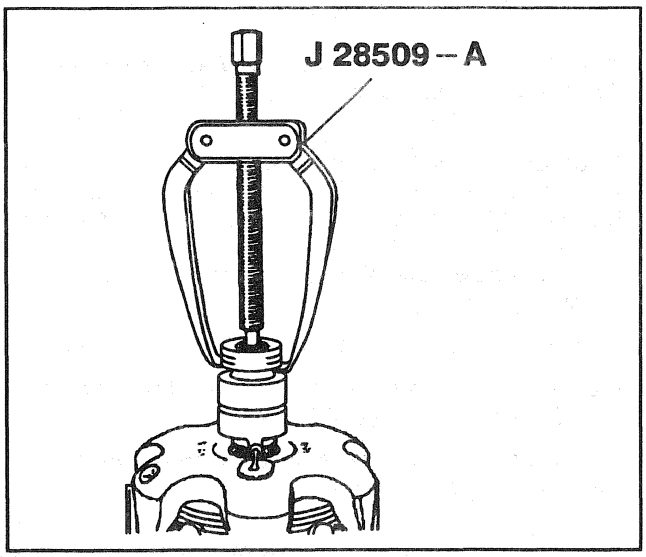


Figure 6—Removing the Slip Ring End Bearing

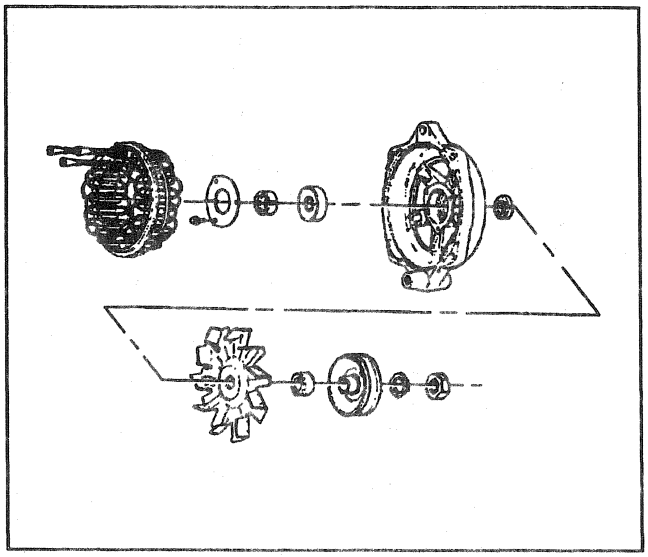


Figure 5—CS-144 Components (2 of 2)

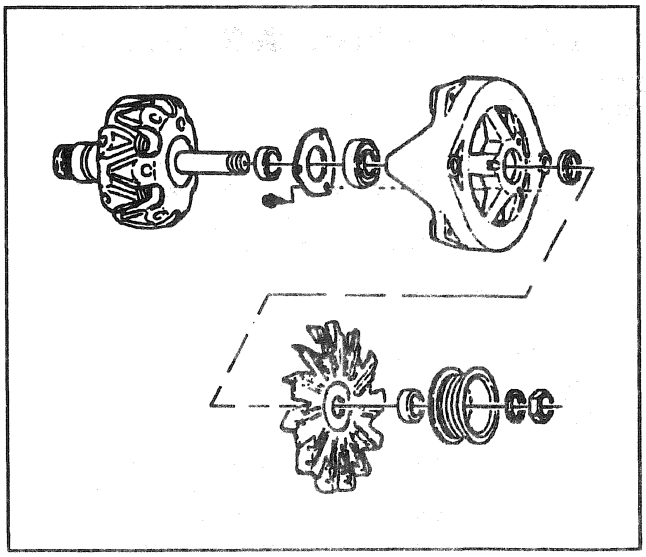


Figure 7—Drive End Frame Components

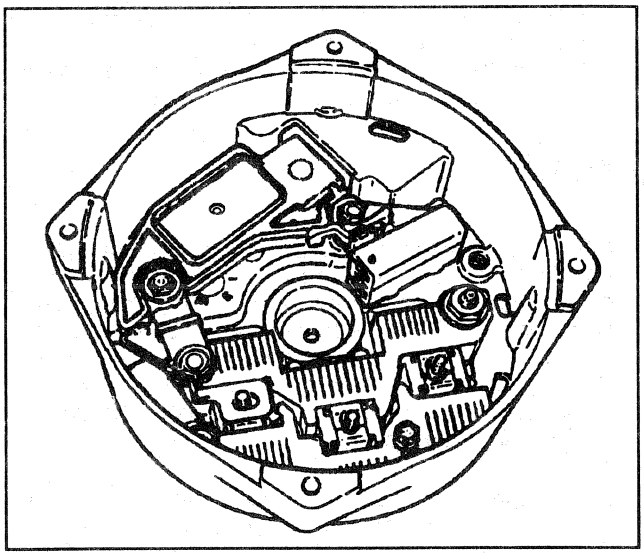


Figure 8—Slip Ring End Frame with Stator Removed

NOTICE: *The rotor may be distorted if the vise is overtightened.*

3. Nut and washer from the shaft.
4. Pulley, collar, fan, and outside collar from the shaft.
5. Drive end frame and the inside collar from the rotor shaft.
6. Three screws and the retainer from the drive end frame (Figure 7).
   - Press the bearing from the drive end frame.
7. Slip ring end bearing (if equipped) from the rotor shaft using J 28509-A (Figure 6).
   - Some models have a pressed-on race that should not be removed.

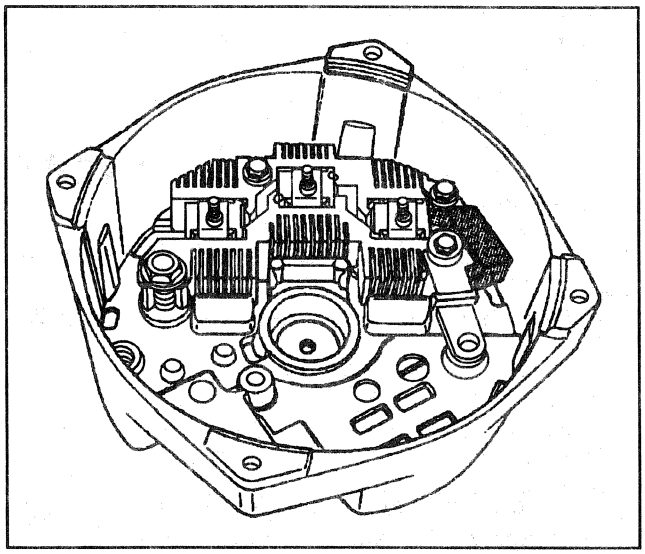


Figure 9—Rectifier Bridge in End Frame

SLIP RING END FRAME

Remove or Disconnect (Figures 4, 5, 8 and 9)

1. Three rectifier bridge to stator nuts.
2. Stator.
3. One screw from the brush holder and two insulated screws from the regulator connector.
4. Brush holder, regulator, and connector from the end frame (Figure 8).
5. BAT terminal nut from the insulated heat sink (Figure 9).
6. Two screws and washers from the grounded heat sink.
7. Capacitor and rectifier bridge from the frame (Figure 9).
8. BAT terminal from the outside of the frame.

INSPECTION AND REPAIR

CLEANING AND INSPECTION

Clean

- All metal parts except the voltage regulator, rectifier bridge, stator, rotor, and bearing assemblies in a suitable solvent.
  — Wipe or blow the parts dry.

Inspect

1. Brush holder for damage.

Clean

- Brush holder. Make sure the brush pockets are clean.
- Brushes with a soft, dry cloth.

2. Brushes for wear. If the brushes are worn to 11 mm (0.4 in) or less in length, replace the brush holder assembly. Use a retainer pin to hold the brushes in the holders.
3. Brush springs for broken wire or corrosion.
4. Slip ring end of the rotor shaft for overheating or scoring. If signs of overheating or scoring are present, replace the rotor. The slip ring end bearing must be replaced any time the two halves of the generator are separated.
5. Drive end bearing for roughness, looseness, or wear. If the condition of the bearing is in doubt, replace it.
6. Windings for burned insulation. Replace the rotor or stator if either looks burned.
   - Burned insulation appears as very dark or blackened wiring. A strong acidic odor will be apparent.
7. Terminal connectors for corrosion or breaks.
8. Windings on the stator for chipped insulation. If the chipped area is small and the rest of the stator is OK, repair the stator with insulating varnish.

9. Slip rings for scoring, wear, or pitting.
   A. If the rings are dirty, clean with a 400 grain or finer polishing cloth.
   B. Spin the rotor and hold the polishing cloth against the slip rings until they are clean.
   C. If scored, worn, or pitted, true the rings in a lathe to 0.05 mm (0.002 in).
   D. Finish with 400 grain or finer polishing cloth.
      • Blow away all dust.
10. Rotor and stator windings electrically as described under "Electrical Tests" in this section.
11. Generator housing for cracks, warping, or other damage.
12. If the regulator, brush assembly, or connector needs replacing, it will have to be unsoldered from the other two components. Use as little heat as possible to protect the regulator (Figure 10).

ELECTRICAL TESTS

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

Rotor Field Winding Tests

The rotor may be tested electrically with a self-powered test lamp or an ohmmeter (Figure 11).

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 and refer to "Generator Specifications," in this section. An ammeter reading above the specified value indicates shorted windings.

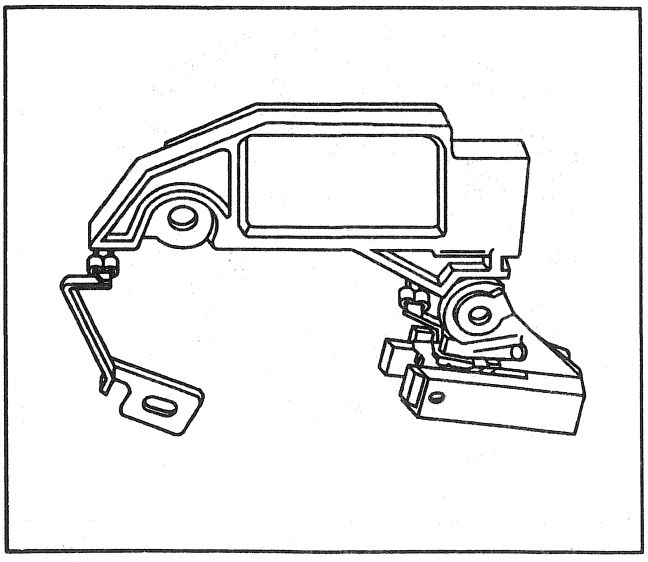


Figure 10—Regulator Connections

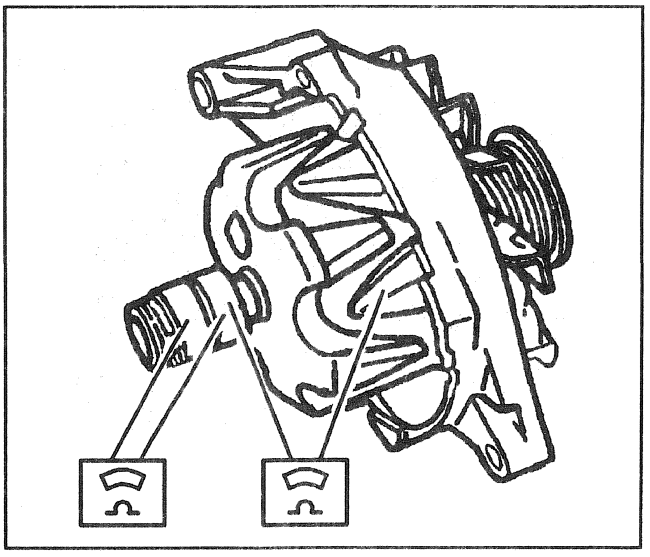


Figure 11—Testing the Rotor Field Windings

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 it is 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

Test the stator with a self-powered test lamp or an ohmmeter (Figure 12). If the ohmmeter reads low, or if the lamp lights when connected from any stator lead to bare metal on the stator frame, the stator is grounded.

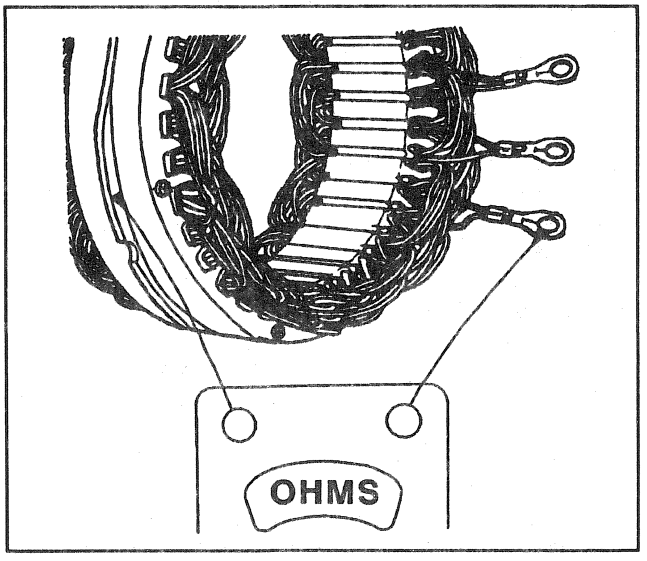


Figure 12—Testing the Stator For Grounds

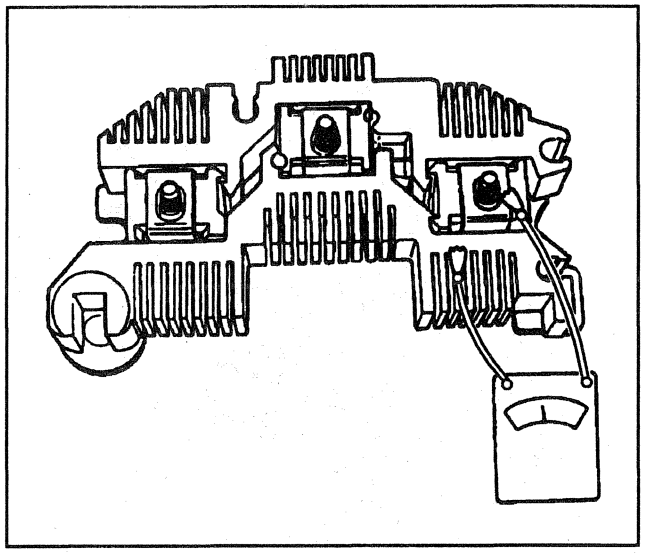


Figure 13—Rectifier Bridge Test

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

To test the rectifier bridge, connect an ohmmeter to the grounded heat sink and one of the three terminals, while pressing down firmly on the flat metal clip (Figure 13). Observe the ohmmeter reading and reverse the lead connectors to the grounded heat sink and the same metal clip. 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's 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.

ASSEMBLY

SLIP RING END FRAME

Assemble

1. Two locators from the brush holder with needle-nose pliers or side cutters.
   A. File the jagged edges down to the level of the surrounding material. Keep loose particles away from the brush slots.
   B. Blow away any dust.

Install or Connect (Figures 4, 5, 8 through 10, and 14)

1. Terminal insulator to the outside of the slip ring end frame.
2. BAT terminal to the rectifier bridge with a washer and nut.
3. Rectifier bridge into the end frame.
4. Capacitor.
   - Make sure the side with the insulator material is placed against the end frame (ground).
5. Two bolts through the rectifier bridge.
6. Two insulated screws through the rectifier bridge.
   - If the brush holder, regulator, or connector has been replaced, connect it by crimping the connectors to the other components. Solder the connection using as little heat as possible to avoid heat damage to the regulator (Figure 10).
7. Brushes into the brush holder.
   A. If the brushes are being reused, be sure they are clean. Wipe them with a clean, dry cloth.
   B. Retract the brushes in the holder.
   C. Retain the retracted brushes with a retaining pin.
   D. Make sure the pin extends through the end frame when the brush holder is in place. After the rotor and drive end frame are installed, the pin will be pulled out, allowing the brushes to contact the slip rings.
8. Brush holder, regulator, and connector assembly into the end frame (Figure 8).
   - The metal side of the capacitor strap should rest against the regulator connection.

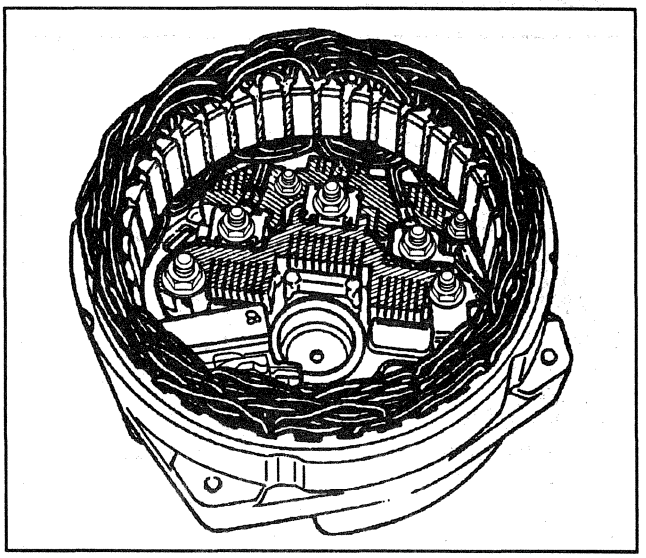


Figure 14—Stator Installed in the Slip Ring End Frame

9. One bolt into the brush holder.
   - If a brush holder with locator bosses is being replaced with a holder without locators, make sure to align the brush holder assembly and hold it with your fingers while tightening the brush holder attaching screw.
10. Two insulated screws through the regulator connector.
11. Stator into the end frame, aligning the three stator leads to the three rectifier bridge terminals (Figure 14).
12. Three rectifier bridge nuts. Tighten the nuts securely.

DRIVE END FRAME

Install or Connect
(Figures 4 through 6 and 15)

1. Drive end bearing into the frame.
   - Press against the outer race to press the bearing into place.
2. Retainer with three screws.

NOTICE: ***On models with a slip ring end ball bearing on the rotor shaft, this bearing must be replaced with a new bearing any time the two halves of the generator are separated. If not replaced, the bearing may bind and fail due to distortion of its outer tolerance rings. This does not apply to roller-type slip ring end frame bearings.***

3. New slip ring end bearing onto the rotor shaft or into the drive end housing (Figure 15).
   - Press against the inner race (bearings on the rotor shaft) or the outer race (bearings in the drive end housing) until the stop is reached.
4. Rotor shaft through the inside collar and through the end frame.
5. Outside collar, fan, and fan collar onto the shaft (Figure 6).

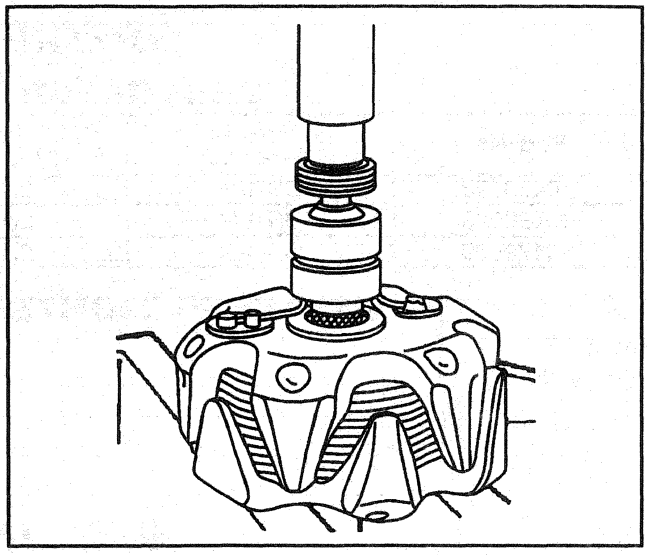


Figure 15—Installing the Slip Ring End Bearing

6. Pulley, washer, and pulley nut onto the shaft.

Tighten

- Pulley nut to 100 N·m (74 lb ft).

MAIN ASSEMBLY

Assemble

1. Drive end frame and rotor assembly to the slip ring end frame, lining up the marks.
   - If the slip ring end bearing is on the rotor shaft, follow these steps:
     — Carefully guide the slip ring end bearing into the slip ring end frame.
     — Make sure the tolerance rings on the bearing outer race are not damaged.
2. Four through-bolts. Tighten securely.
   A. Remove the brush retainer from the end frame.
   B. Test the generator output.

SPECIFICATIONS

GENERATOR SPECIFICATIONS

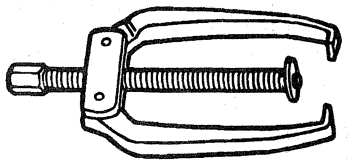
Part No.	Series (Type 100)	Rotor Field-Ohms 27°C (80°F)	Field Current @ 12 Volts 27°C (80°F) AMPS	Ampere Rating
10480022	CS-144	2.1-2.4	5.0-5.7	124
10480023	CS-144	2.1-2.4	5.0-5.7	145
10479959	CS-144	2.1-2.4	5.0-5.7	124

FASTENER TIGHTENING SPECIFICATIONS

Item	N·m	Lb Ft
Pulley Nut	100	74

T2532

SPECIAL TOOLS

1  J 28509-A

1. Bearing Remover

F7092

SECTION 6D4

IGNITION SYSTEM

CAUTION: Before removing or installing any electrical unit, or when a tool or equipment could easily come in contact with exposed electrical terminals, make sure the ignition switch and headlamp switch are in the OFF position. In cases where the circuit would still be "live" or "hot at all times," disconnect the negative battery cable. This is to help prevent personal injury and/or damage to the vehicle or components.

CAUTION: This vehicle has a Supplemental Inflatable Restraint (SIR). Refer to the SIR Component Location View in order to determine whether you are performing service on or near the SIR wiring. When you are performing service on or near the SIR components or the SIR wiring, refer to the SIR On-Vehicle Service information. Failure to follow CAUTIONS could result in possible air bag deployment, personal injury, or otherwise unneeded SIR system repairs.

NOTICE: ***Always use the correct fastener in the proper location. When you replace a fastener, use ONLY the exact part number for that application. General Motors will call out those fasteners that require a replacement after removal. General Motors will also call out the fasteners that require thread lockers or thread sealant. UNLESS OTHERWISE SPECIFIED, do not use supplemental coatings (paints, greases, or other corrosion inhibitors) on threaded fasteners or fastener joint interfaces. Generally, such coatings adversely affect the fastener torque and joint clamping force, and may damage the fastener. When you install fasteners, use the correct tightening sequence and specifications. Following these instructions can help you avoid damage to parts and systems.***

CONTENTS

GENERAL DESCRIPTION

The ignition system consists of the battery, distributor, ignition switch (gasoline engines) or engine control switch (diesel engines), spark plugs, and the primary and secondary wiring. For information on the battery, refer to SECTION 6D1. Refer to SECTION 3F1 for information on the ignition switch.

DISTRIBUTOR IGNITION (DI) SYSTEM

The distributor ignition system includes the distributor (Figures 1 and 2), hall effect switch (camshaft position sensor), ignition coil (Figures 3 and 4), secondary wires, spark plugs, knock sensor and crankshaft position sensor. The ignition system is controlled by the Vehicle Control Module (VCM). The VCM monitors information from various engine sensors, computes the desired spark timing and controls the dwell and firing of the ignition coil via an ignition control line to the coil driver. For information on the distributor ignition system diagnostics, refer to the Engine Controls, Transmission Diagnosis, and Electrical Diagnosis Manual.

The distributor connects the ignition coil and spark plugs through secondary wires. The rotor directs the spark to the appropriate cylinder. The distributor has an internal camshaft position sensor (hall effect switch) that connects to the VCM through the primary engine harness and provides cylinder identification.

Unit Repair Information

For bench repair of the distributor, refer to the SECTION 6D4A.

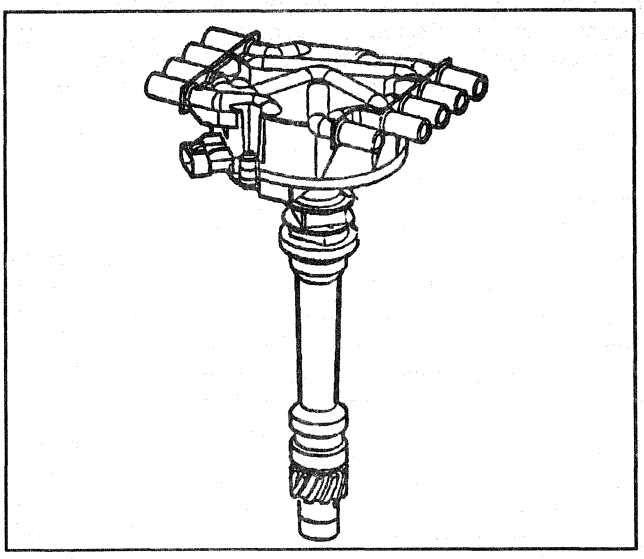


Figure 1—Distributor (5.0L, 5.7L, and 7.4L)

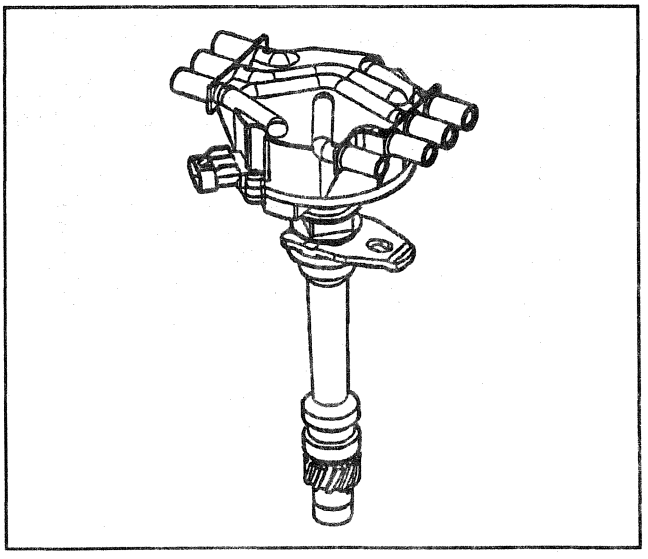


Figure 2—Distributor (4.3L)

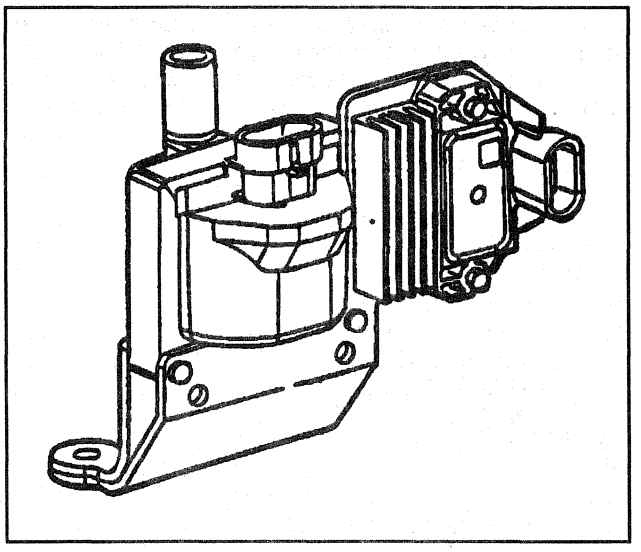


Figure 3—Ignition Coil (4.3L, 5.0L, and 5.7L)

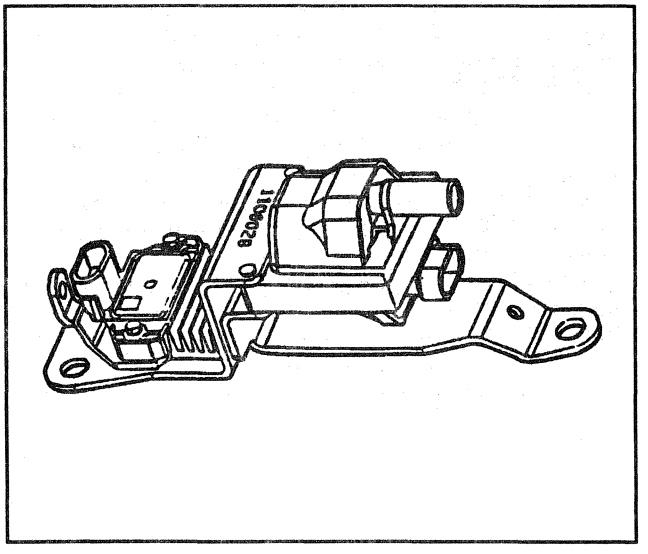


Figure 4—Ignition Coil (7.4L)

IGNITION BASE TIMING

NOTICE: ***The distributor on the 4.3L engine is located in a fixed, non-adjustable position. No attempt should be made to adjust the engine base timing by rotating the distributor. Attempting to do so may result in engine cross-fire and mis-fire conditions.***

Refer to the Engine Controls, Transmission Diagnosis, and Electrical Diagnosis Manual for ignition base timing information on the 5.0L, 5.7L, and 7.4L engines.

SPARK PLUGS

Resistor-type, tapered-seat spark plugs are used. No gasket is used 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 (Figure 5). These features give the HE spark plug long life durability. Refer to SECTION 0B or to the Vehicle Emissions Control Information label on the engine cooling fan shroud for correct gap information.

If the spark plug shell hex is not fully engaged in the spark plug socket wrench, the socket may cock at an angle and cause insulator cracking and/or breakage during plug installation or removal.

Normal or average service is assumed to be a mixture of idling, low speed, and high speed operation with some of each making up the daily total driving. Occasional or intermittent high-speed driving is essential to good spark plug performance. It provides increased and sustained combustion heat that burns away any excess deposits of carbon or oxide that may have accumulated from frequent idling or continual stop-and-go or slow-speed driving. Spark plugs are protected by an insulating boot made of special heat-resistant material that covers the spark plug terminal and extends downward over a portion of the plug insulator. These boots prevent flash-over with resultant missing of the engine,

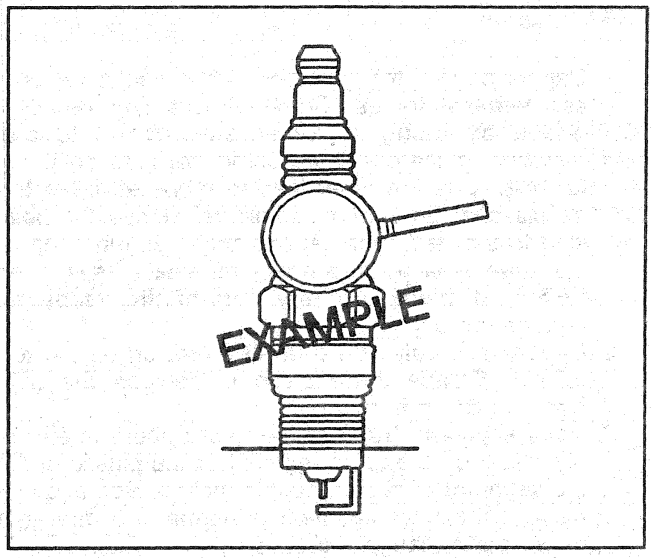


Figure 5—High Efficiency (HE) Spark plug

even though a film is allowed to accumulate on the exposed portion of plug porcelains.

Do not mistake corona discharge for flash-over or a shorted insulator. Corona discharge is a steady blue light appearing around the insulator, just above the shell crimp. It is the visible evidence of a high-tension field, and has no effect on ignition performance. Usually it can be detected only in darkness. This discharge may repel dust particles, leaving a clear ring on the insulator just above the shell. This ring is sometimes mistakenly regarded as evidence that combustion gases have blown out between the shell and insulator.

SPARK PLUG WIRES

The spark plug wiring is encased in a rubber jacket. The silicone spark plug boots form a tight seal on the plugs. Refer to "Spark Plug Wiring and Boots," for service precautions.

DIAGNOSIS

DISTRIBUTOR IGNITION (DI) SYSTEM

For a description and diagnosis of this system and the malfunction indicator (commonly referred to as the "Service Engine Soon") lamp, refer to the Engine Controls, Transmission Diagnosis, and Electrical Diagnosis Manual.

For distributor component tests, refer to SECTION 6D4A.

DISTRIBUTOR INSPECTION

NOTICE: ***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.***

Inspect

1. Cap for cracks, tiny holes or carbon tracks between cap terminal traces. Carbon tracks can be diagnosed by using an ohmmeter. With the cap removed, place one base ohmmeter lead on a cap terminal. Use the other lead to probe all other terminals and the center carbon ball. Move the base lead to the next terminal and probe all other leads. Continue until all secondary terminals have been tested. If there are any non-infinite readings, replace the cap.
2. Cap for excessive build up of corrosion on the terminals. Scrape them clean or replace the cap. Some build up is normal.
3. Rotor segment. Replace the rotor if there is excessive wear on the rotor segment or the plastic under the segment or staked post is melted. Some looseness of the rotor segment is normal if it does not cause performance problems.
4. Shaft for shaft-to-bushing looseness. If the shaft wobbles, replace the housing assembly.
5. Housing for cracks or damage.
   - For hall effect switch diagnostics, refer to the Engine Controls, Transmission Diagnosis, and Electrical Diagnosis Manual.

IGNITION COIL TEST

Tool Required:
J 39200 Digital Multimeter

- Make sure the ignition switch is "OFF."

1. Disconnect the distributor lead and wiring from the ignition coil.

NOTICE: ***Do not insert the J 39200 probe into the ignition coil connectors. The female terminals could be spread and deformed, resulting in intermittent operation of the coil. Be sure to make contact with only the front edge of the terminals.***

2. Connect an ohmmeter as shown in Figure 6, Step 1. Use the high scale. The reading should be infinite. If not, replace the coil.
3. Connect the ohmmeter as shown in Figure 6, Step 2. Use the low scale. The reading should be 0.1 ohms. If not, replace the coil.
4. Connect the ohmmeter as shown in Figure 6, Step 3. Use the high scale. The meter should read 5k - 25k ohms. If not, replace the coil.
5. Reconnect the distributor lead and wiring to the coil.

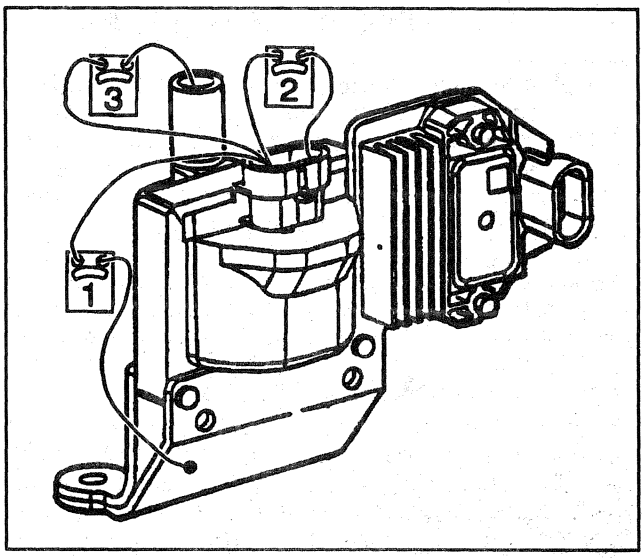


Figure 6—Testing the Ignition Coil (typical)

VISUAL INSPECTION OF SPARK PLUG WIRES AND BOOTS

1. Inspect the routing of the wires. Improper routing can cause crossfiring.
2. Inspect each wire for any signs of cracks or splits in the wire.
3. Inspect each boot for signs of tears, piercing, arc through, or carbon tracking. If the boot needs to be replaced, twist it a half-turn in either direction to break the seal before pulling on the boot to remove the wire.

Spark Plug Wire Resistance Test

1. Disconnect both ends of each wire. Make sure the wire terminals are clean.
2. Set J 39200 on the high scale and connect it to each end of the wire being tested. Twist the wire gently while watching J 39200.
3. If J 39200 reads above 30,000 ohms (no matter how long the wire is), or fluctuates from infinity to any value, replace the wire.
4. If the resistance of any wire is not within the following ranges, replace the wire being tested.
   - 0 to 15-inch wire - 3,000 to 10,000 ohms.
   - 15 to 25-inch wire - 4,000 to 15,000 ohms.
   - 25 to 35-inch wire - 6,000 to 20,000 ohms.
   - Longer wire - should measure about 5,000 to 10,000 ohms per foot.

