Engine Cooling System

Objectives: At the end of this lesson you shall be able to
- **state the necessity of the cooling system**
- **list out the different types of cooling systems**
- **state the advantages of the forced type of cooling system**
- **draw the water circulation path in an engine block**
- **state the function of the water pump, radiator, temperature indicator, pressure cap**
- **state the need and function of the thermostat valve, recovery system**
- **state the different types of thermostat valves.**

Combustion of fuel inside a cylinder develops a very high temperature (Appx. 2200^0C). At this temperature the engine parts will expand and tend to seize. Similarly the lubricating oil will loose its property. Therefore it is necessary to keep the engine temperature to operating limits. This is done by the cooling system. Heat is removed from the engine by cooling media (water or air) and is dissipated to the atmosphere.

Types of cooling systems

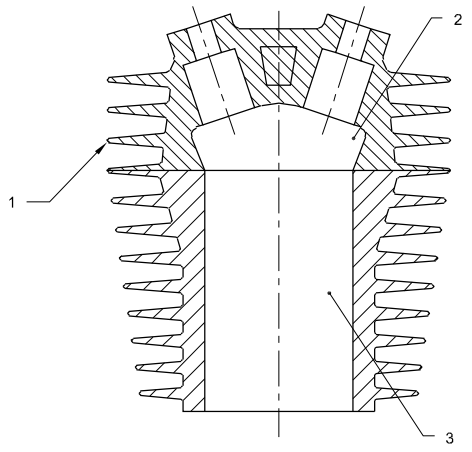
There are two types of cooling systems used in engines.

- Direct cooling - air cooling.
- Indirect cooling - water cooling.

Air-cooled engines

In air-cooled (Fig 1) engines, cylinders are semi-independent. They are not grouped in a block. Metal fins (1) are provided on the head (2) and cylinder (3), to help dissipate heat from the engine. In some engines fans are also used to improve air circulation around the cylinders and heads. This type of cooling system is employed in two-wheelers and small stationary engines. These are used in both S.I. and C.I. engines.

Fig 1

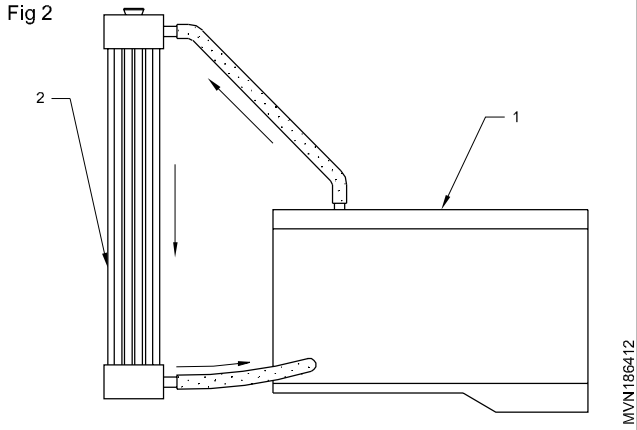


Water cooling

Two types of water cooling systems are used.

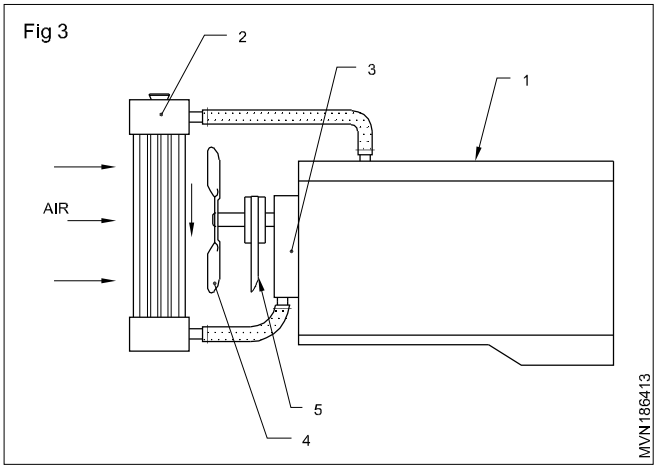
- Thermo-siphon system (Fig 2)
- Forced circulation system (Fig 3)

Fig 2



Thermo-siphon system

Fig 3



In this system no pump is used for water circulation. Water circulation is obtained due to the difference in the densities of hot and cold water. Water absorbs the heat and rises up in the block (1) and goes to the radiator's (2) top side. Water is cooled in the radiator (2). It again goes to the water jackets in the engine. To maintain a continuous flow of water the level of water is maintained at certain minimum level. If the water level falls down the circulation will discontinue. This system is simple but the rate of cooling is very slow.

