Chapter 2

LUBRICATION

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

General

1. These engines are lubricated on the dry-sump principle, one pressure only being employed throughout the engine. The pressure pump feeds oil, through external pipes and internal ducts, to the main and big-end bearings, the magneto drive intermediate and the tachometer drive gears, and by an oil jet to the magneto drive spiral gears. The cylinder walls, the camshaft, the small end bearings, and the remaining gears in the timing gear cover are lubricated by splash.

2. In Mk. 1 variants, the drain oil returns to the oil tank by gravity through pipes from the front and the rear of the engine. These pipes meet at a T-piece below the magneto and oil pump drives at the rear of the engine and whence a single pipe conveys the oil to the oil tank.

3. The Mk. 7 engine is provided with two scavenge pumps. One pump collects the oil which drains from the front of the crankcase and the other pump deals with the drain oil from the rear of the crankcase and the timing gear cover; the use of the two pumps ensures that the engine is efficiently scavenged in all attitudes of flight. From the scavenge pumps the oil is returned to the tank.

4. Filters are placed in the oil pipe lines to protect the pumps and engine components from damage which might be caused by the admission of foreign particles.

Oil pump (Gipsy Major Mk. I, IC and IF)

5. The pressure-pump is of the meshed gear type and embodies a spring-loaded relief valve. It is spigot-located in an aperture at the bottom of the timing gear cover, and is secured by five studs and nuts. The pump is driven by a spur gear which is keyed to the end of the driving-gear spindle and which meshes with the camshaft timing gear within the timing gear cover. Although the unit is self-contained, it cannot be completely dismantled without removing the timing gear cover, as the driving gear is larger than the aperture in the timing gear cover.

6. The oil pump body is in three parts, namely, the front cover, the gear housing,

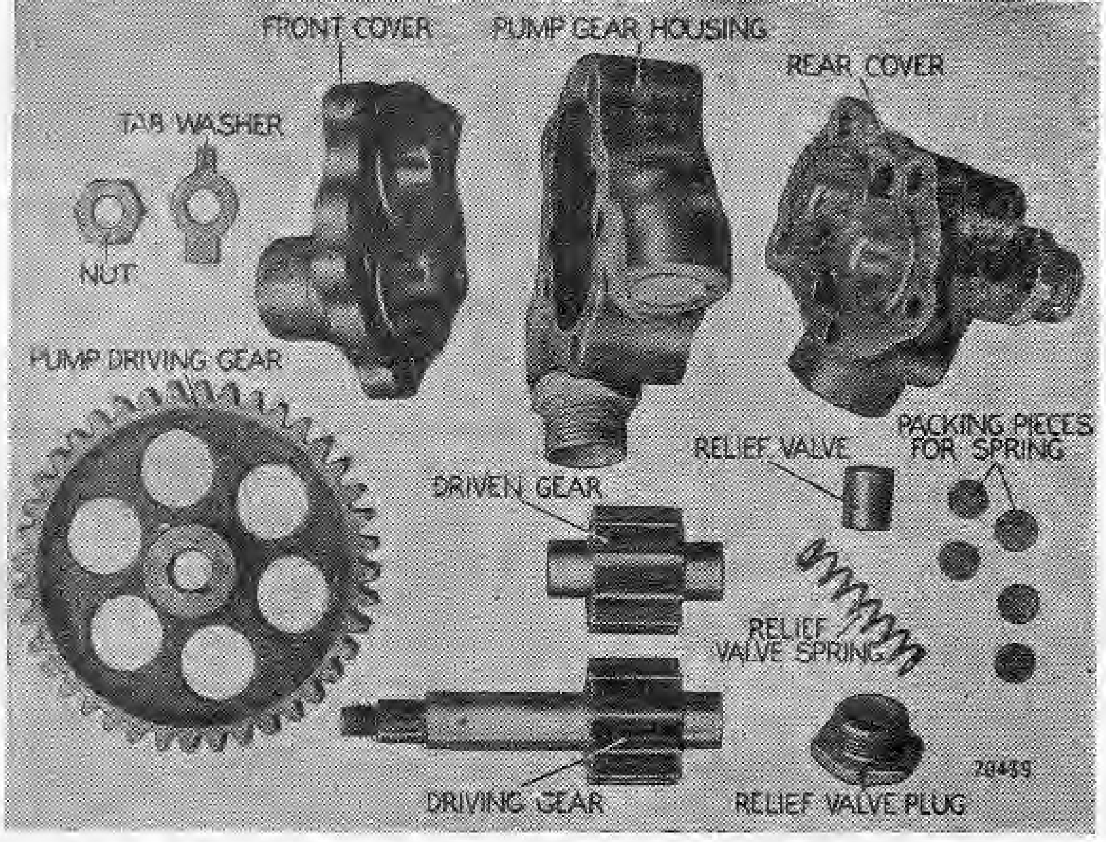


Fig. 1. Components of pressure-pump (Gipsy Major Mk. I, IC and I F)

and the rear cover, all of which are machined from magnesium alloy castings. The front cover is a flat plate, bored and bushed to form the bearings for the front ends of the pump gear spindles. The driving-gear spindle projects through the front cover which is extended forwards to provide the necessary bearing support and machined to form a spigot which locates the pump unit within the aperture in the timing gear cover.

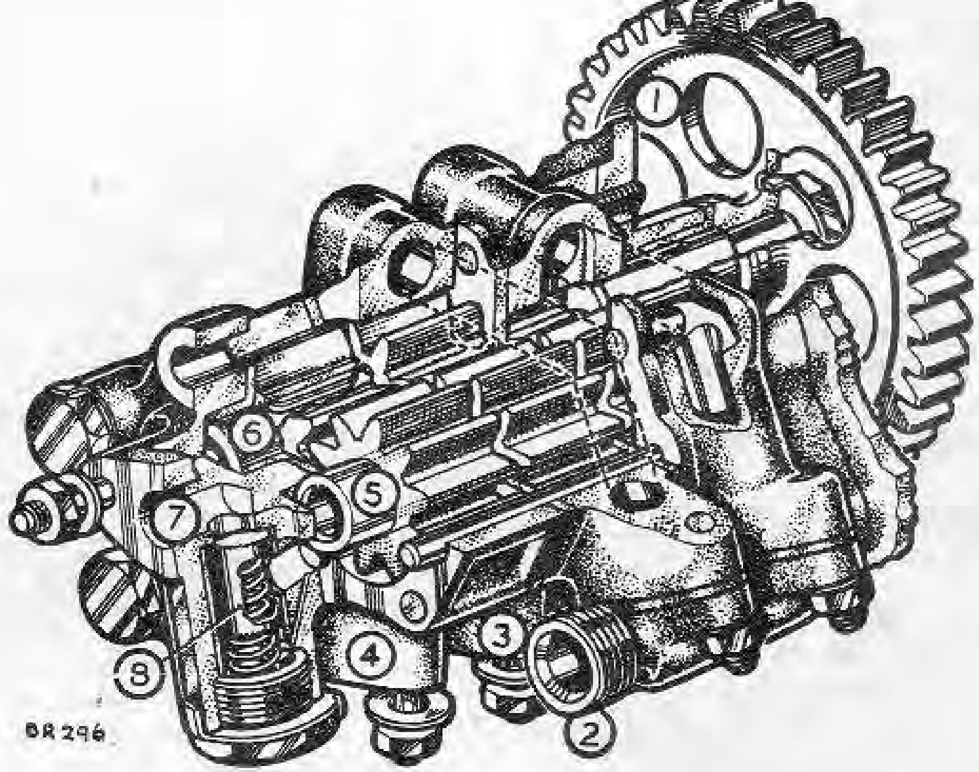
7. The gear housing conforms, in external shape, to the front and rear covers and embodies two elbows. The bottom one is the inlet connection and is screwed to take the oil pipe union whilst the top elbow is blanked by a sealing plug. Five drilled bosses around the periphery of the housing match up with the similarly drilled front and rear covers, the whole unit being secured on the five studs at the rear of the timing gear cover by spring-washered nuts.

8. The rear cover embodies the rear bearings, outlet connection and spring-loaded relief valve. Two phosphor-bronze bushes, forming the rear bearings for the pump gear spindles, are pressed into recesses machined in the cover.

9. The pump gears with their integral spindles are machined from nickel-chrome steel. The driven gear and spindle is hollow throughout its length, and a small hole between two teeth of the gear permits oil to reach the ends of the spindle to lubricate the bearings. The driving spindle is extended forward through the front cover of the pump and is stepped down and screwed at its forward end to take the pump driving gear, which is keyed to the shaft and retained by a tab-washered nut. This spindle is also hollow for the greater part of its length, a radially drilled hole being provided between two teeth as in the case of the driven gear. A second hole at the forward end of the spindle allows oil to reach the front bearing.

Oil pumps (Gipsy Major Mk. 7)

10. The three gear type oil pumps are assembled into one composite unit and secured with studs to the timing gear cover, the pressure pump being to the rear. The detail parts of this pressure and dual scavenge pump unit are similar to those of the single pressure-pump previously described. Each pump is enclosed in its own housing and is separated from its neighbour by dividing plates along the surface of which are shallow grooves to permit the escape of oil and so prevent a build-up of pressure caused by oil trapped between the gear teeth. The two end pumps are also enclosed by a front and rear cover respectively. The whole assembly is aligned by two long dowels and is held together by the fixing studs of the unit.



1 PUMP DRIVING GEAR
2 SCAVENGE PUMPS OUTLET
3 REAR SCAVENGE PUMP INLET
4 PRESSURE PUMP INLET
5 IDLER SPINDLE
6 DRIVING SPINDLE
7 PRESSURE PUMP OUTLET
8 RELIEF VALVE

Fig. 2. Pressure and scavenge pump unit (Gipsy Major Mk. 7)

11. The only working parts common to all three pumps are the two gear spindles. These pass through the three pump housings and are supported in plain bearings in the front and rear covers. The driven-gears spindle protrudes through the front cover and is keyed and threaded at this end to receive the pump driving gear. The gears for the forward scavenge pump are integral with the two spindles, whilst those for the rear scavenge pump and pressure pump are keyed to them. Each pair of gears rotates in its own pump housing and the dividing plates and covers fit closely to the gears to prevent leakage of oil across the face of the latter.

12. The oil enters and leaves each pump through ports drilled into the pump housing, the three inlet ports communicating with oil pipe unions fitted in line beneath the oil pumps unit. The scavenge pump outlet ports are connected to a common connection fitted at an angle, on the starboard side. The pressure pump outlet, however, connects through internal oil passages to a union on the end of the pump rear cover.

Pressure relief valve

13. A pressure relief valve is fitted into the pump rear cover. Transfer ducts connecting outlet to inlet are drilled in the pressure pump rear cover and, when the unit is at rest, are sealed by the relief valve which consists of a small spring-loaded cylinder held in position by a plug beneath the pump. When the pump is in operation the delivery pressure causes the valve to lift against the pressure of the spring, so that oil is by-passed back to the inlet side and the resultant pump outlet pressure maintained constant at a pre-set value. The spring loading and consequently the oil pressure is adjusted by shims between the end of the spring and the cap-nut; shims being added to increase the pressure and vice versa.

