on temperature is reached this bimetal disk well snap over, closing a contact the circuit system and there by closing the electric of device to be started. After cooling down and reaching the cut off temperature. The bimetal disk will auto mechanically return into its original position and open the contact. The electric circuit is opened again.

Coolant properties of an engine

A efficient cooling system removes 30 to 35% of the heat generated in the combustion chamber.

- Coolant should be remove heat at a fast rate, when the engine is hot.
- Coolant should be remove heat at a slow rate when the engine is started until the engines reaches at its normal operating temperature.
- Coolant should not remove too much heat from the engine. Too much removal of the heat decreases thermal efficiency of the engine.
- It should circulate freely in the coding system.
- It should be prevent frequency and rust formations.
- It should be reasonably cheap.
- It should not waste by vaporisation.
- It should not deposit any foreign mater in the water jackets/radiator.

Change of engine coolant interval

1 Coolant should be replace as per specified by the manufacture.

2 Coolant should be replace during major repair in an engine or radiator.

3 Coolant should be replace at dilute (oil mix with water).

Anti- Freeze mixtures

1 Wood alcohol

2 Denatured alcohol

3 Glycerine

4 Ethylene glycol

5 Propylene glycol

6 Mixture of alcohol and glycerine

Fan: The fan is mounted behind the radiator on the water pump shaft. When engine is running the fan is drawn air through radiator core tubes and fins to cool the water in radiator.

In modern vehicles cooling fan is operated through electric power and it has fun actioning as per sensor base signal delivered by ECU normally it is not operating till water temperature is not reached as specified temperature limit.

Engine lubricating system

Objectives: At the end of this lesson you shall be able to
- **list out the different types of engine lubricating systems**
- **explain the function of each system**
- **draw the oil circulation path in an engine block**
- **state the function of the pressure relief valve**
- **state the types of the pressure relief valve**
- **list out the different types of crankcase ventilation**
- **explain the positive crankcase ventilation.**

Types of lubricating system

The following types of lubricating systems are used in engines.

1 Petrol-oil lubrication

2 Dry sump lubrication

3 Splash lubrication

4 Pressurized lubrication

5 Combined lubrication

Petrol-oil lubricating system (Fig 1)

In this system the lubricating oil is mixed with the petrol(2). The ratio of petrol and oil is 20:1. When fuel goes in the crankcase chamber (1) and crankshaft bearings, the oil mist sticks to the moving parts and gives the lubricating effect. This system is mostly used in two-stroke engines.

Dry sump lubricating system (Fig 2)

In this system the lubricating oil is delivered from a separate tank (1) to the components by an oil pump (2). The oil lubricates the moving parts and flows back to the oil sump

Fig 1

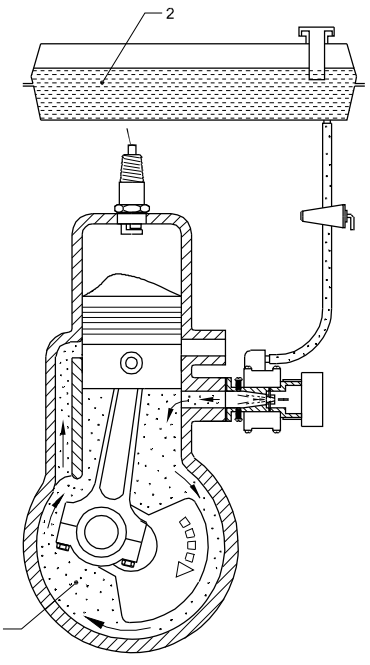
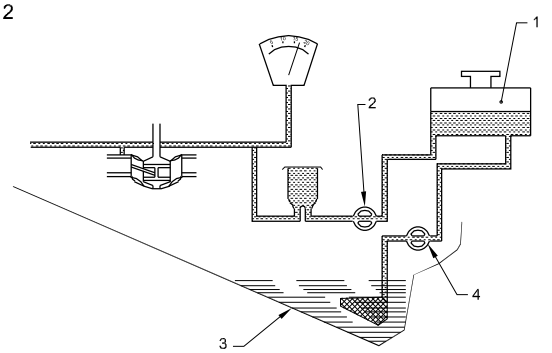


