Chapter Two

THE LUBRICATION SYSTEM

Contents

Illustrations

THIS CHAPTER contains a description of the lubrication and rear bearing oil cooling system. Fig. 1 shows the location of the oil pump, the suction and pressure filters, the relief valve and oil-level sight-glass on the sump, and the drive arrangement for the two metering pumps.

The lubrication system illustrated in Fig. 2 is completely self-contained, the oil being carried in a sump which is attached to the underside of the bottom wheelcase. The oil is circulated by a normal gear-type pump through suitable filters. The supply of oil to the rear main bearings is accurately metered by an individual metering pump. Pre-mod. 431, the front main bearing was fed by a metering pump also, but when mod. 431 has been embodied, this bearing receives a continuous flow of oil under pressure via a restrictor. Unmetered oil is supplied under pressure to all the principal bearings in the top and bottom wheelcases. To avoid contamination of the main supply by oil which has been raised to a considerable temperature, all the oil delivered to the rear bearing is allowed to drain to waste. High temperatures do not occur in the case of the front bearing and, therefore, the oil supplied to that bearing returns to the main supply. All the oil circulated by the pumps, with the exception of that supplied to the rear bearing, returns to the sump by gravity.

Oil under pressure is also circulated through a muff, or annulus, surrounding the rear bearing and is returned to a suitable point in the main system so that the continual circulation of oil around this bearing assists in its cooling.

Although this chapter describes the lubrication system of the Ghost 48 Mk. 1, the majority of the information is equally applicable to the Ghost 48 Mk. 2, Fig. 3 and 4 illustrating the oil sump and the circulation of the latter engine.

OIL SUMP

The oil-sump consists of a rectangular light-alloy box which is attached to the underside of the bottom wheelcase by nineteen studs and plain nuts. A synthetic rubber sealing strip is employed to form an oil-tight joint. The sump contains the oil pressure filter, the relief valve and oil-level sight-glass, and provides the mounting for the suction filter, oil pump and metering pumps.

The sump contains approximately two gallons of oil and is provided with a sight-glass whereby the oil level can be observed. To protect the engine from the total loss of lubricant should the sight glass be broken, the latter is isolated from the sump by a spring loaded plunger. In order to read the oil level, this plunger must be pressed inwards, against the action of its spring, until a groove turned in the plunger aligns with the oil passage to the sight-glass. After a short interval to allow the level in the sump and sight-glass to equalise, the oil level may be observed in the sight-glass and the oil level plunger released. To ensure oil-tight joints, synthetic rubber seatings, one in sump at the lower end, and one in the bottom wheelcase at the upper end, are fitted at the extremities of the sight-glass.

The oil level plunger and its spring operate in a machined boss at the lower end of the sight-glass housing, and are retained by a retaining plug which is locked by a tab washer. A synthetic rubber sealing ring in the retaining plug prevents the escape of oil around the oil-level plunger. An instruction PRESS TO READ is marked on the sump adjacent to the plunger.

