LUBRICATION SYSTEM

FUNCTIONS OF LUBRICATION

1. It keeps friction and wear on the moving parts to a minimum.

2. It acts as a coolant and transfers the heat from the moving parts.

3. It keeps the moving parts clean and carries the impurities to the oil filter.

4. It reduces corrosion and noise in the engine.

5. It also acts as a sealant around the piston and rings.

Terminologies in lubrication system

- **Oil** – The lubricant (vegetable, mineral or synthetic).
- **Filter** – This is usually a paper element
- **Strainer** – It's a primary oil filter fitted on the oil pump pickup pipe in most engines (simply wire mesh).
- **Main gallery** – Is a drilling or casting in the engine block through which oil passes to various parts of engine.
- **Oil pressure switch** – Is a switch to operate oil pressure warning light. Gives warning if oil pressure drops.
- **Oil pump –** Is a device which provides flow to oil, which distribute it around the engine and force oil in between some bearing surfaces
- **Pressure relief valve** – Is a valve to limit the oil pressure by returning oil to the sump when the set pressure is reached.
- **Crankcase ventilation/engine breathing** – Is a system to prevent buildup of pressure in the sump.
- **Viscosity** – This is a measure of the resistance to flow of a liquid. Greater viscosity means more resistance meaning better lubrication but it is more difficult to pump and move.
- **Viscosity index** – The viscosity of oil changes with temperatures, Index gives an indication of the charge.
- **SAE** – Multi-grade oils-the higher the SAE(Society of Automotive Engineer) numbers, the higher the viscosity. Example SAE 20 has a lower viscosity than SAE 40.Thinner oil when cold makes the engine easier to crank over, but without the special additives it would become too thin at higher temperatures. Multi-grade oils contains an additive known as a viscosity extender to get the best of both worlds
- **Oiliness** – The ability of an oil to cling to a surface.
- **Additives** – Chemicals added to oil to improve its properties. They range from detergents for cleaning to viscosity extenders to make multi-grade oils

PRINCIPLES OF LUBRICATION SYSTEM

- ❑ There are three main principles/theories of lubrication system.

- ❖ Hydrodynamic lubrication
- ❖ Hydrostatic lubrication
- ❖ Boundary lubrication

HYDRODYNAMIC LUBRICATION

- This refers to when a wedge-shaped oil film having adequate pressure to carry the load is formed between two sliding flat surfaces.
- Lubrication in places between:-piston and cylinder, camshaft bearing, connecting rod, valve tips and push rods .

BOUNDARY LUBRICATION

- This occurs when the engine starts from cold and there is metal to metal contact between engine parts as the oil film is too thin and supply of oil is less due to lower pump speed and may also occur at high engine loads

HYDROSTATIC LUBRICATION

- It occurs when there is a thin film of oil resisting a sudden squeezing ou.t when a shaft rotates

PROPERTIES OF LUBRICANT

1.Viscosity – its ability of molecules of oil to cling together and so drag adjacent layers of oil when relative motion exists between a pair of solid surfaces separated by an oil film. Therefore it is a measure of an oil ability to resist internal shearing.

2.Oiliness – refers to that property of an oil that makes it a more effective lubricant that some other liquid which has the same viscosity. The oil that effects the greater reduction in friction is said to be oilier

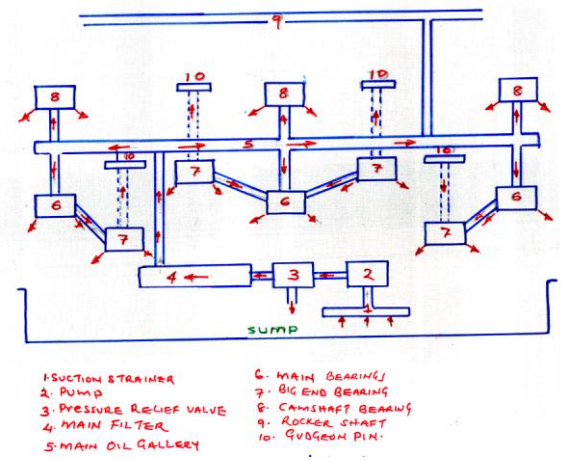
3.SAE classification of oils-oils were originally identified by vague grading such as light, medium or heavy, but the viscosity of any grade differed from one producer to another. This difficulty was overcome by a special system of oil-viscosity classification devised by Society of Automobile Engineers in the USA. I.e. SAE system of classification.

