

# Lubrication System

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## Introduction



- Basic functions and types of engine lubrication systems
- Components of a lubrication system and their functions
- Requirements of gas turbine engine lubricating oil

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## Functions of Lubrication System

1. Provides lubrication and cooling for parts that are in contact and have relative movement:
  - gears, bearings, splines and accessory drives
2. To 'clean' the engine by collecting foreign matter that can cause rapid component failure
3. Protects the components from corrosion
4. In turbo-prop engines, the lubricating oil operates the propeller variable pitch system

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## Types of Lubrication System

Two main types of lubrication systems:

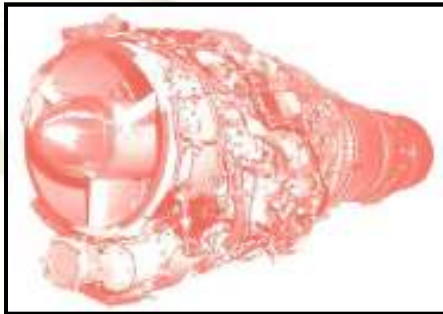
1. Self-contained re-circulatory system
  - oil is distributed around the engine and returned to the oil tank by pumps
2. Total loss or expendable system
  - oil is spilled overboard after performing its functions

Most gas turbine engines today use the re-circulatory system

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## Total Loss Lubrication System

- Oil is ejected overboard after performing function
- Does not require any oil cooler, scavenge pump or filter
  - Simple and incurs less weight penalty
- Suitable for use on engines which run for short duration, such as short range fighter aircraft and drones



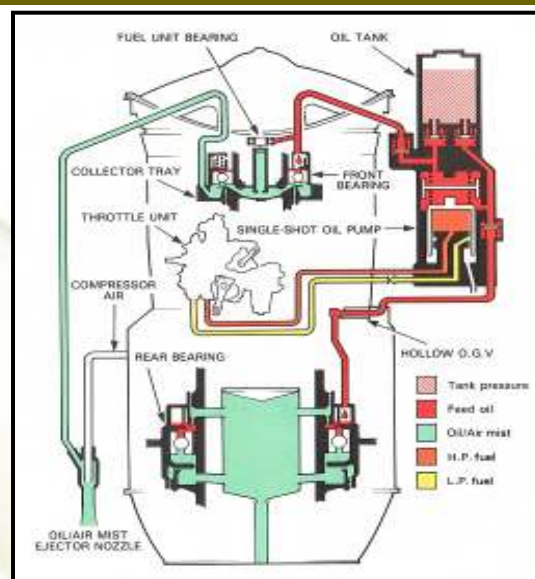
Rolls Royce Viper With Total Loss Lubrication System

- Originally developed as short-life engine for drones
- Later used on Jet Provost and executive jets

Source: Page 180, "The Jet Engine" (1986) by Rolls Royce plc.

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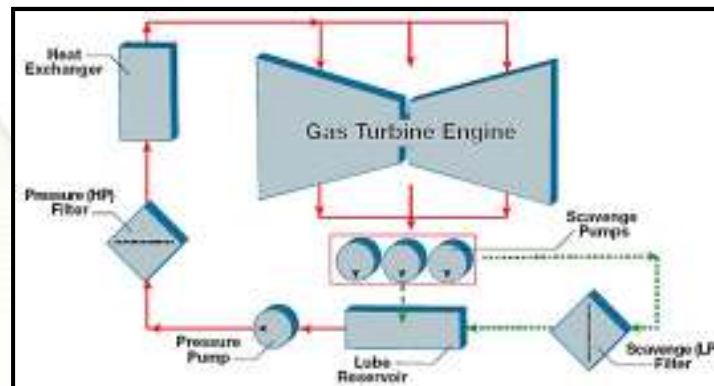
## Total Loss Lubrication System



Source: Page 76, "The Jet Engine" (1986) by Rolls Royce plc.