Pump circulation system (Forced feed system)

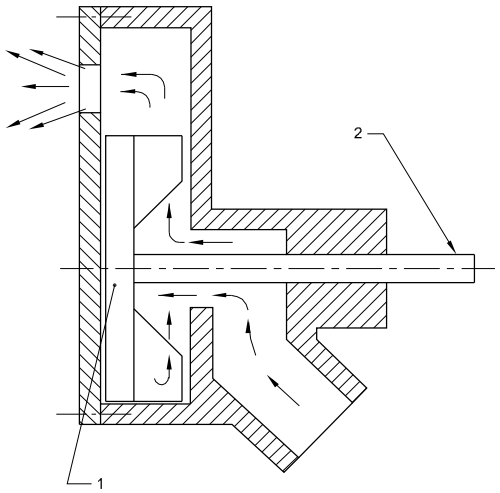
In this system water is circulated by a pump (3). The pump is driven by a belt (5) which is connected with the crankshaft pulley. The circulation depends upon the engine speed. More water is circulated at higher engine speed.

The water absorbs heat from the engine and flows to the radiator's (2) top tank. Water from the top tank of the radiator (2) flows down to the bottom tank. The fan (4) draws the air through the radiator's fins and cools the hot water. Cold water from the bottom tank is again pumped to the engine and the cycle is repeated.

Water pump

The centrifugal type water pump (Fig 4) is used in engines. It is mounted on the front side of the cylinder block or head. The water pump is driven by the crankshaft pulley through the fan belt. The impeller (1) is mounted on one end of the water pump shaft (2). The shaft (2) is fitted in the pump housing with bearings. A water seal is provided in the pump to prevent leakage of water and to prevent water entering into the bearings. When the impeller rotates it draws water from the lower tank of radiator, and pumps water to the engine block, by centrifugal force under pressure. The fan is mounted on the water pump pulley.

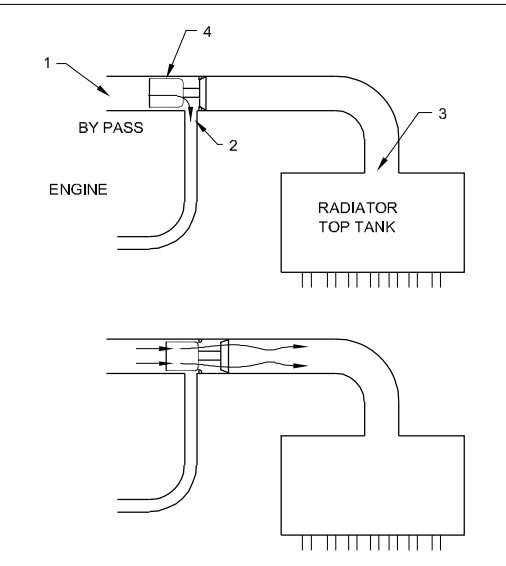
Fig 4



Thermostat

The thermostat (Fig.5) helps to bring the cold engine to the operating temperature quickly.