DIAGNOSIS OF SPARK PLUGS

CONDITION	POSSIBLE CAUSE	CORRECTION
Brown to grayish-tan deposits and slight electrode wear.	Normal wear.	Clean, regap, and reinstall spark plugs.
Dry, fluffy black carbon deposits.	Poor ignition output.	Check distributor to coil connections. Refer to the Engine Controls, Transmission Diagnosis, and Electrical Diagnosis Manual for this model.
Wet, oily deposits with very little electrode wear.	1. "Break-in" of new or recently overhauled engine. 2. Excessive valve stem guide clearances. 3. Worn intake valve seals.	1. Degrease, clean and reinstall the plugs. 2. Refer to SECTION 6A. 3. Replace the valve seals.
Red, brown, yellow and white colored coatings on insulator. Engine missfires intermittently under severe operating conditions.	By-products of combustion.	Clean, regap, and reinstall. If heavily coated, replace.
Colored coatings heavily deposited on the portion of the spark plug projecting into the chamber and on the side facing the intake valve.	Leaking valve seals if condition is found in only one or two cylinders.	Check the valve seals. Replace if necessary. Clean, regap, and reinstall the spark plugs.
Shiny yellow glaze coating on insulator.	Melted by-products of combustion.	Avoid sudden acceleration with wide-open throttle after long periods of low speed driving. Replace the spark plugs.
Burned or blistered insulator tips and badly eroded electrodes.	Overheating.	1. Check the cooling system. 2. Lean air-fuel mixture. Refer to the Engine Controls, Transmission Diagnosis, and Electrical Diagnosis Manual for this model. 3. Check the heat range of the spark plugs. May be too hot. 4. Check ignition timing. May be over-advanced. 5. Check the torque value of the plugs to ensure good plug-engine seat contact.
Broken or cracked insulator tips.	Heat shock from sudden rise in tip temperature under severe operating conditions. Improper gapping of spark plugs.	Replace the spark plugs. Gap correctly.
		D0071

ON-VEHICLE SERVICE

SERVICE PRECAUTIONS

Some service tachometers and electronic diagnostic equipment may NOT be compatible with this ignition system. Consult your representative of such equipment.

1. When making compression tests, disconnect the engine harness connection to the ignition coil.
2. No periodic lubrication of the distributor is required. Engine oil lubricates the lower bushing. The upper bushing is prelubricated and sealed.
3. The material used to construct the spark plug wires is very pliable and soft. This wire will withstand high heat and carry a high voltage. Due to the

more pliable wire, scuffing and cutting become easier. It is therefore extremely important to route the spark plug wires correctly to prevent chafing or cutting. When removing a spark plug wire from a spark plug, twist the boot on the spark plug and pull on the boot to remove the wire.

DISTRIBUTOR REPLACEMENT

Remove or Disconnect (Figures 7 through 9)

- Make sure the ignition switch is "OFF".

NOTICE: ***If the distributor is removed from the engine, it can be re-installed using "procedure A" as long as the crankshaft has not rotated from its initial position. If the intake manifold, cylinder head, crankshaft, camshaft, timing sprocket or complete engine was removed or replaced, "procedure B" must be followed to correctly install the distributor. A DTC code may also indicate an incorrectly installed distributor and engine or distributor damage may occur. Procedure B must then be used.***

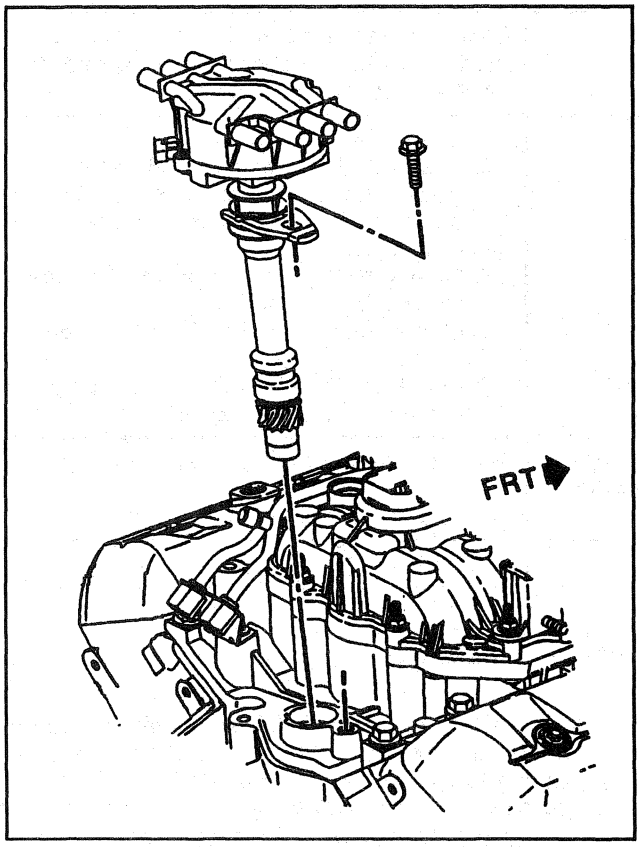


Figure 7—Distributor Installation and Removal (4.3L)

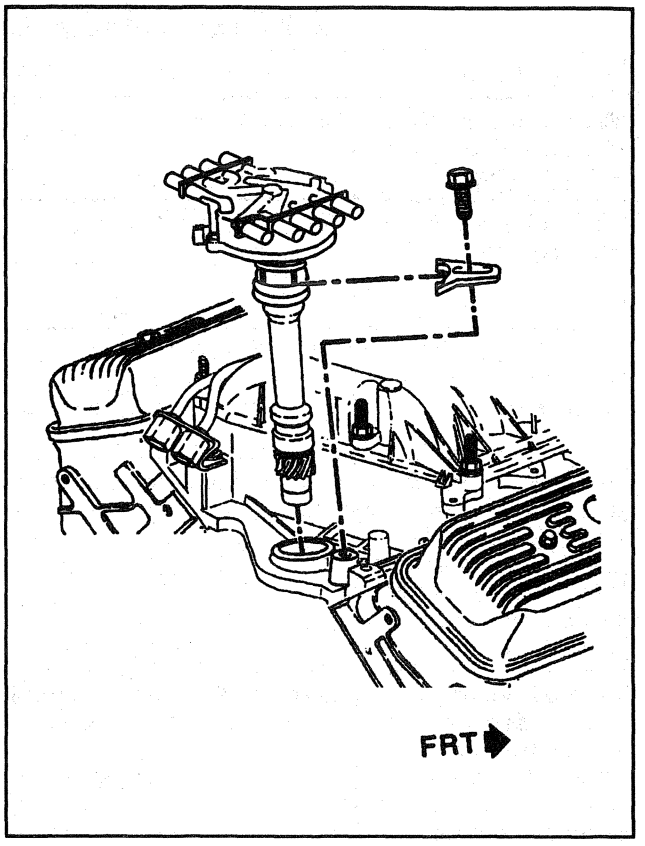


Figure 8—Distributor Installation and Removal (5.0L and 5.7L)

Procedure A

1. Spark plug and coil leads from the distributor cap.
2. Three wire hall effect switch connector from the base of the distributor.
3. Two screws holding the distributor cap to the housing
4. Distributor cap.
   A. Use a grease pencil to note the position of the rotor segment in relation to the distributor housing. Identify the mark with a 1.
   B. The distributor housing and intake manifold should also be marked with a grease pencil for proper alignment when reinstalling.
5. Mounting clamp hold down bolt.
6. Distributor.
   - As the distributor is being removed from the engine, you will notice the rotor move in a counter-clockwise direction, 42 degrees. This will appear as slightly more than one clock position. Noting the position of the rotor segment, by placing a second mark on the base of the distributor, will aid in achieving proper rotor alignment during distributor installation. Be sure to identify the second mark on the base with the number 2.

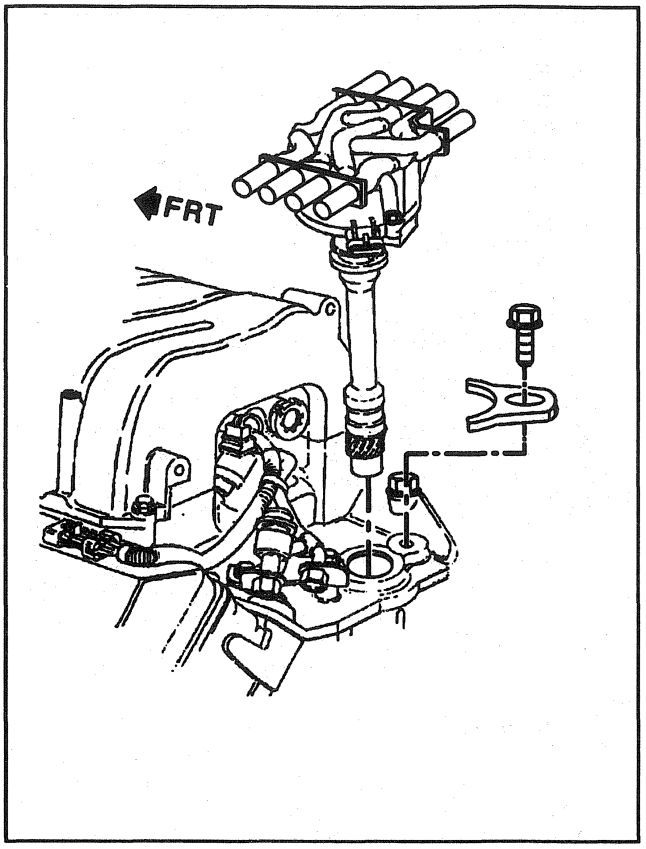


Figure 9—Distributor Installation and Removal (7.4L)

Install or Connect (Figures 7 through 14)

A. If the original distributor is to be replaced, rather than repaired, remove the new distributor cap. Using a grease pencil, place two marks on the new distributor housing in the same location as the two marks on the original housing.

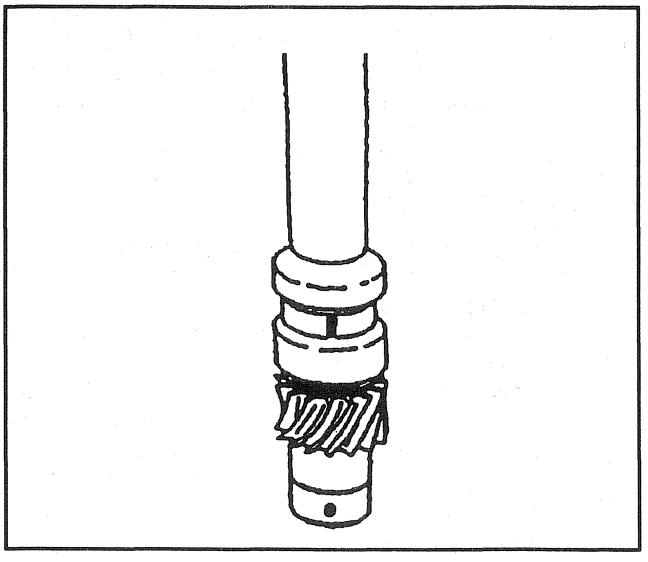


Figure 10—Distributor Alignment Indicator

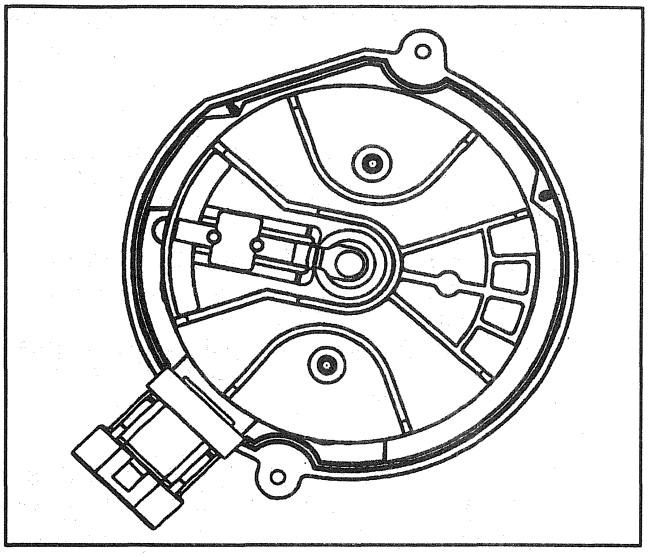


Figure 11—Rotor Position (5.0L, 5.7L, and 7.4L)

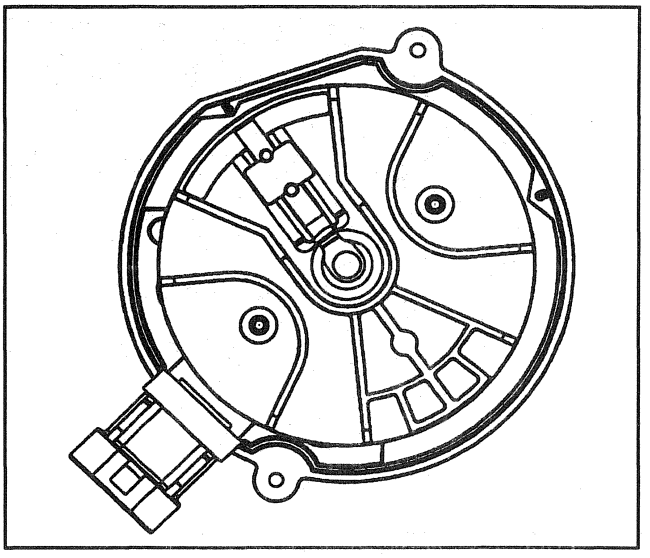


Figure 12—Installed Rotor Position (5.0L, 5.7L and 7.4L)

B. When installing the distributor, align the rotor segment with the number 2 mark on the base of the distributor. Guide the distributor into place, making sure the grease pencil marks on the distributor housing and the intake manifold are in line. As the the distributor is being installed, you will notice the rotor will move in a clockwise direction, 42 degrees. ONCE THE DISTRIBUTOR IS COMPLETLY SEATED, the rotor segment should be aligned with the number 1 mark on the base. If the rotor segment is not aligned with the number 1 mark, the gear teeth of the distributor and camshaft have meshed one or more teeth out of time. To correct this condition, remove the distributor and re-install it following the procedure at step B.

1. Distributor cap and mounting screws. Do not overtighten the screws as the boss may strip.

2. Distributor mounting clamp and tighten to the proper torque.

Tighten

- Distributor clamp and bolt to 27 N·m (20 lb ft).
- Distributor cap screws to 5 N·m (40 lb in).

3. Three wire hall effect switch connector to base of the distributor.
4. Spark plug and coil leads to the distributor cap.
   - If a check engine light is illuminated after installing the distributor and a DTC P1345 is found, the distributor has been installed incorrectly. You now must refer to procedure B for proper distributor installation.

Procedure B

- Bring the engine up to Top Dead Center (TDC) of cylinder number 1. Make sure it is on the compression stroke.

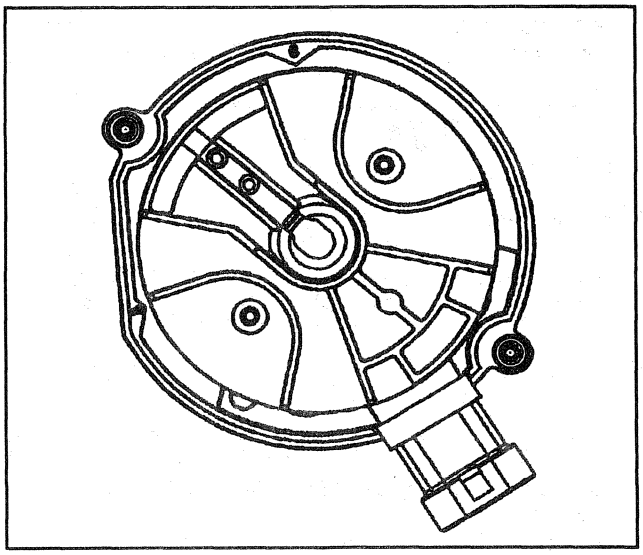


Figure 13—Rotor Position (4.3L)

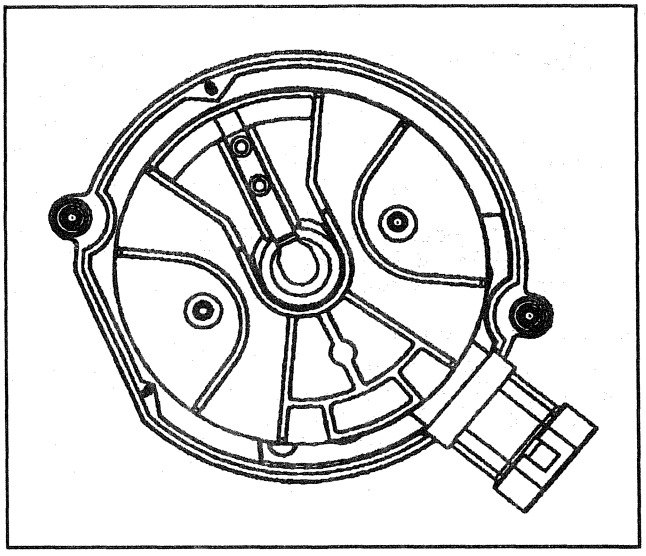


Figure 14—Installed Rotor Position (4.3L)

A. Remove the distributor cap screws and cap to expose the rotor.
B. Align the pre-drilled indent hole in the distributor driven gear with the white painted alignment line on the lower portion of the shaft housing (Figure 10). The rotor segment should point to the cap hold area as shown in Figures 11 and 13.
C. Using a long screw driver, align the oil pump drive shaft in the engine in the mating drive tab in the distributor.
D. Guide the distributor into place, making sure the spark plug towers are perpendicular to the center line of the engine.
E. ONCE THE DISTRIBUTOR IS FULLY SEATED, the rotor segment should be aligned with the pointer cast into the distributor base (Figures 12 and 14). This pointer will have a "6" or an "8" cast into it, indicating the distributor is to be used in a 6 cylinder or 8 cylinder engine. If the rotor segment does not come within a few degrees of the pointer, the gear mesh between the distributor and camshaft may be off a tooth or more. If this is the case, repeat the procedure again to achieve proper alignment.

Install or Connect (Figures 7 through 14)

1. Cap and mounting screws. Do not overtighten the screws as the boss may strip.
2. Distributor mounting clamp and tighten to proper torque.

Tighten

- Distributor clamp and bolt to 27 N·m (20 lb ft).
- Distributor cap screws to 5 N·m (40 lb in).

3. 3 wire hall effect switch connector to base of distributor.
4. Spark plug and coil leads to the distributor cap.
   - If a check engine light is illuminated after installing the distributor and a DTC P1345 is found, the distributor has been installed incorrectly.

IGNITION COIL REPLACEMENT

Remove or Disconnect (Figures 15 through 17)

- Make sure the ignition switch is "OFF."

1. Wiring connectors at the side of the coil.
2. Coil wire.
3. Studs/bolts holding the coil bracket and coil to the manifold.
4. Coil bracket and coil.
   - Drill and punch out the two rivets holding the coil to the bracket.
5. Coil from the bracket.

Install or Connect (Figures 15 through 17)

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

1. Coil to the bracket with two screws.

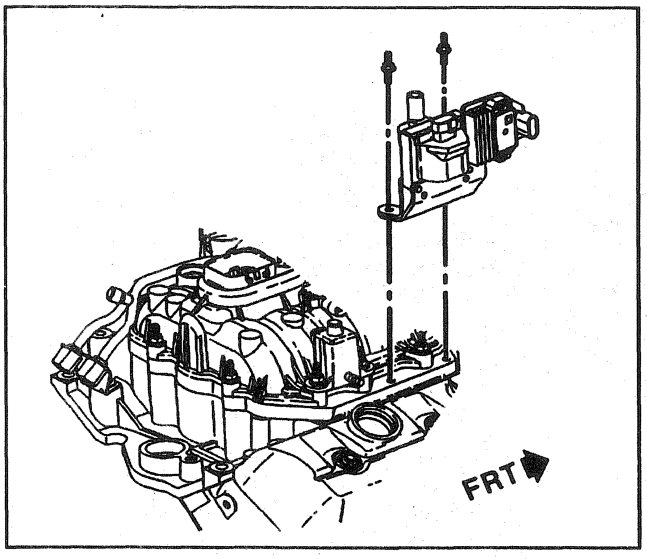


Figure 15—Ignition Coil Mounting (4.3L)

2. Coil and bracket to the intake manifold with studs/bolts.

Tighten

- Ignition coil hold-down studs/bolts to 11 N·m (8 lb ft)

3. Coil wire.
4. Wiring connectors.

SPARK PLUG REPLACEMENT

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 plugs that are either "hotter" or "colder" than the heat range specified. Using plugs of the wrong heat range can severely damage the engine.

Remove or Disconnect

- Make sure the ignition switch is "OFF."

NOTICE: ***Twist the spark plug boot one-half turn to release it. Pull on the spark plug boot only. Do not pull on the wire or the spark plug lead may be damaged.***

1. Spark plug wires and boots.
   - Label the plug wires.

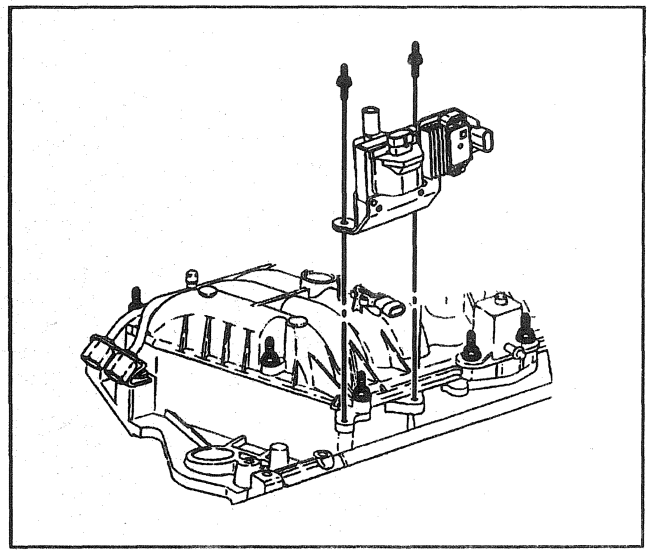


Figure 16—Ignition Coil Mounting (5.0L and 5.7L)

NOTICE: ***Be sure to use J 39358 or equivalant spark plug socket. Failure to do so could cause cracking of the insulator and arcing inside the plug, resulting in engine miss fire.***

2. Spark plugs using J 39358 or equivalant.

Inspect

- Each plug for wear and gap. Refer to "Diagnosis of Spark Plugs," in this section.

Install or Connect

NOTICE: ***Make sure each spark plug threads smoothly into the cylinder head and is fully seated. Cross-threading or failing to fully seat spark plugs can cause overheating of the plugs, exhaust blow-by, or thread damage.***

1. Spark plugs.

Tighten

- Spark plugs to 30 N·m (22 lb ft) in a new cylinder head and 20 N·m (14 lb ft) in a used head.

2. Wire and boot assemblies. Refer to "Spark Plug Wiring and Boots," in this section, for precautions.

SPARK PLUG WIRING AND BOOTS

Service Precautions

1. Twist boots one-half turn before removing.
2. When removing the boot, do not use pliers or other tools that could tear the boot.

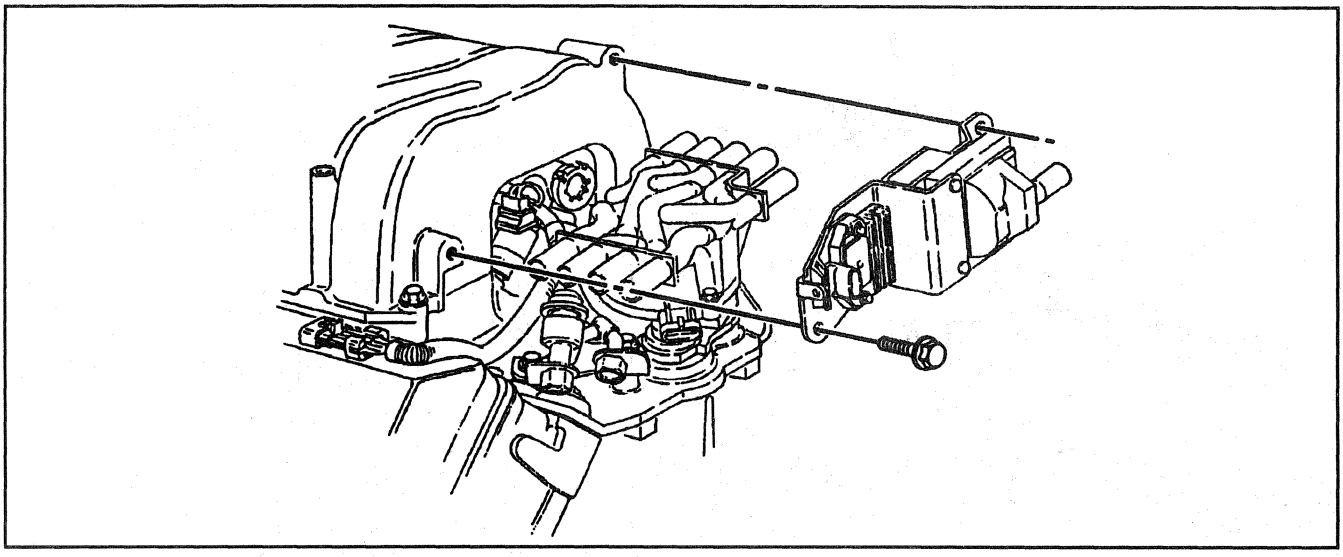


Figure 17—Ignition Coil Mounting (7.4L)

3. Do not force anything between the wire and the boot, or through the silicone jacket of the wiring.
4. Do not pull on the wires to remove the boot. Pull on the boot or use a tool designed for this purpose.
5. Special care should be used when installing spark plug boots to ensure the metal terminal within the boot is fully seated on the spark plug terminal and the boot has not moved on the wire.

NOTICE: ***If boot to wire movement has occurred, the boot will give a false visual impression of being fully seated. Make sure that 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.***

- If they have been correctly installed, a stiff boot with only slight looseness will be noted. If the terminal has not been properly seated on the spark plug, only the resistance of the boot will be felt when pushing sideways.

SPARK PLUG WIRE REPLACEMENT

Spark plug wire routings must be kept intact during service and followed exactly when spark plug wires have been disconnected or when replacement of the spark plug wires is necessary. Failure to route the spark plug wires properly can lead to radio noise and crossfiring of the spark plugs, or shorting of the leads to ground. The correct routing for each engine is shown in Figures 18 through 23.