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## Re-Circulatory Lubrication System



Source: [http://www.pall.com/main/aerospace-defense-marine/aerospace-engine-lube-systems-54960\\_page](http://www.pall.com/main/aerospace-defense-marine/aerospace-engine-lube-systems-54960_page)

- 2 basic re-circulatory systems:
  - pressure relief valve
  - full flow system
- Major difference - control of oil flow to the bearings

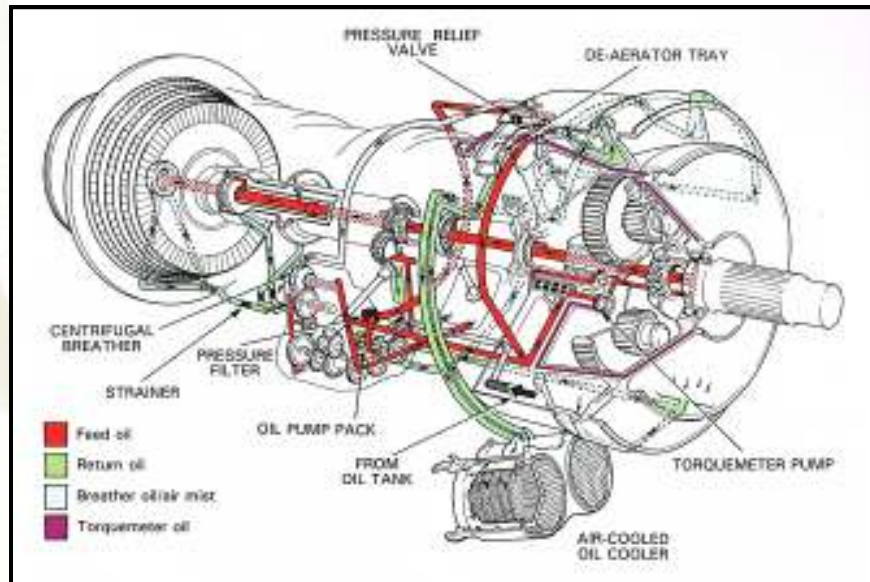
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## Pressure Relief Valve System

- Pressure relief valve regulates feed line pressure
  - Valve opens at pressure corresponding to the idling speed of the engine
  - Constant feed pressure over normal engine operating speeds
  - Excess oil from relief valve is returned directly to oil tank
- **Disadvantages:**
  - Unsuitable for engines with high bearing chamber pressures
    - Large pumps required
    - Difficult to match required flow rate at low engine speeds

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## Pressure Relief Valve System



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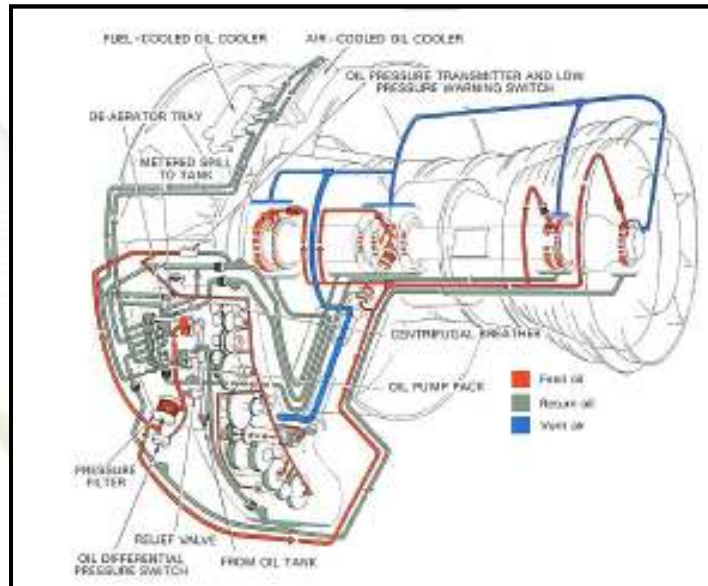
Source: Page 74, "The Jet Engine" (1986) by Rolls Royce plc.

## Full Flow System

- Relief valve for overpressure protection and is normally closed
- Oil from the oil pump is delivered directly to the oil feed jets
- Allows smaller oil pump because there is no requirement to supply sufficient pressure to overcome the pressure relief valve
- Size of the oil pump is determined by the flow rate requirement at maximum engine speed.

