SECTION 6B

ENGINE COOLING

GENERAL DESCRIPTION

The cooling system maintains engine temperature at an efficient level during all engine operating conditions. When the engine is cold the system cools slowly, or not at all, to allow the engine to warm up quickly.

The cooling system includes a radiator and recovery sub-system, cooling fan, thermostat and housing, water pump, and drive belts.

Operation of the cooling system requires proper functioning of all components. Coolant is drawn from the radiator by the water pump and circulated through water jackets in the engine block, intake manifold, and cylinder head(s), and then directed back to the radiator where it's cooled.

This system directs some coolant through hoses to the heater core, to provide for heating and defrosting. A recovery bottle is connected to the radiator to recover coolant displaced by expansion from high temperatures and maintain correct coolant level. As the coolant cools and contracts it is drawn back into the radiator by vacuum.

RADIATOR

A cross-flow radiator is used on all models. Tanks in this type radiator are located to the right and left of the core, instead of above and below.

Radiators used with automatic transmissions have oil coolers with inlet and outlet fittings for transmission fluid circulation. Cars with manual transmissions use radiators without oil coolers. Vehicles equipped with air conditioning use a radiator with extra cooling capability.

An aluminum-plastic radiator, used on some models, can be identified by a note on the outlet tank 5" below the filler neck which reads, "Important - for repair see Harrison Service Manual". Service procedures for the aluminum plastic radiator are described in that manual and in this section.

Radiator Cap

A pressure-vent cap is used on the cross-flow radiator to allow a buildup of 103 kPa (15 psi) in the cooling system. This pressure raises the boiling point of coolant to approximately 125°C (262°F) at sea level. **Do not remove radiator cap to check engine coolant level; check coolant visually at the see-through coolant reservoir. Coolant should be added only to the reservoir.**

> **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 engine is hot and pressure is high will cause the solution to boil instantaneously and possibly with explosive force, spewing the solution over engine, fenders and person removing cap. If the solution contains flammable antifreeze, such as alcohol (not recommended for use at any time), there is also the possibility of causing a serious fire.**

The pressure-type radiator filler cap contains a blow off or pressure valve and a vacuum or atmospheric valve (Figure 1). The pressure valve is held against its seat by a spring of pre-determined

strength, which protects the radiator by relieving pressure if it exceeds 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 off and which otherwise might cause the radiator to collapse.

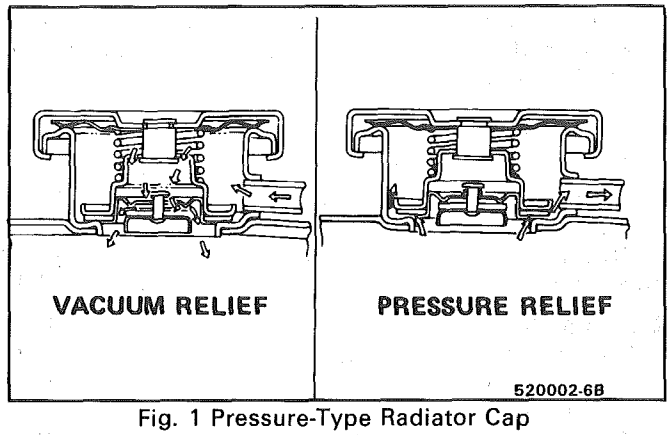


Fig. 1 Pressure-Type Radiator Cap

The radiator cap is designed to discourage inadvertent removal. The finger grips have been removed so the cap is round in shape. It also must be pushed downward before it can be removed. A rubber asbestos gasket is added to the diaphragm spring at the top of the cap. Embossed on the cap is a caution against its being opened and arrows indicating the proper closed position.

Every vehicle has a radiator cap. Also, J, N and P Series vehicles with 2.5L engines have a thermostat housing cap. For these engines, add coolant through the thermostat housing (with the thermostat and cap removed).

Recovery Bottle

A "see-through" plastic reservoir, similar to the familiar windshield washer jar, is connected to the radiator by a hose. As the car is driven, the coolant is heated and expands. The portion of the fluid displaced by this expansion flows from the radiator into the recovery bottle. When the engine is stopped and the coolant cools and contracts, the displaced coolant is drawn back into the radiator by vacuum. Thus, the radiator is kept filled with coolant to the desired level at all times, resulting in increased cooling efficiency. Coolant level should be between "ADD" and "FULL" marks on recovery bottle. These marks are approximately two quarts apart so that a 50/50 mixture can be added (one quart of ethylene glycol anti-freeze and one quart of water).

FAN

Electric Fan

Fans range in sizes from 290mm (11.6 in) to 422mm (16.9 in) with 4 to 7 blades to aid air flow through the radiator/condenser. The fan is driven by an electric motor which is attached to the radiator support.

The fan motor is activated by a coolant temperature switch. If the vehicle is equipped with

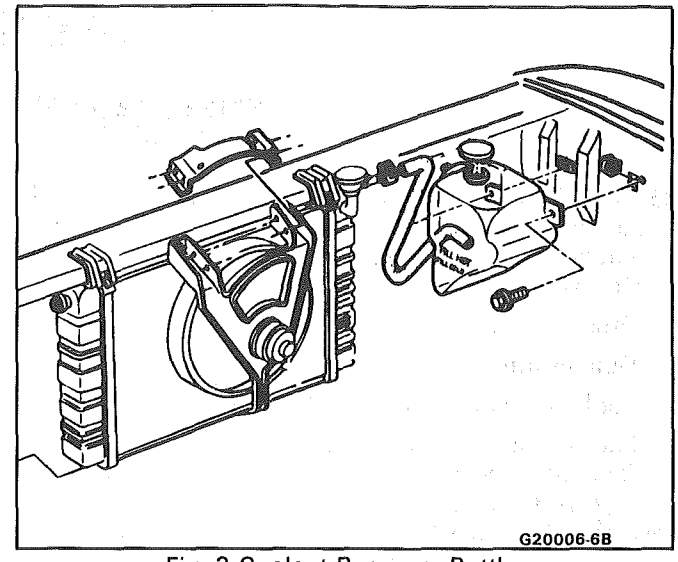


Fig. 2 Coolant Recovery Bottle

A/C, a second switch can activate the circuit, depending upon A/C compressor head pressure to the condenser.

CAUTION: If a fan blade is bent or damaged in any way, no attempt should be made to repair and reuse the damaged part. A bent or damaged fan assembly should always be replaced with a new fan assembly. It is essential that fan assemblies remain in proper balance and proper balance cannot be assured once a fan assembly has been bent or damaged. A fan assembly that is not in proper balance could fail and fly apart during subsequent use, creating an extremely dangerous condition.

The majority of non-A/C cars use a fan with four blades which are unevenly spaced and have curled tips to provide minimum noise. A fan shroud is used to prevent recirculation of air around the fan on most cars.

Thermostatically Controlled Fluid Clutch Fan

A thermostatically controlled fluid clutch fan is used on some air conditioned vehicles. It operates only when additional air flow is required to reduce radiator coolant temperatures. This clutch is of a simple, functional design. It is made of lightweight metal filled with silicone oil and is hermetically sealed. The finned (rear) housing contains a hub assembly (secured to the housing bearing) which attaches to the engine water pump. Four bosses with tapped holes in the rear face provide for attachment of the engine fan. The front surface of the housing has six deep circular grooves which index with six matching bosses on the rear face of a floating clutch. A separator plate and front cover, with thermostatic coil control, complete the clutch assembly.

During periods of operation when radiator discharge air temperature is low, below approximately 66°C (150°F), the clutch limits the fan speed to 800-1400 rpm. In this position, the clutch is disengaged

since a small oil pump driven by the separator plate forces the silicone oil into a reservoir between the separator plate and the front cover assembly. In this position, the passage from this cavity to the clutch area is closed by a slide valve. As operating conditions produce a high radiator air temperature discharge, above approximately 66°C (150°F), the temperature sensitive bi-metal coil tightens to move the slide valve (attached to the coil) which opens a port in the separator plate. This allows a flow of silicone oil into the clutch chamber to engage the clutch, providing a maximum fan speed of approximately 2200 rpm. The clutch coil is calibrated so that, with a road load at an ambient temperature of approximately 32°C (90°F), the clutch is just at a point of shift between high and low fan speed. No attempt should be made to disturb the calibration of the engine clutch fan assembly as each assembly is individually calibrated at the time of manufacture. Under certain temperature conditions there is a lateral movement at the fan tip which should not be considered as a hub or bearing failure. This condition is a design feature of the clutch assembly which allows up to approximately 1/4" lateral movement measured at the fan tip.

Testing a clutch fan by holding the small hub with one hand and rotating the aluminum housing in a clockwise/counter-clockwise motion will cause the clutch to freewheel, which is a normal condition when operated in this manner. This should not be considered a test by which replacement is determined.

Temperature Switch

This switch activates a warning lamp in the instrument cluster if the engine overheats. With optional instrumentation, a temperature gage replaces the warning lamp and the temperature switch is replaced with a transducer. See Section 8A for Temperature Switch location and diagnosis.

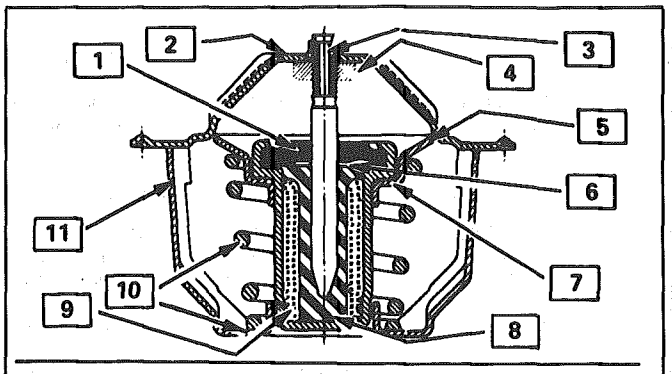
Coolant Temperature Fan Switch

This switch regulates voltage to the coolant fan relay, which operates the fan whenever the engine coolant temperature exceeds 230° F (110° C). For location and diagnosis see Section 8A for Coolant Temperature Fan Switch.

Thermostat

A pellet-type thermostat is used in the coolant outlet passage to control the flow of engine coolant, to provide fast engine warm-up and to regulate coolant temperatures. A wax pellet element in the thermostat expands when heated and contracts when cooled. The pellet element is connected through a piston to a valve. When the pellet element is heated, pressure is exerted against a rubber diaphragm which forces the valve to open. As the pellet element is cooled, the contraction allows a spring to close the valve. Thus, the valve remains closed while the coolant is cold, preventing circulation of coolant through the radiator. At this point, coolant is allowed to circulate only throughout the engine to warm it quickly and evenly.

As the engine warms, the pellet element expands and the thermostat valve opens, permitting coolant to flow through the radiator, where heat is dissipated through the radiator walls. This opening and closing of the thermostat permits enough coolant to enter the radiator to keep the engine within operating limits.



1–FLANGE SEAL
2–FLANGE
3–PISTON
4–NUT
5–VALVE SEAT
6–TEFLON SEAL
7–VALVE
8–RUBBER DIAPHRAGM
9–WAX PELLET
10–COIL SPRING
11–FRAME

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Fig. 3 Pellet Type Thermostat

Coolant Recovery System

A recovery-type cooling system is standard on all cars and is designed to maintain the engine at proper operating temperatures. The recovery tank collects coolant that expands with rising temperature and would otherwise overflow from the system. When the system temperature drops, the coolant is drawn from the recovery tank back into the radiator by the suction created by coolant contraction. The cooling system has been filled at the factory with a high-quality, inhibited, year-around coolant that meets the standards of General Motors Specification 1825-M. This coolant solution provides freezing protection to at least -37°C (-34°F). It has been formulated to be used for two full calendar years or 30,00 miles, whichever first occurs, of normal operation without replacement, provided the proper concentration of coolant is maintained.

DIAGNOSIS

The following diagnostic information covers common problems and possible causes. When the proper diagnosis is made the problem should be corrected by part replacement, adjustment, or repair as required. Refer to the appropriate section of the service manual for these procedures.

SERVICE PROCEDURES

Cooling System Care

The radiator cap should not be removed to check coolant level. Check the coolant level visually in the "see-through" coolant recovery tank every time hood is up. Level should be near "ADD" mark when the system is cold. At normal operating temperature the coolant level should increase to the "FULL" mark on the recovery tank. Coolant should be added only to the reservoir to raise level to the "FULL" mark. Use a 50/50 mixture of high-quality ethylene glycol antifreeze and water for coolant additions.

ENGINE COOLING SYSTEM COMPLAINT

TO AVOID NEEDLESS TIME AND COST IN DIAGNOSING COOLING SYSTEM COMPLAINTS, THE CUSTOMER SHOULD BE QUESTIONED ABOUT DRIVING CONDITIONS THAT PLACE ABNORMAL LOADS ON THE COOLING SYSTEM.

1. DOES OVERHEATING OCCUR WHILE PULLING A TRAILER?

   IF ANSWER IS "YES" — HOW HEAVY IS TRAILER? IF TRAILER WEIGHT IS GREATER THAN 1,000 LBS. & CAR IS EQUIPPED WITH NORMAL DUTY COOLING SYSTEM, A HEAVY DUTY COOLING PACKAGE IS REQUIRED (PER MFR'S TRAILER HAULING SPECS.). FURTHER DIAGNOSTIC CHECKS SHOULD NOT BE REQUIRED.