Fig 2



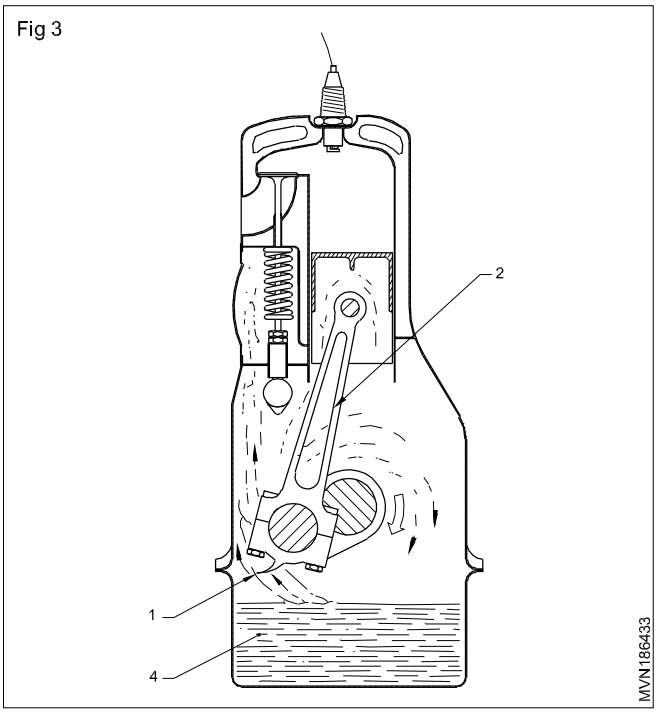
(3). A scavenging pump (4) is provided to pump oil from the sump to the tank.

The lubrication effect is not affected when the vehicle is climbing up or moving down.

Splash type lubricating system (Fig 3)

In this system the lubricating oil is stored in a sump(4). A dipper (1) is made at the lowest part of the connecting rod (2). When the crankshaft rotates the dipper (1) dips in the oil once in every revolution of the crankshaft and splashes oil on the cylinder walls.

Fig 3



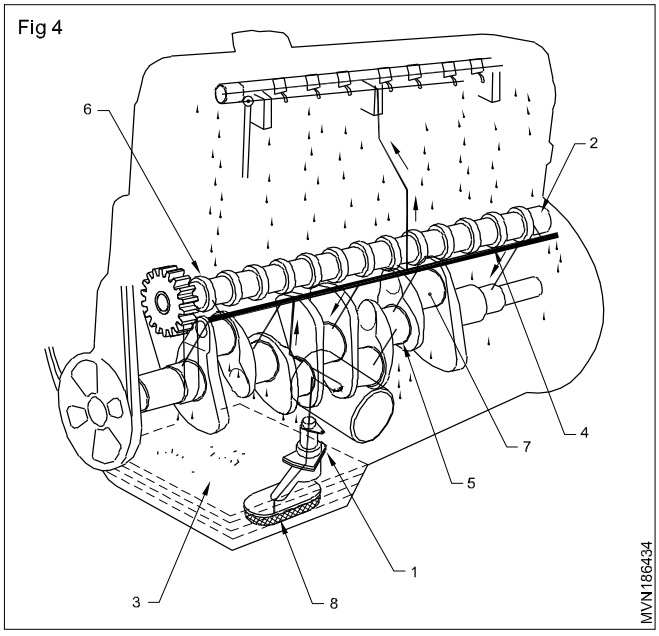
Pressure lubricating system (Fig 4)

In the system the lubricating oil is circulated to all the moving parts of the engine under pressure, by the oil pump (1) driven by the camshaft (2).

The oil from the sump (3) is sucked by the oil pump (1) through the strainer (8) and suction pipe. The strainer filters the solid dust particles. The oil flows to the main gallery (4) from the filter's outlet. From the main oil gallery (4) the oil flows to the crankshaft main journals (5) and camshaft bushes (6).