Suction filter

14. The suction filter, which is situated in the oil line from the tank to the pressure pump, is mounted vertically on the end of the port magneto mounting arm. It consists of a reinforced gauze sleeve enclosed in a magnesium alloy casing. Inlet and outlet unions

are provided; the former, near the top of the casing, is so positioned that the inlet oil fills the space surrounding the filter element, whilst the outlet is connected by an internal oil duct to the inside of the element. One end of the gauze filter is held in a recess which surrounds the outlet oil duct and the upper end fits into a similar recess in a large plug screwed into the top of the filter casing. A hexagonal drain plug is provided at the lowest point of the filter casing, adjacent to the outlet union. Copper-asbestos washers are used to prevent leakage of oil from around the plug and the joints of the unions.

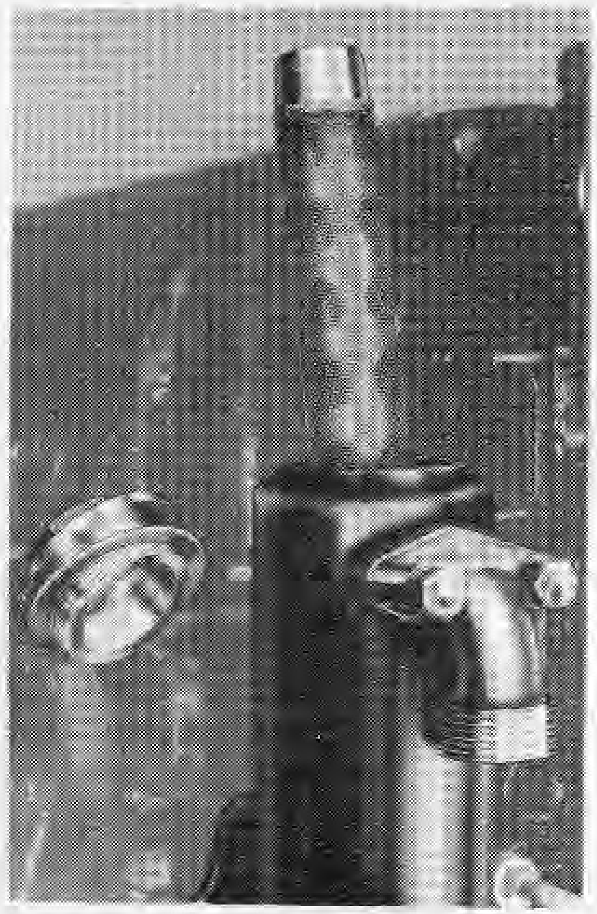


Fig. 3. Suction filter

Pressure filter

15. The Auto-klean pressure filter is fitted into a circular casing mounted across the back of the rear cover. Integral with the filter casing are two arms which support the carburettor and ignition controls. In this type of filter the oil percolates between thin laminated plates set close together. A system of scraper blades, which removes the sediment from between the plates, increases the overhaul life of the filter. The filter plates are flat wheel-like discs with eight spokes radiating from the centre to a circumferential ring. They are packed on to a central rod and are held approximately 0·003 in. apart by thin spacer plates which are similar to the filter plates except that they have no circumferential ring. Scraper blades 0·002 in. thick, supported on a square rod, project one into each of the annular spaces between the filter plates. The whole plate pack is clamped to the filter end-cover through which the central rod protrudes. The end of the rod is fitted with a handle so that the plates can be rotated against the stationary scraper blades. A gland is provided to prevent leakage of oil at the point where the central rod emerges from the cover.

16. The oil enters the unit through an inlet elbow situated on the rear side of the filter body. After passing between the filter plates the oil flows from the eight longitudinal passages, formed by the spaces between the spokes of the plates, into an annular groove around the outside of the filter end-cover. Three outlets are situated on the filter body so that their inside openings coincide with the annular groove in the filter cover. The main oil outlet is fitted with a large union on the top of the filter, whilst the two auxiliary outlets, situated one above the other at the rear of the filter body are threaded to receive a banjo pillar. The upper of these two latter outlets is used to feed oil to the magneto gears oil jet and the lower one is provided for an oil pressure gauge connection. The oil jet is protected by a small gauze filter fitted around the upper union.

Oil sump (Gipsy Major Mk. 7 only)

17. The oil sump (or settling tank) is a magnesium alloy casting mainly cylindrical in shape, secured to the lowest point of the engine rear cover. An integral housing inside the bottom of the sump accommodates the rear scavenge filter. A circular opening in the back of the filter housing connects it with the inside of the sump whilst a port in the side of the housing connects with the outlet union on the filter side of the sump casing.

Scavenge filters (Gipsy Major Mk. 7 only)

18. The rear scavenge filter consists of brass gauze sweated to a reinforcing copper sleeve. One end of the sleeve fits into a recess formed at the inner end of the filter housing so that all scavenge oil must pass through the filter gauze. The outer end of the filter is located in a similar recess on the inner face of a triangular cover plate which is secured to the outside of the filter housing.

19. The front scavenge filter is similar to the rear scavenge filter and is contained in a

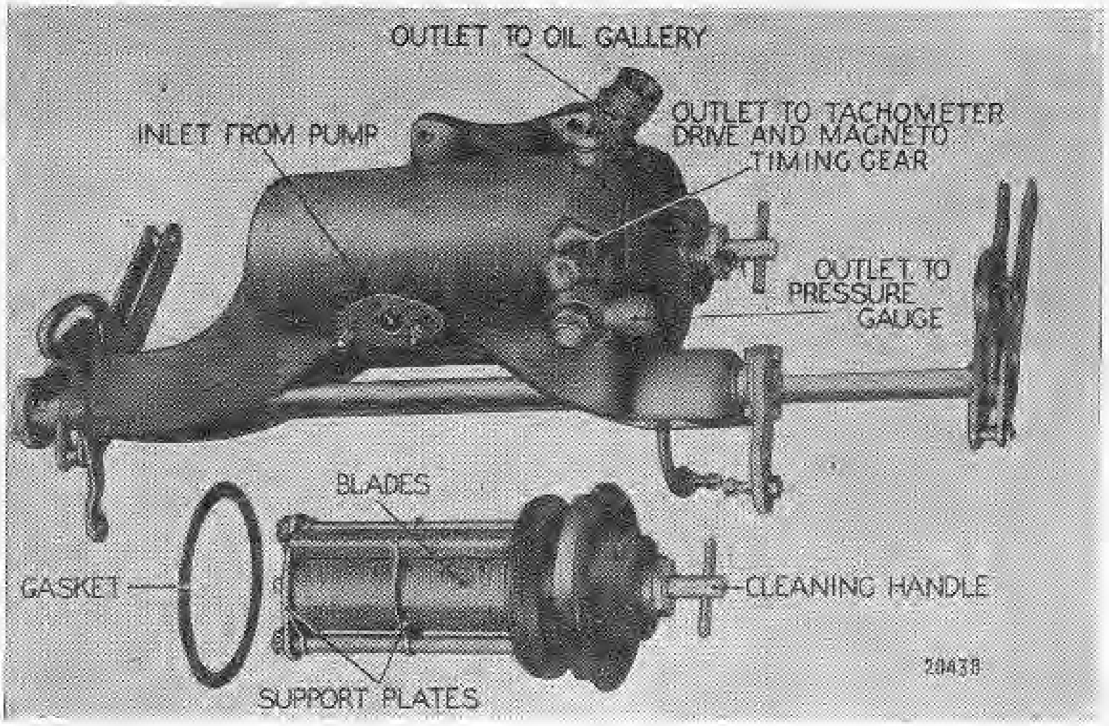


Fig. 4. Pressure filter

small housing secured by three studs to the lower forward end of the crankcase. A threaded boss at the bottom of the casing accommodates the outlet union.

Pressure lubrication system

20. The remainder of this chapter should be read in conjunction with fig. 6 or 7 which are diagrammatic representations of the complete gravity return lubrication system of the Mk. 1 variants and the dual scavenge pump system of the Mk. 7 respectively. The oil supply is drawn from the aircraft tank through the suction filter and external piping to the inlet side of the pressure pump. A further short length of pipe conveys the oil from the pressure pump to the pressure filter.

21. The main bearings are supplied with oil under pressure from the main oil gallery which runs along the starboard side of the top cover and which is connected at its rear end to one branch of a union fitted to the main oil outlet on the top of the pressure filter. The oil is fed from the oil gallery to the main bearings through holes drilled in the crankcase walls and webs and, through the top cover, the holes lining up to form continuous ducts when the top cover is fitted. The oil is admitted to the bearing surfaces through holes drilled in the lower half-bearing shells and is spilled from the ends of each bearing after circulating around oil grooves.

22. The big-end bearings are lubricated from No. 2 and 4 main bearings. Two radial holes in each of these hollow main bearing journals admit oil under pressure from the bearing surfaces. Ducts drilled in the crankwebs allow the oil to pass to the hollow crankpins where it emerges through two further radial holes into the big-end bearing.

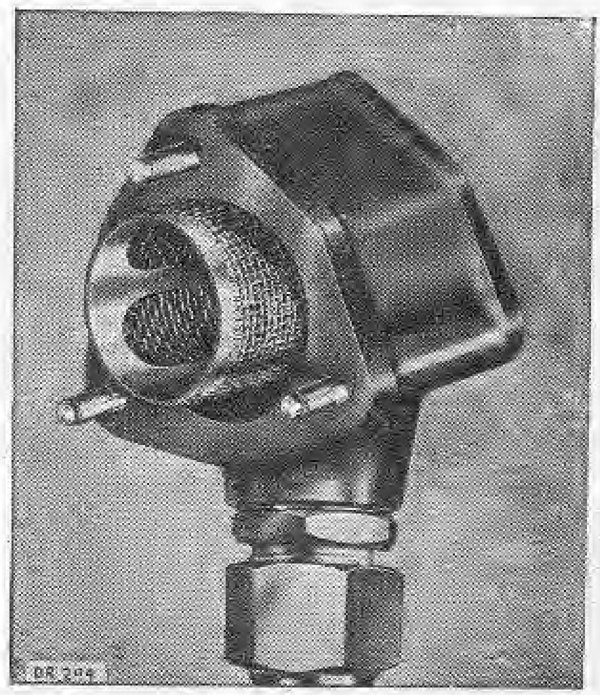


Fig. 5. Front scavenge filter (Gipsy Major Mk. 7)

23. The plain bearings for the magneto drive intermediate gear are lubricated by oil from No. 5 main bearing. Passage for the oil is provided by a drilling from this bearing into the bore in the rear wall of the crankcase in which the magneto drive static spindle is fitted. Lateral holes drilled in this spindle allow the oil to flow into the space between the two plain bearings in the integral shaft of the magneto drive intermediate gear and thence into the bearings.

24. The magneto drive spiral gears and the tachometer drive gears are lubricated by an oil jet connected by a pipe to the upper of the two subsidiary outlets on the pressure filter casing. The upper end of the pipe is connected to a union fitted to the face of the timing gear cover. Drillings in the timing gear cover, which connect with the union, carry the oil into the plain bearing of the tachometer driving gear shaft. Further drillings lead to a nozzle which sprays the oil on to the magneto driving spiral gears.

