3. ENGINE TESTING

SERVICE INFORMATION

Compression and leak-down tests offer important knowledge of the mechanical condition of the engine in question. Both tests must be done to accurately evaluate engine condition. A compression test can quickly show if all contributing factors allow engine operation within basic service limits or if either the piston rings/cylinder(s), or the valves/valve seats in the case of 4-strokes, are suspect. In order for a compression test to be accurate, the instructions must be followed closely, the engine must contain only standard components and the battery on electric start models must be in perfect condition. A leak-down test can effectively pin-point whether the piston rings/cylinder(s), valves/valve seats, head gasket, or crankcase seals and gaskets in the case of 2-strokes, individually or all together are in need of service.

TROUBLESHOOTING

Cylinder compession is low or uneven

- Faulty valve mechanism
  - Incorrect valve clearance
  - Bent, burned or sticking valves
  - Worn or damaged valve seat
  - Incorrect valve timing
  - Broken valve spring
  - Faulty hydraulic valve adjuster
- Faulty cylinder head
  - Leaking or damaged head gasket
  - Warped or cracked cylinder head surface
- Faulty cylinder or piston
  - Worn or damaged piston ring(s)
  - Worn piston or cylinder
  - Sticked piston ring in the ring groove

NOTE

- On the 2-stroke engine, inspect the following items when compression is low or uneven with signs of lean air/fuel mixture.

- Crankcase primary compression too low (2-stroke engines)
  - Damaged reed valve
  - Damaged crankshaft seal
  - Damaged crankcase or cylinder base gasket

High cylinder compression

- Excessive carbon build-up on piston or combustion chamber

COMPRESSION TESTING

GENERAL

A compression test is a quick and easy way to check the general condition of an engine. This test should be performed prior to any tune-up work, especially if the machine did not come in under its own power. If the engine has a burnt valve for instance, the customer should be notified that the tune-up will have no benefit without the other necessary engine work. A compression test should also be done if you feel that the motorcycle, scooter or ATV lacks power, especially during acceleration.

A compression test can be inconclusive though, if the engine is not completely stock, if the battery is not in perfect condition (in electric-start models, engine cranking speed may be low) or if the test instructions are not followed completely. In each of these situations, the compression registered will be lower than the service limit in the Model Specific service manual.
When you do get a valid compression test, there is something else to consider.
What if the compression is below the service limit, or if the compression is relatively even between each cylinder, and the engine is not smoking ? There may be no reason for an expesive rebuild on a good running engine. If, on the other hand, the compression on any one cylinder in a twin or multi-cylinder engine is significantly lower, the engine must be rebuilt.

TESTING

NOTE

- If the motorcycle has a decompressor, be sure it is adjusted properly before checking compression. On motorcycles equipped with an automatic decompression starting system as first introduced on the XR600R and NX650, the decompressors must be deactivated prior to checking.

Warm up the engine to normal operating temperature.
Ten minutes of stop and go riding is sufficient.

Stop the engine and remove a spark plug from each cylinder.
Install the compression gauge attachment to the cylinder to be tested.
Connect the compression gauge

NOTE

- Make sure that there are no leaks around the attachment.

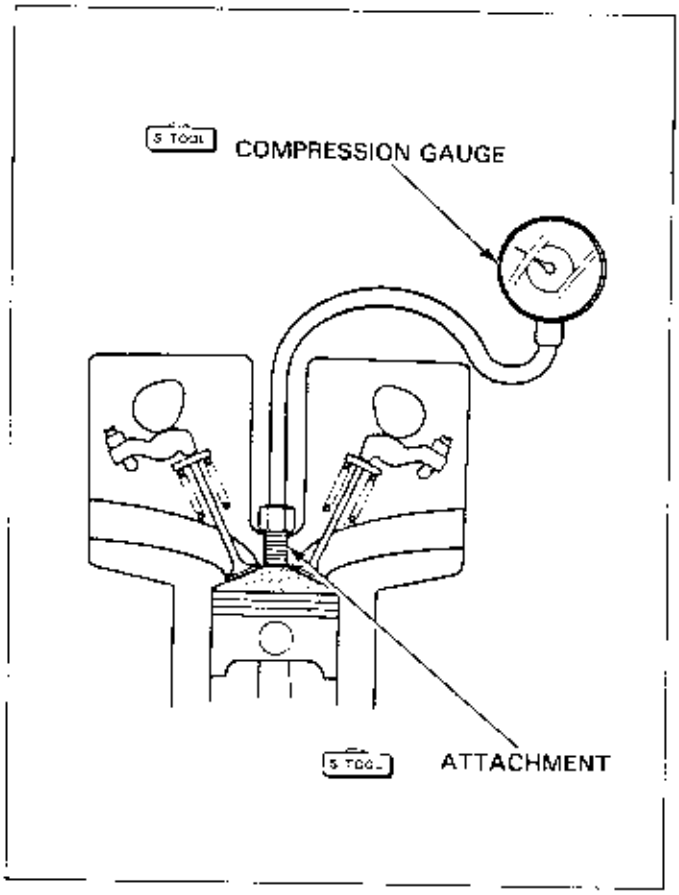
TOOL:
COMPRESSION GAUGE 07305-0010000

Kick start models:
Fully open the throttle and choke valves, strongly kick the starter pedal through several times, and check the compression.

Electric start models:
Turn the engine stop switch "OFF"
Fully open the throttle and choke valves, crank the engine with the starter motor, and check the compression.

NOTE

- To avoid discharging the battery, do not operate the electric starter for more than seven seconds.



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If compression is low, drop small amount of clean engine oil into the cylinder, then recheck the compression.
- If compression increases to more than the previous reading, inspect the cylinder and piston rings.
- If compression remains low, check the valves, valve seats and cylinder head.
- If compression is high, check for the accumulation of carbon deposits in the combustion chamber and/or the piston head.

LEAK-DOWN TESTING

4-STROKE LEAK-DOWN TEST INFORMATION

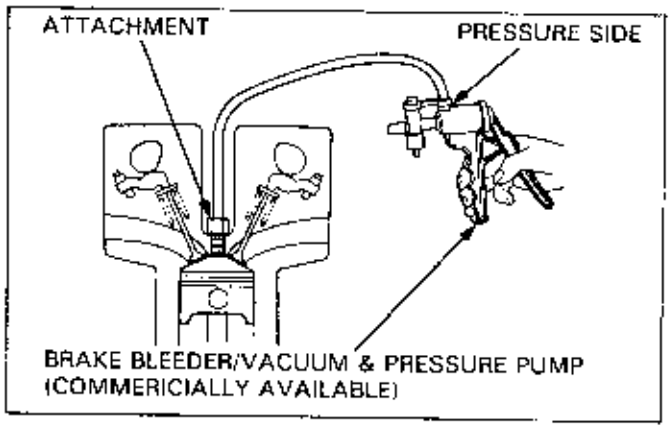
A leak-down test is an more comprehensive engine diagnostic test than a compression test. The leak-down tester consists of a calibrated pressure gauge connected to a pressure regulator and a flow restrictor.
The tester allows you to measure the rate at which air leaks past a cylinder's rings and valves.

There are several tools, specifically designed for leak-down testing 4-stroke engines, that are commercially available from several general tool sources.

A leak-down test provides a clear indication of whether or not the combustion chamber is sealing properly. The test involves pressurizing the combustion chamber and measuring the rate at which the air is lost past the rings and valves (or head gasket). A range of the allowable percentage of leak-down past the rings and valves is suggested by each tester manufacturer. But perhaps more important than a determination of whether the engine needs repair, is to find out more precisely where the problem lies.

The first step in the test is to install the hose from the tool into the spark plug hole, as you would in a compression test. Next position the crankshaft with the piston at top dead center. Be sure to remove the wrench from the crankshaft after postioning in case the air pressure against the piston puts the cranksahft in motion.

Then pressurize the combustion chamber with a steady, regulated pressure, again, as instructed by the tester manufacturer. Now you simply listen to the airbox, exhaust and crankcase filler cap to determine whether the intake valve(s), exhaust valve(s) or rings, respectively, are leaking.



Squirting a little soapy water around the cylinder and head mating area will tell you if the head gasket is leaking to the outside atmosphere. Checking for bubbles in the cooling system of a liquid-cooled machine will tell you whether or not the head gasket is leaking into the cooling passages. The only thing this test won't tell you is the difference between a head gasket leak into the adjacent cam chain (or gear) well, and a leak past the piston rings.

Be sure to follow the leak-down test tool manufacturer's instructions precisely when making this inspection.

2-STROKE PRESSURE/VACUUM LEAK-DOWN TEST INFORMATION

Regular crankcase leak-down testing is much more important to the lifespan of a 2-stroke engine than a 4 stroke. Because the engine relies on a very precise air/fuel mixture to ensure proper engine lubrication, the slightest air leak can lead to an engine seizure. Consider these regularly scheduled tests as cheap insurance.

Pressure/vacuum tests on 2-stroke engines should always include both a pressure and a vacuum tests, both or which are performed with essentially the same equipment.

Pressure/vacuum leak-down test equipment, specifically designed for 2-stroke engines, is commercially available through various motorcycle and general tool sources.

A pressure/vacuum leak-down test tool consists of hand pressure/vacuum pump and various adaptors to seal your engine. The test provides a clear indication of where a leak, or leaks, exist. Possible areas for leaks include anywhere upstream of the carburetor until the mixture is ignited and forced out the exhaust. Leaks can occur between the mating surfaces of the crankcases if the gasket fails. If this gasket fails between the crankcase and the transmission, the mixture will become much richer as transmission oil is slowly drawn into the engine. Similarly, a leaking crankshaft seal on the transmission primary gear side will also consume transmission oil. Other air leaks include the cylinder base gasket, the magneto side crankshaft seal, leaks between the reed valve assembly and its gaskets, and leaks in the carburetor mounting boot between the carb and the reed valve.

The first step in the testing procedure is to remove the exhaust and to effectively seal the exhaust port. This is done with a plate fastened to bolt over the exhaust port, backed by a rubber sheet or with some form of expandable rubber plug. Next the carburetor is removed and a plug is clamped snugly in place where the carburetor was. This leaves only the seals and gaskets to show any defects they may have. Then an attachment is inserted into the spark plug hole and pressure applied with a hand pump. Often a brake bleeder pressure/vacuum tool is used for this purpose.

Spraying soapy water around the inlet tract, reed valve and crankcase mating areas will produce bubbles where there are leaks.

The vacuum portion of the test ensures that the negative sealing characteristics of the crankshaft seals are adequate.

Be sure to follow the leak-down test tool manufacturer's instructions precisely when making this inspection.

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4. LUBRICATION

SERVICE INFORMATION

4-Stroke Engines:

- Refer to the Model Specific manual for:
  - Oil pump removal/installation
  - Oil strainer screen cleaning
  - Oil filter replacement
  - Oil level inspection/oil change
- The service procedures in this section can be performed with the engine oil drained.
- When removing and installing the oil pump use care not to allow dust or dirt to enter the engine.
- If any portion of the oil pump is worn beyond the specified service limits, replace the oil pump as an assembly.
- After the oil pump has been installed check that there are no oil leaks and that oil pressure is correct.

2-Stroke Engines:

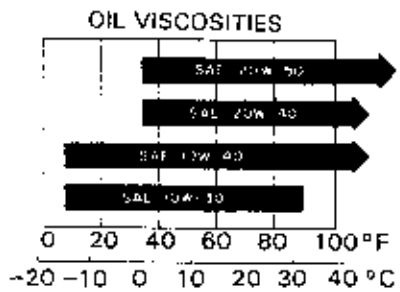
- When removing and installing the oil pump, clean the engine around the pump and oil pump itself.
- Do not attempt to disassemble the oil pump.
- Bleed air from the oil pump if there is air in the oil inlet line and each time the oil line is disconnected.
- Fill the oil outlet line with oil whenever the oil outlet line is disconnected.
- Refer to section 2 for oil strainer screen cleaning and oil pump control cable adjustment.

SERVICE DATA

Use only recommended oil for your vehicle. Viscosity requirements vary according to the air temperature range encountered during operation. Refer to the Model Specific manual for specific oil recommendations for the model you are servicing.

GENERAL

Oil recommendations:

4-Stroke engine/ transmission and 2-Stroke transmission oil	API Service Classification: SE or SF Viscosity: SAE 10W–40 Other viscosities shown in the chart may be used when the average temperature in your riding area is within the indicated range.	
2-Stroke engine oil	Separate lubrication Mechanical lubrication systems	Pro-Honda Two-Stroke oil or equivalent
	Premix-Type systems	Pro-Honda Two-Stroke oil or equivalent (no concentrates) 20:1 is the only recommended fuel/oil ratio

TROUBLESHOOTING

4-Stroke Engines:
Oil level low
- Oil consumption
- External oil leaks.
- Worn piston ring or incorrect piston ring installation
- Worn valve guide or seal.
- Oil pump worn or damaged (Dry sump engine)

Oil contamination (White appearance)
- From coolant mixing with oil (liquid-cooled engine)
  - Faulty water pump mechanical seal.
  - Faulty head gasket.
  - Water leak in crankcase.

