CHAPTER 5

GAS TURBINE ENGINE LUBRICATION SYSTEMS

(Completely Revised)

Objectives

1. In compiling the material for this Chapter due consideration has been given to the relevant Skill and Knowledge Specifications (SAKS) for the trade of Aircraft Technician (Propulsion). This Chapter covers the SAKS requirements in the following subject areas:

- Requirements of a gas turbine lubrication system.
- Basic principles of different types of lubrication systems.
- The purpose and function of system components.
- Relevant safety and servicing precautions.

Introduction

2. The purpose of a lubricant and the way it performs has been explained in Chap 5 of Sect 1. You should, therefore, already be familiar with the meaning of the various terms used to indicate the characteristics of oil and the stages in lubrication.

3. Most of the shafts in a gas turbine engine are supported in lightly-loaded ball or roller bearings which are, in general, subjected to *radial loads* only. In such systems, the oil used needs

to be quick flowing and of low viscosity. With a free-flowing, low-viscosity oil, *only low pressures* are needed to create a flow which will provide adequate lubrication, protection, and cooling for gears and bearings.

Because of the high temperatures involved, the constituents of a mineral-based oil tends to break up and such an oil is unsuitable for gas turbine engines. Most gas turbine engines are lubricated by *synthetic oil,* which is better able to withstand the high temperatures encountered.

4. Unlike piston engine lubrication systems, the oil in a gas turbine system does not become contaminated by the products of combustion. Consequently, frequent oil changes are unnecessary. Furthermore, the oil consumption rate is moderate, even when the oil from very hot bearings is spilled overboard (as in the partial loss system discussed later). This means that the oil system for a gas turbine engine can be very compact and form an integral part of the engine.

5. Just as in the piston engine lubrication systems discussed in p 1.5.6, gas turbine engines may have a separate oil tank (a 'dry sump' system) or the oil may be contained in the sump itself (a 'wet sump' system). In either system, oil is circulated through the engine by a feed pump and is normally returned to the tank or sump by one, or more, scavenge pumps.

Engine Driven Pumps

6. **Spur gear type.** Both the pressure and the scavenge pumps are spur gear type pumps. A relief valve is fitted in the pressure pump to limit the maximum oil pressure in the system (Fig 2.5.1). Sometimes a compound relief valve is fitted in the system to give different limiting pressures to separate engine components. The gears of the pumps are housed in close fitting chambers which allow the oil to be carried round by the gears when they rotate. The tips of the teeth are usually chamfered to relieve the pressure of the oil which is trapped between the gears where they mesh. The scavenge pump, fitted in a dry sump system, is similar to the pressure pump but of greater capacity.

7. **Servicing.** Spur gear pumps need little servicing. Loss of efficiency is shown by a decrease in oil pressure for a given engine speed and an increase in oil temperature. When this occurs, the pump should be removed for overhaul and a replacement should be fitted.

8. A replacement pump must be checked for freedom of rotation before fitment. Reference should always be made to the appropriate engine Air Publication prior to fitment. All pumps should be oil primed after fitting, and the pump which is removed should be inhibited and blanked off before being returned to the stores. An illustration of a spur gear type pump with a relief valve is shown at Fig 2.5.1.

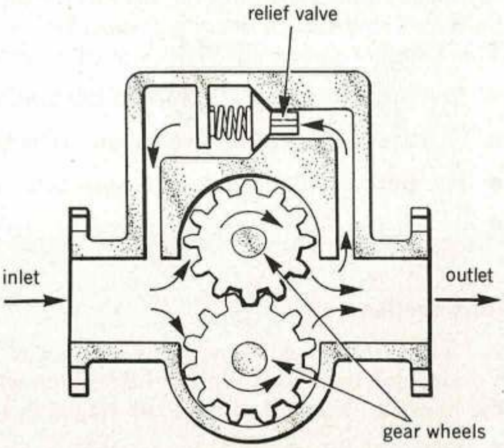

Fig 2.5.1. An oil pump with a relief valve

Metering Pumps

9. Metering pumps are used where a concise oil supply is needed — enough to give adequate lubrication without wasteful consumption. Lubricating the front bearing of a low pressure compressor is a typical situation where a metering pump is used.

10. A light alloy casing is fitted with a steel liner to form a cylinder bore. The cylinder carries two plungers in opposition to one another (*see* Fig 2.5.2). The upper, or metering, plunger is spring loaded downwards, whilst the lower, or pumping, plunger is spring loaded on to a cam operated tappet. As the cam rotates, the pumping plunger moves down to induce oil to flow into the space between the two plunger crowns. As the pumping plunger moves upwards, oil at first returns to the inlet feed but, as the inlet port is shut off, the remaining oil moves upwards with the pumping plunger and the spring loaded metering plunger until the delivery port opens. The trapped oil is then discharged as the two plungers come together. The quantity of oil metered is altered by positioning the metering plunger in the cylinder to vary the amount of trapped oil. An example of a metering pump is illustrated at Fig 2.5.2.

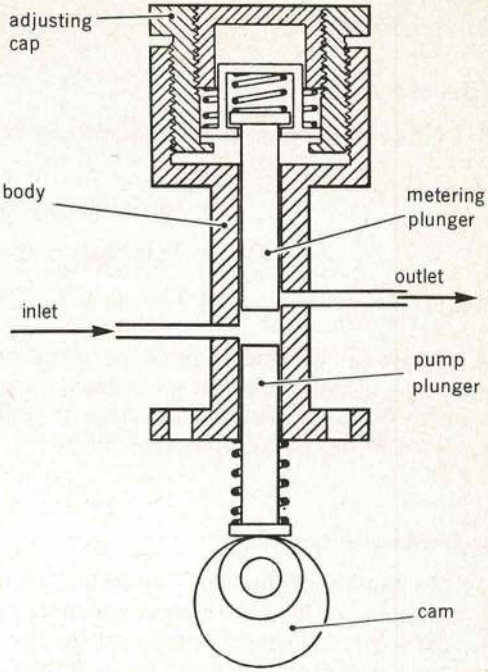

Fig 2.5.2 A metering pump

11. **Servicing of metering pump.** If faulty operation is suspected, the pump delivery may be tested by disconnecting the delivery pipe and, with the engine running, checking the flow into a graduated measure. This test should be limited to the time specified in the engine Air Publication. The bearing fed with oil must be primed using a syringe after the test. When the pump output falls below the expected figures, the pump must be replaced. The pump should be examined for oil leaks at pipe unions and adjusting cap and also for insecurity of attachment. Make sure that the cap nut is locked.