From the crankshaft main journal (5) the oil flows to the crankpin (7). From the camshaft bush it flows to the

Fig 4



cylinder head and lubricates the rocker bushes. When the crankshaft rotates the oil splashes from the connecting rod bearings and lubricates the piston rings and liner. In some engines an oil hole is drilled from the connecting rod big end to the small end to lubricate the gudgeon pin bush.

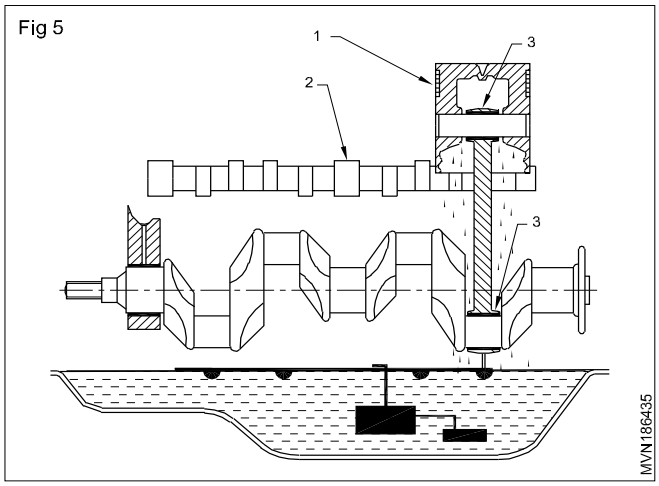
A relief valve is provided in the path between the oil pump and the filter. The relief valve limits the maximum pressure of the oil in the system. An oil pressure gauge or indicating lamp is provided to indicate the oil pressure.

After lubricating the various parts of the engine, the oil reaches the oil sump.Combined lubricating system

Combined lubricating system (Fig 5)

It is a combination of splash lubricating system and pressure lubricating system. Some parts are lubricated by the splash lubricating system - such as the cylinder wall (1), camshaft bearings (2), connecting rod bearing (3) and the remaining parts are lubricated by pressure lubricating system.

Fig 5



Pressure relief valve

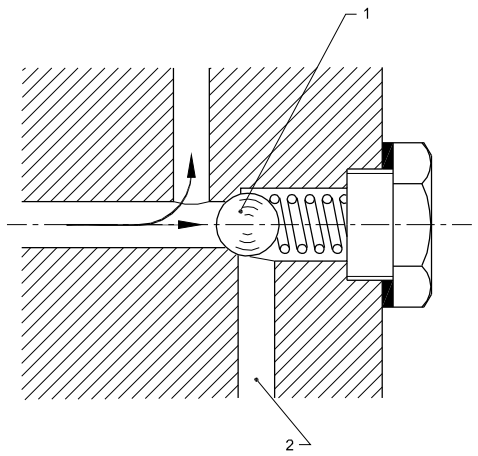
The pressure relief valve is used to limit the maximum pressure of the oil. When the oil pressure increases more than the prescribed limit, the relief valve opens and allows oil to return back to the oil sump directly.

Following types of relief valves are used.

- Ball type
- Plunger type

Ball type (Fig 6)

Fig 6

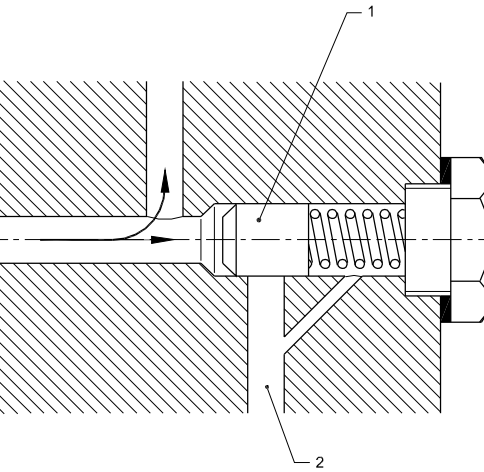


In this type of relief valve a spring-loaded ball (1) opens the connection to the return channel (2) when the oil pressure over comes the spring force. The oil flows through the return channel back to the oil sump.

Plunger type relief valve (Fig 7)

This type of relief valve is similar to that of the ball type except that a plunger (1) is used instead of a ball. A leakage oil relurn passage is provided to allow oil to return to the oil sump which has passed through the plunger (1).

