Chapter 4

IGNITION

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LIST OF ILLUSTRATIONS

General

1. Ignition is provided by a dual system consisting of two independent ignition groups. Each group consists of a magneto with an integral distributor (one magneto being fitted with an impulse starter), an ignition harness and four sparking plugs. On Gipsy Major Mk. 1 variants the ignition system is not screened, but on the Gipsy Major Mk. 7 it is completely screened to obviate radio interference.

Magnetos

2. The magnetos on Gipsy Major Mk. 1 variants are two B.T.H. type AG4–6; a few early engines were fitted with type AG4–4 which are identical with type AG4–6 except for the distributor group Part No. CX54726 which replaces Part No. CX52849. These magnetos are not screened.

3. The magnetos on the Gipsy Major Mk. 7 are two B.T.H. type AG4–8, which are the same as type AG4–6 but fitted with cast aluminium screens suitable for screened harness attachment and have fully screened contact breaker covers. On later Mk. 7 engines B.T.H. type AG4–10 magnetos are used. They are identical with the type AG4–8 with the exception of the distributor screen which has been modified to obviate interference with the engine mounting structure of the aircraft. The timing lever on the type AG4–8 and AG4–10 is of thinner section material than that of the type AG4–6 to give the required clearance to the distributor screen, and the distributor moulding has a slightly longer spigot to facilitate locating the screen. Mod. No. 2010, which is applicable to all the above types of magneto, introduces a spring contact for short circuiting the magneto primary circuit when the contact breaker cover is removed. Magnetos with this modification embodied have the suffix /1 added to their type number.

4. The magnetos, which are of the rotating armature type, produce two sparks per revolution and are therefore driven at crankshaft speed, the starboard magneto clockwise and the port one anti-clockwise, when viewed from their driving ends. They are base mounted in an inverted attitude beneath two cantilever arms integral with the rear

cover and are driven through a right-angle spiral gear train. With this arrangement, the rear of the magnetos face outwards, which places the contact breakers and distributors in an easily accessible position for servicing.

5. A Simms flexible vernier coupling is used as the driving medium between each magneto and the driving gear. The driven and driving members of the coupling each consist of a metal flange, on the face of which are a number of serrations. Between the two halves is a flexible rubber coupling which has corresponding serrations on each face. This coupling relieves the magneto spindle of any stresses which might arise as a result of slight axial malalignment, and, as the driven half of the coupling has twenty serrations and the driving half only nineteen, a vernier adjustment of $\frac{1}{19}$ deg. of crankshaft rotation can be obtained for the purpose of ignition timing.

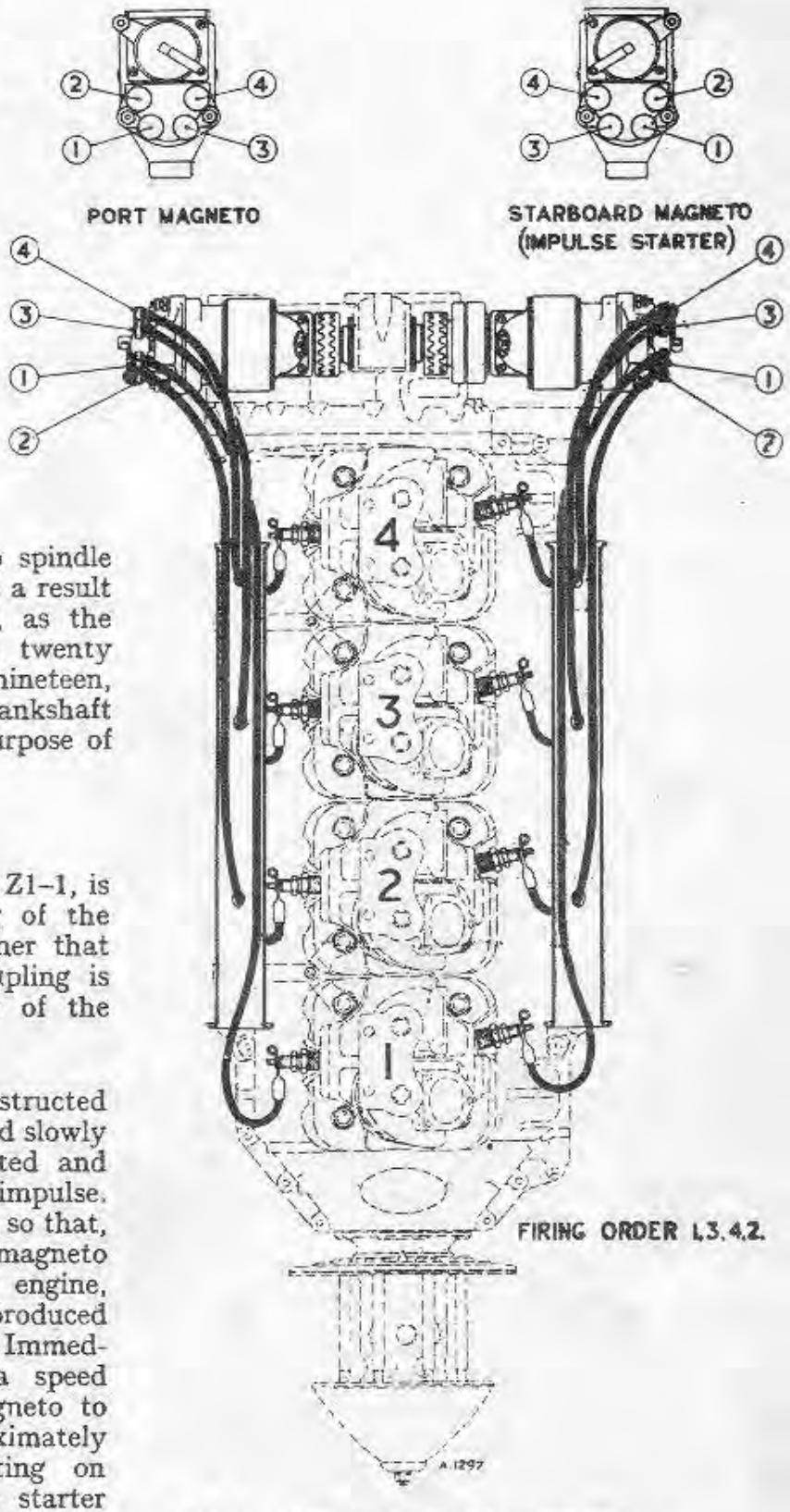


Fig. 1. Diagram of high tension leads (unscreened ignition)

