INTRODUCTION

The primary function of the engine lubrication system is to maintain a positive and continuous oil supply to the engine's bearings. Engine oil pressure must be high enough to get the oil to the bearings with enough force to cause the oil flow that is required for proper cooling. Fig. 1.

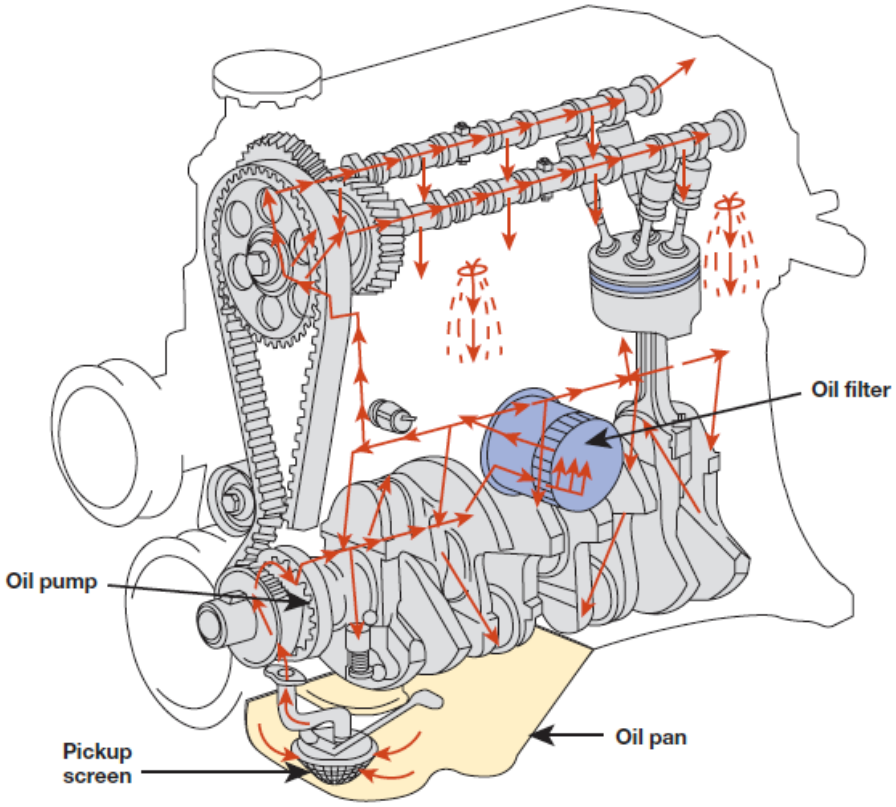

Figure 1. Lubrication system.

The normal engine oil pressure range is from 10 to 60 PSI (200 to 400 kPa) or 10 PSI per 1,000 engine rpm. Fig. 2.

Figure 2. The dash oil pressure gauge may be a good indicator of engine oil pressure. If there is any concern about the oil pressure, always use a mechanical gauge to be sure.

It is normal to see the following:

- Higher oil pressure when the engine is cold due to the oil being cold and at a higher viscosity
- Lower oil pressure when the engine is at normal operating temperature due to the oil becoming thinner even though it is multiviscosity oil
- Lower oil pressures at idle and higher pressures at higher engine speeds because oil pumps are “positive displacement” pumps

All production automobile engines have a full-pressure oil system. The oil pump is required to:

- Provide 3 to 6 gallons per minute of engine oil to lubricate the engine
- Maintain pressure, by forcing the oil into the lubrication system under pressure

On crankshaft-driven oil pump systems, the oil pump assembly is often made as part of the engine’s front cover so that it turns at the same speed as the crankshaft. On older engines that use a distributor, the distributor drive gear meshes with a gear on the camshaft. Fig. 3.

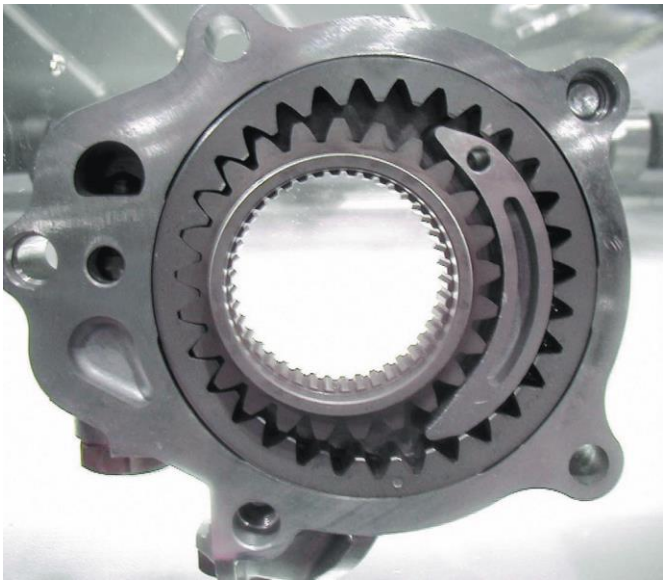

Figure 3. This oil pump is driven by the crankshaft and is located in the front engine cover.