2. IS CAR EQUIPPED WITH ADD—ON OR AFTER MARKET AIR CONDITIONING SYSTEM?

   IF ANSWER IS "YES" — WAS HEAVY DUTY RADIATOR INSTALLED WITH THE SYSTEM? IF NOT, INSTALL HEAVY DUTY AIR CONDITIONING RADIATOR FOR THE CAR MODEL INVOLVED (PER MANUFACTURER'S SPECS.). FURTHER DIAGNOSTIC CHECKS SHOULD NOT BE REQUIRED.

3. IS OVERHEATING OCCURRING AFTER PROLONGED IDLE, IN GEAR, A/C SYSTEM OPERATING?

   IF ANSWER IS "YES" — INSTRUCT OWNER ON DRIVING TECHNIQUES THAT WOULD AVOID OVERHEATING SUCH AS:
   a. IDLE IN NEUTRAL AS MUCH AS POSSIBLE — INCREASE ENGINE R.P.M. TO GET HIGHER AIR FLOW & WATER FLOW THROUGH RADIATOR.
   b. TURN A/C SYSTEM OFF DURING EXTENDED IDLES IF OVERHEATING IS INDICATED BY HOT LIGHT OR TEMP. GAGE.

   FURTHER DIAGNOSTIC CHECKS SHOULD NOT BE REQUIRED.

4. IS OVERHEATING OCCURRING AFTER PROLONGED DRIVING IN SLOW CITY TRAFFIC, TRAFFIC JAMS, GARAGES, ETC.?

   IF ANSWER IS "YES" — INSTRUCT OWNER ON DRIVING TECHNIQUES THAT WOULD AVOID OVERHEATING — SAME AS FOR PROLONGED IDLES — NO. 3 FURTHER DIAGNOSTIC CHECKS SHOULD NOT BE REQUIRED.

IF NONE OF THE ABOVE APPLY, GO TO DIAGNOSTIC CHART

TO EFFECTIVELY USE THIS CHART, QUESTION THE OWNER TO DETERMINE WHICH OF THE FOLLOWING (3) CATEGORIES APPLIES TO THE COMPLAINT:

1. HOT LIGHT OR HOT INDICATION ON TEMPERATURE GAGE
2. BOILING
3. COOLANT LOSS

1. IF COMPLAINT IS HOT LIGHT OR HOT INDICATION ON TEMPERATURE GAGE —

   WAS HOT LIGHT ACCOMPANIED BY BOILING? IF ANSWER IS "YES", GO TO BOILING ON CHART
   IF ANSWER IS "NO", GO TO HOT LIGHT ON CHART

2. IF COMPLAINT IS BOILING — GO TO BOILING ON CHART

   IF PROBLEM REMAINS, GO TO COOLING FAN DIAGNOSIS SECTION 8 (IF SO EQUIPPED).

3. IF COMPLAINT IS COOLANT LOSS —

DETERMINE IF CUSTOMER IS OVERFILLING THE SYSTEM, THIS WOULD NORMALLY RESULT IN SMALL AMOUNTS OF COOLANT LOSS THROUGH THE OVERFLOW TUBE. IF THIS IS THE CASE, INSTRUCT THE CUSTOMER ON PROPER FILL LEVEL & NO FURTHER DIAGNOSTIC CHECKS SHOULD BE REQUIRED.

IF OVERFILLING IS NOT THE PROBLEM, GO TO COOLANT LOSS ON CHART.

NOTICE: ANYTIME COOLING SYSTEM IS OBVIOUSLY CONTAMINATED, THE SYSTEM SHOULD BE DRAINED AND FLUSHED.

CAUTION — THE COOLING SYSTEM IS DESIGNED TO OPERATE AT 15 P.S.I. PRESSURE & TEMPERATURES EXCEEDING 200°F. CAUTION SHOULD BE EXERCISED WHEN REMOVING PRESSURE CAP OR SERVICING THE SYSTEM.

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Fig. 4 Cooling System Diagnosis Chart (1 of 3)

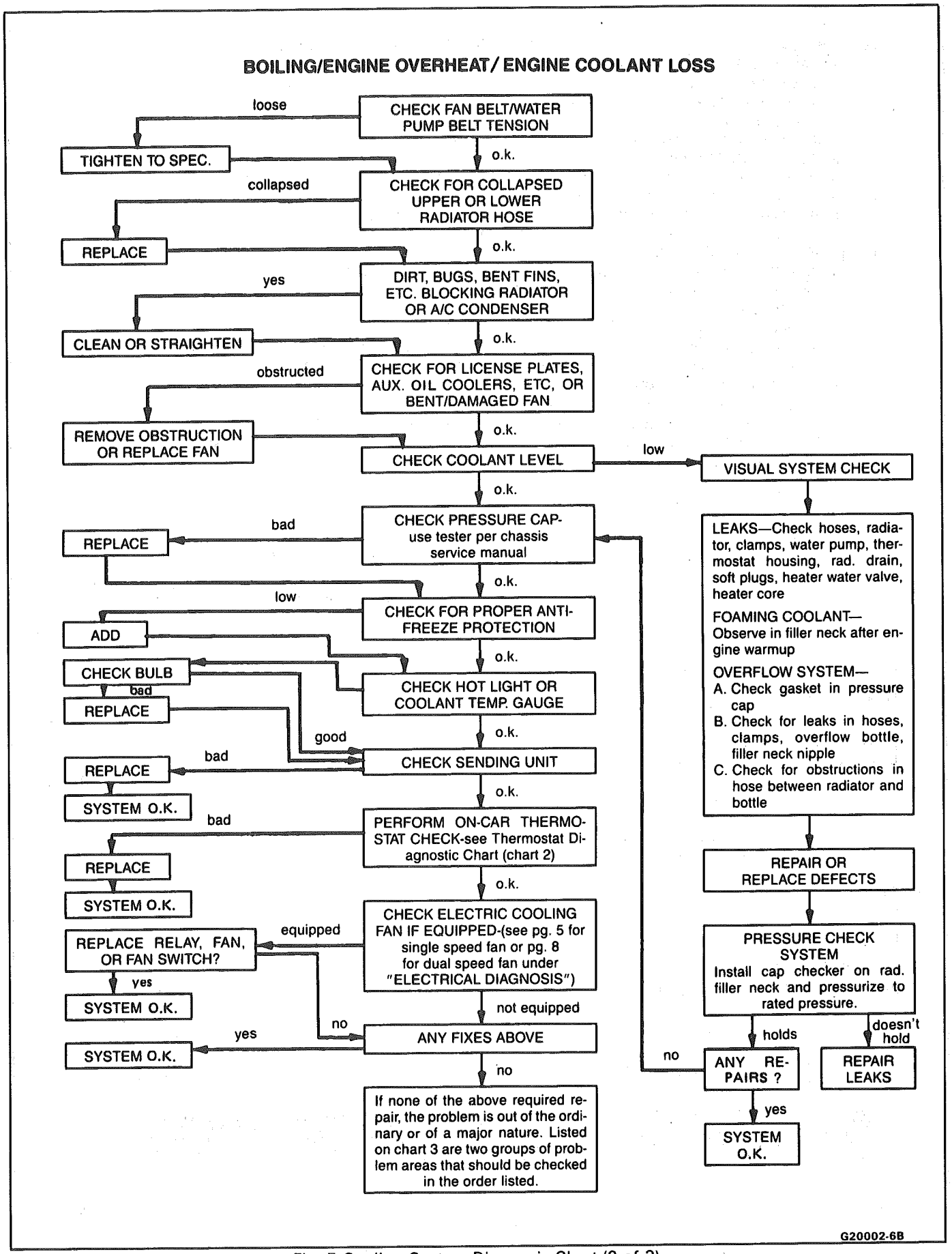

Fig. 5 Cooling System Diagnosis Chart (2 of 3)

A. PROBLEMS NOT REQUIRING DISASSEMBLY OF COOLING SYSTEM –

1. LARGE OBSTRUCTIONS BLOCKING RADIATOR OR CONDENSER
   - a. AUXILIARY OIL COOLERS
   - b. LICENSE PLATES
   - c. SPARE TIRES

   } RELOCATE
   - d. ICE, MUD OR SNOW OBSTRUCTING GRILLE – REMOVE
2. ENGINE OIL OVERFILL – CHECK ENGINE OIL DIPSTICK
3. WRONG RADIATOR FOR APPLICATION – CHECK PART NO. AGAINST PARTS LIST
4. LOOSE, DAMAGED OR MISSING AIR SEALS – SEE BODY SERVICE MANUAL
5. MISSING OR DAMAGED LOWER AIR BAFFLE – SEE BODY SERVICE MANUAL
6. WRONG IGNITION TIMING – SEE CHASSIS SERVICE MANUAL

B. PROBLEMS REQUIRING DISASSEMBLY OF COOLING SYSTEM –

1. INCORRECT OR DAMAGED FAN – CHECK PART NO. AGAINST PARTS LIST
2. FAULTY EMISSION SYSTEM COMPONENTS (COULD CAUSE OVERHEATING AT IDLE)
   - a. PCV VALVE
   - b. TVS OR TCS

   } SEE CHASSIS SERVICE MANUAL
3. PRESSURE CHECK COOLING SYSTEM WITH PRESSURE CAP INSTALLED – WILL SHOW IF PRESSURE CAP LEAKS BECAUSE OF RADIATOR FILLER NECK DAMAGE
4. DEFECTIVE WATER PUMP
   - a. ERODED OR BROKEN IMPELLER VANES
   - b. FAILED BEARING OR SEAL – CHECK FOR SHAFT OR BEARING PLAY
5. PLUGGED RADIATOR TUBES – SEND TO RADIATOR REPAIR SHOP FOR FLOW CHECK
6. INTERNAL SYSTEM LEAKS
   - a. HEAD GASKET – SEE CHASSIS SERVICE MANUAL
   - b. CRACKED BLOCK
   - c. TIMING CHAIN COVER
   - d. INTAKE MANIFOLD GASKET
7. PLUGGED COOLANT PASSAGES IN CYLINDER HEADS – REMOVE HEADS AND CHECK VISUALLY

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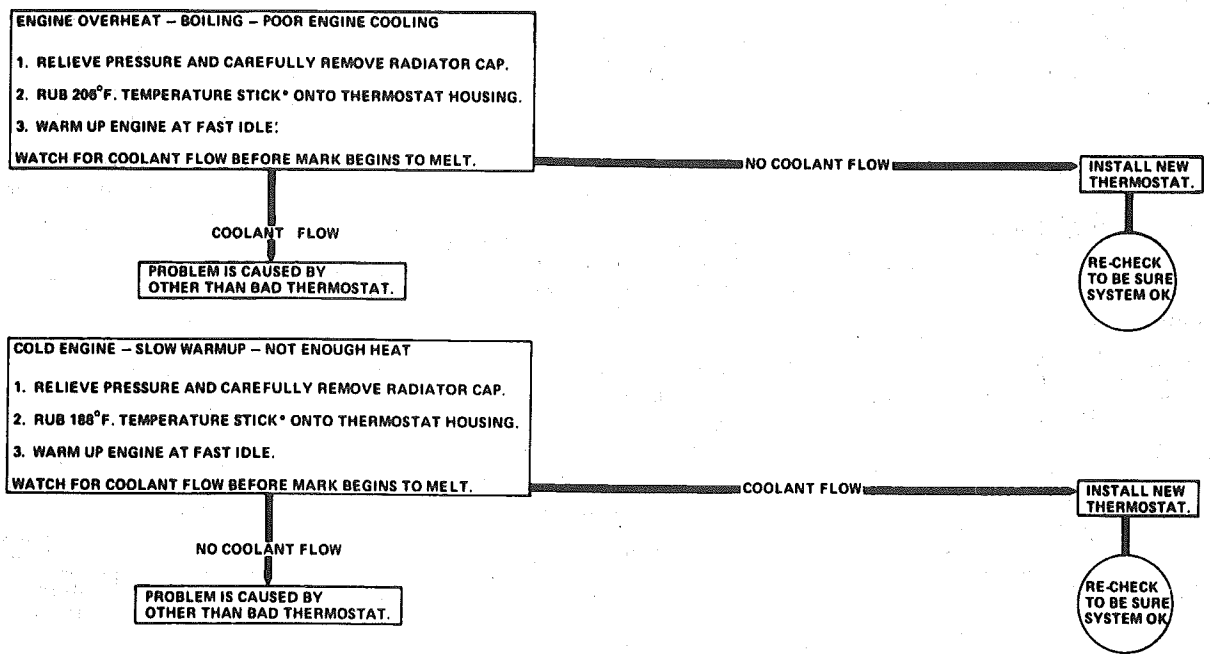
Fig. 6 Cooling System Diagnosis Chart (3 of 3)



*NOTE: THE TEMPERATURE STICK IS A PENCIL LIKE DEVICE WHICH HAS A WAX MATERIAL CONTAINING CERTAIN CHEMICALS WHICH MELT AT A GIVEN TEMPERATURE. THEMPERATURE STICKS CAN BE USED TO DETERMINE A THERMOSTAT'S OPERATING TEMPERATURE BY RUBBING 188°F. AND 206°F. STICKS ON THE THERMOSTAT HOUSING. THE MARKS MADE BY THE STICKS SHOULD MELT WHEN COOLANT TEMPERATURES OF 188°F. AND 206°F. ARE REACHED, RESPECTIVELY. THESE TEMPERATURES ARE THE NORMAL OPERATING RANGE OF THE THERMOSTAT, THEREFORE, IF THE COOLANT FLOWS AS INDICATED ON THE DIAGNOSIS CHART, THE THERMOSTAT MAY BE DEFECTIVE.