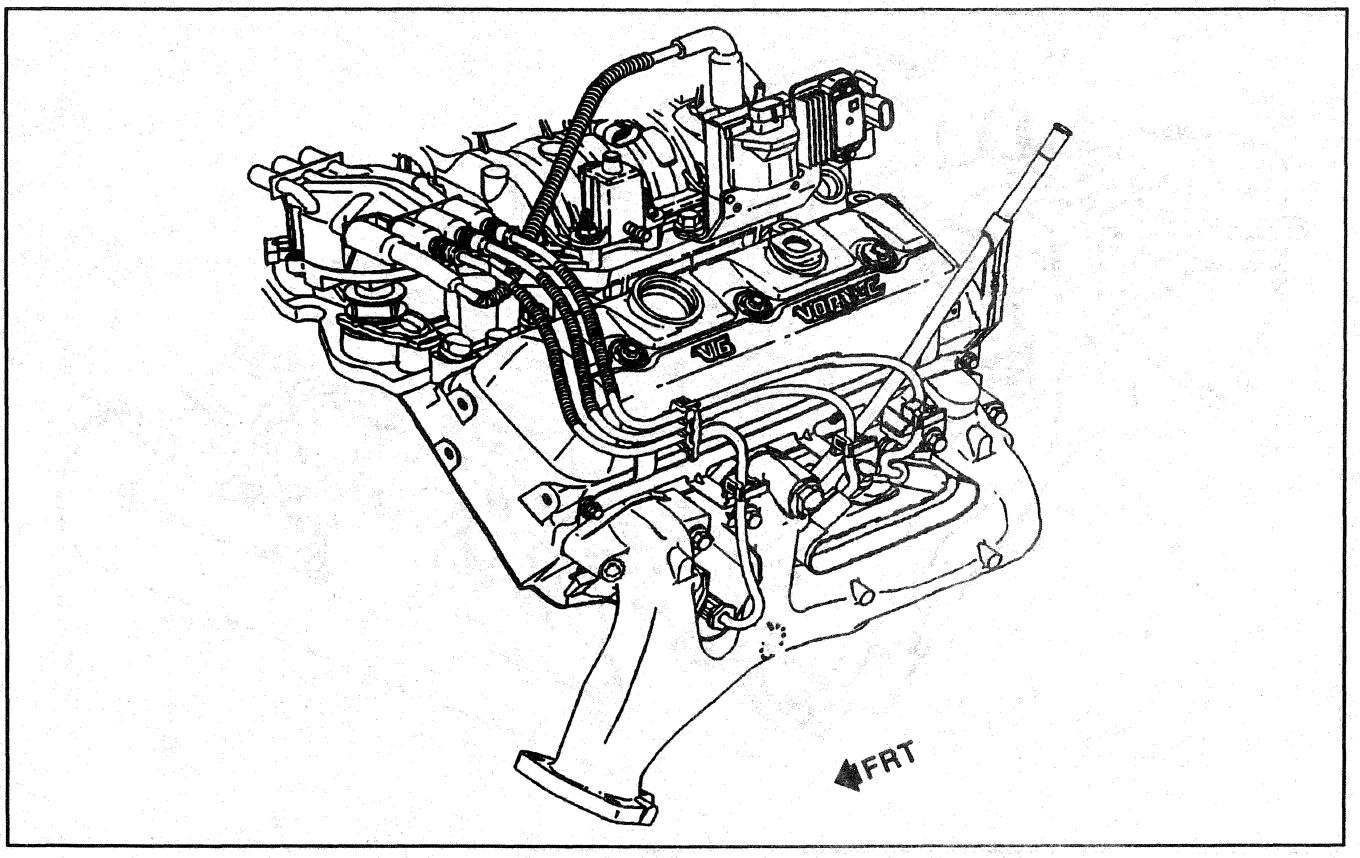


Figure 18—Spark Plug Wire Routing - (4.3L) Right

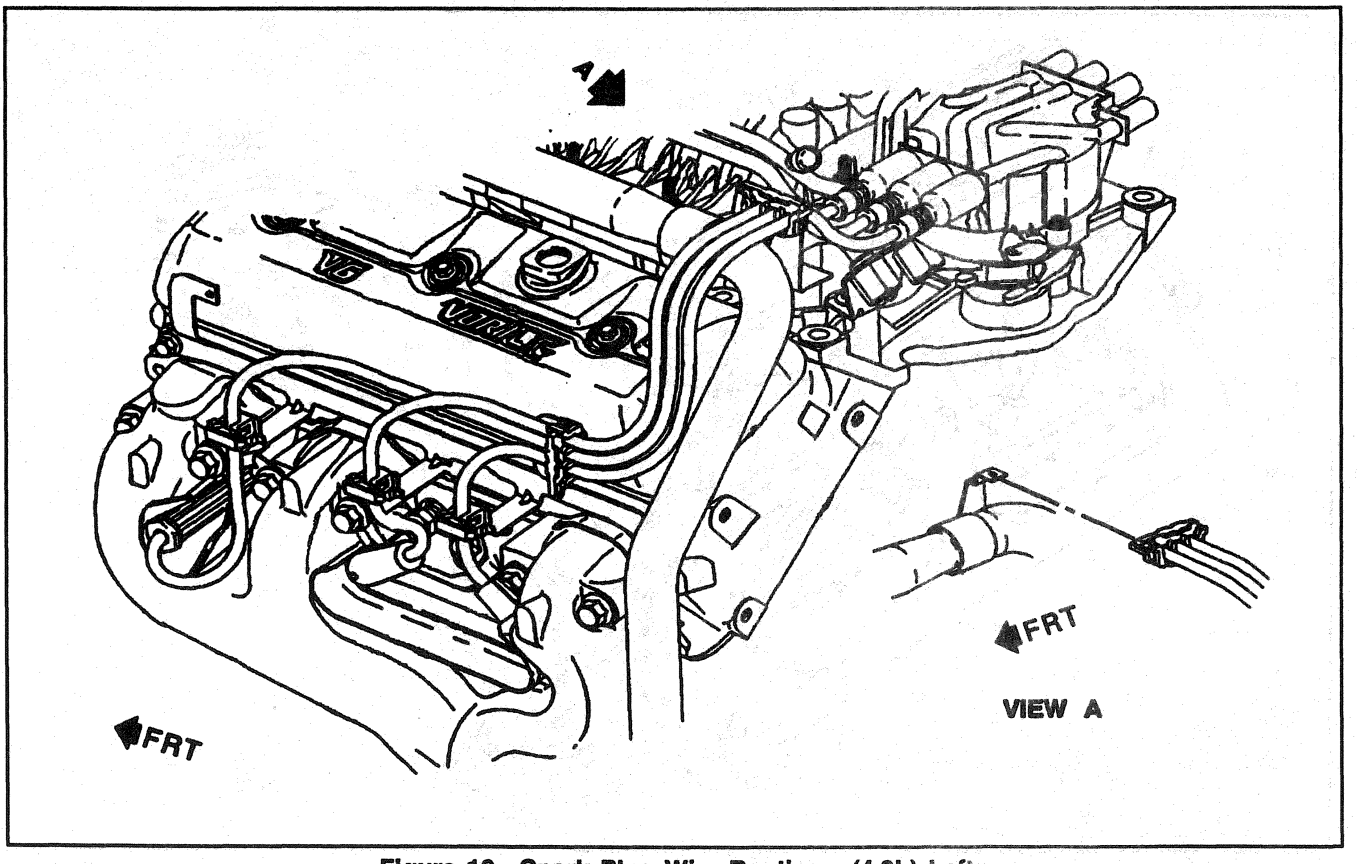


Figure 19—Spark Plug Wire Routing - (4.3L) Left

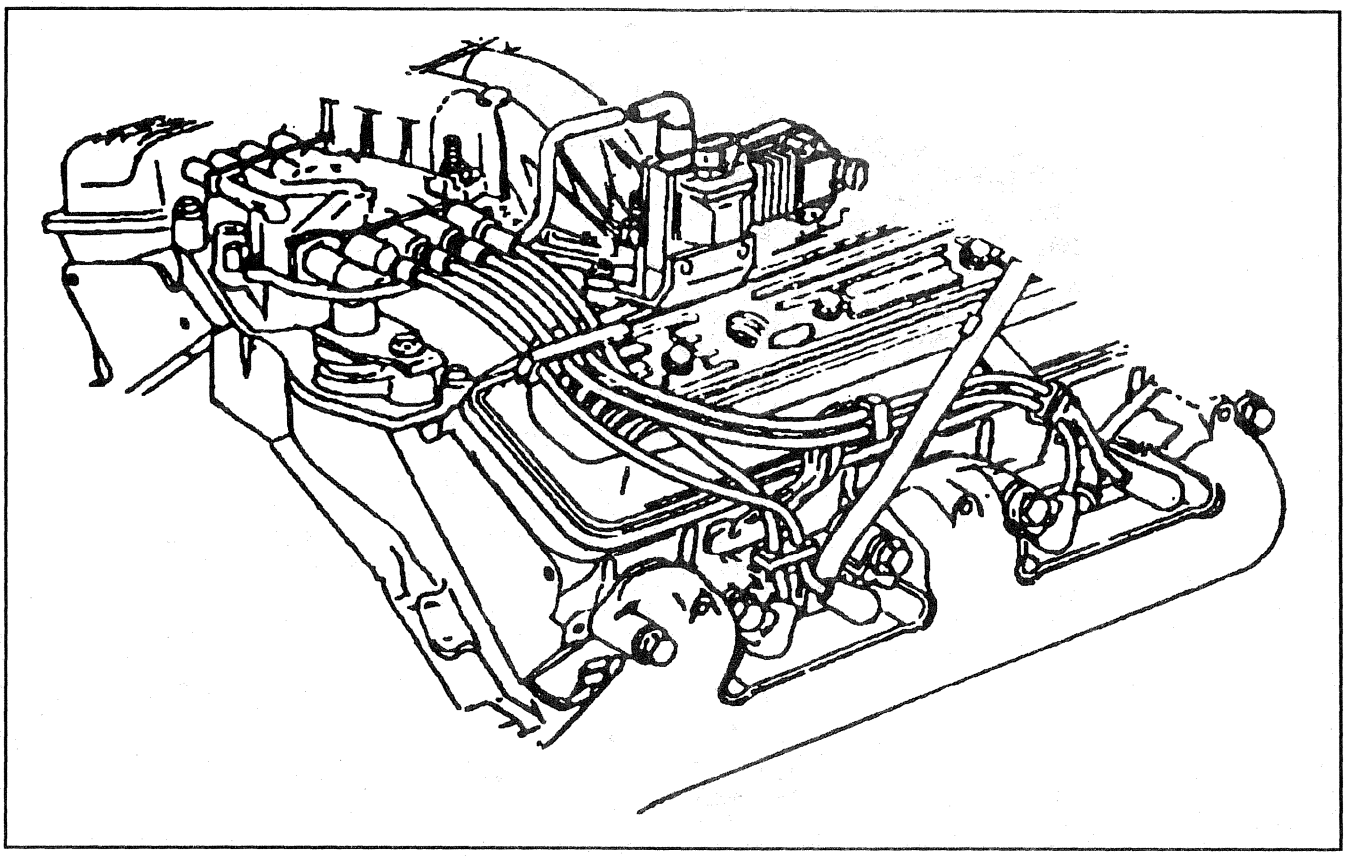


Figure 20—Spark Plug Wire Routing - (5.0L and 5.7L) Right

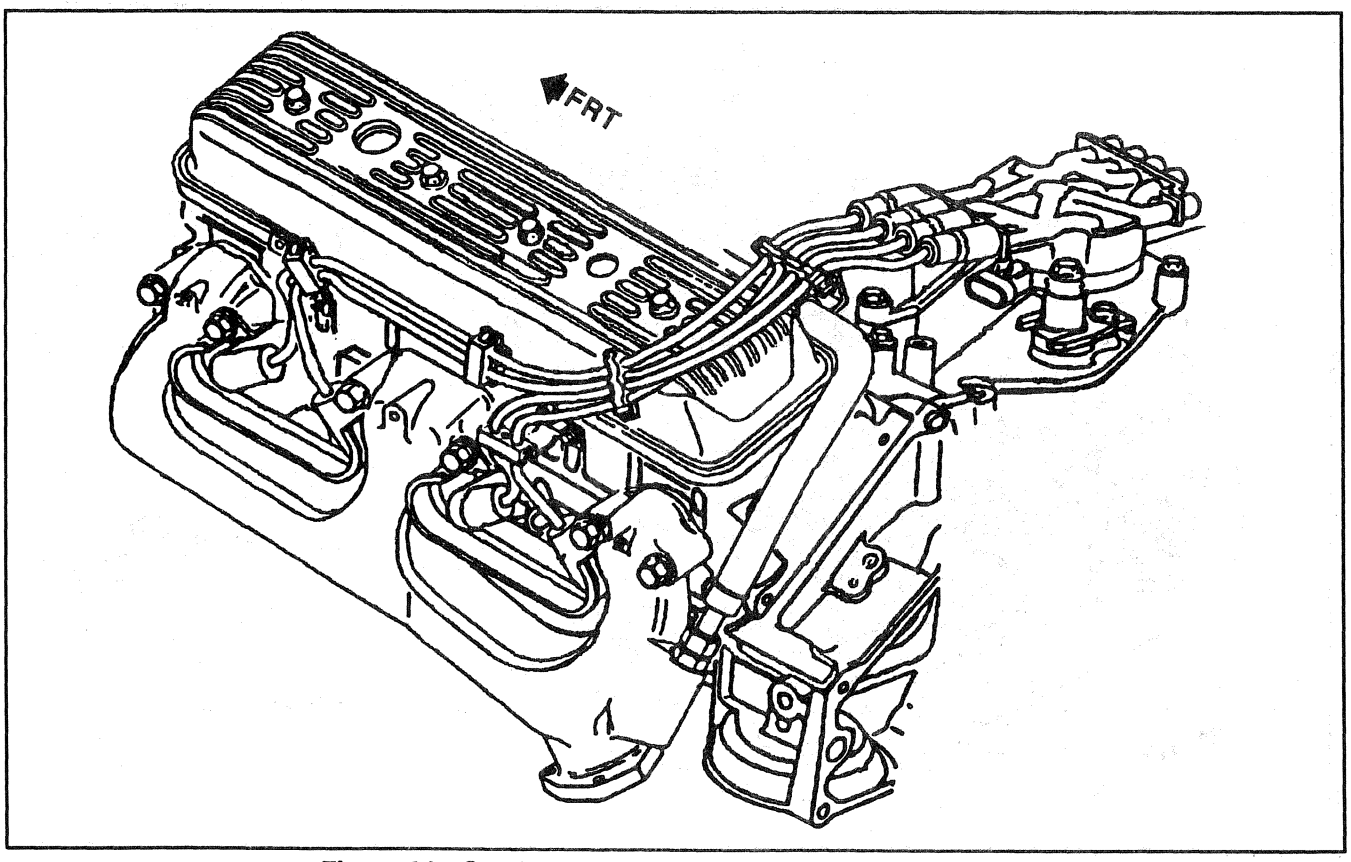


Figure 21—Spark Plug Wire Routing - (5.0L and 5.7L) Left

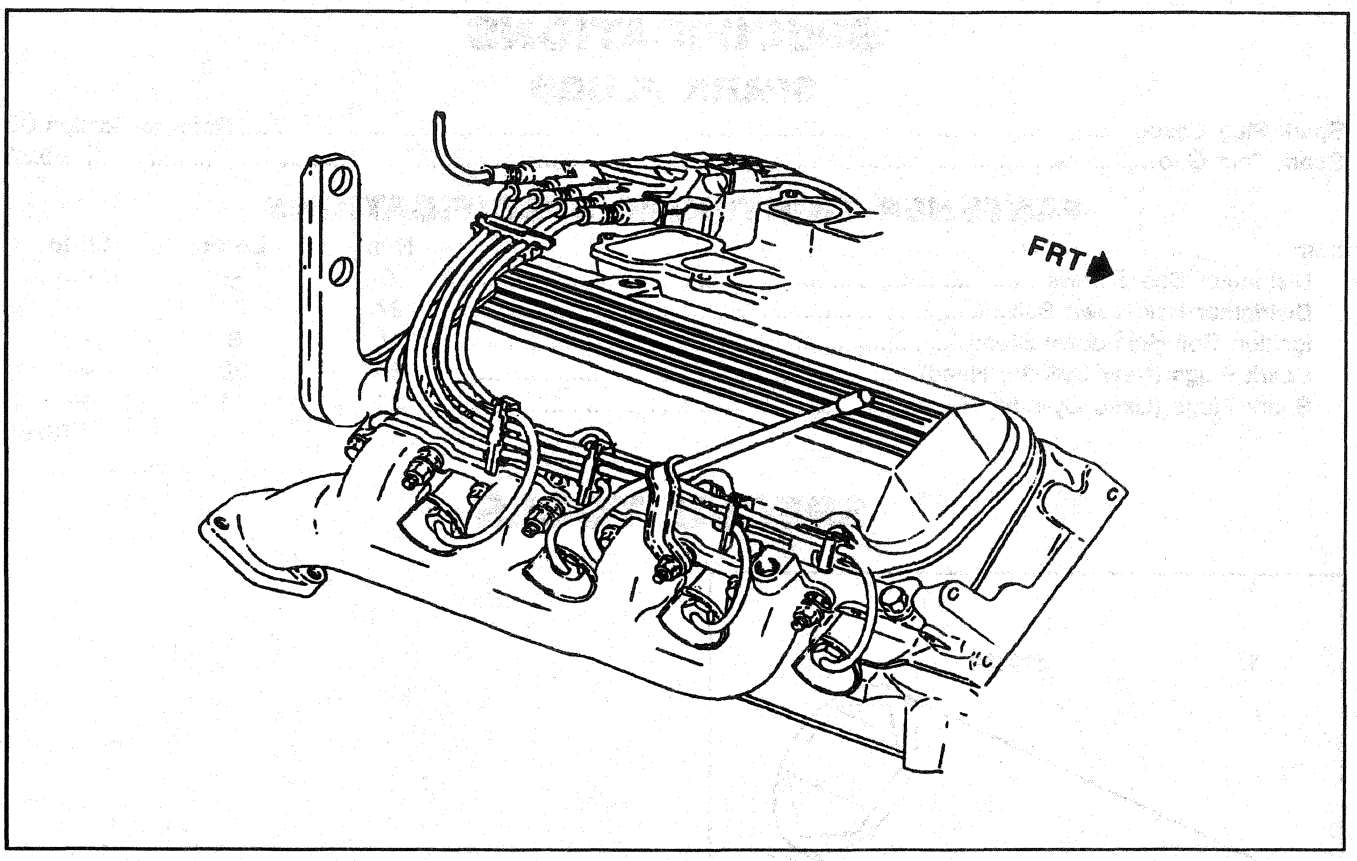


Figure 22—Spark Plug Wire Routing - (7.4L) Right

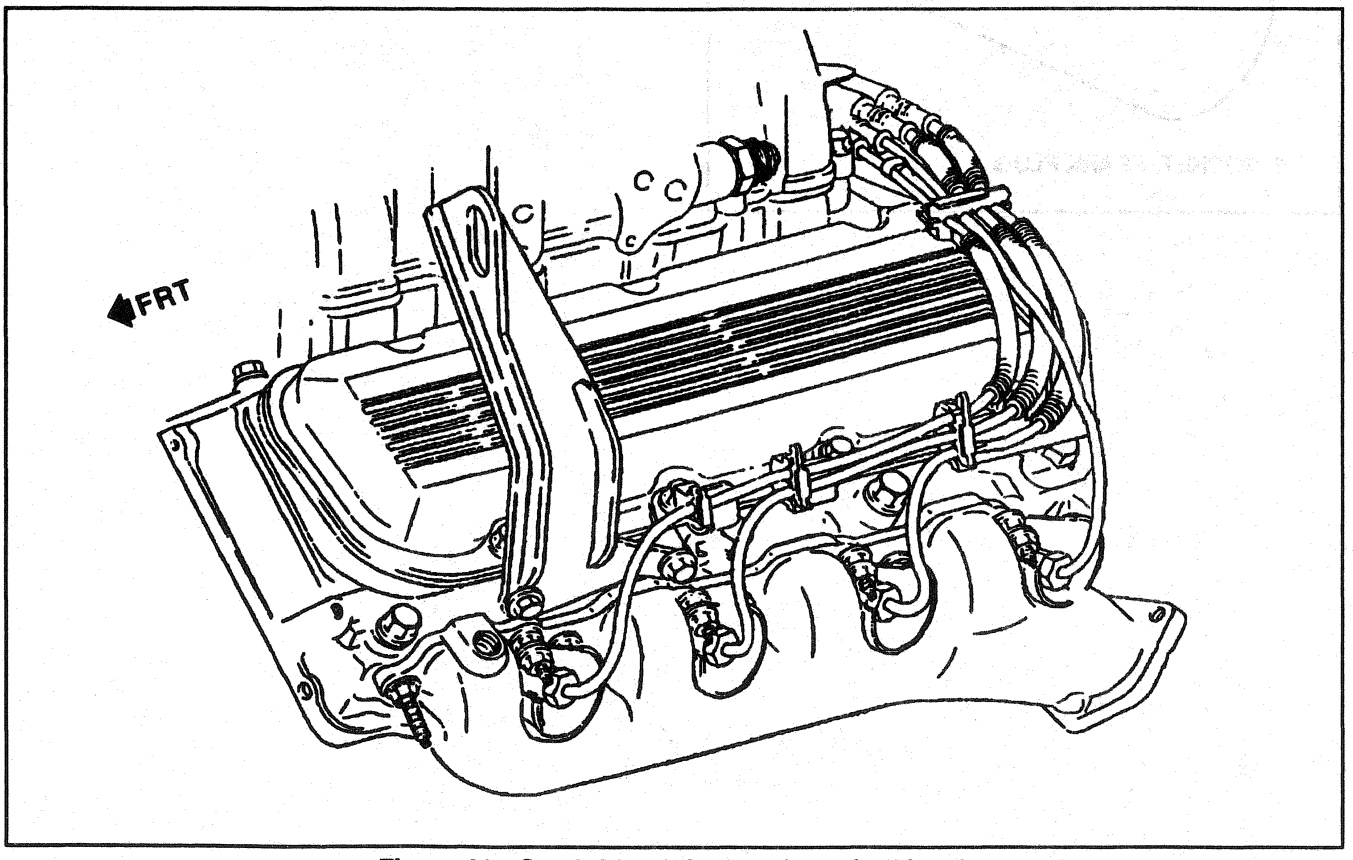


Figure 23—Spark Plug Wire Routing - (7.4L) Left

SPECIFICATIONS

SPARK PLUGS

Spark Plug Usage ..... Refer to Section 0B
Spark Plug Gap 0.60

FASTENER TIGHTENING SPECIFICATIONS

Item	N·m	Lb Ft	Lb In
Distributor Cap Screws	5	—	40
Distributor Hold-down Bolt	27	20	—
Ignition Coil Hold-down Studs	11	8	—
Spark Plugs (New Cylinder Head)	30	22	—
Spark Plugs (Used Cylinder Head)	20	14	—

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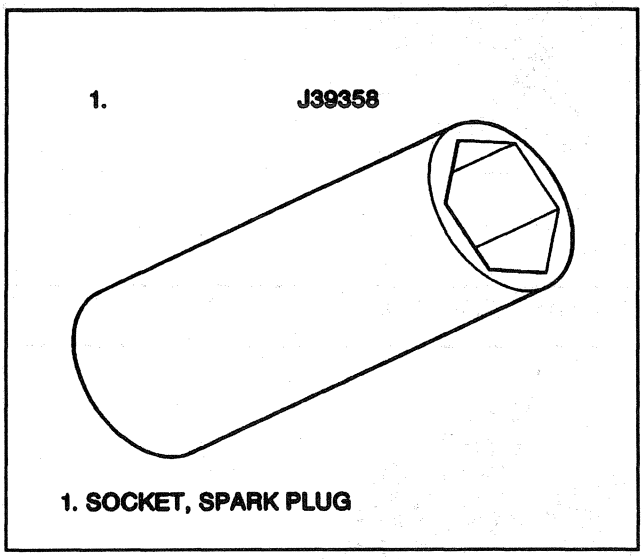
SPECIAL TOOLS



1. SOCKET, SPARK PLUG

SECTION 6D4A

DISTRIBUTORS

CAUTION: This vehicle has a Supplemental Inflatable Restraint (SIR). Refer to the SIR Component Location View in order to determine whether you are performing service on or near the SIR wiring. When you are performing service on or near the SIR components or the SIR wiring, refer to the SIR On-Vehicle Service information. Failure to follow CAUTIONS could result in possible air bag deployment, personal injury, or otherwise unneeded SIR system repairs.

NOTICE: ***Always use the correct fastener in the proper location. When you replace a fastener, use ONLY the exact part number for that application. General Motors will call out those fasteners that require a replacement after removal. General Motors will also call out the fasteners that require thread lockers or thread sealant. UNLESS OTHERWISE SPECIFIED, do not use supplemental coatings (paints, greases, or other corrosion inhibitors) on threaded fasteners or fastener joint interfaces. Generally, such coatings adversely affect the fastener torque and joint clamping force, and may damage the fastener. When you install fasteners, use the correct tightening sequence and specifications. Following these instructions can help you avoid damage to parts and systems.***

CONTENTS

GENERAL DESCRIPTION

DISTRIBUTORS

This ignition system includes the distributor (Figures 1 and 2), hall-effect switch, ignition coil, secondary wires, spark plugs, knock sensor and crankshaft position sensor. The ignition system is controlled by the Vehicle Control Module (VCM). The VCM monitors information from various engine sensors, computes the desired spark timing and controls the dwell and firing of the ignition coil via an ignition control line to the coil driver. For information on the ignition systems diagnostics, refer to the Engine Controls, Transmission Diagnosis, and Electrical Diagnosis Manual.

The distributor connects the ignition coil and spark plugs through secondary wires. The rotor directs the spark to the appropriate cylinder. The distributor has a hall-effect switch that connects to the VCM through the primary engine harness and provides cylinder identification information.

Identification

The part number is pin stamped into the plastic base (directly below the high tension terminals and next to the three pin camshaft sensor connection).

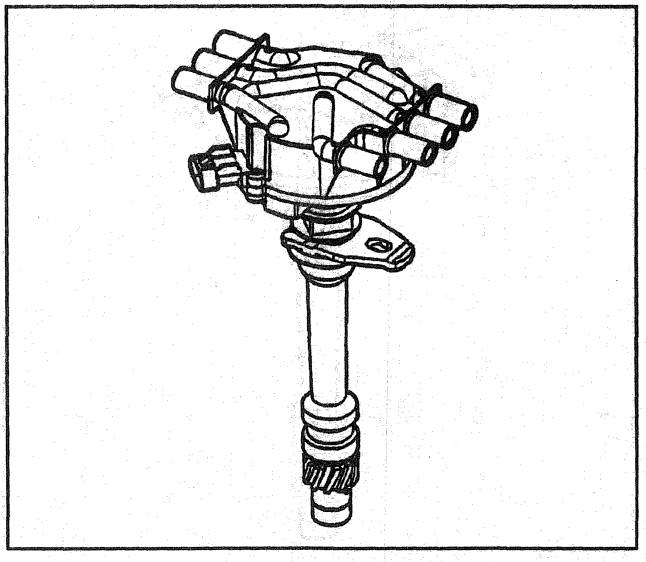


Figure 1—Distributor (4.3L)

Ignition Coil

The coil driver controls the current flow in the primary winding of the ignition coil when signaled by the VCM. The interconnects are made by the primary engine harness. The ignition coil can generate up to 35,000 volts and connects to the distributor through a secondary wire.

Secondary Wires

The secondary wires carry voltage between the ignition coil, distributor, and spark plugs. The secondary wire connections form a tight seal that prevents voltage arching.

Hall-Effect Switch

The hall-effect switch connects to the VCM through the primary engine harness and provides cylinder identification information. The hall-effect switch is located under the distributor cap.

Crankshaft Position Sensor

The crankshaft position sensor connects to the VCM through the primary engine harness and provides crankshaft reference information to the VCM for spark and fuel delivery. The crankshaft position sensor is located in the front cover behind the crankshaft balancer.

DISASSEMBLY

Disassemble (Figures 3 through 8)

NOTICE: ***It is possible to install the distributor driven gear in two positions. Make sure when installing the gear that the dimple found below the roll pin hole in the gear is on the same side as the rotor segment. If not, the gear is installed 180 degrees off and a no-start condition may occur. Premature wear and damage may result.***

1. Two screws holding the cap to the housing.
2. Cap from the housing.
3. Two screws from the rotor.
4. Rotor.
   - Note which locating holes the rotor was removed from (Figure 7).
5. Two screws holding the hall-effect switch.
6. Hall-effect switch.
   - The square cut hole in the vane wheel must be aligned with the hall-effect switch in order to remove the hall-effect switch (Figure 7).
7. Roll pin from the shaft (Figure 6).
   - Note the dimple located below the roll pin hole on the one side of the gear. The dimple will be used to properly orient the gear on the shaft during assembly.
8. Driven gear, washer, and tang washer.
9. Thermal insulator (7.4L distributor only).
10. Shaft.

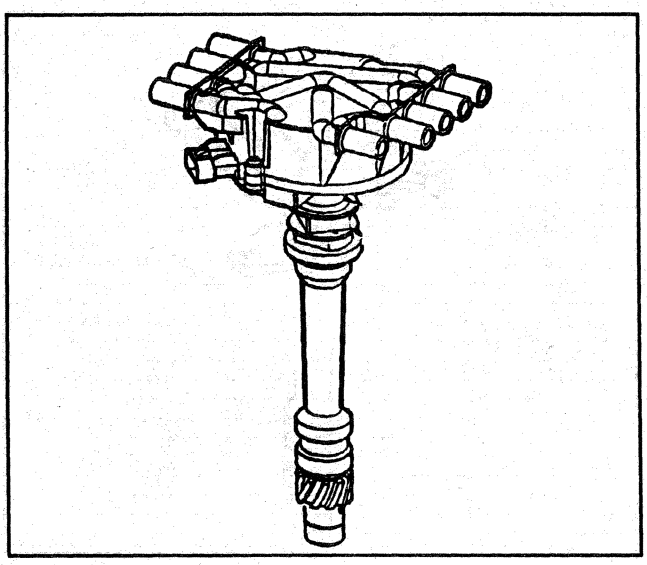


Figure 2—Distributor (5.0L, 5.7L and 7.4L)

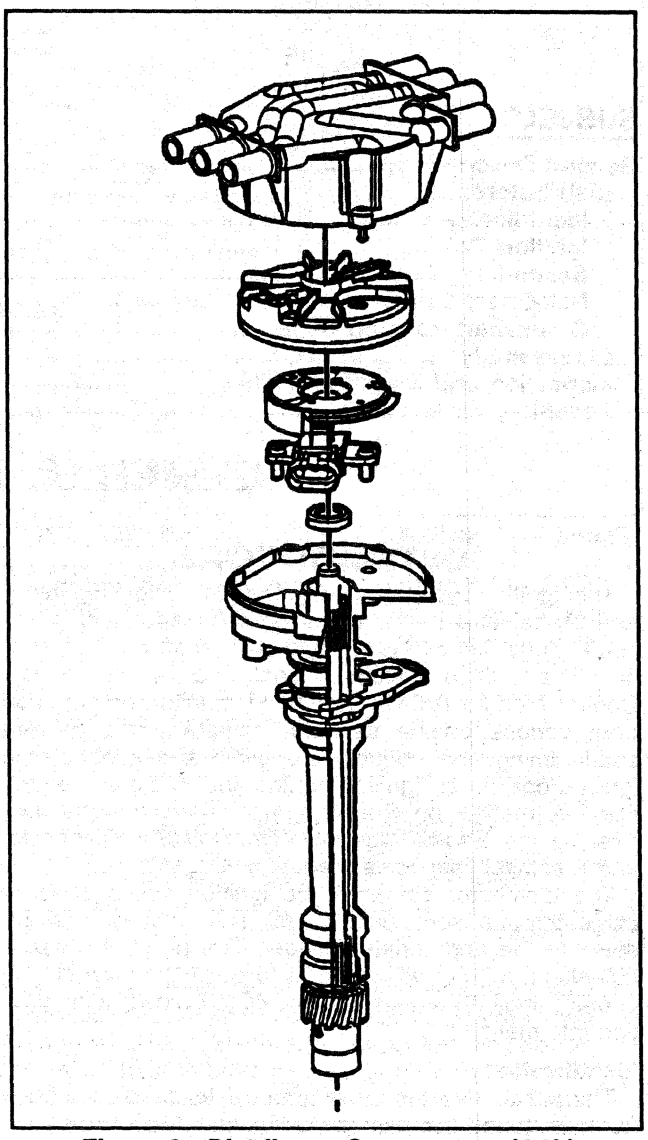


Figure 3—Distributor Components (4.3L)

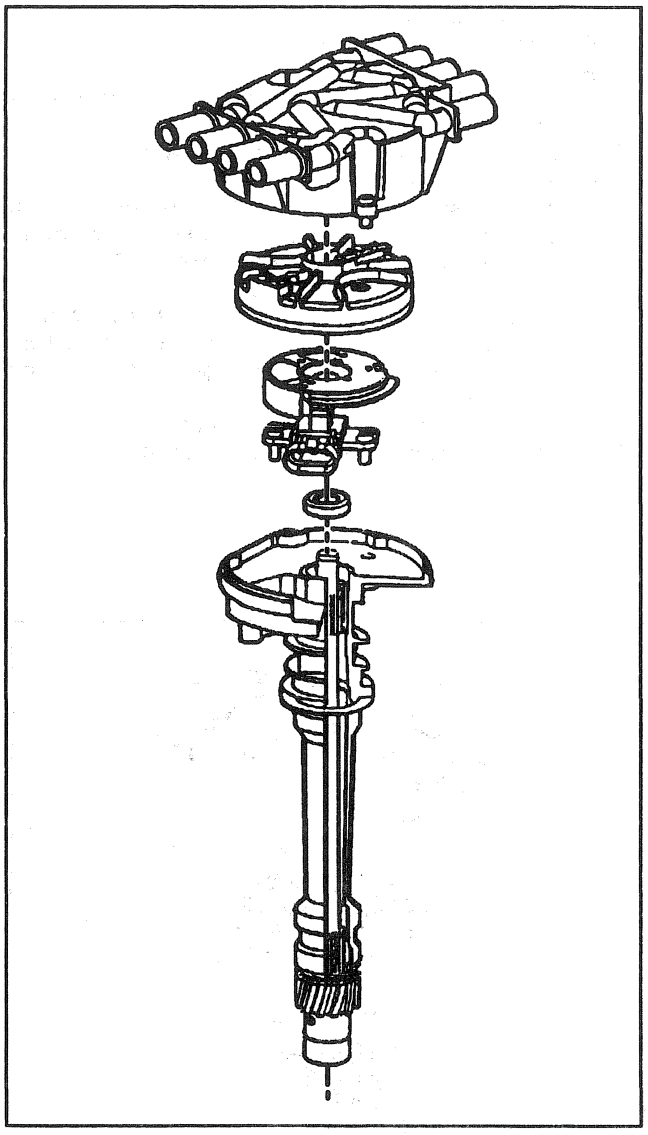


Figure 4—Distributor Components (5.0L and 5.7L)

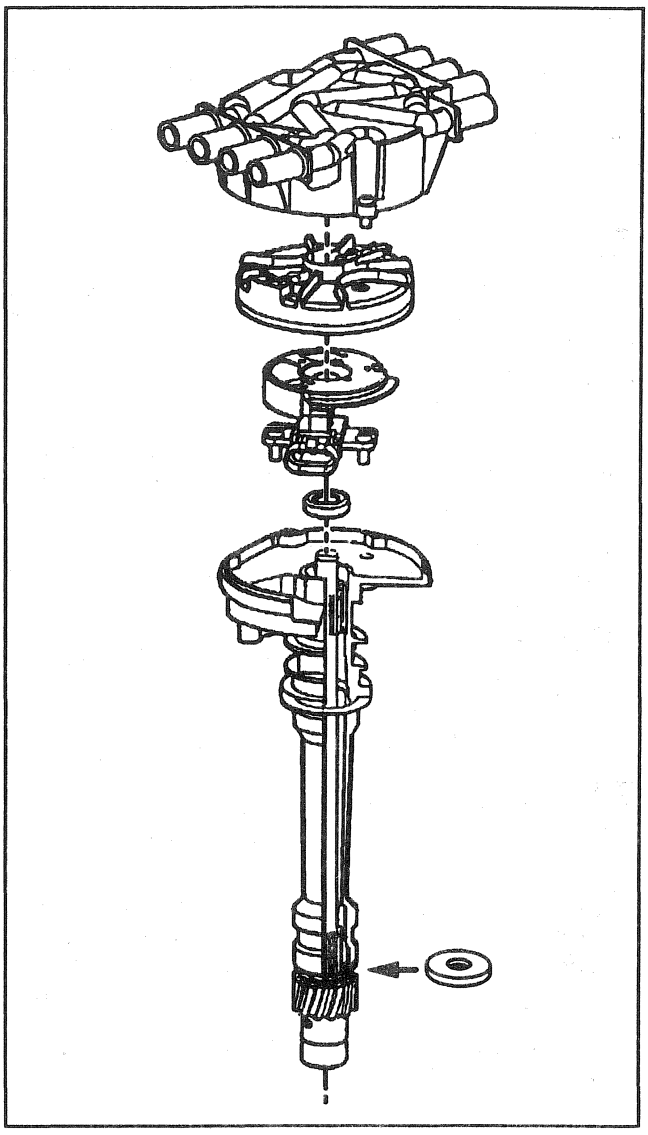


Figure 5—Distributor Components (7.4L)

NOTICE: ***Failure to keep cleaning agents away from the hall-effect switch may result in premature failure.***

- If the shaft can't be removed from the distributor housing due to varnish buildup, use a cloth dampened with varnish remover to clean the shaft.

INSPECTION AND ELECTRICAL TESTS

Inspect

1. Cap for cracks, tiny holes or carbon tracks between cap terminal traces. Carbon tracks can be diagnosed by using an ohmmeter. With the cap removed, place one base ohmmeter lead on a cap terminal. Use the other lead to probe all other terminals and the center carbon ball. Move the base lead to the next terminal and probe all other leads.

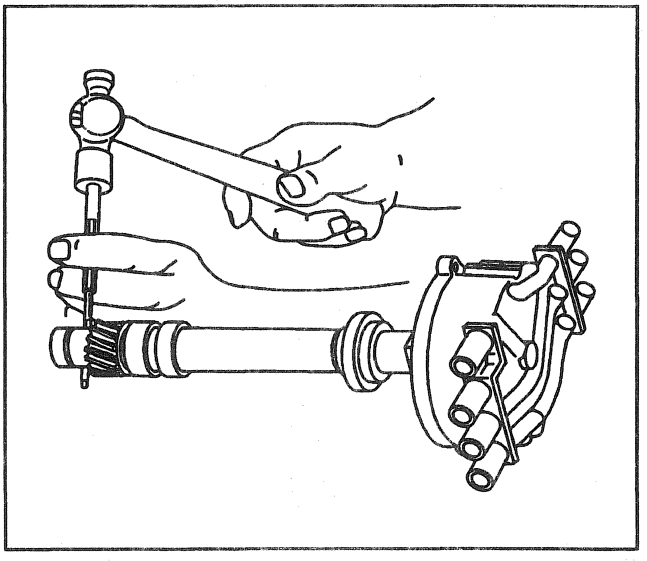


Figure 6—Removing/Installing the Roll Pin (Typical)

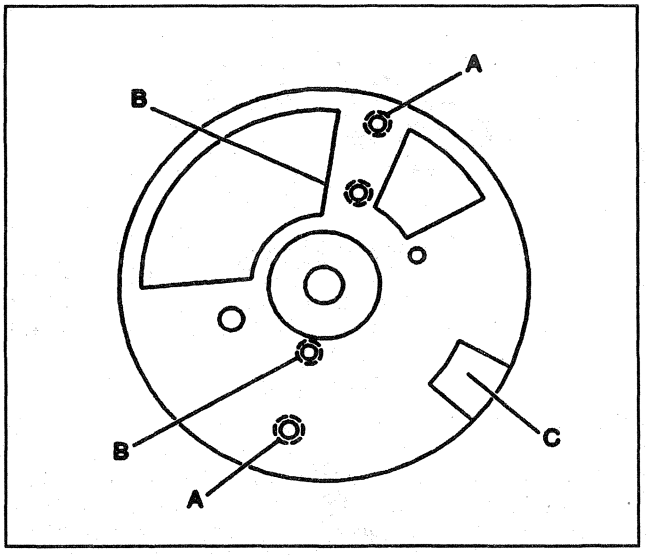


Figure 7—Vane Wheel in Distributor

Continue until all secondary terminals have been tested. If there are any non-infinite readings, replace the cap.

2. Cap for excessive build-up of corrosion on the terminals. Scrape them clean or replace the cap. Some build-up is normal.
3. Rotor segment. Replace the rotor if there is excessive wear on the rotor segment. Some looseness of the rotor segment is normal and does not cause performance problems.
4. Shaft for shaft-to-bushing looseness. Insert the shaft in the housing. If the shaft wobbles, replace the housing assembly.
5. Housing for cracks or damage.
   - Refer to the Engine Controls, Transmission Diagnosis, and Electrical Diagnosis Manual for ignition system diagnosis.

ASSEMBLY

Assemble (Figures 3 through 8)

1. Hall-effect switch.
2. Two screws holding the hall-effect switch. Do not overtighten the screws as the base may strip.
3. Shaft.
4. Thermal insulator (7.4L distributor only).
5. Tang washer, washer, and driven gear.
   - When the driven gear is properly installed the dimple located below the roll pin hole, in the driven gear, will be on the same side as the rotor segment when the rotor is installed in the distributor. If the driven gear is installed incorrectly, the dimple will be on the opposite side of the rotor segment.
6. Roll pin.
7. Rotor.
   - "A" shows the mounting holes. "B" shows the locating holes (Figure 7).
8. Two screws holding rotor.

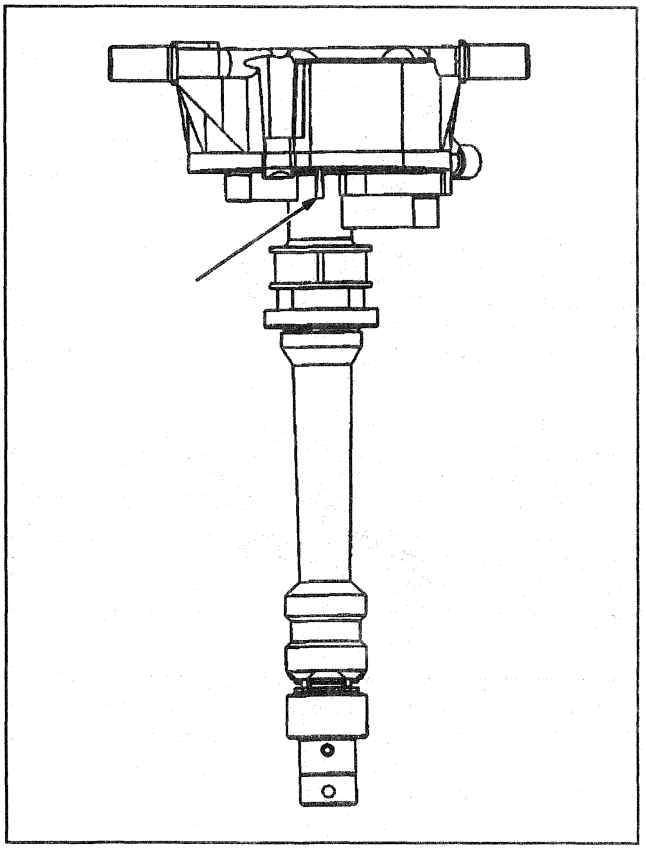


Figure 8—Distributor Alignment Indicator

Tighten

- Screws to 2 N.m (20 lb in).

Installation of the distributor into the engine will require the distributor cap off of the assembly. Refer to the Engine Controls, Transmission Diagnosis, and Electrical Diagnosis Manual.

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	N.m	Lb Ft	Lb In
Screw, Distributor Rotor	2	—	20

SECTION 6D5

ENGINE WIRING

CAUTION: This vehicle has a Supplemental Inflatable Restraint (SIR) System. Refer to the SIR Component and Wiring Location view in order to determine whether you are performing service on or near the SIR components or the SIR wiring. When you are performing service on or near the SIR components or the SIR wiring, refer to the SIR On-Vehicle Service information. Failure to follow the CAUTIONS could cause air bag deployment, personal injury, or unnecessary SIR system repairs.

NOTICE: ***Always use the correct fastener in the proper location. When you replace a fastener, use ONLY the exact part number for that application. General Motors will call out those fasteners that require a replacement after removal. General Motors will also call out the fasteners that require thread lockers or thread sealant. UNLESS OTHERWISE SPECIFIED, do not use supplemental coatings (paints, greases, or other corrosion inhibitors) on threaded fasteners or fastener joint interfaces. Generally, such coatings adversely affect the fastener torque and joint clamping force, and may damage the fastener. When you install fasteners, use the correct sequence and tightening specifications. Following these instructions can help you avoid damage to parts and systems.***

When it is necessary to move any of the wiring, whether to lift wires away from their harnesses or move harnesses to reach some component, take care that all wiring is replaced in its original position and all harnesses are routed correctly. If clips or retainers break, replace them. Electrical problems can result from wiring or harnesses becoming loose and moving from their original positions or from being rerouted. Refer to Figures 1 through 22 for the correct routing of the engine wiring.