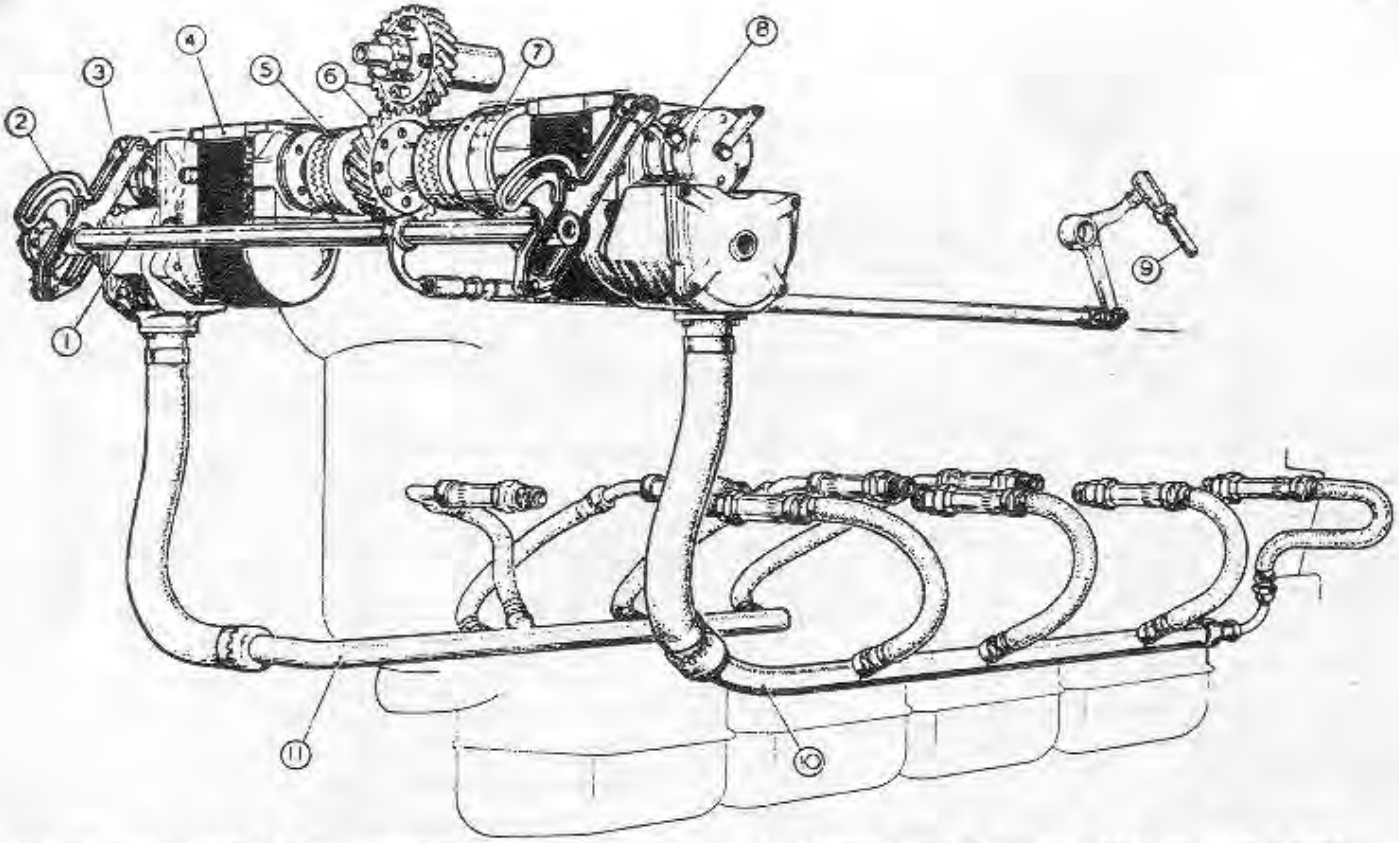
Impulse starter

6. An impulse starter B.T.H. type Z1–1, is fitted behind the vernier coupling of the starboard magneto in such a manner that the driven half of the Simms coupling is integral with the driving member of the impulse starter.

7. The impulse starter is so constructed that, when the engine is being rotated slowly for starting, the magneto is arrested and then gives a momentarily forward impulse. This occurs twice in every revolution so that, momentarily at each impulse, the magneto speed greatly exceeds that of the engine, causing a powerful spark to be produced regardless of the speed of the engine. Immediately the engine has attained a speed sufficiently high to enable the magneto to generate normally, that is at approximately 160 r.p.m., centrifugal force acting on weighted pawls frees the impulse starter which then functions as a spring coupling between the engine and magneto.

Variable timing control

8. The advance and retard control lever of each magneto, which is clamped to its respective magneto cam ring, is limited in movement to 25 degrees. These two timing



1 CONTROL CROSS-SHAFT CONNECTED TO PILOT'S THROTTLE LEVER AND TO CARBURETTOR THROTTLE VALVE
2 PORT IGNITION CONTROL QUADRANT ON THE CROSS SHAFT
3 LINK BETWEEN IGNITION QUADRANT AND PORT MAGNETO ADVANCE AND RETARD LEVER
4 PORT MAGNETO INCLUDING INTEGRAL DISTRIBUTOR
5 SIMMS FLEXIBLE COUPLING THROUGH WHICH PORT MAGNETO IS DRIVEN
6 MAGNETO DRIVE SPIRAL GEARS IN REAR COVER
7 IMPULSE STARTER FITTED ON STARBOARD MAGNETO ONLY
8 MAGNETO EARTHING SWITCH TERMINAL
9 CONTROL ROD CONNECTED TO CARBURETTOR THROTTLE VALVE
10 STARBOARD IGNITION HARNESS AND SPARKING PLUGS
11 PORT IGNITION HARNESS AND SPARKING PLUGS

Fig. 2. Screened ignition equipment

levers are connected by slotted cam and link arrangements, one to each end of the throttle operating cross-shaft. Thus, movement of the pilot's throttle lever alters the ignition timing in addition to controlling the carburettor. The profiles of the slotted cams are so designed that both magnetos are fully retarded when the pilot's throttle lever is in the slow-running position, then they are advanced rapidly as the throttle is initially opened and finally remain fully advanced over the remaining wide range of throttle settings.

Sparking plugs

9. The eight sparking plugs are fitted in pairs, one either side of each cylinder head, each set of four plugs being supplied with H.T. current by the distributor of the magneto on the same side of the engine. 12 mm. thread sparking plugs are employed. Mk. 1 variants are fitted with unscreened sparking plugs and the Mk. 7 with screened sparking plugs to suit the type of ignition system fitted to the engine.

Ignition cables

10. The unscreened ignition cables on Mk. 1 variants are held together by a "systoflex" sleeve over part of their length and by a light aluminium tube where they run alongside the cylinder heads.

11. The screened ignition cables on the Mk. 7 are arranged in two self-contained assemblies one for each side of the engine. The cables are totally enclosed in a screened harness composed of an assembly of flexible and rigid metal conduits. The screening of the whole system is completed by the end of the flexible conduits being connected respectively to the outlet on the distributor cover and a union to the screened portion of each sparking plug.

Chapter 5

INSTALLING AND REMOVING

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LIST OF ILLUSTRATIONS

General

1. This chapter describes the installation of an engine as received by a unit. As the majority of installations will be a replacement this chapter has been written to facilitate easy cross reference between the procedure for either installing or removing an engine.

2. Due to possible variations between aircraft and between the equipment installed in individual aircraft of the same type, the sequence given in the following paragraphs may require adjustment to suit the exigencies of local conditions, and the equipment and facilities available. Reference should also be made to the Aircraft Manufacturer's Publication which may contain specific information applicable to a particular installation. For instance the Mk. 7 installed in the Auster T Mk. 7 (see aircraft manual) should be removed complete with the engine bearers, and the airframe components attached to the engine and engine bearers removed afterwards. In such instances it will similarly be necessary to attach the engine bearers and other relevant airframe components to the engine before it is installed.