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Fig. 7 Thermostat Diagnosis Chart

NOTICE: If recommended quality antifreeze is used, supplemental inhibitors or additives claiming to provide increased cooling capability are not necessary. They may be detrimental to the efficient operation of the system, and represent an unnecessary operating expense.

Every 12 months or 15,000 miles, the cooling system should be serviced as follows:

1. Wash radiator cap and filler neck with clean water.
2. Check coolant for proper level and freeze protection.
3. Pressure test system and radiator cap for proper pressure holding capacity, 103 kPa (15 psi). If replacement of cap is required, use the proper cap specified for car model.
4. Tighten hose clamps and inspect all hoses. Replace hoses whenever cracked, swollen or otherwise deteriorated.
5. Clean frontal area of radiator core and air conditioning condenser.

DRAINING AND REFILLING THE COOLING SYSTEM

Replace hoses every 24 months or 30,000 miles or earlier if cracked, swollen or otherwise deteriorated. Every two years or 30,000 miles, whichever first occurs, the cooling system should be flushed and refilled using the following recommended procedure:

1. Remove radiator cap, or thermostat housing cap (VIN 0, J, R and U), when engine is cool by:
   a. Slowly rotating cap counterclockwise to detent. (Do not press down while rotating.)
   b. Wait until any residual pressure (indicated by a hissing sound) is relieved.
   c. After all hissing ceases, press down on cap while continuing to rotate counterclockwise.

   CAUTION: To avoid the danger of being burned, do not remove radiator cap while engine and radiator are still hot. Scalding fluid and steam may be blown out under pressure.
2. Remove the thermostat by using the wire handle to lift it out of the housing (VIN 0, J, R and U).
3. With the thermostat removed, reinstall the thermostat housing cap (VIN 0, J, R and U).
4. Open radiator drain valve and block drain plugs to drain coolant. On VIN R and 9 (P series) engines, open coolant pipe plugs.
5. Close valve. Reinstall drain plugs, and add sufficient water to fill system.
6. Run engine, drain and refill the system, as described in steps 4 and 5 a sufficient number of times, until the drained liquid is nearly colorless.

   Important

   - BLOCK DRIVE WHEELS, place transmission in PARK (automatic transmission) or NEUTRAL (manual transmission) and set the parking brake.
7. Allow system to drain completely. Then close radiator drain valve tightly, and reinstall block drain plugs.
8. Remove recovery cap leaving hoses in place. Remove coolant recovery tank and empty of fluid. Flush tank with clean water, drain and reinstall.
9. Add sufficient ethylene glycol coolant, meeting GM specification 1825-M, to provide the required freezing and corrosion protection - at least 50 percent solution -37°C (-34°F). Fill radiator to the base of the radiator fill neck and add sufficient coolant to the recovery tank to raise level to the "FULL" mark. Reinstall recovery tank cap.
10. Run engine, with radiator cap or thermostat housing cap removed, until normal operating temperature is reached. (Radiator upper hose becomes hot.)
11. With engine idling, add coolant until level reaches bottom of filler neck and reinstall cap, making certain arrows line up with overflow tube.

    CAUTION: Under some conditions, the ethylene glycol in engine coolant is flammable. To help avoid being burned when adding coolant, DO NOT spill it on the exhaust system or hot engine parts.

    It is the owner's responsibility to keep the freeze protection at a level appropriate to the temperatures which may occur in the area of vehicle operation.
    a. Maintain cooling system freeze protection at -37°C (-34°F), to ensure protection against corrosion and loss of coolant from boiling, even though freezing temperatures are not expected.
    b. Add ethylene glycol base coolant that meets GM Specification 1825-M, when coolant additions are required because of coolant loss, or to provide additional protection against freezing at temperatures lower than -37°C (-34°F).

NOTICE: Alcohol or methanol base coolants, or plain water, are not recommended at any time.

DRIVE BELT

NOTICE: Routine inspection of the belt may reveal cracks in the belt ribs. These cracks will not impair belt performance and therefore should not be considered a problem requiring belt replacement. However, the belt should be replaced if belt slip occurs or if sections of the belt ribs are missing.

A single (serpentine) belt is used to drive all engine accessories formerly driven by multiple drive belts. All belt driven accessories are ridgedly mounted with belt tension maintained by a spring loaded tensioner.

The drive belt tensioner has the ability to control belt tension over a fairly broad range of belt lengths.

However, there are limits to the tensioner's ability to compensate for varying lengths of belts. With the tensioner outside of its operating range, poor tension control and/or damage to the tensioner may result. The tensioner has provisions for a visual check to verify that it is in the "operating range" (see Figures 608 and 609).

ALUMINUM RADIATOR REPAIR

This radiator utilizes an aluminum core with plastic side tanks. The core and side tanks can be replaced separately and core repair is easily made with the hot melt adhesive method. A transaxle oil cooler is located in one of the side tanks. The oil cooler can be replaced. The drain cock is located on the lower part of one of the tanks. The drain cock is also serviceable.

Core

The core is made of aluminum and is of the crossflow design. It utilizes large tubes that resist plugging, and repairs to the tubes and core are easily made using the hot melt adhesive method.

The core is attached to the tanks by clinched tabs on the core that can be bent back if tank or core replacement is required.

If the damage to a tube is too severe, a tube can be blocked or plugged as explained in "Tube Blocking. " No more than two tubes should ever be blocked on a core. Also replace the core if more than three tabs are broken on one side, or if two adjacent tabs are broken.

Tanks

The tanks are attached to the core by the use of clinched tabs. The clinched tabs can be bent back if the tanks need to be removed from the core. Bend the tabs back only enough to remove the tank. Overbending will weaken the tabs.

A high temperature rubber gasket is used to seal the mating surface between the core and the tank. (See Fig. 8). The gasket must be replaced any time a tank is removed from the core.

Transaxle Oil Cooler

The transaxle oil cooler is located in one of the radiator side tanks. The oil cooler can be replaced by removing the tank from the core.

A leaking oil cooler gasket can be replaced without removing the tank from the core.

Drain Cock

The aluminum/plastic radiator utilizes a two piece plastic drain cock and a rubber seal. The drain cock is serviceable (See Fig. 9).

ALUMINUM RADIATOR SERVICE

The aluminum-plastic radiator can be repaired at the dealership. The following components are easily replaced:

- Core
- Tanks and gaskets
- Oil coolers and gaskets
- Drain cock and gasket

The **tanks cannot be repaired** if broken or cracked. The radiator core can be replaced and the new core used with the original tanks and oil cooler.

Precautions

As with all cooling system service, take measures to prevent personal injury and damage to the system.

CAUTION: To help avoid the danger of being burned, do not remove the radiator 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.

NOTICE: DO NOT USE "BOIL OUT" TANKS OR VATS. Common service methods may actually destroy an aluminum radiator. Caustic or lye cleaning solutions must NOT be used for aluminum radiators.

- Do not open the hood if you can see, or hear, steam or coolant escaping from the engine compartment.
- Do not remove radiator cap if radiator feels warm.
- Do not remove the radiator cap or coolant recovery tank cap if the coolant in the recovery tank looks like it is boiling.
- Wear eye protection.
- Wear gloves to protect your hands against excessive heat, or the effects of chemicals on your skin.
- Prevent dirt and water from entering the transmission oil cooler.
- Do not use boil-out tanks, or vats, or other tanks that have been used for copper and brass radiators. The flux, acid, and caustic cleaners remaining in these tanks will attack the aluminum and cause radiator failure. A separate test tank containing clean water is strongly recommended for servicing aluminum-plastic radiators.

NOTICE: Never use shop air that is not regulated at 20 psi (138 kPa) to pressure test radiator. Pressures over 20 psi (138 kPa) will damage the radiator.

DIAGNOSIS

Leak Testing

Some core leaks can be detected by merely adding water to the radiator. It is helpful to clean the core so that the damaged area can be more easily found.

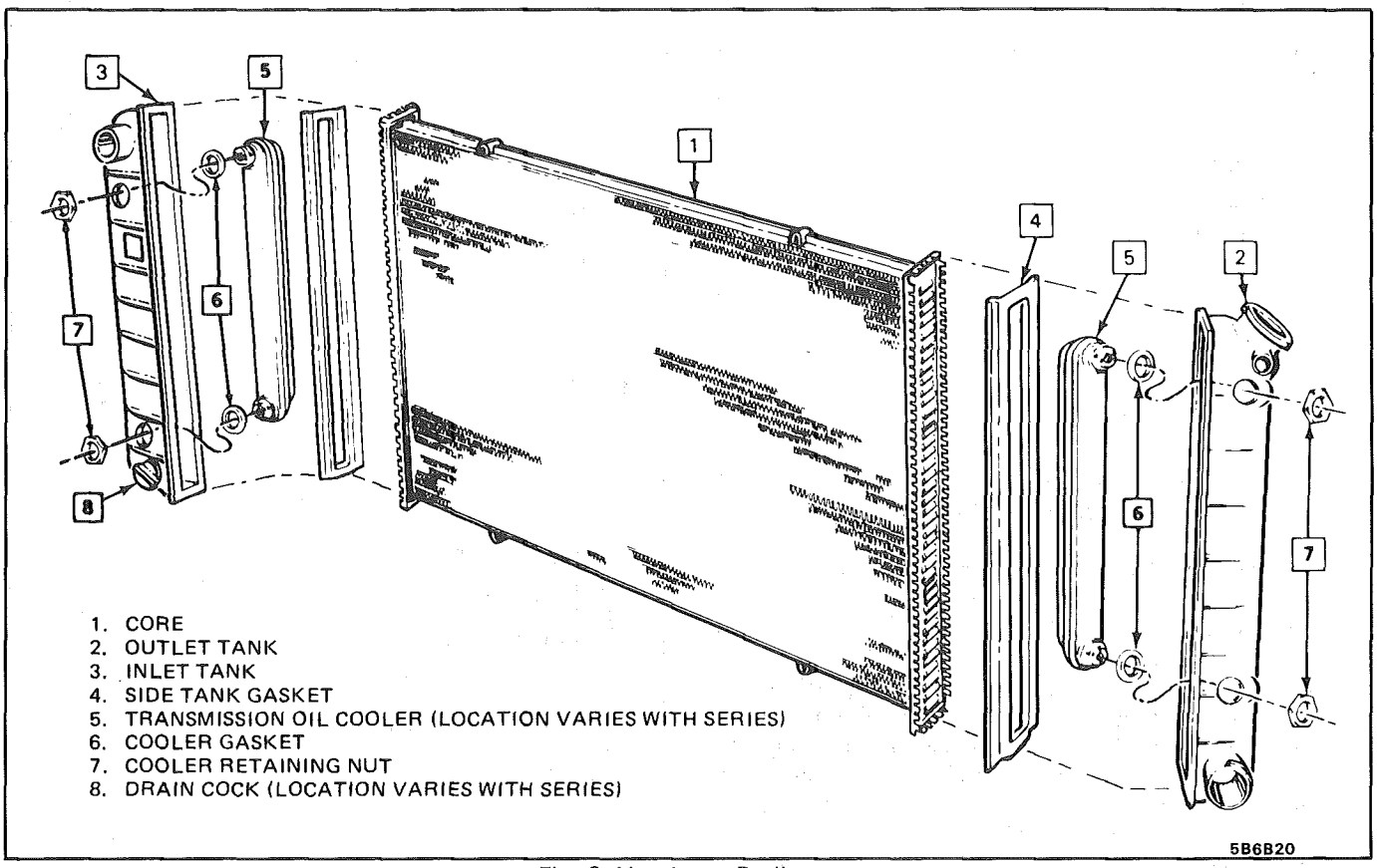


Fig. 8 Aluminum Radiator

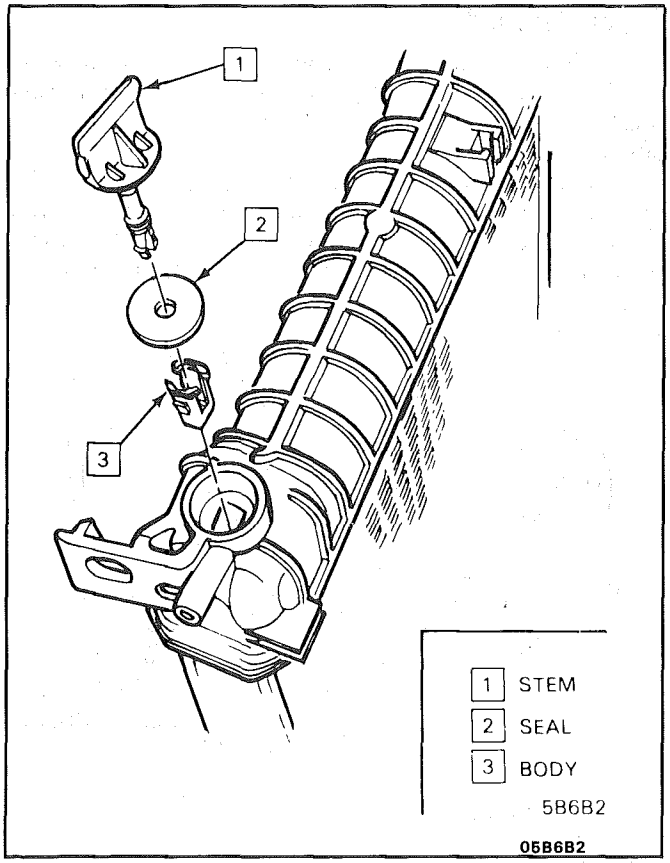


Fig. 9 Aluminum Radiator Drain Cock

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 solution.