ASE TEST TOPICS

1. Diagnose engine lubrication system problems; perform engine oil pressure tests.

Proper oil pressure is very important for the operation of any engine. Low oil pressure can cause engine wear, and engine wear can cause low oil pressure. If main thrust or rod bearings are worn, oil pressure is reduced because of leakage of the oil around the bearings. To check oil pressure:

- With the engine off, remove the oil pressure sending unit or sender, usually located near the oil filter.
- Thread an oil pressure gauge into the threaded hole. Fig. 4.

- Start the engine and observe the gauge. Record the oil pressure at idle and at 2500 RPM. Most vehicle manufacturers recommend a minimum oil pressure of 10 PSI per 1000 RPM. Therefore, at 2500 RPM, the oil pressure should be at least 25 PSI.

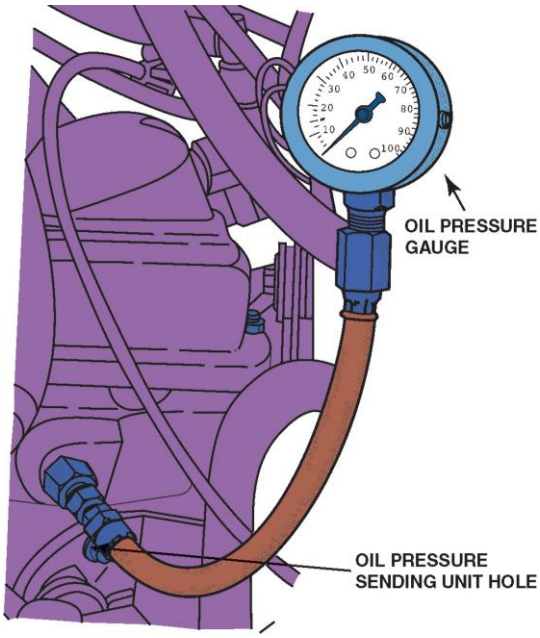

Figure 4. Checking oil pressure.

2. Perform engine oil leak tests.

Oil leaks can lead to severe engine damage if the resulting low oil level is not corrected. Besides causing an oily mess where the vehicle is parked, the oil leak can cause blue smoke to occur under the hood as leaking oil drips on the exhaust system. Finding the location of the oil leak can often be difficult.

What looks like an oil pan gasket leak can be a rocker cover gasket leak. Always look for the highest and most forward place you see oil leaking; that should be repaired first. Fig. 5.

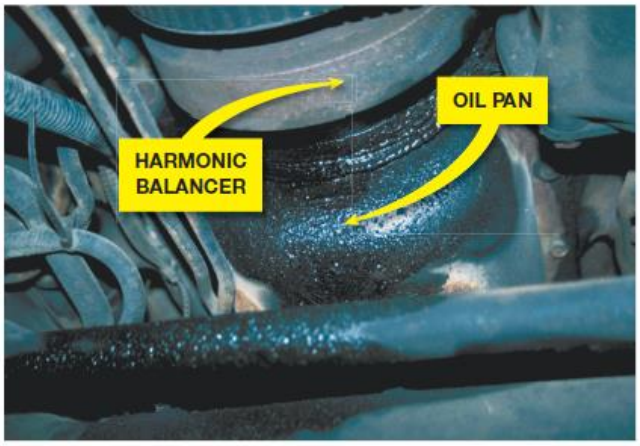

Figure 5. This leak could be the oil pan gasket or a valve cover gasket.

3. Inspect engine oil pump (includes gears, rotors, housing, and pick-up assembly); inspect pressure relief devices, control systems, and pump drive (includes belt/chain drive).

The gears and housing are examined for scoring. If the gears and housing are heavily scored, the entire pump should be replaced. Fig. 6.

Figure 6. A worn oil pump end plate.