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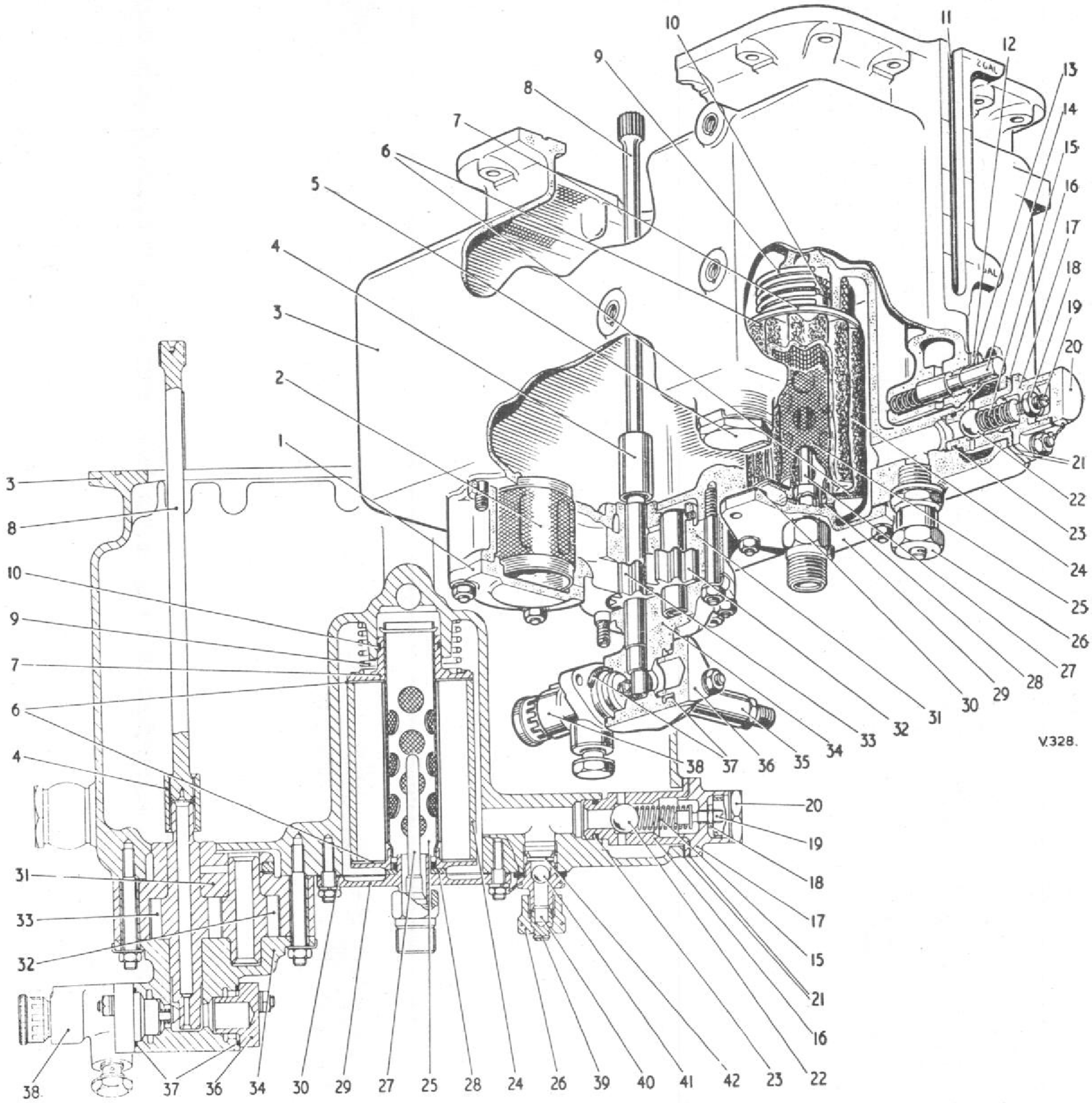

1 SUCTION FILTER COVER
2 GAUZE SUCTION FILTER
3 SUMP
4 OIL PUMP DRIVE SHAFT SLEEVE
5 DRAIN PLUG
6 END PLATE WASHER
7 PRESSURE FILTER END PLATE
8 OIL PUMP DRIVE SHAFT
9 OVERLOAD VALVE SPRING
10 SEALING RING
11 OIL LEVEL SIGHT GLASS APERTURE
12 OIL LEVEL PLUNGER RETAINING PLUG
13 SEALING RING
14 OIL LEVEL PLUNGER
15 RELIEF VALVE SPRING
16 RELIEF VALVE HOUSING
17 RELIEF VALVE CAP
18 LOCK NUT
19 RELIEF VALVE ADJUSTING STOP
20 RELIEF VALVE PLUG
21 SEALING GASKETS
22 RELIEF VALVE
23 SEALING RING
24 PRESSURE FILTER ELEMENT
25 PRESSURE FILTER SUPPORT TUBE ASSEMBLY
26 UNION NUT
27 OIL TEMPERATURE THERMOMETER
28 WASHER BONDED TO FILTER COVER
29 PRESSURE FILTER COVER
30 JOINT WASHER
31 OIL PUMP BODY
32 OIL PUMP DRIVEN GEAR
33 OIL PUMP DRIVING GEAR
34 OIL PUMP COVER
35 OIL RESTRICTOR
36 BLANKING COVER ON UNUSED METERING PUMP FACE
37 SEALING RINGS
38 METERING PUMP
39 SPLIT PIN
40 BLANKING NIPPLE
41 BALL
42 RETAINING PIN

Fig. 1. Oil sump assembly (Ghost 48 Mk. 1).