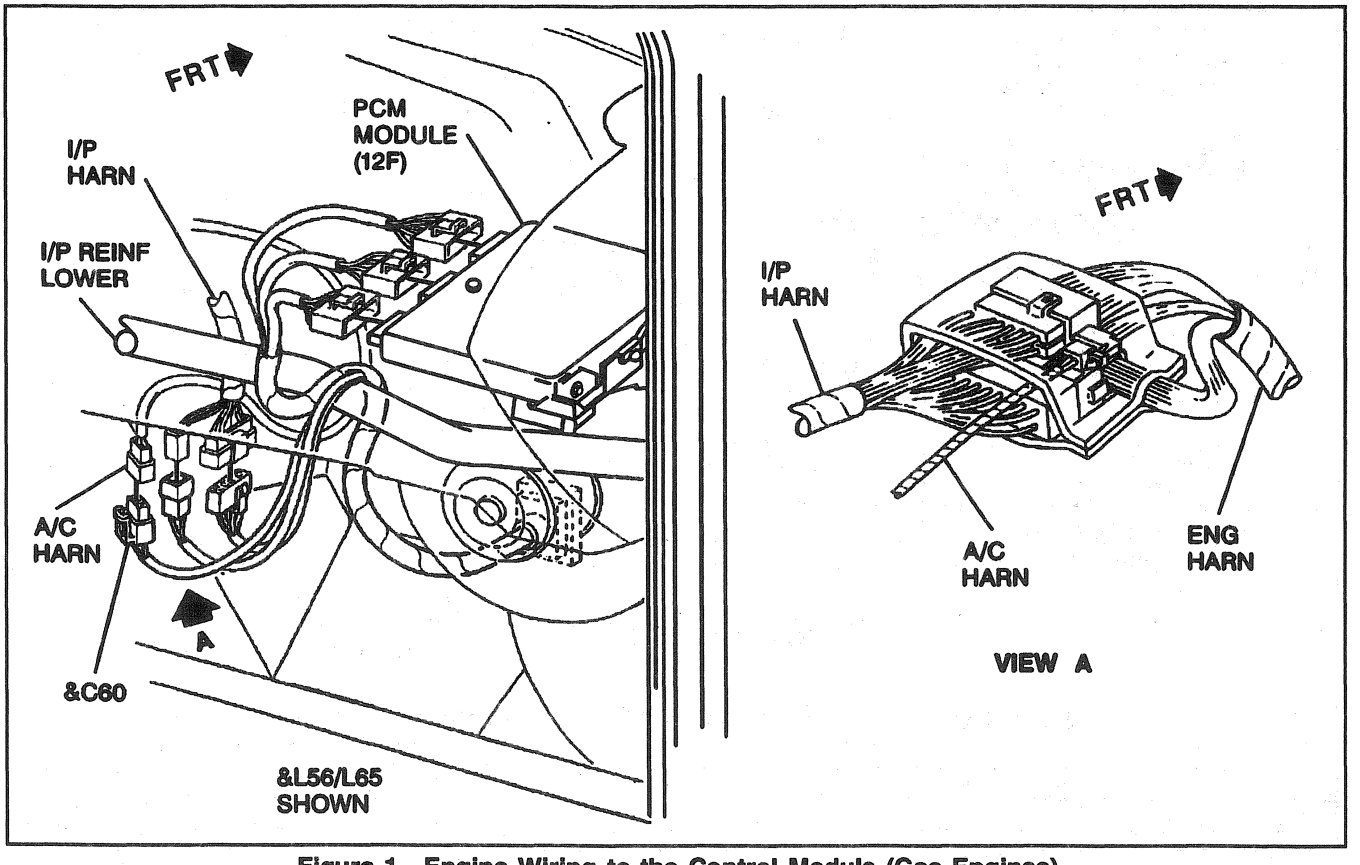


Figure 1—Engine Wiring to the Control Module (Gas Engines)

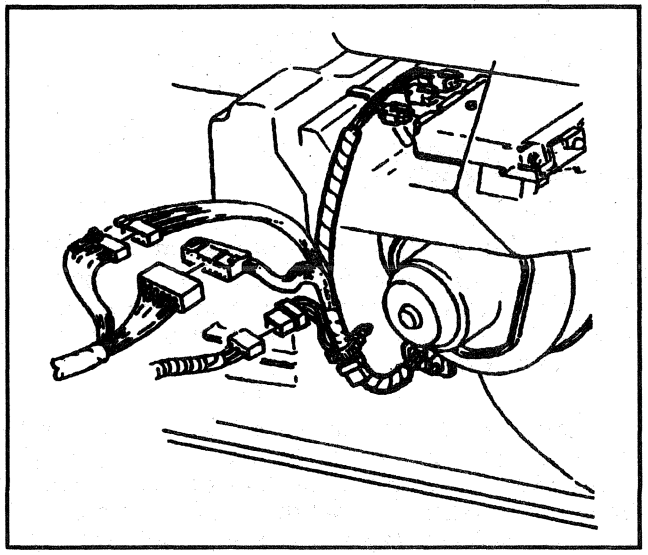


Figure 2—Engine Wiring to the Control Module (Diesel Engines)

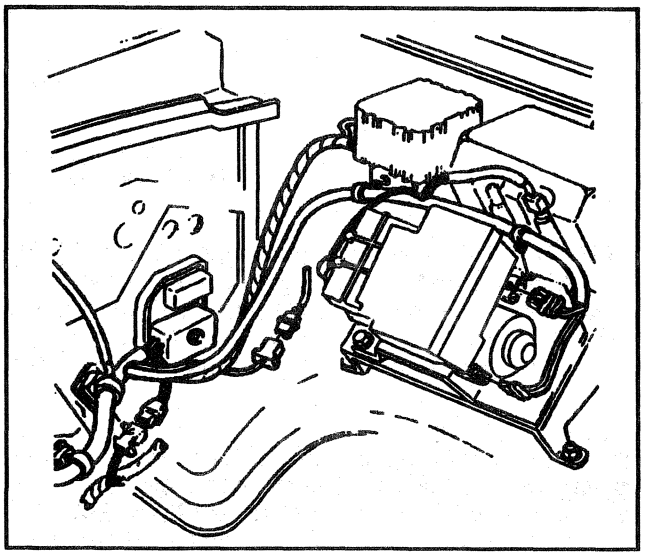


Figure 4—Engine Wiring from Junction Block (Diesel Engine)

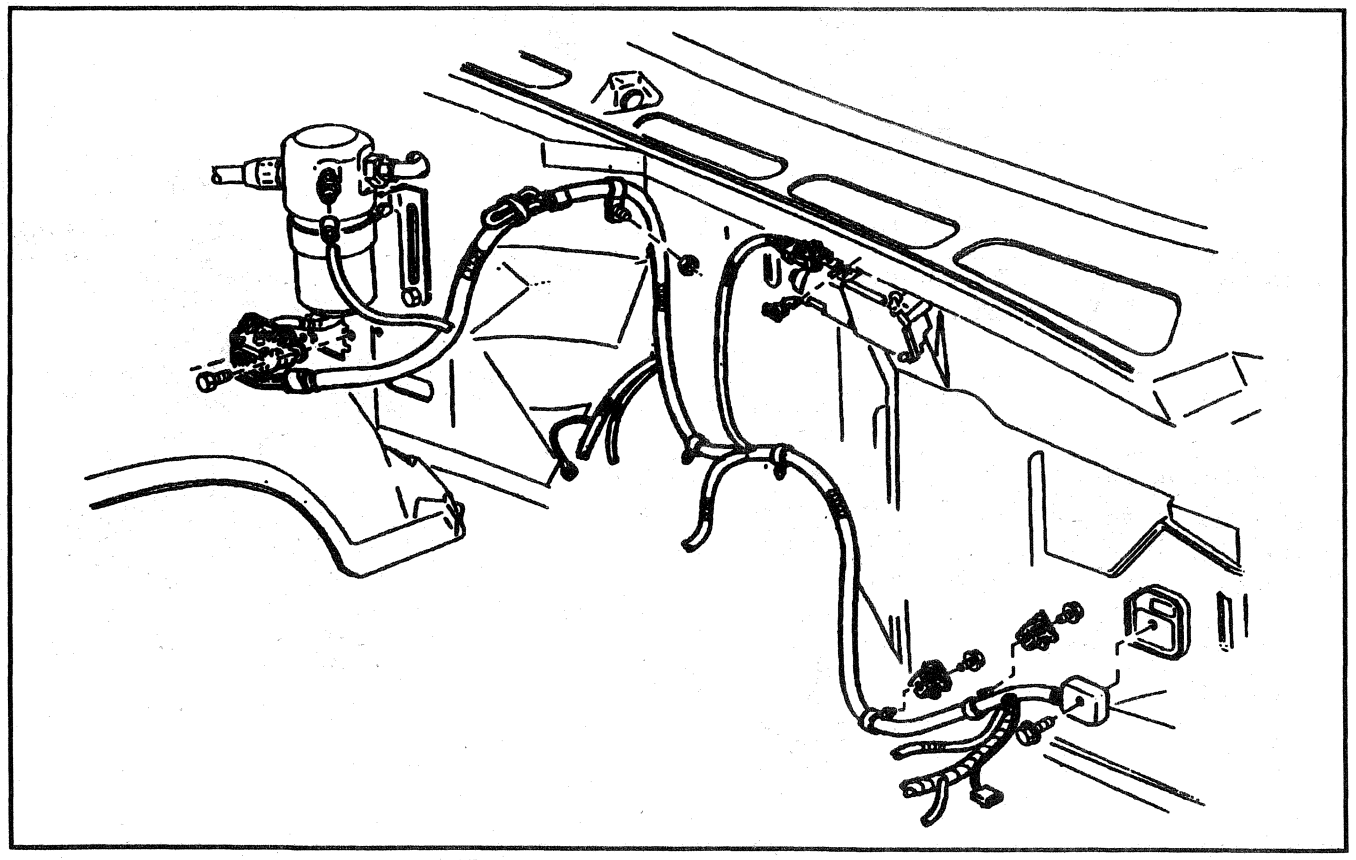


Figure 3—Engine Wiring at the Cowl

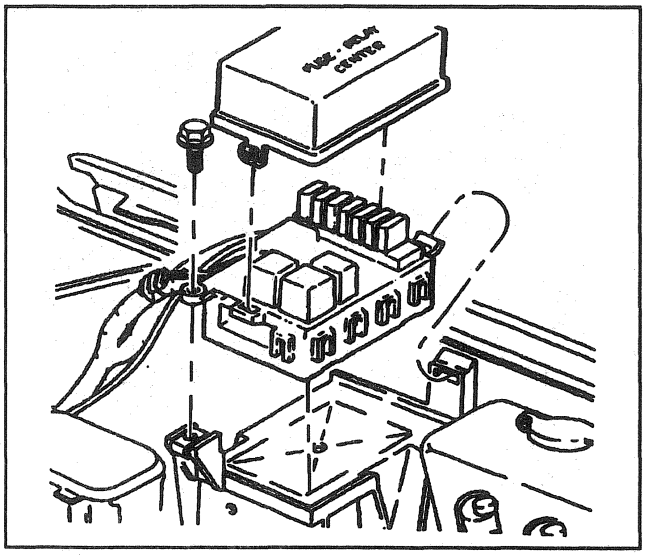


Figure 5—Engine Wiring to the Fuse Relay Center

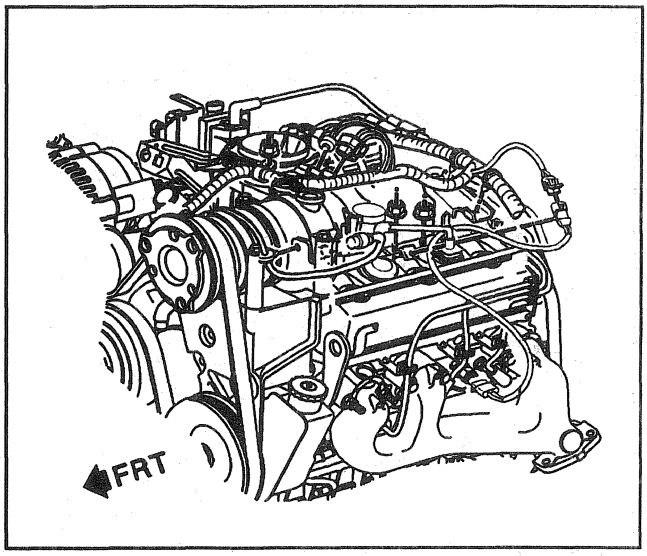


Figure 7—Engine Wiring to A/C Compressor (4.3L)

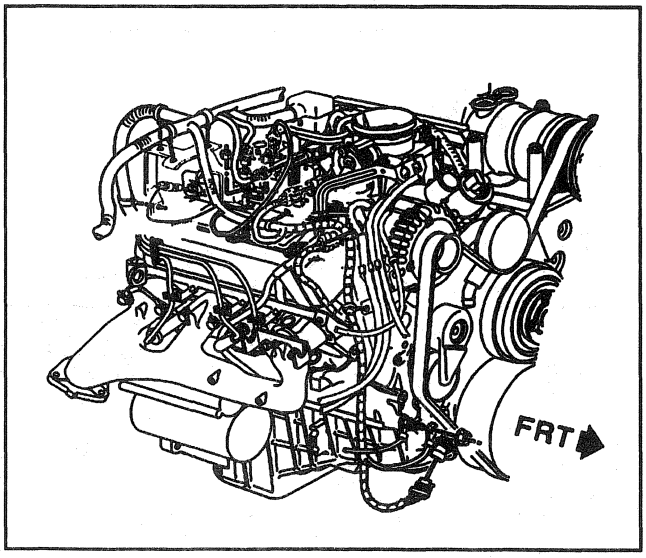


Figure 6—Engine Wiring (4.3L)

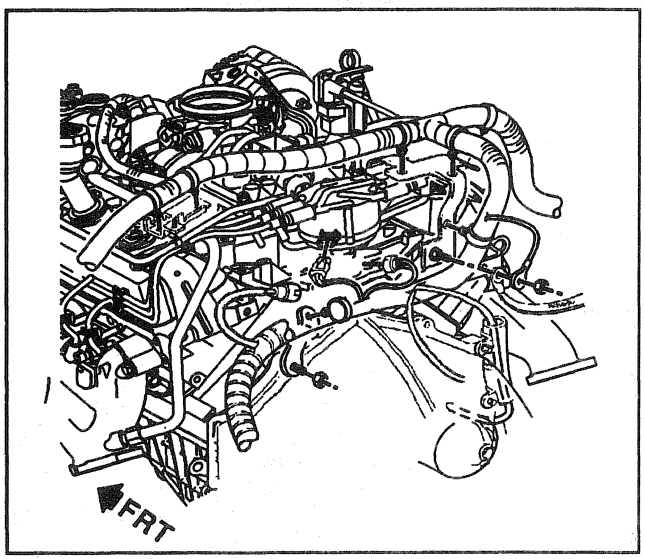


Figure 8—Engine Wiring Views - Rear (4.3L)

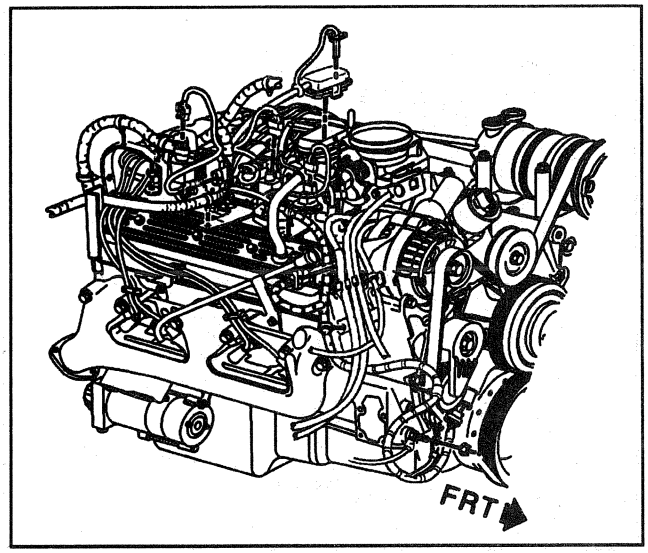


Figure 9—Engine Wiring Views - Top (5.0L and 5.7L)

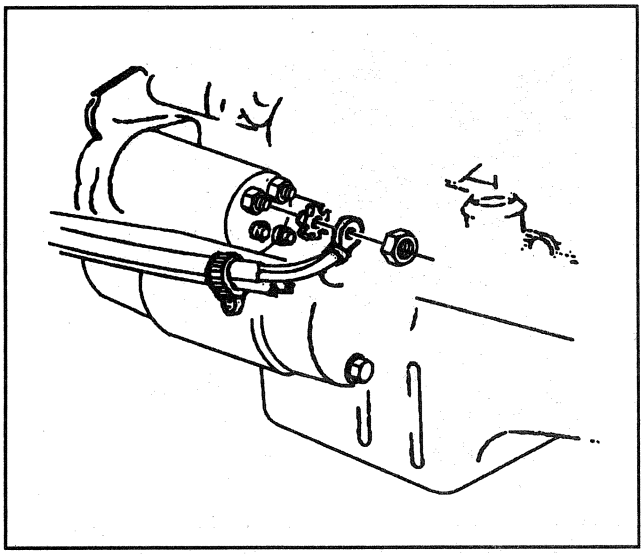


Figure 10—Starter Connections (5.0L and 5.7L)

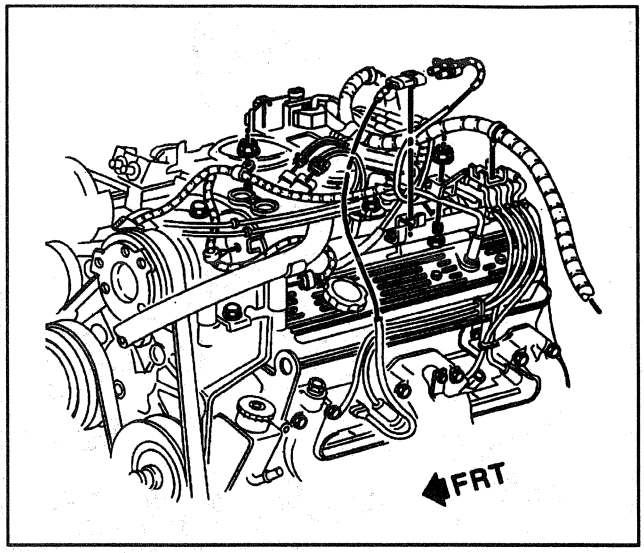


Figure 11—Engine Wiring Views - Left Side (5.0L and 5.7L)

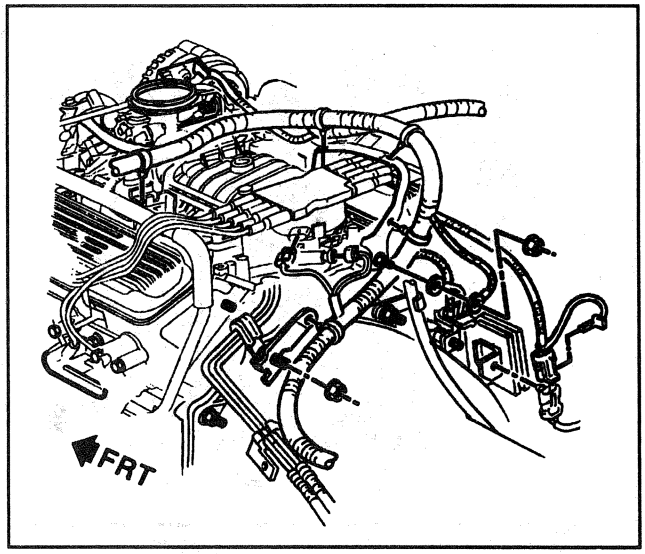


Figure 12—Engine Wiring - Rear (5.0L and 5.7L)

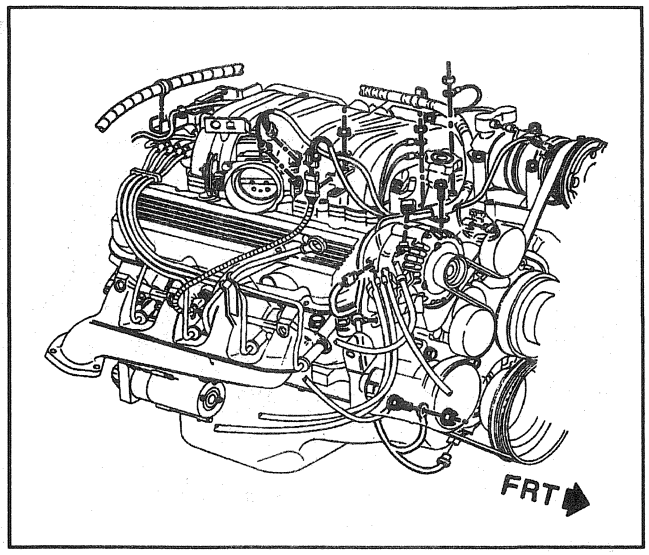


Figure 13—Engine Wiring - Right Side (7.4L)

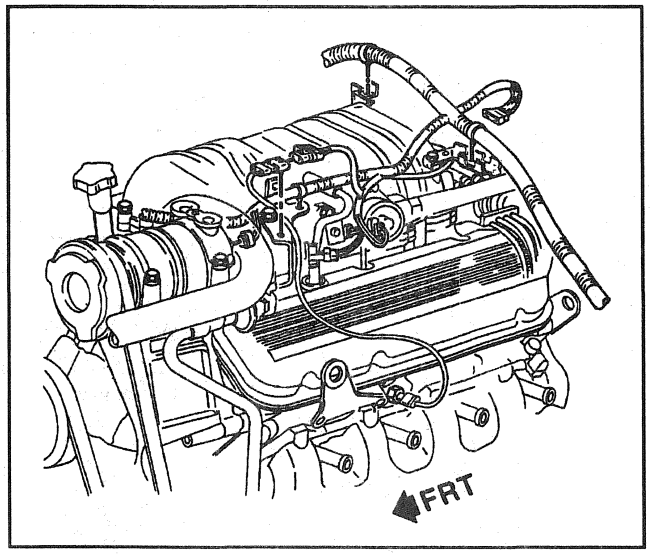


Figure 14—Engine Wiring - Left Side (7.4L)

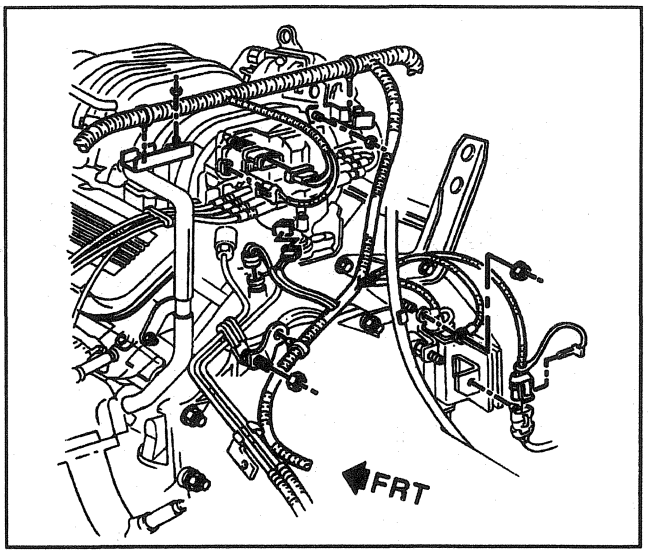


Figure 15—Engine Wiring - Rear (7.4L)

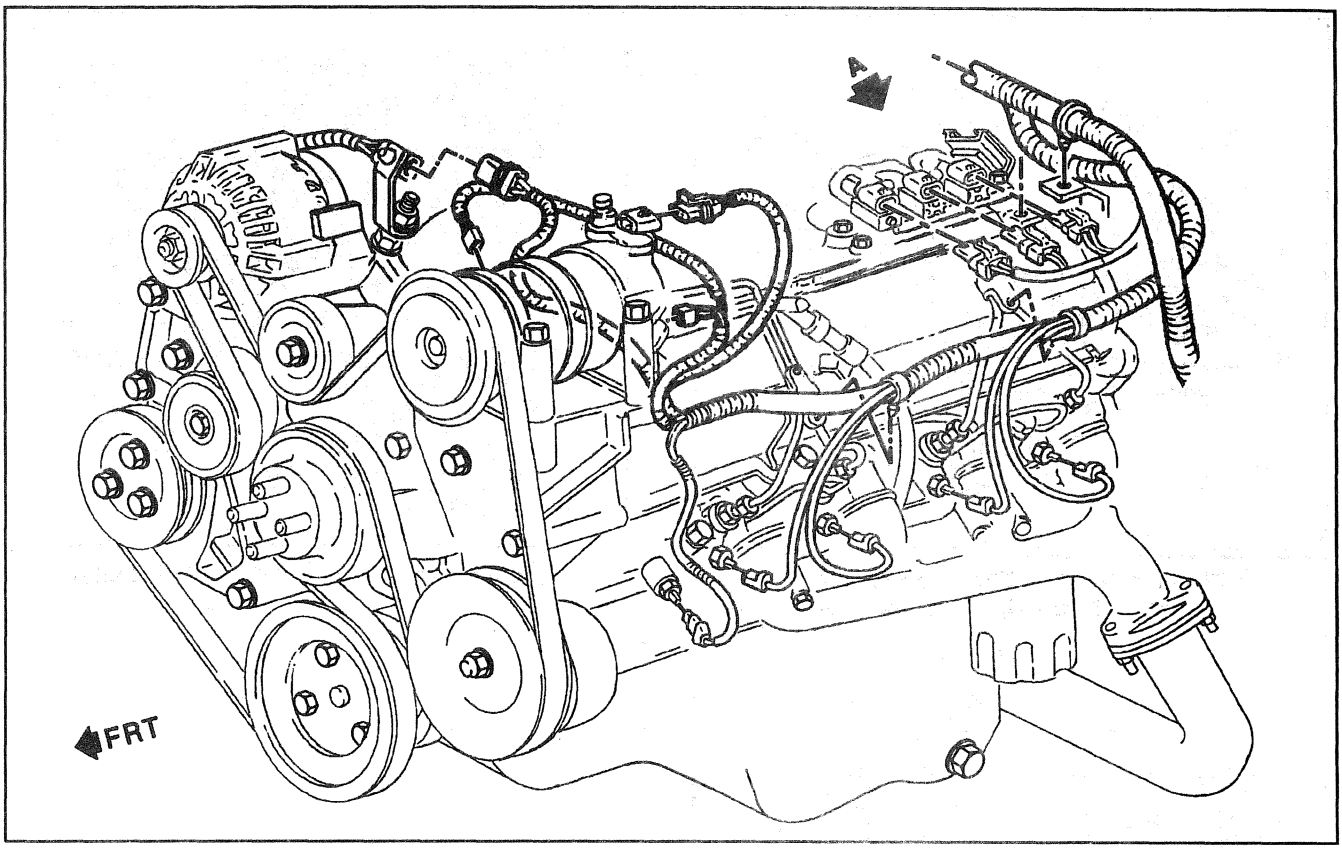


Figure 16—Engine Wiring - Left Side (6.5L Diesel Engines)

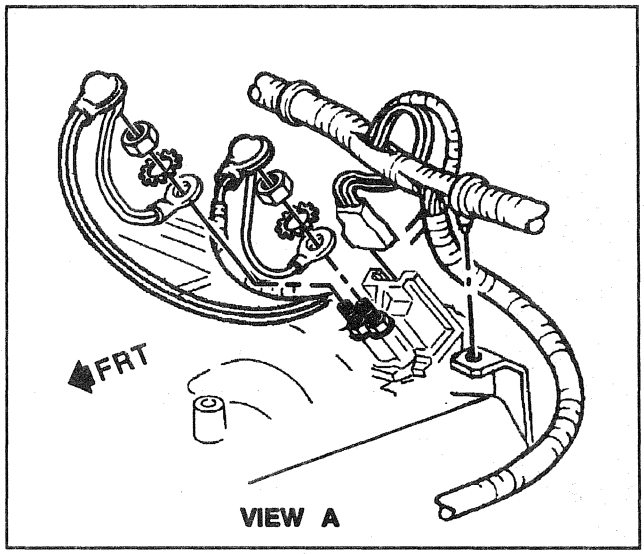


Figure 17—Engine Wiring - Left Side Views (6.5L Diesel Engines)

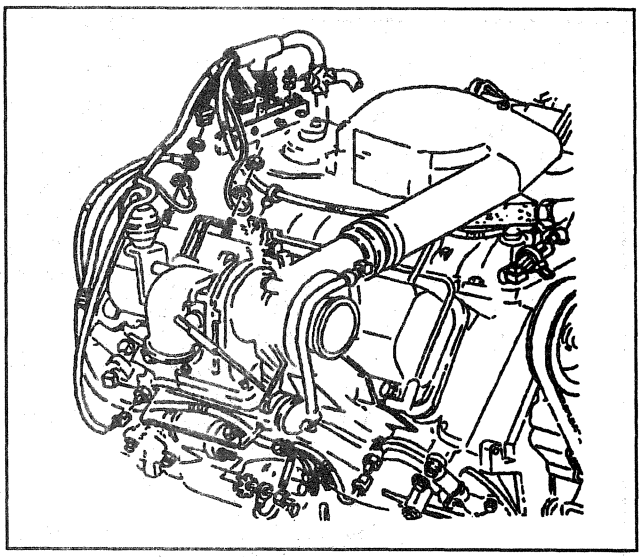


Figure 18—Engine Wiring - Right Side (6.5L)

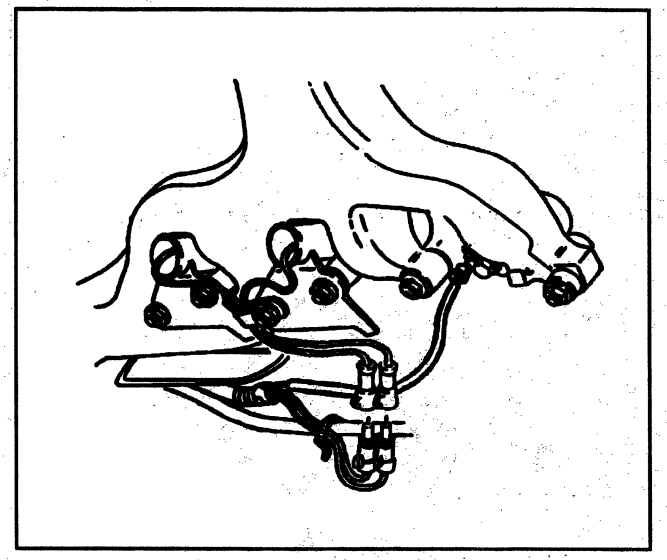


Figure 19—Glow Plug Connections (6.5L Turbo Diesel Shown)

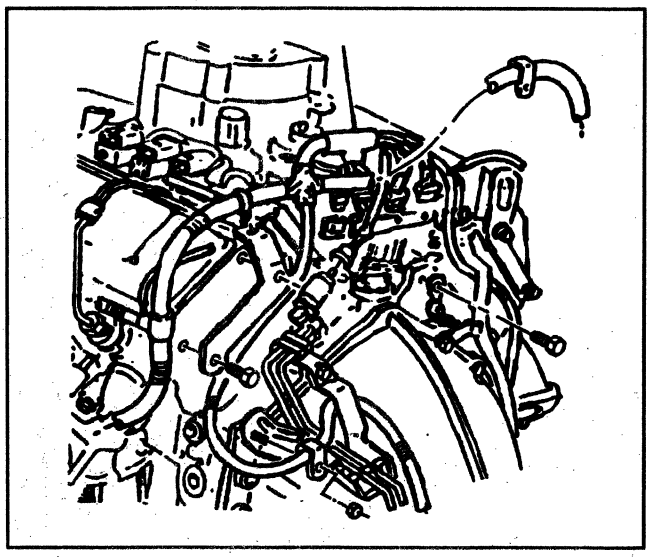


Figure 20—Engine Wiring - Rear (6.5L)

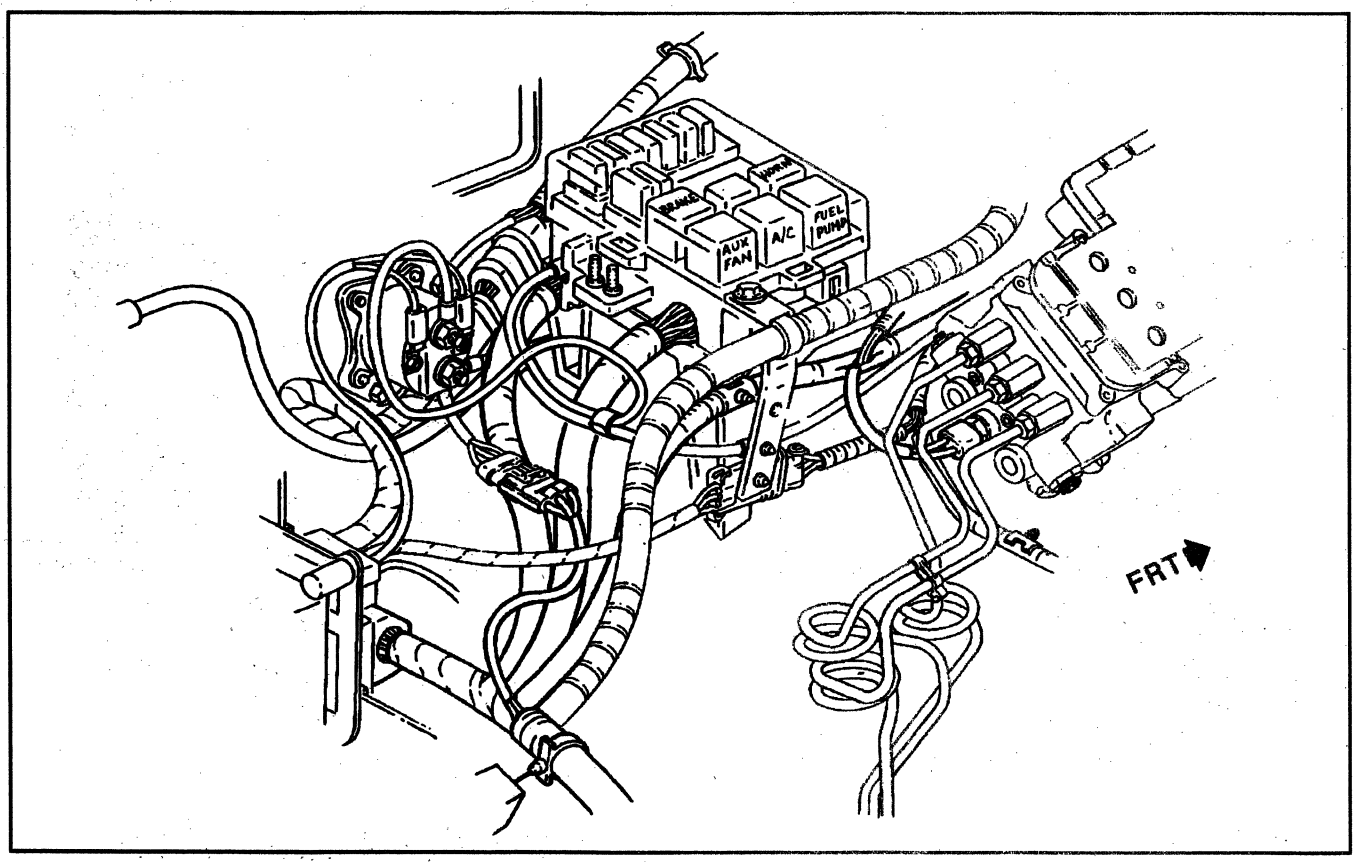


Figure 21—Engine Wiring to Dash (4.3L, 5.0L, 5.7L and 7.4L Engines)

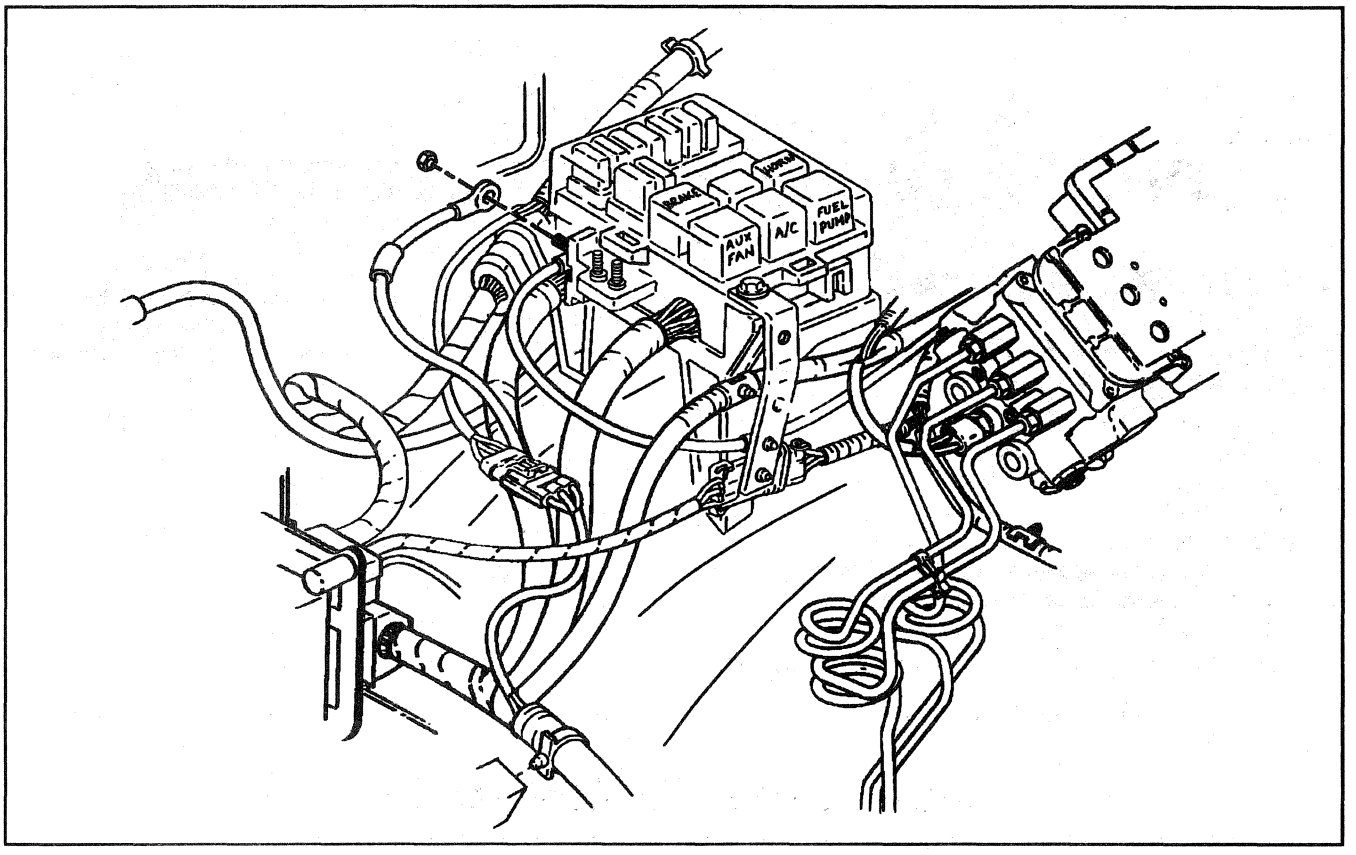


Figure 22—Engine Wiring to Dash (6.5L Diesel)

SECTION 6D6

DIESEL GLOW PLUG ELECTRICAL SYSTEM

There are two versions of the 6.5L diesel available in these vehicles. Included are: the turbocharged light duty (RPO L56, VIN S), and the turbocharged heavy duty (RPO L65, VIN F). These engines use an electronically-controlled injector pump and glow plug electrical system. For diagnosis, refer to the Engine Controls, Transmission Diagnosis and Electrical Diagnosis Manual.

