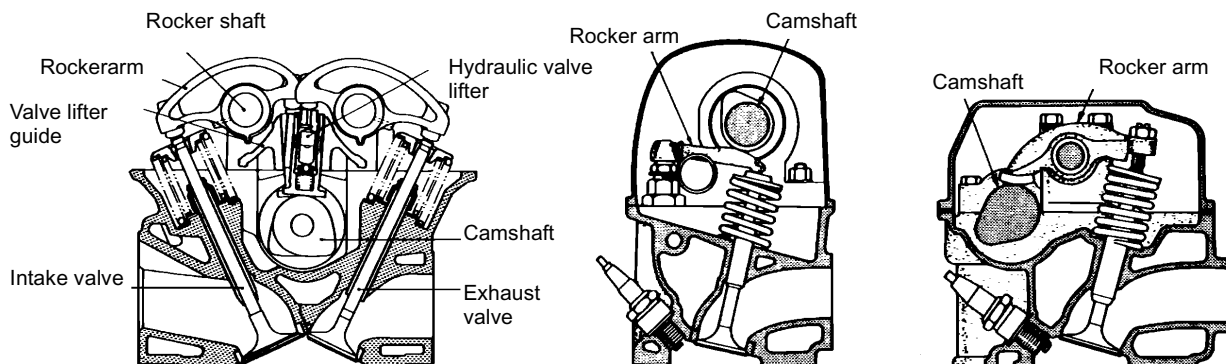


## (2) OVERHEAD CAMSHAFT (OHC).

An improvement over the OHV type, the OHC has a reduced number of intermediate parts between the camshaft and valve, and the camshaft is located above the cylinder head. Because intermediate parts such as push rods, etc. are eliminated, this type is more suitable for higher speed operations than the OHV type. The OHC is now the major type used in gasoline engines. (MA, GA, SR, RB and VG series engine, etc.)



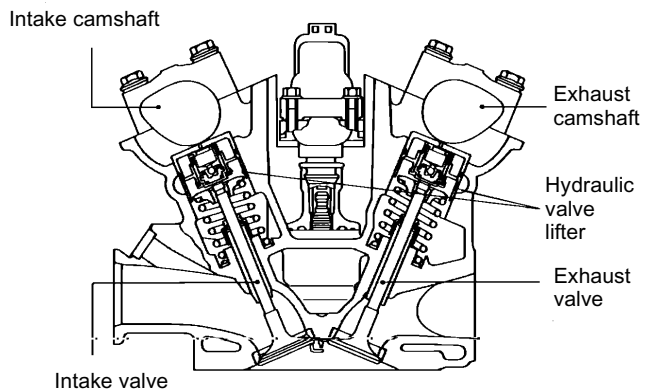
OHC type

TEM032

## (3) DOUBLE OVERHEAD CAMSHAFT (DOHC)

This type has two camshafts, one used exclusive for the operation of intake valves and the other for exhaust valves. Generally, this type has no rocker arms as the cam pushes directly on the valve. The valve mechanism is light weight.

This type is therefore, the most suitable for the high speed operations. Some engines use rocker arms because a large valve stroke can be obtained. This type also has two camshafts, and can utilize four valves (two intake and two exhaust valves per cylinder). Thus, the area of the intake and exhaust ports is large and intake efficiency is improved.



DOHC type

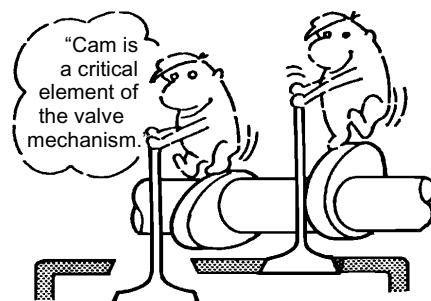
TEM033

Twin cam engines mean DOHC type engines.

## 2. CAMSHAFT

### 2-1. DESCRIPTION

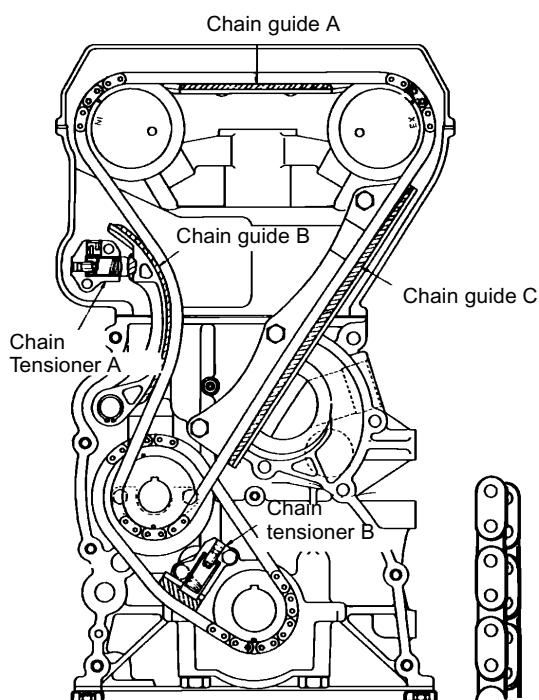
The camshaft cams open and close the intake and exhaust valves at the most optimal time, corresponding to the up and down motion of the piston. Even if the piston displacement, shape of the combustion chamber, shape and size of the intake and exhaust ports have been determined, the performance and characteristics of an engine can be changed depending upon the relative position and shape of the cam. Thus, the cam is a critical element having great influence on engine performance.