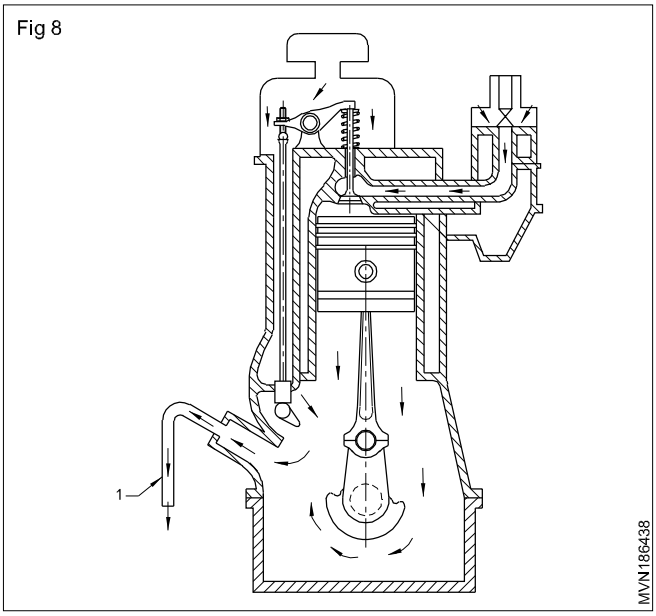
Fig 7



Crankcase ventilation (Fig 8)

In the crankcase oil gets diluted due to the mixture of blow by gases, carbon particles, metallic particles, sand, dust, dirt and the acids formed out of the exhaust gas condensation such as sulphuric acid and phosphoric acid. This affects lubrication and forms a sludge (accumulation of dirty oil). Frequent cleaning and change of oil is needed. To overcome this problem, crankcase ventilation is provided. Fresh air is allowed in the crankcase which passes out after circulation through a breather pipe (1) in the rear. This arrangement is known as OPEN TYPE CRANKCASE VENTILATION.

Fig 8



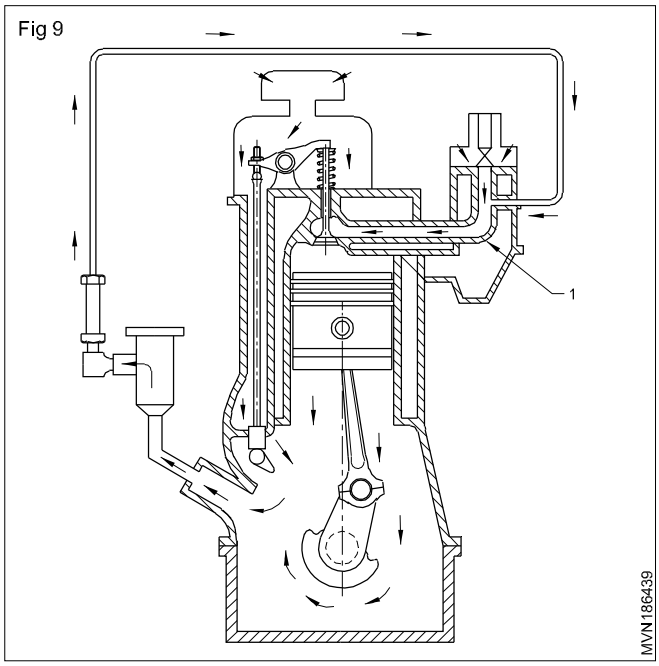
Positive crankcase ventilation (Fig 9)

The exhaust gases and other particles going out of the engine are toxic and injurious to public health. To overcome this positive crankcase ventilation or closed type ventilation is provided. In this arrangement all air flowing out of the engine crankcase is drawn back into the inlet manifold (1) and fed into the engine. This prevents the flow of gases outside the engine.

Function of sump

Oil sump is the lowest part of the crank case (Engine). It provides a covering for the crankshaft and contains oil in it. In wet sump lubricating system, the oil is taken out from the sump and after lubricating different parts of engine again oil drops in to oil sump. It is made of steel pressing/aluminium/ east iron. It contains drain plug at its lowest part to drawn out the oil. In dry sump lubricating system the oil is stored drain in a separate oil tank.