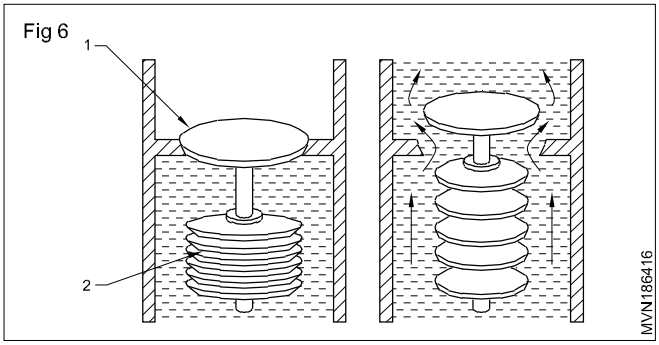
Fig 5



It is fitted in between the water outlet of the cylinder head (1) and the inlet (2) of the radiator in the water cooling system. When the engine is cold, the thermostat (4) is closed. It does not permit water to enter the radiator. Water recirculates in the engine through the bypass hole (2) and the engine reaches the operating temperature quickly. Once the engine has reached the operating temperature the thermostat (4) opens. It closes the bypass hole (2) and now permits water to enter the radiator tank (3). Thermostats are rated to open at different temperatures. Two types of thermostats are used.

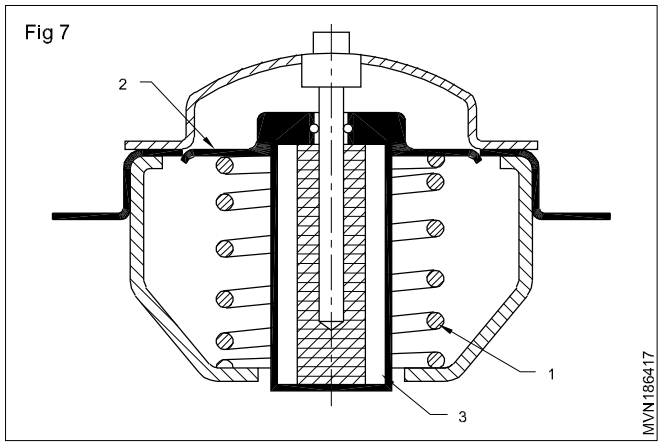
- Bellows type (Fig 6)

Fig 6



- Wax type (Fig 7)

Fig 7



Bellows type

It has a flexible metal bag closed at both ends. The metal bag is partially filled with ethyl which has a low boiling temperature.

When the engine is cold the valve (1) closes its outlet passage and does not allow water to reach the radiator top tank from the engine, but is circulated through the bypass port to the engine.

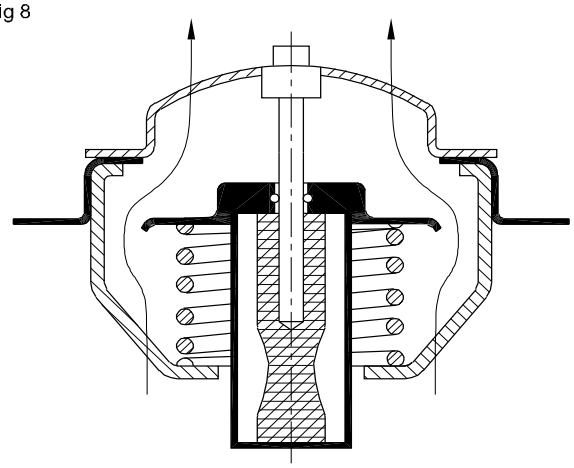
When the water reaches the working temperature, ethyl in the closed bellow (2) expands and opens the valve (1). Now the water reaches the radiator top tank from the engine. In the valve's opened position the bypass passage is closed.

Wax pellet type

In this type a wax pellet (3) (Fig 8) is used as a heating element. When the circulating water's temperature is lesser than the operating temperature, the spring (1) keeps the valve (2) in the closed position and the water does not reach the radiator top tank from the engine.

As the water reaches the operating temperature the wax pellet expands and forces the valve (2) to open against the spring tension. Now the water reaches the radiator top

Fig 8



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tank, from the engine. At this position the bypass port is closed by the valve.

Components of water cooling system

Objectives: At the end of this lesson you shall be able to
- **state the constructional features of a radiator**
- **state the need of a pressure cap**

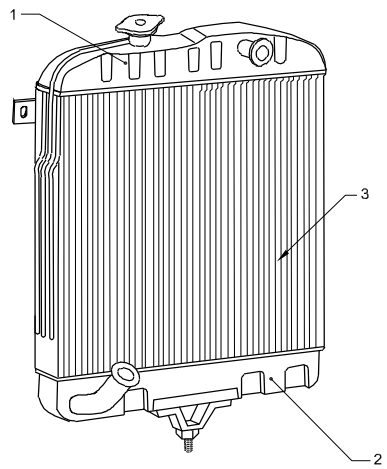
Radiator

The purpose of a radiator in the cooling system is to cool hot water coming out of engine.