Low or no oil pressure
- Clogged oil orifice and/or orifices.
- Incorrect oil being used.

Only On Models Equipped With Oil Pressure Switch:
High oil pressure
- Pressure relief valve stuck closed.
- Plugged oil filter, gallery, or metering orifice.
- Incorrect oil being used.

Low oil pressure
- Pressure relief valve stuck open.
- Clogged oil filter screen.
- Oil pump worn or damaged.
- Internal oil leaks.
- Incorrect oil being used.
- Low oil level

No oil pressure
- Oil level too low.
- Oil pump drive chain or drive sprocket broken.
- Oil pump damaged (pump shaft)
- Internal oil leaks.

2-Stroke Engines With Separate Oiling System:
Excessive smoke and/or carbon on spark plug
- Faulty oil pump (too much oil flow)
- Low quality engine oil

Overheating or seized piston
- No oil in tank or clogged oil line
- Air in oil lines
- Faulty oil pump (too little oil flow)
- Clogged oil strainer
- Oil not flowing out of tank
- Clogged oil tank cap breather hole
- Clogged oil strainer

2-Stroke Engines Using Premixed Fuel/Oil:
Excessive smoke and/or carbon on spark plug
- Improper jetting for altitude, air temperature and track conditions
- Improperly mixed fuel/oil—too much oil in fuel
- Fuel/oil mixture too old—gasoline has evaporated/gone bad

Overheating or seized piston
- Improper jetting for altitude, air temperature and track conditions
- Fuel/oil mixture too old—oxidized oil/degraded lubrication
- Premix oil too old—oxidized/degraded lubrication
- Poor quality premix oil
- Improperly mixed fuel/oil—too little oil in fuel
- Using fuel/oil premix ratio other than 20:1

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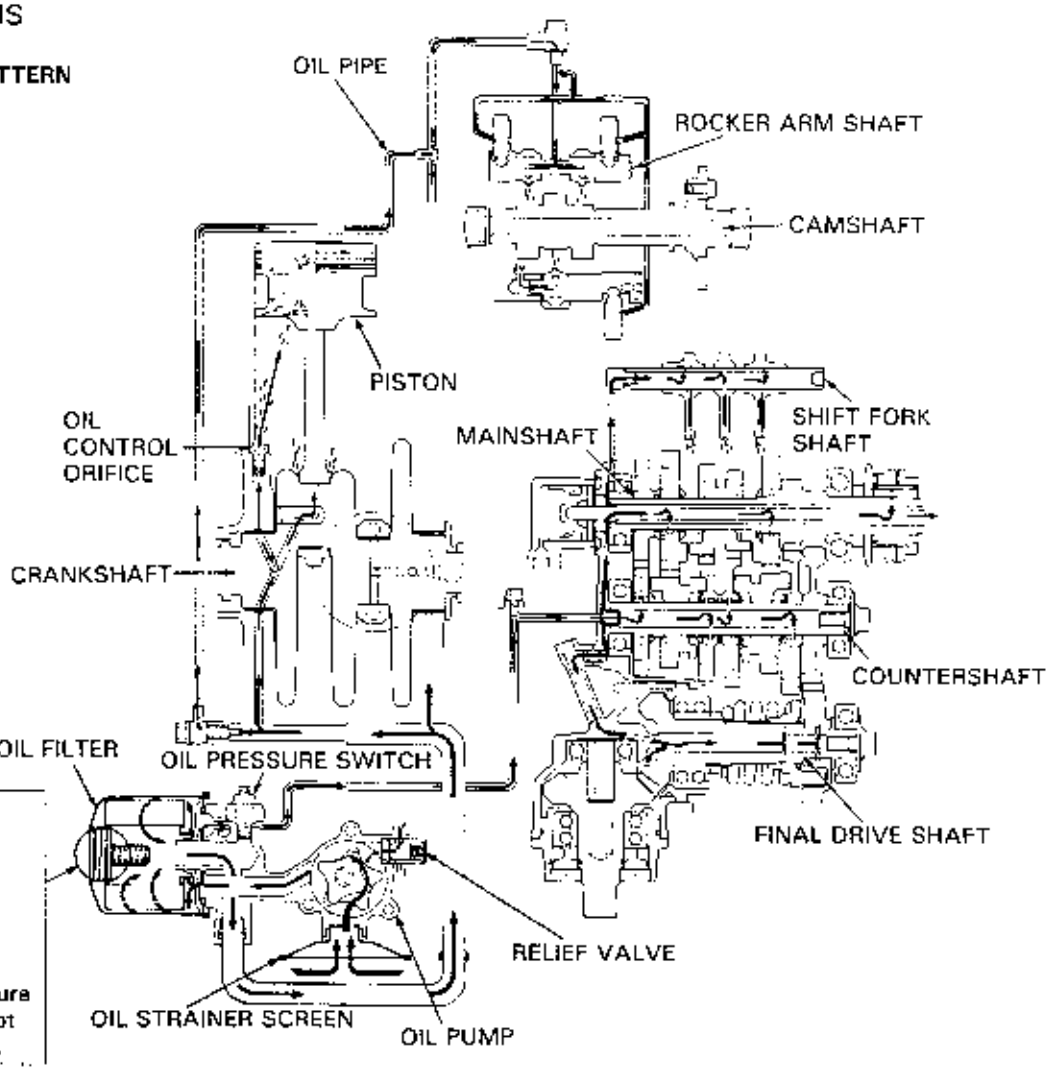
SYSTEM DESCRIPTIONS

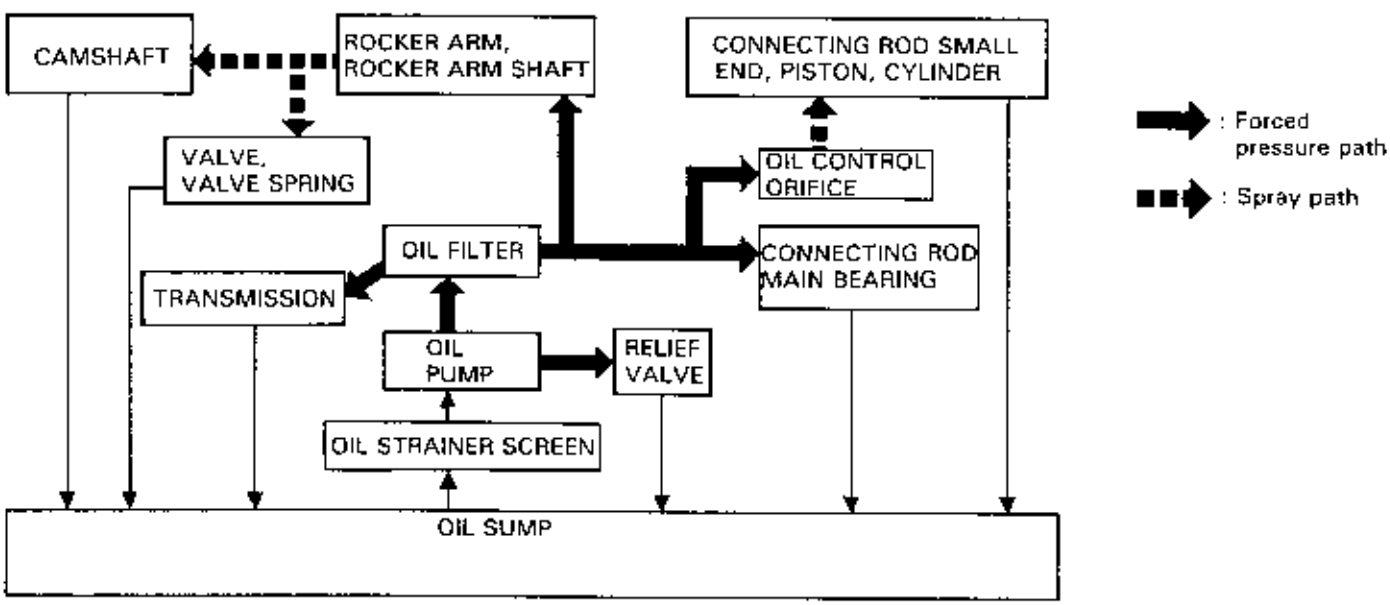
4-STROKE SYSTEMS

TYPICAL OIL FLOW PATTERN



NOTE

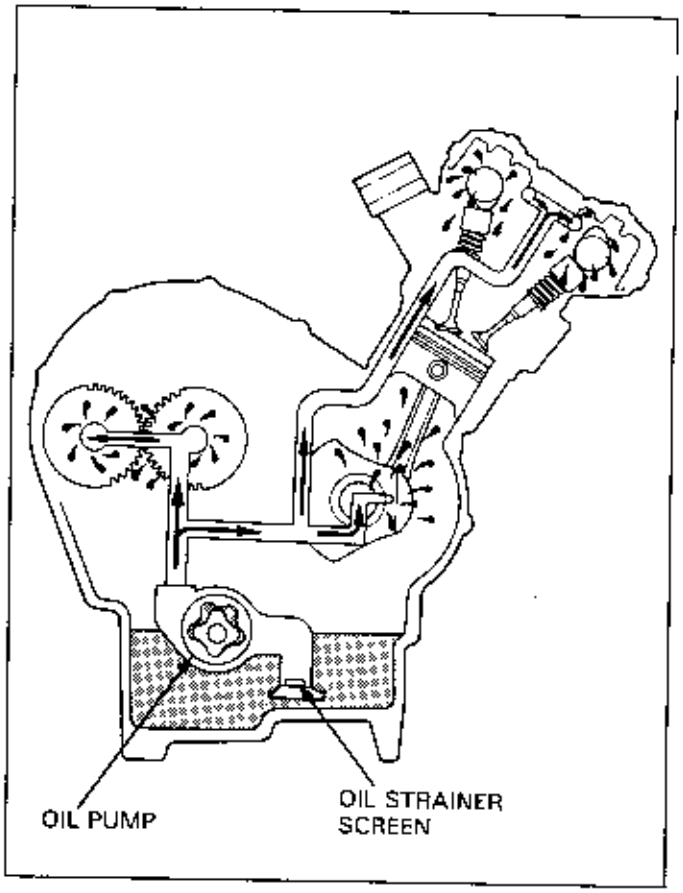
Some systems include a relief valve that opens to maintain the oil flow when the filter is excessively restricted due to contaminants, or, when the oil temperature is so low that it will not flow through the filter.



FOUR-STROKE ENGINES

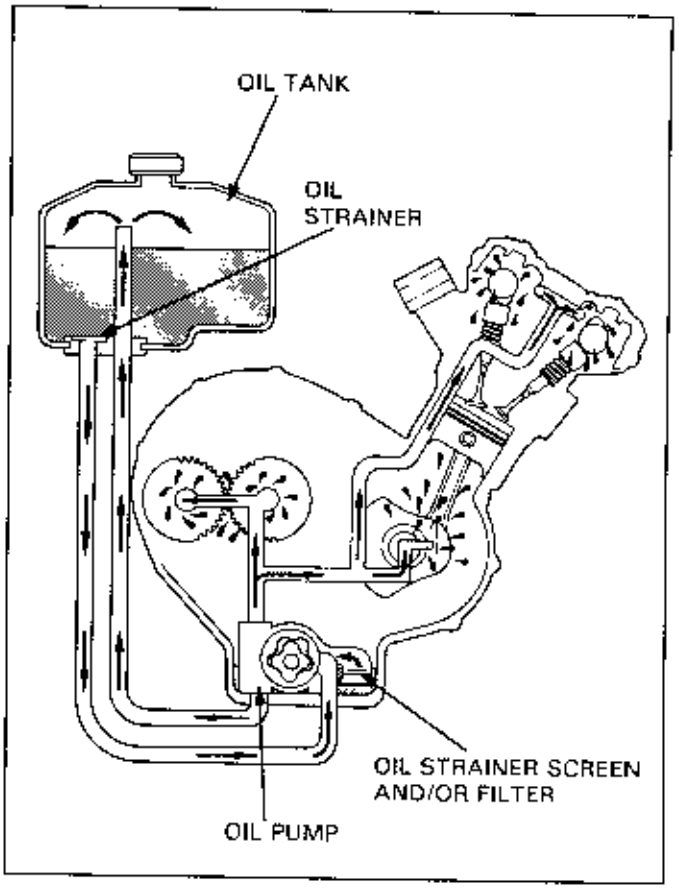
Wet-Sump Type
Wet-sump engines contain their total oil volume within their crankcases. In these systems, oil is pumped from the sump in the crankcase, through a strainer screen and/or oil filter and then is pressure fed to various engine components. Oil returning from these now lubricated areas flows back into the sump by gravity.