4.Viscosity index-is a measure of a lubricant's consistency of viscosity with temperature change. High viscosity index indicates that there should be little change in viscosity with reasonable temperature rise

5. Flash point and fire point – this is the lowest temperature at which the oil gives a 'flash' when a lighted stick is passed over, it is said to be its flash point. The lowest point at which oil continues to burn for five seconds is the fire point. Engine run at high temperature necessitating higher fire and flashes points.

6. Pour point – is the lowest temperature at which oil can be poured. This properties enables the oil to flow through oil galleries.

Block diagram of lubrication system

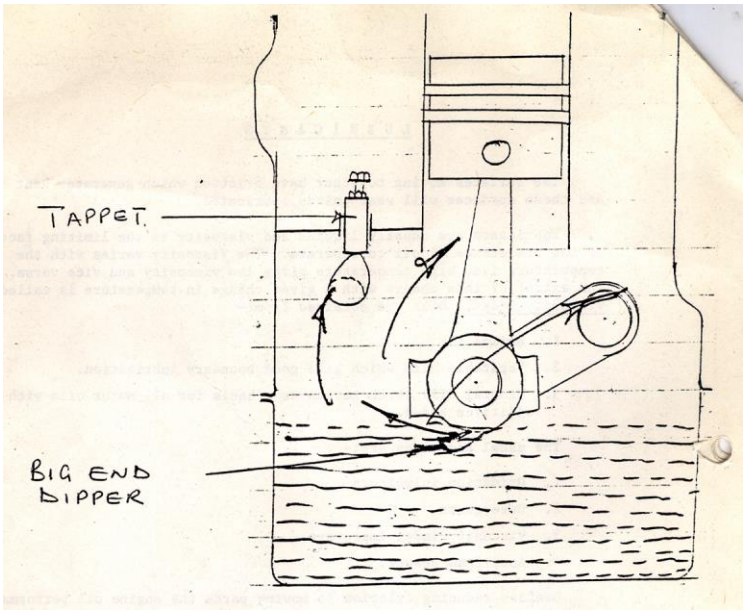


Methods of lubrication

- There are two main methods of lubrication:

    1. Splash feed
    2. Forced feed

SPLASH SYSTEM



- Splash lubricated engines have con-rods with an extension that dips into the oil as the crankshaft revolves. The “dipper” feeds the big-end bearing and splashes oil onto the upper parts as the engine, such as the cylinder walls.
- The system is adequate for low power, slow revving engines, but it is not suitable for high performance units.

- This is because the pressure created during combustion tends to squeeze the oil away from the bearings surfaces.

FORCED FEED (PRESSURE FEED) SYSTEM

- To counteract the loss of oil from bearings, modern lubrication systems feed the oil under pressure between the surfaces to keep them apart.
- There are two main types:

  i. **Dry sump**

  ii. **Wet sump**.

Dry Sump

- The system has two pumps, the scavenge and the pressure pump. Scavenge pump is located at lowest point of an oil sump and it pumps out oil in a tank.
- Pressure pump takes oil from tank and feeds it to the crankshaft main and big end bearings after proper filtration through the main filter.
- This pump is driven by a gearing on the camshaft. The rest of oil circuit is the same as wet sump system.