25. To lubricate the tachometer drive unit, pressure oil is fed to an annular groove cut around the upper bush of the driving shaft, it then passes through a hole in the spigoted portion of the tachometer drive casing, and after filling the casing, works past the upper bush to the small spiral gears in the upper housing. A passage, connecting the upper housing with the spigot, permits excess oil from the housing to drain back into the timing gear cover.

26. All working components not supplied with oil by the pressure system are lubricated by splash. The oil mist which fills the inside of the engine also contributes towards lubrication and engine cooling.

27. The cylinder walls, pistons and gudgeon-pins, cams and camshaft bearings are all lubricated by splash oil released from the main and big-end bearings. This splash oil in the crank-case is supplemented by two jets in each big-end bearing. Each time that the oil holes in the crankpins coincide with two holes drilled in the bearing a spurt of oil is directed into the crankcase.

28. The propeller thrust bearing is lubricated by oil spilled from the front of No. 1 main bearing. Excess oil is returned to the crank-case through three holes, one situated in front of No. 1 main bearing and two drilled obliquely from the front of the thrust bearing housing.

29. The timing gears and oil pump driving gear are all lubricated by a spray of oil thrown up by the magneto driven spiral gear from a shallow trough below the gear.

30. The camshaft rear bearing is supplied with additional oil from a small cavity, formed between the bearing securing flange and the rear wall of the crankcase, which collects the oil as it drains down the wall of the crankcase, the oil then passes to the bearing through an obliquely drilled hole.

31. The four rocker assemblies are lubricated by separate oil baths contained in the rocker covers. Some oil seeps down the push rod covers from the crankcase to lubricate the push rods and tappets but it is not sufficient to maintain the lever in the rocker covers which must be "topped up" periodically.

32. On Gipsy Major Mk. 1, 1C and 1F engines, the oil which drains from the rear of the crankcase to the bottom of the timing gear cover, flows into a short length of flexible hose which is attached to the lowest point of the timing gear cover by a flanged ferrule and four studs. At the lower end of this hose is a T-connection, one branch of which is connected to the front drain outlet on the crankcase, while the other is connected to the return pipe to the oil tank.

Dual-pump scavenge system (Gipsy Major Mk. 7)

33. The oil from the timing gear cover drains down the sides of the crankcase rear wall and the sides of the timing gear cover into the sump. From the sump the oil is drawn through the rear scavenge filter and returned to the aircraft tank by the front scavenge pump which is connected to the rear scavenge filter by a short length of piping.

34. The drain oil which collects in the bottom of the crankcase flows around the cylinder barrel extensions and through cored holes in the crankcase webs to either the front or rear of the engine, the direction of flow depending upon the flight attitude of the engine. If the flow is rearwards it joins the timing gear cover drain oil. If the oil drains towards the front of the engine it is drawn by the rear scavenge pump, i.e. the centre pump of the pump unit, through the forward scavenge filter and a long pipe fitted to the starboard side of the engine. It is then returned to the aircraft tank through the common scavenge outlet union.

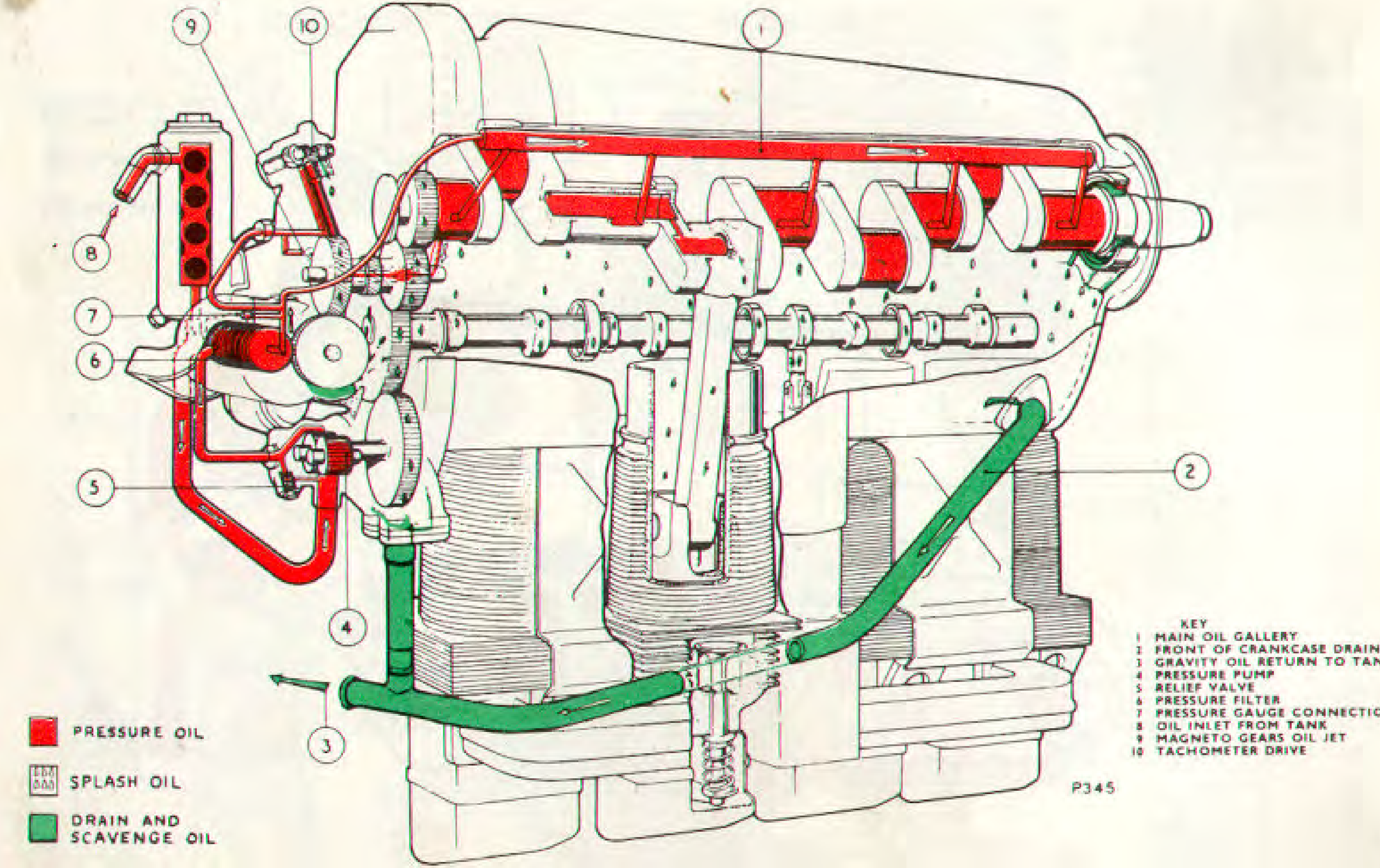


FIG. 6 LUBRICATION DIAGRAM GIPSY MAJOR Mk.I, IC and IF

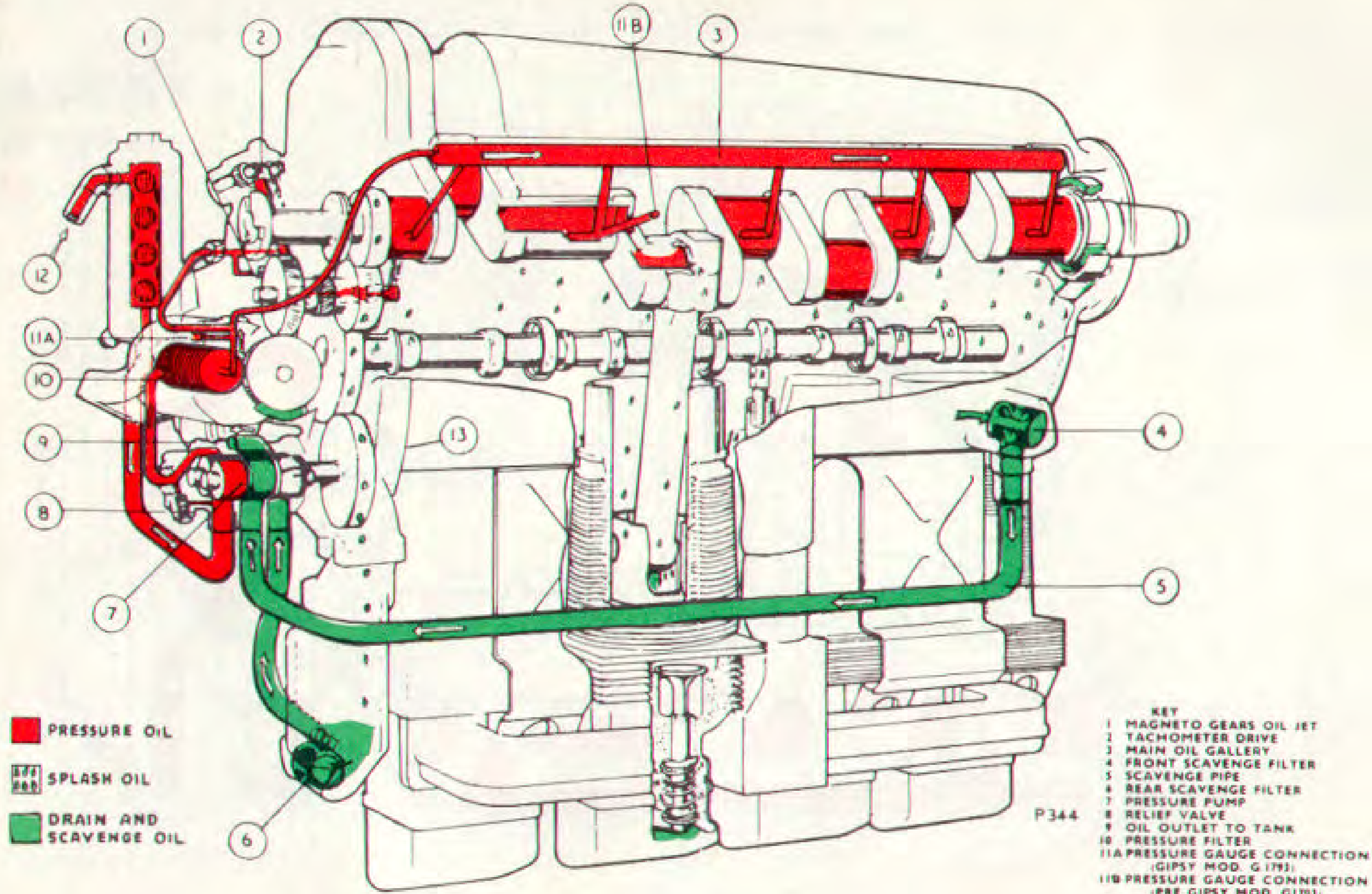


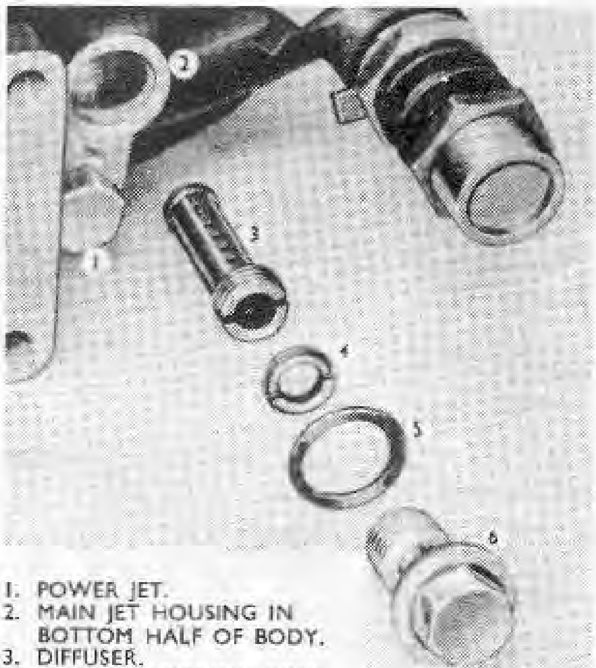
FIG. 7 LUBRICATION DIAGRAM, GIPSY MAJOR Mk 7

Oil pressure gauge connection

35. Normally a banjo pillar to take capillaries for one or two oil pressure gauges, according to the requirements of the installation, is fitted into the main oil duct on the outlet end of the pressure filter. On Mk. 7 engines prior to the embodiment of Gipsy modification G 1793 (Auster aircraft mod. 298), the oil pressure gauge connection is on the starboard side of the crankcase in line with No. 4 main bearing as indicated in fig. 4 of Chapter 5.