It has a large cooling surface area to allow enough of air to pass through it. Water circulated through it is cooled by the passing air.

The radiator (Fig 1) consists of an upper tank (1),a lower tank (2) and in between the upper and lower tank radiator cores (3) are provided. The upper tank (1) is connected to the water outlet of the engine through a rubber hose. The lower tank (2) is connected to the water pump through rubber hoses.

Fig 1



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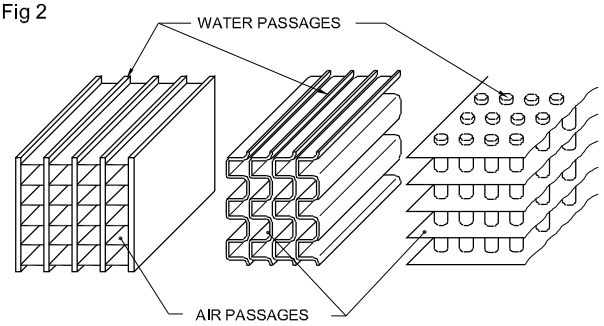
Radiator cores are classified into two types.

- Tubular core (Fig 2)
- Cellular core (Fig 3)

Tubular core

In a tubular type the upper and lower tanks are connected by tubes. Water passes through these tubes. Cooling fins are provided around the tubes, to absorb and radiate heat to the atmospheric air.

Fig 2



TUBULAR RADIATOR SECTIONS

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Cellular cores

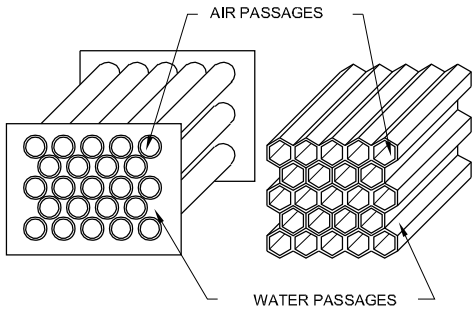
In the cellular type a large number of individual air cells are provided and surrounded by water. Because of its appearance, the cellular type is known as a 'honeycomb' radiator.

The material of the core is of copper and brass. The parts are normally connected together by soldering.

Pressure cap

In normal atmospheric conditions water boils at 100°C. In higher altitude height the atmospheric pressure is low and water boils at a temperature below 100°C. To increase the boiling temperature of water the pressure of the cooling system is increased. This is achieved by providing pressure

Fig 3



CELLULAR RADIATOR SECTION

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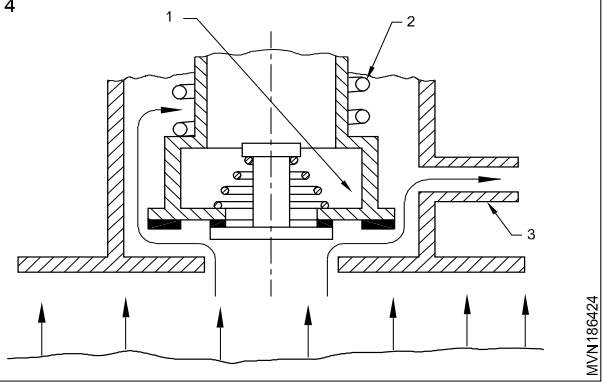
caps to seal the system. The coolant loss, due to evaporation is also minimized, by using a pressure cap. (Fig 4)

Fig 4



It also permits the engine to operate at a higher temperature so that better efficiency of the engine is achieved.

The pressure cap is fitted in the filler neck portion on the top of the radiator tank. If pressure is increased by 15 P.S.I., the boiling temperature raises to 113°C. The pressure cap has two valves.