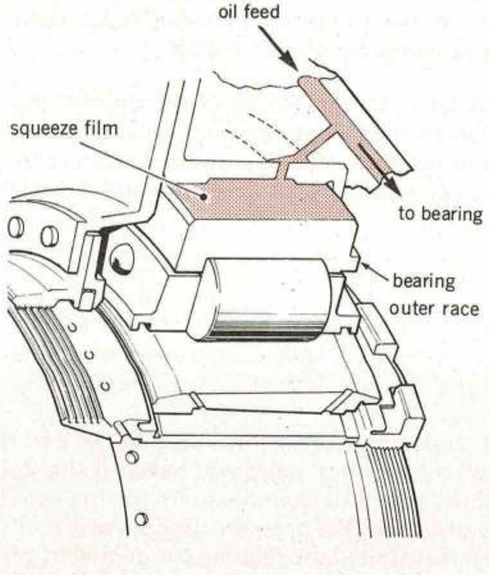

Fig 2.5.3 A squeeze film bearing

Special Bearings

12. To minimise the effect of dynamic loads transmitted from the rotating assemblies to the bearing housings, some engines are fitted with 'squeeze film' type bearings (Fig 2.5.3).

These bearings have a small clearance between the outer track of the bearing and the housing, the space between being filled with feed oil. The oil film modifies the radial action of the rotating assembly and, hence, the dynamic loads transmitted to the bearing housing. In this way, the vibration level of the engine and the possibility of damage by fatigue are reduced.

OIL SYSTEMS

Types of Systems

13. Gas turbine engine oil systems can be placed into one of three categories:

- Recirculatory systems.
- Total loss (expendable) systems.
- Partial loss systems.

14. Most gas turbine engines use a self-contained recirculatory oil system. However, some engines — usually those for specialized purposes — use the partial loss or the total loss systems, in which oil from very hot bearings is spilled overboard after doing its job. Each system is discussed in the paragraphs that follow.

Recirculatory Systems

15. In systems of this type, the oil (which is contained either in a separate tank or in the sump) is circulated around the engine by a single pressure pump at a fast rate of flow and at a relatively low pressure. Scavenge pumps return the oil to the tank or the sump. The system is, thus, complete within the engine. Recirculatory systems may be further sub-divided into 'pressure relief systems' and 'full flow systems'.

- **Pressure relief system.** In this type of recirculatory system, the pressure pump has the capacity to supply a greater amount of oil than the engine needs. A pressure relief valve maintains a selected pressure and directs surplus oil back to the inlet side of the pump.
- **Full flow system.** In this type of recirculatory system, the output of the pressure pump is related to the engine speed and is made equal to the amount of oil that the oil jets can pass plus a calibrated 'bleed back' to the inlet side of the pump. A pressure relief valve is incorporated but it operates only if the system pressure becomes excessive.

16. The type of circulatory system used will depend upon the design of the engine and its intended use. In this respect, each type of engine has its own oil system that is peculiar to that engine type. Because of this, it is important that the appropriate AP be consulted when carrying out maintenance tasks on an engine. However, to understand these principles of lubircation in a gas turbine engine, we shall consider 'typical' systems.

Recirculatory System — Pressure Relief Type

17. This is typical of the system fitted to a modern gas-turbine engine. A simplified schematic diagram is illustrated in Fig 2.5.4.

The oil supply is contained in a combined tank and sump which form part of the external wheelcase. The spur gear type pressure pump draws oil from the sump and passes it through a fuel-cooled oil cooler and a close-mesh (pressure) filter, which incorporates a by-pass valve. This valve, which is set to open at a pre-determined pressure, limits the pressure difference across the cooler when the oil is cold. From the cooler, the oil is distributed throughout the engine by pipes and drillings in the castings. A pressure relief valve in the distribution gallery is set, normally, at about 2 bars (30 psi) and spills excess oil back to the sump.

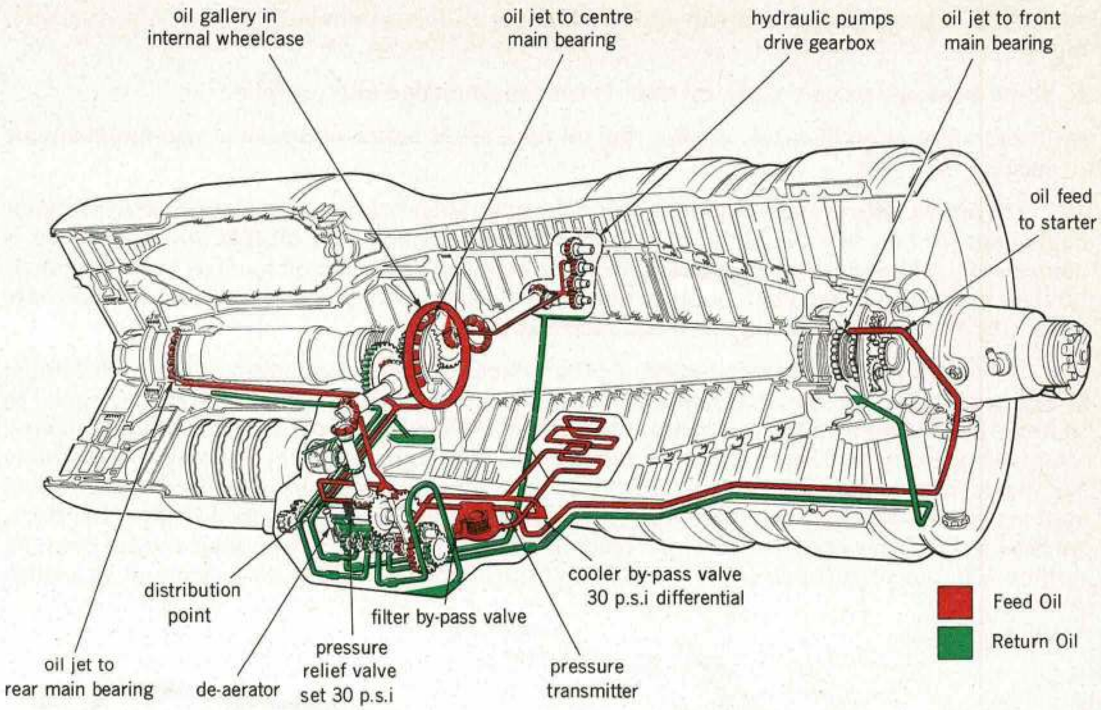

Fig 2.5.4 A turbo-jet engine oil system (pressure relief valve type)

The main bearings and wheelcase gears are lubricated by pressure oil jets. Each jet is directed on to the bearing face through a small diameter hole, protected by a slotted thread-like filter. Thus only a controlled (or calibrated) amount of oil reaches the bearings.