If they are lightly scored, the clearances in the pump should be measured. These clearances include the space between the gears and housing, the space between the teeth of the two gears, and the space between the side of the gear and the pump cover. A feeler gauge is often used to make these measurements.

In engines with a full-pressure lubricating system, maximum pressure is limited with a pressure relief valve. The relief valve (sometimes called the pressure regulating valve) is located at the outlet of the pump. The relief valve controls maximum pressure by bleeding off oil to the inlet side of the pump. The relief valve spring tension determines the maximum oil pressure. Fig.7.

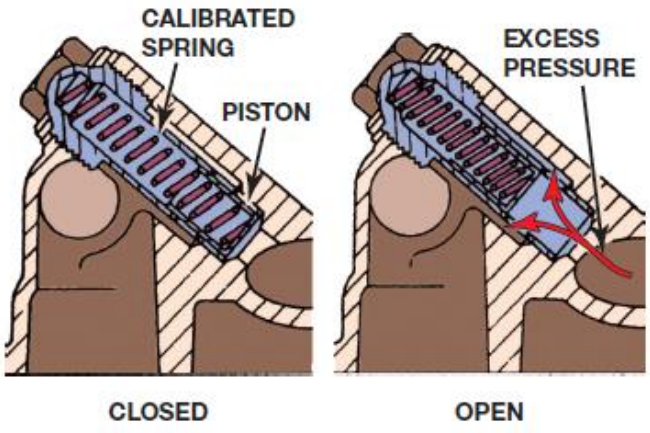

Figure 7. Oil pressure relief valve.

4. Inspect, flush, and test internal and external engine oil coolers.

Oil temperature must be controlled on many high-performance or turbocharged engines. A larger capacity oil pan helps to control oil temperature. Some engines use remote mounted oil coolers. Coolant flows through the oil cooler to help warm the oil when the engine is cold and cool the oil when the engine is hot. Fig. 8.

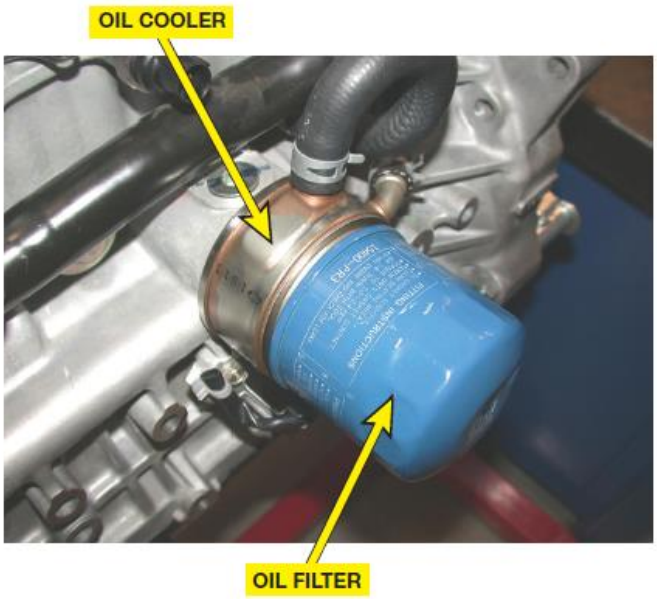

Figure 8. Oil is cooled by a flow of coolant.

5. Change engine oil and filter(s) using proper type, viscosity, and rating per manufacturer's specifications.

Most vehicles built since the mid-1990s are equipped with a warning light that lets the driver know when the engine oil should be changed. The two basic types of oil change monitoring systems include:

- Mileage only. The service light will come on based on mileage only and may include a service "A" or "B" based on what service needs to be performed.
- Algorithm. Computer programs contain algorithms that specify instructions a computer should perform (in a specific order) to carry out a task. This program uses the number of cold starts, the run time of the engine, and inputs from the engine coolant temperature (ECT) sensor to determine when the oil should be changed.

The oil within the engine is pumped from the oil pan through the filter before it goes into the engine lubricating system passages. The filter is made from either closely packed cloth fibers or a porous paper. Large particles are trapped by the filter. If the filter becomes plugged a bypass valve allows the engine to be lubricated with dirty oil, rather than having no lubrication at all. Fig. 9 and 10.