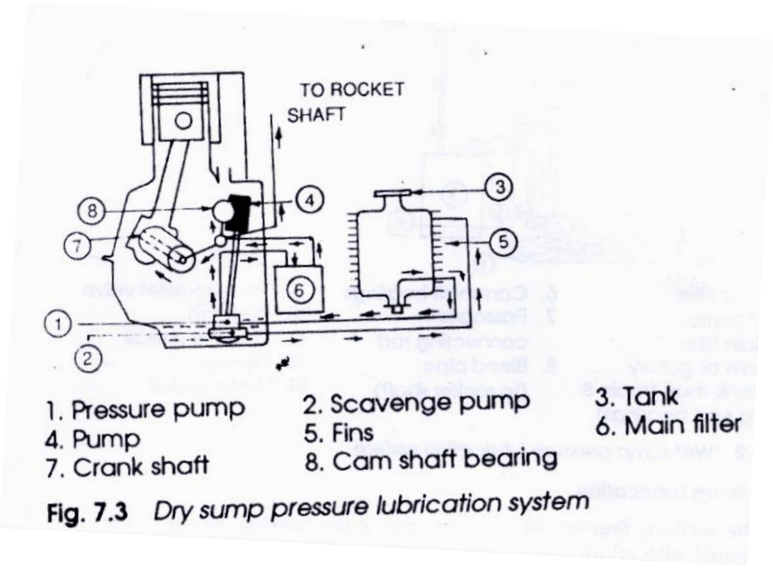


Fig. 7.3 *Dry sump pressure lubrication system*

Advantages of Dry Sump

a) Oil galleries remain clean and oil pressure improves.

b) Lesser formation of varnish and sludge.

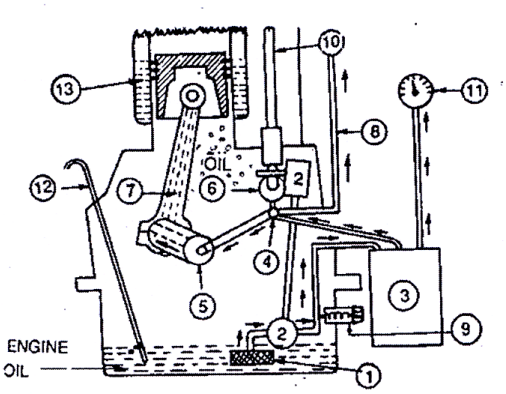
c) Separate tank has fins around it in order to constantly cool the oil by atmospheric air.

d) Impurities can be drained out on settling down from this tank, by a drain plug. Comparatively pure oil flows into the system.

❖ The only disadvantage is the initial high cost and expensive to maintain.

Wet sump

- Oil stored in engine sump with its level above pump inlet but below the crankshaft.
- Sump filter filters coarse particulate in the oil, and oil pump feeds oil under pressure to main oil gallery through main filter.
- Oil is then forced to main crankshaft bearings, big end bearings and camshaft bearings through passage in crank case.
- Some engines have drilled passages in the connecting rod, where oil travels up and is splashed inside the piston. The piston have holes drilled on the oil ring grooves which pass the oil to the cylinder walls and the excess oil on the walls is scraped back by the oil rings.
- Bleed pipes carries oil under pressure from the main oil gallery to the rocker shaft bearings and timing gears or timing chain.
- Valve stems, push rods and springs are splash lubricated while the remainder oil flows to the engine sump under gravity



1. Sump filter
2. Oil pump
3. Main filter
4. Main oil gallery
5. Crank shaft (main & big end bearings)
6. Camshaft bearings
7. Passages in connecting rod
8. Bleed pipe (to rocker shaft)
9. Pressure relief valve
10. Push rod
11. Pressure guage
12. Dipstick
13. Water jacket

Oil pressure relief valve

- As the pressure increases above a fixed value, the spring loaded ball or plunger is lifted up allowing oil to flow back through a return passage either to the sump or pump intake. Thus the pressure is relieved and the ball comes down to its original position.
- The cap can be screwed down to increase pressure or screwed up to reduce it.
- On the plunger type the number of shims under the cap adjusts the spring load and it is usually used in stationary engines

Oil pressure relief valve

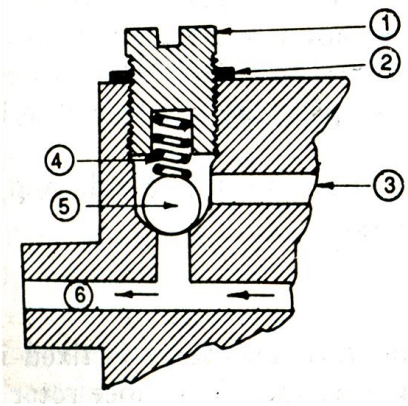
The valves are used to perform the following:

a. Limit pressure within the system.

b. Reduce pressure for a given circuit.