TEM034

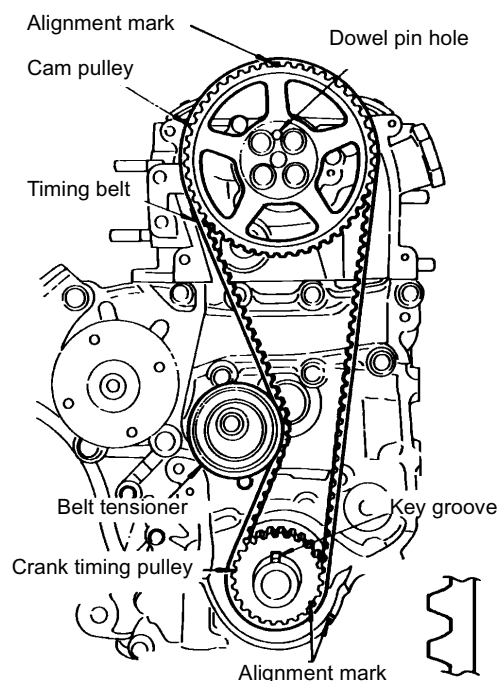
Camshaft

### (1) CAMSHAFT DRIVE



TEM035

Camshaft drive (timing chain type)



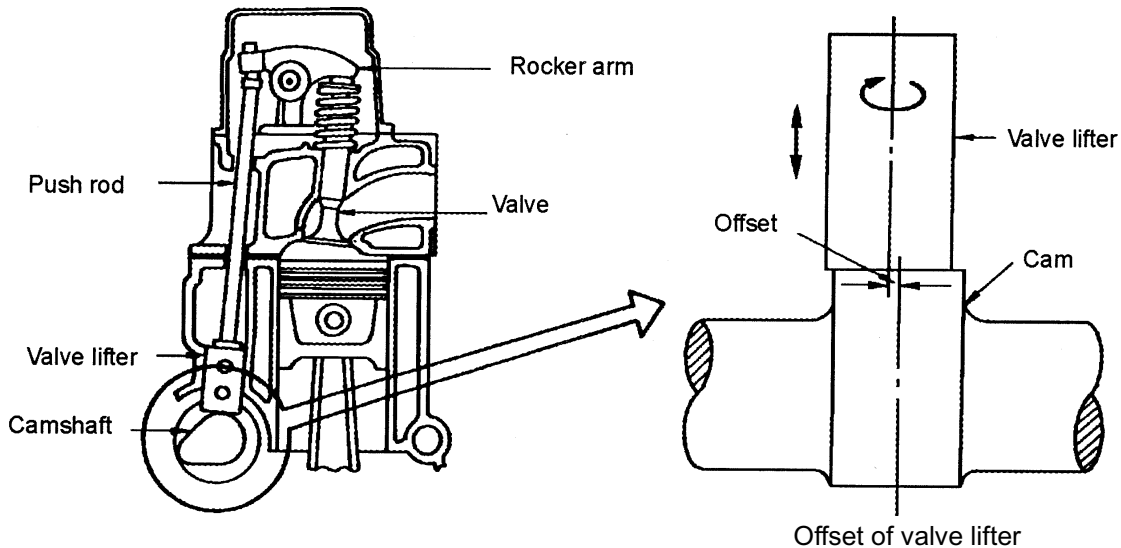
TEM036

Camshaft drive (Cog belt type)

There are several methods of camshaft drive and a representative one is the chain drive. As timing chains tend to swell outward due to centrifugal force, chain guides and chain tensions are used.

In order to operate the camshaft with the specified valve timing, when an overhaul is conducted, it is important to correctly position the crankshaft and camshaft during reinforced with synthetic fiber cord) are used.

### 3. VALVE LIFTER



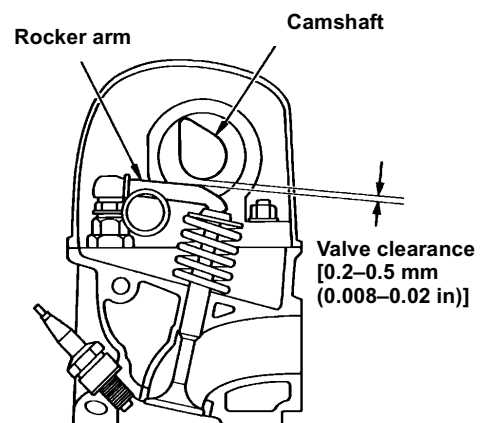
TEM037

The valve lifter (also called tappet) converts the rotary motion of the cam into a reciprocating motion, and opens and closes the valve via the push rod and rocker arm. The valve lifter is made of special cast iron and its cam contact surface is hardened. The central axes of the cam is slightly offset from that of the valve lifter which rotates the valve lifter up and down, thus uneven wear of the contact surface is prevented.