Some wet-sump engines use only a strainer screen to filter the oil. Others use a combination of a strainer screen and a centrifugal-type filter, or a more conventional pleated paper-type filter.



Dry-Sump Type
Dry-sump systems use an external oil tank and dual-function oil pumps. In this system, the pump draws in oil for delivery to the various components and pumps oil out of the sump and back to the oil tank.

Since this design eliminates the need for space to contain the oil within the lower portion of the crankcases, the engine can be positioned lower than would otherwise be possible. This design often incorporates routing and oil storage configurations that aid in lowering oil temperature.



General
A spray-type system is often utilized in either design illustrated here as well as in some two-strokes engine designs. Here oil is literally sprayed through oil jets directly into internal components such as the connecting rod, to help ensure lubrication and cooling of the rods and pistons.
Some systems include oil pressure-controlling relief valves to help ensure lubrication even if the filter is clogged or the oil temperature is so low that it will not flow through the filter.

Oil filters and/or strainer screens are postioned within the lubrication sytem to trap contaminants before the oil is routed back into the lubricant pathways.

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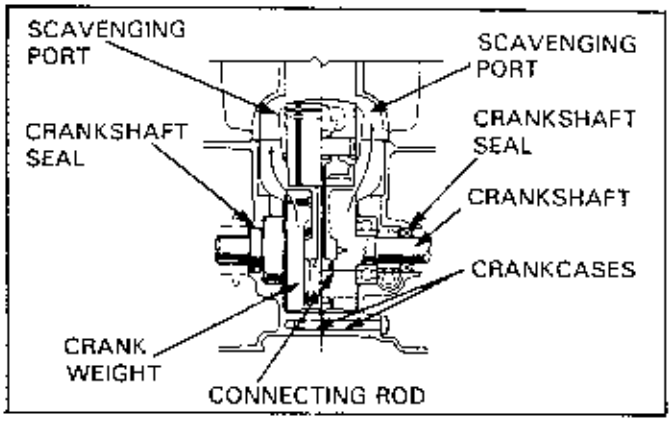
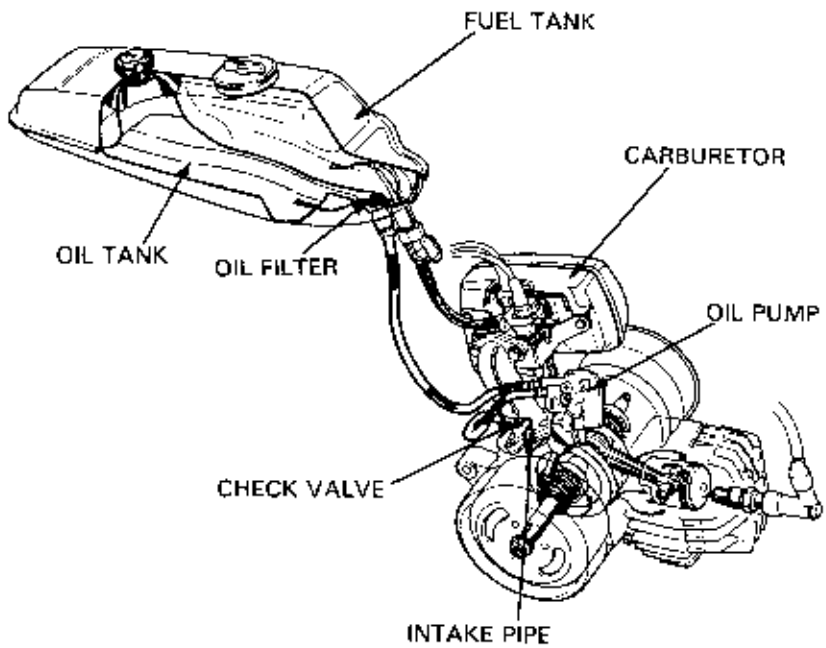
TWO-STROKE LUBLICATION SYSTEMS

Unlike four-stroke engines, two-stroke engines use the internal crankcase area as a suction chamber and, therefore, cannot use a sump-type oiling system. Consequently, the following two systems have been adopted in order to provide lubrication to the cylinder, piston rings, connecting rod and crankshaft bearings. Each system type relies on oil ingested together with the gasoline. In Separate Oil systems, engine lubrication oil is introduced downstream of the carburetor. Oil is combined with the gasoline before it reaches the carburetor in Premixed systems.



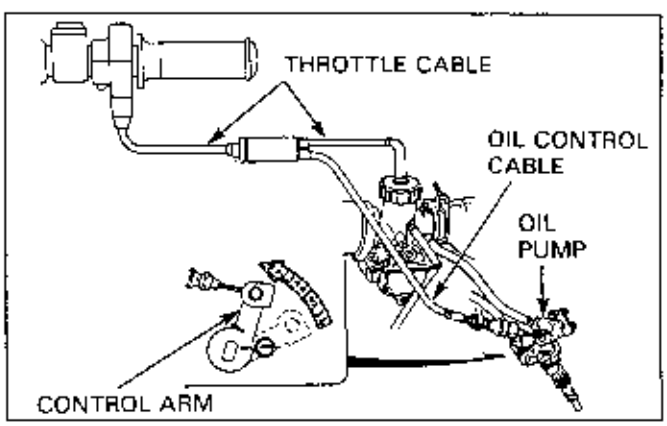
SEPARATE OIL SYSTEMS:
Virtually all street motorcycle and scooter two-stroke engines use a pump-operated system to lubricate engine components. Oil in this type of system is drawn from a separate oil tank by an oil pump that introduces the oil directly into the air/fuel inlet tract beyond the carburetor.

Periodic level checks and refilling of the oil tank is required since the oil in the tank is continually drawn upon when the engine is running.



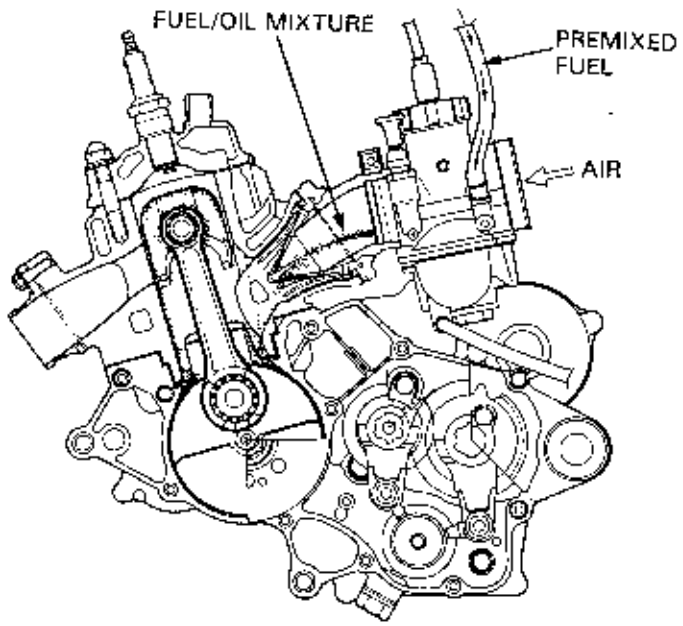
The amount of lubricant delivered to the engine is dependant on both engine rpm and throttle position.

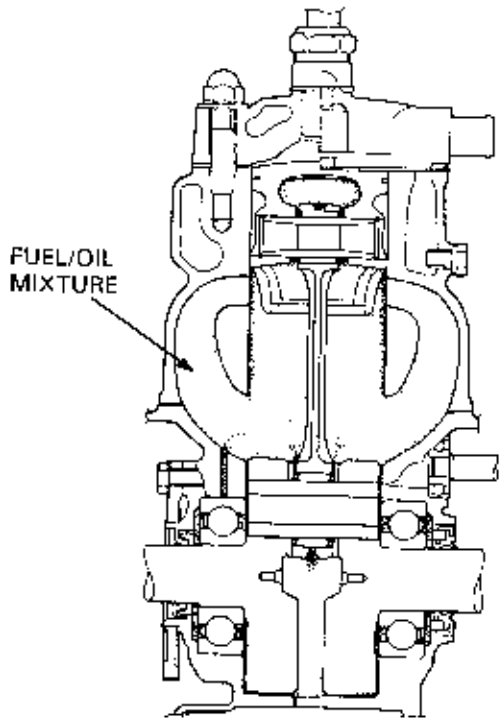
Some of these systems include provisions for circulating the transmission oil within the gearbox portion of the crankcases with the same oil pump.



PREMIXED [OIL IN FUEL] SYSTEMS:
Premixing engine oil with gasoline is the most widely used system on competition models.

The combined air/fuel/oil mixture is introduced directly through the inlet tract with the assistance of the carburetor. Lubrication to the crankshaft and both connecting rod bearings as well as the piston rings and cylinder walls is achieved as this mixture is drawn into the crankcase by the suction of the piston movement.





It is important to USE ONLY A 20:1 FUEL/OIL RATIO. All Honda engines are designed to operate most efficiently and with greatest durability using a 20:1 premix ratio. All standard carburetor jetting is based on this ratio.

Standard jetting is based on 20:1 at sea level and 20°C (68°F).

CAUTION

- **Use of a fuel/oil premix ratio other than 20:1 may affect overall jetting, engine performance and may lead to premature engine wear or damage.**

Freshness of the fuel/oil mixture is very important to both the overall performance of the machine as well as the lubricating efficiency of the oil.

Only use gasoline that has been pumped from a high-volume station within the previous two weeks if optimal competition performance is required. Even general use applications call for gasoline that is no more than eight weeks old.

For optimal lubrication efficiency in this system, use the premixed fuel/oil within 24 hours after it is mixed. Two-stroke premix oil that is not stored in resealable containers should be discarded in a proper manner if it is not used completely within one month after opening. Oil stored in non sealed container is subject to oxidation that degrades the oil's lubrication qualities.

Vegetable-type premix oils separate from gasoline more easily than mineral oils, especially in cold weather. It is advisable to use mineral oil when ambient temperatures below 0°C (32°F) are expected.

CAUTION

- **Mixing vegetable and mineral-based oils will cause premature engine wear or damage.**

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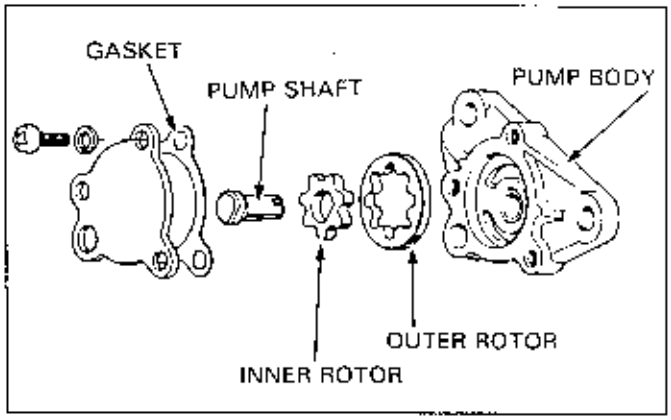
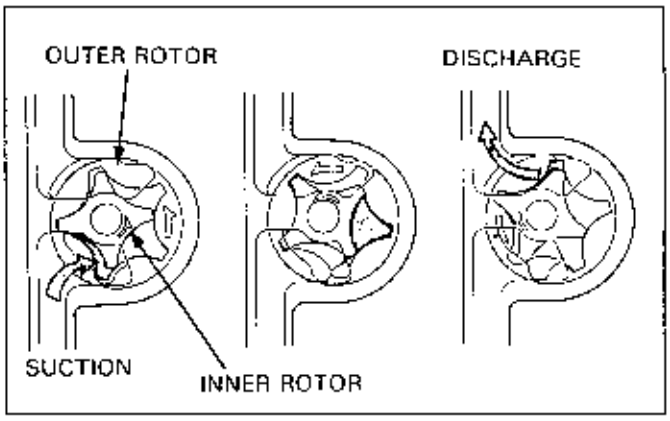
OIL PUMP DESCRIPTIONS