On-Vehicle Pressure Testing

You can pressure-test the aluminum-plastic radiator with a common pump and gage, such as BT-7002-3 or J-24460-01 with J-23699 (Figure 10). With the system at a cool temperature, remove the radiator cap, connect the gage, and apply normal system operating pressure. Do not exceed 20 psi (138 kPa). Watch the gage needle for an indication of a leak, and examine the radiator and other cooling system parts for signs of escaping coolant.

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

If the radiator is found to be leaking during the pressure test, mark the leak area so that it is easily found once the radiator has been removed from the vehicle.

Off-Vehicle Leak Testing

NOTICE: Do not use boil-out tanks, or vats, or other tanks that have been used for copper and brass radiators. The flux, acid, and caustic cleaners remaining in these tanks will attack the aluminum and cause radiator failure. A separate test tank

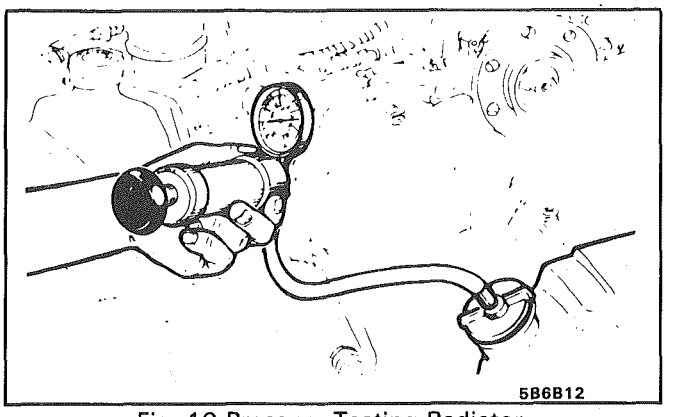


Fig. 10 Pressure Testing Radiator

containing clean water is strongly recommended for servicing aluminum-plastic radiator.

1. Install test fittings or rubber test caps in the inlet and outlet necks and seal the oil cooler fittings with metal plugs to protect the cooler and keep the fluid from running out (Fig. 11).
2. Attach pressure tester and gradually apply air pressure until 20 psi (138 kPa) is attained. Do not exceed 20 psi (138 kPa). Check pressure gage to see if there is a pressure loss. To ensure that there are no small leaks, run water over the repair area and look for bubbles. (A mild detergent is very helpful).
   If a large water tank is available, the radiator can be submerged, and a check for air bubbles can be made.

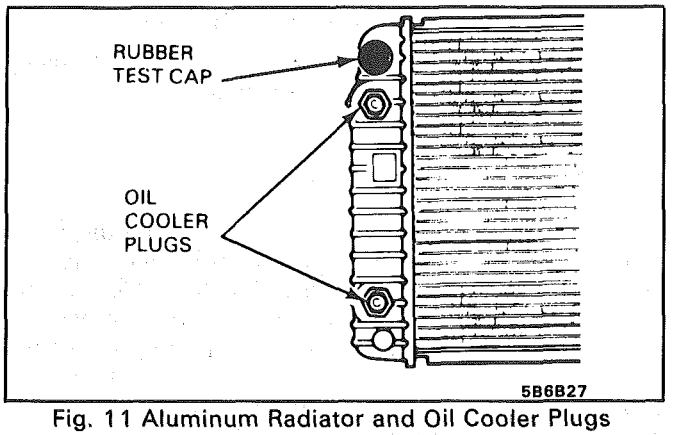


Fig. 11 Aluminum Radiator and Oil Cooler Plugs

Repairable Leaks

There are two types of leaks that can be repaired on the aluminum-plastic radiator: core leaks and gasket leaks. Leaks in the plastic tanks cannot be repaired.

Core leaks can occur in a tube, or in the joints between the tubes and headers. Gasket leaks can occur in the joints between the plastic tanks and the headers, or in the joints between the oil cooler fittings and the tank. Some leaks can be repaired while the radiator is on the car; however, it is usually best to remove the radiator.

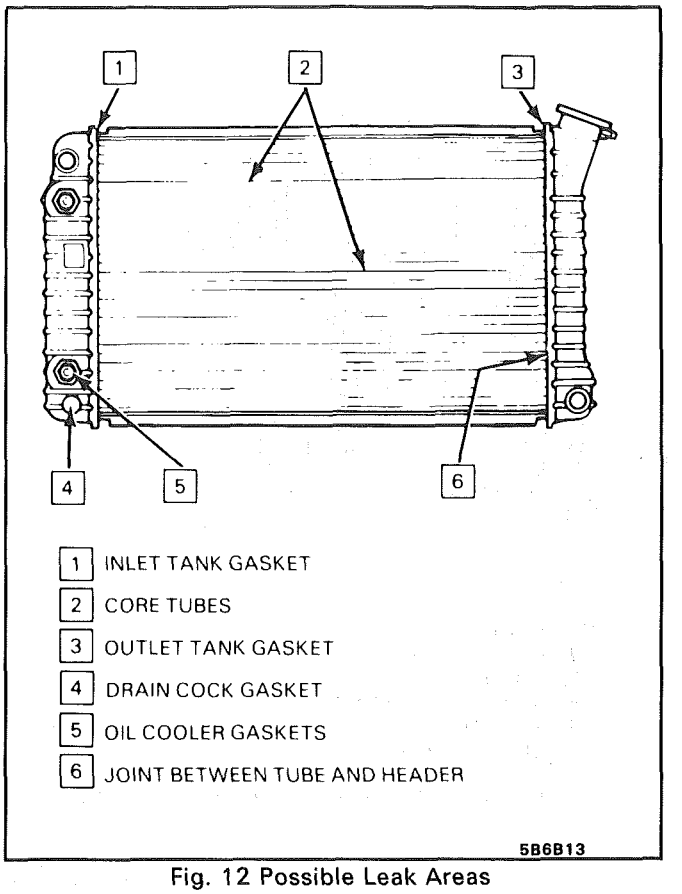


Fig. 12 Possible Leak Areas

Repair Methods

There are several methods that can be used to repair the radiator core, but the hot melt adhesive method has been found to be the most simple and effective.

The kit contains adhesive sticks, cotton swabs, wire brush and primer. The adhesive stick is reusable, has an indefinite shelf life, and is waste-free. The sticks must be stored in a sealed container to keep them dry (Fig. 13).

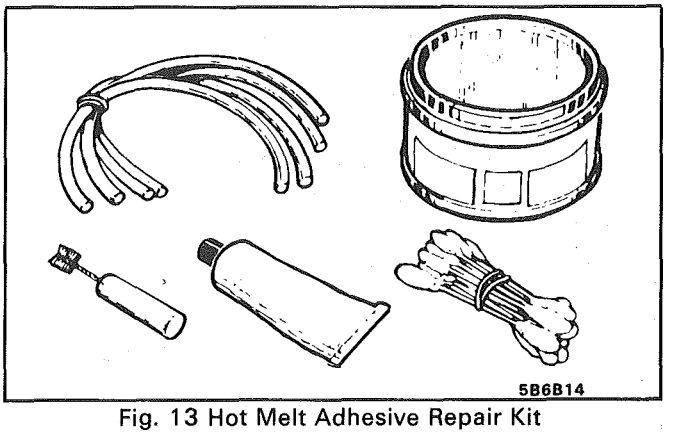


Fig. 13 Hot Melt Adhesive Repair Kit

Special Preparation

Cooling Fin Removal

For damaged areas that are between the cooling fins, it may be necessary to remove some of the fins. Do not remove more fins than necessary. Usually 6mm

(1/4") beyond the leak or damage area is enough to make an effective repair. (Fig. 14).

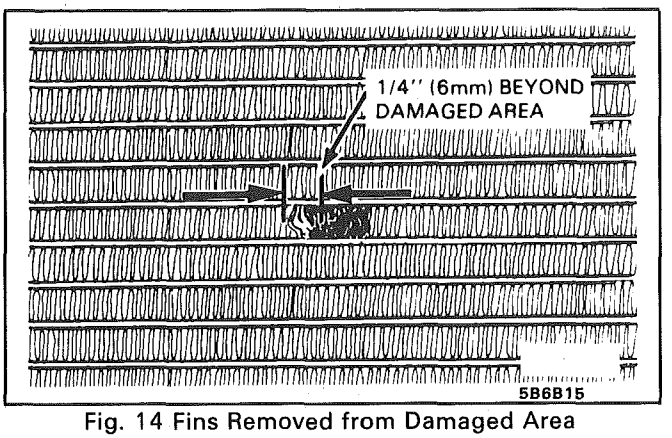


Fig. 14 Fins Removed from Damaged Area

Tube Blocking

If a tube is severely damaged, it can be blocked off. (Fig. 15).

NOTICE: DO NOT BLOCK OFF MORE THAN TWO TUBES IN A RADIATOR. BLOCKING OFF MORE THAN TWO TUBES WILL REDUCE THE COOLING CAPABILITY OF THE SYSTEM.

The tube should be cut off 6mm (1/4") from the header and pinched shut before it is cleaned and sealed. (See General Core Sealing).

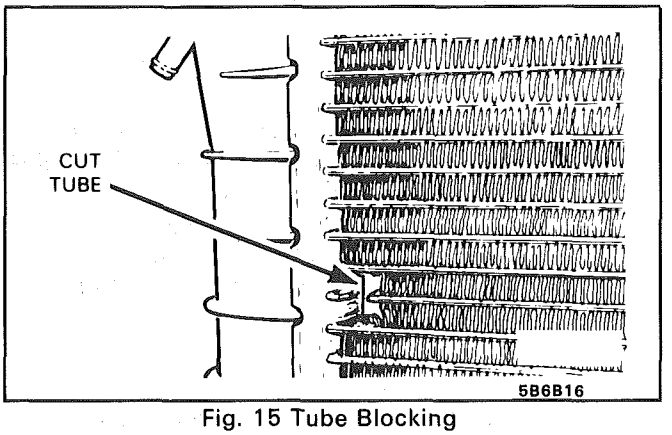


Fig. 15 Tube Blocking

Header Repair

If the header or a tube near the header requires a repair, the side tank does not have to be removed. A damp cloth can be placed against the side tank where the repair has to be made (Fig. 16). The side tank can also be submerged in a tank of water up to the header (Fig. 17).

NOTICE: One of these procedures has to be used when repairs are made on or near the header, to prevent damage to the tank or gasket.

General Core Repair

Preparation of the surface in the repair area cannot be overemphasized. If the leak area surface is not clean, none of the repair materials will stick to the surface.

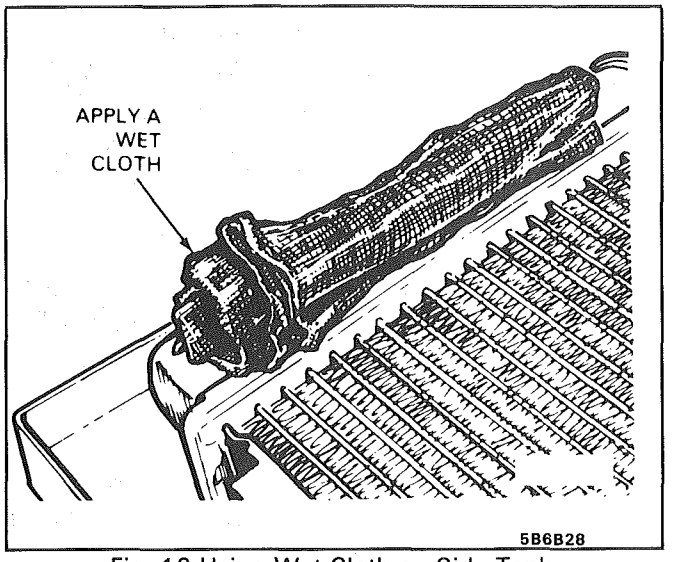


Fig. 16 Using Wet Cloth on Side Tank

1. Position the core so the repair area is accessible.
2. Apply a wet cloth if you are working near the plastic tanks or the joints between the core tubes and header (Fig. 16); or submerge the tank in water (Fig. 17).

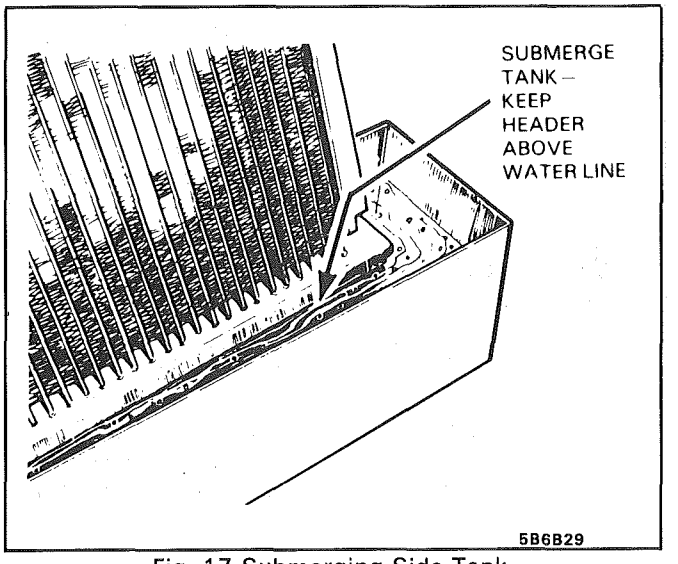


Fig. 17 Submerging Side Tank

3. Heat the repair area slightly with a small torch or heat gun to be sure it is dry. **Do not use a blow torch.**
4. Brush the area to be repaired with the small steel brush that is supplied in the kit and blow dust away from repair area. (See Fig. 18).
5. Open the tube of primer, using the spurred cap or a pin, and apply primer to the repair area only. Use of the primer produces a stronger repair. **Do not heat the primer.**

CAUTION: The primer contains trichlorethane.