Breather

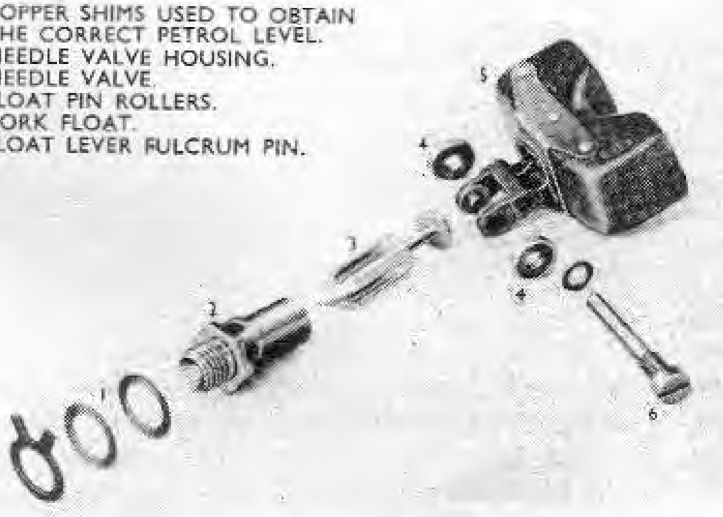
36. The crankcase is vented to atmosphere through an elbow on the timing gear cover immediately above the starter mounting face and a baffle is fitted within the engine to prevent the escape of liquid oil. Each rocker cover has an individual vent or overflow pipe.



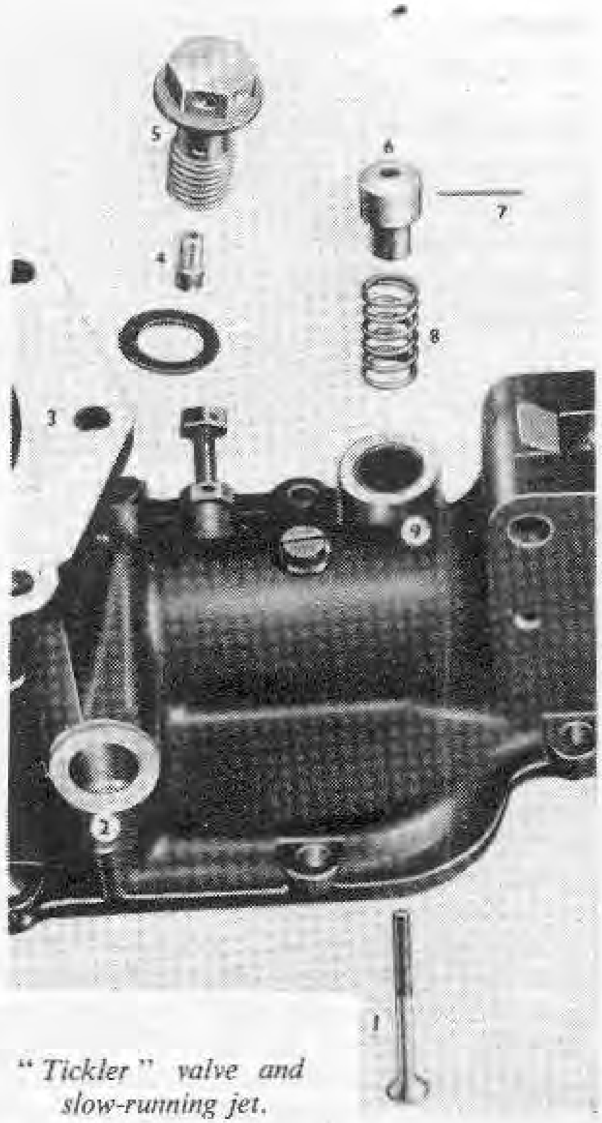
1. POWER JET.
2. MAIN JET HOUSING IN BOTTOM HALF OF BODY.
3. DIFFUSER.
4. DIFFUSER LOCKING RING.
5. FIBRE WASHER.
6. MAIN JET.

Main jet and diffuser.

1. COPPER SHIMS USED TO OBTAIN THE CORRECT PETROL LEVEL.
2. NEEDLE VALVE HOUSING.
3. NEEDLE VALVE.
4. FLOAT PIN ROLLERS.
5. CORK FLOAT.
6. FLOAT LEVER FULCRUM PIN.



Needle valve, housing and float assembly.



"Tickler" valve and slow-running jet.

1. "TICKLER" VALVE.
2. SLOW-RUNNING JET HOUSING.
3. FIBRE WASHER FOR JET PLUG.
4. SLOW-RUNNING JET.
5. SLOW-RUNNING JET PLUG.
6. "TICKLER" VALVE KNOB.
7. STEEL PEG SECURING THE KNOB TO THE "TICKLER" VALVE.
8. "TICKLER" VALVE SPRING.
9. "TICKLER" VALVE HOUSING.

Hobson A.I.48 carburettor details

Chapter 3

CARBURATION

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

GENERAL

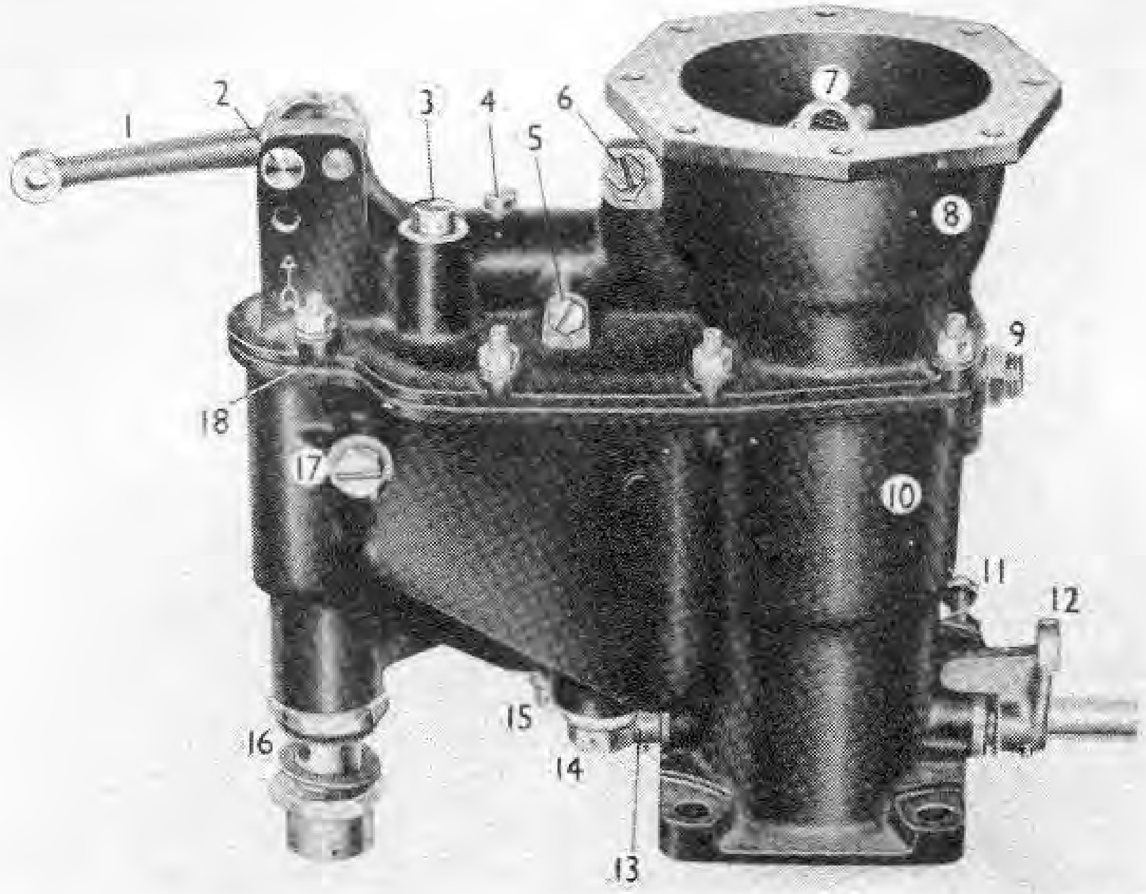
1. The carburation system of these engines consists of a Hobson A.I.48 down-draught carburettor (*fig.* 1) which is placed between a two-position, hot and cold, air-intake and an induction manifold. On certain installations fuel is supplied to the carburettor by gravity, whilst on other installations two fuel pumps are employed for this purpose. The Mk. 1 and 1F are fitted with a Hobson A.I.48H1M carburettor, and the Mk. 1C and 7 with an A.I.48 H3M. The A.I.48 H3M has a larger diameter choke than the A.I.48 H1M and is normally fitted with a larger main jet; the power jet also may be larger, but the exact jet sizes are dependent on the tuning of the individual engine. With these exceptions, both carburettors are identical.

2. The construction of the carburettor, which incorporates three jet-systems, ensures the maximum economy for all running conditions. The butterfly throttle valve forms part of the slow-running system giving an even distribution of mixture which, together with an overlap between the operation of the slow-running and main jets, prevents flat spots during the change-over period. A power jet supplements the main jet during full throttle operation, thus permitting the main jet to be calibrated for economical cruising and not as a compromise between cruising and full throttle conditions. A manual mixture control admits additional air for economical cruising and prevents over-richness under altitude conditions. On some installations this mixture control is permanently locked in the rich position.

JET SYSTEMS

3. Although the three jet-systems vary in mechanical detail each operates on the basic principle of a calibrated hole through which a metered quantity of fuel is passed. Each jet is housed in a duct, which is connected to a choke tube, and which may be described as constituting one limb of a simple U-tube, the other limb being formed by the float chamber or fuel reservoir.