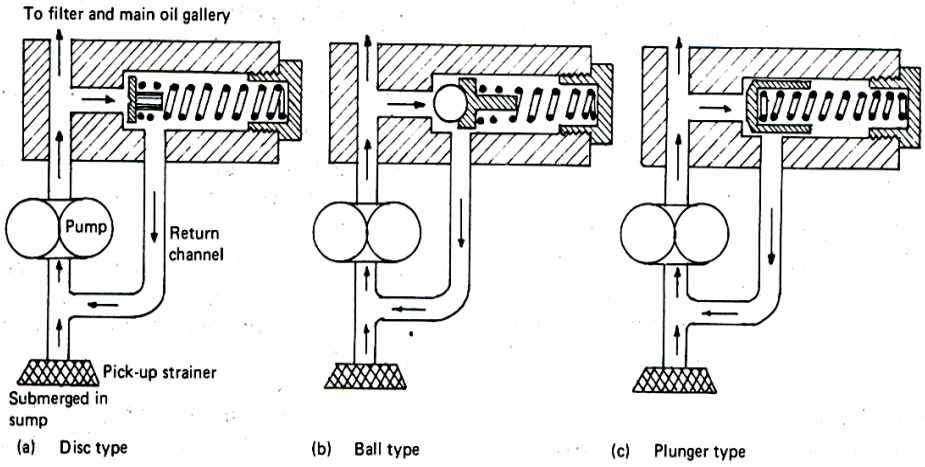
c. Adjust oil pressure entering a circuit.

d. Unload pump.



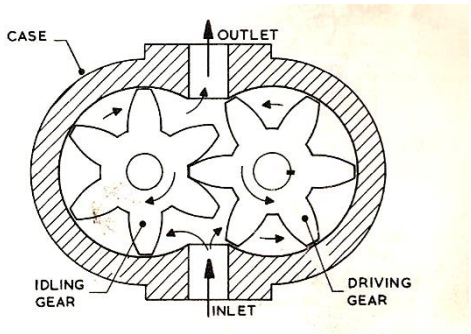
1. Cap
2. Lock nut
3. Return passage
4. Spring
5. Ball
6. Outlet

Types of oil pressure relief valves



GEAR TYPE PUMP

- It contains two spur gears which are in mesh enclosed in a cast iron pump body.
- One of the gears is on the idle shaft and other on the main shaft.
- Main shaft gear gets its drive from the camshaft or crankshaft.
- On rotation, the gears deliver oil under pressure which gets developed between the teeth spaces.



OIL STRAINER

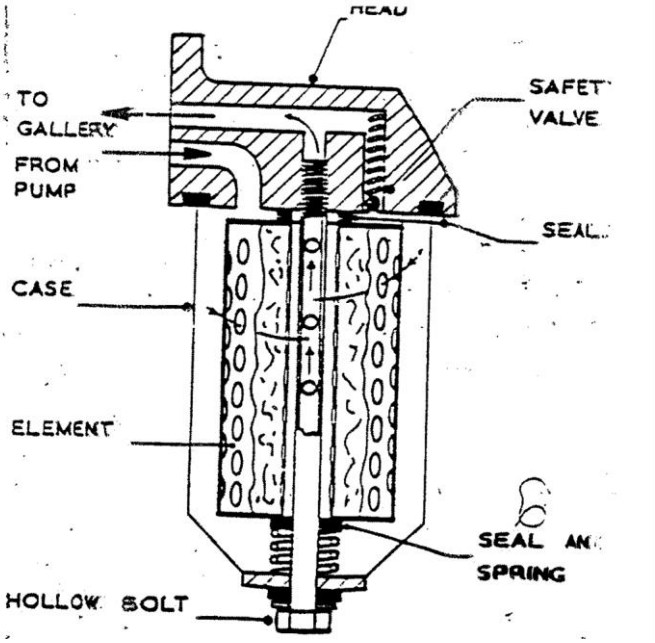
- ✓ A floating intake screen is attached to the oil pump inlet pipe. A meshed screen filters oil of its coarse contaminants and clean oil enters the system.
- ✓ The pipe can be detached by opening the lock nut and the filter cleaned of the oil sludge which reduces the oil pressure