SUCTION FILTER

The suction filter consists of a perforated brass tube covered with sixteen-mesh brass gauze. It is accommodated at the bottom of the sump in the oil pump body and is enclosed by a light-alloy cover which is secured by four studs, plain and spring washers, and nuts. All the oil from the sump passes through this filter before entering the oil pump.

OIL PUMP

The oil pump is a conventional gear-type pump and is driven off the gear train in the bottom wheelcase through a vertical driving shaft and a driving sleeve. Each end of the driving shaft is serrated to engage at the upper end with the mating serrations within the oil pump driving gear which is in the bottom wheelcase, and at the lower end to engage similar serrations within the sleeve. Corresponding serrations at the upper end of the oil pump driving gear integral spindle also engage the serrations within the sleeve. A circlip inside the sleeve locates it relative to the driving shaft and the driving gear spindle.

The driving and driven gears within the oil pump are integral with their spindles and operate in a recess machined in the underside of the oil pump body; bearings for their integral spindles are machined in the oil pump body and in the oil pump cover. The integral spindle of the driving gear is extended upwards to engage with the driving shaft and sleeve, and downwards, where it is machined with an eccentric or cam, to operate the metering pumps.

The oil pump body consists of a light-alloy casting suitably machined to accommodate the oil pump gears and to provide bearings for the upper ends of their integral spindles; it is also machined to accommodate the suction filter. The oil pump body is secured to the underside of the sump by eleven studs, plain and spring washers, and nuts, four of which are also used to secure the suction filter cover and six for the oil pump cover.

The oil pump cover is a light-alloy casting machined to provide bearings for the lower ends of the oil pump gear spindles and mounting faces for the metering pumps. This cover encloses the oil pump gears and is secured by six of the studs which are used to secure the oil pump body to the sump. Four metering pump mounting faces are provided on the oil pump cover but two only are used; the redundant mounting faces are blanked off with suitable covers.

PRESSURE FILTER

The pressure filter is contained in a compartment cast in the sump and is enclosed by the steel pressure-filter cover. The pressure filter also serves as the thermometer pocket for the oil temperature gauge, a suitable union adapter being incorporated in the cover for the bulb. The cover is secured to the sump by six studs, spring washers and nuts, a Klingerit washer being used to form an oil-tight joint. All the oil, except that employed to cool the rear bearing, passes through this filter.

The pressure filter consists of a felt Tecalemit filter element mounted on a 120 mesh gauze-covered, perforated support tube. Synthetic rubber washers and metal end plates seal the ends of the filter elements, the whole assembly being firmly pressed together by an overload valve spring at the top. The bottom end-plate seats on a synthetic rubber seating washer which is situated between it and the pressure filter cover. In the event of the felt element becoming clogged, the oil pressure will build up and force the bottom end plate and the filter assembly against the overload valve spring; unfiltered oil can then by-pass the filter elements through ports which become exposed at the base of the assembly.

PRESSURE RELIEF VALVE

The pressure relief valve consists of a spring-loaded ball valve which is contained in a housing situated in the starboard side of the sump adjacent to the oil level plunger. A synthetic rubber seal is fitted into a groove in the relief valve housing to ensure an oil-tight joint. A cage limits the extent to which the ball valve can lift off its seat. These parts are retained in the sump by the relief valve body which is secured to the side of the sump by two studs, plain and spring washers and nuts.

The relief valve body contains the relief valve adjusting stop by which the spring loading on the ball valve is adjusted. A $\frac{1}{4}$ in. B.S.F. plain nut locks the adjustment which is protected from accidental alteration by a cap-nut.

METERING PUMPS

Two Tecalemit metering pumps are mounted on the oil pump cover and are actuated by an eccentric, or cam, formed on the integral spindle of the oil pump driving gear. Each metering pump is secured to the oil pump cover by two studs, plain and spring washers and 2 B.A. plain nuts. A synthetic rubber sealing ring around the spigot of each metering pump ensures an oil-tight joint. One metering pump feeds the precise quantity of oil required by the rear bearing whilst the other feeds the front bearing.