- **It could be harmful, or fatal, if swallowed. If swallowed, get medical attention.**

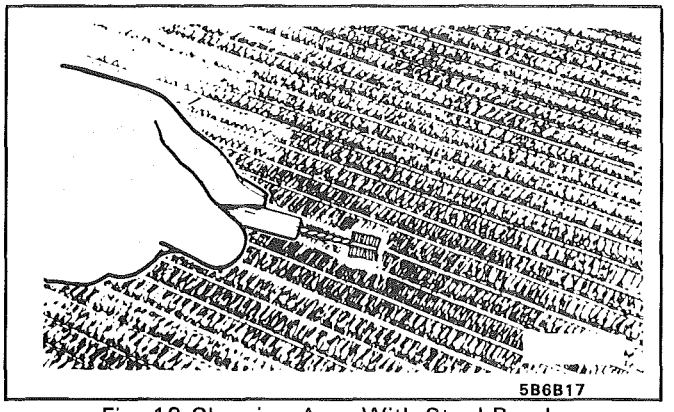


Fig. 18 Cleaning Area With Steel Brush

- **Use with adequate ventilation.**
- **In case of eye contact, flush with plenty of water and get medical attention.**
- **In case of body contact, wash thoroughly with soap and water.**
- **Do not mix the primer with water.**

6. Scrub the repair area with a cotton swab until a fresh swab stays clean. The clear, yellow-brown coating does not have to be removed (Fig. 19).

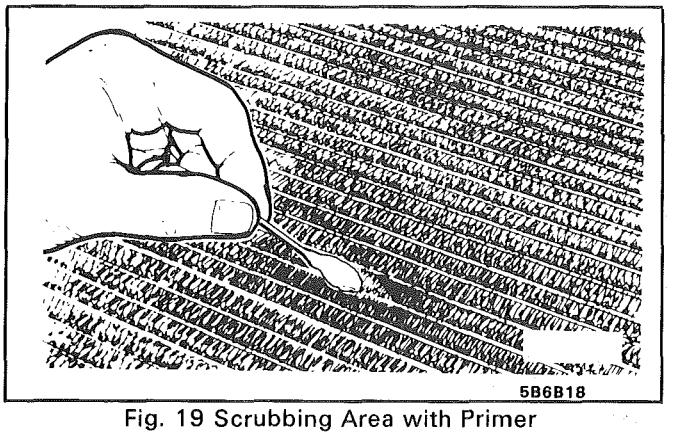


Fig. 19 Scrubbing Area with Primer

7. Heat the repair area with the heat gun or by moving the torch in a circular pattern (Fig. 20). Use a soft, small blue flame (like a gas stove flame).

8. Withdraw the torch and rub the adhesive stick on the repair area (Fig. 21). The adhesive will flow at a temperature of approximately 500°F (260°C). If the stick doesn't start to melt, remove it and reapply the heat. **Do not heat the stick directly with a flame. High heat will burn and char the adhesive.**

9. Continue heating until the adhesive flows and wets the entire repair area and fills the joint. If a hole is in the center of a tube, heat the tube and let the hot surface melt and pull in the adhesive. The force of the flame or heat gun will also tend to guide the adhesive toward the hole. For leaks between a tube and header, flow the adhesive completely around the tube and header joint with the tank installed.

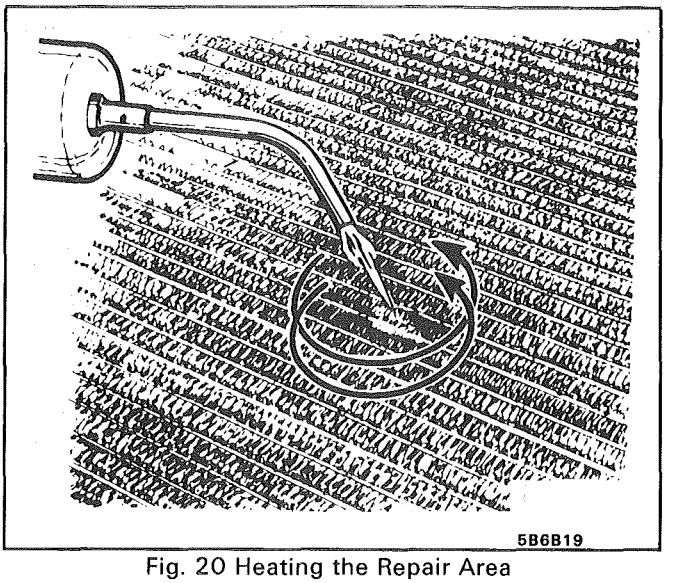


Fig. 20 Heating the Repair Area

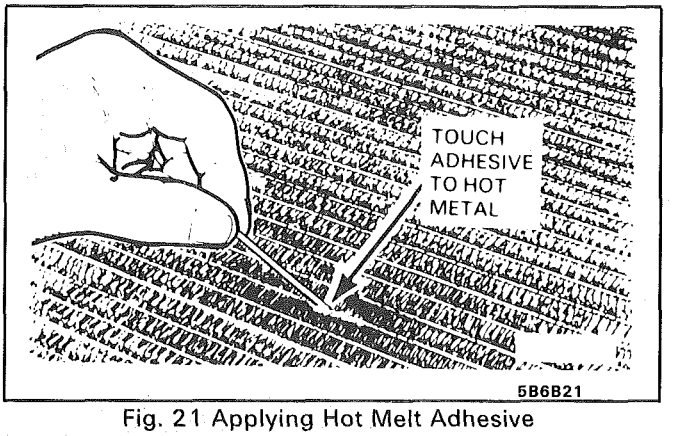


Fig. 21 Applying Hot Melt Adhesive

10. Heat the repair area until the adhesive is bubble-free and smooth, with a light yellow color. Curing is not required.
11. Test the radiator for leaks, when cool. If the repair area still leaks, reheat it gently to dry it. Heat and reflow the adhesive, or apply more as necessary, to repair the leak.

Tank Gasket Leak Repair

Tank gasket leaks can easily be mistaken for tank or header leaks. If a plastic tank leaks from the header joint gasket, tighten the clinch tabs with locking-type pliers (Fig. 22). If this method doesn't seal the leak, remove the tank for further inspection.

1. Pry open the clinch tabs, except those under inlet, outlet, and filler necks, using J33419-A or a screwdriver (Fig. 23). Lift tabs only enough to allow removal.

NOTICE: Care should be taken not to overbend tabs. Overbending could result in breakage. If there are more than 3 tabs broken on one side of the header, or more than 2 adjacent tabs together, the core must be replaced.

2. Lift the tank and slide it out from under the remaining clinched tab. You may have to tap the

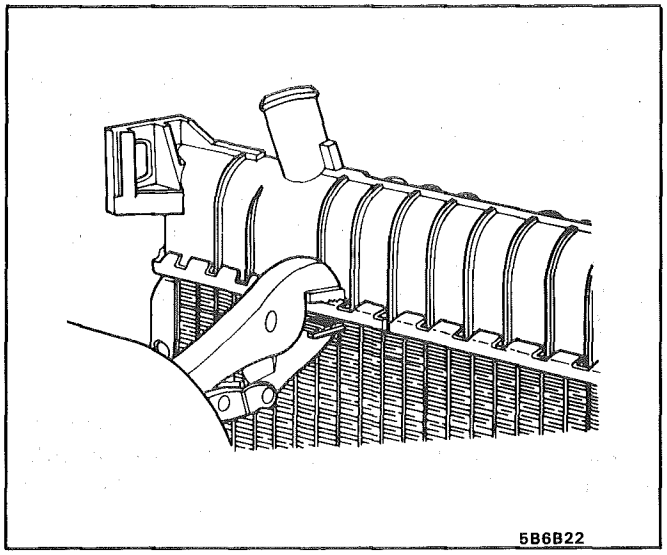


Fig. 22 Tightening Clinch Tabs

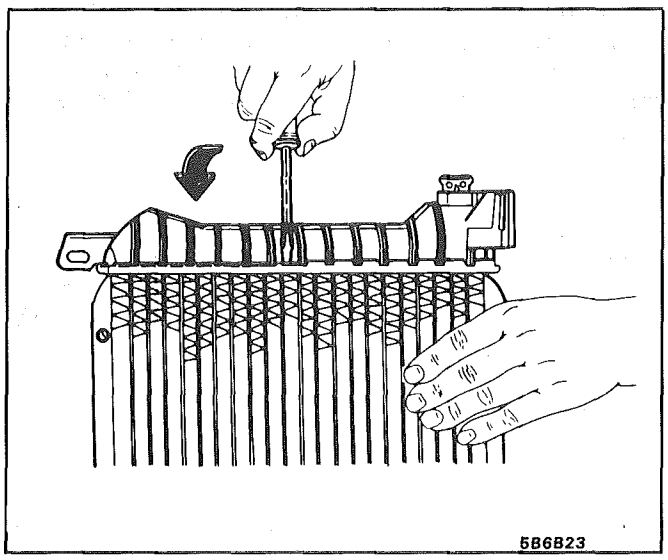


Fig. 23 Opening Clinch Tabs

tank with your hand to dislodge the gasket. Lift the remaining tab(s) with pliers.

3. Remove and discard the gasket.
4. Clean the header and gasket groove of all dirt and old rubber.
5. Clean the sealing edge of the plastic tank.
6. Examine the header gasket surface and tank flange for evidence of leakage, and clean or repair the surface to remove dirt, burrs, and bumps.
7. Remove the oil cooler, if equipped, and install it in the new tank.
8. Dip or coat the new tank gasket in engine coolant and position it on the header surface. The coolant helps hold the gasket in place.
9. Position the tank and gasket to the header, clamp it in place and secure it by bending four clinch tabs as shown in Fig. 24.
10. Clamp remaining clinch tabs around the header using the clinching tool or pliers (Fig. 25).

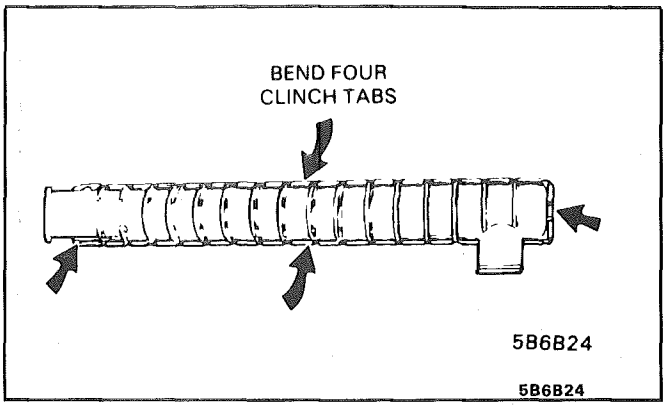


Fig. 24 Seating Tank to Core

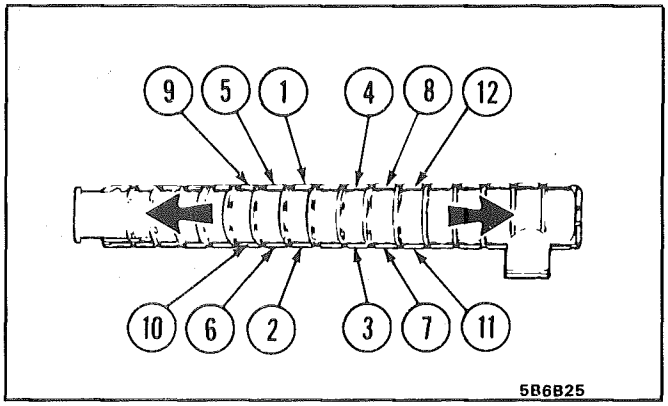


Fig. 25 Clinching Sequence

NOTICE: Tighten the clinch tabs as you would cylinder head bolts, starting at the center and working out to the ends.

11. Replace the core if there are more than three tabs broken on one side or two adjacent tabs broken.
12. Install the drain cock, if removed.
13. Test the radiator for leaks.

Oil Cooler Gasket Replacement

The outlet tank must be removed to replace the oil cooler, but the oil cooler gaskets can be replaced without removing the tank.

1. Remove the radiator and lay it on a flat surface.
2. Remove the bottom oil cooler nut and loosen the top nut.
3. Press the oil cooler into the hole and remove the gasket using a small hook (Fig. 26).
4. Blow-dry all surfaces on the tank and oil cooler.
5. Install a new gasket **without lubrication.** Be sure it is seated properly inside the lip of the fitting.
6. Reach into the inlet or outlet opening and push the oil cooler into position against the tank.
7. Assemble the oil cooler nut loosely.
8. Replace the other gasket by following the same procedure.
9. Install the oil cooler nuts and torque to 20 N·m (15 lb. ft.). Do not overtighten, as damage to the gasket could result.
10. Leak-test the radiator.