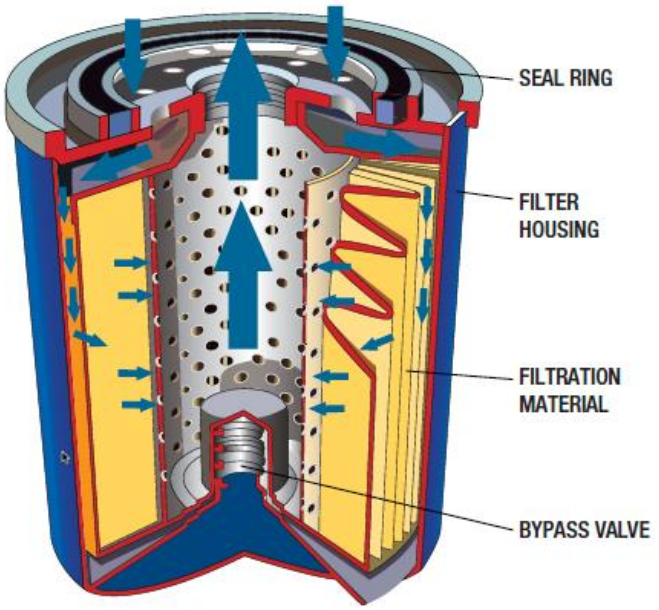

Figure 9. Cutaway oil filter, showing the parts.

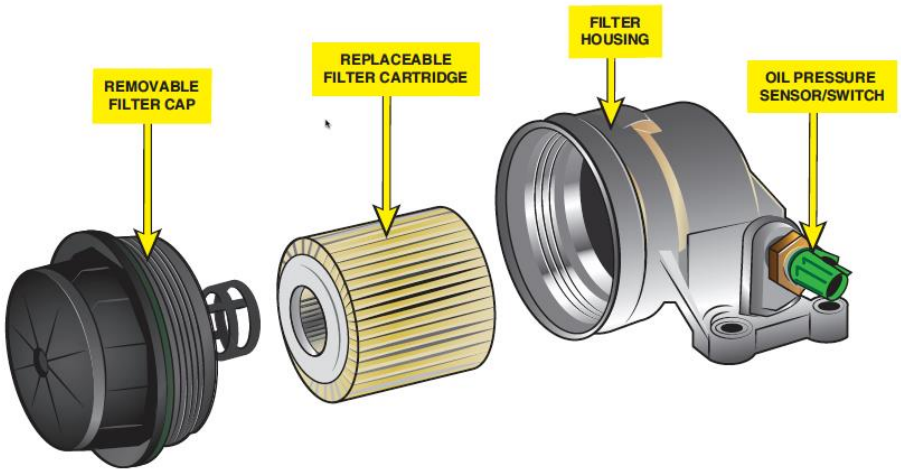

Figure 10. A cartridge-type oil filter.

An SAE 5W-30 multigrade oil meets the SAE 5W viscosity specification when cooled to 0°F (−18°C) and meets the SAE 30 viscosity specification when tested at 212°F (100°C). Most vehicle manufacturers recommend the following multiviscosity engine oils.

- SAE 0W-16
- SAE 0W-20
- SAE 5W-20
- SAE 5W-30

6. Diagnose engine cooling system problems; perform cooling system pressure and leak tests.

Coolant flows through the engine, where it picks up heat. It then flows to the radiator, where the heat is given up to the outside air. The coolant continually recirculates through the cooling system. Fig. 11.