3. The sequence of operations detailed in para. 14 to 33 when making the installation connections can be applied equally well to removal, by reversing the sequence and reading the word "connect" as "disconnect". Similarly, the list given in para. 7, of blanks and transport spares to be removed during installation, is the same as those that will require fitting when an engine is removed. When installing an engine in place of one that has been rejected for bearing failure, or for any other reason that has led to swarf or metal particles being found in the oil filters, it is essential to dismantle the airframe portions of the lubricating system and thoroughly flush out all components before the replacement engine is installed;

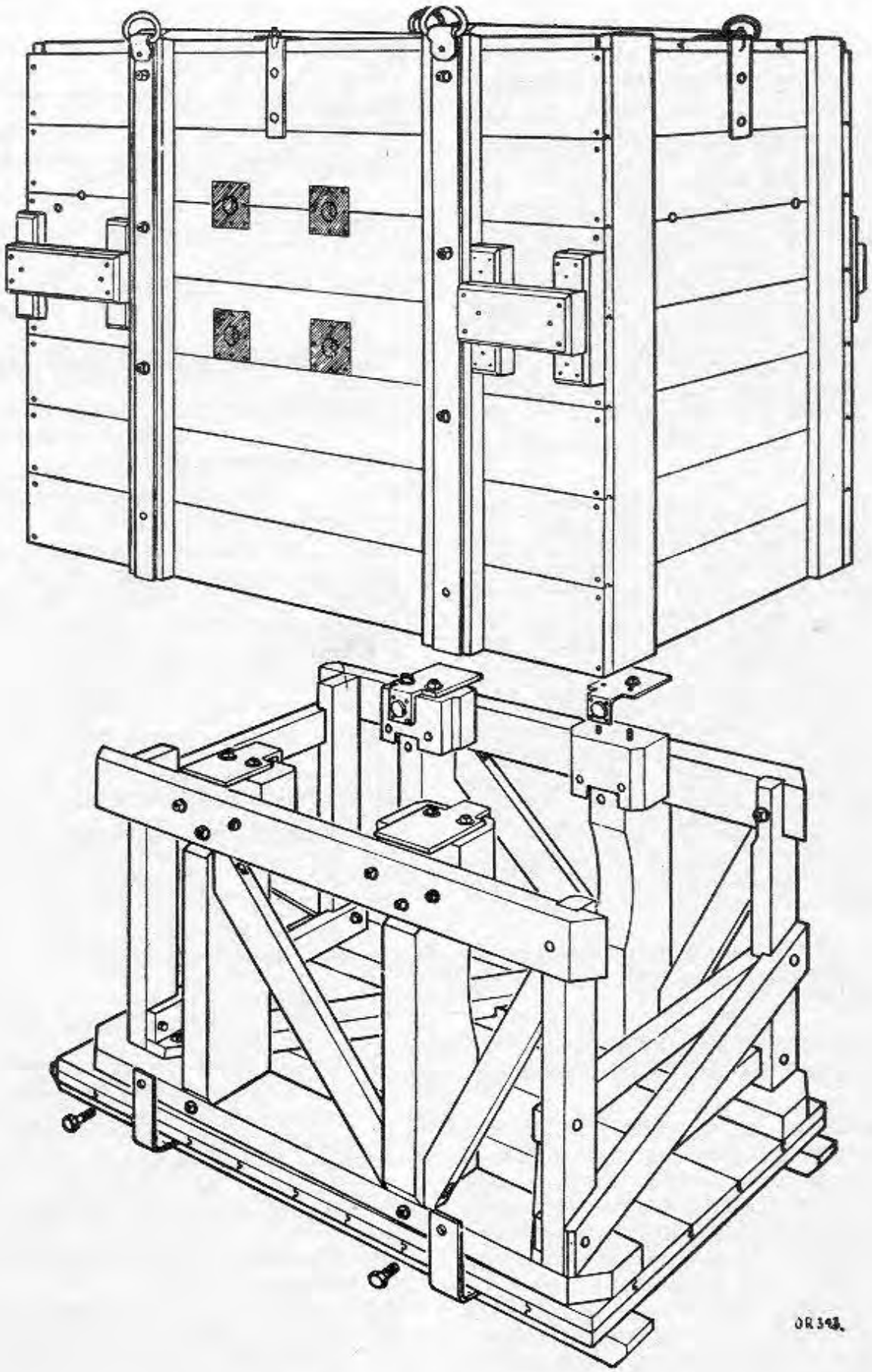


Fig. 1. Packing and transit case, R.A.F. type.

alternatively, replacement components may be fitted.

Slinging

4. A portable crane capable of hoisting a weight of at least 30 cwt., being the combined weight of the engine and its transport case, is necessary, the lift required being dependent on the type of aircraft. The approved lifting slings must be used for hoisting the case and the engine respectively. Ensure that the sling is correctly attached to the crane and to the case so that the load will balance correctly. Similarly when lifting the engine, ensure that the front and rear legs of the sling are attached to their corresponding lifting eyes in the engine top cover.

Unpacking

5. The engine will be received in a wooden packing and transit case illustrated in fig. 1, which is provided with four slinging rings. Four large set-bolts are situated at the bottom of the metal stiffening straps, two at each side. Remove these set-bolts and lift off the shell of the case, leaving the engine bolted to the stand attached to the base of the case. The operation of removing the shell should be carried out carefully to avoid fouling the engine. The engine log book, appropriate copies of the relevant issue or receipt vouchers and forms will be with the engine, and the following components may be attached to it, but not installed:—

Two sections of airscoop, wrapped in greaseproof paper, tied to the top cover.

Two carburettor jets (main and power), in a linen bag tied to the engine.

6. Examine the engine externally for any damage that may have occurred in transit or while it was being unpacked. Such damage is likely to be confined to the projecting parts. Any damage or evidence of corrosion must be reported to the Inspector-in-Charge. Carefully check the engine, and any loose components and equipment, against the documents which accompany the engine. A shortage of any component should be recorded, and the relevant issue or receipt vouchers and forms suitably endorsed.

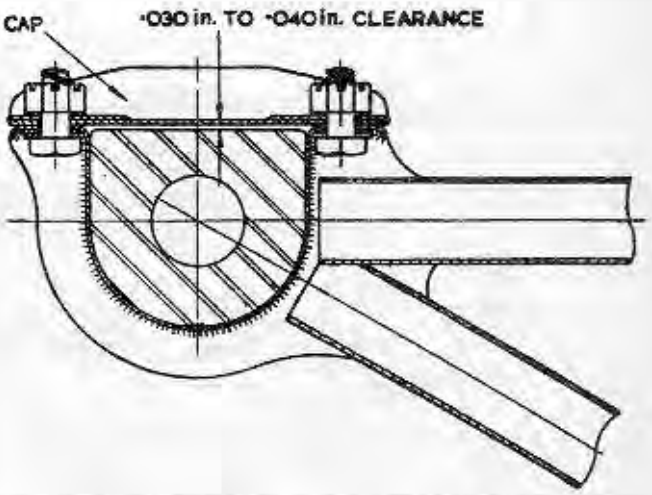


Fig. 2. Rubber mounting block clearance

Blanks and transport spares

7. It is advisable to leave blanks and aperture covers in position until immediately before the relevant component is to be mounted on the engine, or the relevant connection is to be made. This will reduce the likelihood of dust or other foreign matter entering the engine, particularly when operating in dry sandy localities. The following is a list of the blanks etc., that will require removal at the appropriate stage.

(1) Eight dummy sparking plugs, AGS.1628.

(2) Adhesive tape on valve gear breather pipes.

(3) Adhesive tape on fuel pump oil drain connections (Mk. 1 when fitted with engine-driven fuel pumps and Mk. 7).

(4) Rubber cap, Part No. 1920-6 on carburettor or fuel pump inlet.

(5) Grease-proof paper wrapping round the two magnetos; there may also be adhesive tape over the magneto ventilation holes.

(6) Rubber cap, Part No. 1920-6, on crankcase breather connection.

(7) Rubber cap, Part No. 1920-6, on oil inlet connection.

(8) Rubber cap, Part No. 1920-6, on tachometer drive connection; two on Mk. 1 variants, one on Mk. 7.

(9) Blanking tube for oil pressure gauge connection.