Each metering pump consists of a light-alloy casting into which is fitted a steel cylinder with a plain bore. The cylinder contains two opposing pistons; the inner piston has a tappet head which bears on the eccentric on the oil pump driving gear spindle. A coil spring, which is fitted under the tappet head and surrounds the exposed portion of the steel cylinder, ensures that the tappet head maintains contact with the eccentric. The position of the spring-loaded outer piston in relation to the inner piston is adjusted by a knurled cap screwed into the end of the cylinder. Eleven equally spaced notches, numbered from 0 to 10, are cut in the outer periphery of the cap and a flat spring-steel tongue engages in one of these notches to lock the cap at the required setting.

Oil under pressure is supplied to the metering pump from a space under the pump spigot from which a drilling in the metering pump body communicates with a port in the steel cylinder. A second port in the steel cylinder communicates with the outlet from which the metered oil supply is piped to the front and rear bearings respectively. When the eccentric is at its lowest position, relative to the metering pump under consideration, the inner piston uncovers the inlet port in the cylinder and the space between the two pistons fills with oil. As the eccentric rotates, the inner piston is moved outwards covering the inlet port. The two pistons then move together with a metered quantity of oil between them. Towards the outer extremity of the pump stroke, the outer piston uncovers the outlet port and the continued movement of the inner piston expels the metered quantity of oil. The quantity of oil delivered depends on the position of the outer piston with reference to the inner piston and is controlled by the setting of the knurled adjustment. Delivery of the metering pumps is only slightly affected by the oil inlet pressure.

Before being fitted to the engine each metering pump is adjusted on a test rig; the setting is also checked whilst the engine is running on the test bed to ensure that the delivery from each pump is not less than 180 cc. per hour at 3,000 r.p.m.

LUBRICATION

A filler cap in the top of the air compressor drive housing provides access to the top wheelcase, through which the sump is filled with oil, therefore, both wheelcases are automatically primed as the oil runs through the engine to the sump. For this reason, when filling or replenishing, sufficient time must be allowed for the oil to drain down into the sump before checking the level in the sight-glass.

Oil is drawn by the gear type pump from the sump through the suction filter and is pumped to the rear bearing cooling muff and through the pressure filter. The oil pressure on the inlet side of the pressure filter is controlled by the adjustable relief valve which by-passes excess oil back into the sump. From the pressure filter, drillings in the sump and in the bottom wheelcase convey oil under pressure to the principal bearings in the bottom wheelcase and to the metering pumps. An external pipe conveys oil under pressure from the bottom wheelcase to ducts in the top wheelcase which lead it to the principal bearings therein. The gears in the top and bottom wheelcases and in the centre housing are lubricated by the splash created by oil escaping from the ends of the bearings and falling under the influence of gravity to the bottom of the engine. To prevent the top wheelcase becoming filled with oil, two external drain pipes lead from suitable points in the top wheelcase to the bottom wheelcase, whence the oil can return to the sump. The heavily loaded starter gears are lubricated by a jet of oil taken off the pressure system.

The front and rear bearings are continually supplied with an accurately metered quantity of oil by individual metering pumps. As the oil supplied to the rear bearing may deteriorate as a result of the high temperatures at which this bearing operates, the oil is allowed to drain to waste, but that supplied to the front bearing, which operates at much lower temperatures, is returned to the sump.