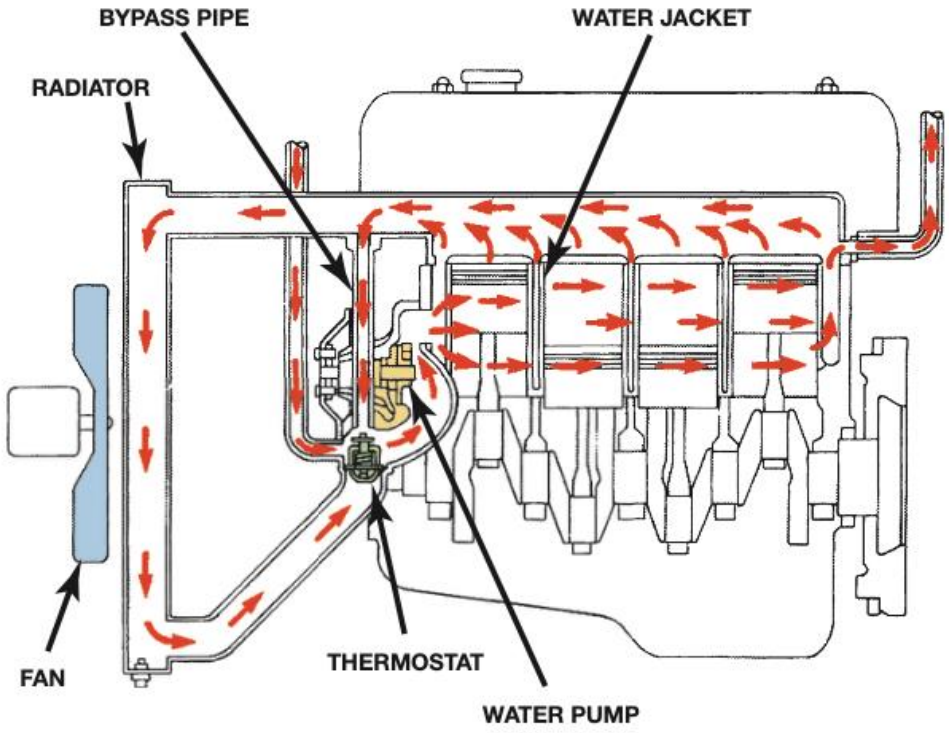

Figure 11. Engine cooling system.

Pressure testing using a hand-operated pressure tester is the standard test when looking for leaks.. The radiator cap is removed (engine cold!) and the tester is attached in the place of the radiator cap. By operating the plunger on the pump, the entire cooling system is pressurized.

A typical hand-operated pressure tester applies pressure equal to the radiator cap pressure. The pressure should hold; if it drops, this indicates a leak somewhere in the cooling system. Fig. 12.

Figure 12. Pressure testing.

7. Inspect and test radiator, heater core, pressure cap, and coolant recovery system; replace as required.

Some older cooling systems connect the overflow from the radiator to a plastic reservoir to hold excess coolant while the system is hot. When the system cools, the pressure in the cooling system is reduced and a partial vacuum forms. This vacuum valve in the cap pulls the coolant from the plastic container back into the cooling system, keeping the system full. Because of this action, the system is called a coolant recovery system. Fig. 13.

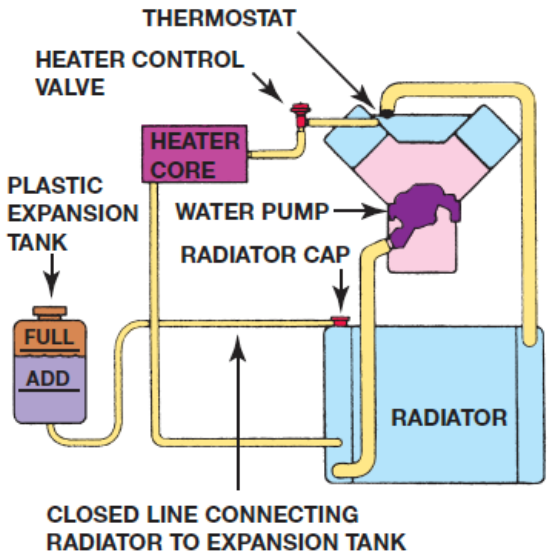

Figure 13. Coolant recovery system.

Most vehicles use a surge tank, which is located at the highest level of the cooling system and holds about 1 quart (1 liter) of coolant. The tank also is where the pressure cap is installed. A hose attaches to the bottom of the surge tank to the inlet side of the water pump. A smaller bleed hose attaches to the side of the surge tank to the highest point of the radiator. The bleed line allows some coolant circulation through the surge tank. Air in the system will rise below the radiator cap and be forced from the system if the pressure in the system exceeds the rating of the radiator cap. Fig. 14.

Figure 14. Surge tank and pressure cap.

To test the pressure cap, an adapter is used to attach the pump to the cap to determine if the cap can hold pressure and release it when pressure rises above its maximum rated pressure setting. Figure 15.

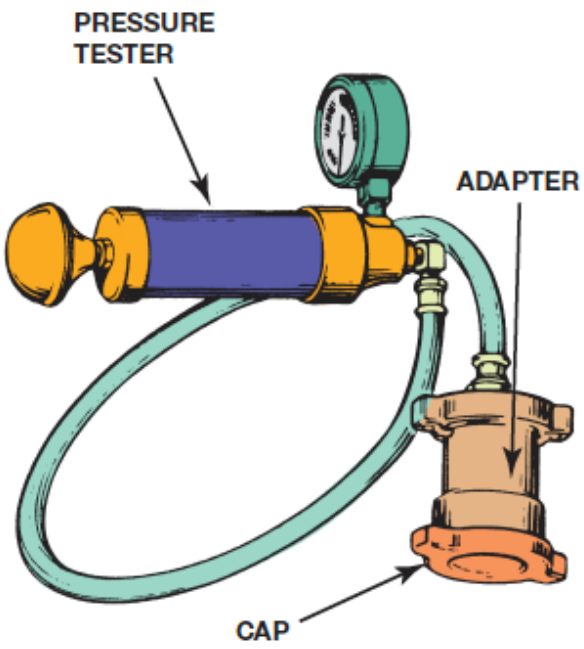

Figure 15. Testing the pressure cap.