#### 3-1. VALVE CLEARANCE

Proper clearance [approx. 0.2 to 0.5 mm (0.008 to 0.020 in)] between the rocker arm and cam is provided so that the valve is not prevented from achieving a close fit in the valve seat due to a lifting action by the cam as a result of the expansion, contraction or wear of valve related parts. This clearance is called valve clearance.

If the valve clearance is too large or too small, the valve timing will be changed, resulting in engine performance being adversely affected. If the valve clearance is too small, the valve fails to correctly fit in the valve seat, which results in defective compression. If the clearance is too large, when the valve is opened its end face is strongly tapped, which causes a noise (called rocker or tappet noise). Valve clearance becomes enlarged because the whole engine expands when the engine temperature rises.

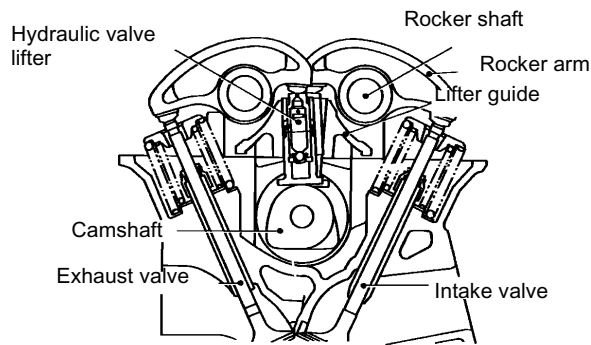


TEM038

Valve clearance

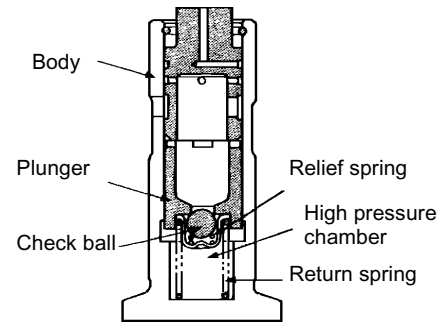
### 3-2. HYDRAULIC VALVE LIFTER

Hydraulic valve lifters, which are used in some engines, always maintain valve clearance at zero through hydraulic pressure. If the hydraulic valve lifters are used, valve clearance adjustment is unnecessary. With zero clearance, noise can be reduced.



TEM039

Installation position of hydraulic valve lifter



TEM040

Structure of hydraulic valve lifter



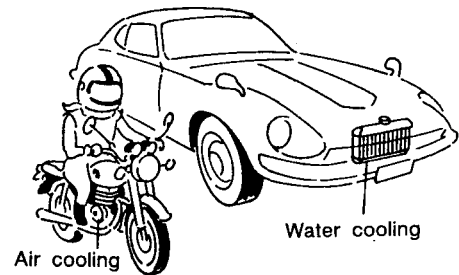
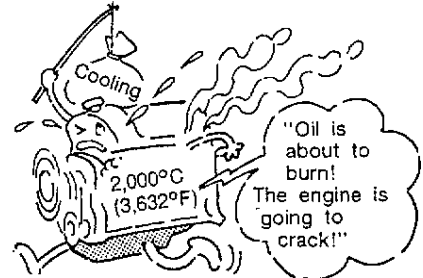
## COOLING SYSTEM

### 1. DESCRIPTION

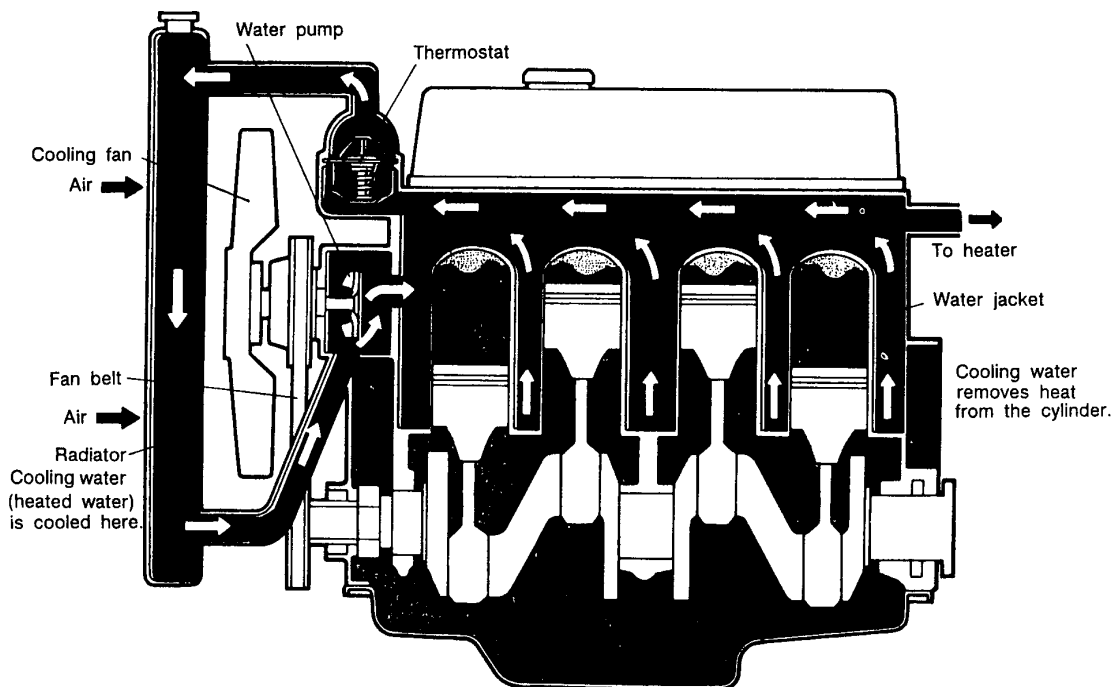
While an engine is running, combustion in the combustion chamber takes place at  $2,000^{\circ}\text{C}$  ( $3,632^{\circ}\text{F}$ ) or more, thereby heating various engine parts. If allowed to continue, the cylinder walls, pistons and valves would overheat, causing engine malfunction.