Five scavenge pumps complete the circulation cycle by returning the oil through a de-aerator into the sump. Each pump is protected from contamination by a coarse-mesh strainer. Five scavenge pumps are used in this system, each handling the scavenge oil from one particular part of the engine:

- Front main bearing
- Rear main bearing
- External wheelcase
- Centre main bearing and internal wheelcase
- Hydraulic and fuel pumps and drives.

The reason for five pumps is that the oil jets give different 'calibrated' rates of flow and each pump has the same capacity. Thus, the capacity of the pump must be matched to the appropriate load.

The external wheelcase incorporates a centrifugal breather which separates the oil from the outgoing air and allows the oil to return to the sump.

18. With further development in gas turbine engine technology and the resultant larger and more powerful engines, the pressure relief valve controlled lubrication system has proved to be less than ideal. This is because the single pressure system presents a mean flow of oil to the engine which depends upon the pressure relief valve setting and not upon the requirements of

the engine. The pressure relief valve controlled lubrication system has the following disadvantages:

- Some bearings receive more oil than is needed at engine idle rev/min.
- For modern large diameter engines the oil pressure is below optimum at maximum engine speed.

19. **Oil feed at idle rev/min.** At idling speed the main shaft bearings need less oil than at higher engine speeds but, in a pressure relief valve controlled system, the oil flow to the bearings is controlled by the setting of the relief valve. Thus at idle rev/min the oil pump is supplying more oil than the bearings need but, because of the relief valve action, oil flow and pressure increase cannot be proportional to engine speed increase.

20. **Oil feed at maximum engine speed.** As the engine speeds up from idle rev/min to maximum engine speed (100%), the oil pump speeds up in proportion to the increase in engine speed so that the flow of oil through the pump is increased. However, the oil pressure cannot increase above the pressure setting of the relief valve. Thus, although a greater oil pressure is desirable for the higher bearing loads experienced at max rev/min, pressure relief valve controlled systems provide an almost *constant* oil pressure throughout the engine speed range. Therefore, we have a situation where the bearings receive *too much* oil at idle engine speed and *less than* the optimum amount of oil at *full power* (100% rev/min). Modern engines are, in general, of a much

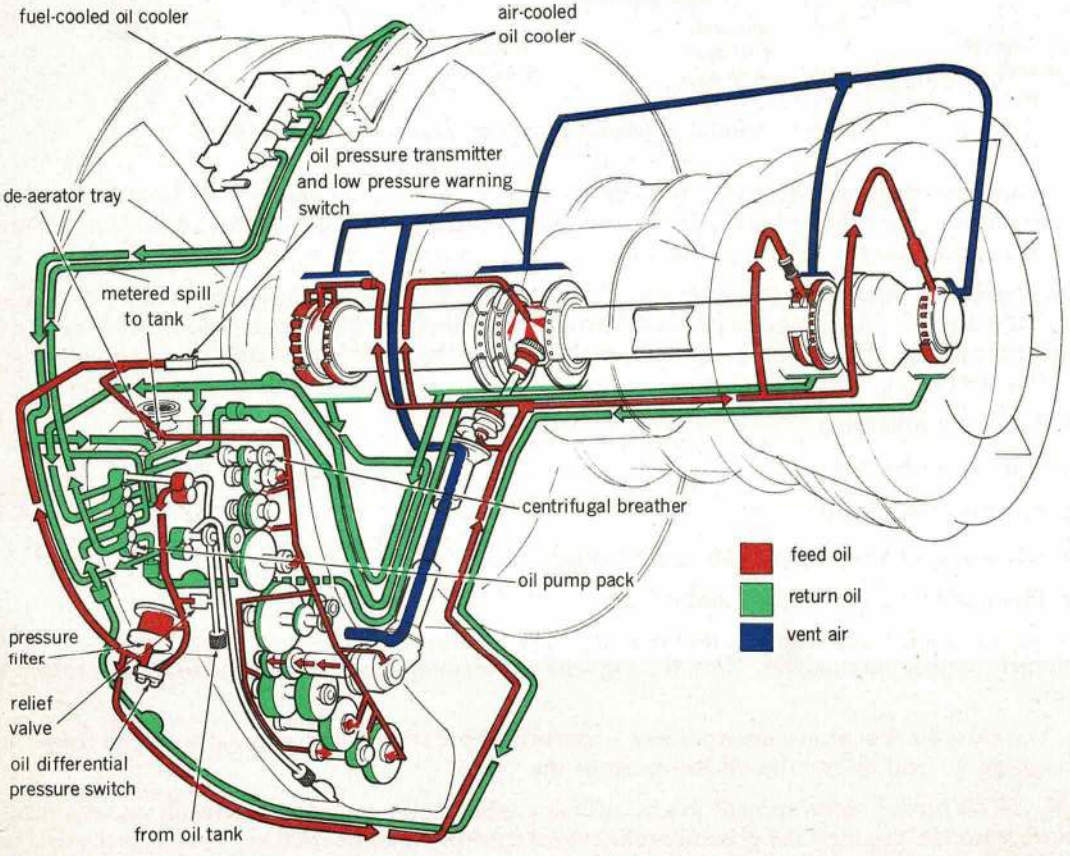

Fig 2.5.5 Turbo-jet engine oil system (full flow type)

larger diameter than the early gas turbine engines and the rotating assemblies impose greater loads upon their support bearings. For ideal lubrication, the main rotating assembly bearings of a modern engine require a difference in oil pressure for idle, cruise, and maximum engine speed. To fulfil this requirement, an oil system has been evolved which is not pressure controlled. This is the 'full flow' oil system.

Recirculatory Oil System — Full Flow Type

21. The full flow lubrication system is an alternative to the pressure relief valve oil system and full flow systems are in use as a means of lubricating many modern high power gas turbine engines.