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## Full Flow System



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Source: Page 75, "The Jet Engine" (1986) by Rolls Royce plc.

## Oil System Components – Oil Tank

- Oil reservoir
- Usually mounted on the engine or the gearbox
- Provisions for:
  - Oil replenishment
  - Oil drainage
  - Sight glass or dipstick to check oil level
- De-aerating device to remove the air from the returning oil.

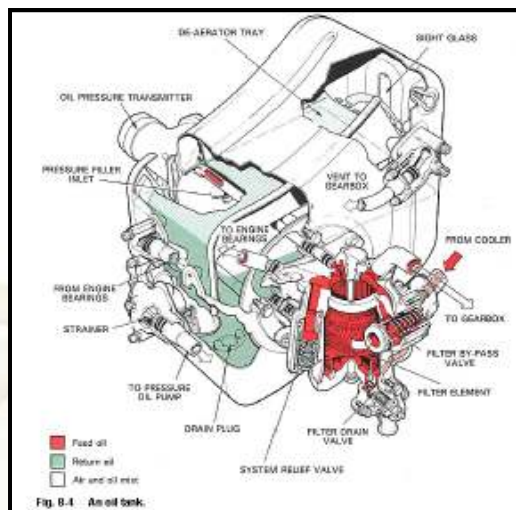


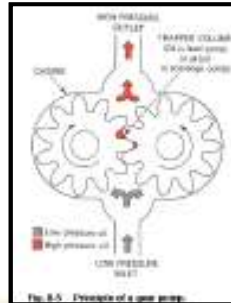
Fig. B.4 An oil tank.

Source: Page 77, "The Jet Engine" (1986) by Rolls Royce plc.

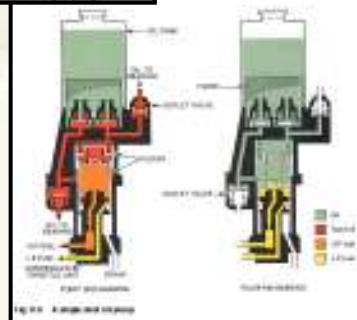
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## Oil Pump

- Delivers oil to the engine's lubrication system
  - Pressure feed system (directs oil to components)
  - Scavenge system (returns scavenged oil to oil tank)
- Oil pump failure may cause catastrophic engine failure
- Types of oil pumps
  - Gear type pumps used in re-circulatory oil systems
  - Single shot pumps used in total loss lubrication system



Watch video on [Gear type pump](#)

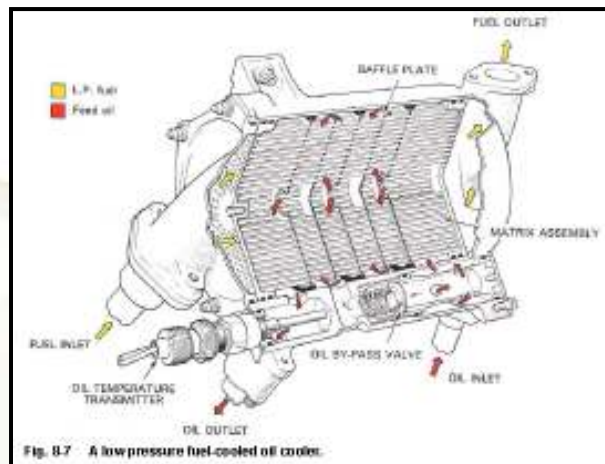


Source: Page 78-79, "The Jet Engine" (1986) by Rolls Royce plc.