OIL FILTERS

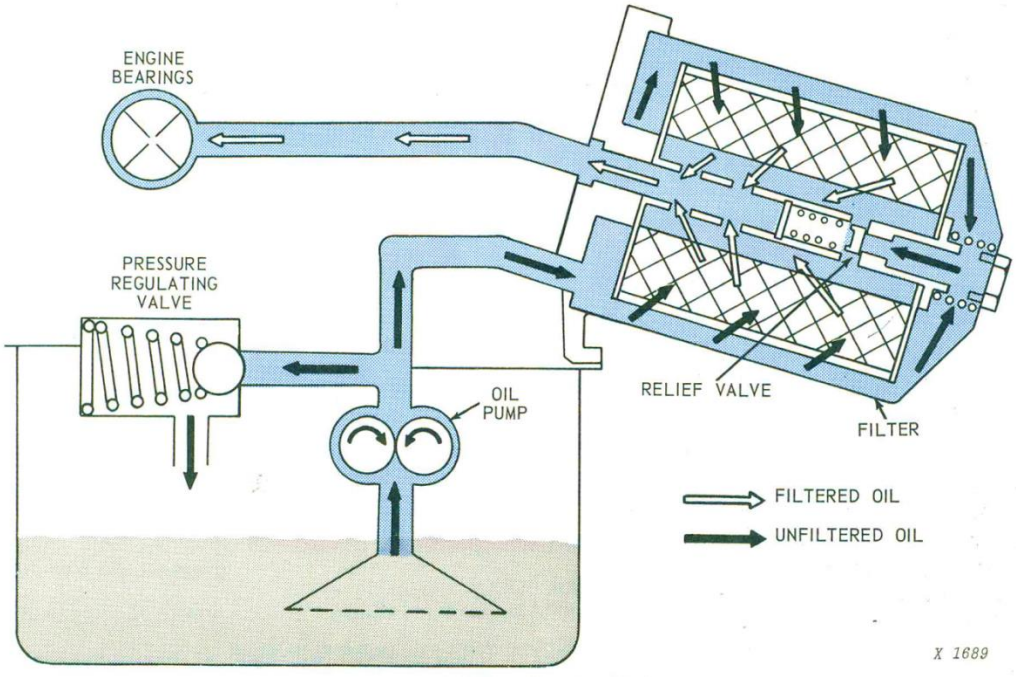
- Abrasive particulate matter like carbon deposits, dust, dirt and metal filings which get mixed with sump oil can cause serious wear in bearings piston and cylinder and other components parts.
- Engines nowadays are equipped with two filters-pry and secondary.
- The pry has a coarse wire mesh fitted at pump inlet. It filters out bigger particulate matter.
- The sec has a large filtering media to filter out finer particles. Its located on the pressure side and has a replaceable element.
- These filters are further divided into two types depending upon their location in the system.
- These are:
    - **Full flow type.**
    - **By pass type.**