(10) Rubber cap, Part No. 1920-6, on oil return connection.

(11) Rubber cap, Part No. 1920-6, on induction manifold drain connection.

(12) Rubber cap, Part No. 1920-6, on heater muff inlet.

(13) Rubber cap, Part No. 1920-6, on heater muff outlet.

(14) Rubber cap, Part No. 1920-6, on heater muff drain.

(15) Four blanking plates, Part No. 1920-7, on exhaust ports.

(16) Cover, Part No. 1920-11, on cold-air intake.

(17) Blanking plate, Part No. 1920-1, on starter mounting face (Mk. 7 only).

(18) Blanking cover, Part No. 1920-2, on carburettor main jet.

(19) Blanking cover, Part No. 1920-3, on carburettor power jet.

Preparation for installing

8. A considerable part of the preparation will be done before the engine is lifted off the transport stand, but certain operations are possible only whilst the engine is suspended from the crane.

9. When preparing a Mk. 7 engine, remove the blanking plate and fit the electric starter in accordance with the instructions given at the end of this chapter. Do not remove the starter mounting blanking plate which is fitted instead of a starter adapter on Mk. 1 variants.

10. The airframe should be placed in the rigging position and the rear end of the fuselage anchored to a ground ring, or to a suitable weight. This will prevent the aircraft overbalancing on to its nose whilst the engine is being mounted. Ensure that parts of the engine control system and connections, pipes, wiring, etc., that are secured to the firewall are correctly fitted, and that they are stowed securely out of the way. This will facilitate mounting the engine and prevent their being fouled when the engine is lowered into position. Examine all parts of the engine mounting structure for security, slackness if present may cause vibration when the engine is run. Reference should also be made to para. 14 and to the relevant aircraft publication

Removing engine from transit stand

11. Attach the engine-lifting sling to the crane and engage the hooks on the sling with the two lifting eyes provided on the top cover of the engine. Take the weight of the engine on the crane and remove the bolts which secure the transport bearer arms to the stand. Avoid letting the engine swing which might cause damage through contact with the stand, then raise the engine slowly until it is clear and at a convenient height for the next operation.

Fitting engine bearer arms

12. With the engine suspended from the crane, remove the sixteen nuts securing the four transport bearer arms and fit the correct bearer arms according to the Part No. listed in the table below, for the aircraft in which the engine is to be installed. The nuts and washers provided for securing the transport bearer arms are suitable in size and strength for securing the flight bearer arms. When attaching the bearer arms to the crankcase, ensure that each is fitted in its correct position. On Mk. 1 variants the front and rear arms are different, and those for the port and starboard sides of the crankcase differ also. It is important that

Aircraft	Front Port	Front Starboard	Rear Port	Rear Starboard
Tiger Moth	1401–10	1401–11	1401–12	1401–13
Magister	1901–37	1901–38	1901–39	1901–40
Auster	1921– 6	1921– 6	1921– 6	1921– 6

the diameter of the spigot on the bearer-arm flange is within the limits 44·88 to 44·98 mm. so that all shear loads will be taken by the spigot and not by the fixing studs. Having fitted the four bearer arms and securely tightened the sixteen nuts, lock them with the tab-washers provided.

Rubber mounting blocks

13. Where the "compression type" rubber mounting blocks are of similar shape and

design to those used for transport purposes, it is stressed that the transport rubber blocks are not suitable for use in the aircraft and that only the correct blocks specified for the aircraft in question must be fitted. These rubber blocks must be kept free of oil or grease and it is advisable, when fitting them to the bearer arms, to apply french chalk lightly to the outside of the blocks. Where the well-known Gipsy arrangement of mounting blocks is used, it is important that they are neither compressed nor unduly slack in their housings on the engine mountings. A clearance of approximately 0·030 to 0·040 in. (*fig.* 2) should be left between the top edge of the rubber block and the housing cap when the latter is bolted right down. If necessary, washers may be fitted to the two bolts to raise the cap sufficiently. Any departure from this condition may cause excessive vibration to be transmitted to the airframe.

Specific information

14. Before commencing to install an engine, reference must be made to the Aircraft Manufacturer's Publication which may contain specific instructions applicable to the particular installation. The following notes, do not over-ride such instructions but the combination of engine and aircraft indicated should be related to the general information given under the appropriate headings in this Chapter.

Preparation for installing (*Mk. 1 variant in Tiger Moth*).

(1) Remove the distributor cover from the port magneto.

(2) Remove the top half of the breather pipe which is fitted to the airframe bulkhead.

(3) Remove the starboard, rear, engine mounting from the airframe.

Installing engine

(1) Locate the port side engine bearer arms first; when these are correctly positioned, tilt the engine slightly to locate the starboard, front, engine bearer arm.

(2) Fit the starboard, rear, engine mounting.

(3) Refit the distributor cover on the port magneto.

(4) Reconnect the upper portion of the engine breather pipe.

Preparation for installing (*Gipsy Major Mk. 1 and Mk. 1F in Magister*).

(1) Fit the tachometer drive bracket (aircraft part) to the oil suction filter.

(2) Connect the oil feed pipe (aircraft part) to the oil suction filter.

(3) Remove the distributor from the port magneto.

(4) Remove the distributor from the starboard magneto.

Installing engine

(1) Refit distributor to starboard magneto.

(2) Fit clip (aircraft part) securing crankcase breather pipe to engine oil gallery.

(3) Connect vacuum system suction pipe to the hose connection at rear of induction pipe.

(4) Refit distributor to port magneto.

(5) Connect the ignition earthing lead (aircraft part) to the timing gear cover and refit the securing nut.

(6) Connect tachometer drives clip to bracket on oil suction filter.

(7) Connect oil feed pipe to hose connection on oil tank.

(8) Clip fuel supply pipe to top mounting member, and to carburettor supply pipe.

Preparation for installing (*Mk. 7 in Auster*).

(1) After fitting the engine bearer arms and the rubber mounting blocks, attach the port and starboard engine mounting frames to the engine whilst the engine is still suspended from the crane.

(2) To ensure that the bearer arms cannot foul the engine bearer housings when the mounting rubbers are compressed in either direction, the clearance of the bearer arms in their housings must be checked. The minimum clearance must be 0·125 in.; if necessary the housings and housing caps should be filed to obtain this clearance.

Installing engine

(1) Align the fork-ends at the rear of the top and bottom tubes of the engine mounting frames with the eyebolts secured at each corner of fuselage frame 1, and secure the engine complete with mounting frames to the airframe.

(2) Connect the forward ends of the engine-mounting cross-stays to the eyebolts just aft of the rear bearer plates.

(3) Check the engine alignment and adjust the cross-stays, if necessary, as described in the Aircraft Manufacturer's handbook.

(4) Connect up the cabin heater pipe.

Installing the engine

15. After all preparatory work on the engine and airframe has been completed, raise the engine to a suitable height and move it into position over the airframe. Keep the engine steady and level as it is lowered to prevent any fouling of the airframe fittings. Align the bearer arms with the engine bearers. When the engine is firmly placed, ensure that the two ends of each rubber block are in the same horizontal plane as the tops of the airframe bearer, and secure the engine in position. Detach the sling from the top cover and remove the crane. Reference should also be made to para. 14.

Oil connections

16. Remove the blanking cap from the elbow on the back of the suction filter casing and connect the oil supply pipe.

17. Remove the blanking cap from the oil return connection and connect the oil return pipe; on Mk. 1 variants this connection is made to one branch of an inverted T-piece at the rear of the engine, level with the cylinder heads, and on the Mk. 7 it is at the bottom starboard side of the oil pump.