4. When at rest, the pressure on both limbs of the U-tube is equal and the level of fuel in



1 MIXTURE (ALTITUDE) VALVE CONTROL LEVER
2 FULCRUM PIN FOR CONTROL LEVER
3 FLOODER VALVE KNOB
4 ALTITUDE VALVE SLEEVE LOCATING SCREW
5 MIXTURE ADJUSTING SCREW
6 SLOW-RUNNING MIXTURE ADJUSTING SCREW
7 PRESSURE BALANCE TUBE
8 TOP HALF OF CARBURETTOR HOUSING
9 CHOKE LOCATING SCREW AND LOCK-NUT
10 BOTTOM HALF OF CARBURETTOR HOUSING
11 SLOW-RUNNING THROTTLE STOP
12 THROTTLE VALVE CONTROL LEVER
13 POWER VALVE CAM PINNED TO THROTTLE VALVE SPINDLE
14 POWER JET
15 MAIN JET
16 FUEL SUPPLY UNION
17 FLOAT LEVER FULCRUM PIN
18 CARBURETTOR BODY JOINT WASHER

Fig. 1. Hobson A.I.48 carburettor

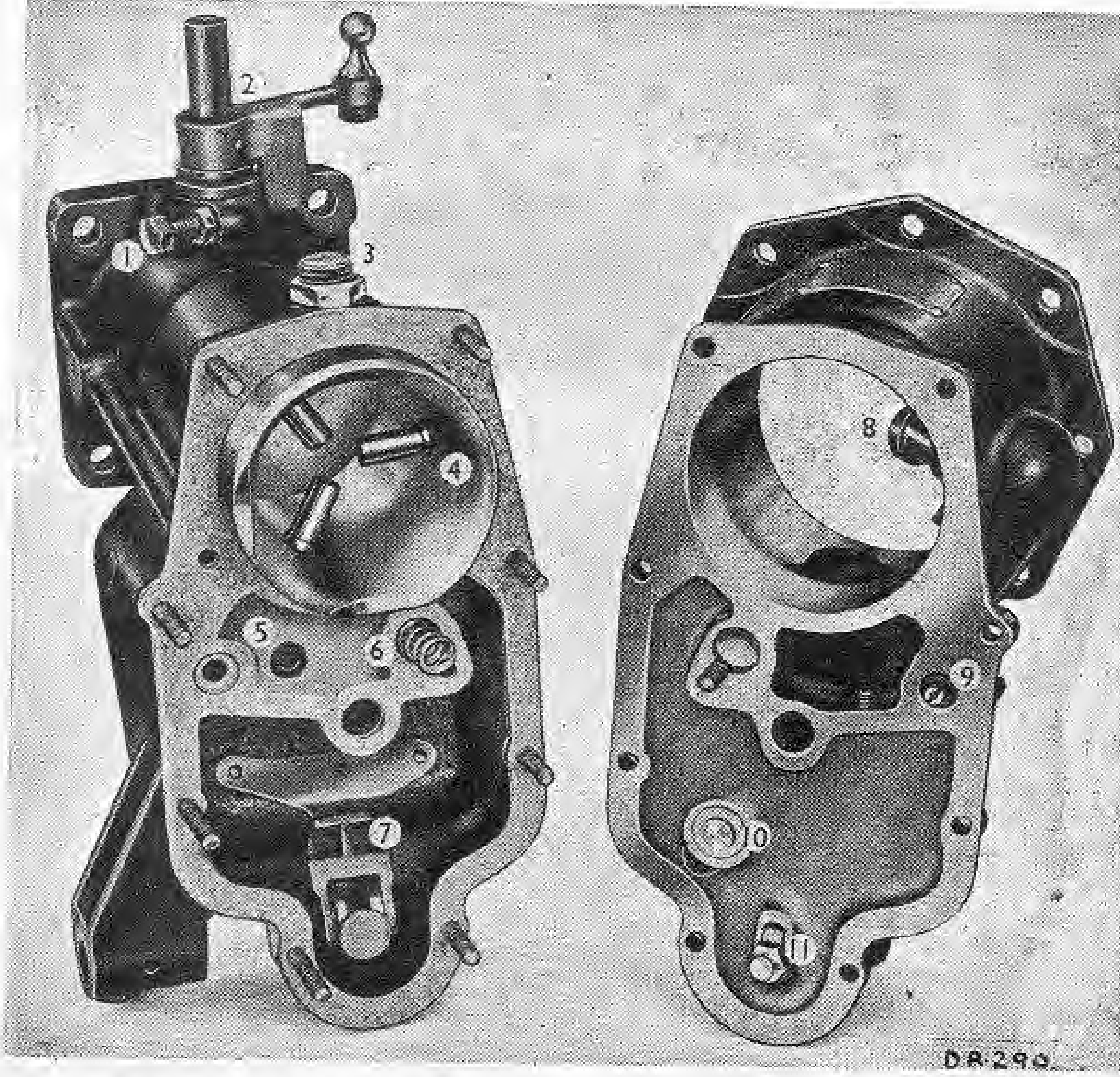
each is the same. When mixture is drawn from the choke tube into the induction manifold, the pressure at this end is decreased and the level of the fuel in the jet ducts rises sufficiently for the fuel to flow into the choke tube. An atomised spray into the choke tube is obtained by the introduction of air from a pressure balance chamber to the jet ducts at some point between the jet and delivery nozzle.

5. It will be observed in the following description, that the above principle applies to all three jets. In the case of the main jet a diffuser is fitted above the jet at the point where the air is introduced to the fuel. This breaks up the air stream and produces a more homogeneous mixture.

CONSTRUCTION OF CARBURETTOR

Carburettor body

6. The Hobson A.I.48 carburettor (*fig.* 2 *and* 3) has all its components enclosed in two light-alloy housings held together by eight studs and nuts. A circular aperture extending vertically through one end of both housings accommodates the choke tube. For ease of reference this end of the carburettor is termed the front and all other faces named accordingly. Each of the choke tube housings is machined with a flange, the upper or circular one being used for the air-intake attachment and the lower or square one for mounting the carburettor on the induction manifold. Into the lower end of the choke housing and below the choke tube itself is



1 SLOW-RUNNING THROTTLE STOP AND LOCK-NUT
2 THROTTLE SPINDLE AND CONTROL LEVER
3 CHOKE LOCATING SCREW AND LOCK-NUT
4 CHOKE
5 DIFFUSER AIR NIPPLE
6 POWER JET VALVE SPRING
7 FLOAT MECHANISM
8 PRESSURE BALANCE TUBE
9 SLOW-RUNNING JET
10 FLOODER VALVE
11 NEEDLE VALVE STOP

Fig. 2. Carburettor housings

fitted a butterfly throttle valve operated by a lever on the front of the carburettor.

Float Chamber

7. The float chamber is formed inside the rear of the lower carburettor housing, fuel being supplied through a banjo union secured to the base of the chamber, while the flow of petrol is controlled by a needle valve operated by a normal cork float. As the petrol level rises in the float chamber the float depresses the needle valve through a pivoted lever attached to the float until the petrol reaches a predetermined level when the inlet is sealed by the needle valve. The fuel level may be adjusted by the removal of one or more of the copper needle-seat shims to raise the level or the addition of shims to lower the level. One shim will vary the fuel level by approximately 1·5 mm., and there is no limit to the number of shims which may be fitted, provided that adequate locking of the needle seat lockwasher can be made. The correct level should be within 19–21 mm below the top face of the float chamber.

8. Fuel may be admitted to the float chamber above the desired level by pressing a spring-loaded button situated on the top of the carburettor. The button depresses the float to allow more fuel to enter and is used to flood the carburettor before starting the engine.

Pressure balance chamber

9. The pressure balance chamber is an air-space formed in the upper carburettor housing around the port and rear sides of the choke housing. It is from this chamber that air is fed to the fuel ducts. Air-intake pressure is maintained inside the chamber by means of a wide tube, the mouth of which faces upstream inside the choke housing. A small passage drilled between the pressure balance chamber and the float chamber, enables air-intake pressure to be maintained above the fuel level in the float chamber.

Main jet and diffuser

10. The jet ducts are all located in the carburettor castings between the float chamber and the choke tube. The main jet duct is drilled centrally through the lower housing, communication with the float chamber being provided by a small horizontal extension of the latter below the duct. The main jet, which is inserted from the underside of the carburettor and threaded directly into the main jet duct, is situated across the float chamber extension. An accurately calibrated hole, drilled at an angle in the base of the main jet, bridges the float chamber extension and admits a metered quantity of fuel to the main jet duct.

11. A perforated diffuser tube is screwed into the main jet duct over the main jet so as to cover the entrance of the air passage. The diffuser is constructed to allow a space to exist between the walls of the duct and the outside of the diffuser. Air is admitted to this space from the pressure balance chamber by an "L" shaped passage.

Mixture control

12. A mixture adjustment and altitude (mixture) control provide two other means of introducing air to the main jet fuel, each being fitted with a valve to regulate the flow of additional air and so control the mixture strength. In each instance air is admitted from the pressure balance chamber to a short upward extension of the main jet duct in the upper housing.

13. The mixture adjustment consists of a small bore passage with its valve taking the form of a pointed screw, which is screwed in or out to regulate the flow of air. This screw is used to adjust the mixture whilst the engine is on its test run, the adjustment is then locked and sealed and should not be altered except on a test bed.

14. The altitude mixture control consists of a hollow cylinder situated horizontally at the top of the upper carburettor housing, the inside of the cylinder being connected both to the pressure balance chamber through a concentric port at the front end to the upper end of the main jet duct through a port in the lower side of the cylinder. A small plunger-type valve, which slides in the cylinder, cuts off or regulates the flow of air to the main jet. The plunger is operated by a lever connected to the aircraft control. As mentioned in para. 2, on some installations this control is locked in the rich position.

Choke tube

15. After the petrol and air emulsion has been formed, it is drawn from the main jet duct via a horizontal passage into an annular cavity around the outside of the choke tube and thence into the inside of the choke tube through three delivery nozzles spaced at 120 deg. apart.