Fig 9



Oil collection pan

Oil pan is the lowest part of the engine. In dry sump lubricating system oil pan is collect the oil after lubricating different parts the engine oil drops in an engine and then oil is sent back to the oil tank by a separate delivery pump.

Oil tank

In dry sump lubrication system, two oil pumps are used one for feed the oil from tank to lubricating system and another pump scavenging pump is sent oil from dry sump to oil tank. In this system oil is not stored in oil sump.

Oil pick up tube: The oil pick up tube is located in oil pump and it is connected from oil strainer to oil pump in wet sump lubrication system.

In dry lubrication system two pick up tube is used to pick up oil from oil tank to engine main gallory and oil drop sump to oil tank through suction pump and scavenging oil pump.

Pick up tube

In dry sump lubricating system pick up tube is connected between delivery pump and oil tank, to pick up the oil from sump to oil tank. In wet sump system pick up tube is connect the stainer and oil pump.

Oil pump & Filter

Objectives: At the end of this lesson you shall be able to
- **state function of oil level and pressure indicator**
- **list out the types of oil pump**
- **list out the type of oil flow system**
- **purpose of the oil cooler.**

Oil level indicator

It is a steel stick graduated at the front end for measuring the level (amount) of oil in the sump. The graduations are “Full” , “Half”, “Low” marks are provided on the bottom end of the dip stick. These marks show whether the oil is up to the required full or half level or the level is so low. The low oil level may cause danger to engine life.

For measuring oil level, remove the stick from the engine, clean and dipped into the oil sump and again taken out to see graduation oil has sticked.

Oil pressure indicator

Oil pressure gauge or oil waring light is provided on the dash board to indicate the lubrication.Oil pressure during engine running.

Oil pressure gauge

It is equipped with pressure lubricating system to warn the engine operator, what is the oil pressure is in the engine. The oil pressures are following types

1 Pressure expansion type

2 Electric type

  a Balancing type

  b Bimetal thermal type

Oil pressure indicating light

The light comes when the ignition switch is turned on and the oil pressure is low. The circuit uses four stage diaphragm switch, which operates a warning lamp according to the pressure required for different engine speeds. The switch is located at the oil main gallery. Its connection with the warning light is through the ignition switch.

Components of the lubrication system

Oil pumps

The oil pump is used to pump oil from the oil sump to the oil galleries at a certain pressure.

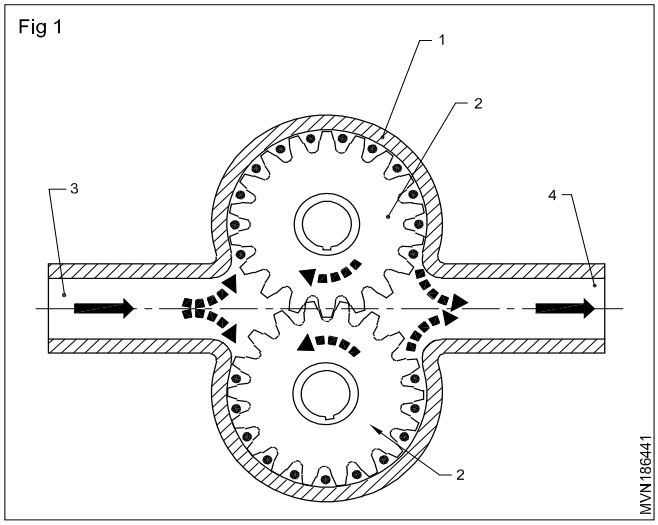
It is located in the crankcase and is driven by the camshaft. Four types of oil pumps are used.

- Gear type oil pump
- Rotor type oil pump
- Vane type oil pump
- Plunger type oil pump

Gear type oil pump (Fig 1)

In this type two gears are fixed in the pump housing (1). The gears (2) have little clearance with the pump housing (1). When the gears rotate a vacuum is created in the casing. Oil is sucked through the inlet (3) and pumped to the oil gallery through the outlet (4).