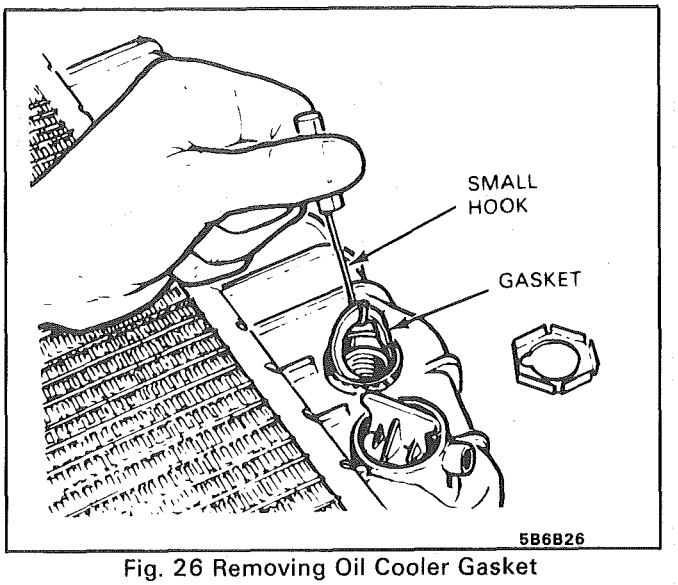


Fig. 26 Removing Oil Cooler Gasket

Oil Cooler Replacement

1. Remove the outlet tank as previously outlined.
2. Remove nuts from the oil cooler fittings.
3. Remove oil cooler and gaskets from tank.
4. Remove old rubber gaskets, throw away, clean and dry seal areas.
5. Place rubber gaskets on a new oil cooler and place onto outlet tank fitting holes, being careful not to loosen or misalign gaskets. Gaskets must be installed dry and free of dirt and oil.
6. Install and tighten nuts snugly onto fittings.
7. Torque nuts to 20 N·m (15 lb. ft.). Overtorquing could cut the rubber gaskets.
8. Replace tank as previously described.
9. Test radiator.

Recore

If the radiator core is damaged beyond repair and the other parts are serviceable, install the original inlet and outlet tanks, oil cooler, radiator cap, and drain valve, onto a new core and install new gaskets.

Drain Cock

If the drain cock does not seal when tightened snugly, remove the drain cock, clean drain and replace. If the body of the draincock is broken, remove the body from the tank by squeezing the sides together with needle nose pliers (Fig. 9).

Special Tools

Special tools are available through normal channels for servicing the aluminum-plastic radiator. The universal Cooling System and Cap Pressure Tester, BT-7518 or J-24460-01, can also be used with the aluminum-plastic radiator.

ON-VEHICLE SERVICE

THERMOSTAT

Remove or Disconnect

1. Battery negative cable at battery.
2. Air cleaner.
3. Drain cooling system.
4. Thermostat housing attaching bolts and remove housing. Remove thermostat from manifold.

Clean

- Clean housing and manifold sealing surfaces.

Install or Connect

1. New gasket.
2. Thermostat in intake manifold.
3. Refer to Section 6E3 for plenum and throttle body installation.
4. Battery negative cable.
5. Fill cooling system.
6. Start engine and run, with radiator cap removed, until radiator upper hose becomes hot (thermostat open).
7. With engine idling, add coolant to radiator until level reaches bottom of filler neck.
8. Cap making sure arrows line up with overflow tube.

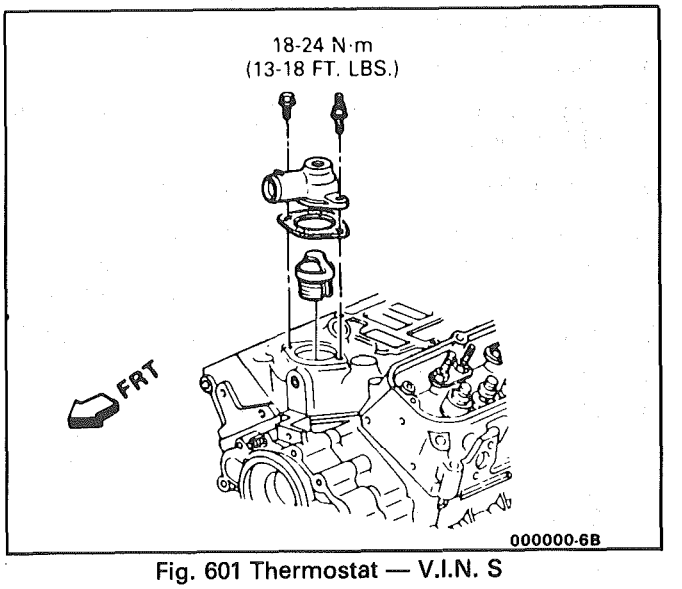


Fig. 601 Thermostat — V.I.N. S

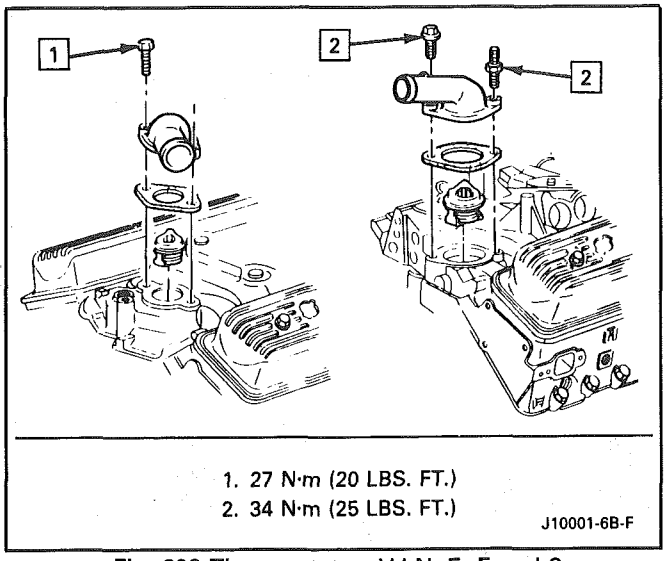


Fig. 602 Thermostat — V.I.N. E, F and 8

ELECTRIC COOLING FAN

CAUTION: Keep hands, tools, and clothing away from engine cooling fan to help prevent personal injury. This fan is electric and can come on whether or not the engine is running. The fan can start automatically in response to a heat sensor with the ignition in the "On" position.

Remove or Disconnect

1. Negative battery cable.
2. Harness from fan motor and fan frame.
3. Fan frame to radiator support attaching bolts.
4. Fan and frame assembly.

Install or Connect

1. Fan and frame assembly.
2. Fan frame to radiator support attaching bolts and torque to specification.
3. Harness to fan frame and fan motor.
4. Negative battery cable.

Inspect

- For proper completion of repairs.
- For operation of fan motor.

WATER PUMP

Remove or Disconnect

1. Battery negative cable at battery.
2. Cooling system.
3. If equipped with M.F.I., remove air intake tube and mass air flow sensor.
4. Fan and radiator upper support, as applicable.
5. Serpentine belt.
6. Generator upper and lower brackets, A/C brace and bracket and, if equipped, power steering pump lower bracket from water pump and swing aside.
7. Radiator lower hose and heater hose from water pump.
8. Water pump to block attaching bolts and remove water pump.

Install or Connect

- If installing a new water pump, transfer heater hose fitting from old unit.

1. With clean sealing surfaces on both block and water pump, install water pump to block with new gaskets and retain with attaching bolts. Torque to specifications. (V6 small bolt 10 N·m, 7 lb. ft., large bolt and nut 20 N·m, 15 lb. ft.) (V8-40 N·m, 30 lb. ft.)
2. Radiator lower hose and heater hose to water pump and torque clamps to 2 N·m (20 lb. in.).
3. Generator upper and lower brackets and, if equipped, the power steering pump lower bracket to the water pump. Torque bolts to 41 N·m (30 lb. in.).
4. Serpentine belt.
5. If equipped with M.F.I., install air intake tube and mass air flow sensor.
6. Fan and radiator upper support, as applicable.
7. Battery negative cable.
8. Fill cooling system with an ethylene glycol antifreeze and water mixture of 50/50.
9. Start engine and run, with radiator cap removed, until radiator upper hose becomes hot (thermostat open).
10. With engine idling, add coolant to radiator until level reaches bottom of filler neck.
11. Cap, making sure arrows line up with overflow tube.

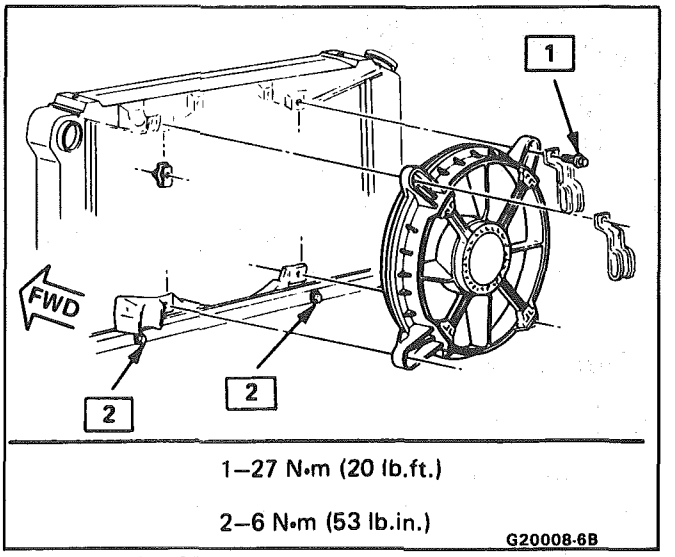


Fig. 603 Fan Mounting V.I.N. E, S (All) F, 8 (w/o A/C)

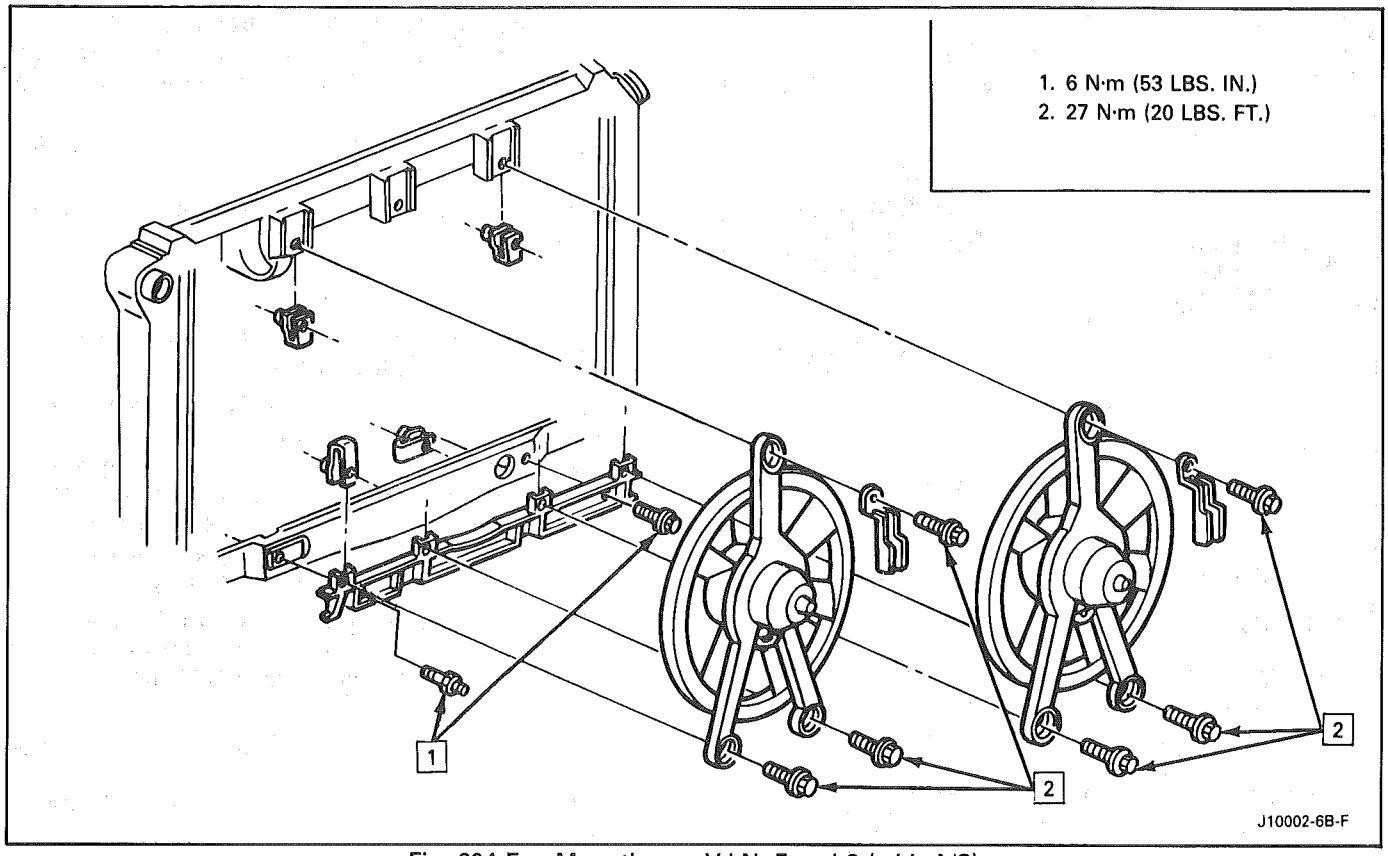


Fig. 604 Fan Mounting — V.I.N. F and 8 (with A/C)