8. Inspect and replace engine cooling system and heater system coolant hoses, pipes, fittings and valves.

Coolant system hoses are critical to engine cooling. As the hoses get old, they become either soft or brittle and sometimes swell in diameter. Their condition depends on their material and on the engine service conditions. A hose should be replaced any time it appears to be abnormal.

Many heater hoses are sizes that can also be used for other purposes, such as oil lines. Always check and use hose that states it is designed for heater or cooling system use. Fig. 16.

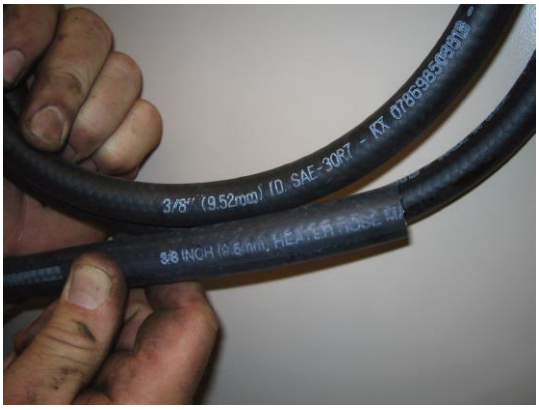

Figure 16. The top 3/8 inch hose is designed for oil and similar liquids, whereas the 3/8 inch hose below is labeled “heater hose” and is designed for coolant.

9. Inspect, test, reinstall or replace engine cooling system thermostat, coolant by-pass, and thermostat housing (including electronically controlled thermostats).

There is a normal operating temperature range between low-temperature and high-temperature extremes. The thermostat controls the minimum normal temperature.

A scan tool can be used on most vehicles to read the actual temperature of the coolant as detected by the engine coolant temperature (ECT) sensor. As the engine warms up the scan tool can see the point where the thermostat opens as a slight decrease in temperature as cooler coolant flows from the radiator.

The thermostat is a temperature-controlled valve placed at the engine coolant outlet on most engines. Some thermostats are electrically heated. Fig. 17 and 18.

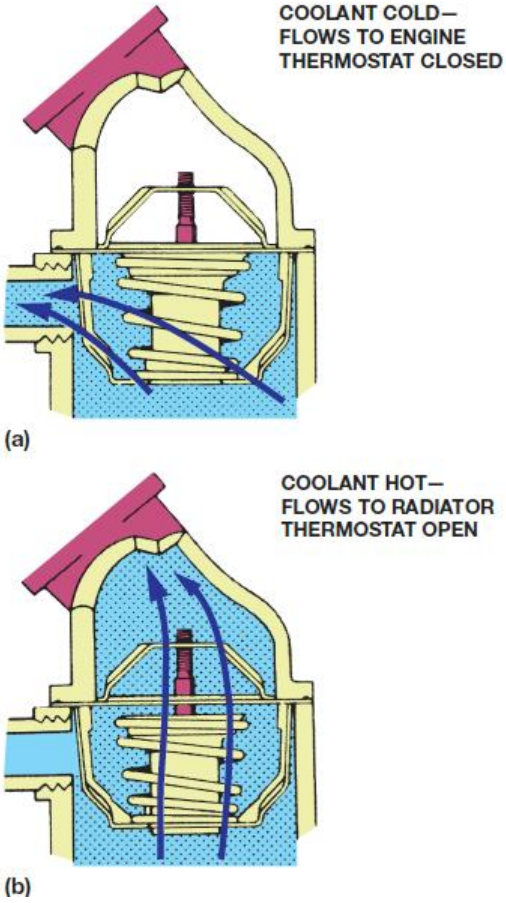

Figure 17. (a) When the engine is cold, the coolant flows through the bypass. (b) When the thermostat opens, the coolant can flow to the radiator.