18. Remove the cap-nut and distance piece from the lower of the two banjo pillars on the back of the pressure filter casing on the Mk. 1 variant and also on Mk. 7 engines when Gipsy modification G1793 is embodied. Pre-mod. the banjo pillar is on the starboard side of the crankcase. Using the same cap-nut and copper washers connect the oil pressure gauge capillary.

19. Remove the blanking cap from the $1\frac{1}{2}$ in. diameter hose connection elbow, on the rear cover and connect the crankcase breather pipe.

20. Where engine-driven fuel pumps are fitted, remove the blanks from the two fuel pump drain hose connections and connect the drain pipes.

Carburation connections

21. Remove the blanking cap from the $\frac{3}{8}$ in. B.S.P. union at the base of the carburettor float chamber (gravity feed installations) or at the rear of the rear fuel pump where engine-driven fuel pumps are fitted, and connect the fuel supply pipe.

22. Remove the blanking cover from the air-intake on the starboard side of the engine; using the fibre gasket, four bolts, spring washers, and nuts which secured the cover, attach the air-intake duct to the engine air-intake.

23. The power jet and the main jet may be supplied attached to the engine in a linen bag. If this is the case, check with the log book that they are the correct size; remove the blanks and fit the jets in the carburettor.

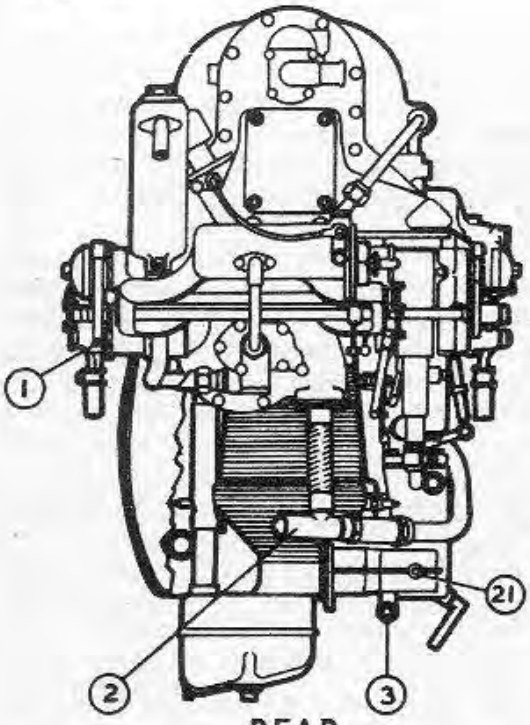
24. Remove the blanking cap from the induction manifold drain situated below the extreme end of the main induction pipe and connect the drain pipe.

Controls

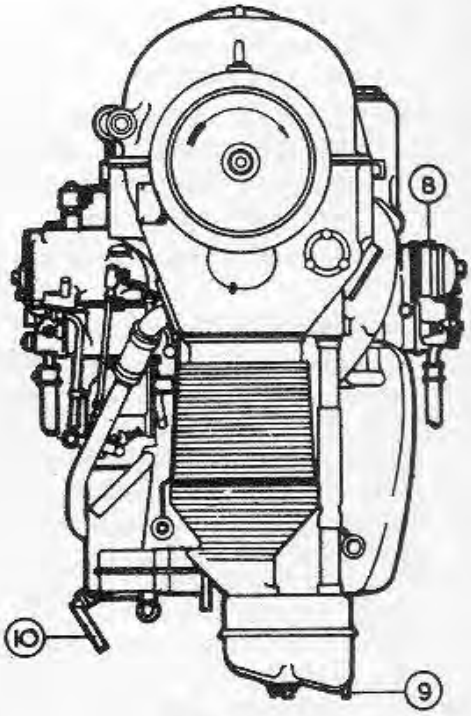
25. Couple the cockpit throttle lever to the lever attached to the port end of the lower control cross-shaft at the rear of the engine; check that the full travel of 70 deg. is obtained. If necessary, the throttle control pick-up lever can be removed from the vernier flange and repositioned to obtain the correct control movement. If this is done, two new bolts (Part No. 1400-B2) and nuts (Part No. A16Y-BP) must be used as these bolts are locked by peening. When the movement is satisfactory, the ends of the new bolts must be shortened and riveted over.

26. Couple the cockpit altitude (mixture) control lever to the lever attached to the port end of the upper control cross-shaft at the rear of the engine, and check that the full $20\frac{1}{2}$ deg. travel of the lever is obtainable; on certain installations the mixture control is locked in the fully rich position. If necessary, the setting of the altitude control pick-up lever can be altered by removing the altitude control operating lever from the vernier flange on the starboard end of the upper control cross-shaft and repositioning it in a similar manner to that described in para. 25.

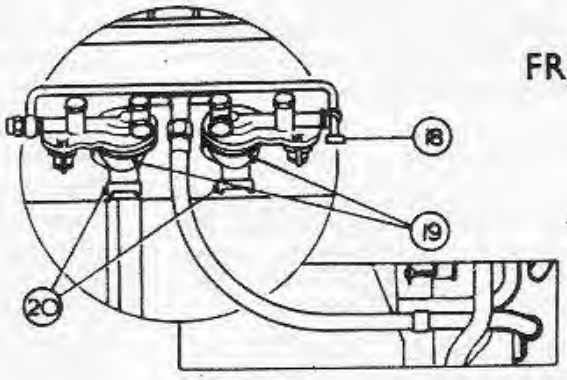
27. On Mk. 7 engines where Gipsy modification G1483 has been embodied couple