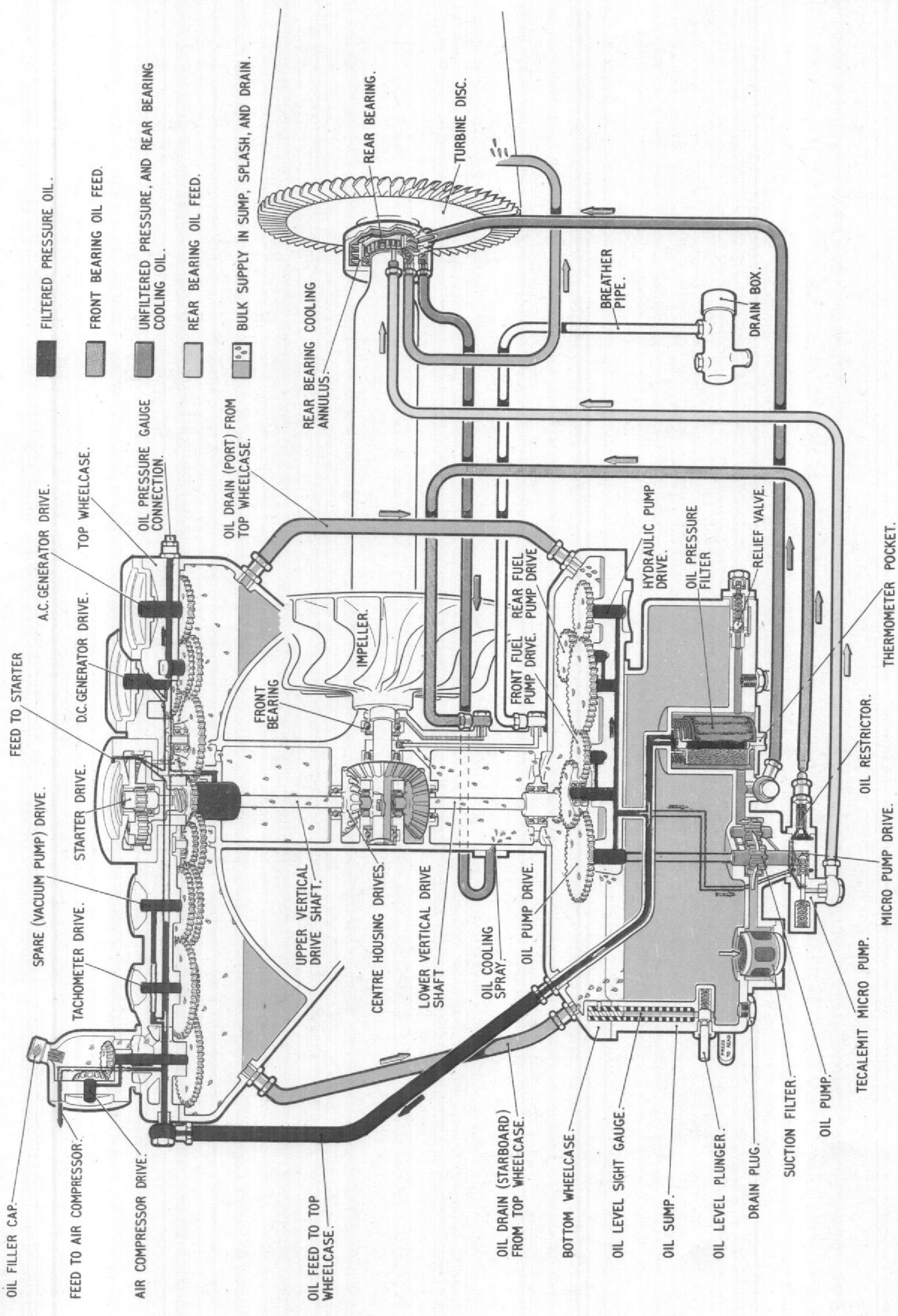

Fig. 2 Oil Circulation (Ghost 48 Mk. 1).

When mod. 431 is embodied, the front bearing metering pump is deleted and oil, under pressure, is passed, via a restrictor, direct to the front bearing giving that bearing an increased flow of oil.

When mod. 1088 has been embodied, the oil which drains from the rear bearing is led into the exhaust cone and consumed therein—Fig. 2 and 4. This prevents the spillage of oil onto the aircraft cowling and eliminates the consequent fire risk.

REAR BEARING OIL COOLING

The rear bearing is partly cooled by air directed into annular spaces and longitudinal grooves between the extension shaft and the hub shaft, and by oil circulated around the bearing housing. Part of the oil delivered by the gear-type pump does not pass through the pressure filter, being diverted instead to cool the rear bearing. After leaving the oil pump the oil stream divides, part of the oil stream flowing into the pressure filter as previously described. The other part of the oil stream is taken through an external pipe to No.11 diffuser bolt. The oil passes through the hollow diffuser bolt and is conveyed by a pipe to the cooling muff which surrounds the rear bearing. The rear bearing cooling muff is ribbed internally so that an increased area is available for heat transfer. Having passed through the muff, the heated oil is piped to No.8 diffuser bolt whence another pipe conveys the oil to a point inside the air-intake casing just below the centre housing, where it is cooled by the air-flow through the air-intake and then returned to the sump by gravity. When mod.483 is embodied the cooling oil by-passes the hollow diffuser bolts and passes through an oil cooler.