Fig 1

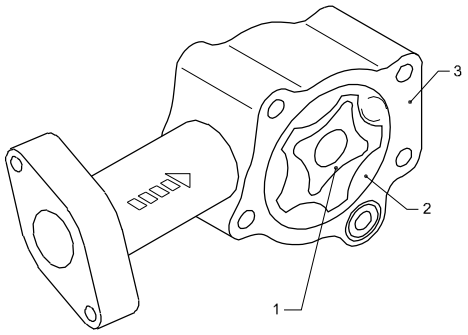


Rotor type oil pump (Fig 2)

The rotor type oil pump consists of an inner driving rotor (1), and an outer drive rotor (2) which rotates freely in the pump housing (3) and runs eccentrically in relation to the inner rotor.

The oil is sucked into the pump in the side where the volume between the rotor teeth increases and is pumped out on the side where the volume decreases.

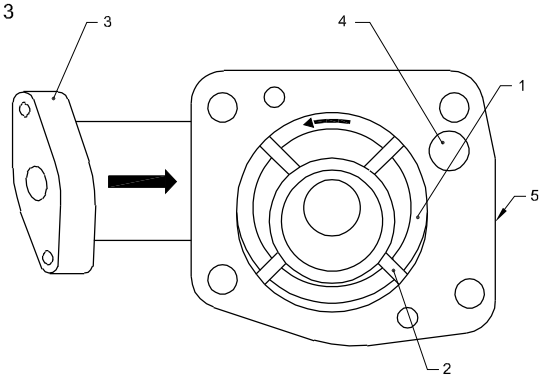
Fig 2



Vane pump (Fig 3)

In the vane type pump the rotor (1) runs eccentrically in the pump housing (5). Spring- loaded vanes (2) slide against the pump housing walls. Suction us created by the vanes (2) when the rotor (1) rotates. Oil is sucked through the inlet duct (3) and discharged through the discharge duct (4).

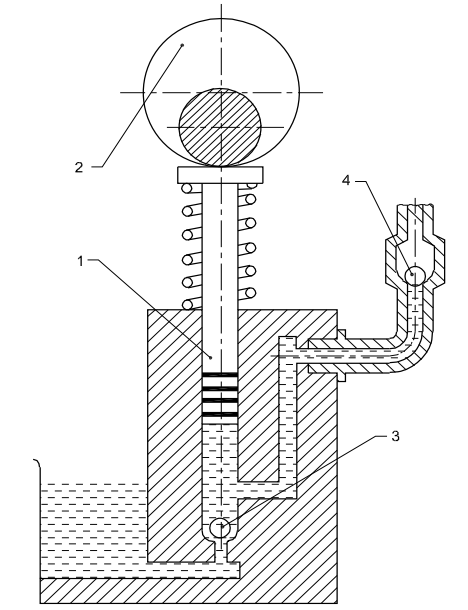
Fig 3



Plunger type oil pump (Fig 4)

In this type of plunger (1) moves up and down in the cylinder. It is operated by a special eccentric cam (2). This pump has two non-return ball valves (3) & (4). These valves are spring-loaded balls. One of these is on the suction side (3).

Fig 4



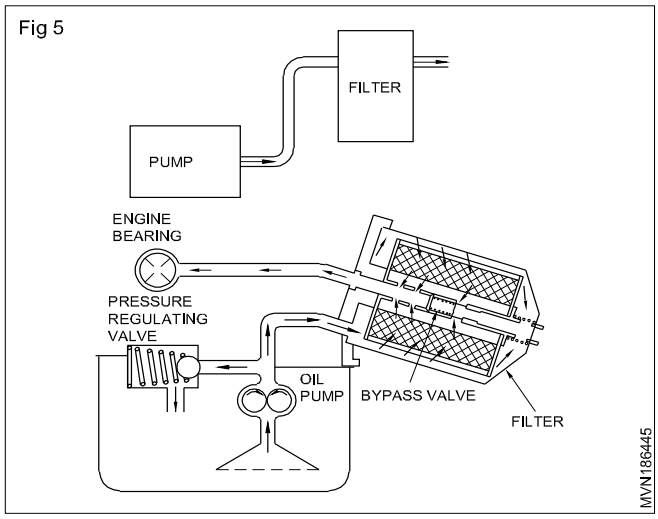
During the upward stroke the oil is sucked through the valve (3). During the downward stroke the non-return valve (3) closes. The other non-return valve (4) which is on the delivery side opens and permits the oil to flow out from the pump. This type of plunger pump is used in medium and high pressure lubricating systems.