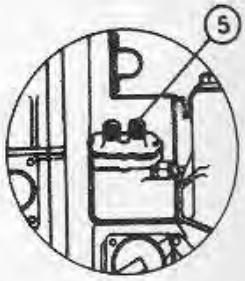


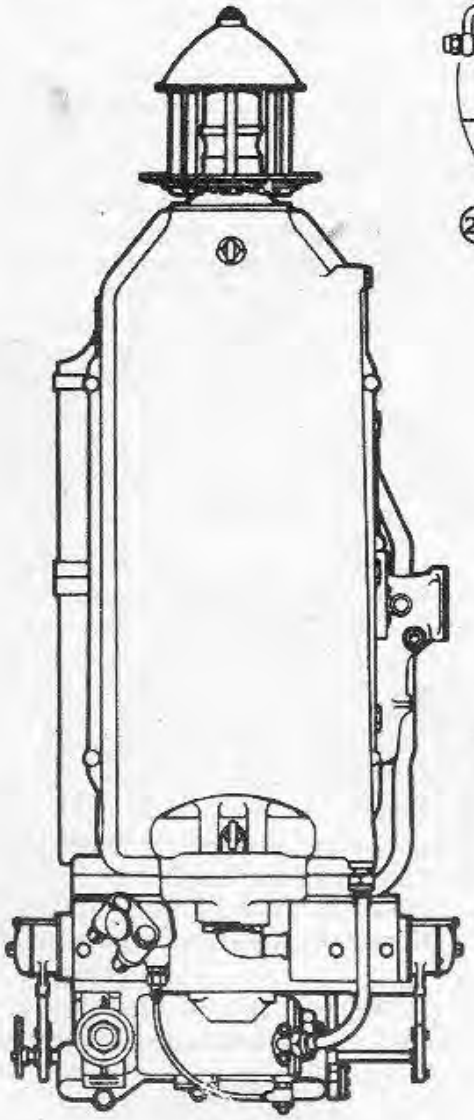
REAR



FRONT





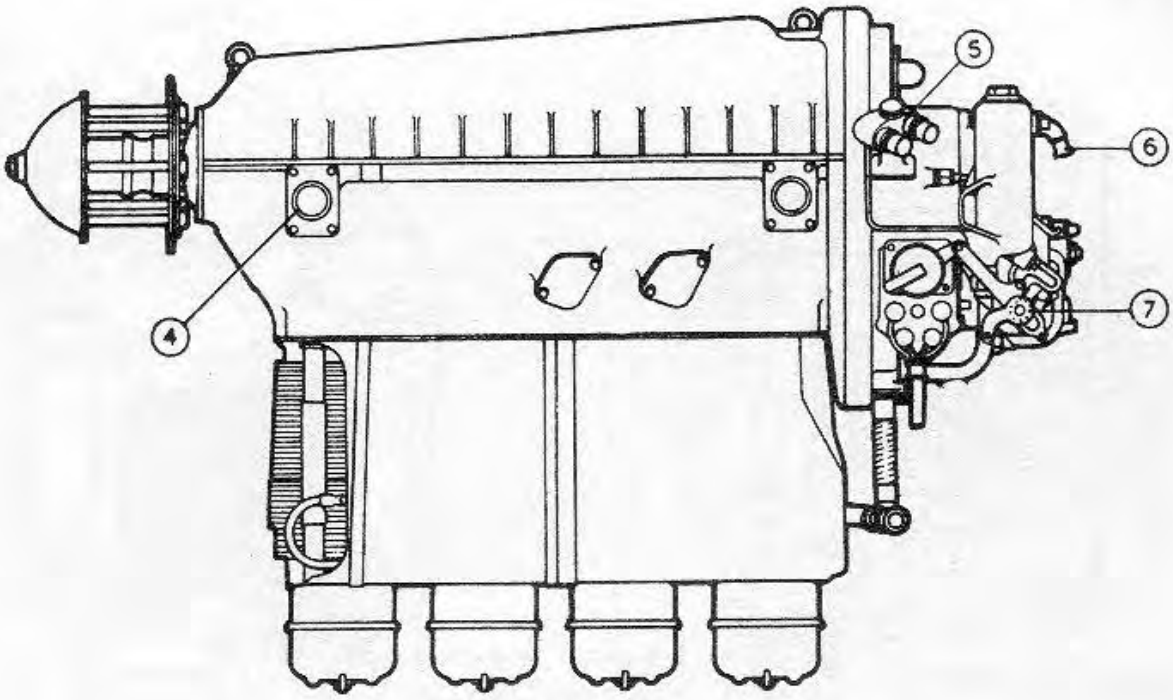


PLAN

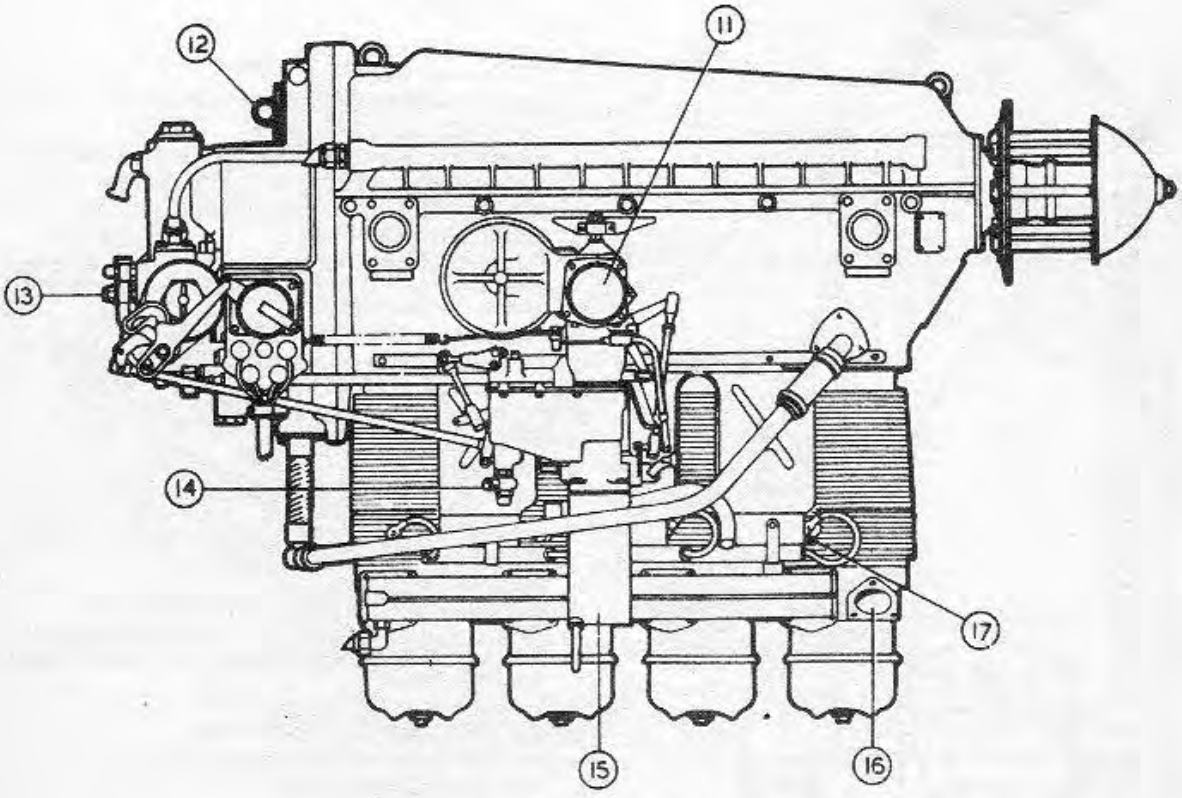
KEY TO FIG. 3

1 ALTITUDE (MIXTURE) CONTROL PICK-UP LEVER
2 OIL RETURN CONNECTION (GRAVITY)
3 INDUCTION MANIFOLD DRAIN
4 BEARER ARM MOUNTING
5 TACHOMETER DRIVE CONNECTION, DUAL, QUARTER ENGINE SPEED; INSERT ON RIGHT SHOWS THE ALTERNATIVE DUAL, ENGINE SPEED TACHOMETER DRIVE FITTED TO THE MK. IC AND MK. I VARIANTS WHEN INSTALLED IN THE MAGISTER AIRCRAFT
6 OIL SUPPLY CONNECTION
7 THROTTLE CONTROL PICK-UP LEVER
8 MAGNETO LOW-TENSION CONNECTION
9 VALVE GEAR BREATHER PIPES (FOUR)
10 INDUCTION MANIFOLD HEATER MUFF DRAIN
11 COLD-AIR INTAKE
12 CRANKCASE BREATHER CONNECTION
13 OIL PRESSURE GAUGE CONNECTION
14 FUEL SUPPLY CONNECTION (GRAVITY FEED)
15 INDUCTION MANIFOLD HEATER MUFF
16 EXHAUST PORTS (FOUR)
17 CYLINDER HEAD TEMPERATURE GAUGE CONNECTION ONE ON EACH CYLINDER HEAD; USED ONLY WHEN GAUGE IS FITTED
18 FUEL SUPPLY CONNECTION (WHEN ENGINE-DRIVEN FUEL PUMPS ARE FITTED)
19 FUEL PUMP DRAINS
20 FUEL PUMP PRIMING LEVERS
21 VACUUM SYSTEM SUCTION PIPE CONNECTION (MAGISTER AIRCRAFT ONLY)