SECTION 6E2

DIESEL EMISSIONS

CONTENTS

GENERAL DESCRIPTION

The 6.5L diesel engine has controls to reduce emissions while maintaining good driveability and fuel economy. The turbocharged light duty engine (RPO L56, VIN S) comes equipped with the following controls:

A. Crankcase ventilation system
B. Powertrain control module
C. Vacuum pump
D. Exhaust gas recirculation (EGR)
E. Cold advance and glow plug control
F. Automatic transmission control

CRANKCASE VENTILATION SYSTEM

The crankcase ventilation system is designed to reduce the crankcase pressure at idle. This lower pressure reduces engine oil leaks. The system consists of a crankcase depression regulator valve located on the right valve rocker arm cover (Figure 1).

The crankcase depression regulator (CDR) valve is used to regulate the flow of crankcase gases back into the engine. The valve is designed to limit vacuum in the crankcase as the gases are drawn from the right valve rocker arm cover, through the valve, and into the intake manifold (Figure 2).

The intake manifold vacuum acts against a spring loaded diaphragm to control the flow of crankcase gases. Higher intake vacuum levels pull the diaphragm closer to the top of the outlet tube. This reduces the amount of gases being drawn from the crankcase and decreases the vacuum level in the crankcase. As the intake vacuum decreases, the spring pushes the diaphragm away from the top of the outlet tube allowing more gases to flow to the intake manifold (Figure 3). For information about the Diagnostic Trouble Codes (DTC), refer to the Engine Controls, Transmission Diagnosis and Electrical Diagnosis Manual.

VACUUM PUMP

A vacuum pump is located on the front right side of the engine and provides a vacuum source to operate the EGR system for the light duty diesel engine and the waste-gate for the turbocharger on both of the diesel engines, and for the air conditioning system (if equipped).

DIAGNOSIS

The purpose of the CDR valve is to maintain 0.75 to 1.0 kPa (3 to 4 Hg inches of mercury) vacuum in the crankcase. Too little vacuum will tend to force oil leaks. Too much vacuum will pull oil into the air crossover.

The CDR valve is checked with a water manometer. The U-tube manometer (Figure 4) indicates pressure or vacuum by the difference in the height of two columns of fluid.

CDR VALVE TEST

1. Connect one end of the manometer to the engine oil level indicator tube hole. The other end of the manometer is vented to atmosphere.
2. Install the air cleaner.
3. Start the engine and observe the manometer reading. It should read one inch of water pressure at

idle to approximately 3 to 4 inches of water vacuum at full load. Add the amount that the manometer column travels up, to the amount the column travels down to obtain total psi/vacuum. An example of a manometer reading is as follows: One-half inch above zero plus one-half inch below zero equals one inch vacuum reading (1/2 inch + 1/2 inch = 1 inch) (Figure 4).

ON-VEHICLE SERVICE

CDR VALVE AND HOSES

NOTICE: ***Do not allow any solvent to come in contact with the diaphragm of the crankcase depression regulator valve because the diaphragm will fail.***

The crankcase depression regulator valve is replaced as an assembly. Replace hoses as required, if inspection indicates cracks or decay. Refer to SECTION 0B for diesel crankcase ventilation system maintenance requirements.

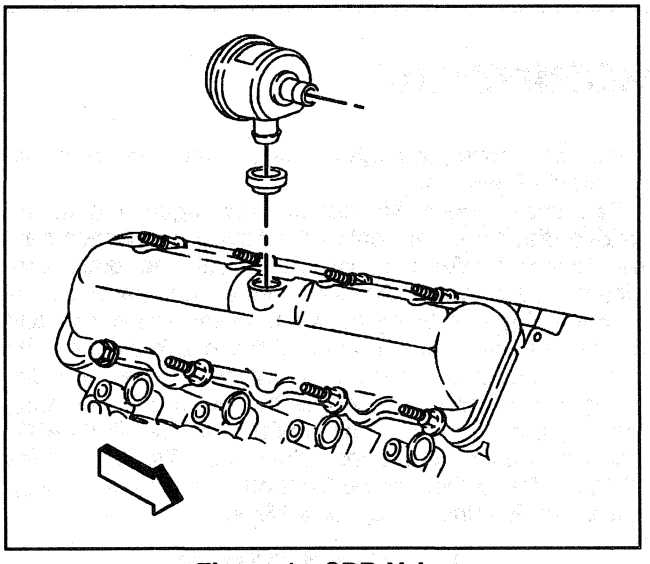


Figure 1—CDR Valve

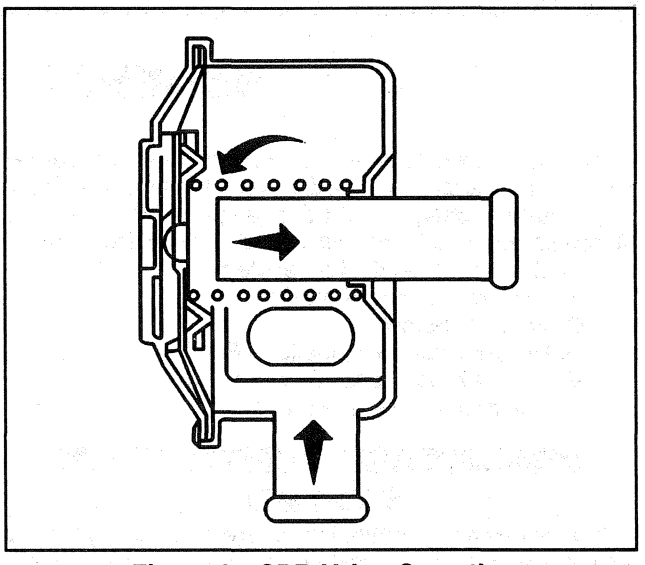


Figure 3—CDR Valve Operation

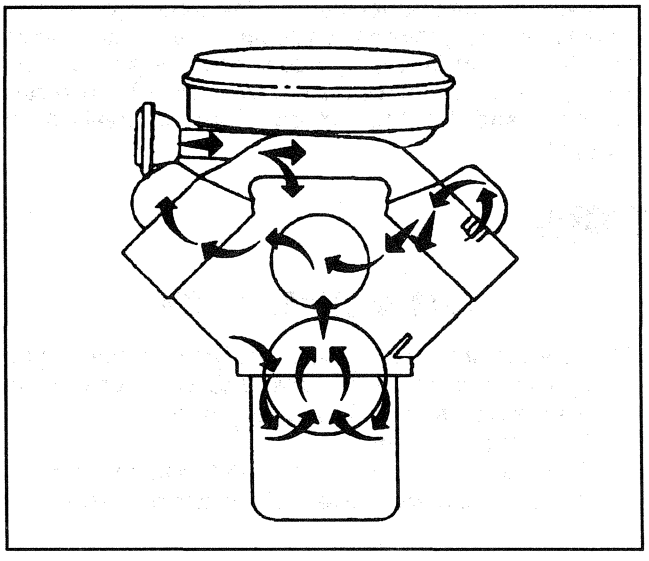


Figure 2—Crankcase Vapor Flow

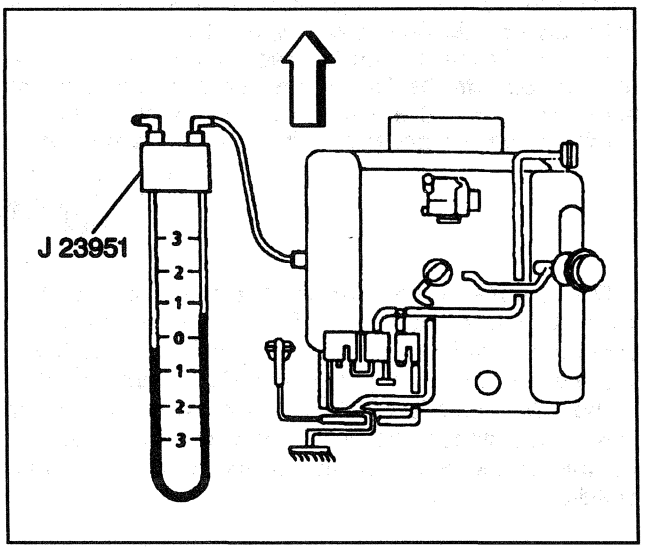
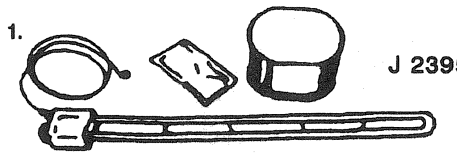


Figure 4—CDR Valve Test

SPECIAL TOOLS



1. MANOMETER

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SECTION 6F

EXHAUST SYSTEM

CAUTION: This vehicle has a Supplemental Inflatable Restraint (SIR) System. Refer to the SIR Component and Wiring Location view in order to determine whether you are performing service on or near the SIR components or the SIR wiring. When you are performing service on or near the SIR components or the SIR wiring, refer to the SIR On-Vehicle Service information. Failure to follow the CAUTIONS could cause air bag deployment, personal injury, or unnecessary SIR system repairs.

NOTICE: ***Always use the correct fastener in the proper location. When you replace a fastener, use ONLY the exact part number for that application. General Motors will call out those fasteners that require a replacement after removal. General Motors will also call out the fasteners that require thread lockers or thread sealant. UNLESS OTHERWISE SPECIFIED, do not use supplemental coatings (paints, greases, or other corrosion inhibitors) on threaded fasteners or fastener joint interfaces. Generally, such coatings adversely affect the fastener torque and joint clamping force, and may damage the fastener. When you install fasteners, use the correct tightening sequence and specifications. Following these instructions can help you avoid damage to parts and systems.***

CONTENTS

GENERAL DESCRIPTION

Exhaust system designs vary according to the engine designation and intended use of the vehicle.

The exhaust pipe(s), muffler(s), and tailpipe(s) are standard equipment. The exhaust system uses a ball joint coupling to secure the exhaust pipe to the engine manifold. The ball joint allows angular movement for alignment purposes.

Other connections on the gasoline engine use a flat flange and gasket, while the diesel engine uses a slip joint coupling design with a clamp and U-bolt.

The exhaust system is suspended by hangers attached to the frame members. These allow some movement of the exhaust system and minimize the transfer of noise and vibration into the vehicle.

The catalytic converter is an emission control device added to the engine exhaust system to reduce hydrocarbon, carbon monoxide, and nitrogen oxide pollutants from the exhaust gases. The catalyst in the converter is not serviceable.

Heat shields are used to protect the vehicle and the environment from high temperatures developed by the exhaust system, especially the catalytic converter.

The catalytic converter(s) used on gasoline engine vehicles with Light Duty Emissions (vehicles below 8,600 lb GVWR). are part of the Y-pipe and are attached forward of the flat flange. For an example of a catalytic converter system of this type, refer to (Figure 1).

The catalytic converters used on gasoline engine vehicles with Heavy Duty Emissions (vehicles above 8,600 lb GVWR) are both part of the Y-pipe assembly and the muffer assembly. One converter is attached forward of the flat flange and the second converter is mounted rearward of the flat fiange. For an example of a catalytic converter system of this type, refer to (Figure 14).

NOTICE: ***The catalytic converters require the use of unleaded fuel only. Using leaded fuel will damage the catalytic converters and other emission system components.***

The diesel engine uses a catalytic converter added to the exhaust system to reduce smoke (particulates). The catalytic converter operates at normal exhaust system temperature; there is no significant temperature increase as a result of oxidation of particulates. For an example of a diesel engine catalytic converter system refer to (Figure 17).

Individual exhaust system replacement components versus one complete assembly will vary upon body/chassis and engine designation.

DIAGNOSIS OF EXHAUST SYSTEM

NOTICE: Replacement of exhaust system parts MUST be OEM standard.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Vibrating or Rattling From Exhaust System	Loose and/or misaligned components.	Align, then tighten connections. Check for damaged hanger or mounting brackets and clamps.
Restricted Exhaust System (Gasoline Engines)	1. "Kinked" exhaust tubing. 2. Restriction within the muffler. Refer to "Restricted Exhaust System Check" in the Engine Controls, Transmission Diagnosis and Electrical Diagnosis Manual. 3. End of tail pipe obstruction. 4. Plugged catalytic converter (may result from serious engine malfunction). Refer to "Restricted Exhaust System Check" in the Engine Controls, Transmission Diagnosis and Electrical Diagnosis Manual.	1. If possible, repair the damaged condition, otherwise replace the component. 2. If restriction is suspected, remove the muffler and visually check it. Replace muffler if condition is doubtful. 3. Remove the obstruction, or if end is crimped, straighten outlet. 4. Replace the catalytic converter. Correct engine malfunction.
Restricted Exhaust System (Diesel Engines)	1. "Kinked" exhaust tubing. 2. Restriction within the muffler. Refer to "Restricted Exhaust System Check" in the Engine Controls, Transmission Diagnosis and Electrical Diagnosis Manual. 3. End of tail pipe obstruction.	1. If possible, repair the damaged condition, otherwise replace the component. 2. If restriction is suspected, remove the muffler and visually check it. Replace muffler if condition is doubtful. 3. Remove the obstruction, or if end is crimped, straighten outlet.
Exhaust Leakage and/or Noise	1. Leakage at exhaust component joints and couplings. 2. Improperly installed or misaligned. 3. Exhaust manifold cracked or broken. 4. Leak between exhaust manifold and cylinder head. 5. Damaged or worn seals or packing. 6. Burned or rusted out exhaust pipe. 7. Burned or blown out muffler. 8. Broken or loose clamps and/or brackets.	1. Tighten clamps or couplings to specified torque. 2. Align, then tighten connections. 3. Replace the manifold. 4. Tighten the manifold to cylinder head nuts and bolts to specifications. 5. Replace the seals or gaskets as necessary. 6. Replace the exhaust pipe. 7. Replace the muffler assembly. 8. Repair or replace as necessary.
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ON-VEHICLE SERVICE

INSPECTION

Inspect exhaust pipes, catalytic converter(s), muffler, and tailpipe for cracked joints, broken welds, and corrosion damage that could result in a leaking exhaust system. Inspect the clamps, brackets, and insulators for cracks and stripped or corroded bolt threads.

The exhaust system, including the heat shield, must be free of leaks, binding, grounding, and excessive vibration. These conditions are usually caused by damaged or loose flange bolts/nuts, heat shields, brackets, or pipes. If any of these conditions exist, check the exhaust system alignment. Align and replace the components as necessary.

REMOVING EXHAUST PARTS

CAUTION: Always wear protective goggles and gloves when removing exhaust parts as falling rust and sharp edges from worn exhaust components could result in serious personal injury.

When removing exhaust components an accumulation of dirt and corrosion can make work difficult. Using a penetrating oil on the threads of bolts can assist in the removal of these components.

INSTALLING EXHAUST PARTS

When installing a new exhaust pipe, muffler, or tailpipe, on any model, check for proper alignment. Rattles and noise vibrations in the exhaust system are usually caused by the misalignment of parts. When aligning the system, leave all bolts and nuts loose until all parts are properly aligned, then tighten, working from the front to the rear.

Damaged exhaust system hangers, hanger brackets, and clamps should be replaced to maintain exhaust system alignment.

NOTICE: ***When jacking or lifting the vehicle from the frame side rails, make sure the lift pads do not contact the catalytic converter as converter damage will result.***

Important

- Apply sealer GM P/N 9985020 or equivalent to all slip joint connections.
- When installing the exhaust pipe to the engine manifold always use a new seal and nuts. Clean the engine manifold stud threads with a wire brush before installing the new nuts.

GASOLINE ENGINE CATALYTIC CONVERTER REPLACEMENT (BELOW 8600 lb GVWR)

Remove or Disconnect

- Raise the vehicle.

1. Oxygen sensor electrical connection(s).
2. Nuts and flange gaskets from Y-pipe and exhaust manifold.
3. Nuts and washers from Y-pipe flat flange.
4. Y-pipe and catalytic converter assembly.

Install or Connect

- Position Y-pipe and catalytic converter assembly to flat flange.

1. Washers and nuts to flat flange studs.

   Tighten

   - Nuts to 48 N·m (35 lb ft).
2. Flange gaskets and nuts to exhaust manifold.

   Tighten

   - Nuts to 65 N·m (48 lb ft).
3. Oxygen sensor electrical connection(s).
   - Check for clearance and alignment.
   - Lower the vehicle.

GASOLINE ENGINE CATALYTIC CONVERTER REPLACEMENT (8600 lb AND OVER GVWR)

Remove or Disconnect

- Raise the vehicle.

1. Oxygen sensor electrical connection(s).
2. Nuts and flange gaskets from Y-pipe and exhaust manifold.
3. Nuts and washers from Y-pipe flat flange.
4. Y-pipe and catalytic converter assembly.
5. Muffler and catalytic converter assembly.

Install or Connect

1. Muffler and catalytic converter assembly.
2. Y-pipe and catalytic converter assembly.
3. Washers and nuts to Y-pipe flat flange.

   Tighten

   - Nuts to 48 N·m (35 lb ft).

4. Flange gaskets and nuts to exhaust manifold.

Tighten

- Nuts to 65 N.m (48 lb ft).

5. Oxygen sensor electrical connection(s).
   - Check for clearance and alignment.
   - Lower the vehicle.

DIESEL ENGINE CATALYTIC CONVERTER REPLACEMENT (ALL GVWR)

Remove or Disconnect

- Raise the vehicle.

1. U-bolts or flange joint from the front and U-bolt from the rear of the catalytic converter assembly.
2. Catalytic converter from front exhaust pipe and intermediate exhaust pipe.

Install or Connect

1. Catalytic converter to the front exhaust pipe and intermediate exhaust pipe.
2. New U-bolts or flange gasket (as equipped) at the front and rear of the catalytic converter.

Tighten

- Nuts to 40 N.m (29 lb ft).
- Check for clearance and alignment.
- Lower the vehicle.