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## Oil Cooler

- The engine oil picks up heat as it is used for cooling of the lubricated components
- Necessary to have an oil cooler in **re-circulatory** oil systems
- Air-cooled or Fuel-cooled (FCOC)
- Bypass valves ensures availability of lubrication oil in the event of blockage



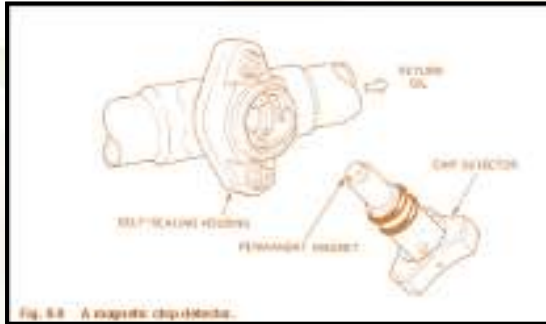
Source: Page 80, "The Jet Engine" (1986) by Rolls Royce plc.

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## Magnetic Chip Detector

- Permanent magnet to collect ferritic debris
- Strategically placed downstream of the engine components (e.g. bearings) to check the health of the engine components
- Warns of impending failure of gears and bearings
  - Checked periodically
  - Cockpit indication

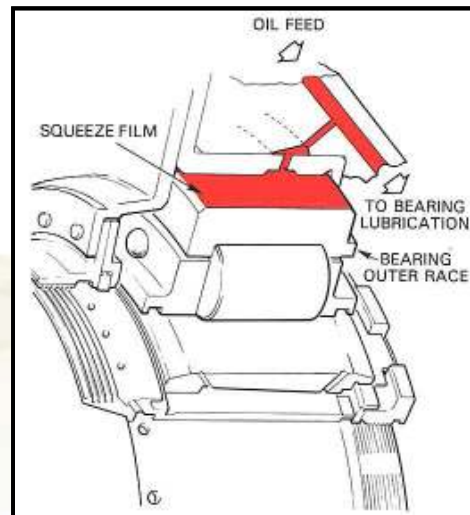


Source: Page 80, "The Jet Engine" (1986) by Rolls Royce plc,

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## Squeeze Film Bearing

- Small clearance between bearing outer race and housing filled with oil
- Oil film dampens the radial motion and the dynamic loads
- Reduces the vibration level of the engine and the possibility of damage by fatigue



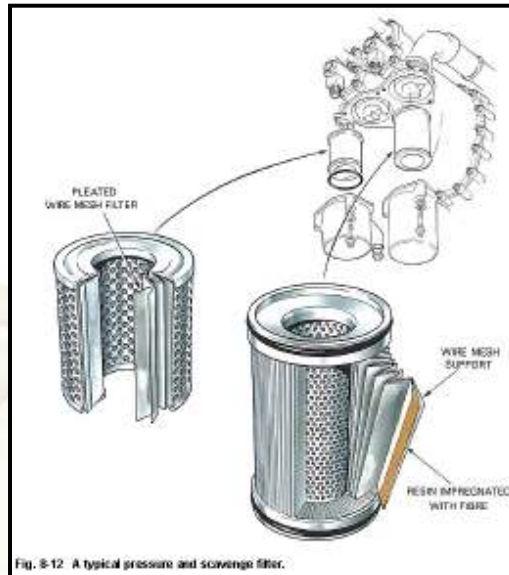
Source: Page 81, "The Jet Engine" (1986) by Rolls Royce plc,

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## Strainers and Filters

- Removes foreign matter
- Coarse strainer – prior to pump inlet
- Fine pressure filter – pressure pump outlet
- 'Pop up indicator' – visual warning of a partially blocked filter



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Source: Page 82, "The Jet Engine" (1986) by Rolls Royce plc.

## Lubricating Oil

- Low viscosity **synthetic oils**
  - Better low- and high-temperature viscosity performance
- Resistance to oxidation, thermal breakdown, and oil sludge formation
- Low viscosity reduces power required for starting, particularly at low temperatures.
- Oil must retain its viscosity (and lubrication characteristics) throughout the entire engine operating range
  - **Viscosity index (VI)** is a measure for the change of viscosity with variations in temperature

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## Summary



- Functions of engine lubrication systems
- Total loss and re-circulatory lubrication systems
- Main components of a lubrication system – Oil tank, pump, cooler, filter, magnetic chip detector, filter
- Requirements of gas turbine engine lubricating oil

## Reflection Question



- Consider the suitability of the types of lubricating systems to be used in a turbofan engine used in a regional jet operating on short-haul flights.