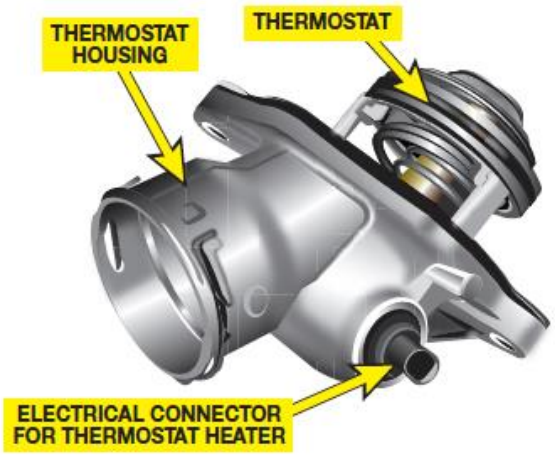

Figure 18. An electrically heated thermostat.

10. Inspect and replace engine water/coolant pump(s) (including electrical water/coolant pumps).

The water pump (also called a coolant pump) is driven by one of three methods.

- Crankshaft belt
- Camshaft
- Electric motor

Coolant recirculates from the radiator to the engine and back to the radiator. Low-temperature coolant leaves the radiator by the bottom outlet. It is pumped into the warm engine block, where it picks up some heat. From the block, the warm coolant flows to the hot cylinder head, where it picks up more heat. The pump pulls coolant in at the center of the impeller. Centrifugal force throws the coolant outward so that it is discharged at the impeller tips. Fig 19.

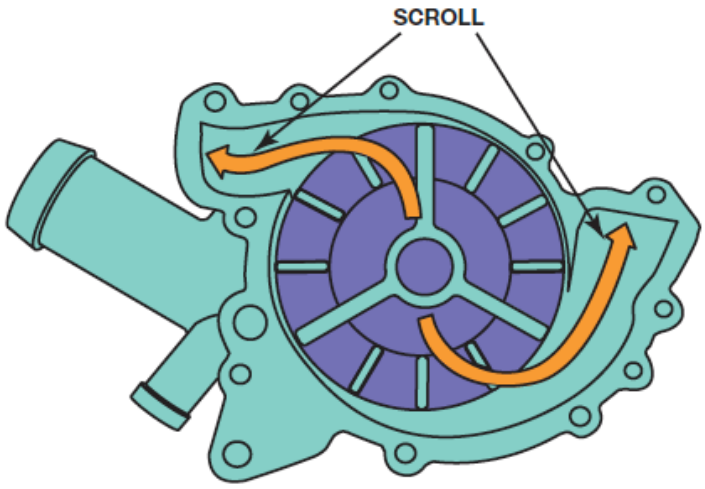

Figure 19. Water pump.

An electric water pump uses a DC motor to power the impeller and is used on most hybrid electric vehicles and some internal combustion engines. The electric water pump usually is attached to the engine and is controlled by the powertrain control module (PCM).

11. Inspect and test engine coolant; drain, flush, and refill cooling system(s) with recommended coolant; bleed air as required.

Antifreeze is a concentrated, glycol-based liquid that must be diluted with water before using. When mixed with water, it is referred to as coolant. Engine coolant is usually a mixture of 50% antifreeze and 50% water.

Coolant can be checked using a coolant hydrometer. The hydrometer measures the density of the coolant. The higher the density, the more concentration of antifreeze in the water. Most coolant hydrometers read the freezing and boiling points of the coolant. Fig. 20.

Figure 20. Coolant hydrometer.

Coolant should be replaced according to the vehicle manufacturer's recommended interval. For most vehicles this interval may be every five years or 150,000 miles (241,000 km), whichever occurs first.

12. Inspect and test engine cooling fan (both electrical and mechanical), fan clutch, fan shroud, air dams, shutters, and electrical circuits; repair or replace as required.

Many rear-wheel-drive vehicles and all transverse engines drive the fan with an electric motor. Most electric cooling fans are computer controlled. To save energy, most cooling fans are turned off whenever the vehicle is traveling faster than 35 mph (55 km/h). Two types of electric cooling fans used, a one two-speed cooling fan, or two cooling fans (one for normal cooling and one for high heat conditions)

On some rear-wheel-drive vehicles, a thermostatic cooling fan is driven by a belt from the crankshaft. The thermostatic fan is designed so that it uses little power at high engine speeds and minimizes noise. Fig. 21.