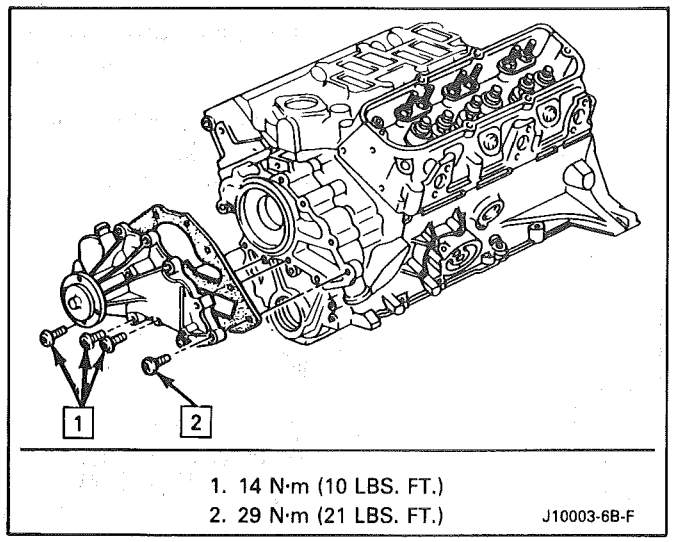


Fig. 605 Water Pump Mounting — V.I.N. S

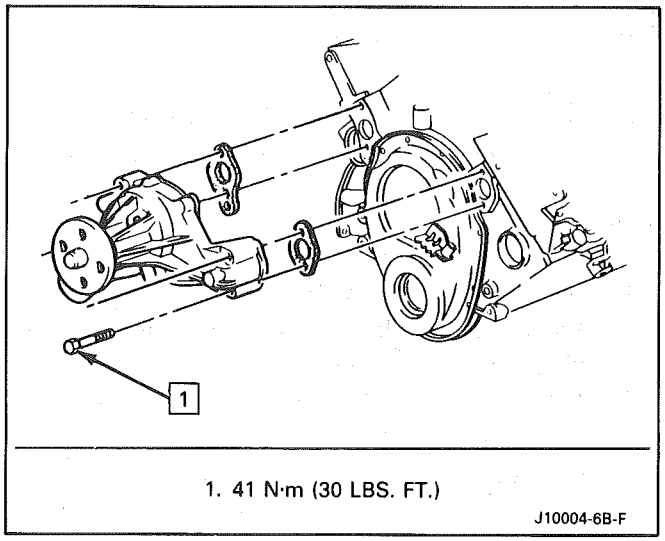


Fig. 606 Water Pump Mounting — V.I.N. E, F and 8

COOLANT RECOVERY BOTTLE

Remove or Disconnect

1. Hose from recovery bottle.
2. Attaching screws and remove bottle.

Clean

- Recovery bottle with suitable solution.

Install or Connect

1. Place bottle in vehicle and torque attaching screws to 3 N·m (27 lb.in.).
2. Coolant hose to bottle.
3. Fill bottle to appropriate mark.

RADIATOR

Remove or Disconnect

1. Negative battery cable.
2. Engine coolant.
3. Fan blade. On fan clutch equipped cars, store clutch in upright position to prevent seal leakage.
4. Upper and lower radiator hoses.
5. On vehicles equipped with automatic transmission, plug transmission cooler lines.
6. Fan shield assembly, if applicable.
7. Radiator and shroud assembly, lift straight up. The radiator assembly is held at the bottom by two cradles secured to the radiator support.

Install or Connect

1. If new radiator, transfer fittings from old radiator to new radiator.
2. Radiator in car, locating bottom of radiator in lower mounting pads.
3. Transmission/Engine oil cooler lines at radiator.
4. Coolant recovery bottle hose at radiator.
5. Coolant hoses at radiator.
6. Upper radiator support bracket.
7. Engine coolant.
8. Negative battery cable.

Inspect

- For proper completion of repair.
- For fluid leaks.

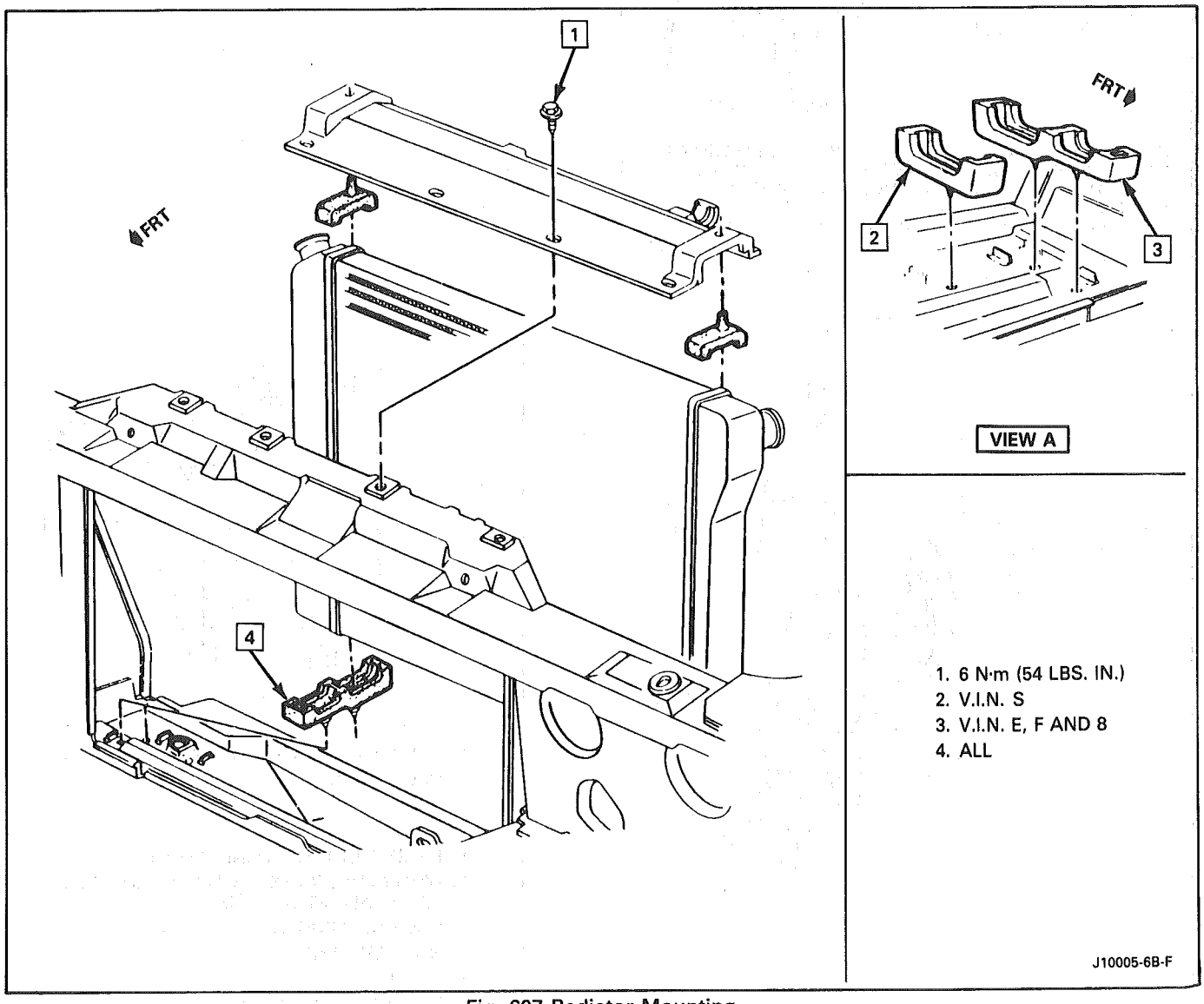
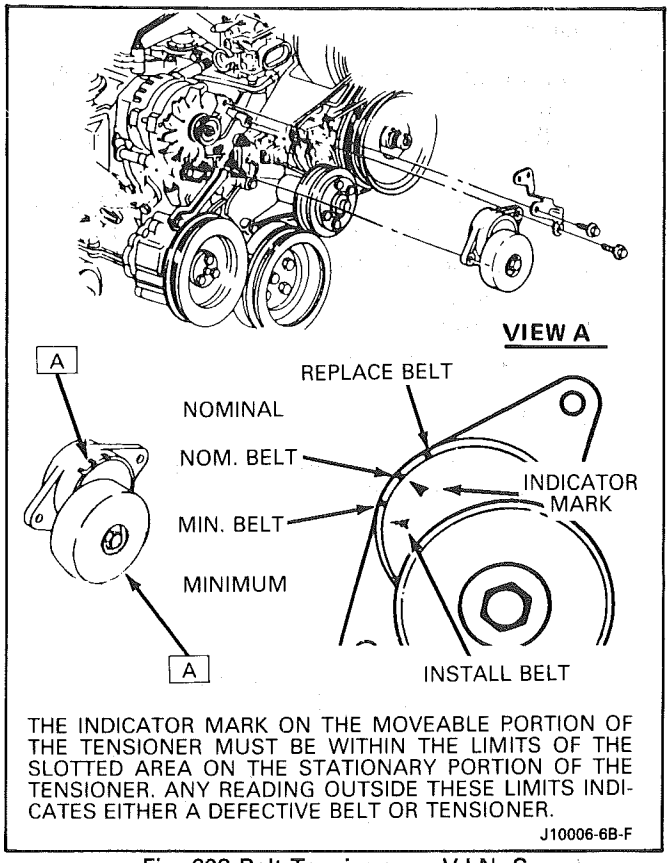


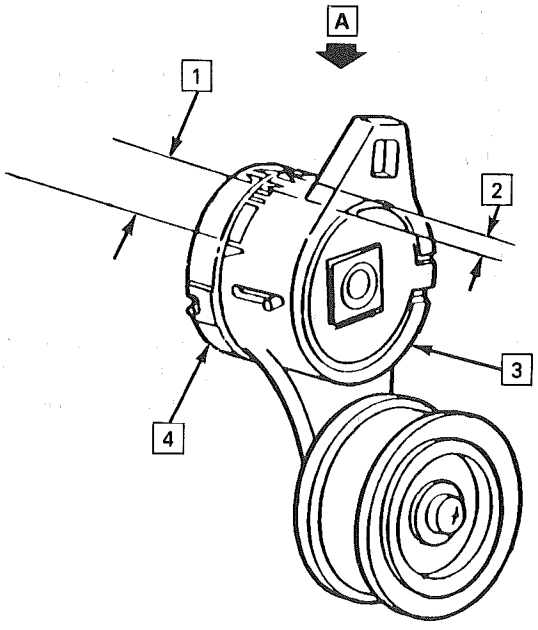
Fig. 607 Radiator Mounting

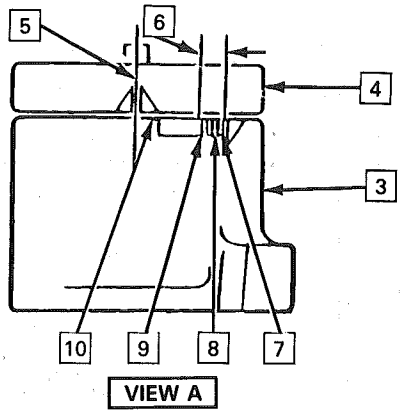


THE INDICATOR MARK ON THE MOVEABLE PORTION OF THE TENSIONER MUST BE WITHIN THE LIMITS OF THE SLOTTED AREA ON THE STATIONARY PORTION OF THE TENSIONER. ANY READING OUTSIDE THESE LIMITS INDICATES EITHER A DEFECTIVE BELT OR TENSIONER.