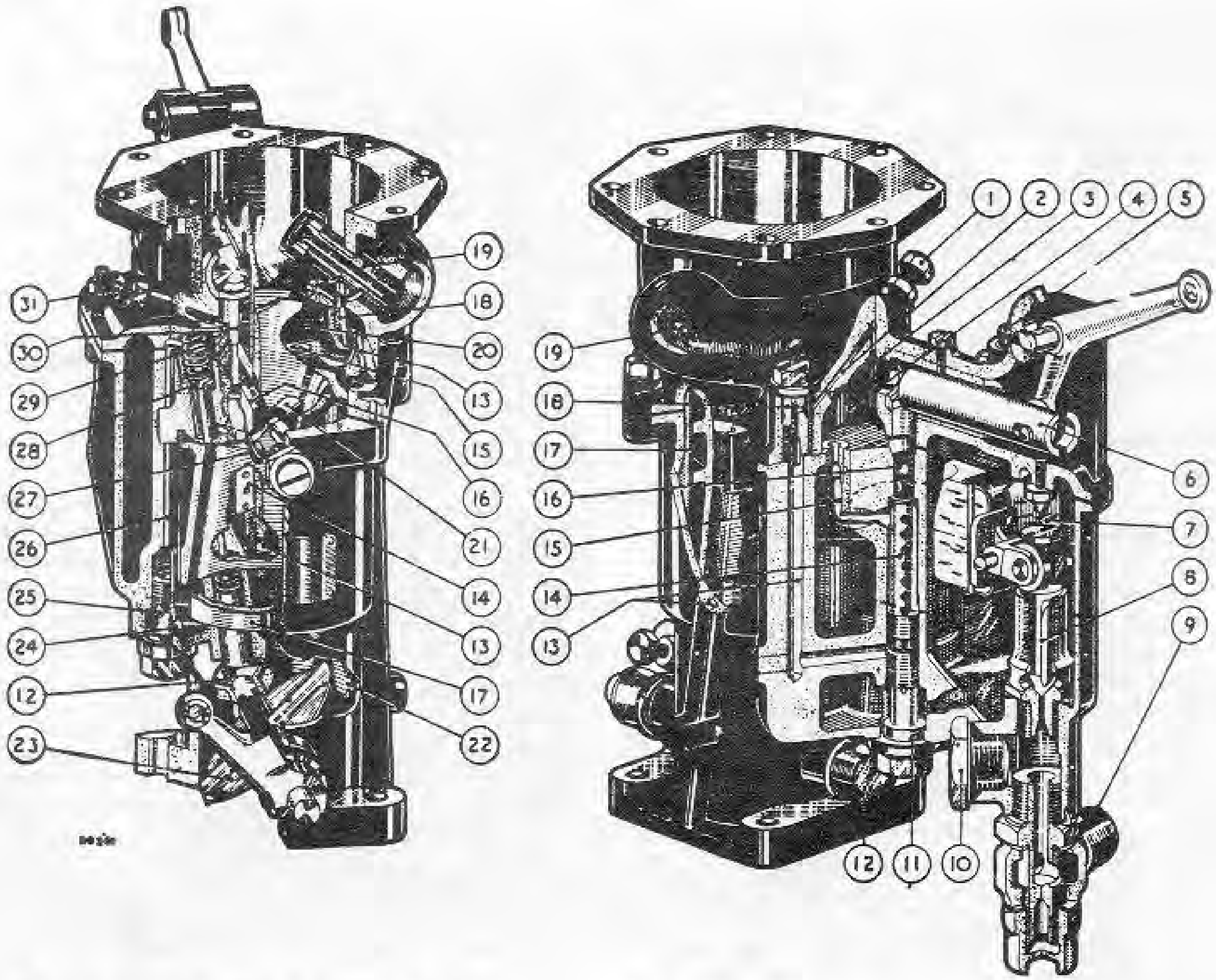
Slow-running jet

16. The slow-running jet is housed in a short drilled duct in the upper carburettor housing and fuel is supplied from the main jet duct, just below the diffuser, through drillings in the lower housing. Two further drillings connect with the slow-running jet, one to introduce air from the pressure balance chamber and the other to conduct the mixture away from the jet. The former drilling is provided with a slow-running adjusting screw similar to the mixture control screw already described, but in this case an additional anti-syphon hole connects the air passage to the pressure balance chamber. The other drilling connects with a further passage down the port side of the choke housing to form a continuous duct through which the mixture flows.

17. The lower end of this passage is intersected by two horizontal delivery orifices, one of which is positioned to deliver the mixture at the point where the edge of the butterfly valve contacts the wall of the choke housing when the valve is closed. The slow-running passage is continued in a transverse passage in the butterfly valve itself and this is intersected at a point approximately one-third across the diameter of the valve by an additional delivery hole.

Power jet

18. The power jet is screwed into the starboard underside of the carburettor



1 SLOW-RUNNING MIXTURE ADJUSTING SCREW
2 AIR PASSAGE TO SLOW-RUNNING SYSTEM
3 ANTI-SYPHON HOLE
4 PRESSURE BALANCE AIR CHAMBER
5 FLOODER VALVE KNOB
6 MIXTURE (ALTITUDE) CONTROL VALVE
7 CORK FLOAT
8 NEEDLE VALVE
9 FUEL SUPPLY UNION
10 ALTERNATIVE FUEL SUPPLY UNION
11 MAIN JET
12 POWER VALVE OPERATING CAM
13 SLOW-RUNNING SYSTEM PASSAGES
14 DIFFUSER
15 AIR PASSAGES TO DIFFUSER
16 MAIN JET DUCT
17 CHOKE TUBE
18 SLOW-RUNNING JET
19 PRESSURE BALANCE AIR INLET
20 FLOAT CHAMBER PRESSURE BALANCE HOLE
21 MAIN JET DELIVERY NOZZLES
22 SLOW-RUNNING DELIVERY ORIFICES
23 BUTTERFLY THROTTLE VALVE
24 FUEL INLET TO POWER JET
25 POWER JET
26 POWER JET SYSTEM PASSAGES
27 POWER JET DELIVERY NOZZLE
28 POWER JET VALVE
29 AIR PASSAGE TO POWER JET SYSTEM
30 AIR PASSAGE TO MAIN JET DUCT
31 MIXTURE ADJUSTING SCREW

Fig. 3. Section views of carburettor

slightly in front of the main jet. Fuel is admitted by a short horizontal passage from the float chamber and, after passing through the jet, flows up a vertical passage to the top of the lower carburettor housing.

19. The power jet is brought into operation at the appropriate degree of throttle opening by the operation of a small mushroom valve, operated by a cam on the end of the throttle spindle. The motion of the cam is transmitted to the valve by a tappet which slides in a steel liner in the lower housing and is held against the face of the cam by a spring. A guide for the valve stem is drilled from the top of the tappet housing at such an angle that it emerges at the top of the lower carburettor housing adjacent to the top of the power-jet fuel passage. The upper end of the valve stem guide opens up to accommodate a valve seat and a valve spring, and to allow for the passage of fuel. The lower end of the valve spring bears on the head of the valve, the other end being located in a shallow hole in the carburettor upper housing. This hole is connected to the power-jet passage by a milled slot across the mating face of the upper housing and to the pressure balance chamber by a small drilling.

20. The fuel therefore flows up the vertical jet passage and through the milled slot into the chamber formed above the valve head where it is emulsified by the air from the pressure balance chamber. The mixture then flows downwards past the valve seat and finally emerges into the choke tube via a horizontal passage and a power-jet delivery nozzle which is situated below the level of the three main jet nozzles.

OPERATION OF THE CARBURETTOR

21. The operation of the carburettor which follows is best understood when read in conjunction with the series of illustrations shown in fig. 4. As previously mentioned the engine draws mixture through three separate systems, the operation of which is dependent upon the degree of opening of the throttle valve.

Slow-running

22. When the throttle valve is almost closed, the depression inside the choke tube is negligible and insufficient to operate the main jet, but the depression around the edges of the throttle valve is considerable. Consequently the fuel rises in the slow-running jet passages and mixture emerges from the lower of the slow-running delivery orifices, additional air being supplied through the upper orifice. A proportion of the mixture passes through the transverse passage in the throttle valve and issues between the throttle valve and the opposite wall of the choke housing and also through the small delivery hole which intersects the transverse passage. In this manner the mixture is evenly distributed over the whole cross-section of the choke housing.

Small throttle openings

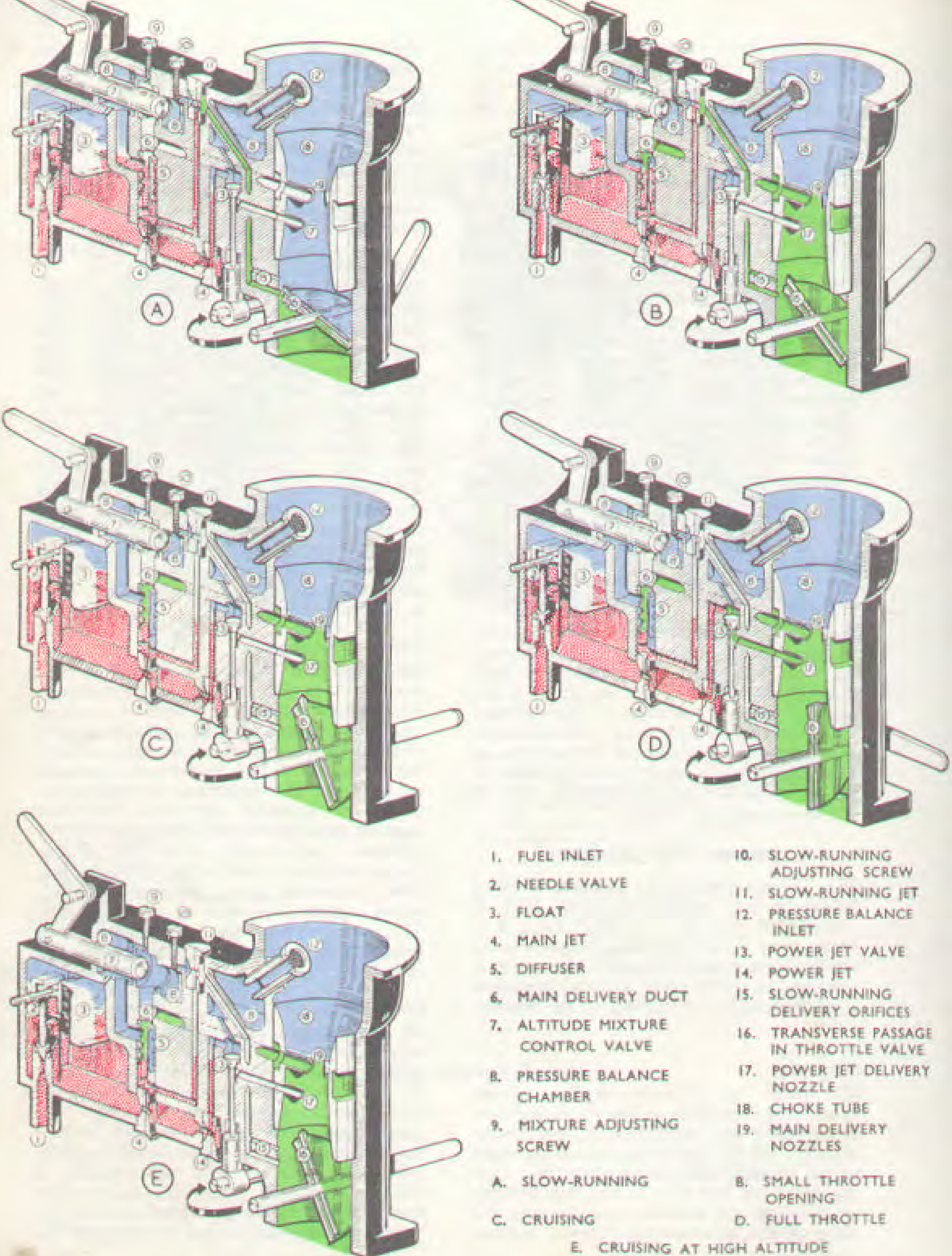
23. When the throttle is opened slightly, the upper of the two slow-running orifices comes under the influence of the depression and the mixture is drawn through both orifices. As the throttle is moved away from the closed position the depression in the choke tube increases sufficiently to cause a small quantity of mixture to flow from the main jet delivery nozzles. The slow-running jet is still in operation, however, and the mixture gains access to the throttle valve transverse passage through the upper slow-running delivery orifice. With this arrangement an overlapping of the operation of the slow-running and main jets occurs which prevents 'flat spots' during the change-over in conditions.