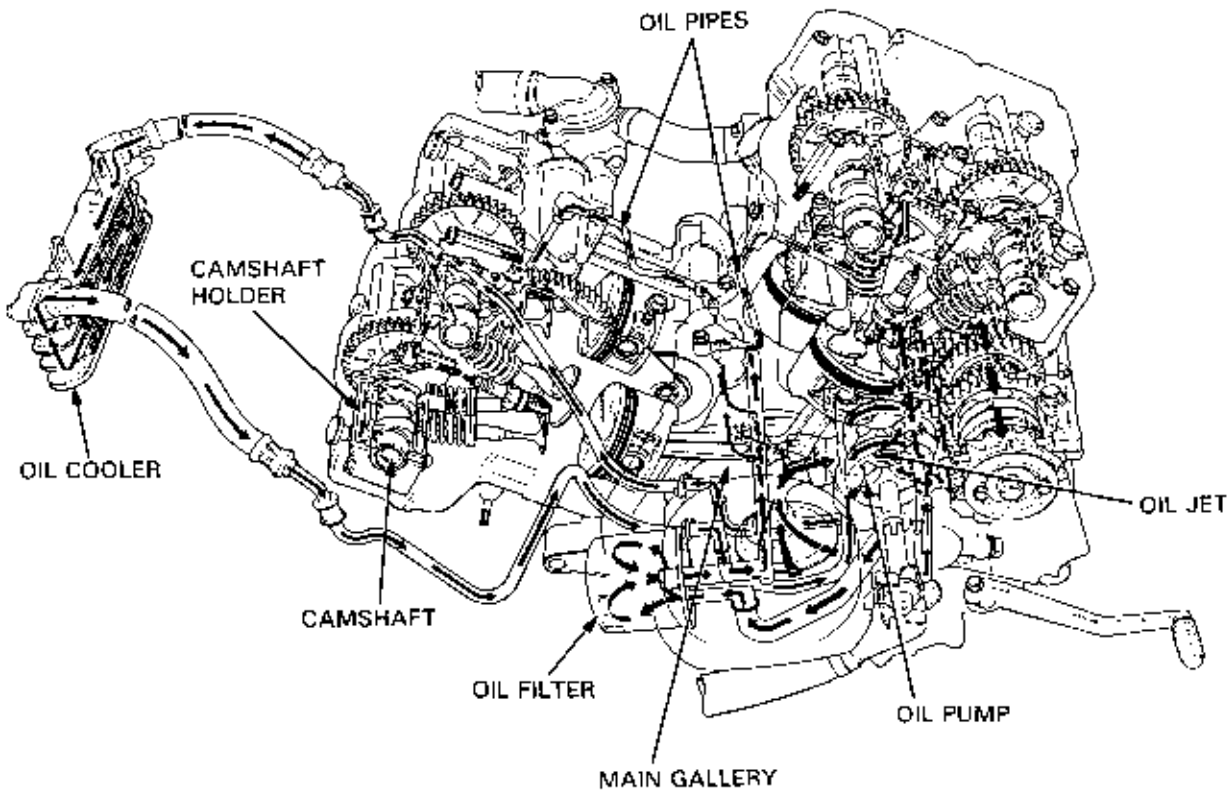
TROCHOID TYPE

The trochoid-type oil pump is the most common oil pump design used in 4-stroke engines. It is designed to turn two rotors within a casing, with an inner rotor fixed on the pump shaft (drive shaft) and an outer rotor on its circumference. When the inner rotor is turned by means of the oil pump shaft, the outer rotor also turns, with the clearance between the two rotors varying. Lubricant is drawn through by suction when the clearance is enlarged. Oil is delivered to the opposite side through this clearance and is then routed into the discharge passage when the clearance lessens. The more teeth the inner and outer rotors have, the less the amount of pulsation. The oil flow volume increases in direct proportion with the increase in thickness of the rotor dimension.



Some models have a double rotor trochoid-type oil pump which collects oil directly from both the oil cooler and the sump.





PLUNGER TYPE

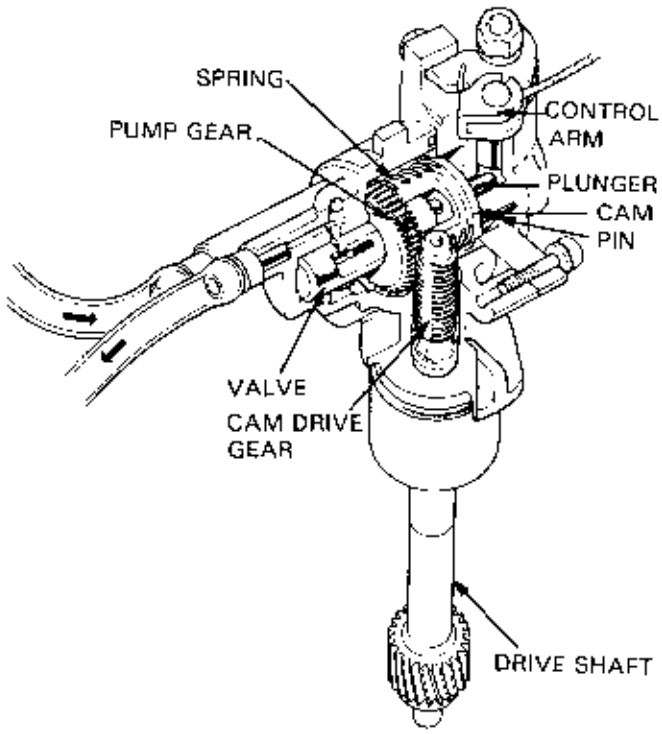
Virtually all non premix lubricated 2-stroke engines are equipped with a plunger-type oil pump.

Some plunger pumps are driven by crankshaft via the oil pump gear shaft, and others are directly driven by crankshaft.

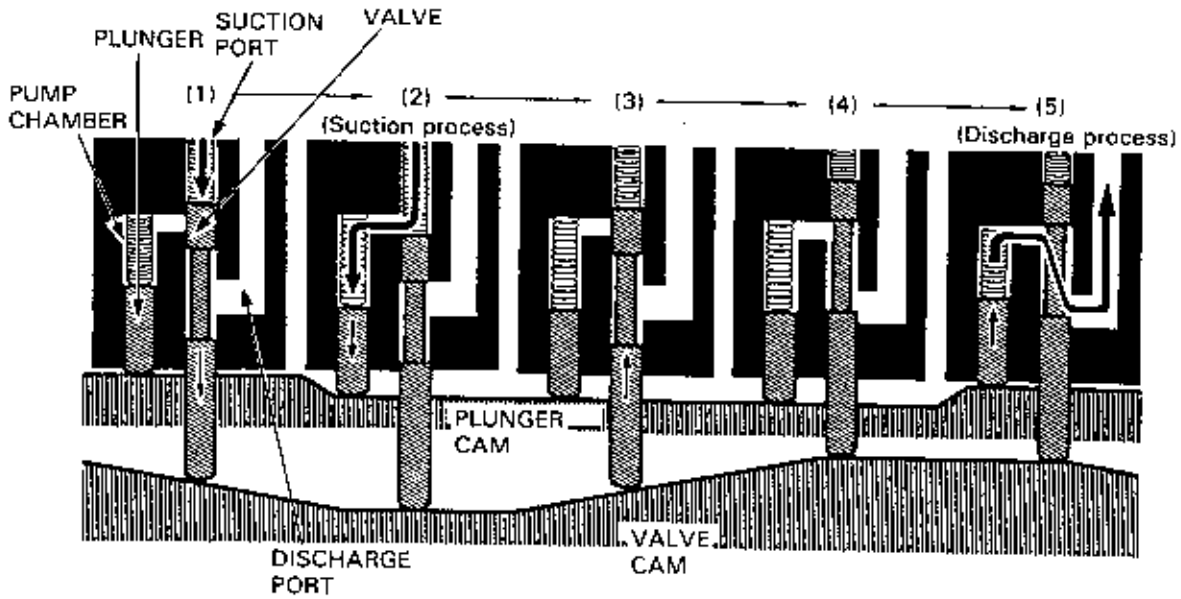
The oil pump cam is depressed under a spring. Turning the cam causes the plunger to reciprocate so that the pumping movement is repeated. The amount of lubricant is controlled proportionally with the cam rotation.

The pump is designed to control the amount of lubricant discharged per crankshaft rotation by varying the plunger stroke through the operation of the cam interlocked with the carburetor throttle.

The combined function of these two mechanisms allows the proper flow of lubricant depending on load conditions and engine rpm.



Oil Pump Operating Principle



(1) As the valve descends, it blocks the outlet passage while gradually opening the inlet passage.
(2) Here at the "bottom dead center" position, the outlet passage is completely closed while the inlet passage is completely opened — allowing free flow of oil into the pump chamber.
(3) With the oil chamber filled, the valve ascends — closing the inlet passage.
(4) The valve ascends further, allowing free flow of oil through the outlet passage.
(5) The plunger also ascends, compressing the oil inside the pump chamber and pumping oil out through the outlet passage, towards the intake pipe via the outlet line.

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OIL PRESSURE CHECK

NOTE

- This procedure is for vehicles equipped with an oil pressure switch.
- If the engine is cold, the pressure reading will be abnormally high. Warm up the engine to normal operating temperature before starting this test.
- Refer to the Model Specific manual for specifications.

Stop the engine and pull off the switch cover. Disconnect the switch wire by removing the screw.

Turn the ignition switch ON and check that the oil warning light does not come on.

If the warning light comes on, there is a shorted circuit in the switch wire. Repair or replace as necessary.

Remove the oil pressure switch (see the Model Specific manual).

Install the attachment as necessary and connect the oil pressure gauge.

(S TOOL)

OIL PRESSURE GAUGE: 07506–3000000

ATTACHMENT: Refer to Model Specific manual.

Check the oil level and add the recommended oil if necessary.

Start the engine and check the oil pressure. If it is normal, replace the oil pressure switch.

Stop the engine.

Apply 3-BOND® sealant or equivalent to the pressure switch threads and install.

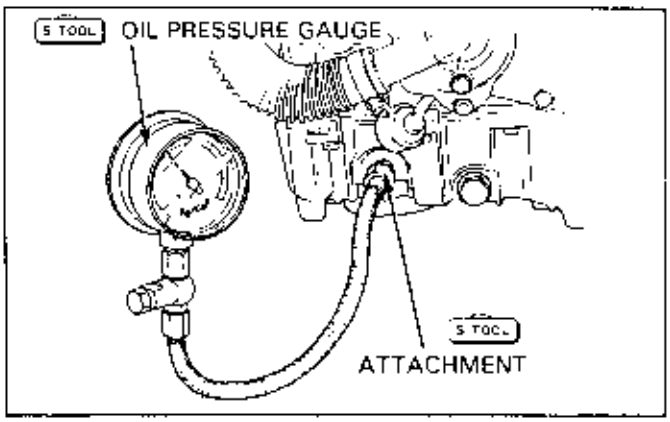
CAUTION

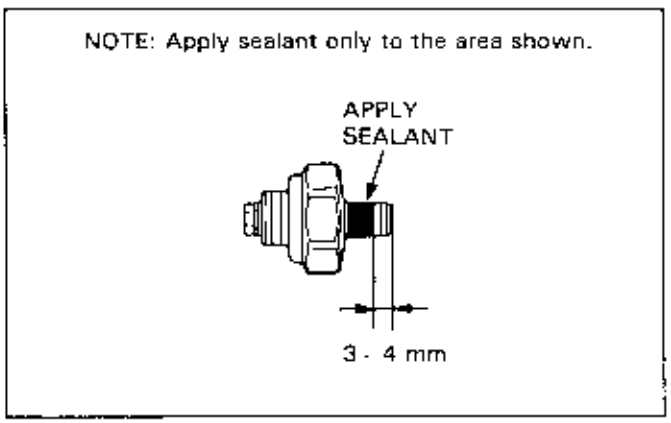
- **Overtightening the switch can cause crankcase damage.**

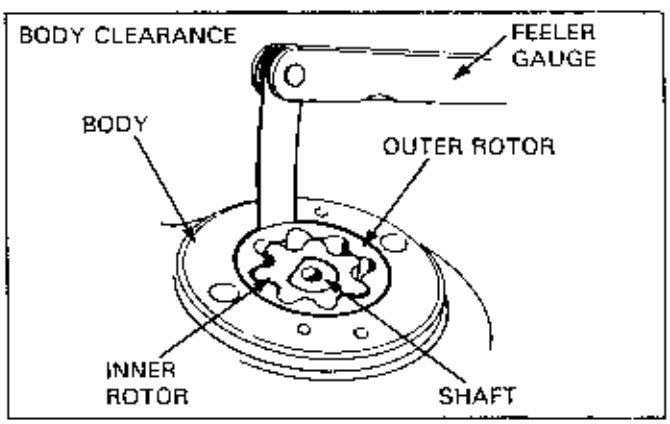
Connect the oil pressure switch wire and start the engine.

Check that the oil pressure warning indicator goes out in one or two seconds.

If the oil pressure warning indicator stays on, stop the engine immediately and determine the cause.