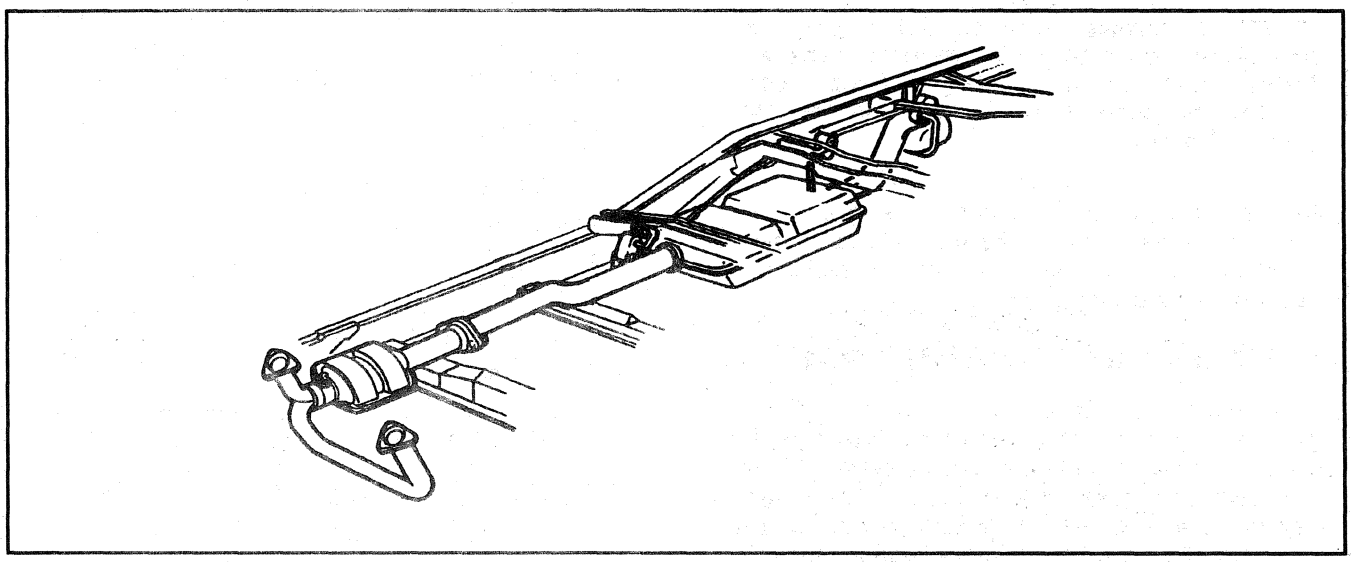


Figure 1—Exhaust System - C/K 1 Regular Cab Long Box w/4.3L Engine

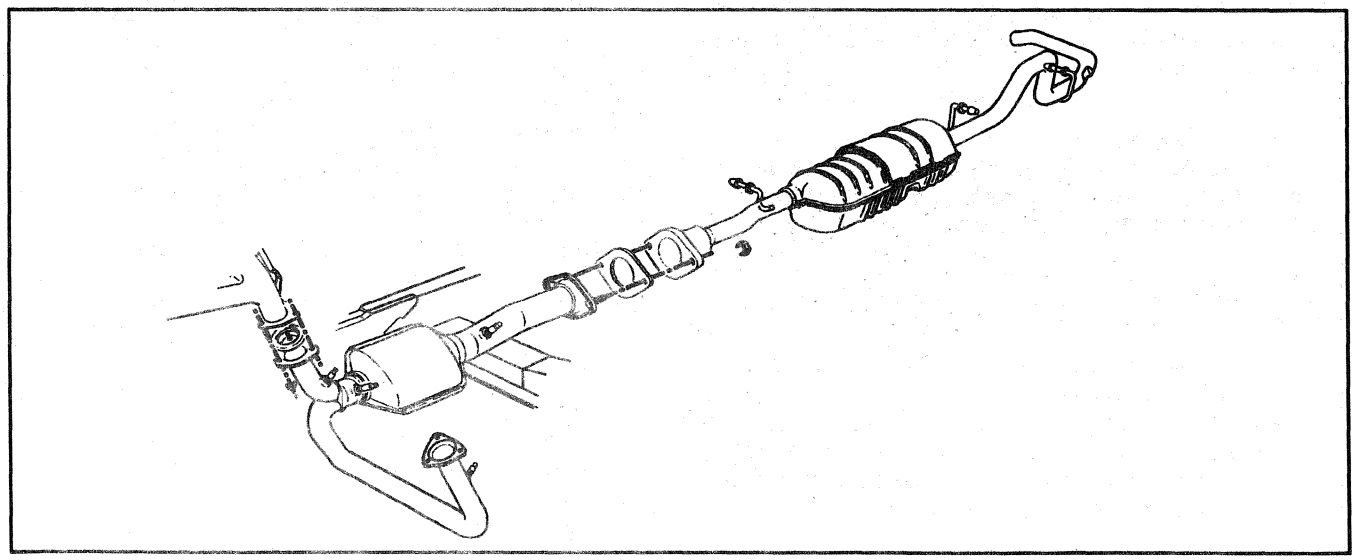


Figure 2—Exhaust System - C/K 1 Regular Cab Short Box w/4.3L Engine

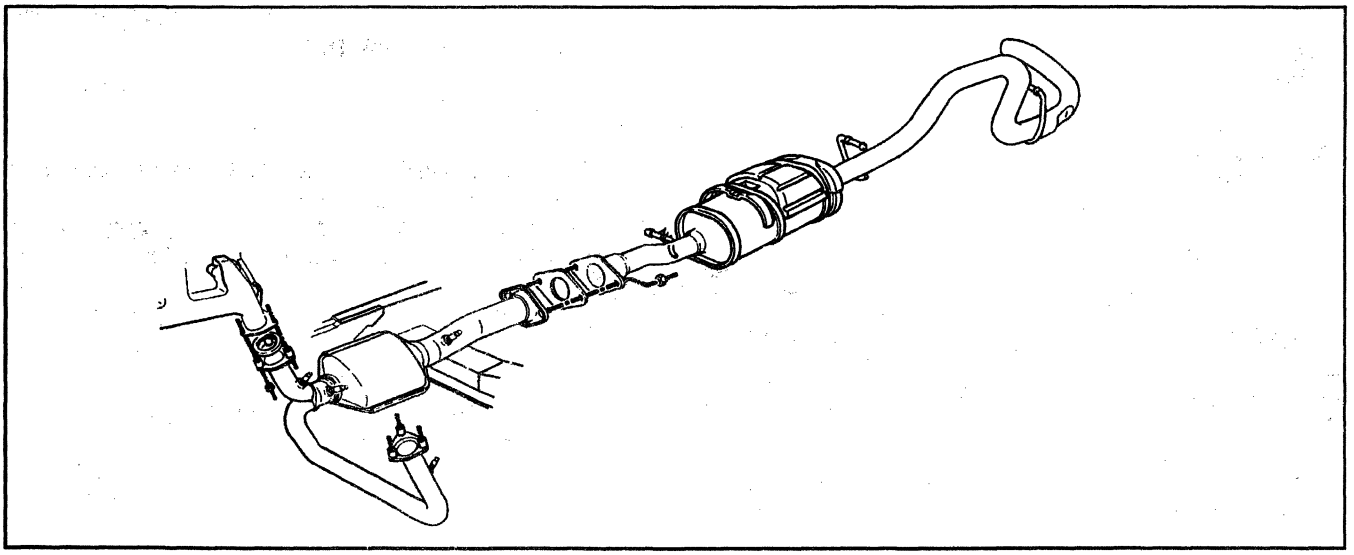


Figure 3—Exhaust System - C/K 1 Regular Cab Short Box w/5.0L Engine

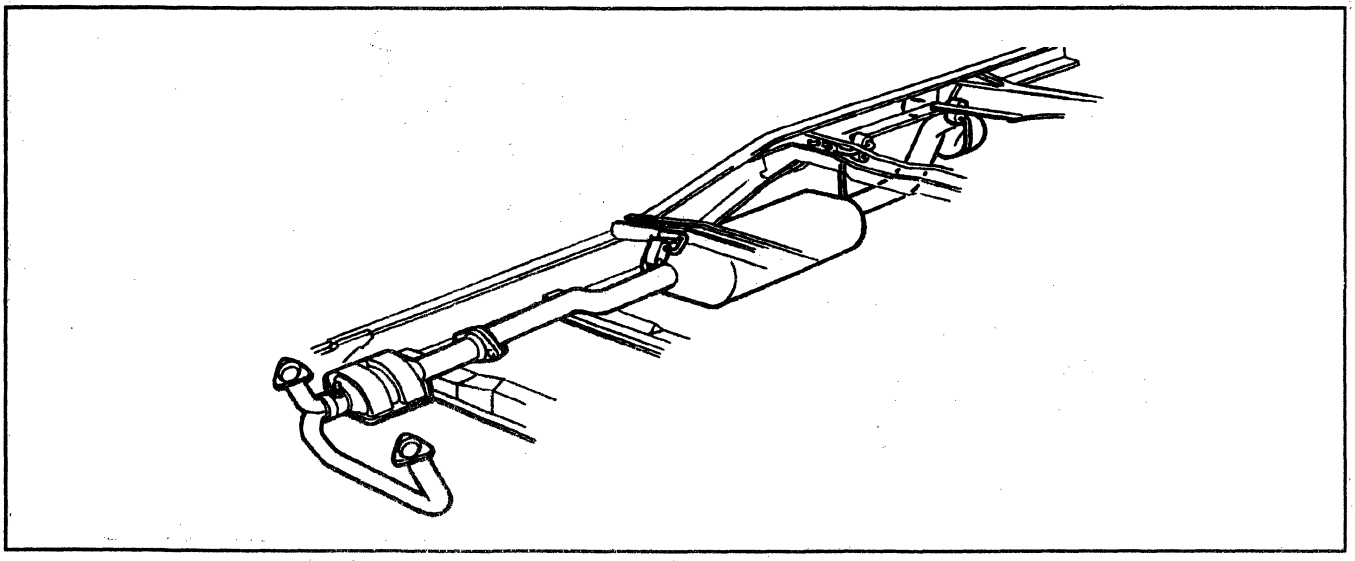


Figure 4—Exhaust System - C/K 1 and 2 Regular Cab Long Box w/5.0L Engine

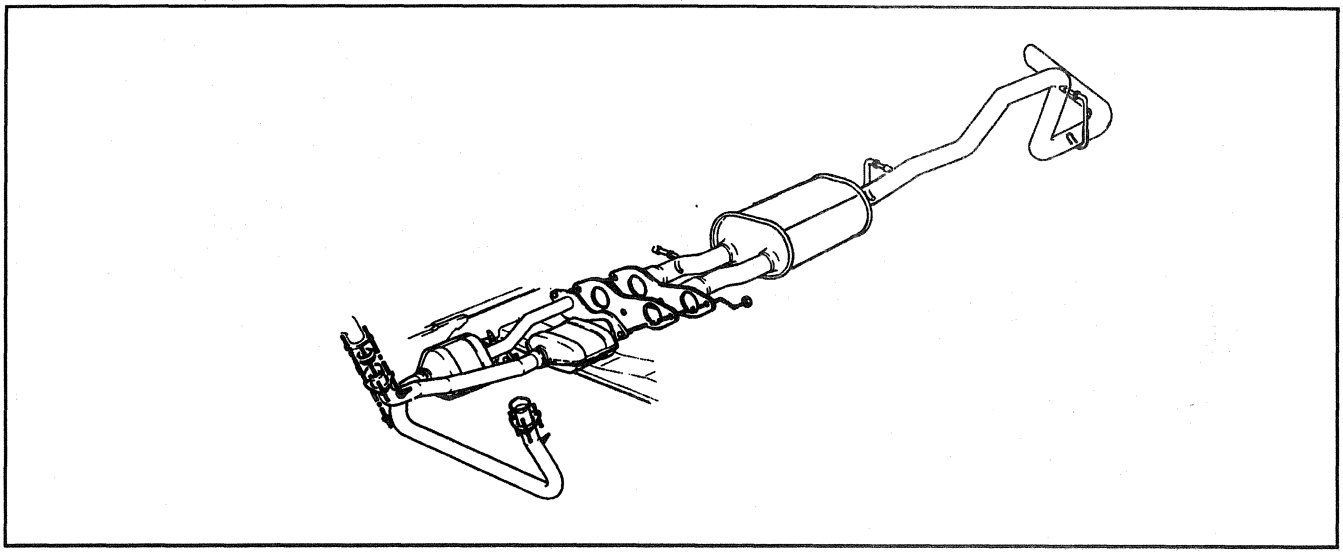


Figure 5—Exhaust System - C/K 1 Regular Cab Short Box w/5.0L Engine

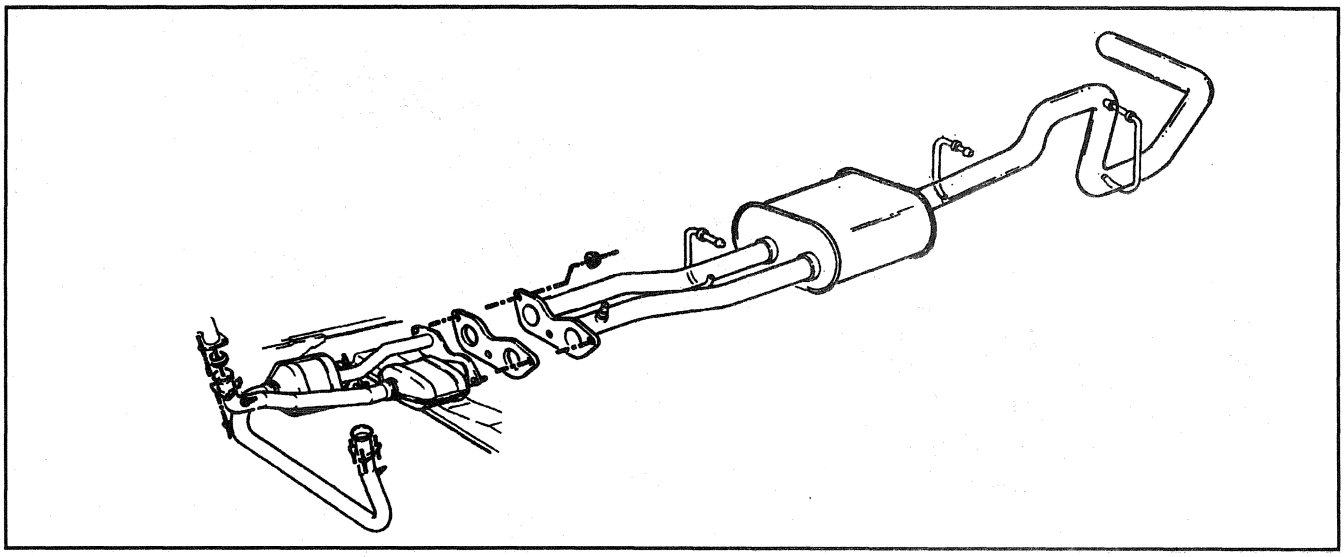


Figure 6—Exhaust System - C/K 1 and 2 Regular Cab w/5.7L Engine under 8,600 GVW

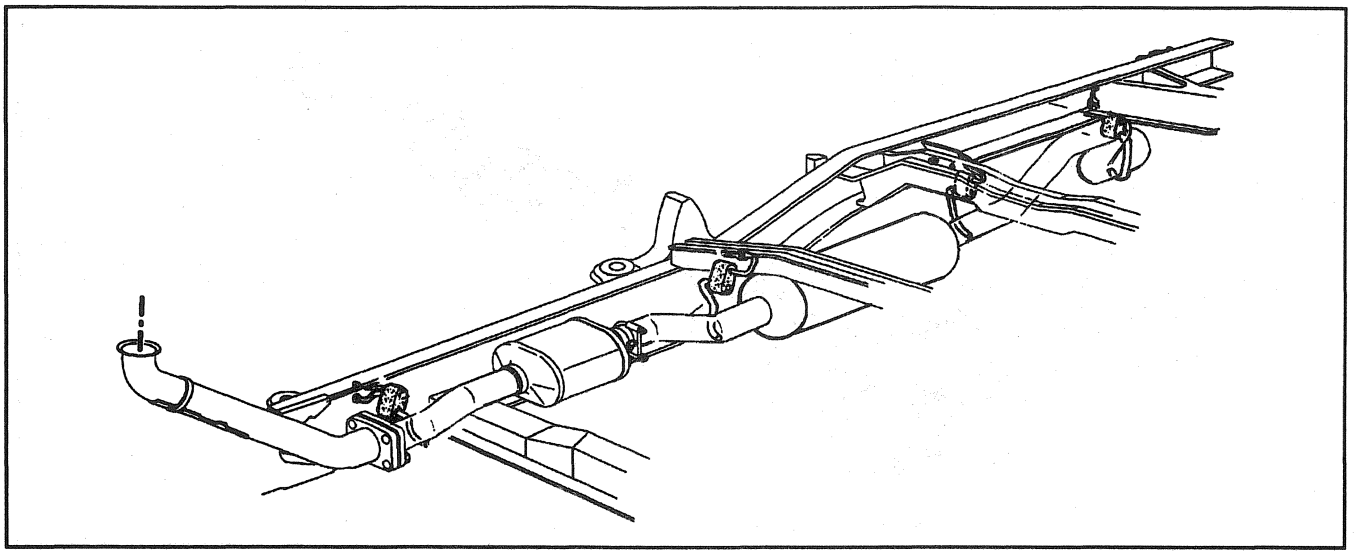


Figure 7—Exhaust System - C/K 1 and 2 Regular Cab Long Box w/6.5L Diesel Engine

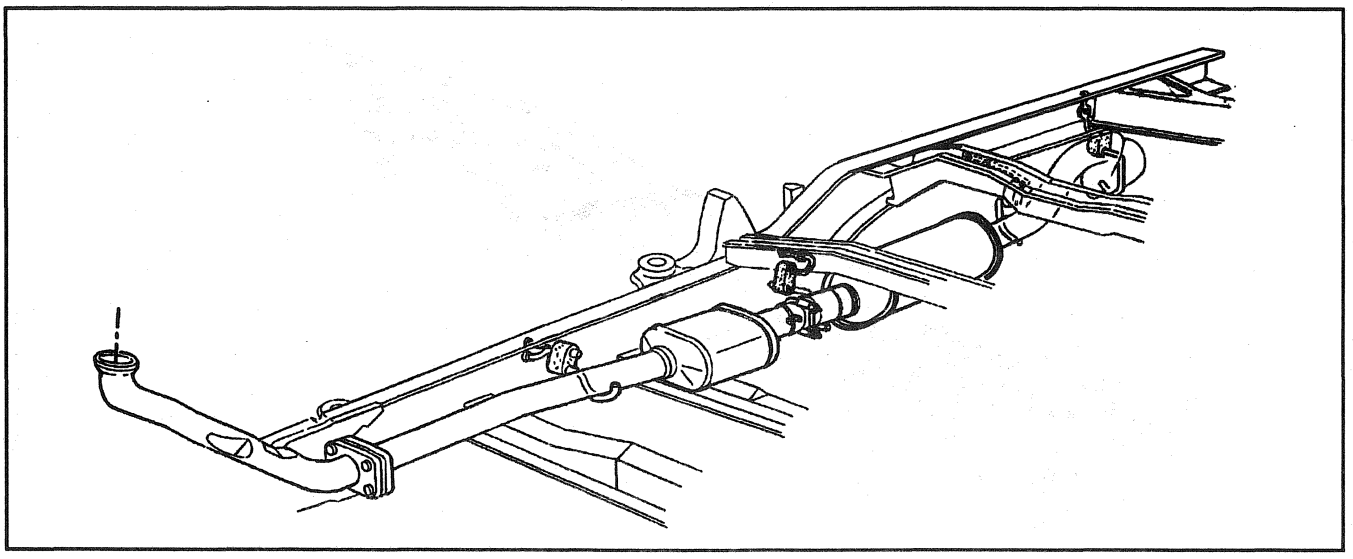


Figure 8—Exhaust System - C/K 2 and 3 Regular Cab w/6.5L Diesel Engine

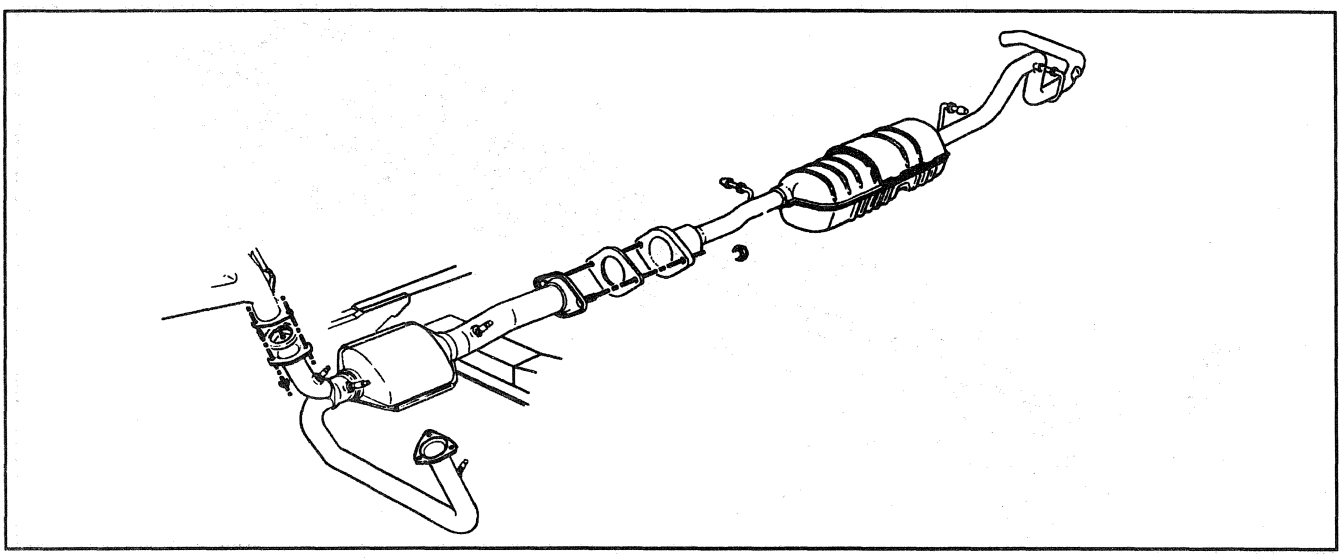


Figure 9—Exhaust System - C/K 1 Extended Cab Short Box w/4.3L Engine

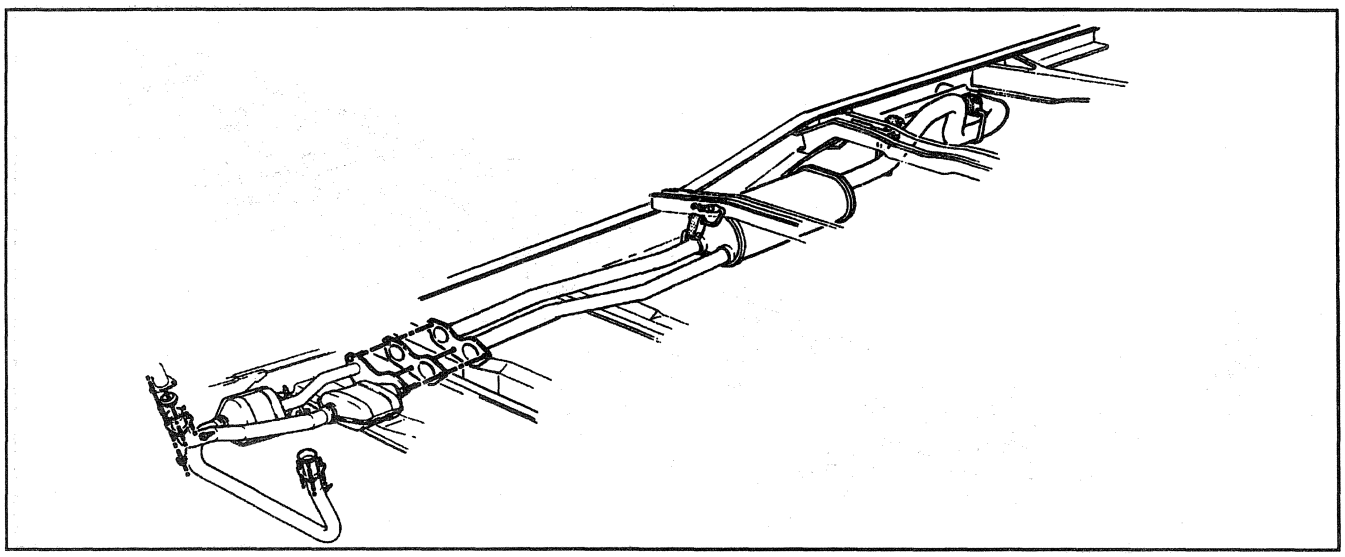


Figure 10—Exhaust System - C/K 1 Extended Cab Long Box w/5.7L Engine

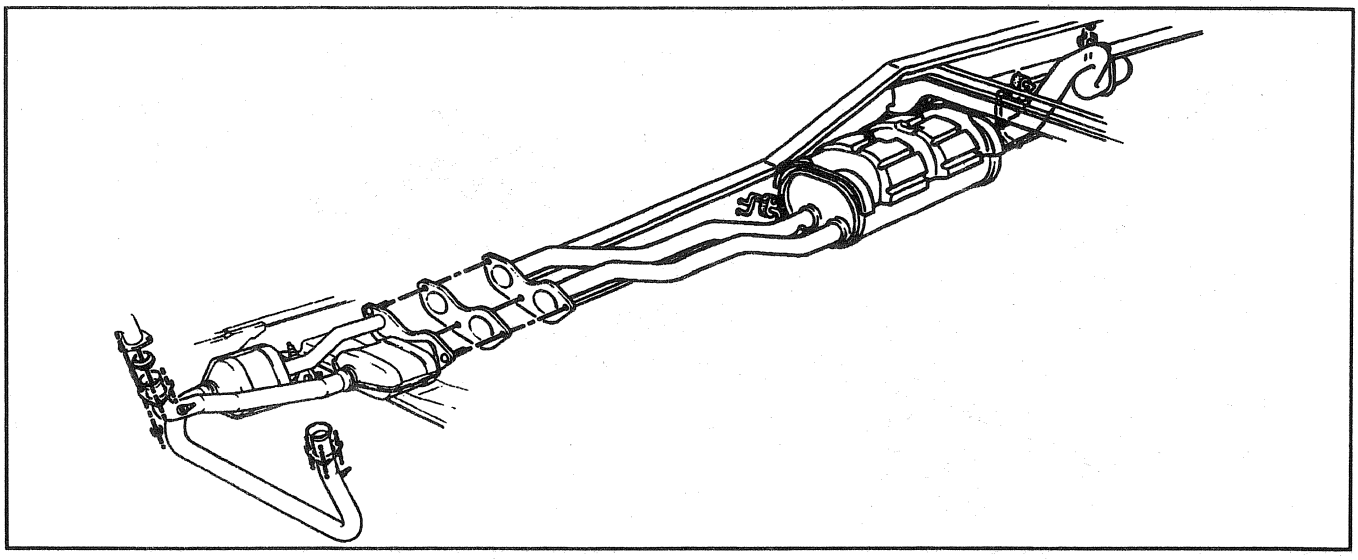


Figure 11—Exhaust System - C/K 1 and 2 Extended Cab Short Box w/5.7L Engine Under 8600 lb GVWR

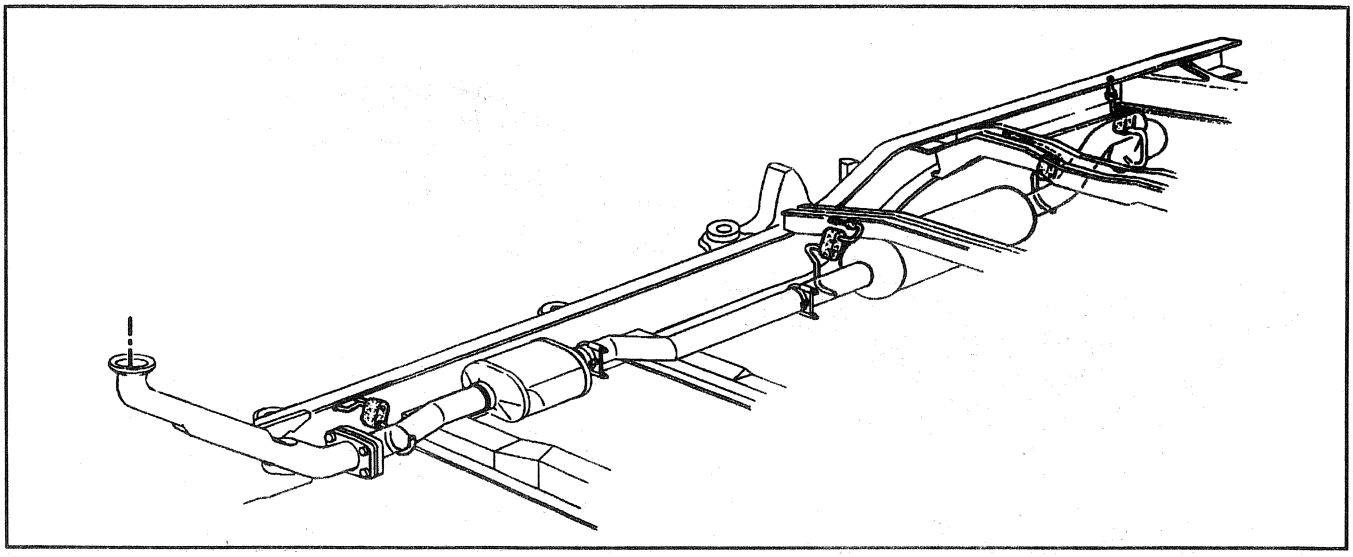


Figure 12—Exhaust System - C/K 1, 2 and 3 Extended Cab Long Box w/6.5L Diesel Engine

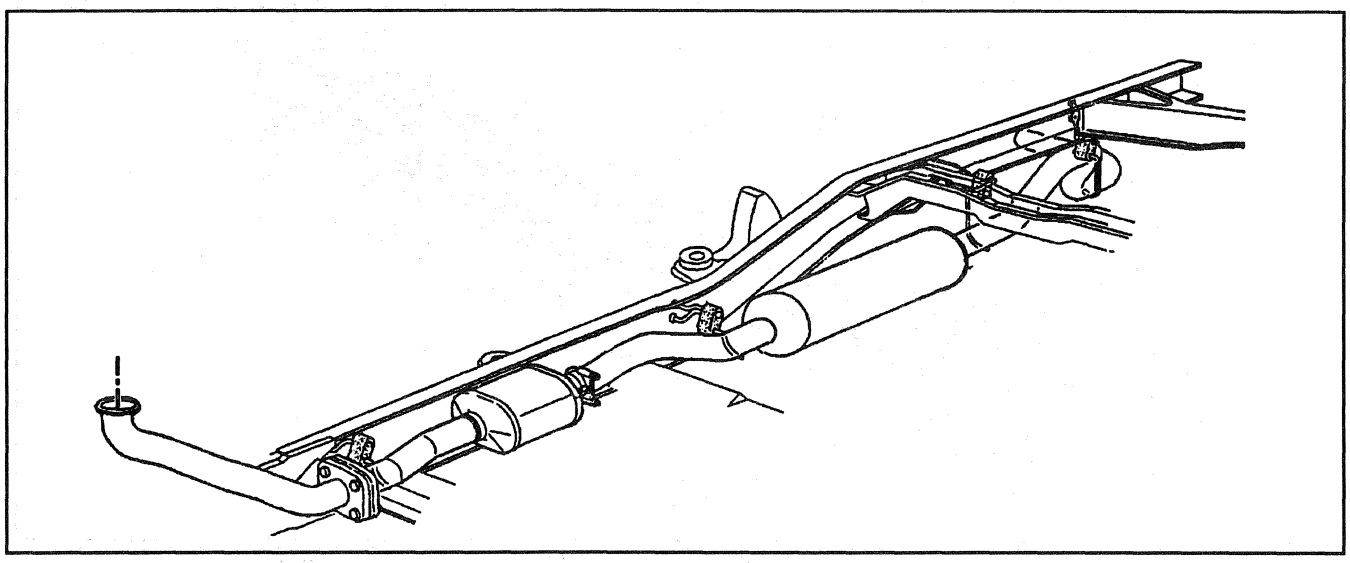


Figure 13—Exhaust System - C/K 1 and 2 Extended Cab Short Box w/6.5L Diesel Engine

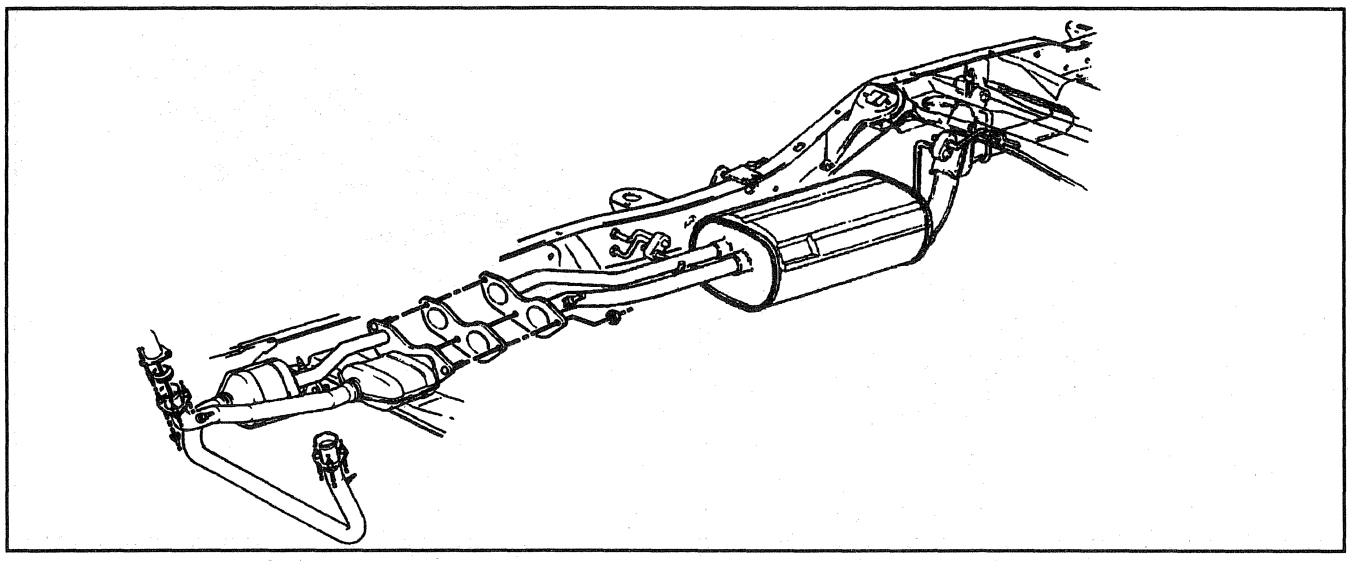


Figure 14—Exhaust System - C/K Two Door Utility w/5.7L Engine

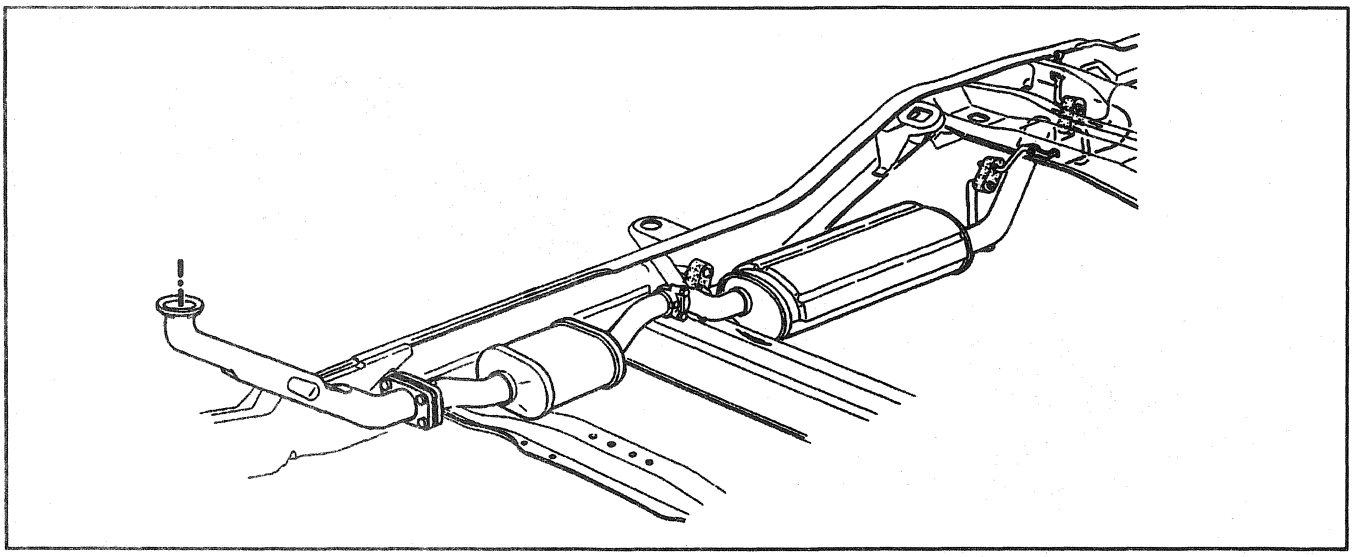


Figure 15—Exhaust System - K1 Two Door Utility w/6.5L Diesel Engine

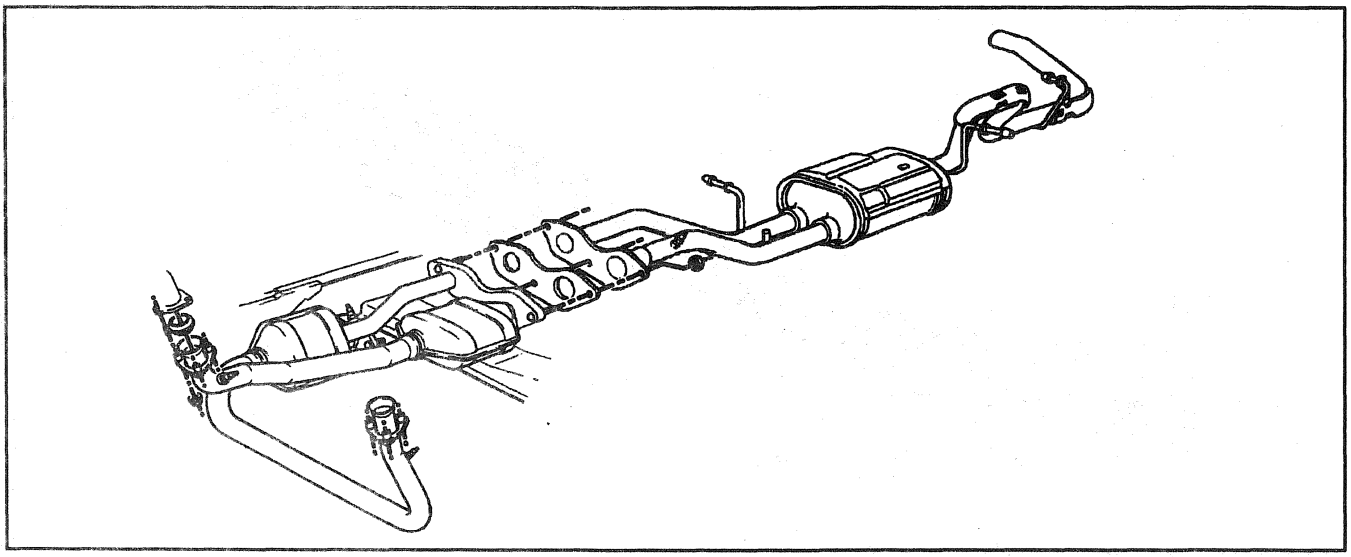


Figure 16—Exhaust System - C/K 1 Four Door Utility w/5.7L Engine

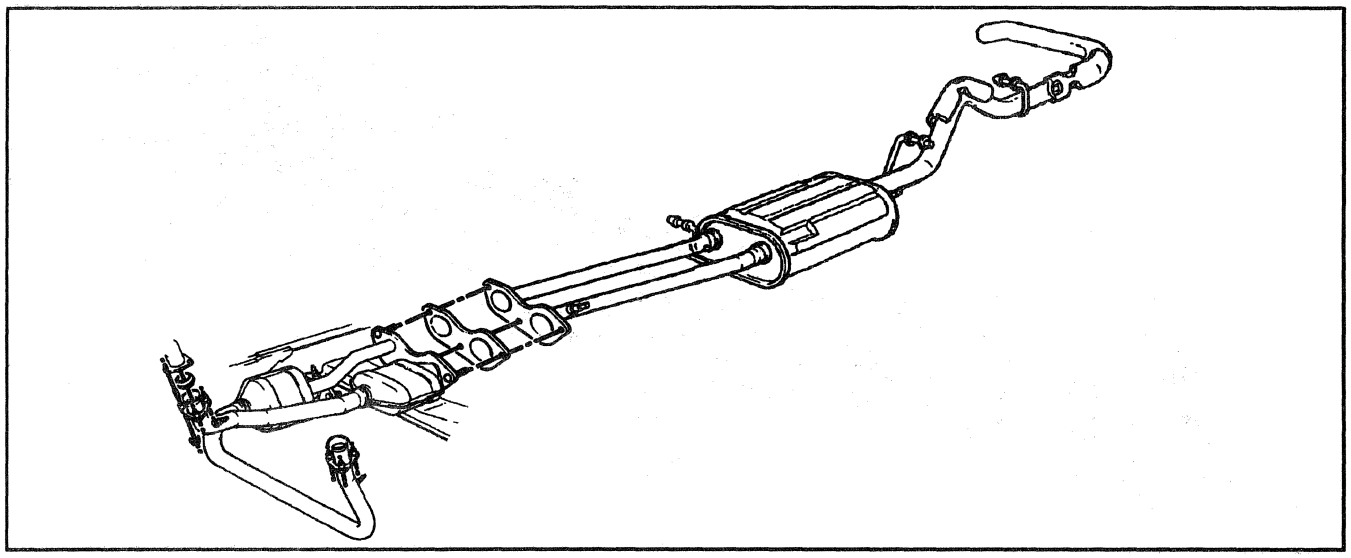


Figure 17—Exhaust System - C/K 1 Suburban w/5.7L Engine

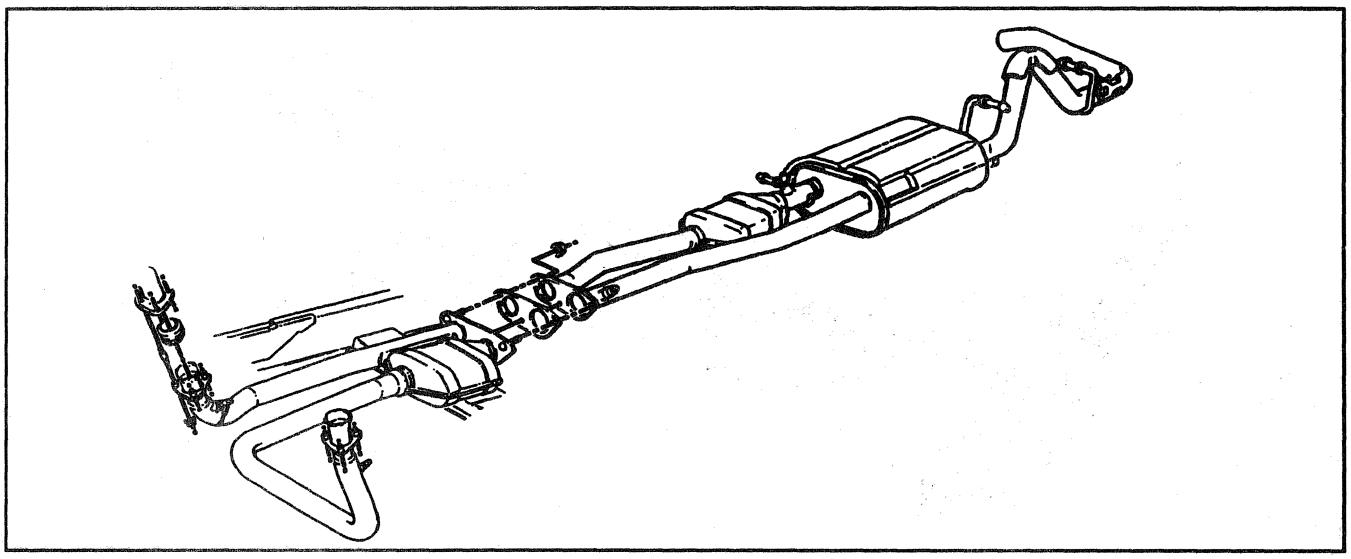


Figure 18—Exhaust System - C/K 2 Suburban w/5.7L and 7.4L Engines

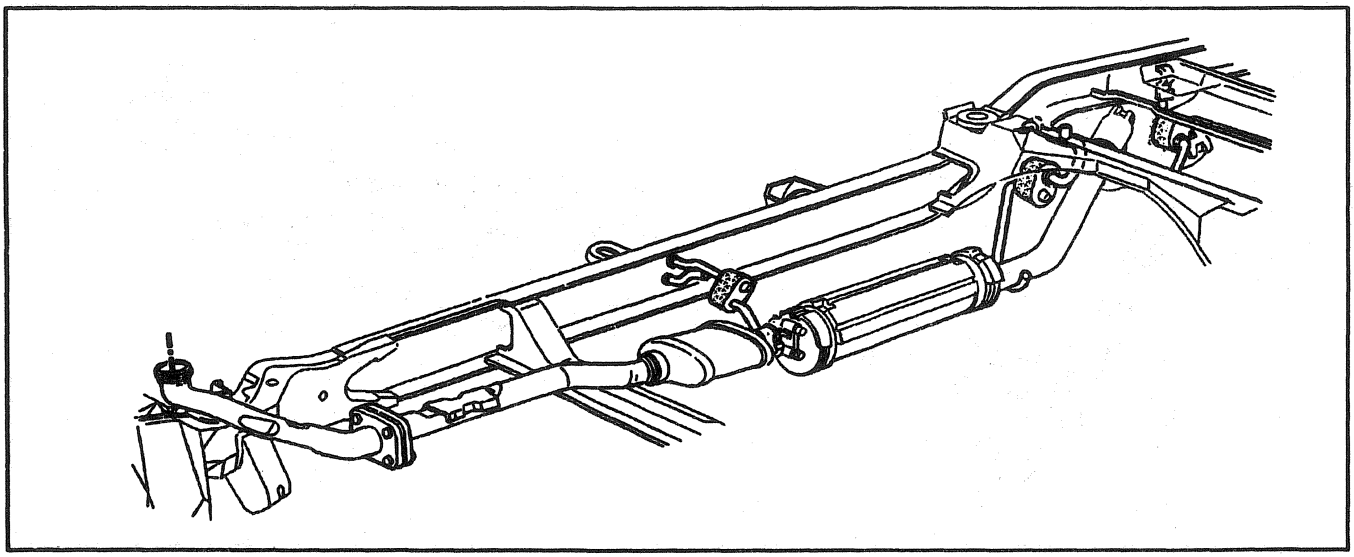


Figure 19—Exhaust System - C/K 1 and 2 Suburban w/6.5L Diesel Engine

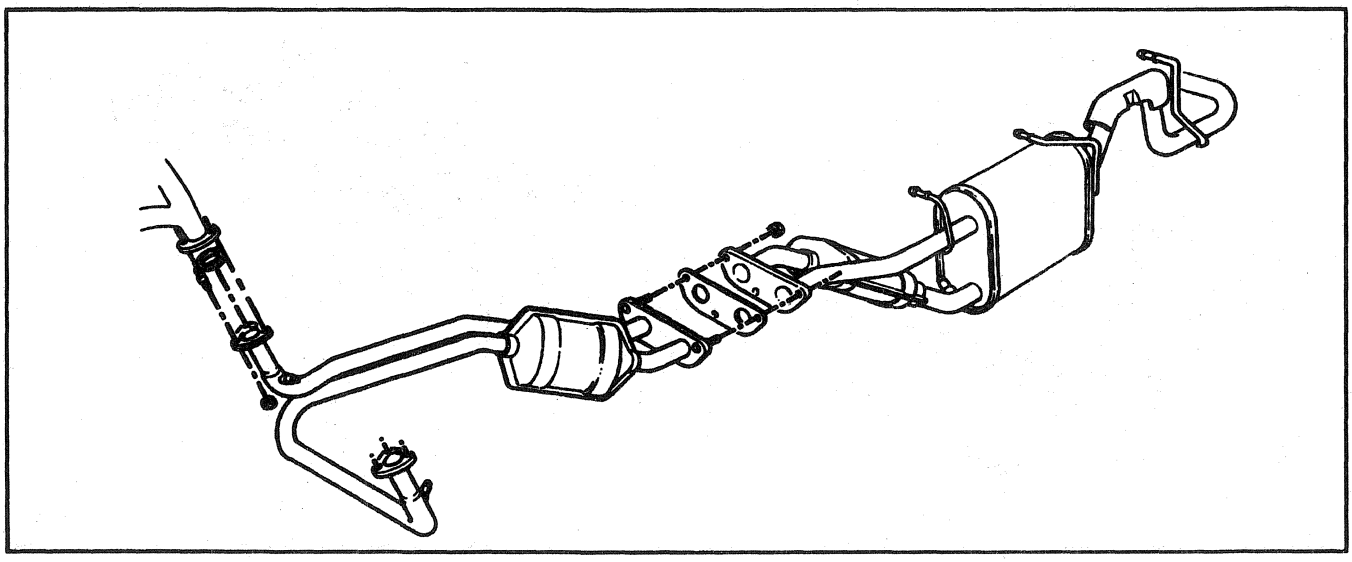


Figure 20—Exhaust System - C 310 Cab Chassis w/7.4L Engine over 15,000 GVW

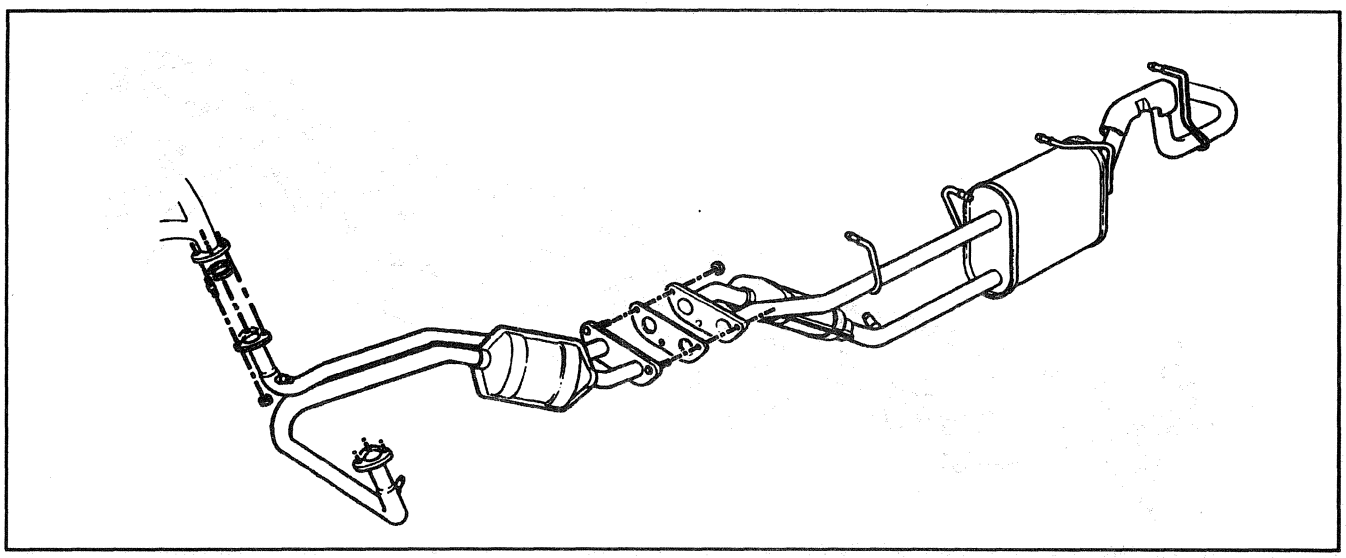


Figure 21—Exhaust System - C 314 Cab Chassis w/7.4L Engine over 15,000 GVW

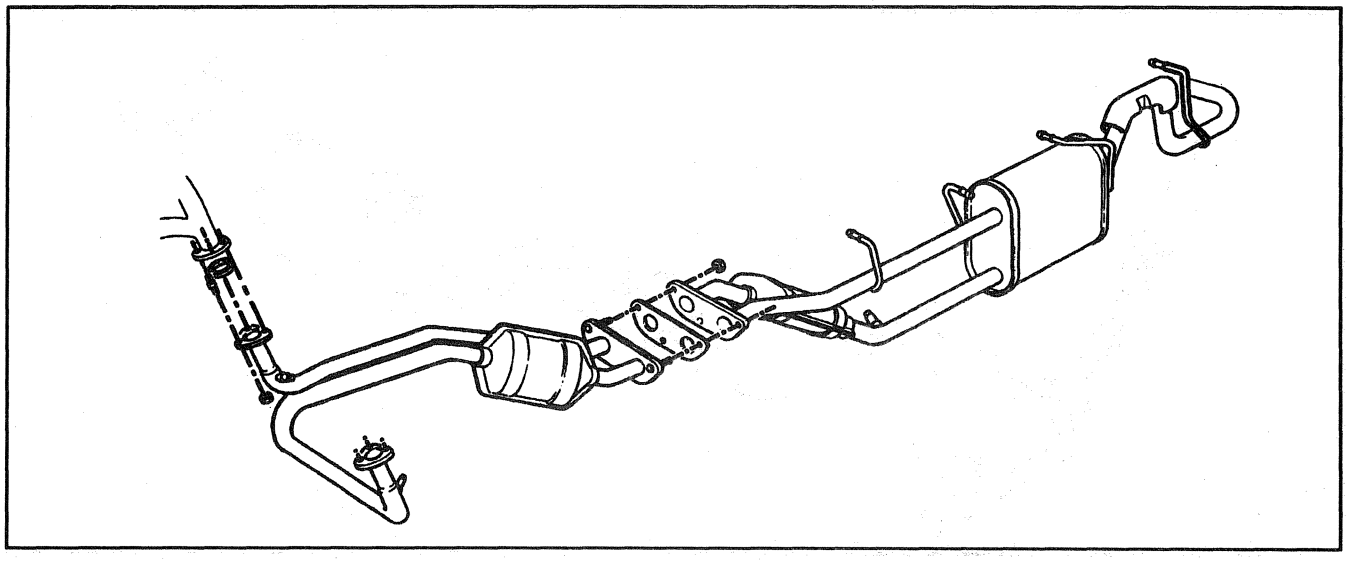


Figure 22—Exhaust System - C 318 Cab Chassis w/7.4L Engine

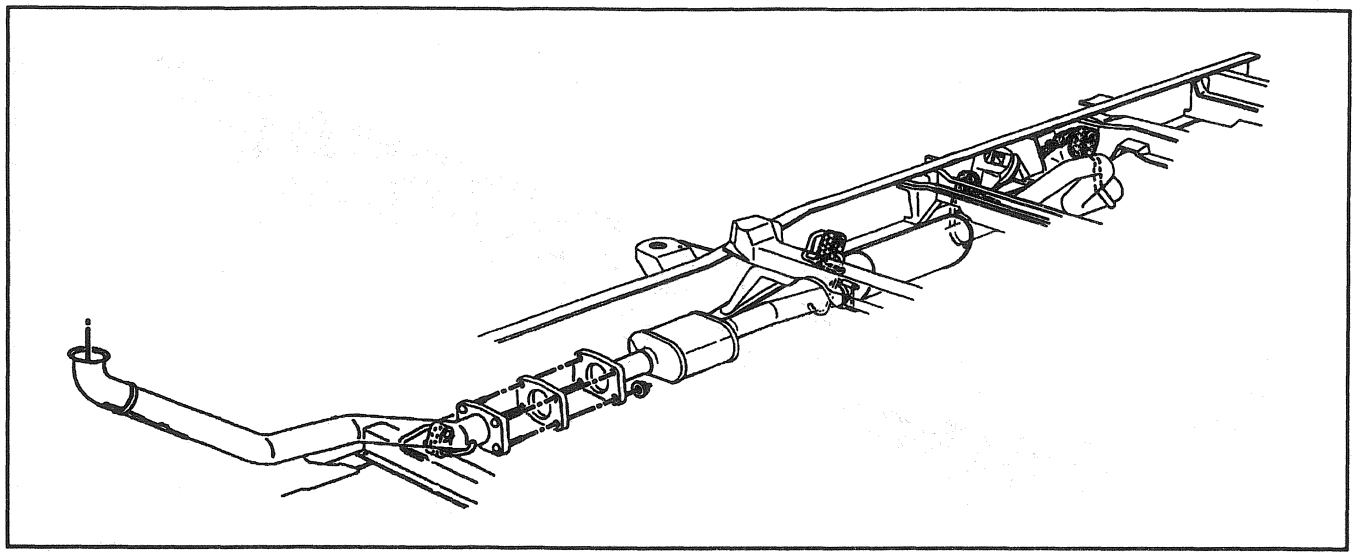


Figure 23—Exhaust System - C 310 Cab Chassis w/6.5L Diesel Engine over 15,000 GVW