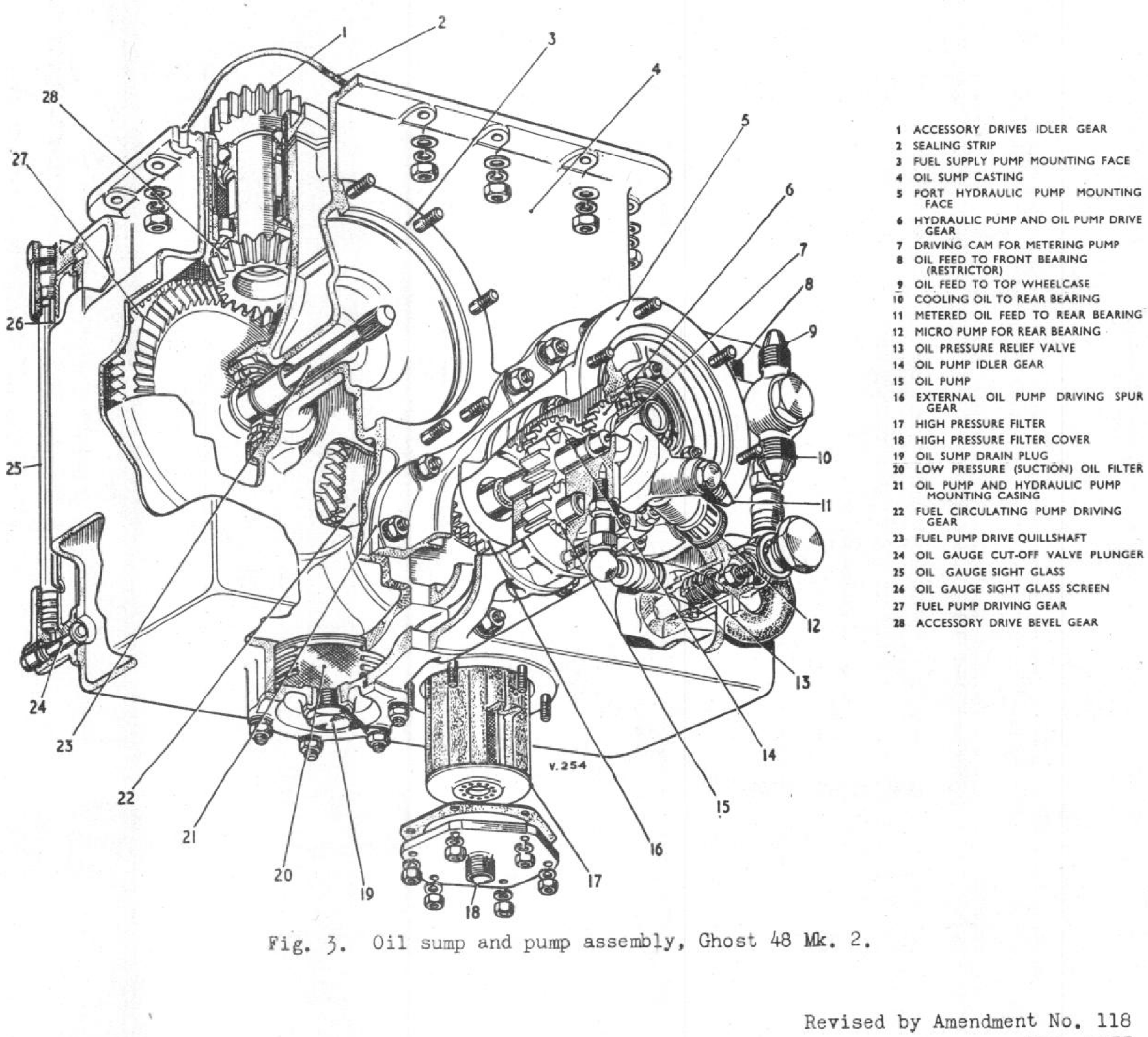

Fig. 3. Oil sump and pump assembly, Ghost 48 Mk. 2.