Cruising at low altitude

24. When the throttle is opened further, the slow-running system cuts out completely. Progressive increase in throttle opening produces a corresponding decrease in the choke tube pressure, which in turn, causes a rise in the rate of fuel flow through the main jet. As the flow increases, more air is required to maintain the same fuel-to-air mixture ratio and this is achieved by the diffuser. The increase in the rate of flow causes the level of fuel in the diffuser to fall, thus uncovering more perforations which admit a greater quantity of air to the fuel. The same mixture ratio is therefore maintained at all degrees of throttle opening and fuel flow.

Full throttle

25. As the main jet is calibrated to operate economically under cruising conditions only, it is necessary to enrich the mixture in order to assist cylinder cooling and suppress detonation at full throttle operation. At approximately 33 deg. before full throttle opening, the cam on the throttle valve spindle raises the power jet valve and a supply of mixture from the power jet supplements that delivered by the main jet to produce the conditions necessary for full power operation.



1. FUEL INLET
2. NEEDLE VALVE
3. FLOAT
4. MAIN JET
5. DIFFUSER
6. MAIN DELIVERY DUCT
7. ALTITUDE MIXTURE CONTROL VALVE
8. PRESSURE BALANCE CHAMBER
9. MIXTURE ADJUSTING SCREW
10. SLOW-RUNNING ADJUSTING SCREW
11. SLOW-RUNNING JET
12. PRESSURE BALANCE INLET
13. POWER JET VALVE
14. POWER JET
15. SLOW-RUNNING DELIVERY ORIFICES
16. TRANSVERSE PASSAGE IN THROTTLE VALVE
17. POWER JET DELIVERY NOZZLE
18. CHOKE TUBE
19. MAIN DELIVERY NOZZLES

A. SLOW-RUNNING
B. SMALL THROTTLE OPENING
C. CRUISING
D. FULL THROTTLE
E. CRUISING AT HIGH ALTITUDE

Fig. 4. Carburettor Flow Diagrams

AIR — FUEL — MIXTURE

Cruising at high altitude

26. When cruising at high altitude the diffuser operates in conjunction with the throttle in the same manner as at low altitude described in para. 24. The lower air densities at higher altitudes however, prevent a sufficient weight of air being drawn into the engine to maintain the required fuel-air ratio and would result in an enrichment of the mixture. Additional air to maintain the correct proportions is obtained by opening the altitude (mixture) control valve which, therefore, also provides economical operation.

27. When alterations of altitude occur, the altitude mixture control valve should be adjusted to admit more or less air as required. The procedure employed to obtain the correct mixture with this valve is explained in Chapter 7, on page 73. This is the only adjustment that the pilot has to make, the automatic properties of the main jet, diffuser and power jet being retained at all throttle settings irrespective of the degree of opening of the altitude mixture control.

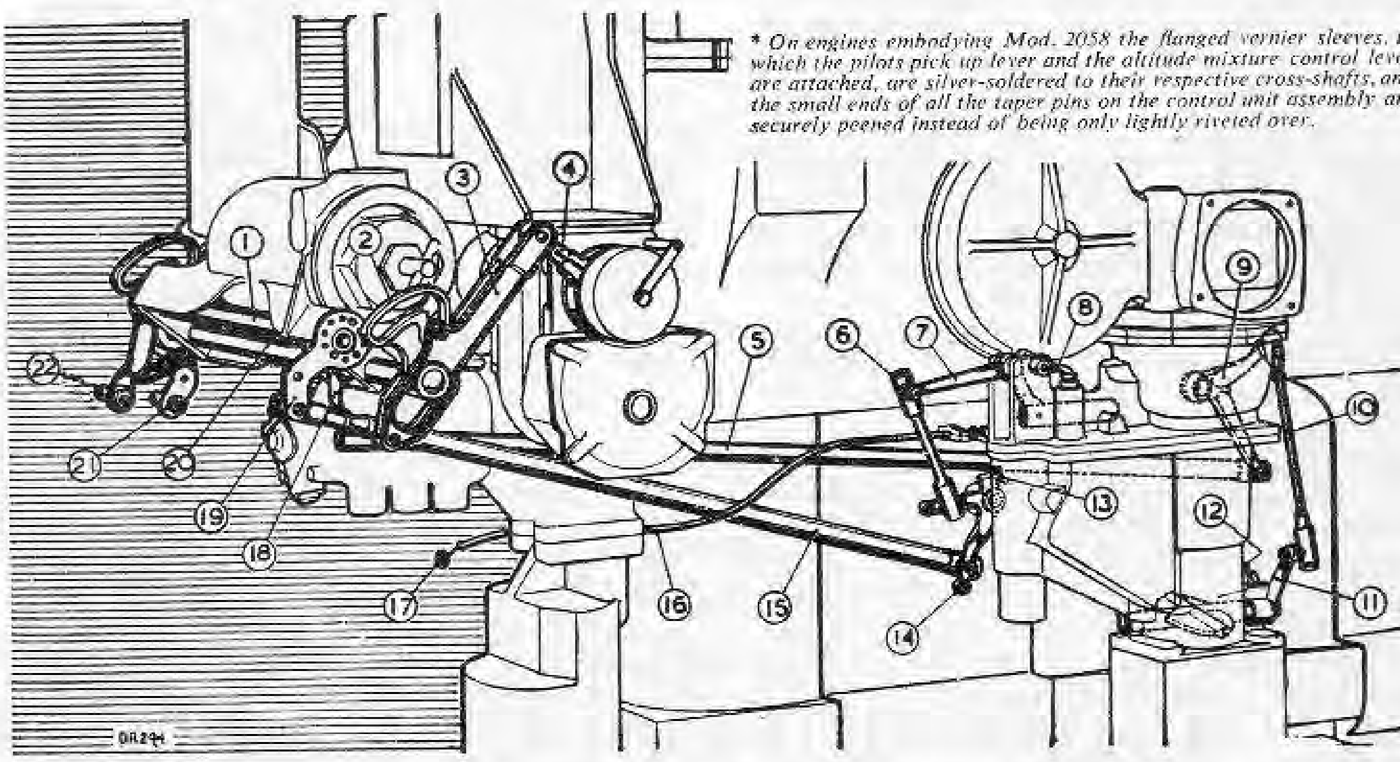
CONTROLS *

28. The carburettor controls illustrated in fig. 5, are connected by bell-cranks and links to two cross-shafts carried in plain bearings in the main bracket which is cast integrally with the pressure filter casing. These cross-shafts are connected to the pilot's throttle and altitude mixture control levers.

29. The combined throttle and ignition controls are picked up from the lower of the two cross-shafts. The pilot's control pick-up lever is bolted to a flanged sleeve at the port end of the shaft. The lever has ten bolt holes and the flanged sleeve eight so that a vernier adjustment of the lever is possible.

30. At the starboard end of the cross-shaft, immediately inside the main bracket, is pinned the throttle operating lever which is

** On engines embodying Mod. 2058 the flanged vernier sleeves, to which the pilots pick up lever and the altitude mixture control lever are attached, are silver-soldered to their respective cross-shafts, and the small ends of all the taper pins on the control unit assembly are securely peened instead of being only lightly riveted over.*



1 MIXTURE (ALTITUDE) CONTROL CROSS-SHAFT
2 IGNITION CONTROL QUADRANT
3 MAGNETO ADVANCE AND RETARD LINK
4 MAGNETO ADVANCE AND RETARD ARM
5 THROTTLE OPERATING TUBE
6 MIXTURE CONTROL OPERATING ROD
7 MIXTURE CONTROL LEVER
8 FLOODER DEPRESSING LEVER
9 THROTTLE OPERATING BELL CRANK
10 THROTTLE OPERATING ROD
11 THROTTLE LEVER
12 THROTTLE SLOW-RUNNING STOP SCREW
13 MIXTURE CONTROL MAXIMUM STOP SCREW
14 MIXTURE CONTROL BELL-CRANK
15 MIXTURE CONTROL OPERATING TUBE
16 FLOODER CONTROL CABLE GUIDE
17 FLOODER CONTROL OPERATING SHACKLE
18 THROTTLE OPERATING LEVER ON CROSS-SHAFT
19 MIXTURE CONTROL OPERATING LEVER ON CROSS-SHAFT
20 THROTTLE CONTROL CROSS-SHAFT
21 PILOT'S THROTTLE PICK-UP LEVER
22 PILOT'S MIXTURE (ALTITUDE) CONTROL PICK-UP LEVER

Fig. 5. Carburettor controls

connected to the lever on the throttle valve by a long horizontal tube, a bell-crank and a vertical rod. The bell-crank is attached to a pivot on the port, or inboard side, of the carburettor choke housing, and the ends of the tube and rod are attached to their respective levers by ball-joints. Movement of the throttle in each direction is limited by a projection on the throttle lever which butts against two stops cast integrally with the carburettor body. The slow-running position of the throttle valve may be varied by an adjusting screw.

31. The ignition controls are inter-linked with the throttle in such a manner that at slow-running the magnetos are fully retarded (*fig*. 6). As the throttle commences to open, the magneto timing is rapidly advanced so that at approximately one-third throttle opening it is fully advanced and remains so right through the higher throttle settings. This arrangement is achieved by a slotted-cam quadrant (*fig*. 5 *and* 6) fitted to each end of the throttle operating cross-shaft. Each quadrant operates a pressed steel link assembly fitted with a roller which rides in the slotted cam. The upper end of each link is attached to its respective magneto advance and retard arm. Movement to the link to produce the desired ignition timing is controlled by the contour of the slotted cam in the quadrant.

32. The altitude mixture control is operated from the upper of the two cross-shafts in the main bracket. The pilot's pick-up lever is attached to the port end of the cross-shaft and the mixture-control operating lever on the starboard end. The latter lever is bolted to a flanged bush in the same manner as the pilot's throttle pick-up lever so that there is an eight-to-ten vernier adjustment. The movement is transmitted to the altitude control valve in a manner similar to that of the throttle valve. All connections between the various levers and links are made with ball-joints.

33. Both arms of the bell-crank and the arm of the mixture-control operating lever have two pick-up holes for the ball-joints, but in the former case the inner holes are used and in the latter the outer hole. The other holes are used when the levers are fitted to other types of Gipsy engines.

34. Movement of the altitude control valve is limited in the closed position by the plunger butting against its valve seat, and in the open position by an adjusting screw threaded into a projection on the bell-crank lever.

35. As mentioned in para. 8, fuel may be admitted to the float chamber above the normal level by pressing the spring-loaded button situated on the top of the carburettor and on gravity feed installation this is the only means provided for flooding the carburettor. Where engine-driven fuel pumps are employed (Magister 1 and Auster T7 aircraft), the carburettor flooder is operated by a small lever pivoted on the top of the carburettor immediately in front of the altitude-mixture control lever pivot. On the port end of the flooder lever pivot is a further spring-loaded lever to which is attached one end of a long pull-wire. The pull-wire is enclosed in a tubular guide which is clipped along the starboard side and rear of the engine. The other end of the pull-wire terminates in a small finger ring. This enables the carburettor to be flooded at the same time as the hand priming levers on the fuel pumps are operated.