J10006-6B-F

Fig. 608 Belt Tensioner — V.I.N. S

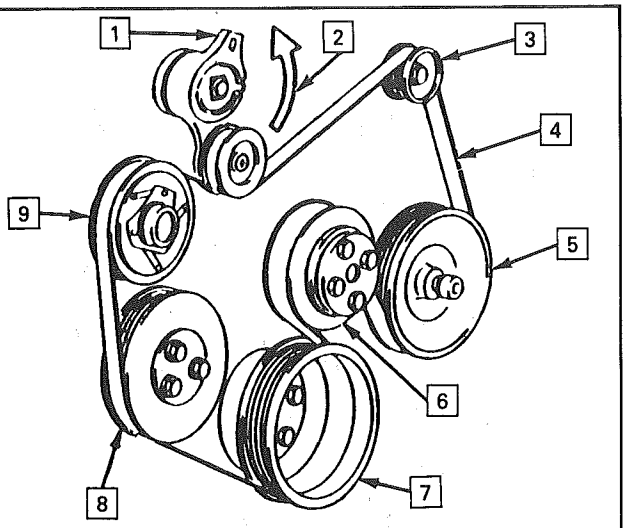




1. USED BELT ACCEPTABLE WEAR RANGE
2. NEW BELT RANGE
3. ARM
4. SPINDLE
5. FIXED BELT LENGTH INDICATOR
6. WITH NEW BELT INSTALLED, FIXED POINTER MUST FALL WITHIN THIS RANGE
7. MINIMUM LENGTH – NEW BELT
8. NOMINAL LENGTH – NEW BELT
9. MAXIMUM LENGTH – NEW BELT
10. REPLACE BELT POSITION

J10007-6B-F

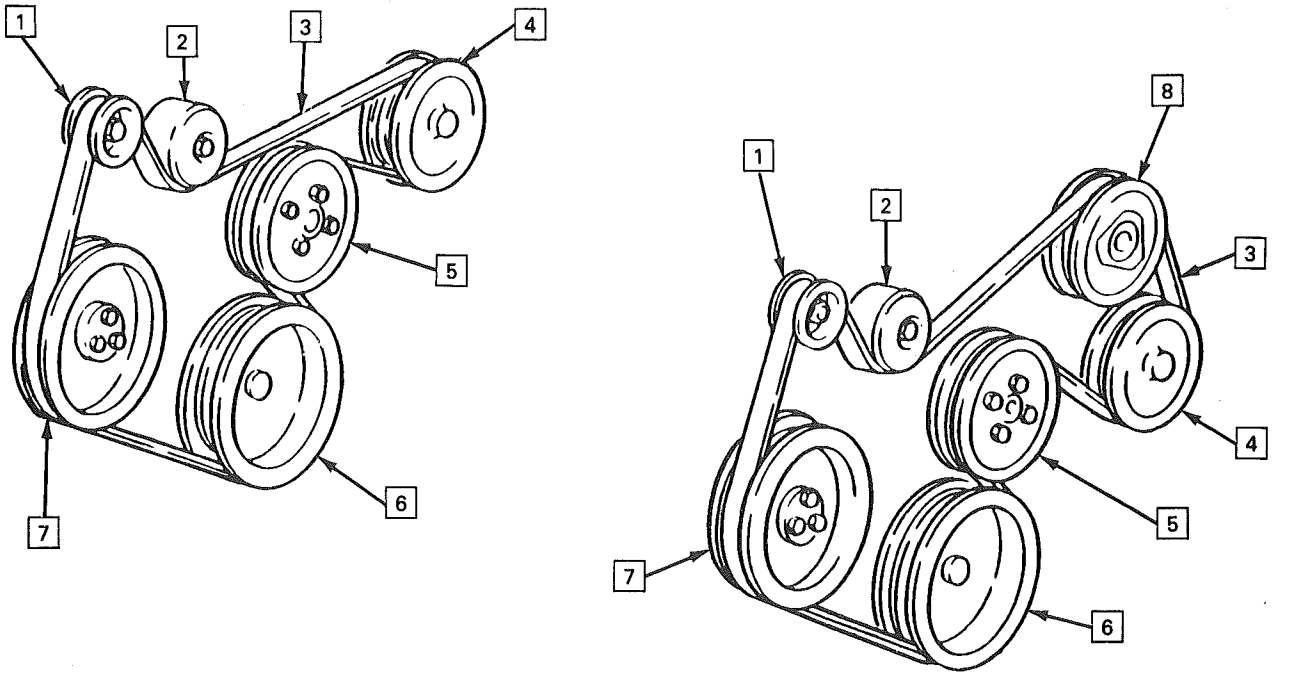
Fig. 609 Belt Tensioner — V.I.N. E, F and 8



1. TENSIONER ASSEMBLY
2. ROTATE TENSIONER IN DIRECTION SHOWN TO INSTALL OR REMOVE BELT
3. GENERATOR ASSEMBLY
4. ACCESSORY DRIVE BELT
5. P/S PUMP
6. WATER PUMP
7. CRANKSHAFT
8. A.I.R. PUMP
9. A/C COMPRESSOR OR BELT IDLER

J10008-6B-F

Fig. 610 Belt Diagram — V.I.N. E, F and 8



1. GENERATOR
2. TENSIONER
3. BELT
4. P/S PUMP
5. WATER PUMP
6. CRANKSHAFT
7. A.I.R. PUMP
8. A/C COMPRESSOR

J10009-6B-F

Fig. 611 Belt Diagram — V.I.N. S (Manual Transmission)

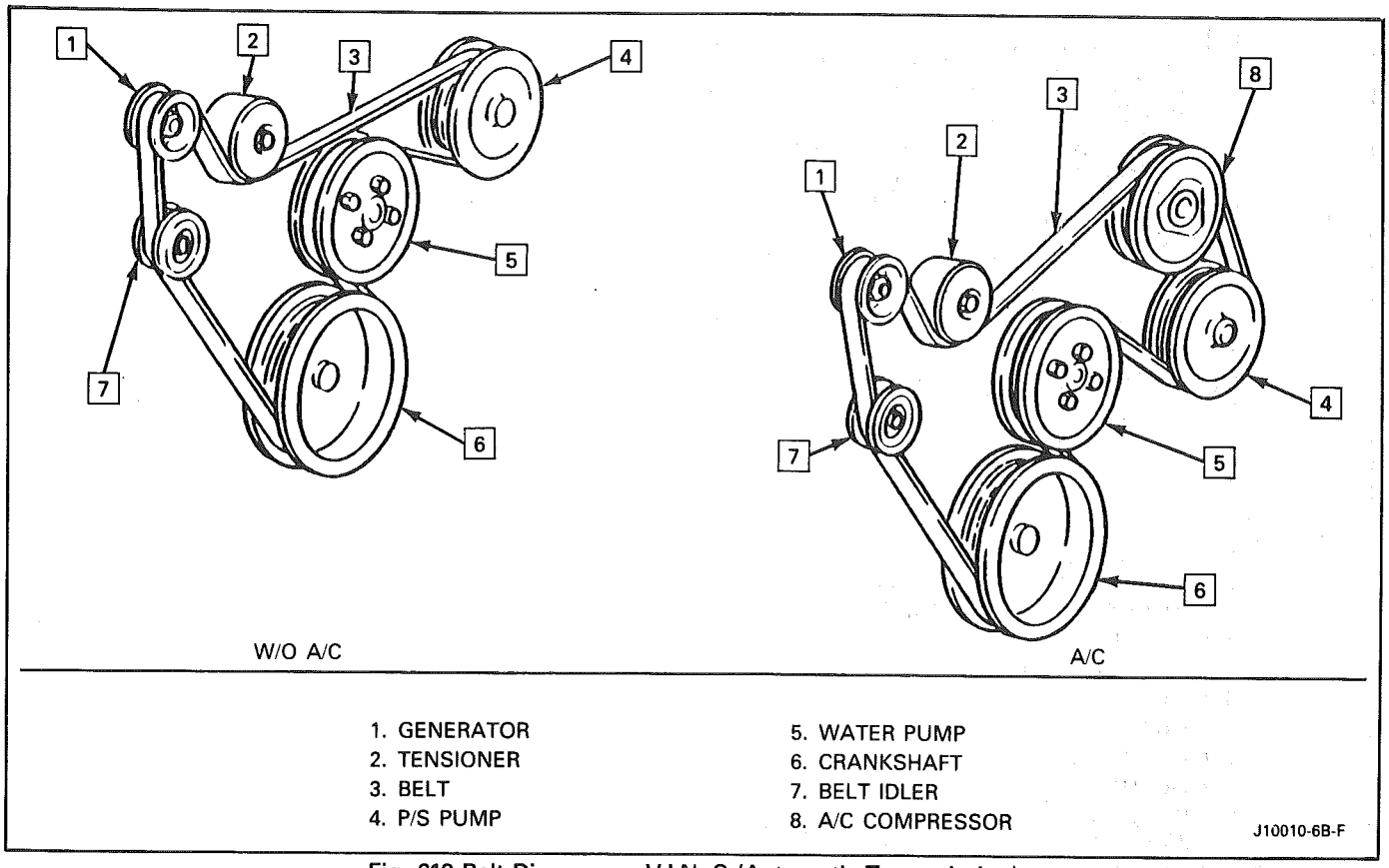


Fig. 612 Belt Diagram — V.I.N. S (Automatic Transmission)

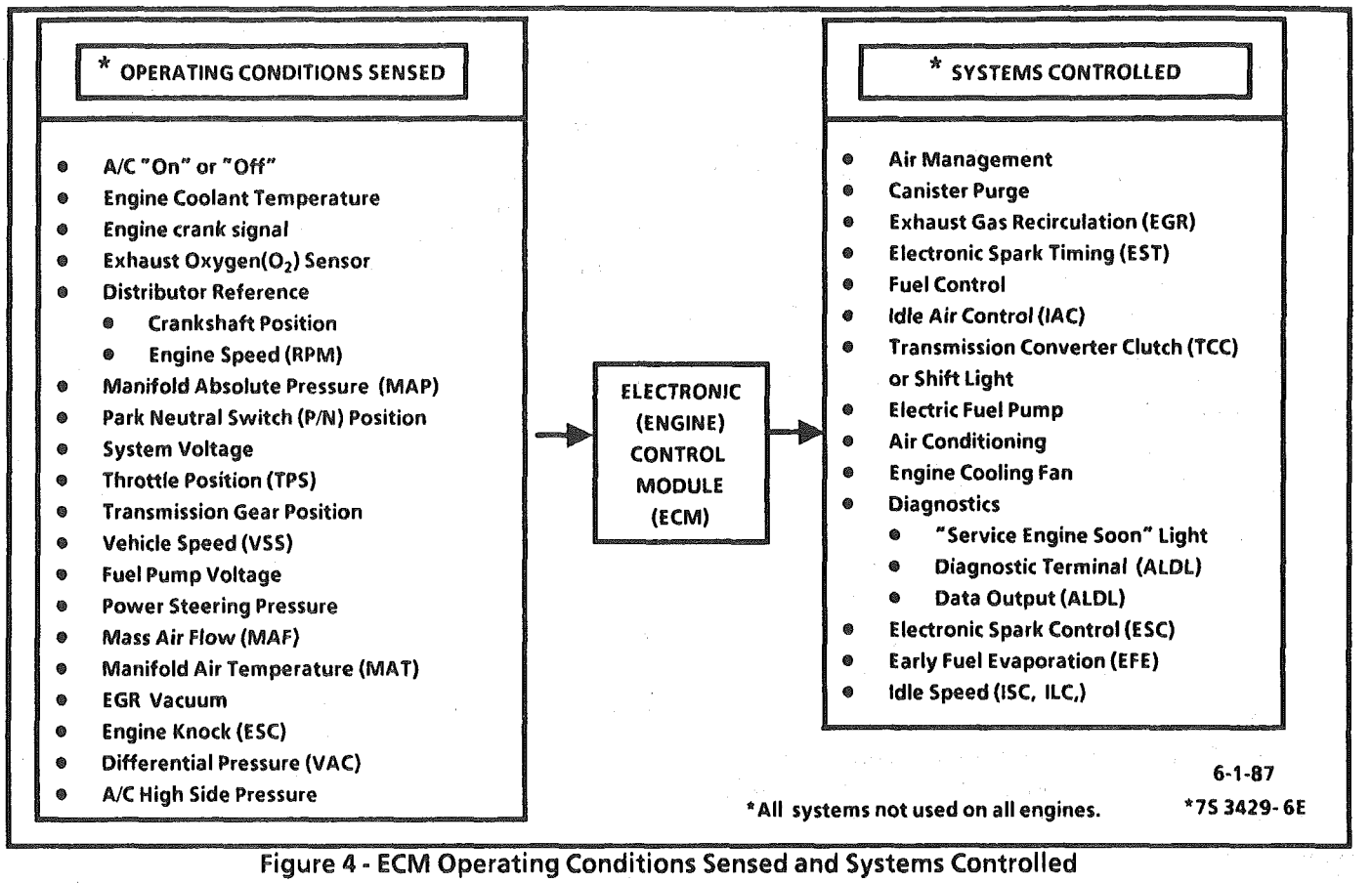


Figure 4 - ECM Operating Conditions Sensed and Systems Controlled

driveaway. This system is not used on all engines and may or may not be controlled by the ECM.

Exhaust Gas Recirculation (EGR)

The EGR system uses a valve to feed a small amount of exhaust gas back into the intake manifold to control formation of NO_x.

Transmission Converter Clutch (TCC)

The TCC is ECM controlled and is used on all engines with an automatic transmission. This system reduces slippage losses in the torque converter by coupling the engine flywheel to the output shaft of the transmission.

Shift Light Control

The ECM controls the shift light on some manual transmission vehicles to indicate the best shift point for maximum fuel economy. This control is not on all applications.

A/C Clutch Control

The ECM may control the A/C clutch on the compressor to improve idle quality. This control is not on all engines.

Electric Cooling Fan Control

Under certain conditions, the ECM may control the electric cooling fan to cool the engine and A/C condenser. At cruising speed, the ECM may turn the fan off for better fuel economy. This control is on transverse engine front wheel drive vehicles.

Positive Crankcase Ventilation (PCV) or Crankcase Ventilation (CV)

The PCV or CV system passes crankcase vapors into the intake manifold. This system is not controlled by the ECM and is used on all engines.

Thermostatic Air Cleaner (THERMAC)

The THERMAC system regulates heated air through the air cleaner to provide uniform inlet air temperature, which gives good driveability under various climatic conditions. This system is not controlled by the ECM.

ABBREVIATIONS AND GLOSSARY OF TERMS

Abbreviations used in this section are listed below in alphabetical order with an explanation of the abbreviation. There are some variations in the use of periods and in capitalization (as mph, m.p.h., Mph,