22. The full flow system, illustrated in Fig 2.5.5, is similar in many ways to the pressure relief system just discussed — *ie* oil is drawn from a tank by a pump and delivered, via a pressure filter, to various parts of the engine; the oil is then returned by scavenge pumps, via the oil cooler, to the tank; also, air is separated from the oil by a de-aerator and centrifugal breather.

23. The major differences from the pressure relief type of recirculatory system are as follows:

- The flow of oil to the bearings is determined by the *speed* of the pressure pump, the size of the oil jets, and the pressure in each of the bearing housings.
- A *metered* spill of feed oil is fed back to the tank. This spill is calibrated to match the pump output to ensure that the oil flow to the bearings, via the oil jets, is the same at all engine speeds.
- The relief valve in this system is set to prevent excessive oil pressure in the feed side of the system.
- A filter by-pass is not normally fitted. The pressure drop across the filter is sensed by a differential pressure switch, any increase in the pressure difference being indicated to give advance warning of a blocked filter.

24. **Advantages of full flow lubrication.** The advantages of full flow lubrication are those of suitable oil flow and oil pressure at all engine speeds. A study of the graph (Fig 2.5.6) will reveal a difference in oil pressure between the pressure relief system and the full flow system and, it will also show that the pressure difference continues throughout the speed range of the engines, with a crossover point at cruising speed. The relief valve system provides too much oil pressure at idle

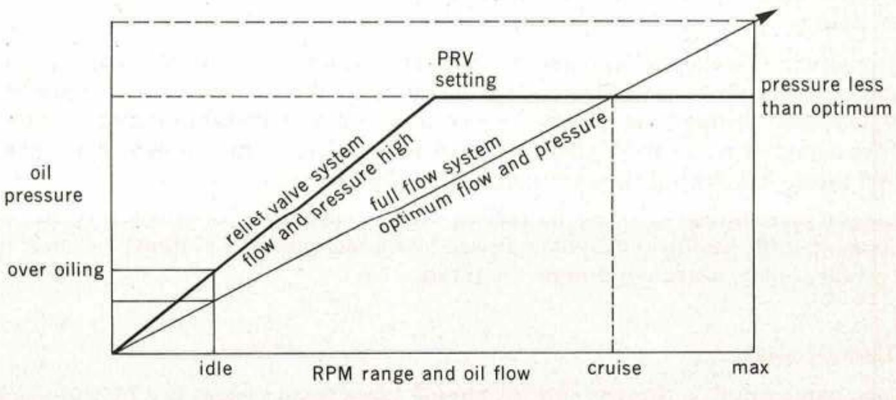

Fig 2.5.6 Comparison of full flow and pressure systems

rev/min, but, because of the relief valve, the oil pressure is below optimum at maximum engine speed. In contrast the pressure provided by the oil pump of a full flow system rises progressively with increased engine speed and is nearer to the optimum value throughout the rev/min range of the engine.

To maintain a high oil pressure at low engine speeds calls for the use of a large capacity oil pump — a pump which, in the relief valve system, cannot take full advantage of increases in engine speed because of the relief valve setting. In the full flow lubrication system the pressure relief valve only operates if excessive oil pressure is generated; therefore, this relief valve is set to a value above that required to protect the main shaft bearings at maximum power. The oil pressure in the full flow system is a product of oil flow and engine speed and, therefore, a smaller oil pump produces a higher pressure at maximum engine speed than the larger capacity oil pump used in the pressure relief valve system.

25. The following additional items may also be found *in both types* of recirculatory oil systems:

- **Magnetic chip detectors,** to provide early warning of bearing failures.
- **'Squeeze film' bearings,** to reduce engine vibration (*see* para 12).
- **An anti-syphon jet,** to prevent oil in the feed line draining through the pressure pump into the gearbox when the engine is stationary; the jet allows the oil to be diverted back into the oil tank.

Total Loss (Expendable) System

26. This system of gas turbine engine lubrication has limited applications. It may be used on small engines running for only short periods of time — *eg* in booster engines for assisted take-off or vertical lift. The outline of such a system is illustrated in Fig 2.5.7.

27. Oil is fed to the bearings by pump pressure. The pump used for this may be either a plunger type or a piston type.

- **Plunger type pump.** This delivers oil in a *continuous* flow to the bearings and is indirectly driven from the compressor shaft.
- **Piston type pump.** This is operated by fuel pressure, the oil supply being automatically selected by the high pressure shut-off valve in the fuel system during starting. The oil is usually delivered *as a single shot* to the front and rear bearings although, on some engines, provision is made for a second shot to be made (*to the rear bearing only*) after a predetermined period.

28. After lubricating the fuel unit and the front bearings, the oil from the front bearings drains into a collector tank and is then ejected into the main gas stream through an ejector nozzle. The oil that has passed through the rear bearings drains into a reservoir at the rear of the bearing, where it is retained by centrifugal force until the engine is shut down; it is then dumped overboard through a central tube in the exhaust unit inner core.

29. This is a system that is simple and cheap. In the situations for which it is suitable, it also offers a considerable saving in weight compared with recirculatory systems, because it does not require an oil cooler, scavenge pumps, or filters.

Partial Loss System

30. As its name implies, this gas turbine engine lubricating system is a hybrid — containing some of the features of a recirculatory system and some of the features of a total loss system. For example, one engine in use has a total loss (expendable) system for the centre and rear main

bearings, but the lubricating oil for the front main bearing is recirculated; only one scavenge pump is used in this case.