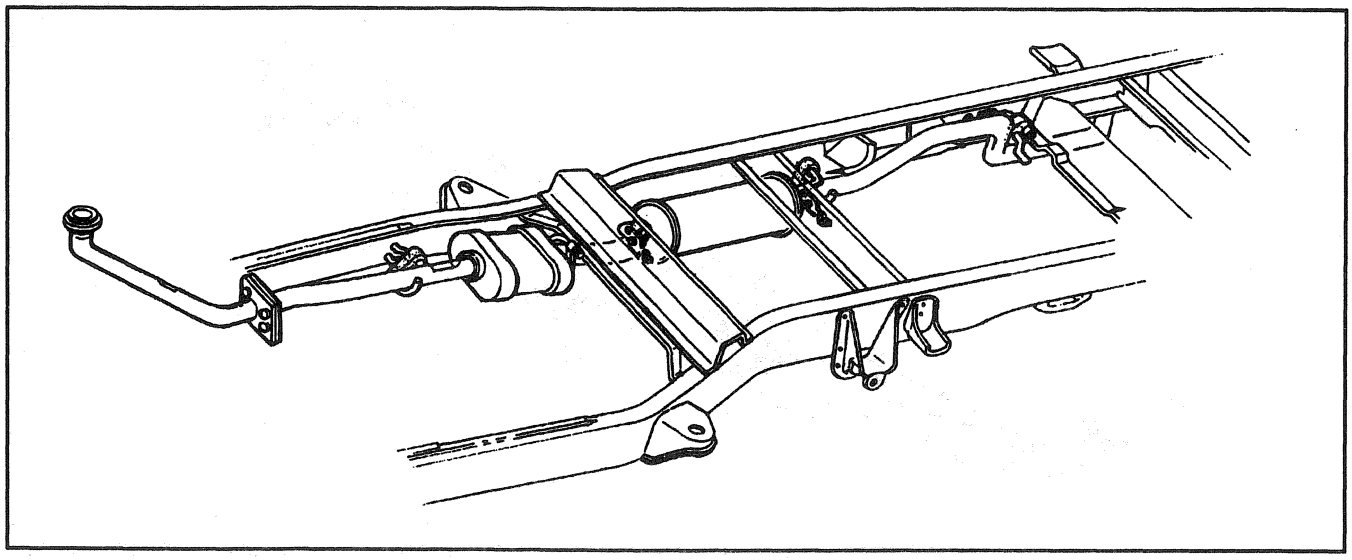


Figure 24—Exhaust System - C/K 310 Cab Chassis w/6.5L Diesel Engine under 15,000 GVW

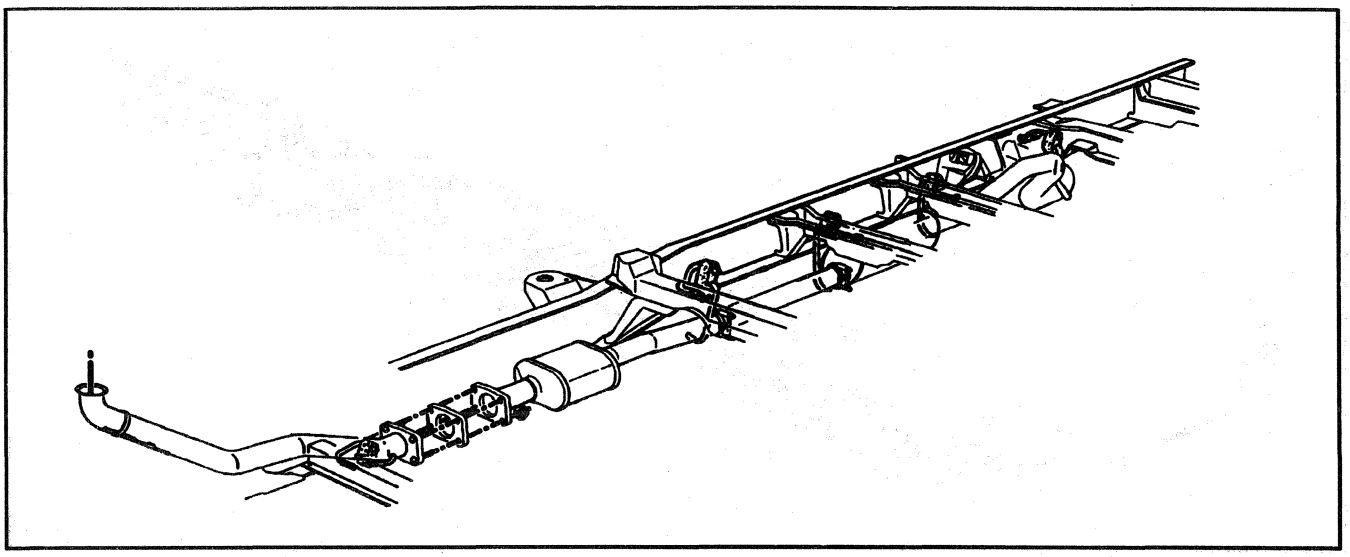


Figure 25—Exhaust System - C 314 Cab Chassis w/6.5L Diesel Engine over 15,000 GVW

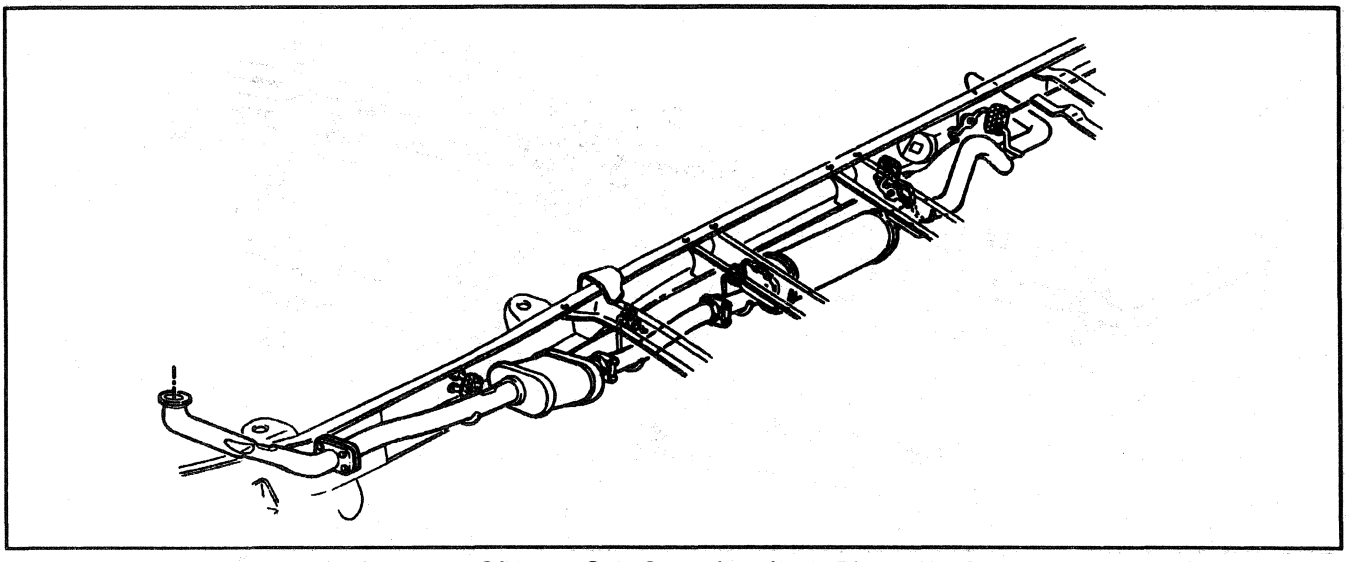


Figure 26—Exhaust System - C/K 314 Cab Chassis w/6.5L Diesel Engine under 15,000 GVW

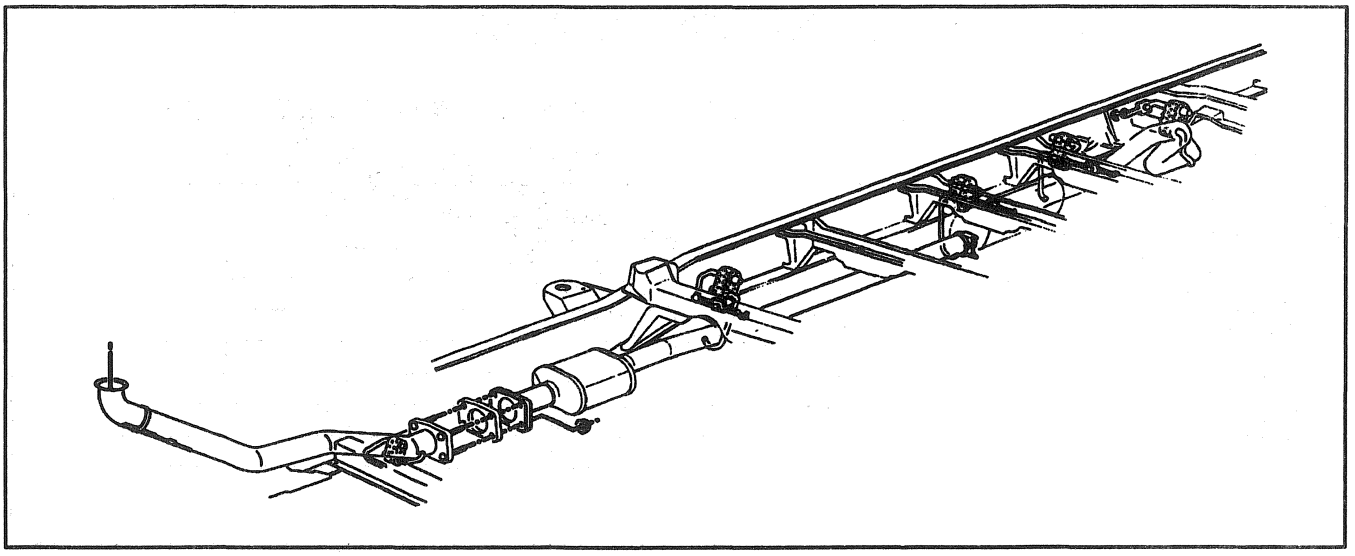


Figure 27—Exhaust System - C 318 Cab Chassis w/6.5L Diesel Engine

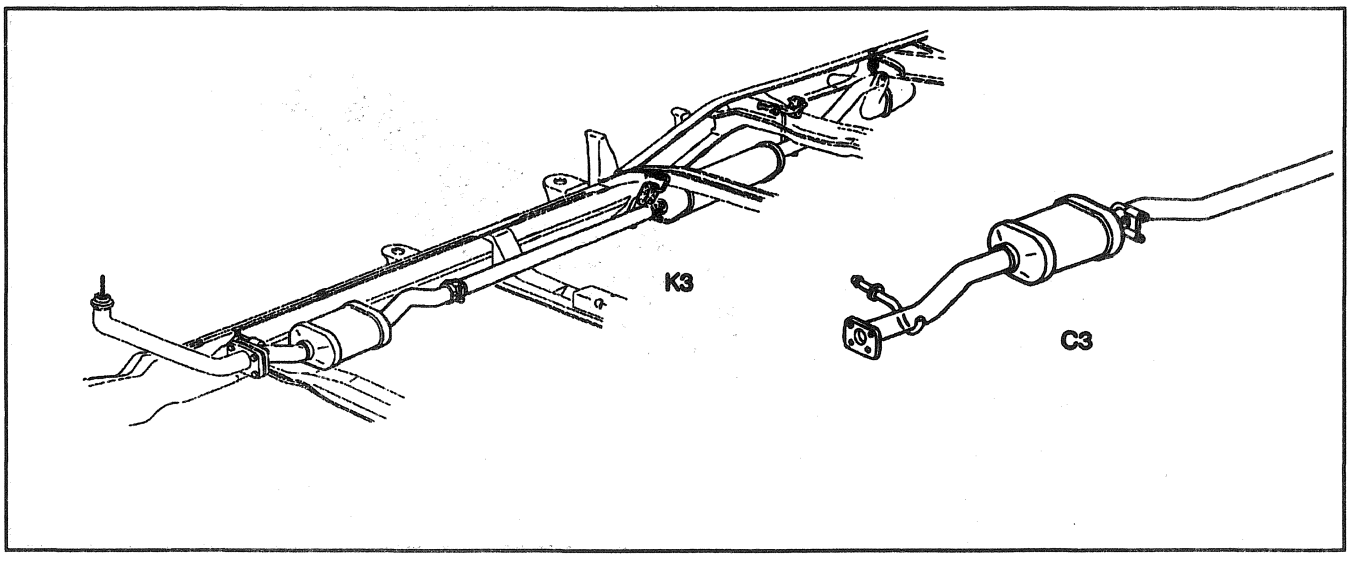


Figure 28—Exhaust System - C/K 3 Crew Cab w/6.5L Diesel Engine

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	N.m	Lb ft	Lb. In.
Crossover Pipe to Manifold Bolt (Diesel Engines)	34	25	—
Exhaust Hanger to Frame Crossmember Bolt	34	25	—
Exhaust Hanger to Frame Nut	48	35	—
Exhaust Manifold Nuts (Gasoline Engines)	65	48	—
Exhaust Manifold Stud (Gasoline Engines)	17	13	—
Exhaust V-Band Clamp (Diesel Engines)	12	—	106
Flange Stud Nuts (Gasoline Engines)	48	35	—
Tailpipe Hanger to Frame Nut	48	35	—
U-Bolt Nuts	40	29	—

SECTION 6H

VACUUM PUMPS

CAUTION: This vehicle has a Supplemental Inflatable Restraint (SIR) System. Refer to the SIR Component and Wiring Location view in order to determine whether you are performing service on or near the SIR components or the SIR wiring. When you are performing service on or near the SIR components or the SIR wiring, refer to the SIR On-Vehicle Service information. Failure to follow the CAUTIONS could cause air bag deployment, personal injury, or unnecessary SIR system repairs.

NOTICE: ***Always use the correct fastener in the proper location. When you replace a fastener, use ONLY the exact part number for that application. General Motors will call out those fasteners that require a replacement after removal. General Motors will also call out the fasteners that require thread lockers or thread sealant. UNLESS OTHERWISE SPECIFIED, do not use supplemental coatings (paints, greases, or other corrosion inhibitors) on threaded fasteners or fastener joint interfaces. Generally, such coatings adversely affect the fastener torque and joint clamping force, and may damage the fastener. When you install fasteners, use the correct tightening sequence and specifications. Following these instructions can help you avoid damage to parts and systems.***

CONTENTS

GENERAL DESCRIPTION

The vacuum pump is used on the light duty turbocharged (L56, VIN S), and heavy duty turbocharged (L65, VIN F) 6.5L diesel engines to operate emission controls. The diaphragm pump does not require periodic maintenance.

The pump is mounted at the right front of the engine. It has a pulley attached that is driven by a multiple ribbed belt. With the exception of the pulley, the vacuum pump is replaced as an assembly. Refer to "Specifications" at the end of this section for vacuum pump applications.

DIAGNOSIS

Refer to Figures 1 and 2 for diagnosis of the vacuum pump.

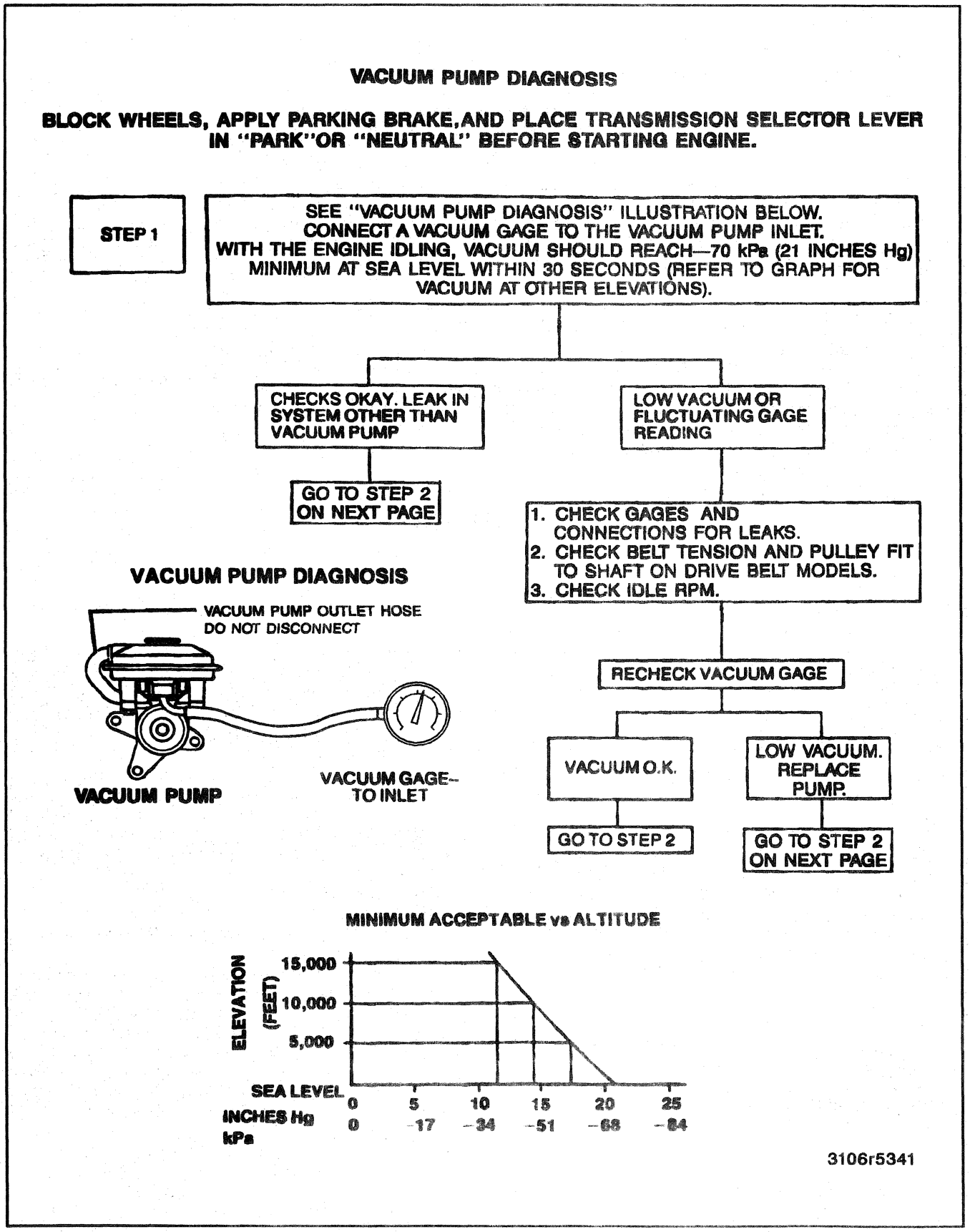


Figure 1—Vacuum Pump Diagnosis

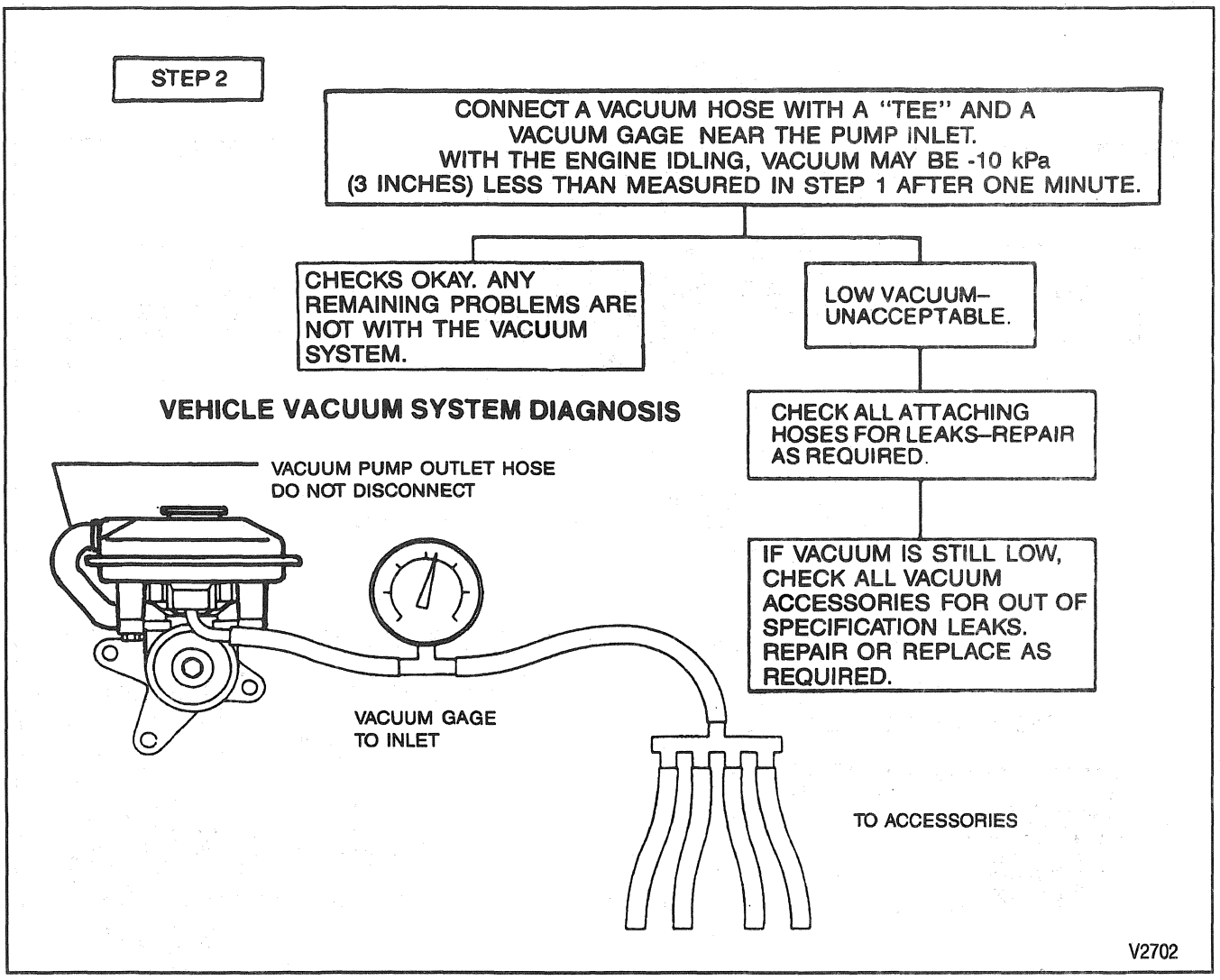


Figure 2—Diagnosis of Vacuum Pump

ON-VEHICLE SERVICE

VACUUM PUMP REPLACEMENT

Remove or Disconnect (Figures 3 through 5)

- Make sure the engine control switch is off.

1. Drive belt. Refer to SECTION 6B.
2. Vacuum hose off the vacuum pipe leaving the hose attached to the pump (Figure 4).
   - Remove the vacuum pump bolts without removing pulley.
3. Vacuum pump bolts.
   Tools Required:
   J 25034-B Pump Pulley Remover
   J 25033-B Pump Pulley Installer

Disassemble (Figure 5)

- Clamp the vacuum pump in a vise.

1. Vacuum pump hose from the vacuum pump pipe.
2. Pulley from the pump using J 25034-B.

NOTICE: ***Do not pry from the back of the pulley. Damage could occur to the pulley or pump.***

Assemble (Figure 6)

1. Pulley to the pump using J 25033-B until the pulley is flush with the end of the shaft (Figure 6).

NOTICE: ***Do not tap the pulley back onto the pump shaft. The pump could be damaged.***

2. Vacuum hose to the vacuum pump pipe.

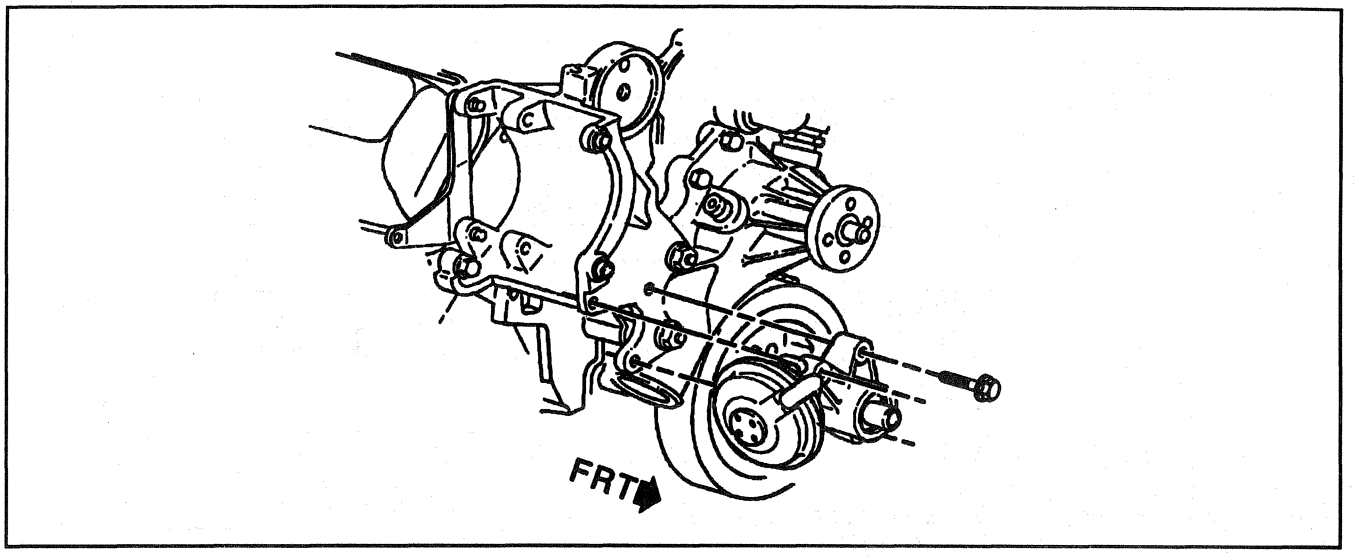


Figure 3—Vacuum Pump Mounting

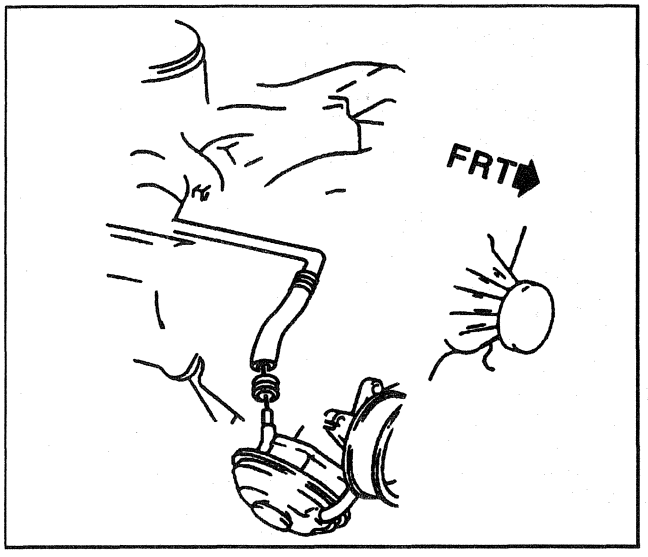


Figure 4—Vacuum Pump Hose

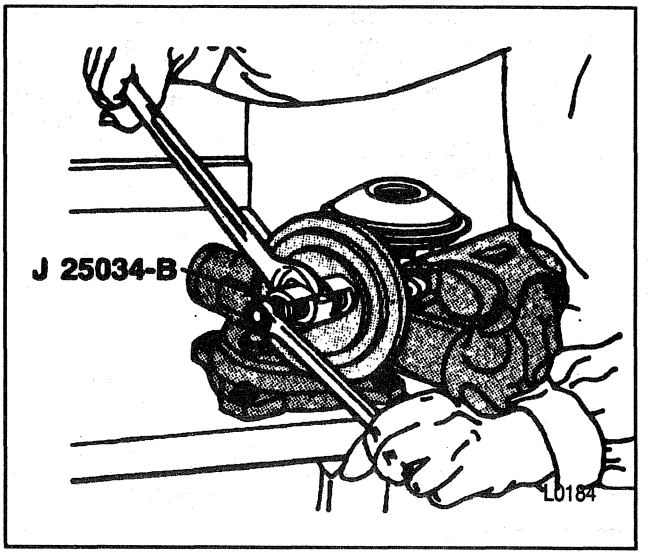


Figure 5—Removing Pulley

Install or Connect (Figures 3 and 4)

NOTICE: ***Refer to "Notice" on page 6H-1.***

1. Vacuum pump to the bracket with bolts (Figure 3).

Tighten

- Bolts to 27 N·m (20 lb ft).

2. Vacuum hose to engine vacuum pipe (Figure 4).
3. Drive belt.

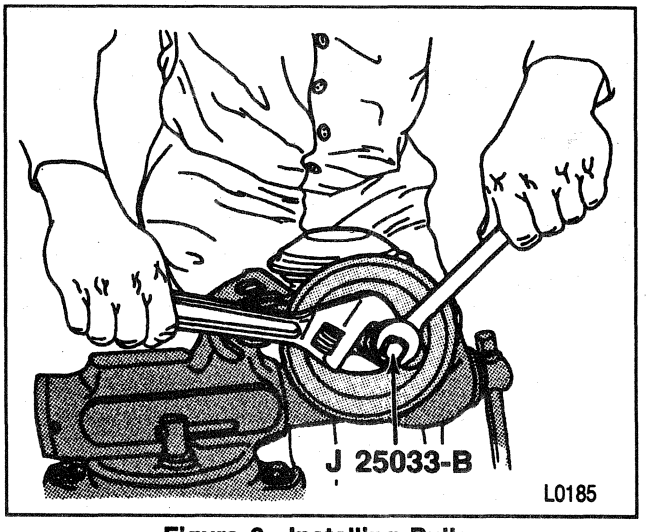


Figure 6—Installing Pulley

SPECIFICATIONS

VACUUM PUMP APPLICATIONS

ENGINE	VACUUM PUMP	PULLEY
6.5L without A/C	26039593	15589758
6.5L with A/C	26039593	15589757

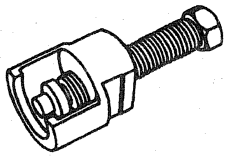
T2142

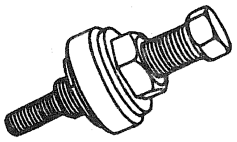
SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	N.m	Lb ft	Lb in
Pump to Bracket Bolts	27	20	—

SPECIAL TOOLS

1.  J 25034-B

2.  J 25033-B

1. Pump Pulley Remover
2. Pump Pulley Installer

F9310

SECTION 6J

TURBOCHARGER

CAUTION: This vehicle has a Supplemental Inflatable Restraint (SIR) system. Refer to the SIR Component Location View in order to determine whether you are performing service on or near the SIR components or the SIR wiring. When you are performing service on or near the SIR componets or the SIR wiring, refer to the SIR On-Vehicle Service information. Failure to follow the CAUTIONS could cause air bag deployment, personal injury, or unnescessary SIR system repairs.

NOTICE: ***Always use the proper fastener in the proper location. When you replace a fastener, use ONLY the exact part number for that application. General Motors will call out those fasteners that require a replacement after removal. General Motors will also call out the fasteners that require thread lockers or thread sealant. UNLESS OTHERWISE SPECIFIED, do not use supplemental coatings (paints, greases, or other corrosion inhibitors) on threaded fasteners or fastener joint interfaces. Generally, such coatings adversely affect the fastener torque and joint clamping force, and may damage the fastener. When you install fasteners, use the correct tightening sequence and specifications. Following these instructions can help you avoid damage to parts and systems.***

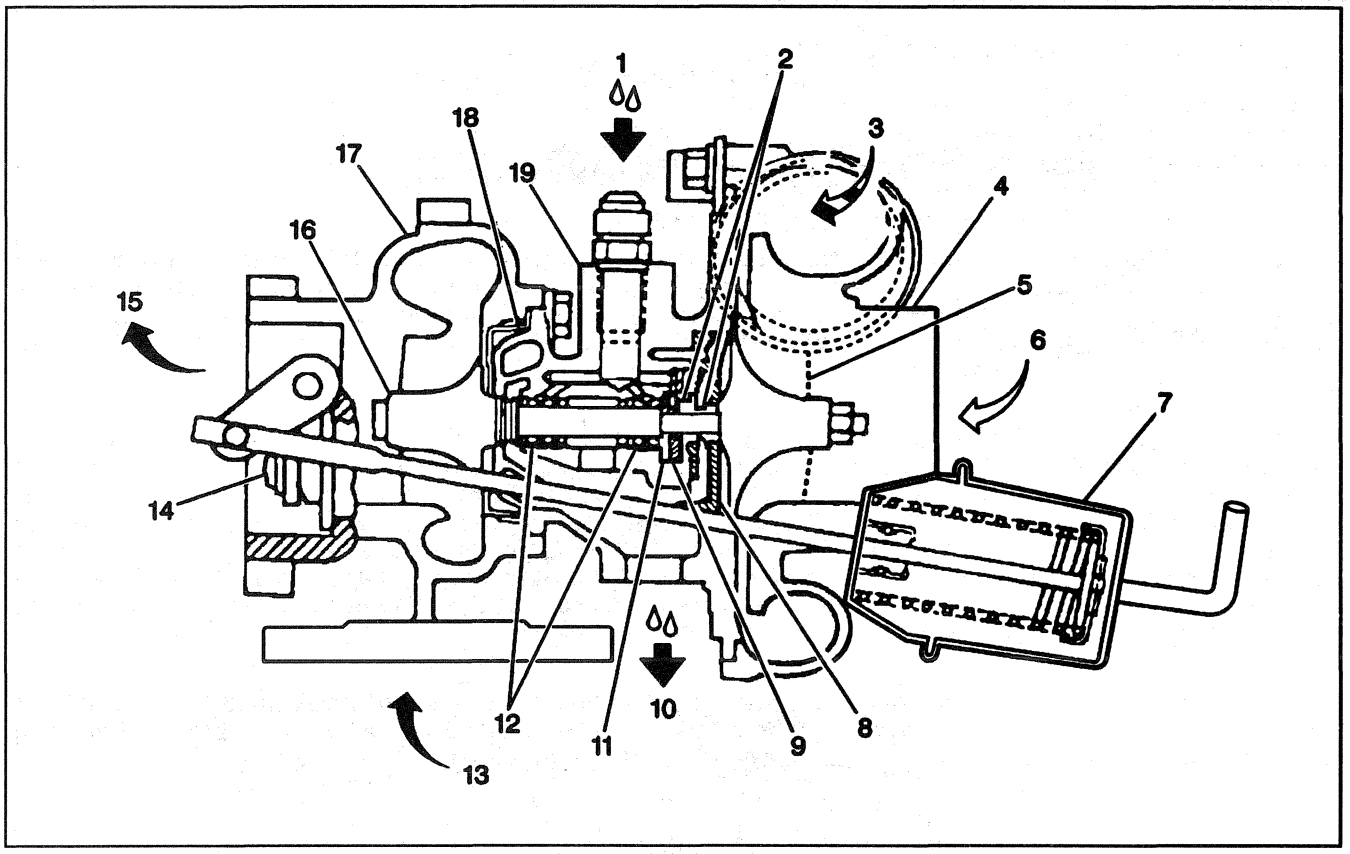
CAUTION: Turbochargers operate at high speeds and temperature. Do not operate the engine and/or turbocharger without all normally installed inlet piping and filters, along with all exhaust piping. Failure to install the above components could result in personal injury and damage to the vehicle.