OIL PUMP INSPECTION

TROCHOID TYPE

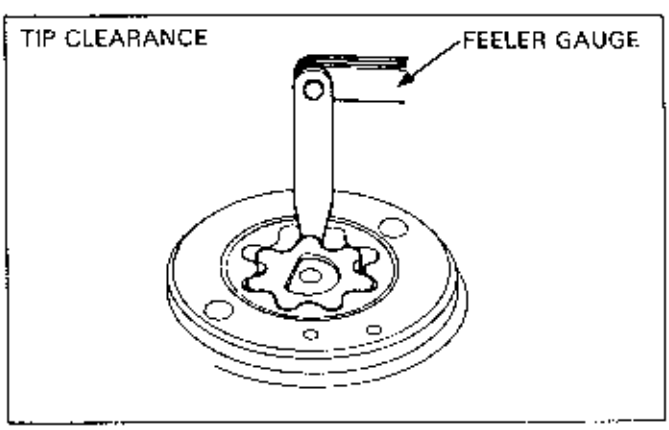
NOTE

- Where there are two pair of inner and outer rotors, check each side of the pump as described below.
- Measure at several places and use the largest reading to compare the service limit.

Disassemble the oil pump and clean the parts with clean oil.

Set the inner and outer rotors into the pump body properly.

Measure body clearance (pump body-to-outer rotor) and tip clearance (inner rotor-to-outer rotor) using a feeler gauge.

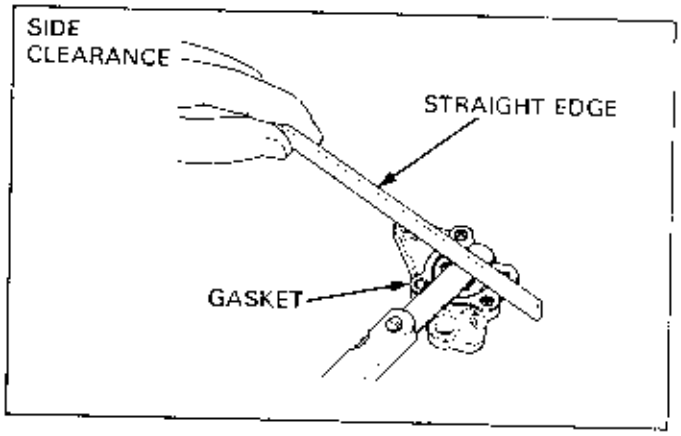


Measure the side clearance (rotor side-to-body) with a straight edge and feeler gauge.

NOTE

- If there is a cover gasket, measure the clearance with the gasket installed.

Refer to the Model Specific manual for all clearance specifications.



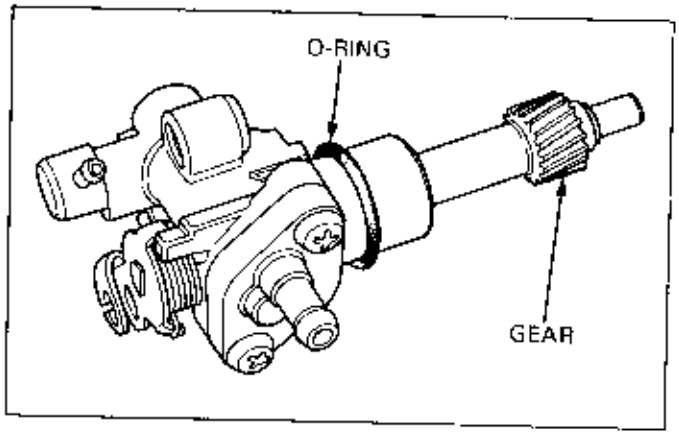
PLUNGER TYPE

NOTE

- Do not disassemble and try to repair a two-stroke oil pump; it will not operate properly once reassembled.
- Replace the pump if it is worn or damaged.

Remove the oil pump and inspect for the following:
— Worn or damaged pump gear
— Oil leaks from seals
— Binding pump shaft

Connect the oil tube from the oil tank to the suction side, then turn the shaft. Check that oil flows out of the outlet.

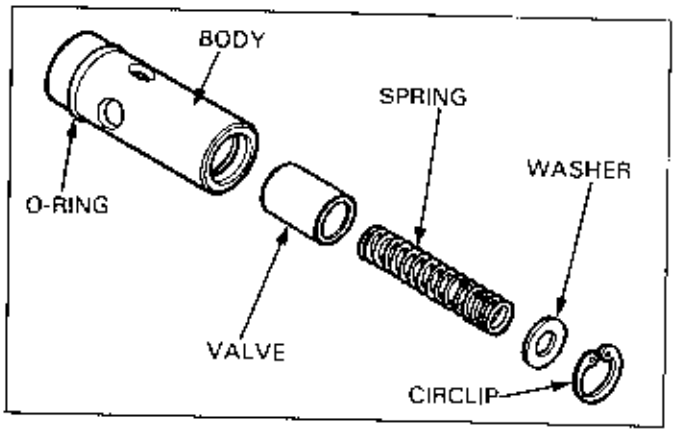


PRESSURE RELIEF VALVE

Remove the snap ring, washer, spring and valve from the valve body.
Check the valve and body for wear, scratches or damage.
Check the snap ring groove for damage. If the snap ring groove is damaged, the oil supply will be reduced and the engine may seize.

NOTE

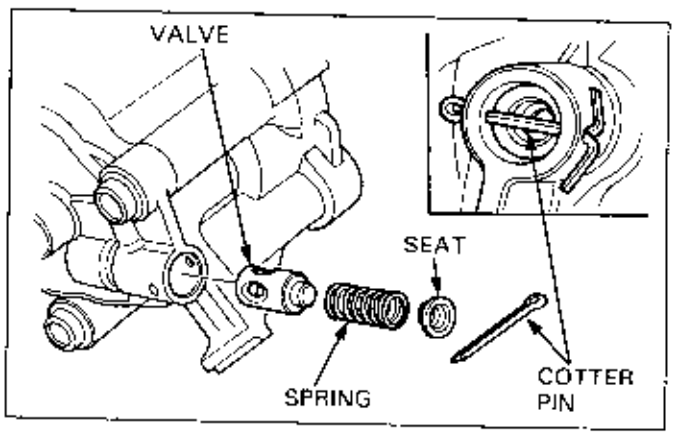
- Install the valve with the open side facing toward the spring.



In-Set Type Oil pump
Remove the cutter pin, seat, spring and valve.
Check the valve for wear or damage.

NOTE

- Install the valve with the closed side facing the spring.



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OIL PUMP/OIL LINE BLEEDING (2-STROKE ENGINES)

CAUTION

- **Be sure to bleed all air from the oil system. Air in the oil system will block or restrict oil flow and can cause serious engine damage.**

NOTE

- Bleed air from the oil suction line and oil pump whenever the oil lines and pump have been removed, there is no oil in the tank, or there is air in the oil lines.
- Bleed air from the oil suction line and pump first, then bleed the oil outlet line.

SUCTION LINE, OIL PUMP BLEEDING

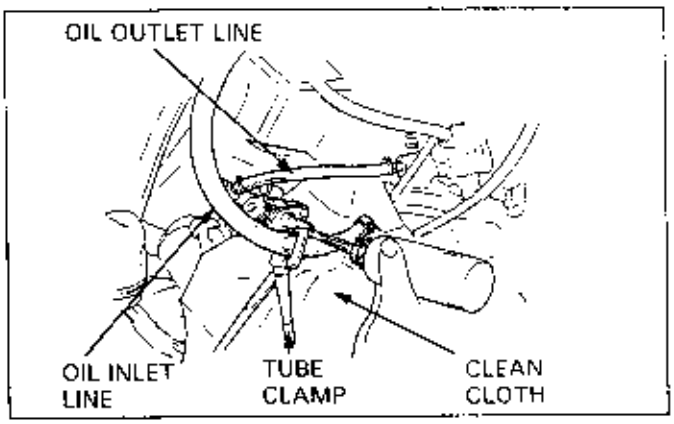
Fill the oil tank with the recommended oil.
Place a shop towel around the oil pump.

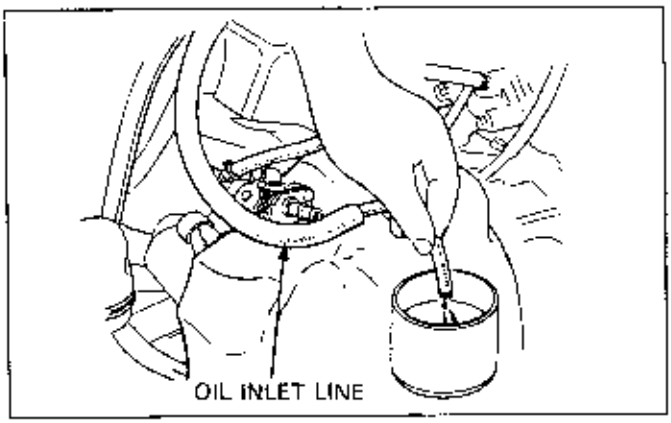
Disconnect the oil lines from the oil pump, and fill the pump with oil through the pump outlet.

Let oil drip from the inlet line to expel any air that may be in the line, and then reconnect the suction line to the pump inlet.
If there is a bleed bolt, loosen it until there are no air bubbles in the oil coming out of the bolt hole, then retighten the bleed bolt.

Check that there is no air in the oil line.

Next, bleed air from the oil outlet line.

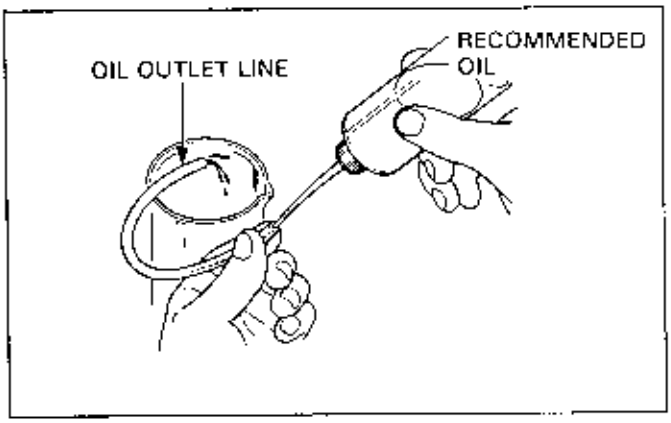




OUTLET LINE BLEEDING

Remove the oil outlet line and close the intake pipe joint.
Bend the oil outlet line into a "U" form with both the ends parallel, and fill the oil outer line with clean oil.

Connect the oil outlet line to the oil pump joint.



Start the engine and allow it to idle with the oil control lever in the fully open position, making sure that oil is flowing out of the oil outlet line.

⚠ WARNING

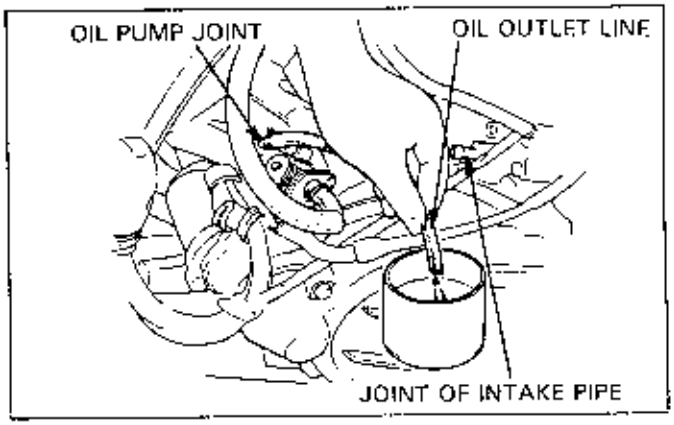
- **Perform this operation in a well ventilated area. Exhaust contains poisonous carbon monoxide gas that can cause loss of consciousness and may lead to death.**

CAUTION

- **Run the engine at the lowest necessary rpm level to avoid possible engine damage if oil flow is restricted.**

Stop the engine and again bleed air from the oil inlet line and oil pump if oil does not flow out within one minute. Then recheck oil flow.

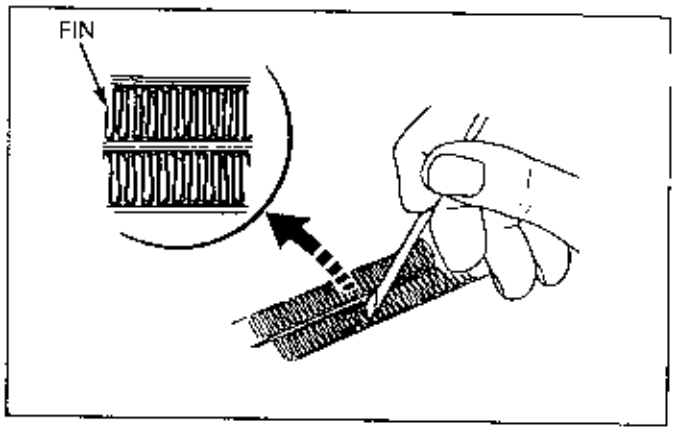
Connect the oil outlet line to the intake pipe joint.



OIL COOLER INSPECTION

Check the oil line connections for leaks.