Accordingly, the engine must be constantly cooled by the cooling system, which maintains acceptable temperatures.

Automobile engine cooling systems are classified into two types according to their cooling method: air-cooled or water-cooled. Generally, water-cooled systems are more commonly used.



TLC001



TLC002

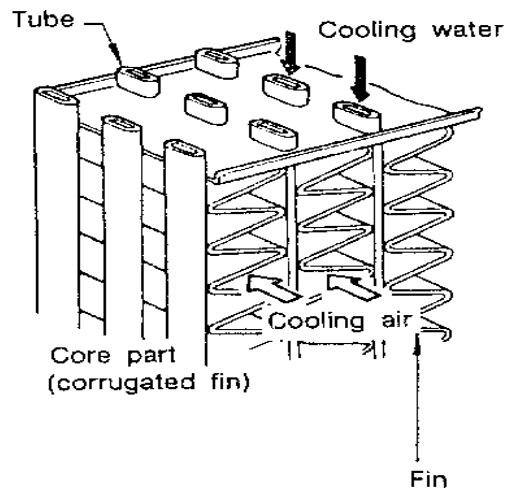
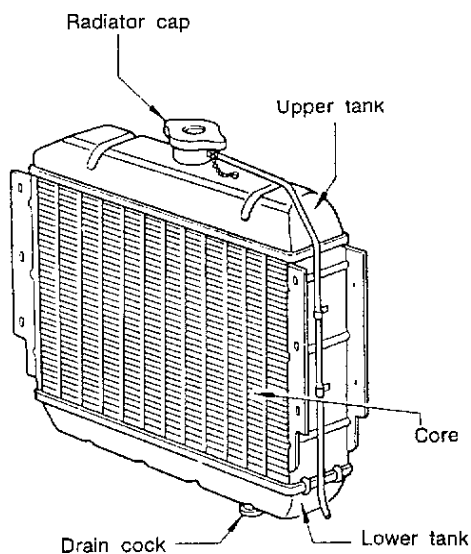
In a water-cooled engine, heat generated in the engine is cooled by engine coolant (cooling water) and the radiator dissipates the heat. A forced circulation system for circulating engine coolant is driven by the water pump. The radiator dissipates heat by means of air that is sucked from outside the vehicle via a radiator fan or through natural air flow while the vehicle is moving.

When an engine is started cold, to expedite warm up, a thermostat closes the water passage to the radiator and engine coolant is, therefore, circulated only within the engine. As the engine warms up, the thermostat opens and the engine coolant is permitted to flow into the radiator and is cooled as described above. It is recirculated through the engine by means of a water pump.

The engine coolant is used to warm the inside of the passenger compartment by circulating it through the heater core.

## 2. RADIATOR, RADIATOR CAP

### 2-1. RADIATOR



TLC003

As shown above, the radiator consists of the upper tank, lower tank, drain cock, radiator cap, etc.

## 2-2. RADIATOR CAP

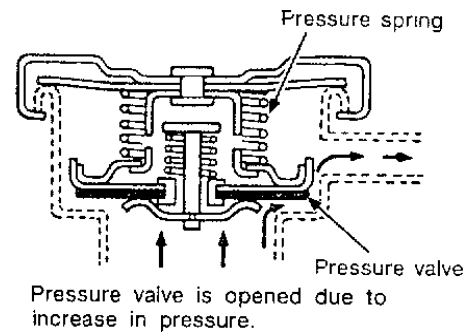
Cooling water boils at 100°C (212°F) under 1 atm. (atmospheric pressure at sea level) and then vaporizes. The radiator cap raises the boiling point of the cooling water, by increasing pressure inside the radiator, thereby increasing its temperature range and improving its cooling efficiency.

If the engine coolant boils, heat is not exchanged (heat transfer) from the engine to the atmosphere, therefore, the engine continues to heat up. This phenomenon is called “overheating”.