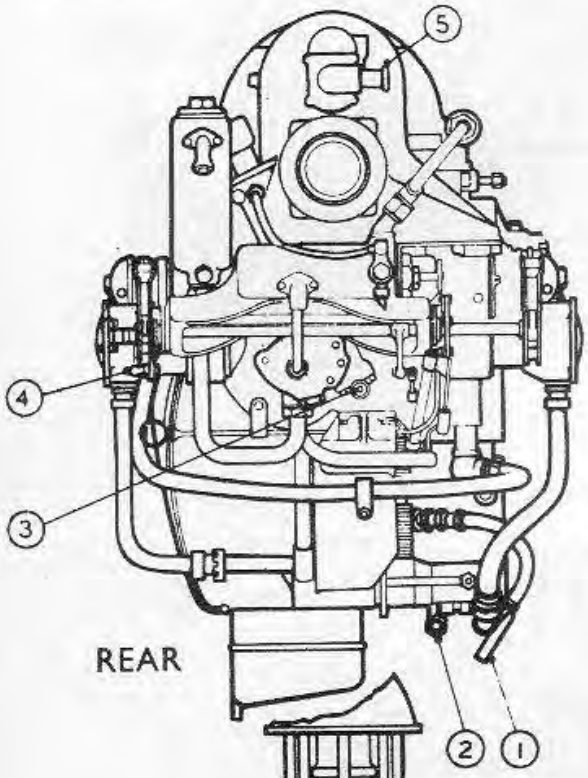
FIG.3 PRINCIPAL INSTALLATION CONNEC

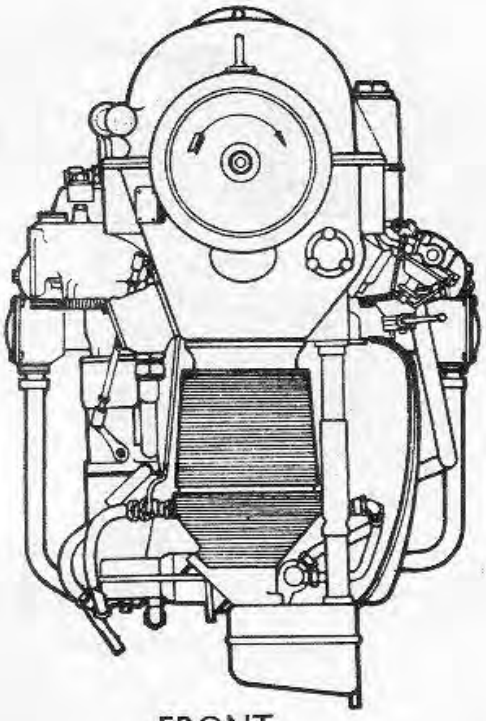


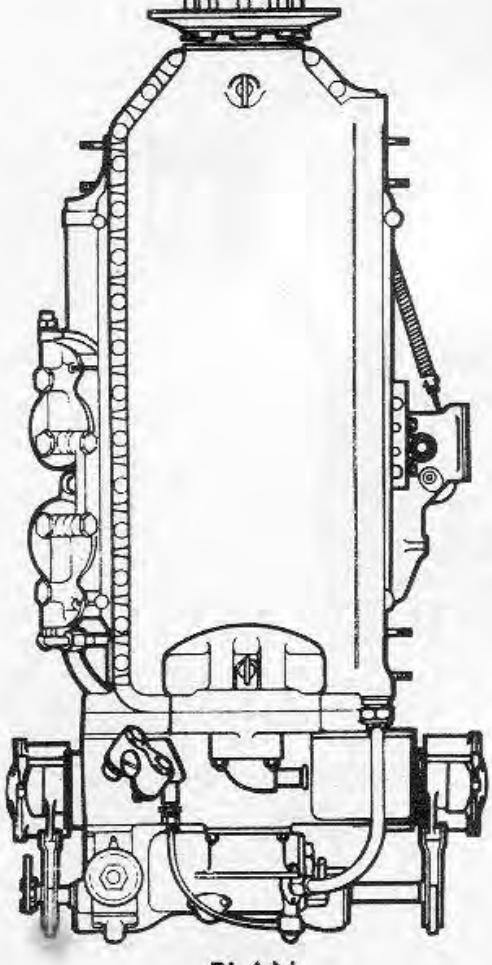
PORT



STARBOARD



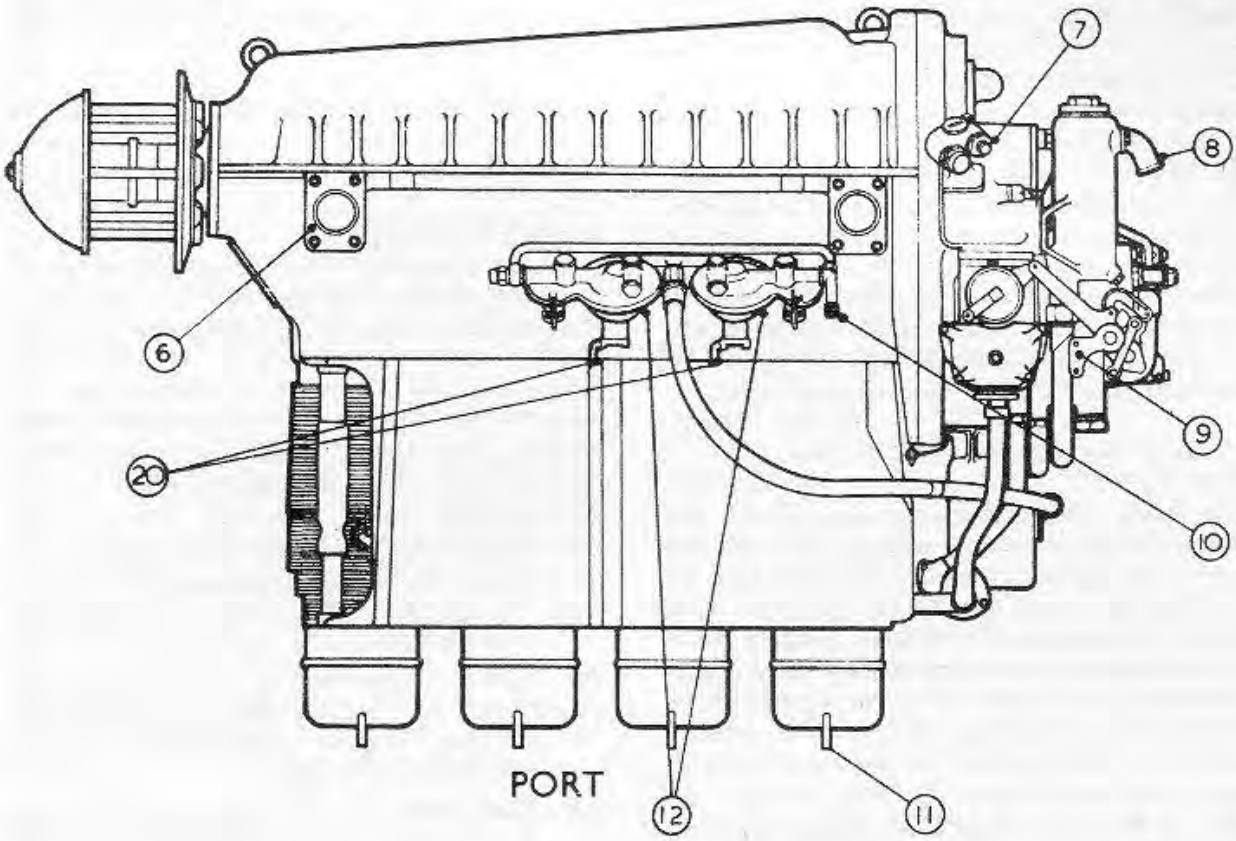




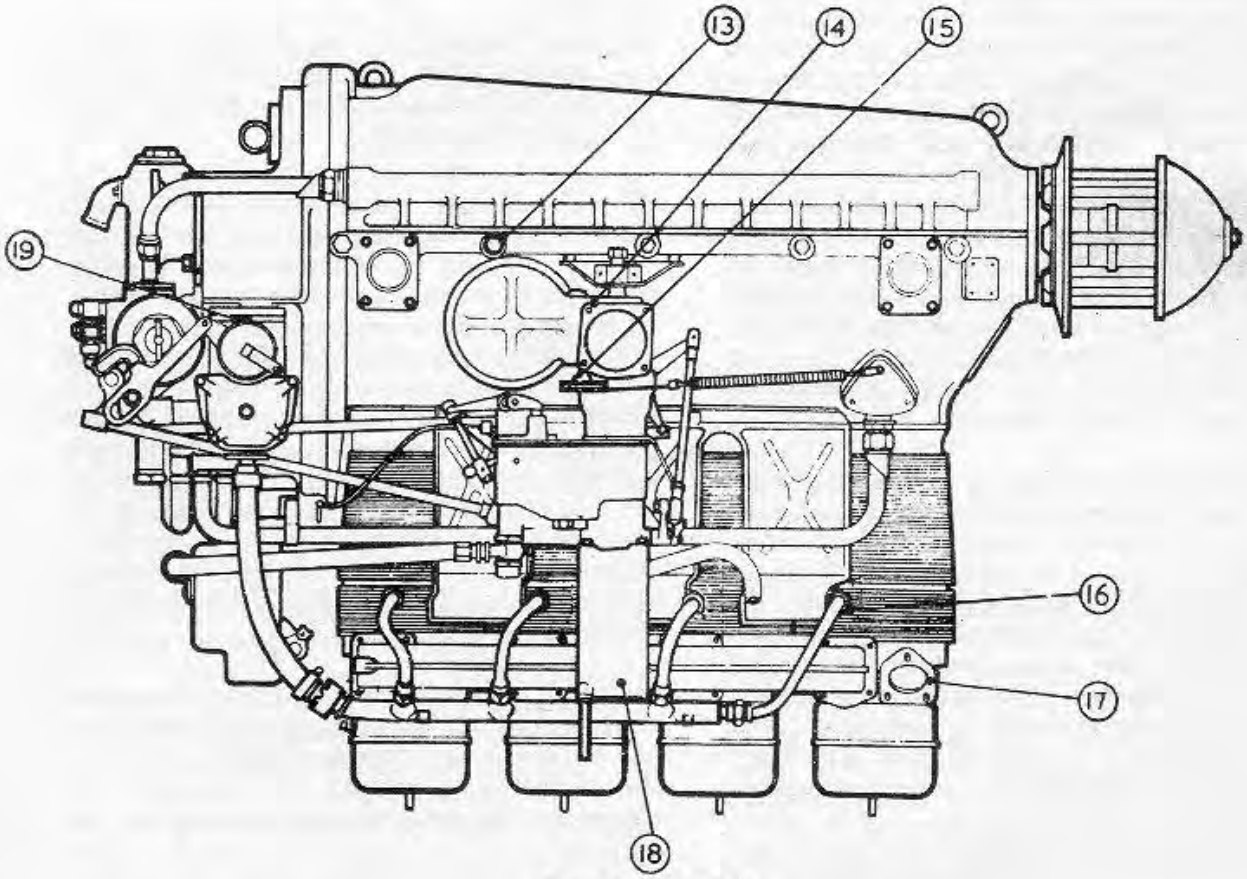
KEY TO FIG. 4

1 INDUCTION MANIFOLD HEATER MUFF DRAIN
2 INDUCTION MANIFOLD DRAIN
3 OIL RETURN CONNECTION (DUAL SCAVENGE PUMPS)
4 ALTITUDE (MIXTURE) CONTROL PICK-UP LEVER
5 CRANKCASE BREATHER CONNECTION
6 BEARER ARM MOUNTING
7 TACHOMETER DRIVE CONNECTION, SINGLE, QUARTER ENGINE SPEED; SECOND CONNECTION BEING PERMANENTLY BLANKED OFF
8 OIL SUPPLY CONNECTION
9 THROTTLE CONTROL PICK-UP LEVER
10 FUEL SUPPLY CONNECTION
11 VALVE GEAR BREATHER PIPES (FOUR)
12 FUEL PUMP DRAINS
13 OIL PRESSURE GAUGE CONNECTION
PRE-MOD. G.1793 (AUSTER AIRCRAFT MODIFICATION 298). WHEN MODIFICATION IS EMBODIED, THIS CONNECTION IS SITUATED ON THE PRESSURE FILTER CASING AS ITEM 13 ON FIG. 3
14 COLD-AIR INTAKE
15 HOT AND COLD-AIR INTAKE CONTROL PULLEY
16 CYLINDER HEAD TEMPERATURE GAUGE CONNECTION, ONE ON EACH CYLINDER HEAD; USED ONLY WHEN GAUGE IS FITTED
17 EXHAUST PORTS (FOUR)
18 INDUCTION MANIFOLD HEATER MUFF
19 MAGNETO LOW-TENSION CONNECTION
20 FUEL PUMP PRIMING LEVERS

FIG.4. PRINCIPAL INSTALLATION



PORT



STARBOARD

CONNECTIONS, GIPSY MAJOR Mk.7

the control cable from the cockpit hot-and-cold air-intake lever to the pulley situated immediately below the cold air-intake flange on the starboard side of the engine. Check that the cockpit control permits full travel of the air-intake flap.

28. Wire the ignition switches to the low-tension connections on the magneto contact breakers. Ensure that the labels on the switches correspond with the magnetos to which they are wired, and that each switch is in the OFF position and that the circuit to earth is complete.

Tachometer drive, exhaust manifold, airscoop, and electric starter