Check the oil cooler for bent or collapsed fins.
Straighten the bent or collapsed fins with a suitable, small, blade-type screw driver if necessary.
Check the air passages for clogging or restriction.
Blow dirt out from between core fins with compressed air or wash off dirt with water.



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5. COOLING SYSTEM

SERVICE INFORMATION

⚠ WARNING

- **Wait until the engine is cool before slowly removing the radiator cap. Removing the cap while the engine is hot and the coolant is under pressure may cause serious scalding.**
- **Radiator coolant is toxic. Keep it away from eyes, mouth, skin and clothes.**
  - **— If any coolant gets in your eyes, rinse them with water and consult a doctor immediately.**
  - **— If any coolant is swallowed, induce vomiting, gargle and consult a physician immediately.**
  - **— If any coolant gets on your skin or clothes, rinse thoroughly with plenty of water.**
- **KEEP OUT OF REACH OF CHILDREN**

- Add coolant at the reserve tank. Do not remove the radiator cap except to refill or drain the system.
- All cooling system service can be made with the engine in the frame.
- Avoid spilling coolant on painted surfaces.
- After servicing the system, check for leaks with a cooling system tester.
- Refer to section 25 for fan motor thermostatic switch and temperature sensor inspections.

TROUBLESHOOTING

Engine temperature too high
- Faulty temperature gauge or gauge sensor (see section 25)
- Thermostat stuck closed
- Faulty radiator cap
- Insufficient coolant
- Passages blocked in radiator, hoses, or water jacket
- Air in system
- Faulty cooling fan motor
- Faulty fan motor switch (see section 25)
- Faulty water pump

Engine temperature too low
- Faulty temperature gauge or gauge sensor
- Thermostat stuck open
- Faulty cooling fan motor switch (see section 25)

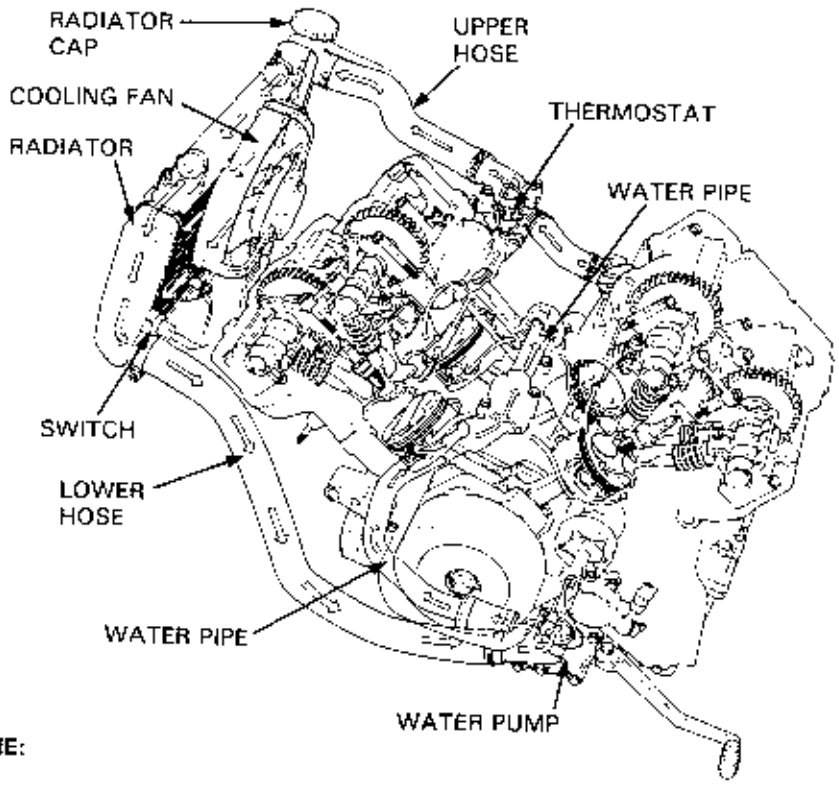
Coolant leaks
- Faulty pump mechanical seal
- Deteriorated O-rings
- Faulty radiator cap
- Damaged or deteriorated gaskets
- Loose hose connection or clamp
- Damaged or deteriorated hoses

SYSTEM DESCRIPTIONS

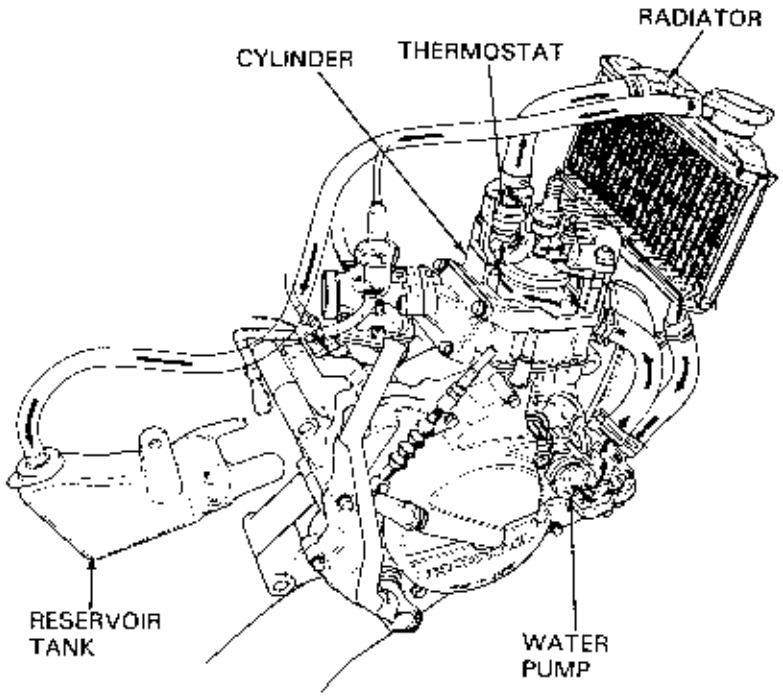
A liquid cooling system allows optimal engine operating temperature while preventing overheating and overcooling. The coolant is pumped through the system by means of a water pump. Combustion heat is absorbed by the coolant in the course of its passage through the water hoses, water jacket around the cylinder, and through the cylinder head. The coolant then passes into the radiator through the thermostat and upper radiator hose. The hot coolant is cooled by air in the course of its passage through the radiator and is then returned into the water pump through the lower radiator hose.

SYSTEM FLOW PATTERNS

TYPICAL 4-STROKE ENGINE:



TYPICAL 2-STROKE ENGINE:



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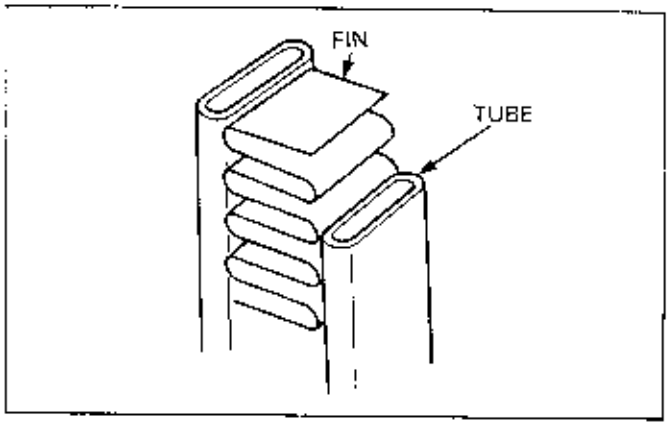
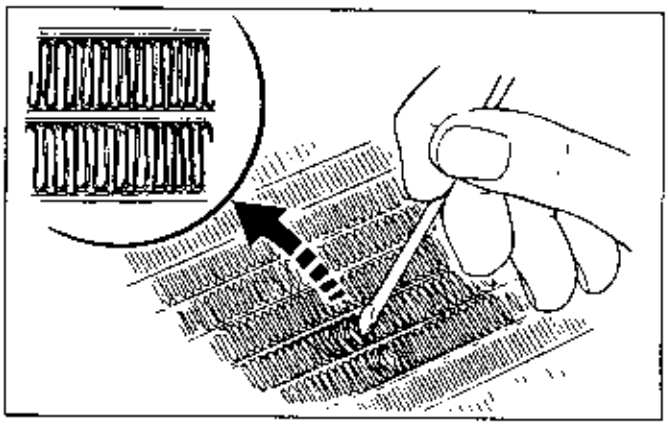
RADIATOR

Coolant temperature is decreased by dissipating heat into the air by means of the radiator fins as the coolant passes through the radiator tube. The larger the fin's surface area, the more the radiator exerts its cooling capacity.



It is important that air is permitted to pass through the radiator fins so that the heat is dissipated from the coolant to the fins and into the atmosphere. Crushed or twisted fins will not permit heat to be dissipated because of inability of the air to pass through them, resulting in lowered cooling capacity. If 1/3 or more of the fins are crushed or twisted, the fins should be repaired using a small flat blade screwdriver.

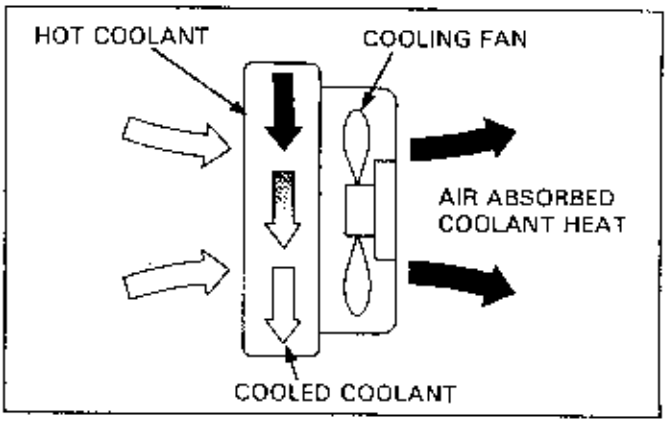


COOLING FAN

Heat is dissipated into the atmosphere because of the difference in temperature between the air and the coolant which has absorbed the heat.

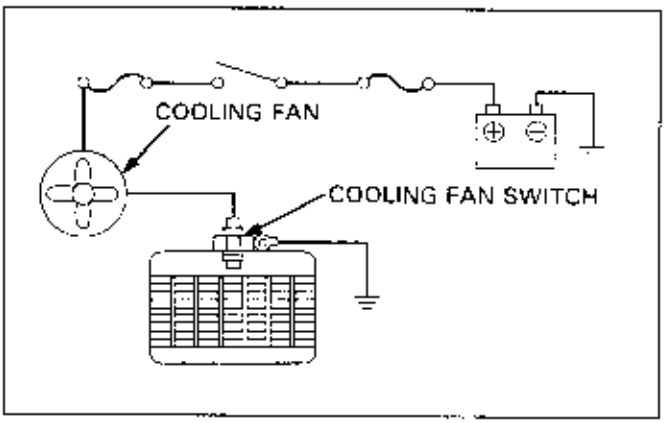
If, however, the engine is not in operation (air around the radiator is stagnant) or when the atmospheric temperature is high, since the temperature difference between the atomosphere and the coolant becomes smaller, heat dissipation is decreased, adversely affecting engine capacity.

A cooling fan maintains the cooling performance under severe conditions. It forces air to flow through the radiator and around the engine to dissipate heat, whether the machine is moving or not.

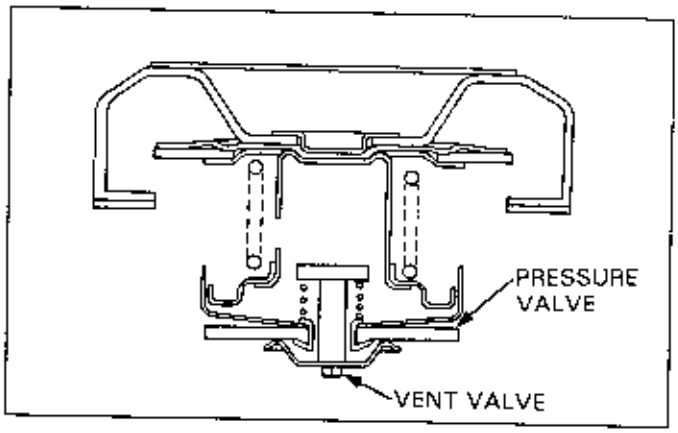


COOLING FAN SWITCH

The fan switch automatically starts or shuts down the cooling fan depending on the temperature of the coolant. While the fan motor switch resistance is normally too high to conduct a current (when the coolant temperature is low), when the coolant temperature rises, the switch resistance is reduced enough to conduct current and causes the cooling fan to turn.



RADIATOR CAP



The boiling point of the coolant may be increased by providing a pressure-type cap (hereafter, radiator cap) on the coolant inlet. The radiator cap serves to increase the coolant temperature as well as to retain pressure in the cooling system.