When overheating occurs, the difference between the temperatures of the inside of the radiator and atmospheric temperature is restricted and, consequently, the radiator’s performance is decreased.

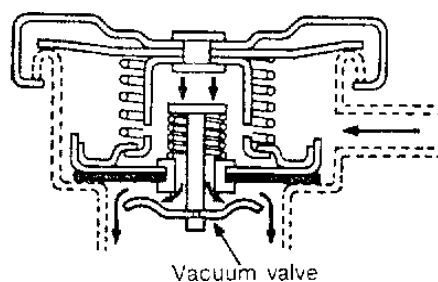
If the engine coolant temperature falls, pressure inside the radiator drops. If allowed to drop below atmospheric pressure, the radiator will collapse due to the pressure. To prevent this from occurring, a vacuum control device is provided.

The pressure valve attached to the radiator’s upper tank is closed by a pressure spring. If the internal pressure rises due to an increase in temperature of the engine coolant and it is allowed to rise above that of the pressure spring [approximately 88 kPa (0.88 bar, 0.9 kg/cm<sup>2</sup>, 13 psi)], then the pressure valve is opened and the excess pressure is released.



TLC004

**OPERATION OF PRESSURE VALVE**



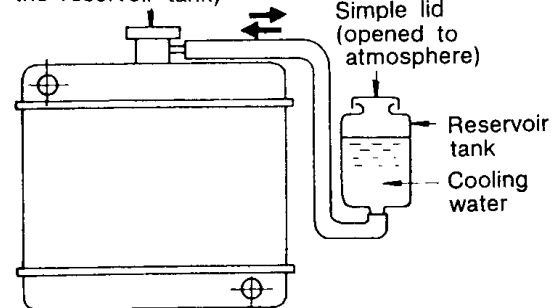
TTL005

**OPERATION OF VACUUM VALVE**

If the engine coolant temperature falls and a negative pressure is created inside the cooling system, the vacuum valve is opened and air is sucked in thus deformation of the radiator is prevented.

If the radiator cap is removed while the engine is warm, hot fluid will erupt from the radiator due to the internal pressure. Be sure to remove the cap after the engine has cooled.

Radiator cap (to be opened at the internal pressure of 88 kPa (0.88 bar, 0.9 kg/cm<sup>2</sup>, 13 psi), allowing cooling water to flow into the reservoir tank)



TLC006

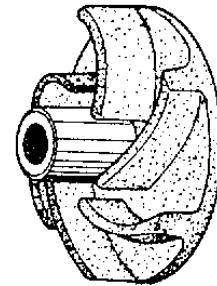
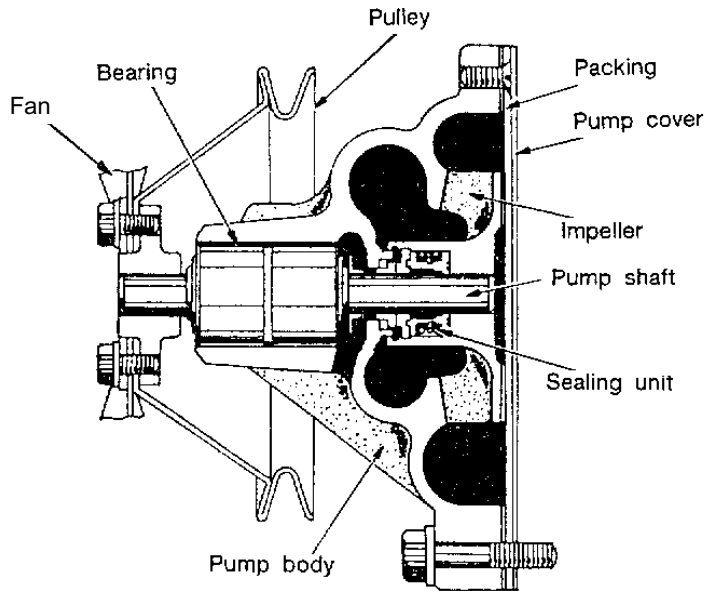
Some radiators are equipped with a reservoir tank of engine coolant. Heated and, therefore, expanded cooling water opens the pressure valve of the radiator cap, flowing into the reservoir, and is returned to the radiator after being cooled in the tank.

With the use of a reservoir tank, it is unnecessary to frequently check the engine coolant level in the radiator.

With radiators that do not have a reservoir tank, if the radiator is fully filled with engine coolant, the coolant may be vented from the radiator cap. The level of engine coolant in the radiator needs to be maintained at the specified level during cold conditions.



### 3. WATER PUMP

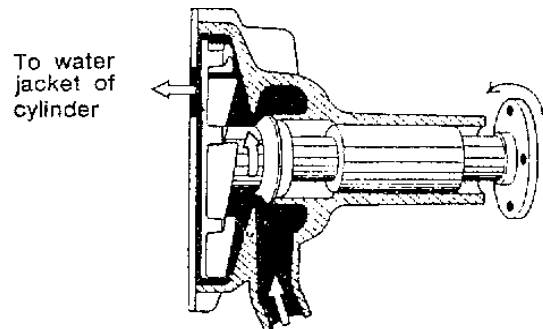


Impeller (centrifugal type)

TLC007

This pump forces engine coolant to circulate uniformly throughout the complex water jacket of each cylinder, and is rotated by the crank pulley with a speed of 0.8 to 1.5 times that of the engine.