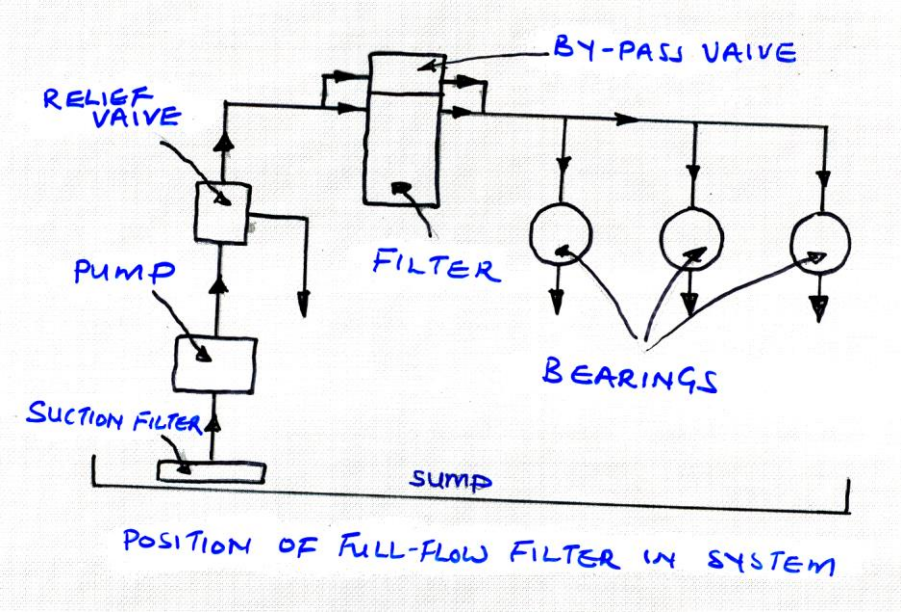
Full Flow filter

- This type of a filter is located outside the crankcase and is provided with a relief valve.
- The valve opens when the oil pressure exceeds a preset value or when the oil is too viscous to flow.
- The entire quantity of oil is made to flow through the filter before it enters the engine.
- The element should be replaced after a recommended time period and cannot be cleaned.
- In case the element gets clogged with sludge the spring loaded bypass valve opens to deliver oil directly to the engine.



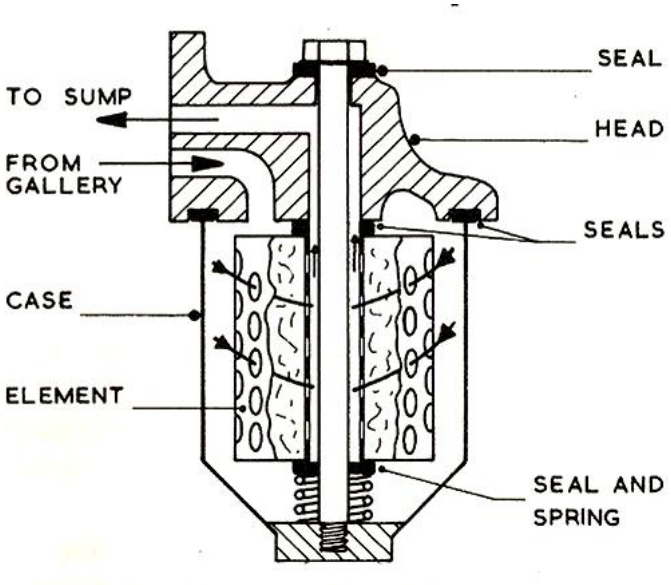
Full Flow Filtration System





Bypass filter

- Is very similar to full flow type except that it has a finer cartridge and no bypass valve.
- The main oil supply goes to the engine and a small proportion is filtered through the bypass filter, after some time the entire sump oil gets filtered.
- In case the filter gets clogged, there is no effect in the oil supply to the engine bearings as only a part of oil passes through it.
- The bypass system allows oil to pass through the filter slowly, thus increasing filtering efficiency.