- Pressure valve
- Vacuum valve

Pressure valve

If the pressure in the system rises it may damage the components. To avoid this a pressure relief valve (1) is used to release the excess pressure. It is a spring- loaded valve. The spring's (2) tension depends on the system's pressure.

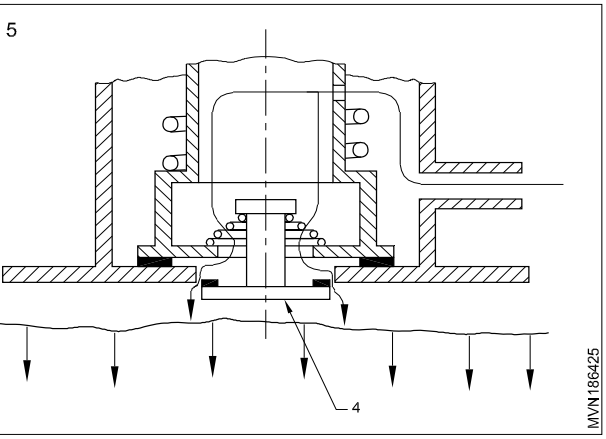
When the cooling water of the engine is heated up it expands which results in high pressure in the system. If the force due to pressure is more than the spring's (2) tension the valve opens and water vapour/steam escapes through the overflow pipe (3) until the pressure is lowered to the preset value.

Vacuum valve

When the engine cools down the pressure in the system decreases due to loss of the coolant and a vacuum is created.(This valve is also located in the cap and fitted in the filler neck of the radiator)

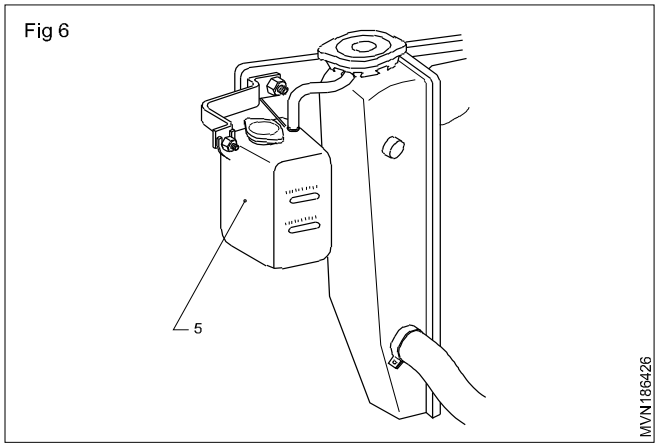
At this time the vacuum valve (4) (Fig 5) opens and air flows into the system until the vacuum is filled up in the system.

Fig 5



In some engines an overflow pipe is connected to an expansion tank (5). The expansion tank (5) (Fig 6) collects the water vapour during the pressure valve operation, and the same vapour, after condensing, goes to the radiator when the vacuum valve is in operation.

Fig 6



Temperature indicator

The temperature indicator is fitted on the instrument panel it indicates the temperature of the water in engine water jackets. There are two types of temperature indicator used in an automobile.

1 Mechanical type

2 Electric type

Mechanical type temperature indicator consists of a sealed bulb that fits in the cylinder head water jacket and connected by a fine tube to temperature pressure gauge on the dash board.

The electric type water temperature sending unit is fitted in the cylinder head water jacket and it is connected through electric wire from ignition switch to temperature use sending units cold terminal through panel indicator bulb, another wire is connected from temperature sending units hot terminal to temperature warning lamp. When the engine temperature reaches normal, the green light circuit is completed by the engine unit and the dial indicates green light. When the engine is over heated the engine unit completes red light circuit and the dial indicates the red light.

In latest vehicle engine coolant temperature (ECT) sensors are using.

Thermo switch

This device is prevents the engine from over heating by activating radiator cooling fan, measuring the coolant temperature and controlling the level gauges and warning lights on the engine control unit. This device have upto four terminals and be installed on the radiator, the cooling system tubes or thermostate, so that the coolant flows across the sensing element (bimetal disc or thermistor).

Function of thermo switch

Theremo switch operates independent from any current supply, temperature detection is effected by means of a by metal disk switch on temperature. When this fixed switch