The impeller rotated by a belt, sucks the engine coolant and then forces it into the water jacket of the cylinder block through the discharge port.



From lower tank of radiator

TLC008

#### CIRCULATION IN WATER PUMP

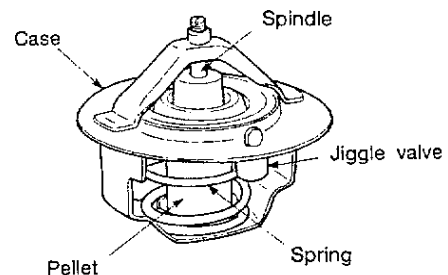
## WAX PELLETTYPE THERMOSTAT

### 4. THERMOSTAT

#### 4-1. DESCRIPTION

The thermostat is placed either in the engine coolant outlet or inlet and automatically maintains the cooling water at a certain temperature level. The ideal engine coolant temperature for obtaining maximum engine performance is 80 to 90°C (176 to 194°F) it must not be outside this temperature range. For this reason, and in order to maintain a proper temperature,

when the engine coolant temperature is low, is it not circulated in the radiator in order to quickly warm up the engine. Only when the engine coolant temperature elevates, it is circulated in the radiator.



TLC009

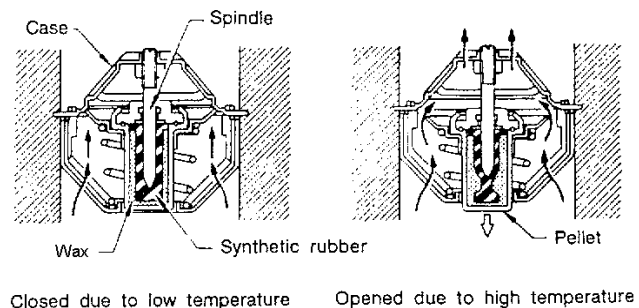
The thermostat maintains engine coolant at its proper temperature by changing the water volume circulating in the radiator.

#### 4-2. OPERATION OF THERMOSTAT

To control the circulation of engine coolant in the radiator, two methods are employed: the thermostat is placed either in the engine coolant outlet of the engine or in the engine coolant inlet. Some engines today employ bottom bypass type thermostats which control not only the engine coolant flowing in and out the engine, but also the engine coolant circulation in the engine. The thermostat is generally placed in the engine coolant outlet, but the bottom bypass type is placed either in the engine coolant outlet or inlet.

##### (1) THERMOSTAT WITHOUT A BYPASS VALVE

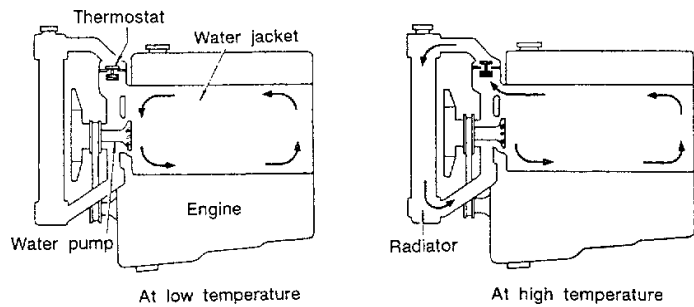
An example of thermostat placed in the engine coolant outlet is explained here. The following figure shows the operation of the wax pellet thermostat. A solid wax, rubber and spindle piston in the center are assembled in the container (pellet), and one end of the spindle piston is fixed to the outer case.



TLC010

A valve, which controls the coolant flow volume, is attached outside the pellet, and it stops the passage of engine coolant when it is not operated. With an increase in cooling water temperature, the wax is melted and its volume expands. The resulting *pressure* generated pushes the spindle piston. As the spindle piston is fixed to the case, the pressure overcomes the loaded spring force and the pellet moves downward opening the valve.

When engine coolant that has been cooled while passing through the radiator core circulates back to the thermostat, the valve closes. The thermostat repeats this operation and controls the flow volume to maintain the proper temperature. Illustration at right shows the flow of engine coolant. When the engine coolant temperature is low, the thermostat is closed and the engine coolant is not sent to the radiator, but circulates within the engine. On the other hand, when the engine coolant temperature rises, the thermostat is opened and the engine coolant circulates in the radiator as well.