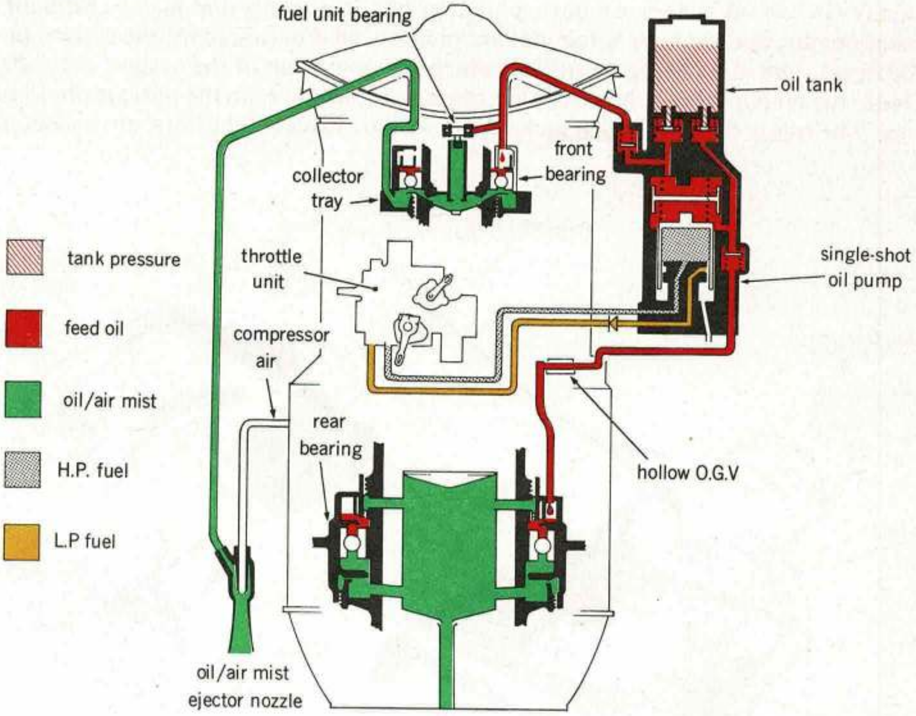

Fig 2.5.7 Lift engine oil system (total loss type)

Turbo-propeller Lubrication System

31. The oil system used for turbo-propeller engines is usually one of the recirculatory systems discussed in paras 15 to 25, but with extensions to cover the needs of propeller operation, reduction gear, and torque recording. As we have seen, the engine bearings need only a *low* oil pressure. But the use of heavily-loaded shafts on the propeller, and also the centrifugal force set up by the reduction gears, make it essential that the bearings and shafts of these systems are protected by a positive film of oil; this requires a *high* oil pressure. The conflicting requirements of low oil pressure for engine bearings, and high oil pressure for propeller shafts and bearings, are met by using a *compound oil pressure relief valve*. This has one input (from the pump) and two outputs: low pressure to engine bearings; high pressure to propeller systems.

OIL SYSTEM COMPONENTS

Main Components

32. In any aircraft oil system, we have a number of components that may be thought of as the *main* components, and we have some that are incorporated to safeguard the system (*ie* to act as *safety* devices). The main components, on which the operation of the system depends, include the oil tank, the oil pump, and the oil cooler; these are considered in the paragraphs immediately following. The safety devices, which include the various valves and filters, are considered later.

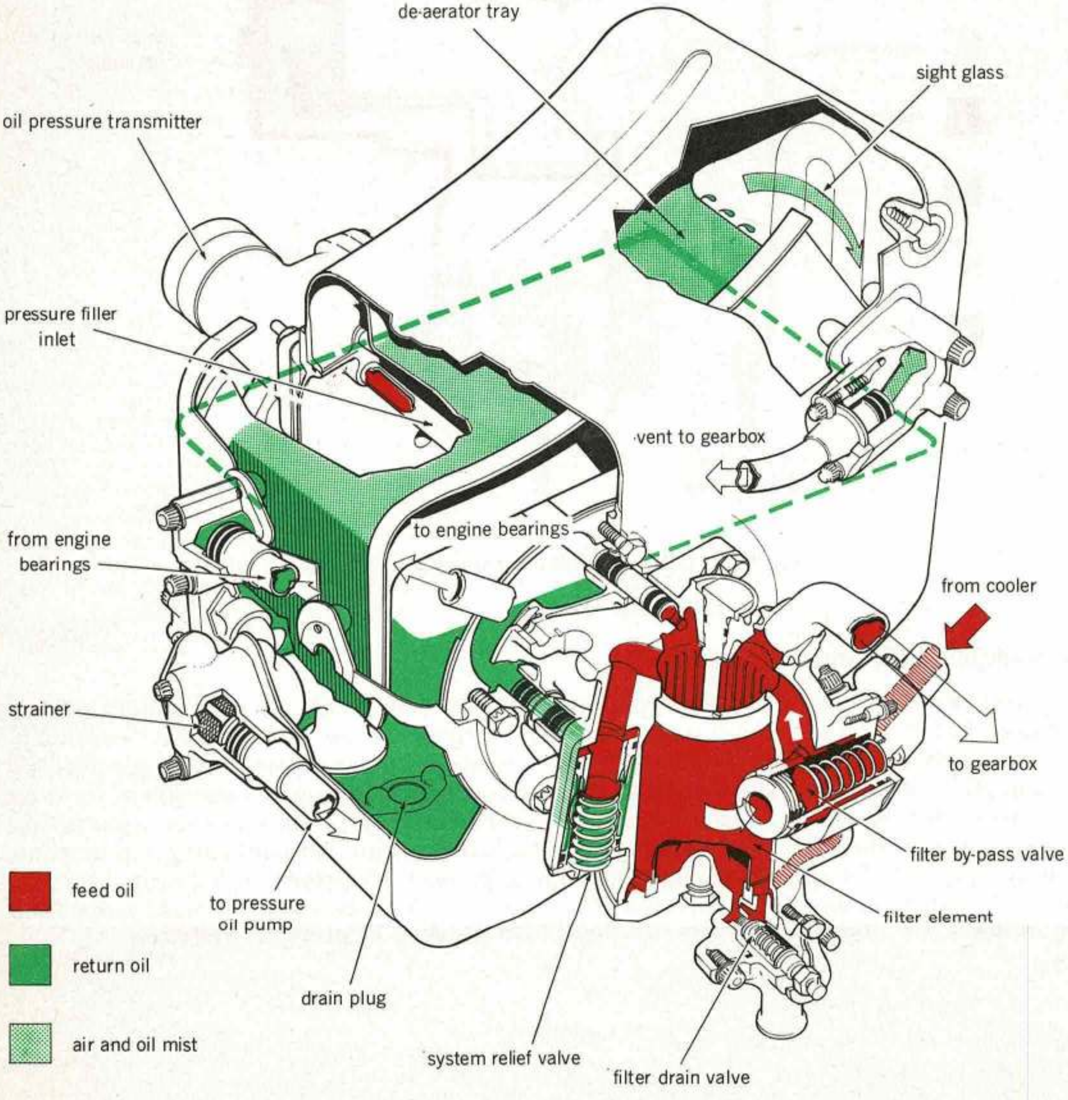

Fig 2.5.8 An aero gas-turbine oil tank

33. **Oil tank.** The oil tank is usually mounted on the engine; it may be a separate unit (Fig 2.5.8) or part of an external gearbox called the sump. It has provision to allow the system to be filled and drained, and a sightglass or dipstick to allow the oil contents to be checked. Usually, the oil level sightglass on the side of the tank is graduated in half pint or in litre increments, between LOW and FULL marks. The tank is replenished either by pressure or by gravity feed. The pressure filler connection contains a non-return valve and a bayonet adapter to which the oil replenishment trolley pipe is connected.