AIR INTAKE

36. The air-intake is secured to the upper, circular flange of the carburettor choke housing, a fibre gasket being employed to make an air-tight joint. The upper end of the air-intake is supported in a "Silentbloc" rubber mounting which is secured to a bracket bolted beneath the top cover mounting flange and is the upper support for the whole induction system. The air-intake is of a two-way construction so arranged that cold air

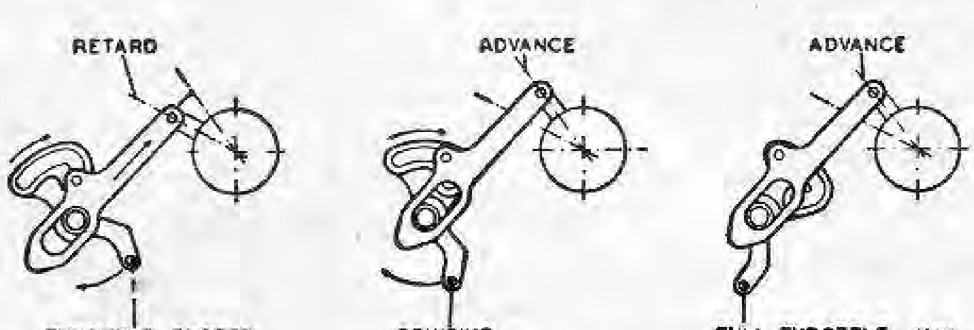


Fig. 6. Throttle and ignition timing relationship

can be drawn from the outside of the engine nacelle or hot air from the vicinity of the crankcase. The source of the air is determined by the position of a flap valve inside the air-intake. On the majority of the engines covered by this handbook, this flap valve is interconnected with the throttle control so that at full throttle cold air is admitted but at the cruising position warm air from the engine bay is admitted through a flame trap. On Gipsy Major 7 engines in which Gipsy Modification G.1483 has been embodied, a separate manual air-intake control is provided in the cockpit.

37. The cold-air inlet, which is circular in shape, faces outwards to starboard and is fitted with a square flange drilled and tapped for four bolts by which the external pipe is attached. A mating flange, suitable for welding to the external pipe, is supplied with the engine, together with a fibre gasket to ensure an air-tight joint.

38. The hot-air inlet faces inwards towards the engine so as to utilise the hot air rising up the crankcase wall from between the inter-cylinder baffles. A flame trap is fitted into the hot-air inlet to eliminate the risk of fire in the event of a back-fire. The flame trap is composed of two continuous strips of steel, one plain and other finely corrugated, that are tightly wound adjacent to one another around a central post, the whole assembly being enclosed in a large flanged ring. The ring is clamped by its flange and by studs and nuts into the mouth of the hot-air inlet. When assembled the steel strips form a honeycomb of very small but comparatively long, passages through the flame trap so that if any burning gases are forced out of the air-inlet, as during a back-fire, they are cooled below their temperature of ignition by the steel walls of the passages. Consequently, when the gases emerge from the flame trap, they are no longer burning and are therefore harmless. The flame trap does not offer any obstruction to the passage of air during normal operation as its diameter is so arranged that the total area of free space for the admission of air is approximately the same as that of the unrestricted cold-air inlet. There is however, a reduction in the power obtainable from the engine due to the use of 'hot air'.

INDUCTION MANIFOLD

39. The induction manifold consists of a main duct which carries the mixture down from the carburettor into a four-branch manifold. At the top of the main duct is a square flange on to which the carburettor is secured by four bolts. Each of the four branches of the induction manifold also has a square flange which mate with the inlet port of the engine. Around the main duct is arranged a square, sheet-steel muff into which exhaust gases are fed to heat the mixture as it passes into the manifold. A drain is provided to allow the escape of any moisture condensation from the muff.

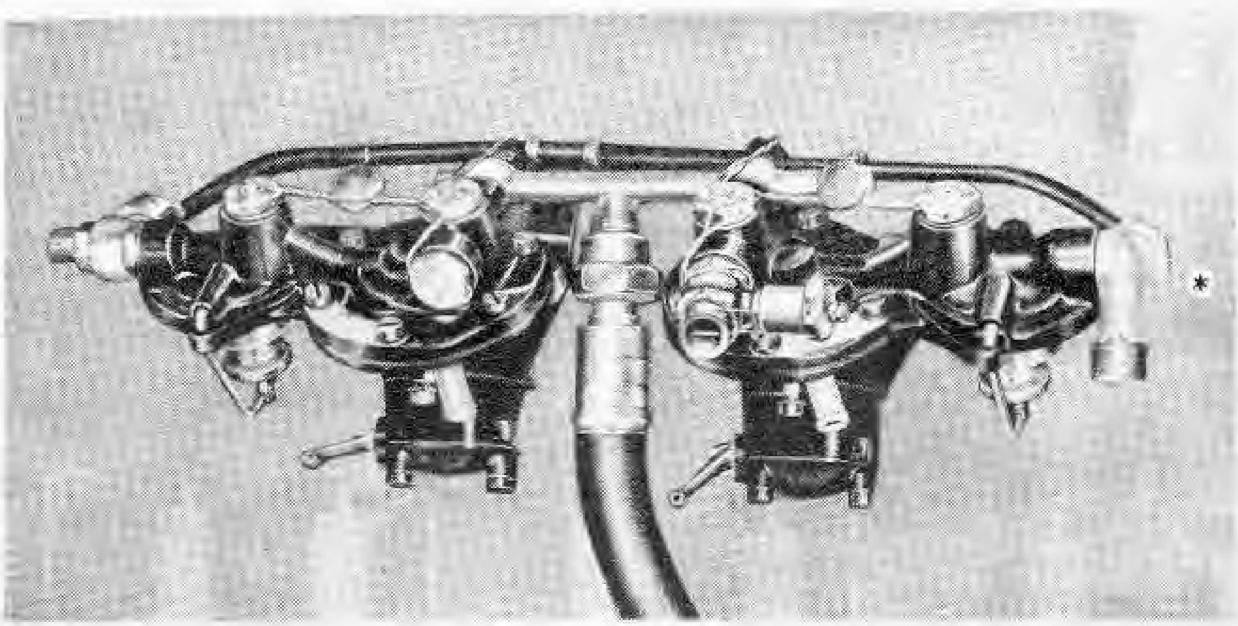


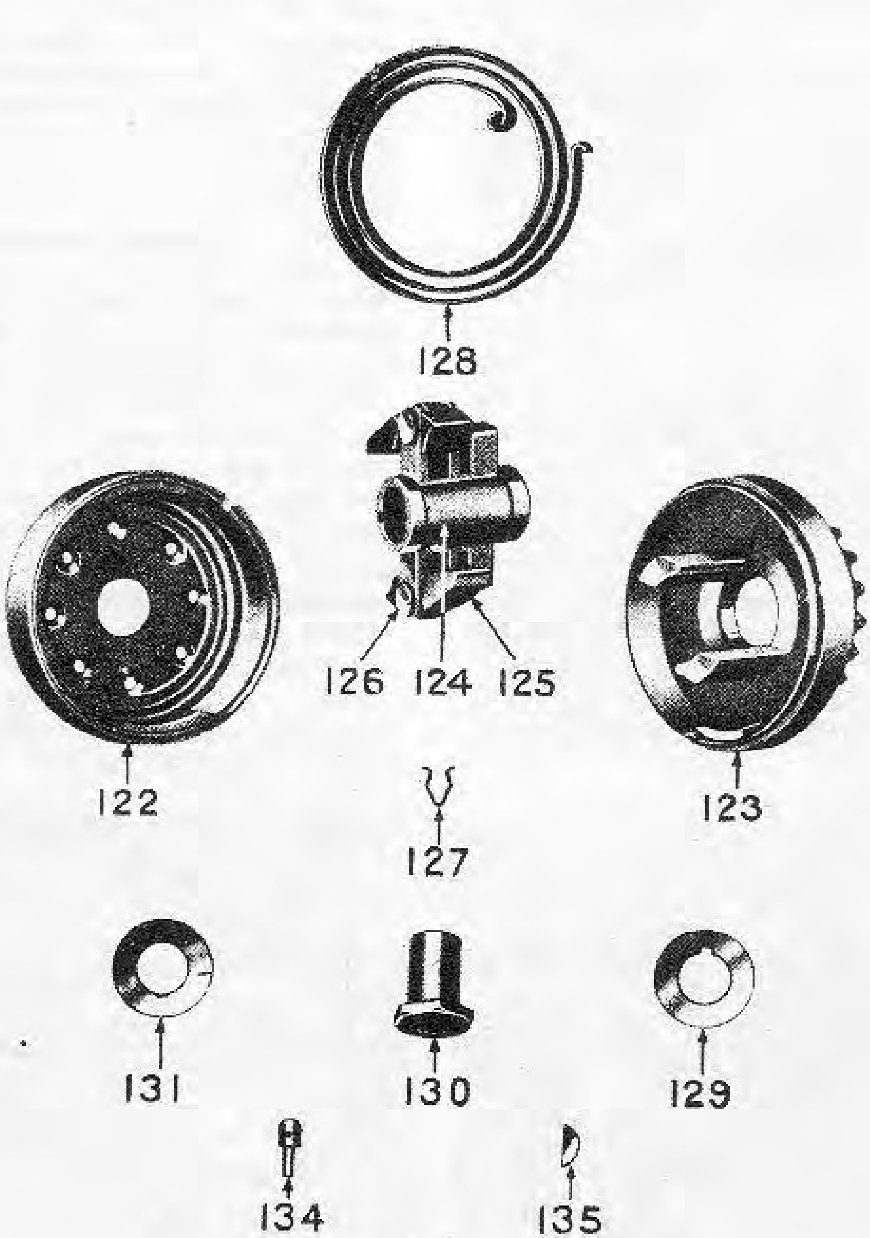
Fig. 7. Fuel pumps (Gipsy Mk. I variants in Magister aircraft and Mk. 7 pre-mod. 1925)

To facilitate the removal of the rear fuel pump filter bowl, Mod. 1925 introduces a double banjo union to replace the two-way branch piece marked in fig. 7.*

40. Beneath the rear end of the manifold is a union to which a pipe is connected to drain any fuel collecting in the manifold as may occur through excessive flooding or priming.

FUEL PUMPS

41. When Mk. 1 variants are installed in Magister 1 aircraft and Mk. 7 in the Auster T7 aircraft, two D.H.A.C. fuel pumps (*fig.* 7) which are described fully in Chapter 17 supply the fuel to the carburettor. They are diaphragm type pumps in which are incorporated the engine fuel filters. Each pump is operated by a lever which rides on an eccentric on the camshaft. An additional hand-operated lever is also provided to prime the engine fuel system before starting. The inlets of the pumps are coupled together by a short copper pipe and their outlets by a T-shaped pipe, the stem of the T being connected to the carburettor inlet by a flexible fire-proof pipe.



The B.T.H. Type Z1-1 Impulse Starter

122 COVER
123 BODY
124 HUB
125 PAWL
126 FULCRUM PIN
127 FULCRUM PIN CIRCLIP
128 SPRING
129 DISTANCE WASHER
130 SECURING NUT
131 TABWASHER
134 LOCKING PIN
135 KEY