Bypass Filtration System

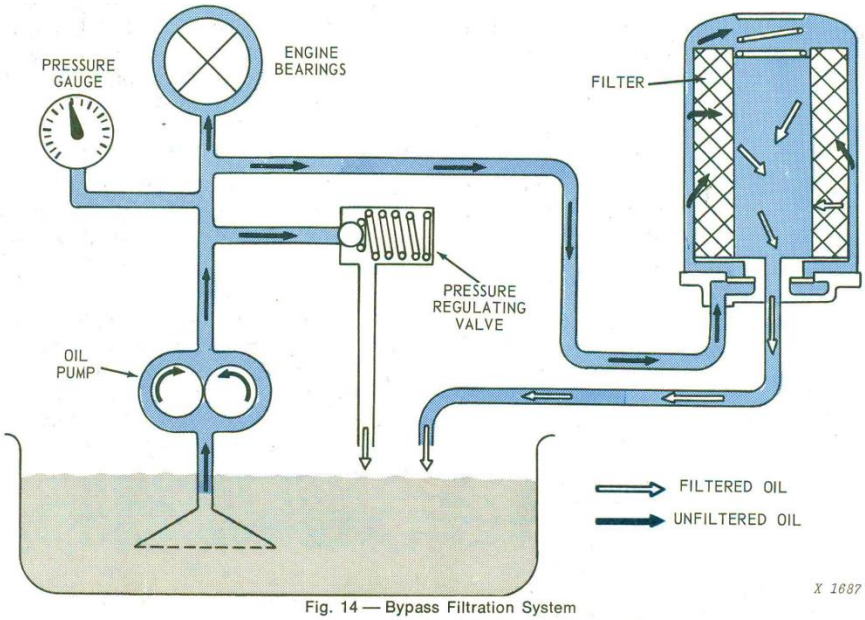
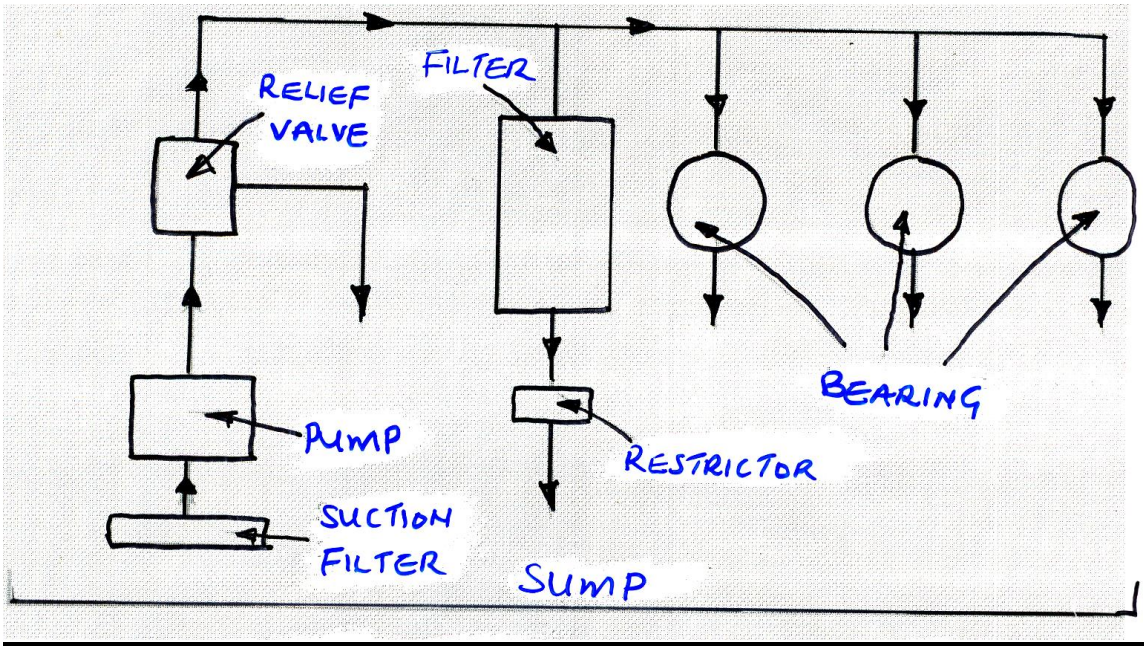