34. A *de-aerator tray* is mounted in the top half of the tank and receives the return oil from the scavenge pumps. The oil, in its passage through the system, will become aerated and steps must be taken to remove the air. As the oil/air mixture flows over the tray, the oil separates and drains down into the sump, whilst the air is vented to atmosphere.

35. **Oil pumps.** The oil pumps fitted in a recirculatory system are normally gear-type pumps. The pumps are usually mounted in a pack containing one pressure pump and several scavenge pumps (Fig 2.5.9); they are driven by a common shaft through the engine gear train. Suitable machining of the gear teeth, or the provision of a milled slot in the casting (adjacent to the delivery side of each pump), prevents pressure locking of the gears.

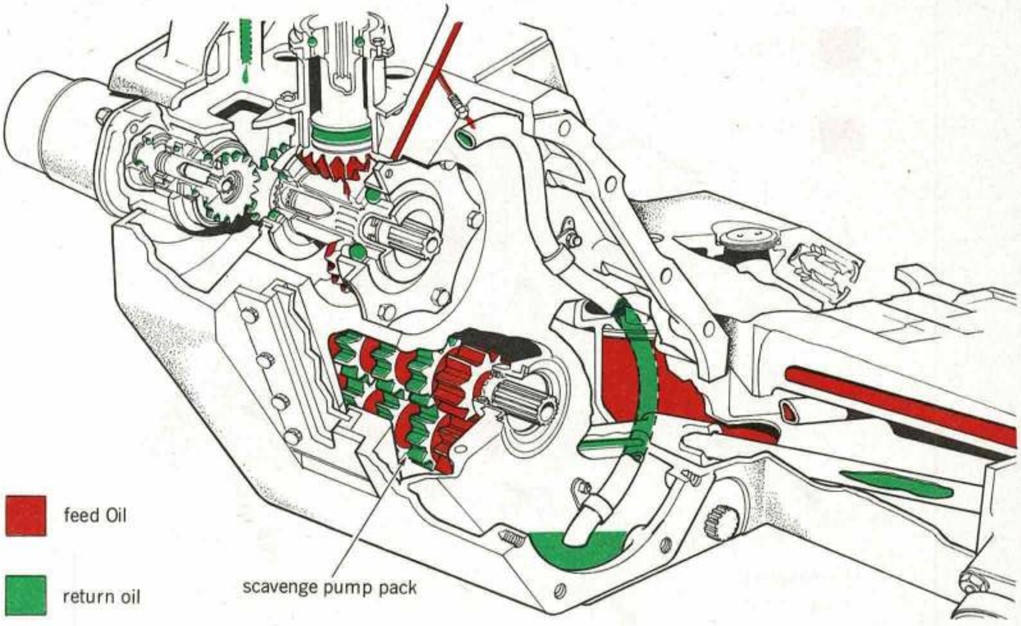

Fig 2.5.9 Scavenge oil pump pack

36. The scavenge pumps have a greater capacity than the pressure pump to ensure complete scavenging of the bearings in a dry sump system. Furthermore, air tends to leak into the bearing housings from the air pressurized seals and this aeration of the oil means that the scavenge pumps have to pump an increased oil/air volume. As we saw in para 34, the air is subsequently removed by the de-aerator.

37. **Oil coolers.** On all engines using a recirculatory type of oil system (*ie* the majority of gas turbine engines), heat is transferred to the oil from the engine and it is common practice to cool this oil by fitting an oil cooler. This is located either in the feed side or in the return side of a

lubricating system, depending upon the operating temperature of the bearings. The oil cooler may be fuel-cooled or it may be air-cooled. The principle of operation of both types is the same — namely, that the heat produced in the oil in its passage through the system is transferred to the cooling medium within the oil cooler (either fuel or air).

- **Fuel-cooled oil cooler.** A fuel-cooled oil cooler is illustrated in Fig 2.5.10. It has a matrix that is divided into sections by baffle plates. A large number of tubes convey the cooling agent (*ie* the fuel) through the matrix, the oil being directed by the baffle plates in a series of passes across the tubes. This gives the necessary exchange of heat from the oil to the fuel. A by-pass valve is fitted across the cooler; this valve operates at a pre-set pressure difference across the cooler and maintains the oil circulation in the event of blockage at the cooler. To prevent contamination of the oil by fuel leakage from the matrix cooling tubes, some engines have a *pressure-maintaining valve* located in the feed line, downstream of the cooler. In systems where this valve can be used, it prevents fuel leakage into the oil by maintaining the oil within the cooler at a higher pressure than that of the fuel.