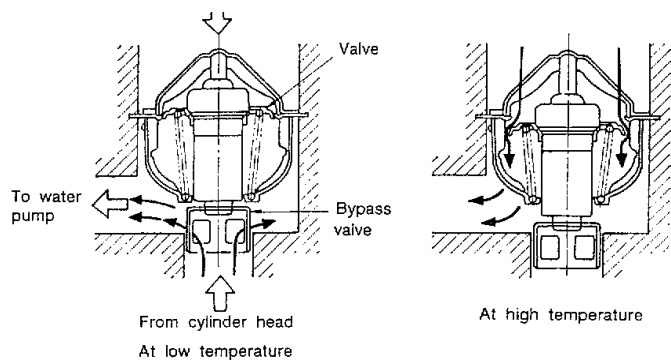


TLC011

**FLOW OF COOLING WATER**

## (2) BOTTOM BYPASS TYPE THERMOSTAT

An example of the thermostat placed in the engine coolant inlet of the engine is explained here. The following figure shows the operation of the bottom bypass type thermostat. This thermostat is shaped like a conventional thermostat the bottom of which a bypass valve is also attached. The bypass valve controls the circulation of engine coolant in the engine.

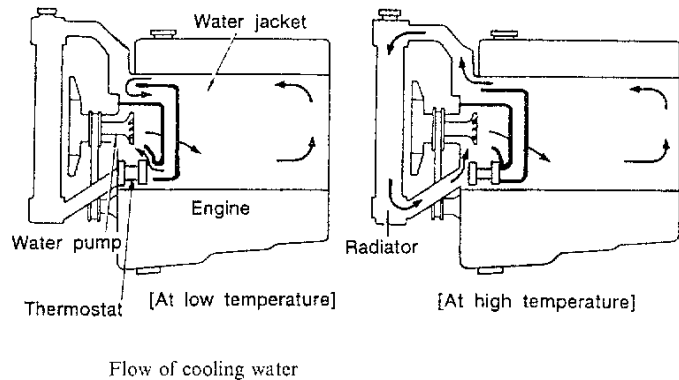


TLC012

**SIGNATURE AND OPERATION OF BOTTOM BYPASS TYPE THERMOSTAT**

When engine coolant temperature is low, the valve on the radiator side is closed and the bypass valve is opened, whereby the engine coolant is not circulated in the radiator. At this time, as the bypass valve begins to close, circulation in the engine is controlled.

When the thermostat without the bottom bypass valve is fully opened, engine coolant circulates in the engine and radiator at the same time.



TLC013

### FLOW OF COOLING WATER

However, the bottom bypass type thermostat stops engine coolant circulation in the engine and circulates it only in the radiator, thereby improving cooling efficiency.

Further, the bottom bypass type functions to control circulation in the engine by permitting the circulation passage to be widened and, compared with conventional types, when the engine is cold, coolant flow resistance is reduced. Accordingly, the load on the water pump is minimized, thereby reducing any loss of engine power output. Foreboding bypass type thermostats, in some cases if the thermostat is removed because of poor cooling performance, the cooling efficiency may be reduced.

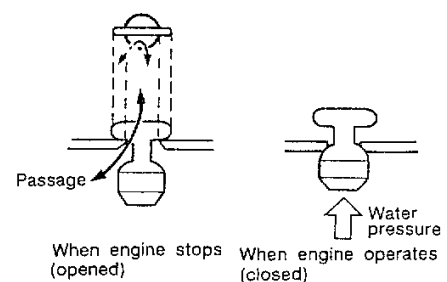
### 4-3. JIGGLE VALVE

When engine coolant is removed from the radiator for replacement, air is introduced into the engine's cooling system.

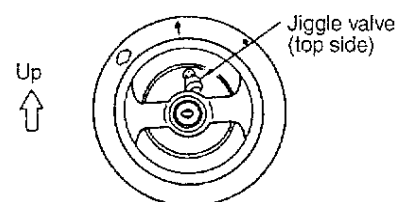
When the engine is refilled with engine coolant, air inside the system must be purged.

The jiggle valve secures the passages from air. It is designed so that, when the engine stops, the passage is opened by its own weight and when the engine operates, the valve is closed by water (coolant) pressure from the water pump.

For engines with the thermostat installed perpendicularly to the mounting surface, it is necessary to install the jiggle valve on the top side.



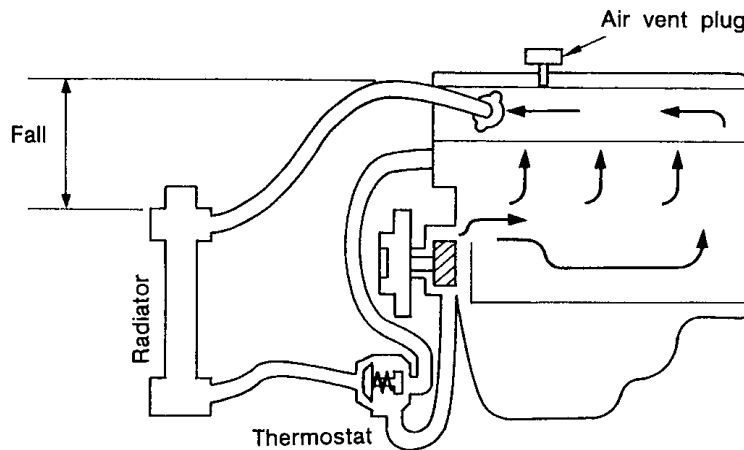
TLC014



TLC015

Modern engines are equipped with an air vent plug. The mounting position of the radiator is lower than the engine for reduction of the air resistance and vehicle styling. The plug is provided for easy air venting.