Oil filter

Full flow oil filter system (Fig 5)

In this system all the oil passes through the filter before reaching the main oil gallery. One bypass valve is provided in the filter which allows oil to reach the main oil gallery directly if the filter is choked.

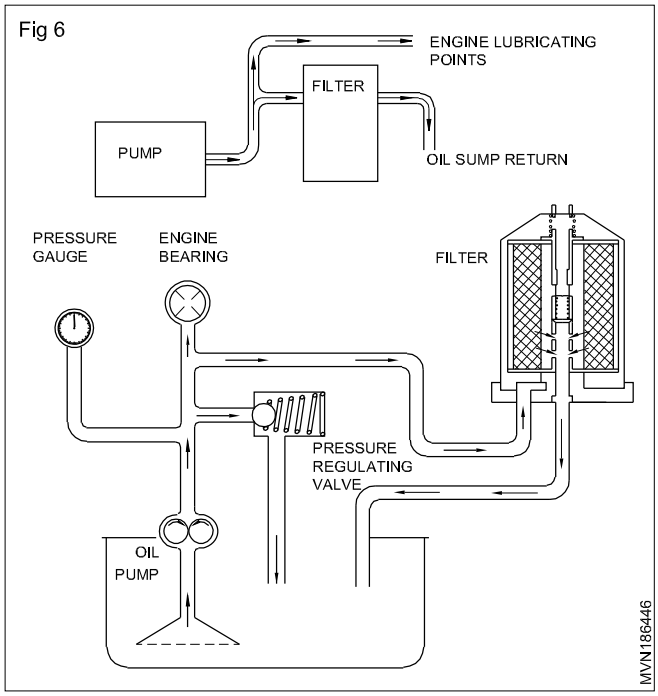
Fig 5



Bypass oil filter system (Fig 6)

In this system only a part of the engine oil enters the filter. After filtering, the oil goes to the oil sump. The remaining oil goes directly to the main oil gallery.

Fig 6

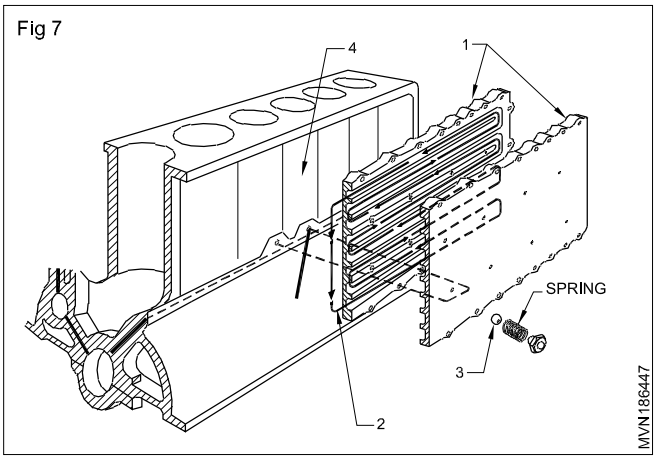


Filter element

Filter elements are made of felt, cotton waste, cloth and paper. Oil filters are replaced after certain kilometres of running of the engine as specified by the manufacturer.

Oil coolers (Fig 7)

Fig 7



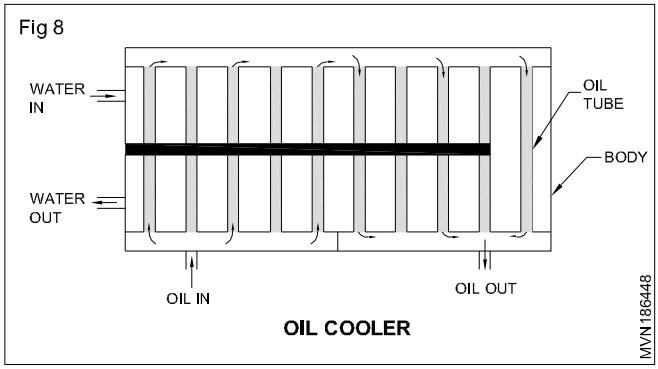
Oil cooler consists of two halves (1). Passages (2) are provided in between the cooler's halves for oil circulation. A ball valve (3) is provided to maintain the required oil pressure. This is made of cast iron. The purpose of the oil cooler is to transfer the heat from engine oil to cooling water and cool the engine oil.