CONTENTS

GENERAL DESCRIPTION

The turbocharger is used to increase the amount of air that enters the engines cylinders. This increase allows a proportional increase in fuel to be injected into the cylinders resulting in increased power output, more complete combustion of fuel, and cooling of the cylinder heads, pistons, valves, and exhaust gas. This cooling effect helps extend engine life.

Heat energy and pressures in the engine exhaust gas are utilized to drive the turbine wheel (Figure 1). Exhaust gas is directed to the turbine housing. The turbine housing acts as a nozzle to direct the exhaust gas flow to the turbine wheel blades which drive the shaft wheel assembly. Since the compressor wheel is attached directly to the shaft, it rotates at the same speed as the turbine wheel. Clean air from the air cleaner and crankcase vapors are drawn into the compressor housing and wheel, where it is compressed and delivered through a crossover pipe to the engine air intake manifold, then into the cylinders (Figure 2). The inside of the turbocharger compressor housing, compressor wheel, and the inside of the intake manifold can be quite oily due to the ingestion of the crankcase vapors. The amount of air pressure rise and air volume delivered to the engine from the compressor outlet is regulated by a waste-gate valve in the exhaust housing.



Legend

(1) Oil Inlet
(2) Piston Ring Seal
(3) Air Outlet
(4) Compressor Wheel
(5) Oil Thrower
(6) Air Inlet
(7) Waste-Gate Actuator, Vacuum
(8) Seal Plate Assembly
(9) Thrust Bushing
(10) Oil Outlet
(11) Thrust Bushing
(12) Journal Bearings
(13) Exhaust Outlet
(14) Waste-Gate Valve Assembly
(15) Exhaust Outlet
(16) Turbine Wheel
(17) Turbine Housing
(18) Heat Protector
(19) Bearing Housing

Figure 1—Turbocharger Internal Components

The position of the waste-gate valve is controlled by the PCM which monitors turbo boost pressure. If increased boost is needed, more vacuum is applied to the actuator to close the waste-gate. If less turbo boost is needed, the vacuum applied to the actuator will be reduced allowing the waste-gate valve to open, resulting in additional exhaust bypassing the turbine wheel (Figure 1).

For more information about vacuum operated waste-gate controlled by the PCM, refer to the Engine Controls, Transmission Diagnosis and Electrical Diagnosis Manual.

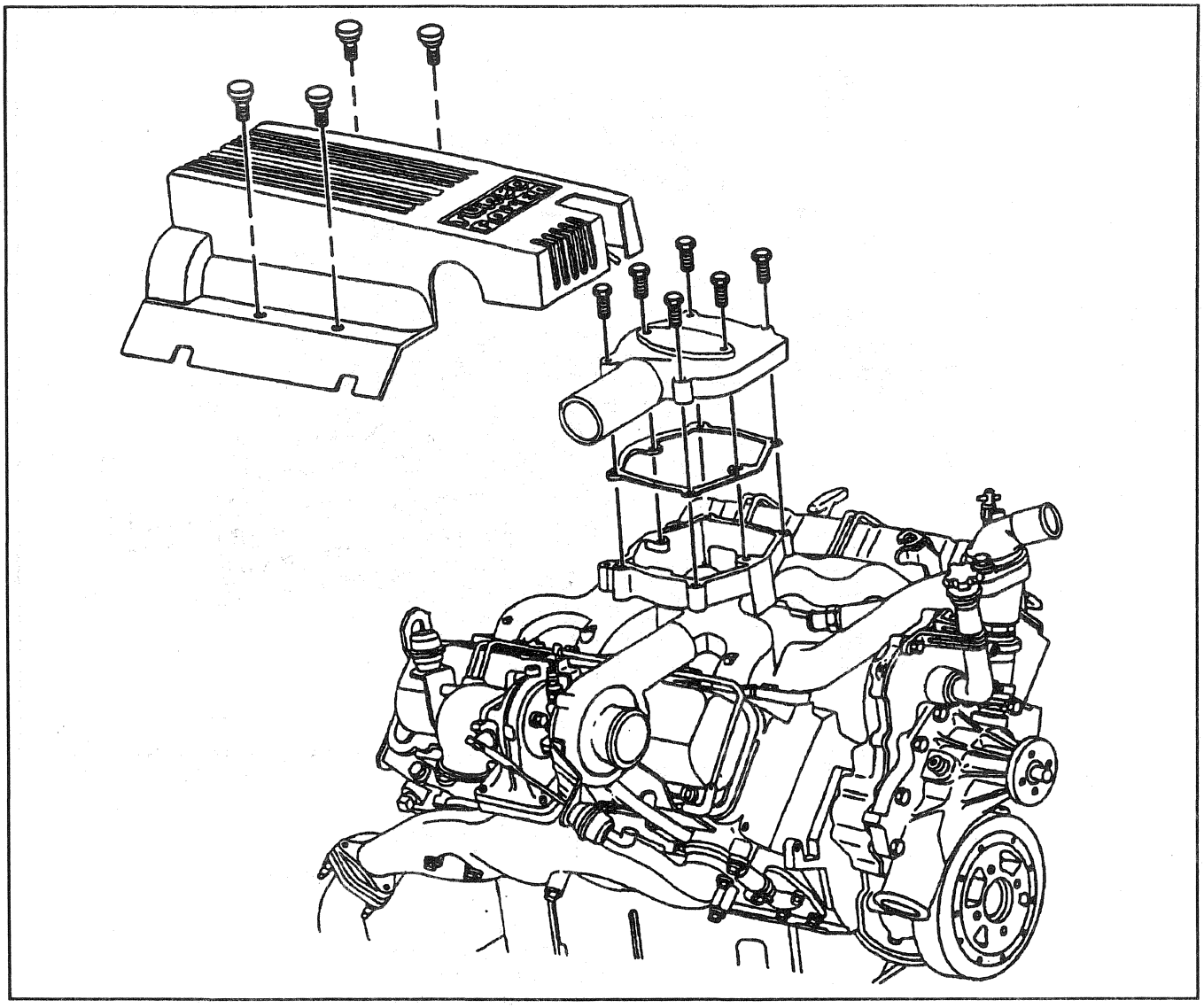


Figure 2—Center Cover for the Turbocharger Assembly

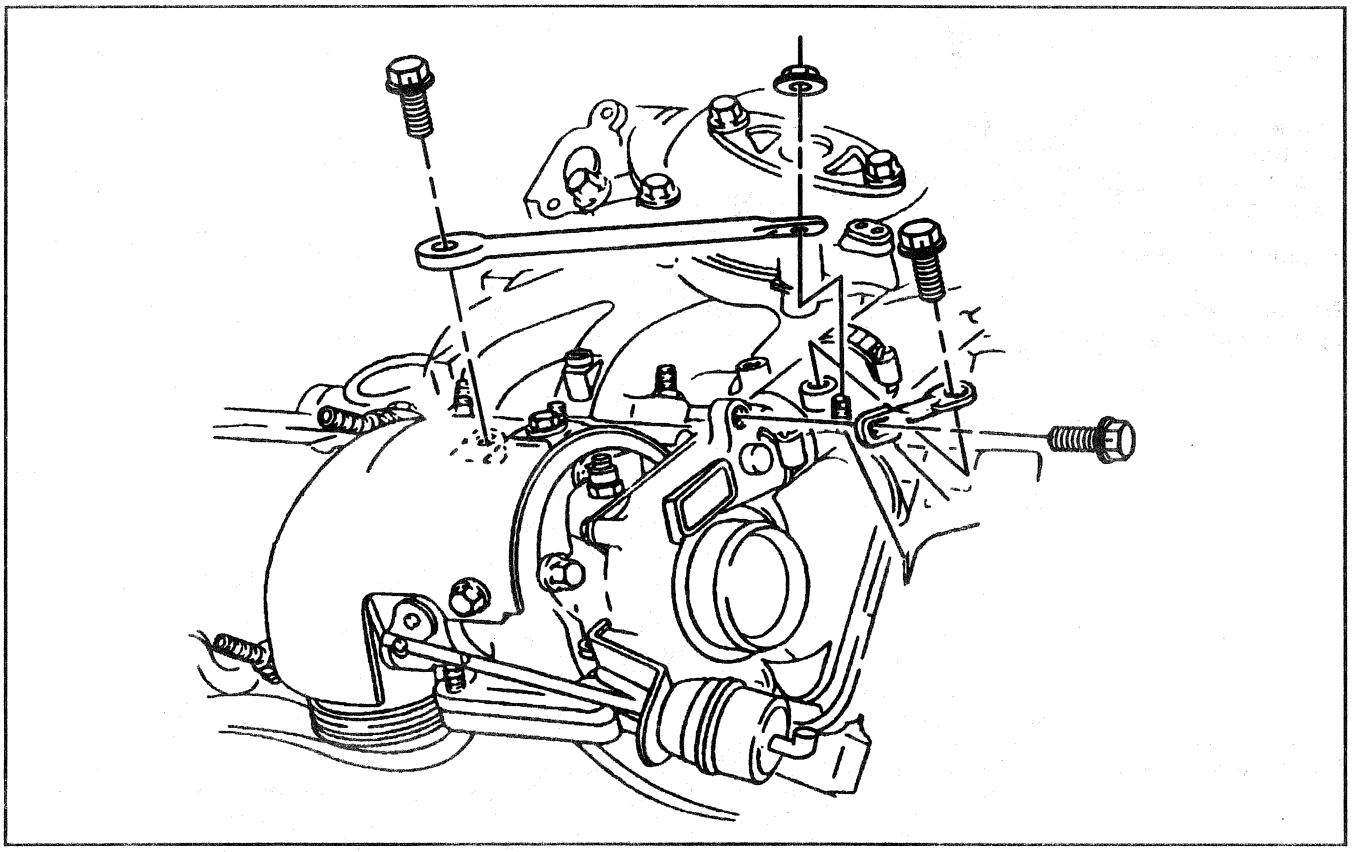


Figure 3—Turbocharger Cover with Brace

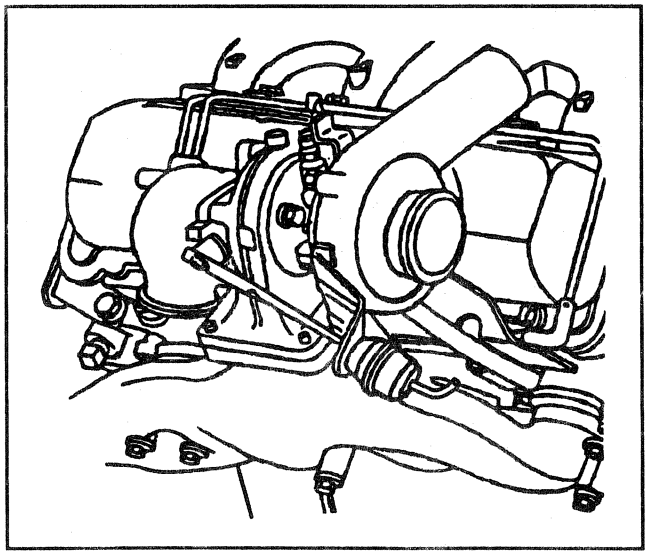


Figure 4—Turbocharger Assembly

DIAGNOSIS OF THE TURBOCHARGER

PROBLEM	POSSIBLE CAUSE	CORRECTION
Engine Lacks Power And Has No Black Smoke At Wide Open Throttle	1. Insufficient fuel supply to injection pump.	1. Refer to Engine Controls.
Engine Lacks Power And Has Black Smoke At Wide Open Throttle	1. Restricted air filter. 2. Obstructed air intake duct to turbocharger compressor wheel. 3. Air leak in compressor wheel inlet/outlet duct. 4. No vacuum signal to wastegate actuator. 5. Ruptured wastegate actuator diaphragm. 6. Air leak between intake manifold and engine. 7. Exhaust gas leak between cylinder head exhaust ports and turbine inlet. 8. Damaged turbocharger (Refer to "Inspection.") 9. Fuel system problem.	1. Replace air filter. 2. Remove obstruction(s). 3. Inspect inlet/outlet ducts for loose connections. Tighten connections and/or replace damaged duct work. 4. Check for DTCs. Refer to Engine Controls, Transmission Diagnosis and Electrical Diagnosis Manual. 5. Refer to "Inspection of the Wastegate Actuator Assembly." 6. Refer to SECTION 6 and SECTION 6F. 7. Repair leaks. 8. Find and correct cause of damage. Replace turbocharger if necessary. 9. Refer to Engine Controls.
Turbocharger Noise	1. Restriction and/or air leak in compressor inlet ducting and/or outlet ducting. 2. Rotating components of turbocharger out of balance. 3. Compressor and/or turbine wheel contacting housing. Refer to "Inspection."	1. Inspect compressor inlet/outlet ducting. Remove any restrictions. Tighten connections and/or replace any damaged duct work. 2. Replace turbocharger. 3. Locate reason for damage and replace turbocharger.
Blue Exhaust Smoke—Warm Engine Only	1. Lack of intake air. 2. Restricted oil drain tube. 3. Oil leakage past turbo seals. (Refer to "Inspection.")	1. Refer to Engine Controls. 2. Clean or replace oil drain tube. 3. Replace turbocharger.
		D0252

INSPECTION

Turbochargers are extremely reliable units. The majority of inoperative turbochargers are caused by dirt in the oil, oil lag (lack of oil flow), foreign objects or debris entering the turbocharger, and plugged or restricted air cleaner systems.

Lack of power, black smoke, blue smoke (excess oil consumption), or other engine performance problems are frequently blamed on the turbocharger when the actual cause is really another engine component. A complete inspection of the turbocharger, and all other engine components that may cause similar conditions, is necessary before replacing the turbocharger. Refer to SECTION 6 for diagnosing engine problems other than those caused by the turbocharger. The following steps and the preceding diagnostic chart will aid in diagnosing problems caused by the turbocharger. If it is determined that the turbocharger is the cause of the problem it must be replaced as a complete unit. **Servicing individual items (except for the waste-gate) on the turbocharger is not recommended.**

Inspect

- A high pitched whine may indicate an exhaust leak or a leak in the air induction system.
- A cycling up and down in pitch often indicates a blockage in the air inlet duct, a restricted air cleaner, or a build up of dirt on the compressor wheel of the turbocharger (oil film is normal).
- A sharp, high pitched scream may indicate that the bearings have deteriorated and one (or both) of the wheels is rubbing on its housing (this results in blue exhaust smoke).
- The compressor wheel blades (Figures 5 through 8). There should not be any bent, broken, eroded, or cracked wheel blades.
- At the housing for signs of rubbing.
- At the compressor wheel for a build-up of dirt.

Important

- With this engine application, the inside of the air intake duct (rubber inlet elbow), turbocharger compressor wheel and housing can be quite oily, due to the venting of the crankcase vapors into the air intake system. This is considered normal.
- **The CDR valve does not prevent oil vapors from getting into the turbocharger compressor inlet system.**

CAUTION: Do not feel any components of the turbocharger while the engine is running. Make sure that the turbocharger has stopped rotating and the turbocharger and engine have cooled down before handling. Rotating parts and extreme heat may cause serious personal injury if handled.

- Carefully grasp the compressor wheel nut with fingers and rotate the wheel in a clockwise direction. It should turn freely with no signs of binding or scraping (housing contact).
- Rotate the turbocharger while pushing in and pulling out on the compressor wheel; it should rotate freely with no contact with the housing.
- Carefully grasp the compressor wheel nut with fingers and rotate while moving the wheel up and down (radially). There should be no compressor wheel to housing contact. **Note: axial and radial play is normal even on a new turbocharger.** If compressor wheel to housing contact exists, it will be very evident when rotating the wheel. The wheel will drag or scrape on the housing surface and visual damage will be evident on the wheel blades and housing surface.

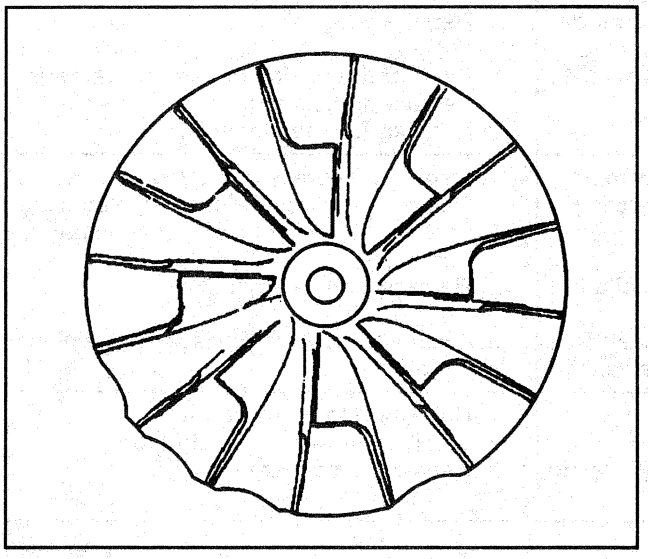


Figure 5—Normal Compressor Wheel

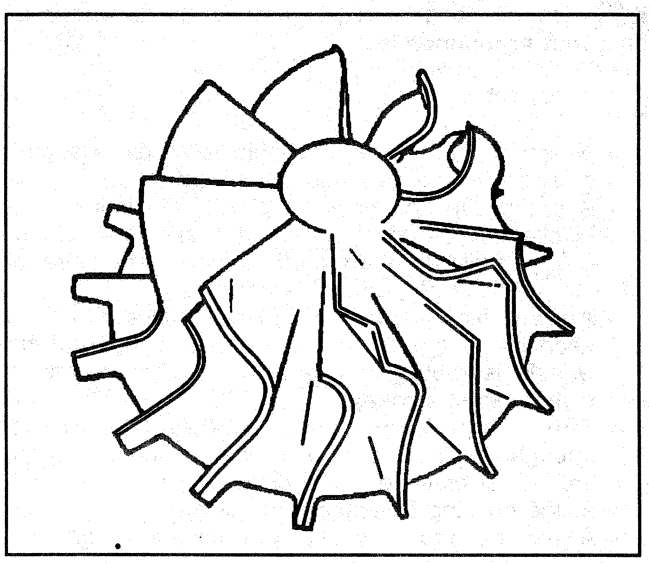


Figure 6—Damage by a Soft Object

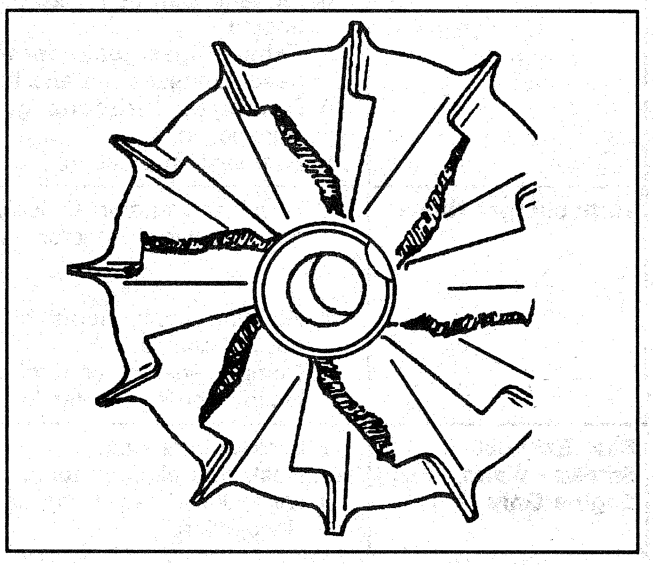


Figure 7—Damage by a Hard Object

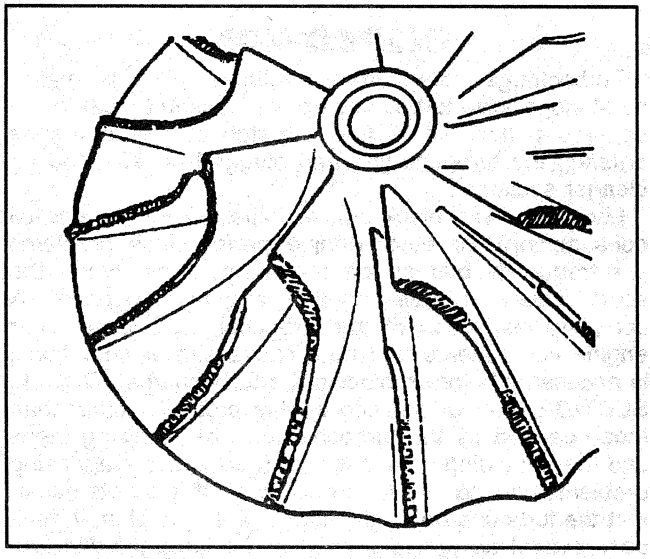


Figure 8—Compressor Blades Show Heavy Rubbing

Important

- If the turbocharger does not pass any one of the above inspections, the turbocharger must be replaced.

INSPECTION OF THE WASTE-GATE ACTUATOR ASSEMBLY

Tool Required:
J 23738 Hand Operated Vacuum Pump

The waste-gate actuator assembly can be replaced separately from the turbocharger assembly. To check operation of the waste-gate actuator (Figures 4 and 9):

1. With the engine off, inspect actuator rod and lever. The actuator rod and lever should move back and forth without any tension.
2. Apply 5 inches Hg vacuum to actuator, actuator rod and lever should close the waste-gate. Look for the rod to move toward the front of the engine.

With the engine running, the actuator rod should snap back to a closed position. If not, the waste-gate actuator is defective and should be replaced. For removal of the waste-gate actuator, refer to "Waste-Gate Actuator Replacement" in this section.

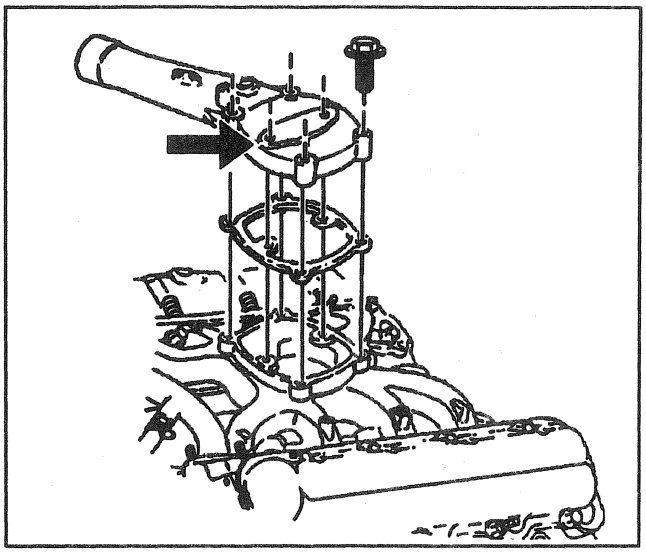


Figure 9—Boost Pressure Test Location

ON-VEHICLE SERVICE

TURBOCHARGER REPLACEMENT

The turbocharger assembly consists of the turbocharger housing, internal components, waste-gate actuator, exhaust elbow, and heat shield.

Remove or Disconnect (Figures 2, 3, 10 through 13)

1. Negative battery cables. Refer to SECTION 6D1.
2. Upper intake manifold cover.
3. Self tapping screw holding CDR valve tube on top of the turbocharger.
4. CDR valve and tube assembly from the air cleaner extension and right valve rocker arm cover. Refer to SECTION 6.

Important

- Usually some quantity of oil will exist inside the vent system. The crankcase vapor consists of vaporized oil that condenses within the vent and intake system. The inside of the air intake duct and compressor wheel housing can be quite oily due to the venting of the crankcase vapors.

5. Air cleaner extension from the air cleaner and compressor inlet.
6. Two bolts retaining the air cleaner to the wheel well and lift the air cleaner assembly off the front air intake duct.
   - This will allow easier access to the turbocharger flange nuts and exhaust clamp.

NOTICE: ***The right front wheel and inner splash shield can be removed for easier access to the turbocharger back flange nut. Refer to SECTION 3E.***

7. Vacuum hose to the waste-gate actuator.
8. Long and short turbocharger braces (Figure 3).
9. Hose clamps at the upper intake manifold to the turbocharger.

NOTICE: ***Silicone sealant is used between the connector hose, the intake extension, and the turbocharger compressor outlet.***

   - Use a thin flat blade screwdriver to break the seal between the connector hose, turbocharger compressor outlet, and the intake extension.
   - Slide the connector hose over the intake extension.

10. Exhaust clamp at turbocharger (Figure 13).
11. Oil feed hose and oil return pipe (Figure 12).
12. Turbocharger assembly and exhaust manifold (Figures 10 and 11).

Install or Connect (Figures 10 through 13)

Important

- Before the turbocharger is installed, perform the following steps:
  A. Check the intake and exhaust systems leading to and from the turbocharger to ensure that there is no foreign debris. Even small debris

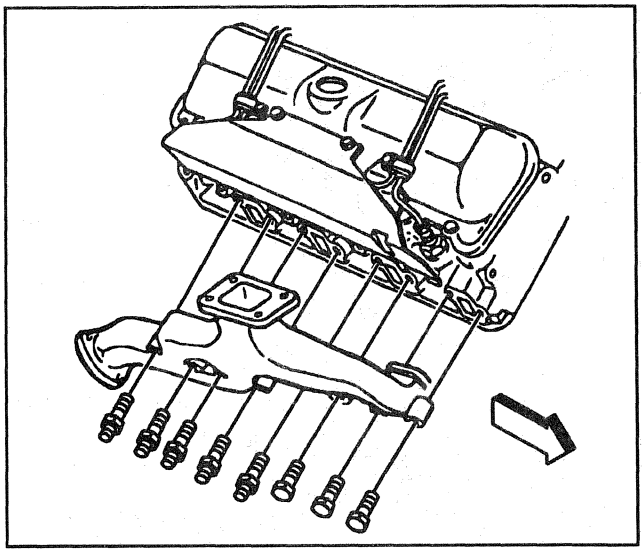


Figure 10—Exhaust Manifold and Heat Shield

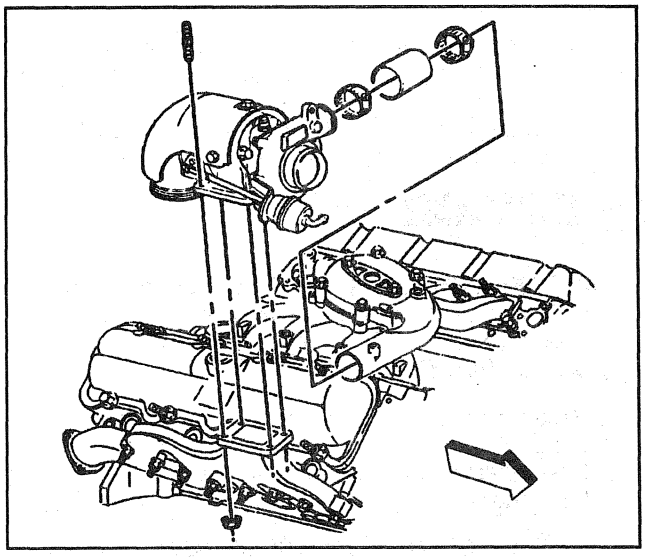


Figure 11—Turbocharger Mounting

can cause severe wheel damage if inducted during high speed operation.

B. Make sure the turbocharger and exhaust manifold flanges are clean and free of any foreign material. Use a high temperature anti-seize compound GM P/N1052771 or equivalent on all threaded fasteners connected to the turbocharger (Figure 11).

1. Turbocharger assembly and the exhaust manifold (Figures 10 and 11).
2. Exhaust manifold bolts and studs.

Tighten

- Bolts and studs to 58 N·m (43 lb ft).

3. Gasket and the oil return pipe (Figure 12).

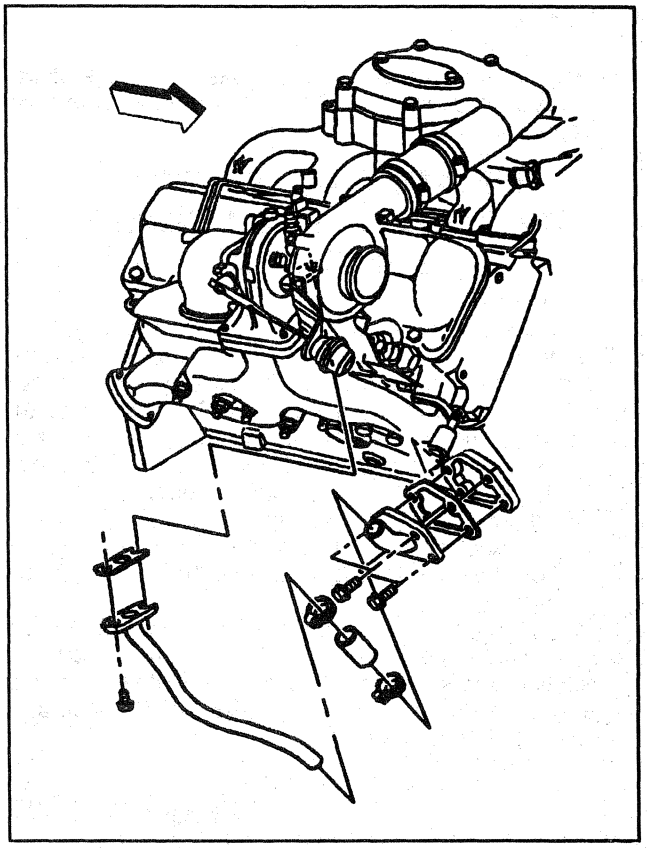


Figure 12—Oil Drain (Return) Tube

4. Tighten bolt.

Tighten

- Bolts to 26 N·m (19 lb ft).

Important

- Fill the oil feed hole at the top of the turbocharger with a small amount of engine oil (1 to 2 cc) while hand rotating the compressor wheel. This will lubricate the turbocharger shaft bearings.

5. Oil feed hose to top of turbocharger.

Tighten

- Fitting to 17 N·m (13 lb ft).

6. Exhaust pipe to turbocharger with clamp (Figure 13).

Tighten

- Clamp to 8 N·m (71 lb in).

Important

- When starting the engine, allow it to idle for two minutes so oil can flow into the oil feed hose.

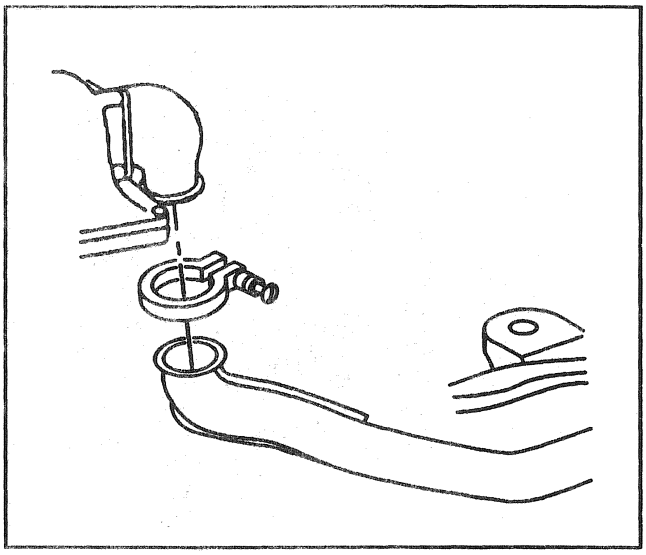


Figure 13—Exhaust Connection

7. Inner splash shield and right front wheel (if removed).
8. Clean surfaces of turbocharger compressor outlet and intake inlet extension housing where the connector hose is fastened.

Important

- Apply silicone sealant GM P/N 9985943 or equivalent to turbocharger compressor outlet hose (not the turbocharger or inlet extension) before installation to prevent oil leakage from the closed breather system.

9. Slide the connector hose over the compressor outlet and then slide the inlet extension into the other end of connector hose. Make sure the connector hose is centered between the compressor outlet and the inlet extension housing.

Tighten

- Clamps to 6 N·m (50 lb in).

10. Long turbocharger brace by guiding the flat end of the brace under the heater inlet.
11. Nut onto the stud.
12. Bolt into the bent end of the brace.

Tighten

- Long turbocharger brace nut to 34 N·m (26 lb ft).
- Long turbocharger brace bolt to 50 N·m (37 lb ft).

13. Short turbocharger brace to extension and compressor housing.
14. Short turbocharger brace bolts.

Tighten

- Short turbocharger brace bolts to 25 N·m (19 lb ft).

15. Vacuum hose to waste-gate actuator.
16. Slide air cleaner onto the front air inlet duct and attach it to the wheelhouse.
17. Large diameter air cleaner bolt.
18. Short diameter air cleaner bolt.

Tighten

- Larger diameter air cleaner bolt to 30 N·m (22 lb ft).
- Smaller diameter air cleaner bolt to 5 N·m (45 lb in).

19. Air cleaner extension onto the air cleaner and compressor inlet.

Tighten

- Extension clamps to 1.7 N·m (15 lb in).

20. CDR valve and tube assembly on the right valve rocker arm cover and extension.
    - Start self-tapping screw through CDR tube bracket and thread into bracket on turbocharger housing.
21. Upper intake manifold cover.
22. Intake manifold cover bolts.

Tighten

- Bolts to 11 N·m (90 lb in).

23. Negative battery cable.

Important

- Run engine at idle for at least 2 minutes after completing the installation of the turbocharger. While running the engine, check for any oil leaks at the oil supply and return hoses.

WASTE-GATE ACTUATOR REPLACEMENT

Remove or Disconnect (Figure 14)

1. Vacuum hose.
2. E-clip retainer from the waste-gate lever pin.
    - Access may be improved by removing the turbocharger heat shield.
3. Two waste-gate bracket mounting bolts.
4. Waste-gate actuator.

Install or Connect (Figure 14)

1. Waste-gate actuator assembly to turbocharger.
2. Shaft pin into lever hole.
3. Two mounting bolts through the waste-gate bracket. Use a sealant on the bolt threads.

Tighten

- Bolts to 23 N·m (17 lb ft).

4. New E-clip on shaft pin.
5. Heat shield (if removed).
   - Use loctite on the heat shield bolts.

Tighten

- Bolts to 6 N·m (56 lb in).

6. Vacuum line to waste-gate actuator.

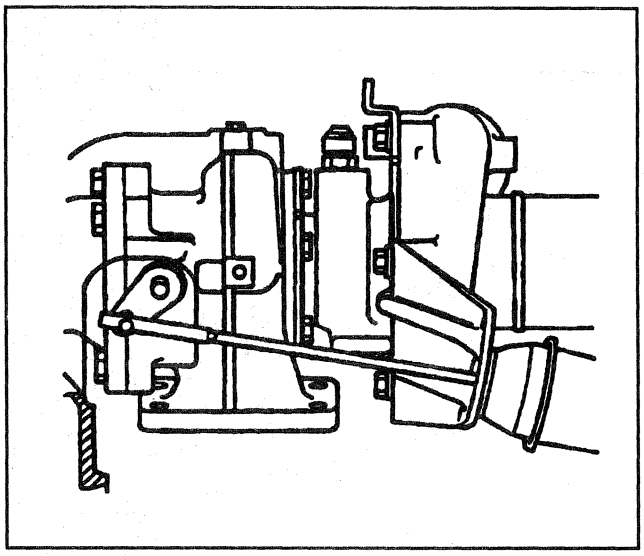


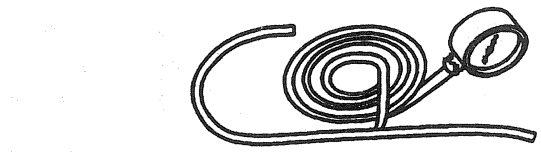
Figure 14—Actuator Assembly Mounting

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	N·m	lb ft	lb in
Actuator Bracket Bolts Air Cleaner Mounting Bracket Bolt/Nut	23	17	—
Air Cleaner Large Bolt	30	22	—
Air Cleaner Smaller Bolt	5	—	45
Exhaust Clamp	8	—	71
Extension (Air Intake) Bolts	23	17	—
Heat Shield Bolts	6	—	56
Oil Drain Tube (Return) Flange Bolts	26	19	—
Oil Feed Line	17	13	—
Rubber Hose Connector Clamps	6	—	55
Rubber Inlet Elbow Clamps	2	—	18
Turbocharger Brace (Long) Bolt	50	37	—
Turbocharger Brace (Long) Nut	34	26	—
Turbocharger Brace (Short)Bolt	25	19	—
Turbocharger to Exhaust Manifold Nuts	58	43	—
Upper Intake Manifold Cover Bolts	11	—	90

SPECIAL TOOLS



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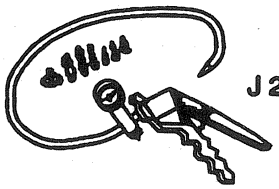

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