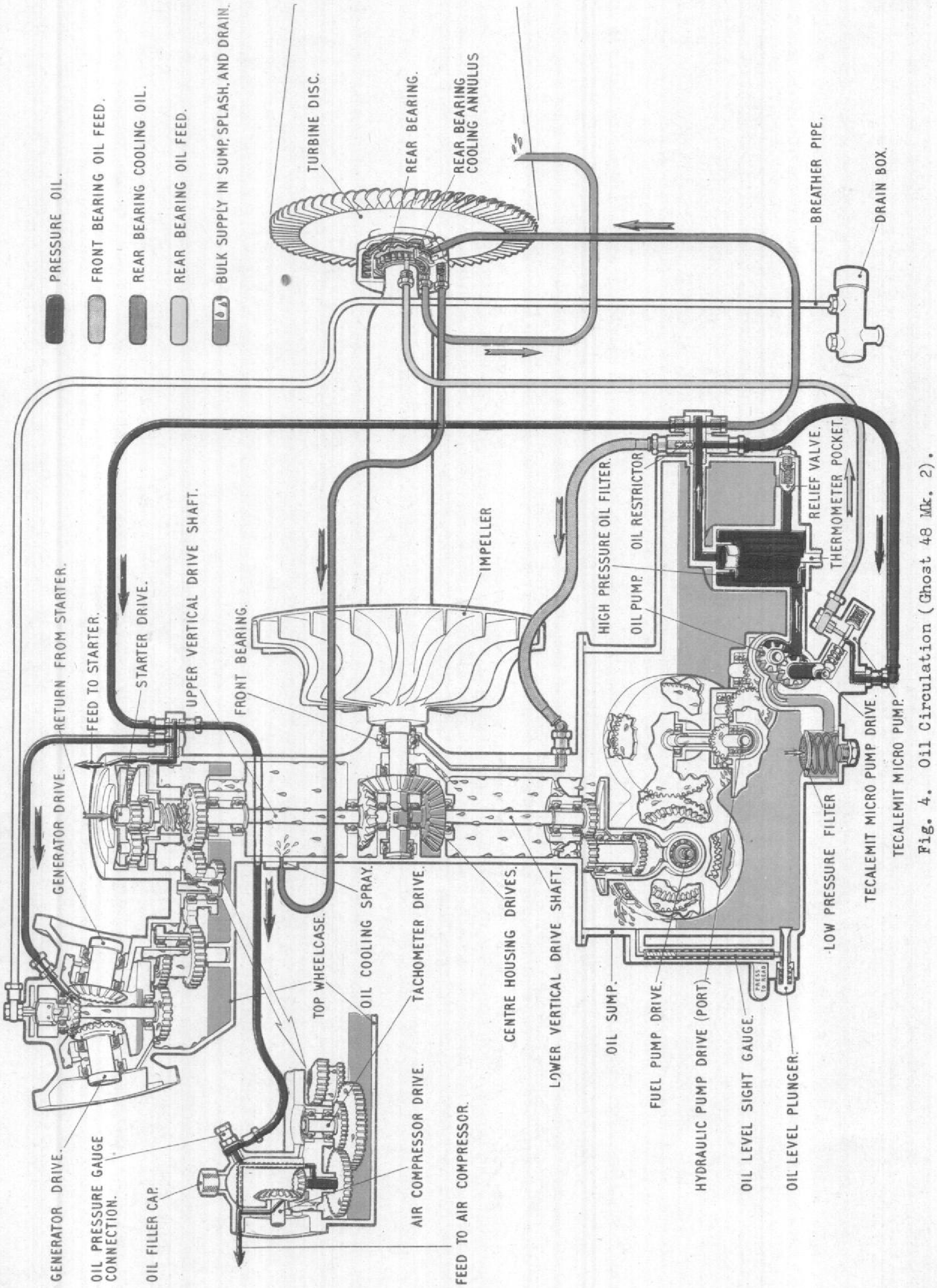

Fig. 4. Oil Circulation (Ghost 48 Mk. 2).