Coolant boiling point (Coolant of 50—50 mixture).

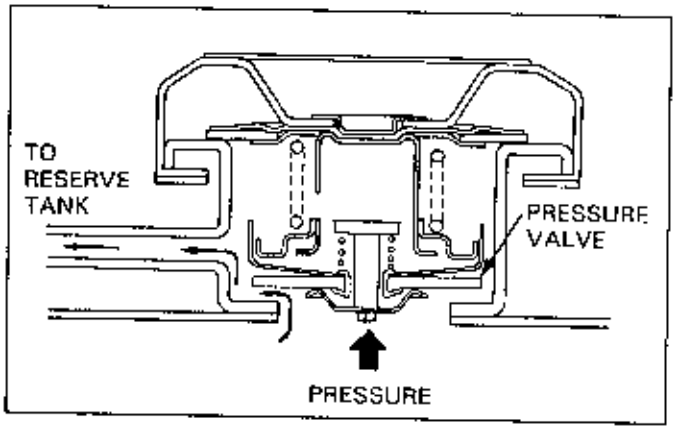
At atmospheric pressure: approximate 100°C (212°F)
Under 12.8 psi (0.9 kg/cm²) pressure:
approximate 125°C (257°F)

⚠WARNING

- **Wait until the engine is cool before slowly removing the radiator cap. Removing the cap while the engine is hot and the coolant is under pressure may cause serious scalding.**

As the coolant temperature increases, the difference in temperature between the coolant and atmosphere becomes greater.
Due to the pressurized system, coolant vapor loss is prevented while the cooling effect is enhanced.

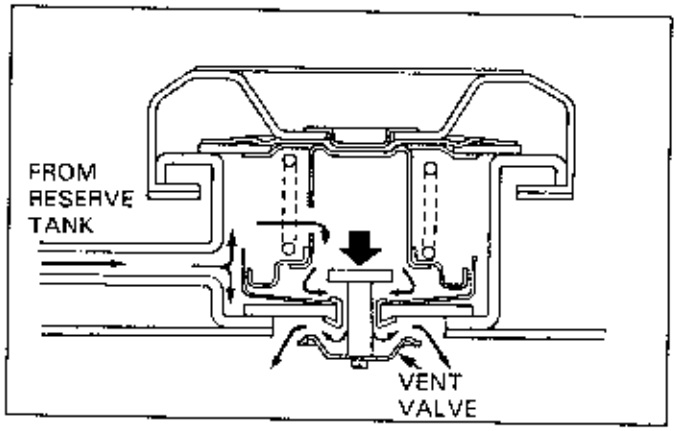
The radiator cap is provided with a pressure valve and vent valve which maintain the pressure in the cooling system at a constant level.



If the pressure in the cooling system is increased due to the increase in coolant temperature, the pressure is kept constant by means of a pressure valve.

If the pressure exceeds the prescribed limit, the pressure valve is opened so that the pressure in the cooling system is regulated by releasing the coolant (whose volume has expanded due to the increase in temperature). The pressure at which the pressure valve begins to open is called the radiator valve opening pressure.

When the coolant temperature is decreased after shutdown of the engine and the cooling system pressure is reduced (with the coolant volume contracted), the vent valve is opened by atmospheric pressure and coolant from the reserve tank flows back into the cooling system.



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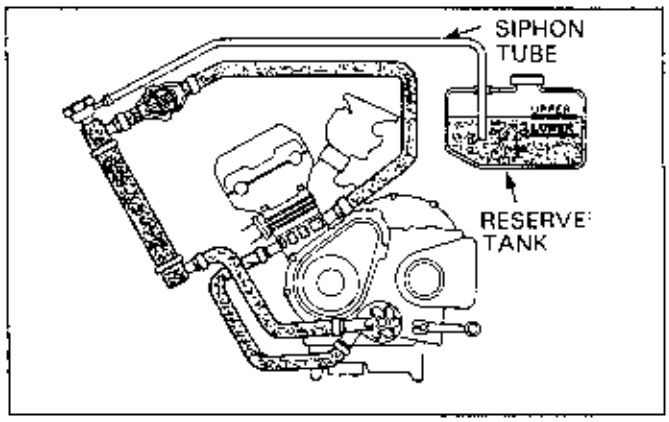
RESERVE TANK

As explained in the preceding paragraph "Radiator Cap", the reserve tank serves to temporarily store the reserve volume of the coolant.
This aids to control the coolant level in the cooling system. The reserve tank is connected to the radiator by means of a siphon tube.

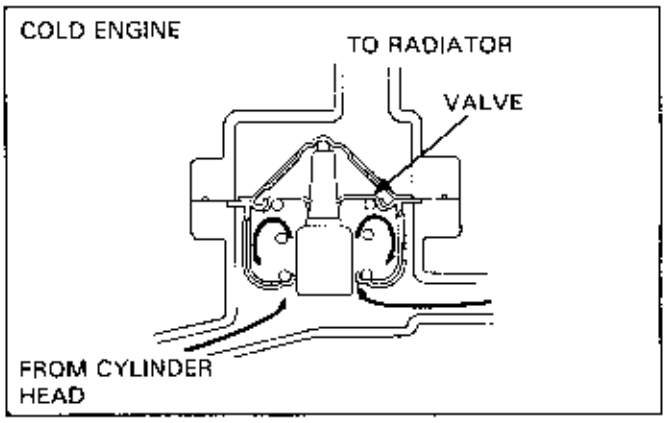


THERMOSTAT

The thermostat is installed between the water jacket of the cylinder head and the radiator.

The thermostat helps warm up the engine by preventing coolant circulation when the temperature of the engine (coolant) is low by closing a valve.

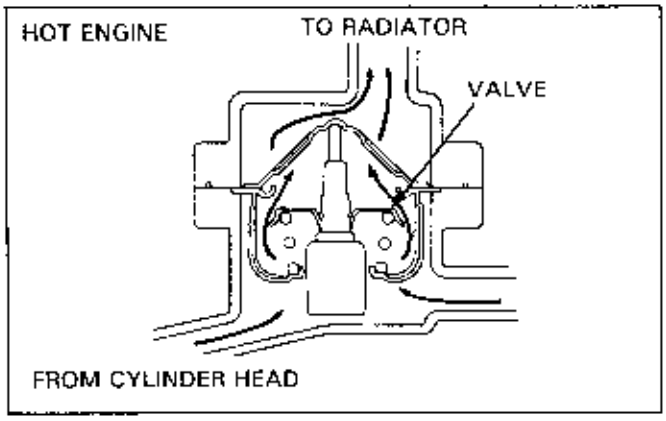
It is an automatic valve designed so that when the engine temperature increases, thermostat wax expands to open the valve, allowing the coolant to circulate through the radiator.



Even if atmospheric temperature varies, the thermostat controls the engine temperature at a constant level.

Leaving the thermostat open allows the coolant to circulate even at low temperatures. This prevents optimum engine operating temperature and leads to overcooling.

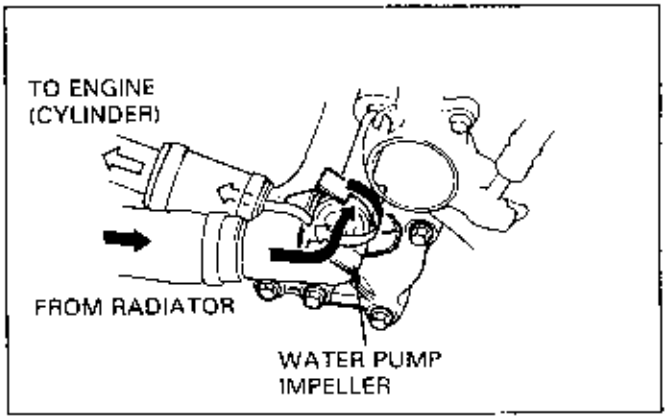
Leaving the thermostat closed contributes to overheating, since it prevents coolant circulation and prevents the radiator from dissipating the heat if the engine temperature exceeds the critical limit.



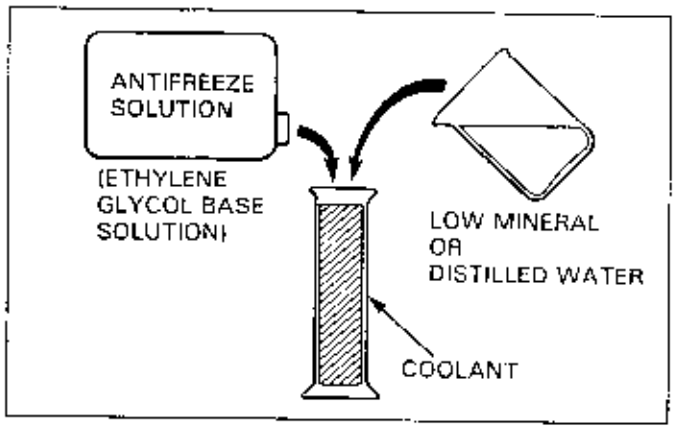
WATER PUMP

The water pump prompts the natural circulation of the coolant in the cooling system, which is carried out by convection. It also feeds the coolant uniformly to the cylinder and cylinder head water jacket so that effective cooling is maintained even if the radiator capacity is reduced.

When the impeller turns, centrifugal force draws the coolant through the water pump inlet and discharges it into the engine's water jacket.



COOLANT



PREPARATION

⚠WARNING

- **Radiator coolant is toxic. Keep it away from eyes, mouth, skin and clothes.**
  - **— If any coolant gets in your eyes, rinse them with water and consult a doctor immediately.**
  - **— If any coolant is swallowed, induce vomiting, gargle and consult a physician immediately.**
  - **— If any coolant gets on your skin or clothes, rinse thoroughly with plenty of water.**
- **KEEP OUT OF REACH OF CHILDREN**

NOTE

- The effectiveness of coolant decreases with the accumulation of rust or if there is a change in the mixing proportion during usage. Therefore, for best performance change the coolant regularly as specified in the maintenance schedule.
- Use coolant designed for use in aluminum engines (ethylene glycol base solution).
- Mix only distilled, low mineral water with the antifreeze.

Mix the distilled water and ethylene glycol base solution with about 5°C (41°F) of tolerance in respect to the minimum temperature.

RECOMMENDED MIXTURE:
50/50 (Distilled water and coolant)

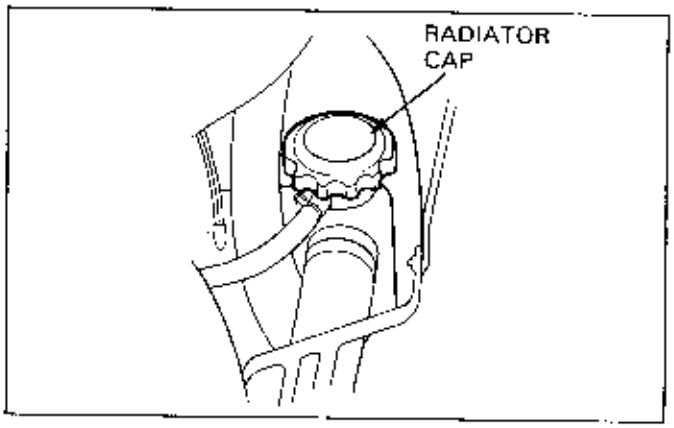
REPLACEMENT

CAUTION

- **Wait until the engine is cool before servicing the cooling system. Removing the radiator cap while the engine is hot and the coolant is under pressure may cause serious scalding.**

Refill the reserve tank with new coolant.

Remove the coolant reserve tank. Empty the coolant and rinse the inside of the reserve tank.



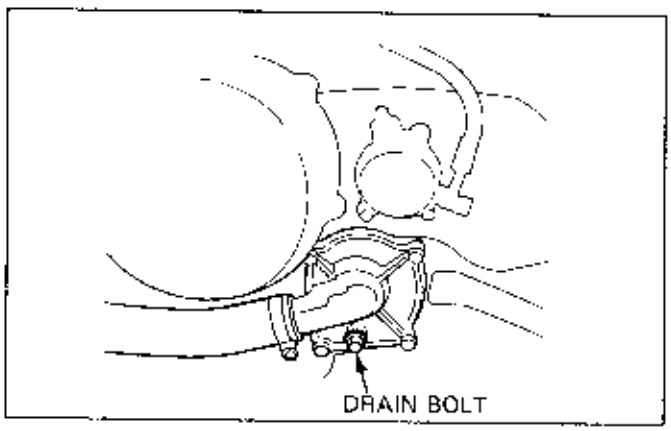
Remove the radiator cap and drain bolt(s), and drain the coolant.
Reinstall the drain bolt(s).

Refer to the Model Specific manual for drain bolt locations.

Pour the recommended coolant through the radiator filler opening up to the filler neck.

Reinstall the reserve tank and fill it to the upper level line with fresh coolant.