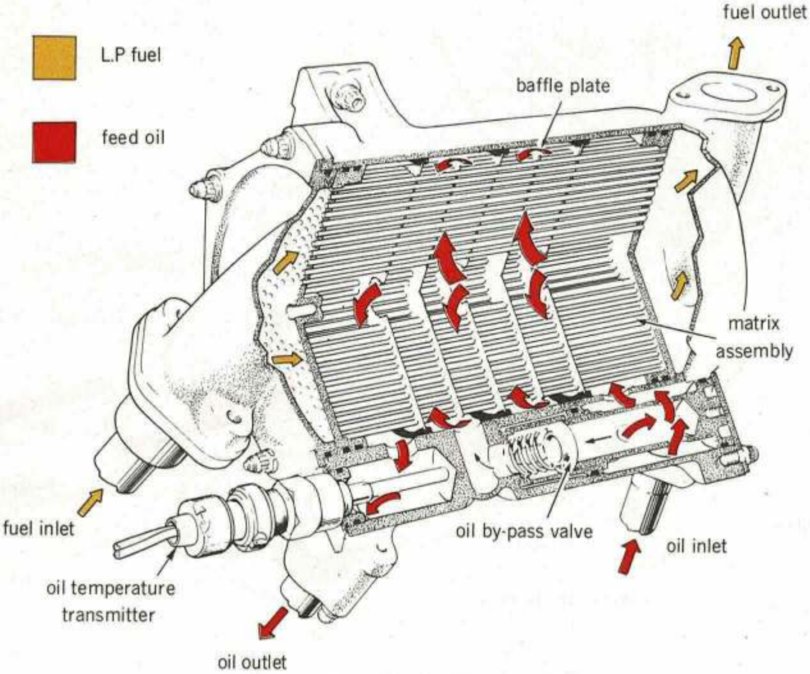

Fig 2.5.10 Fuel cooled oil cooler

- **Air-cooled oil cooler.** The air-cooled oil cooler is similar to the fuel-cooled type both in construction and in operation — except, of course, that air replaces the fuel as the cooling agent. On some engines, the airflow through the matrix is controlled by a flap valve, which is automatically operated when the temperature of the return oil rises to a pre-determined value. A turbo-propeller engine may be fitted with an oil cooler that utilizes the external airflow as a cooling medium. This type of cooler incurs a large drag factor and, as kinetic heating of the air occurs at high forward speeds, it is unsuitable for turbo-jet engines.

Safety and Warning Devices

38. As stated earlier, various devices are incorporated in oil systems to prevent contamination of the oil, to ensure that the correct pressure is maintained, to give warning of faults or possible faults, and so on. Brief notes on some of the many devices are to be found in the paragraphs immediately following. Not every device discussed appears in every system (and some systems may contain devices not mentioned). Nevertheless, those listed can be considered to be common to most systems.

39. **Low pressure warning lamp.** If the oil pressure drops below the safe operating value for the particular system, a pressure sensing switch will initiate a visual warning; the warning usually consists of a lamp switching on in the cockpit (similar to the oil warning system used in most motor vehicles). The sensing switch (referred to as the *oil differential pressure switch*) senses the pressure difference between the feed oil pressure and the return oil pressure. When the pressure difference falls below a pre-determined level, the switch operates to activate the warning circuit.

40. **Pressure relief valve.** The pressure relief valve (Fig 2.5.11) maintains the oil pressure at the pre-set value demanded by the system. The valve is normally integral with the pump assembly and protects the system from excessive pressure. It is usually a spring-loaded plate-type valve which provides no adjustment of pressure setting. As we have already seen, in turbo-propeller engine oil systems, a *compound oil pressure relief valve* is fitted; this has two outputs — one providing normal pressure for engine bearings, and the other high pressure for propeller systems.

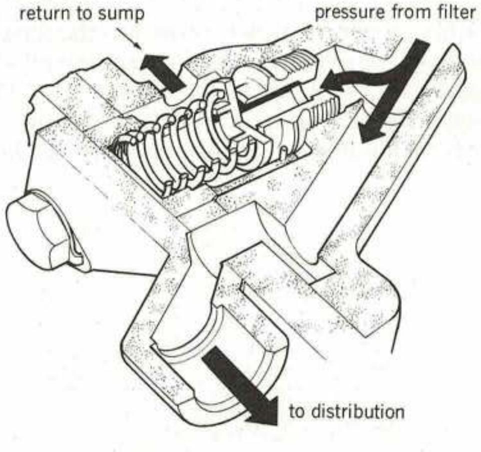

Fig 2.5.11 A pressure relief valve

42. **Pressure filter.** The pressure oil filter housing contains a wire-wound element and incoporates a by-pass valve (*see* para 41). The filter housing can be drained independently of the main oil system. This is done through a drain valve in the housing base. When drained, the filter can be removed for examination, servicing, or replacement, as necessary, without disturbing the rest of the system. A typical pressure filter is illustrated in Fig 2.5.12.

41. **By-pass valve.** This is similar in construction to the normal pressure relief valve just discussed. It is connected in the system in such a way that, should the oil cooler or the pressure filter become blocked (so that the oil flow is restricted), the appropriate by-pass valve will operate to re-route the oil. Although the cooling or the filtering has now been by-passed, oil starvation of the engine bearings is prevented.

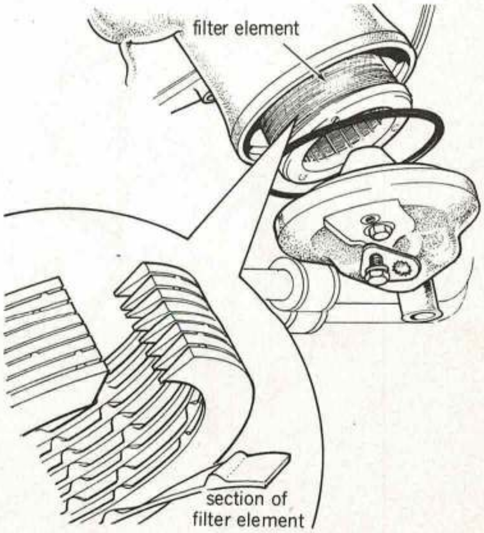

Fig 2.5.12 A pressure filter

43. **Thread-type filter.** Some of the gears in the gearboxes, and also the main bearings of the engine, are lubricated through oil jets. These jets are usually protected by thread-type oil filters (Fig 2.5.13).

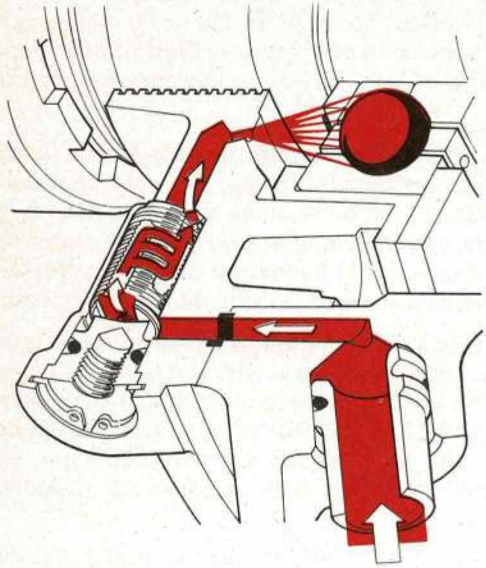

Fig 2.5.13 A thread type oil filter

44. **Scavenge oil strainers.** When the oil has been distributed to all parts of the engine and has done its job, it is returned to the oil tank by pressure from the scavenge pumps. Each pump returns the oil from a particular part of the engine and is protected by a coarse filter (or strainer) in the return line. This arrangement protects the pump gears. It also gives an indication of impending component failure if the strainers are examined for metal particles during periodical inspection.