## RELATIONSHIP OF POSITION BETWEEN RADIATOR AND ENGINE



TLC016

The condition of radiator, engine inlet and outlet hoses and heater hoses should be checked to confirm the integrity. Heated water causes the rubber material to deteriorate from the inside out. Squeeze the hose, it should be firm. If the hose feels mushy or soft in any way, it should be replaced. Check to be sure there is no evidence of damage such as cracked rubber or obvious breakdown of the material.

The cooling system must maintain an optimum temperature under all driving conditions and does so by circulating a coolant-to-water solution through the engine. This solution is responsible for maintaining engine temperature within certain parameters. It provides for heat removal by absorbing heat as it moves through the engine, prevents damage to the engine when temperatures drop below the freezing point, and it also contains inhibitors to prevent corrosion of the cooling system.

## THE COOLANT SOLUTION

Understanding the temperature regulating function of the coolant solution is critical to the efficient operation of the cooling system.

As indicated, the coolant solution must efficiently remove heat from the engine under both very cold and very hot conditions. Water is the best liquid for heat removal. However, water freezes at 0°C (32°F). To prevent freezing of the circulating solution, ethylene glycol (antifreeze) is added to the water. This mixture of antifreeze-to-water may then operate within a certain range of temperature, preventing freezing of the solution as well as boiling and vaporization of the solution.



## ANTIFREEZE

Antifreeze is classified into types: Alcohol base or Ethylene glycol base. Generally, Ethylene glycol base is more commonly used because the effect of Alcohol base lasts only short period (one season). The effect of Ethylene glycol base can last a longer period so it is called Long Life Coolant (LLC).

## LONG LIFE COOLANT (LLC)

The purpose of using LLC for the engine coolant is, in addition to freeze prevention, to prevent the inside of the radiator or engine block (cooling bypass) from rusting, lubricate in the water pump, raise the boiling point of cooling water, etc. The effect of LLC varies in accordance with mileage, period of use, engine type etc., so refer to the Service Manual regarding inspection and maintenance interval.

When using either Nissan genuine coolant or a similar product, inspection and maintenance intervals vary.

If neglecting inspection or replacement of LLC, the radiator or the inside of the cylinder would be rusted and then the water pump of the radiator would be clogged, causing overheating. Also cooling water with poor efficiency due to dirt would cause some trouble in the water pump.

O    Excellent  
△    Good  
X    Failure

Comparative Table of Engine Coolant

	Cooling Performance	Antifreezing	Preventing Corrosion	Preventing Foam	Lubricating Efficiency	Raising boiling point
Ethylene glycol base	O	O	O	O	O	O
Alcohol base	△	O	X	X	X	X
Soft water	△	X	X	X	X	X

\* In the case of using Nissan genuine coolant

## MAXIMIZING THE TEMPERATURE RANGE OF THE COOLANT SOLUTION

There are ways to maximize (extend) the coolant solution's range on both ends (i.e. the freezing point and the boiling point). One is to increase the amount of antifreeze in the solution and the other is to increase the pressure of the solution

## INCREASING THE AMOUNT OF ANTIFREEZE

Increasing the amount of antifreeze in the solution will increase the boiling point as well as extend the range of the freezing point (by lowering the temperature at which the solution will freeze). However, the addition of more antifreeze reduces the heat removing efficiency of the solution.



The coolant to water ratio must be maintained at a maximum of 50% ethylene glycol (antifreeze) to 50% water to provide the heat removing qualities of the water in the solution while still maintaining adequate protection against freezing. It is essential to test the coolant specific gravity with a hydrometer to confirm the coolant to water ratio, at each service inspection.

### INSPECTION FOR COOLING WATER

Inspection of the engine coolant is necessary to confirm if LLC is performing well. There are several ways of inspecting the engine coolant. Mileage or period may be inspected after using new coolant. The mixture ratio of engine coolant may be inspected. To inspect the mixture ratio, a hydrometer or a battery coolant tester should be used.

Outside temperature down to		Composition		Coolant temperature ratio Specific gravity			
°C	°F	Engine coolant (concentrated)	Demineralized water distilled water	15 (59)	25 (77)	35 (95)	45 (113)
-15	5	30%	70%	1.046	1.042	1.038	1.033
				1.050	1.046	1.042	1.038
-35	-30	50%	50%	1.076	1.070	1.065	1.059
				1.080	1.076	1.071	1.065

#### Relation of Freezing temperature / mixture ratio of cooling water

\* In the case of using Nissan genuine coolant

Q: Is LLC quality confirmed by a standard such as API (American Petroleum Institute), which is the standard for engine oil or gear oil?

A: LLC is set by JIS, standing for Japan Industrial Standard, not API.

Q: Why LLC is colored?

A: LLC is colored green or red in order to distinguish it from water. The difference of color has nothing to do with operation efficiency. The color of Nissan genuine coolant is green.