Bleed air from the system.



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AIR BLEEDING

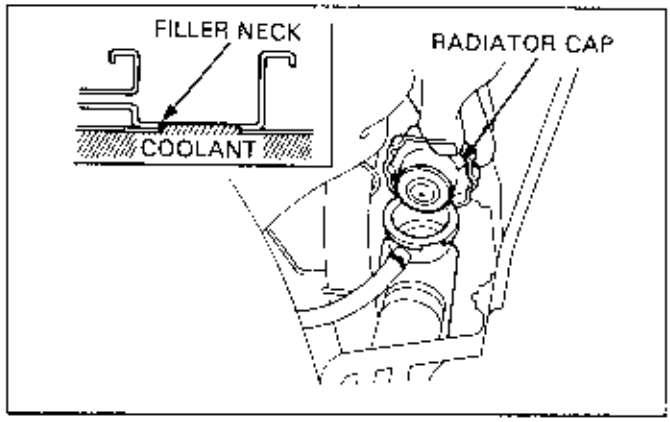
Shift the transmission into neutral.

Start the engine and run it at idle for two to three minutes.

Snap the throttle 3 4 times to bleed air from the system.

Stop the engine and add coolant up to filler neck.

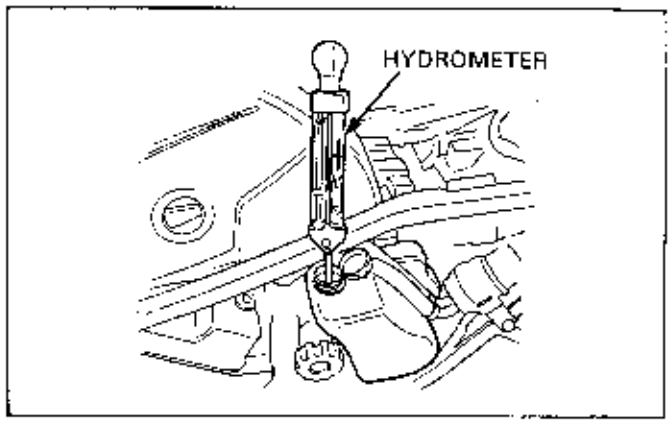
Check the coolant level of the reserve tank and fill to the upper level if the level is low.



SYSTEM TESTING

HYDROMETER TEST

Check the coolant gravity using a hydrometer.
Look for contamination and replace the coolant if necessary.



Coolant gravity chart

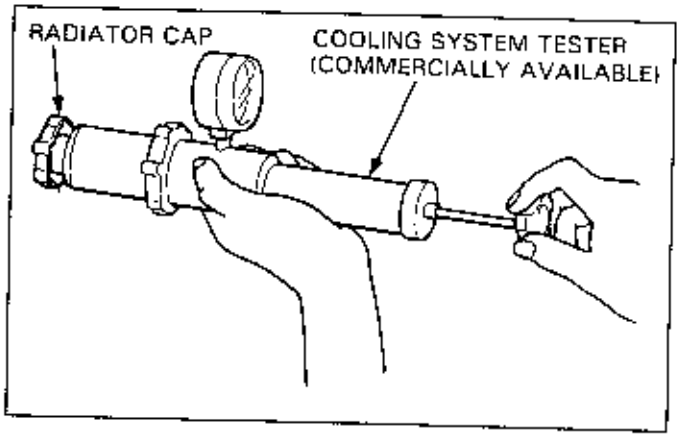
COOLANT TEMPERATURE °C (°F) / COOLANT RATIO %	0 (32)	5 (41)	10 (50)	15 (59)	20 (68)	25 (77)	30 (86)	35 (95)	40 (104)	45 (113)	50 (122)
5	1.009	1.009	1.008	1.008	1.007	1.006	1.005	1.003	1.001	0.999	0.997
10	1.018	1.017	1.017	1.016	1.015	1.014	1.013	1.011	1.009	1.007	1.005
15	1.028	1.027	1.026	1.025	1.024	1.022	1.020	1.018	1.016	1.014	1.012
20	1.036	1.035	1.034	1.033	1.031	1.029	1.027	1.025	1.023	1.021	1.019
25	1.045	1.044	1.043	1.042	1.040	1.038	1.036	1.034	1.031	1.028	1.025
30	1.053	1.052	1.051	1.049	1.047	1.045	1.043	1.041	1.038	1.035	1.032
35	1.063	1.062	1.060	1.058	1.056	1.054	1.052	1.049	1.046	1.043	1.040
40	1.072	1.070	1.068	1.066	1.064	1.062	1.059	1.056	1.053	1.050	1.047
45	1.080	1.078	1.076	1.074	1.072	1.069	1.066	1.063	1.060	1.057	1.054
50	1.086	1.084	1.082	1.080	1.077	1.074	1.071	1.068	1.065	1.062	1.059
55	1.095	1.093	1.091	1.088	1.085	1.082	1.079	1.076	1.073	1.070	1.067
60	1.100	1.098	1.095	1.092	1.089	1.086	1.083	1.080	1.077	1.074	1.071

RADIATOR CAP TEST

Test the radiator cap using the cooling system tester. Replace the cap if the relief pressure is too high or too low, or if the cap does not hold the specified pressure for at least 6 seconds.

NOTE

- Before installing the cap on the tester, wet the sealing surfaces with clean water.



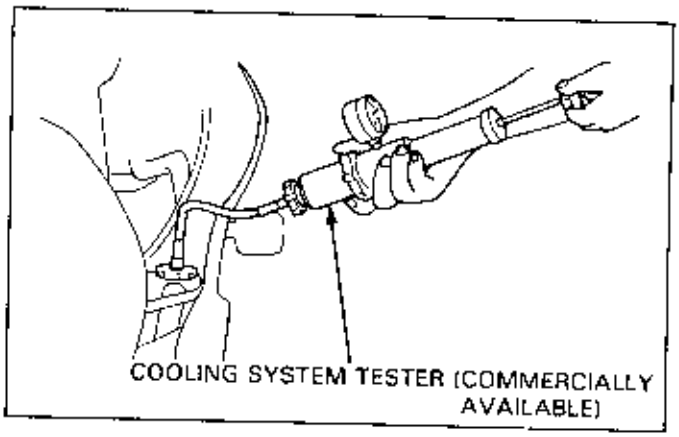
SYSTEM PRESSURE TEST

CAUTION

- **Exceeding the radiator cap relief pressure can damage cooling system components.**

Check that the system holds the specified pressure for at least 6 seconds.

If the system will not hold the specified pressure, check the following and correct as necessary.
- All hose and pipe connections
- Water pump installation
- Water pump seal (for leakage)



THERMOSTAT

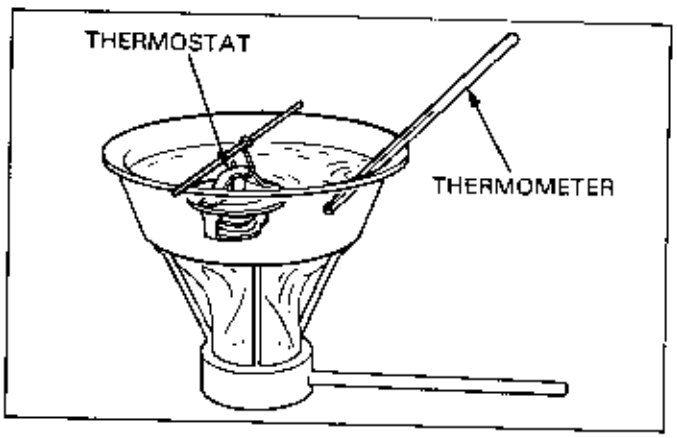
Remove the thermostat (refer to the Model Specific manual).

Inspect the thermostat visually for damage.
Suspend the thermostat in heated water to check its operation.

NOTE

- Do not let the thermostat or thermometer touch the pan, or you will get false readings.
- Replace the thermostat if valve stays open at room temperature, or if it responds at temperatures other than those specified.
- Check for the correct valve lift temperature with the water heated to operating temperature for 5 minutes. Refer to the Model Specific manual for the specific temperature.

Reinstall the thermostat.



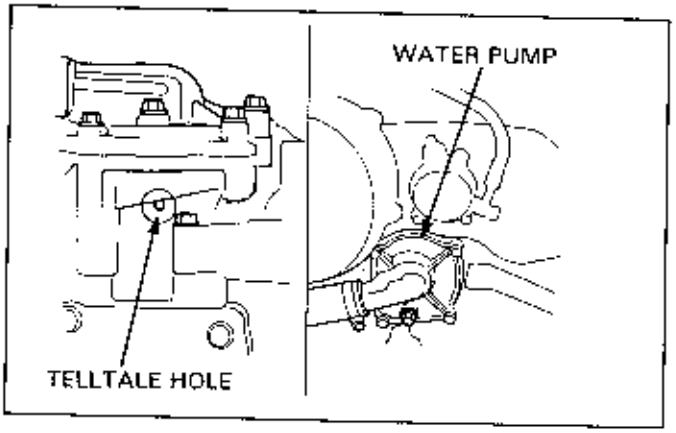
WATER PUMP

MECHANICAL SEAL INSPECTION

Inspect the telltale hole for signs of coolant leakage.
If there is leakage, the mechanical seal is defective and must be replaced.

See the Model Specific manual for mechanical seal replacement procedures.

If the mechanical seal is the built in type, the water pump must be replaced as an assembly.



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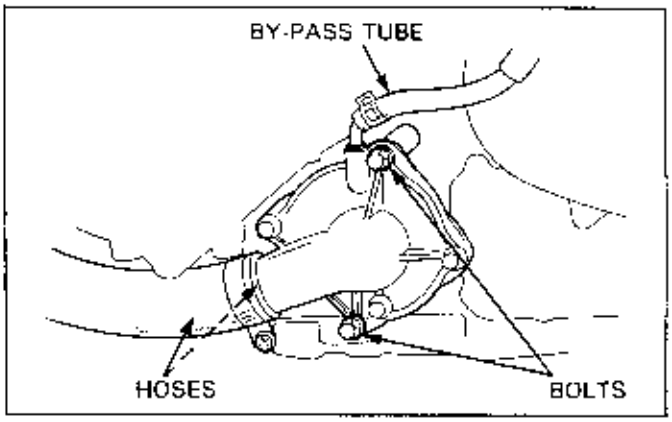
REPLACEMENT

Drain the engine oil and coolant.

Remove the water pump mounting bolts.

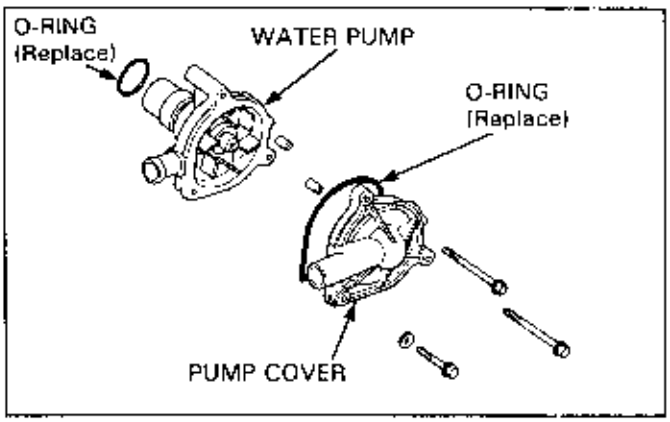
Disconnect the water hoses and by-pass tube, then remove the water pump.



Remove the bolts and separate the pump cover from the body.

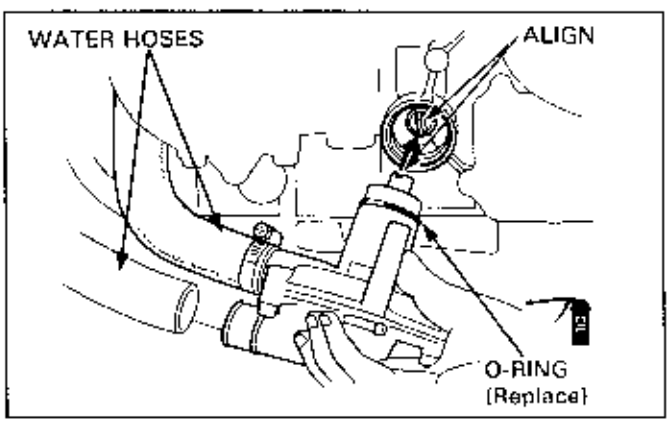
Replace the water pump with new one.

Install a new O-ring into the groove in the pump cover, then install the cover on the pump.



Install a new O-ring onto the water pump.

Align the water pump shaft groove with the water pump drive shaft and install the water pump.



Tighten the pump mounting bolts.

Connect the water hoses and secure the bands and clamp.

Fill the cooling system and add the recommended engine oil.