Fig. 14 — Bypass Filtration System



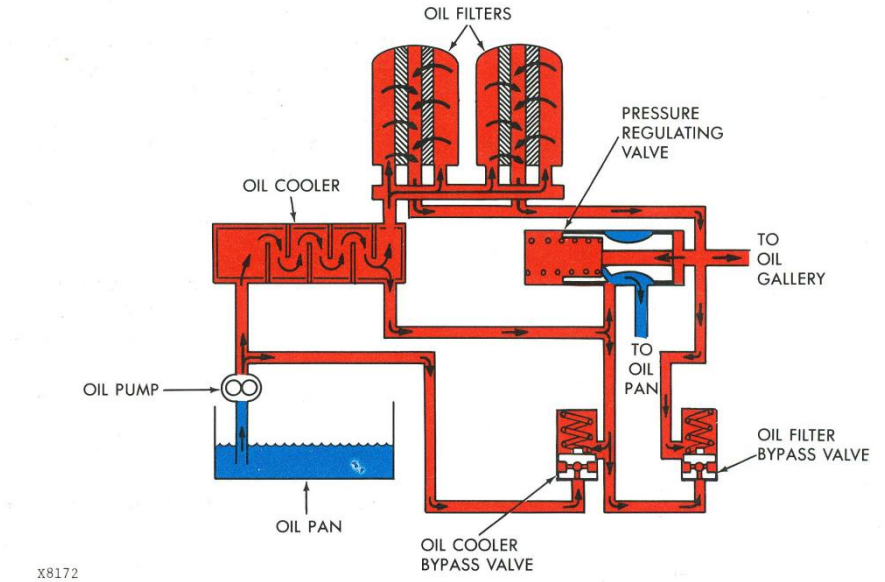


Fig. 16 — Oil Flow Through System With Dual Filters and Oil Cooler

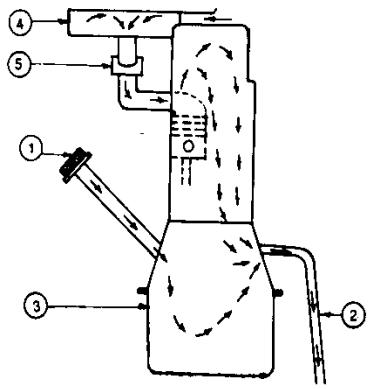
Factors considered in selecting a lubrication system

1. Application
2. Cost
3. Climatic changes

Crankcase Ventilation

- Used to reduce dilution and prevent pressure build up in the crankcase. Constant stream of air is passed through crankcase which carries with it most of harmful vapors to atmosphere.
- Two methods are used:
    a. **Breather tube(open system)**
    b. **Positive crankcase ventilation(closed system)**

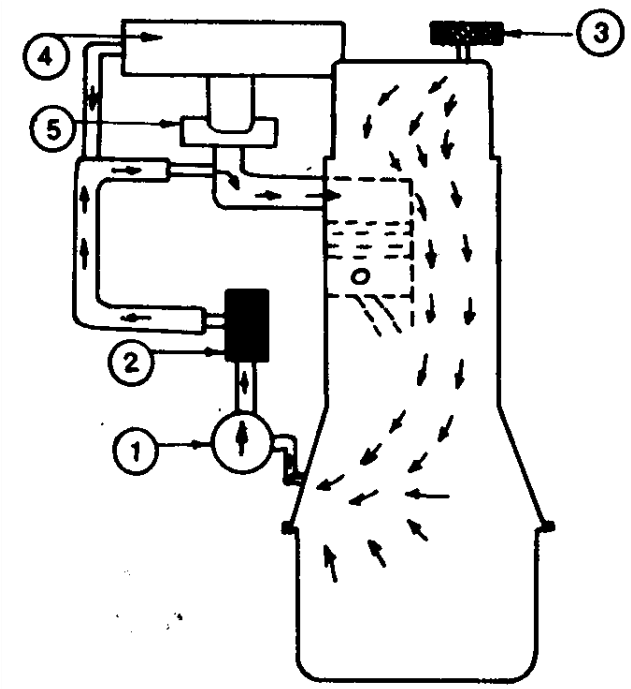
Breather tube(open system) Ventilation



1. Breather tube (filler cap)
2. Road draft tube
3. Crankcase
4. Air cleanrer
5. Carburettor

Fig. 7.9 *Breather tube crankcase ventilation*

- Breather is provided in the oil filler cap. Has oil filler tube, wire gauze filter to avoid entry of siliceous matter into atmosphere. A bent tube (road draft) is connected to the lower end of the crankcase leading to the atmosphere.
- Vacuum caused due to piston intake stroke and flow of air through bent tube draws harmful vapors out of crankcase.
- Atmospheric air enters through breather unit and replaces the foul vapors in the crankcase. The air filter located in the breather hole must be cleaned to sludge periodically or else pressure build-up in the crankcase may increase engine oil consumption.



1. Oil separator
2. P.C.V. valve
3. Filler filter
4. Air cleaner
5. Carburettor

Fig. 7.10 *Positive crankcase ventilation*

This method allows unburnt vapors to be drawn in from the crankcase to the intake manifold. This is made possible by partial vacuum created in the intake during induction stroke of the piston.

A regulator valve (PVC valve) placed between the outlet crankcase tube and the manifold controls the vacuum in the intake manifold. At low speeds, it restricts the flow of vapors into the intake manifold and thus prevents dilution of air/fuel mixture. The method serves to reduce pollution.

ASSIGNMENT

- ***Explain the safety precautions in lubrication system.***