45. **De-aerator.** We have already noted that air from the bearing sealing system mixes with the oil and causes frothing. If the air is allowed to remain in the oil it may cause a lubrication failure. To prevent this, a de-aerating device is installed (*see* para 34); this removes all the air from the oil before the oil is re-circulated round the engine by the pressure pump; the air is vented to atmosphere.

46. **Centrifugal breather.** We note in para 34 that the oil/air mixture returned to the tank is discharged over the de-aerator tray. As this mixture flows over the tray, the air is separated and passes through to the gearbox; it carries some of the oil with it, in the form of a fine mist. The oil/air mist in the gearbox then passes to the centrifugal breather (Fig 2.5.14). As the vanes of the centrifugal breather rotate, the oil in the mixture is caught in the vanes and thrown back into the gearbox; the air is vented to atmosphere.

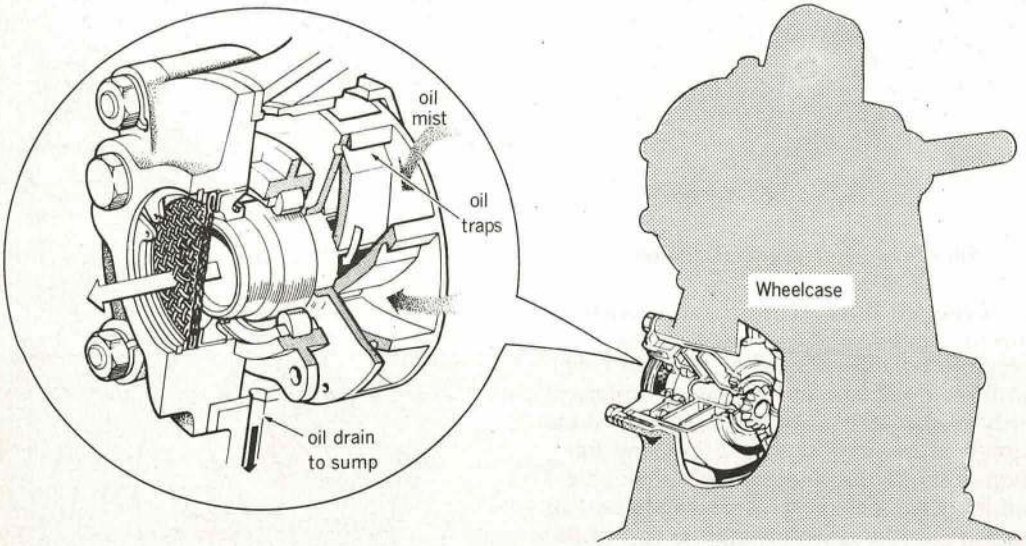

Fig 2.5.14 Centrifugal breather

47. **Magnetic chip detector.** Magnetic detectors may be fitted into the oil system at various points to collect and hold ferrous debris. They are normally fitted in gearboxes and in the scavenge pump return lines to the tank. The collection of ferrous particles on the chip detector provides a warning of impending (or incipient) failure of a component. Some detectors are designed so that they can be removed for periodical examination without having to drain the oil system; others may be checked externally by connecting a suitable test circuit to the plug; finally, some are connected in a cockpit warning system to give an in-flight indication of failure. The chip detector (Fig 2.5.15) fits into a self-sealing housing and has a bayonet-type fitting for easy removal.

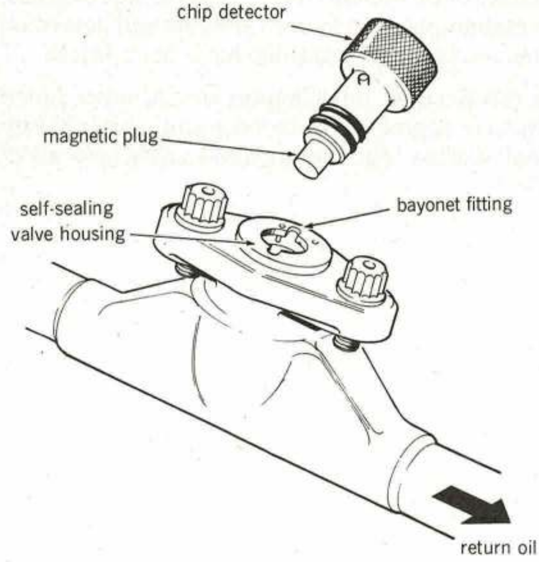

Fig 2.5.15 A magnetic chip detector

48. **Collector tank.** In some installations a collector tank is connected to the thrust bearing chamber. Its purpose is to avoid flooding the bearing chamber with oil during engine rundown. It will also prevent subsequent leakage of oil past the thrust bearing oil seals when the engine is stationary. To provide this, the collector tank is tilted to ensure oil flow away from the bearing chamber into the tank; the tank has a capacity of approximately 1 pint (0.57 litre).

SERVICING OIL SYSTEMS

General Points

49. The procedures to be adopted when carrying out any servicing or maintenance task on a gas turbine engine oil system are given in the appropriate equipment AP for the aircraft. Always carry out the procedures detailed there.

However, during any servicing or maintenance operation, there are normal trade practices that you should be aware of and, as a good tradesman, carry out automatically. These include the following:

- Always ensure scrupulous cleanliness during removal/replacement of components.
- As a matter of routine, check for fuel and oil leaks, and for insecurity of pipelines and other components; rectify as necessary.
- During servicing, blank off any open-ended pipes and apertures to prevent moisture or debris getting in.
- Always examine filters and chip detectors for metal particles before cleaning the components. Do not destroy any evidence of metal particles or other debris. Report the matter to your NCO who will decide what to do.

- Synthetic oils are harmful to paintwork and certain types of rubber. The oil must not be permitted to contaminate those parts of the engine not normally in contact with the oil. Spilt oil must be wiped up immediately.

- These synthetic oils contain additives which, if allowed to come into contact with your skin for long periods, can be toxic through skin absorption. Use a barrier cream before working with such oils, and wash your hands afterwards.

CONCLUSION

50. This Chapter has considered the basic principles of oil systems used in gas turbine engines. We have also discussed the components that are commonly used in such systems and described their operation. Finally, some relevant safety and servicing precautions have been listed.

51. Taken together with previous Chapters in this Section, this Chapter should have added another piece to your overall knowledge of gas turbine engines. We shall continue this build-up of information in the next Chapter, where we shall discuss 'Air cooling and sealing systems'.