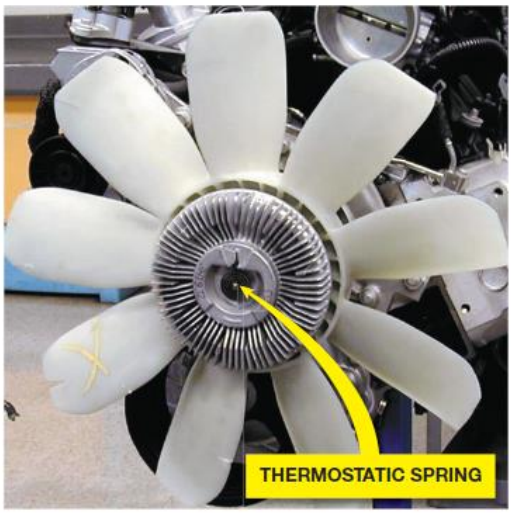

Figure 21. The thermostatic system engages the fan as engine temperatures increase.

Active Grille Shutters (AGS), also called a Radiator Shutter Assembly, are located between the front grille and the condenser. The plastic shutters open or close to control the airflow going under the hood. The primary function of the active grille shutters is to reduce the aerodynamic drag of the vehicle when closed. Unnecessary air entering the engine bay can create aerodynamic drag, decreasing fuel economy.

13. Inspect, test, reinstall, and/or replace pulleys, tensioners, and drive belts; adjust belts and check alignment.

It is generally recommended that all belts be inspected regularly and replaced as needed. Replace any serpentine belt that has more than three cracks in any one rib that appears in a 3 inch span. Fig. 22.

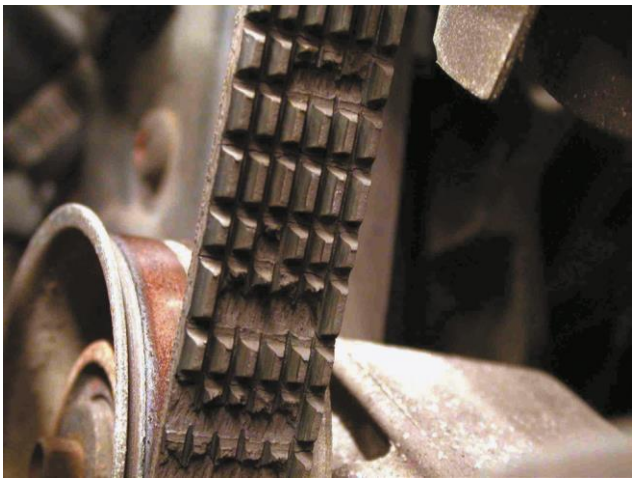

Figure 22. A defective belt.

If the belt needs replacement, first make note of the belt routing. There may be a diagram under the hood. Use a tool to release the tensioner and then remove the belt. Install the new belt and check it for the proper tension. Using a new tensioner is recommended. Fig. 23.

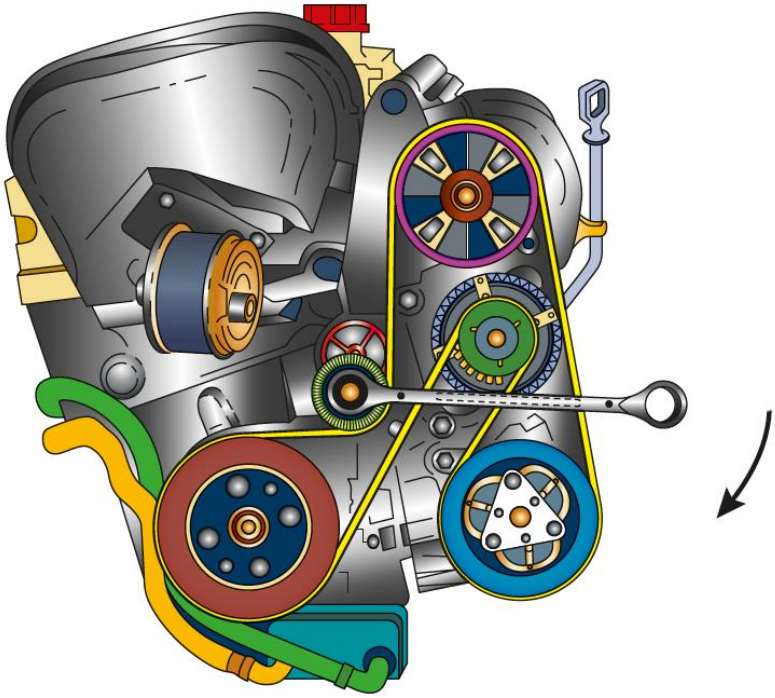

Figure 23. To release the tensioner, push the wrench in the direction shown.