The inner wall of the oil cooler is in contact with cooling water. The engine oil which is made to circulate through the passages provided in the oil cooler, transfers its heat to the cooling water circulating in engine block (4), and the inner wall of oil cooler. This maintains the temperature of the engine.

Oil cooler purpose (Fig 8)

The purpose of an oil cooler us to cool the lubricating oil in heavy duty engines where the oil temperature become quite high the oil must be kept cold in the lubricating system.

Fig 8



An oil cooler is just like a simple heat exchanger. The oil may be cooled in it either by cold water from the radiator. At the time of starting when the water is hotter that the oil, the oil is heated to provide complete circulation in the system. At higher temperatures, when the oil becomes hotter than water, the water cools the oil.

A water type oil cooler, simply consists of tubes in which oil circulates. The water circulates outside the tubes in the casing of the cooler. The heat of the oil is carries away by the circulating water.

Spurt holes and maingallory

The engine parts are lubricated under pressure feed. The oil pump takes the oil through oil strainer and delivers it at pressure of 2.4 kg/cm^2 to main gallory. Further the pressurised oil goes through different size of spurt holes to main bearing camshaft bearing cranks pin, rocker arm and valves, main gallory is act as hub for oil distribution to engine moveable working parts.

Lubricant

Objectives: At the end of this lesson you shall be able to
- **state the need of lubricating an engine**
- **list out the properties of lubricating oils**

Functions of a lubricant

The main function of a lubricant is to minimise the friction between two moving surfaces which are in contact with each other.

It also helps to

- absorb heat from the moving parts due to friction.
- Minimise wear and tear of the components.
- Provide a cushioning effect between the moving parts.
- Clean the parts by carrying away metal chips with it.
- Protect parts from corrosion.
- Prevent blow-by of gases by providing an oil film between the rings and the liner/bore.

Properties of a lubricant

- It should have viscosity to suit the operating conditions.
- The viscosity should remain the same in both hot and cold conditions.
- Its boiling temperature should be high.
- It should be corrosion-resistant.
- It should not develop foam.
- It should withstand critical operating pressure.

Viscosity

It is most important properties of lubricating oils for it determines their ability to flow. An oil with excessively high viscosity is very thick, and it is difficult for penetrate the clearance between the rubbing engine parts, while an oil with too low viscosity flows easily and does not stay in the clearances. So that the engine oil should be used as particular engine specifications and the season (plain area or high attitude area).

Oil additives

Any mineral oil by it self does not posses all the properties. The oil companies add a number of additives into the oil during the manufacturing process main oil additives

- Pour point depressants
- Oxidation inhibitors
- Corrosion and rust inhibitors
- Foaming resistance
- Detergents depressants
- Extreme pressure resistance

Synthetic oil

- Synthetic oils are made from substances other than crude oil
- They can be made from vegetable oils

Types

1 Polyalkylene glycols and their derived

2 Silicon which are manufactured from coal and sand

Application

a This oil can provide longer service life, less friction and improved fuel economy than convention oil.

b It, costs is more than regular SAE graded oils.

SAE oil grade

When expected atmospheric temperature are-	Single viscosity graded oil	Multi viscosity graded oil
Below minus 10° F	SAE5W	SAEFW-20
Above minus 10° F	SAE10W	SAE10W-20, or SAE10W-30
Above plus 10° F	SAE20W	SAE 20W-30 or SAE10W-30
Above 32° F	SAE20 or 20 W SAE 30 Some manufacturers	SAE 20W-30 or SAE10W-30
Above 90° F	SAE 30 SAE 30 Some manufacturers	SAE 20W-30 or SAE 10W -30