29. Remove the blanking caps from the dual tachometer drive connections on the rear cover (single drive connection only on Mk. 7) and couple the flexible drives to the engine. Ensure that each inner flexible drive is free in its outer casing before making the connection, and that the squared end of the inner cable correctly enters the square hole in the engine drive.

30. Remove the four blanking plates from the exhaust ports, and using the nuts, washers, and copper-asbestos gaskets supplied with the engine, securely fasten the exhaust manifold to the cylinder heads. Also remove the blanking caps from the inlet, outlet, and drain connections of the induction manifold heater muff. Fit the larger inlet heater pipe on to the heater muff union and turn the nut until it is held lightly by the union. Insert the small inlet heater pipe into the sleeve at the other end of the larger heater pipe and fit the nut on the small pipe on to the exhaust manifold union. Ensure that the small pipe fits correctly into the sleeve of the large pipe; tighten and lock both nuts securing the pipes to their respective unions.

31. In no circumstances should the large inlet heater pipe be bent or forced into position to meet the small heater pipe when the former is fitted to the heater muff union, as this action will probably result in cracking the welding of the union. If difficulty is experienced with the alignment, the pipes should be changed in an attempt to rectify the discrepancy by selective assembly. The outlet heater pipes should then be fitted and secured to the bracket on the induction manifold.

32 The airscoop should be fitted to the port side of the engine as described in page 82 of Chapter 9.

33. When installing a Mk. 7 engine, the electric cables must be connected to the two terminals on the electric starter.

Checking the Installation

34. Having completed all installation work, carefully check all connections for tightness, and ensure that all lockings are correctly made. Ensure that the blanks have been removed from all vents or drains and the connections made. Fit the cowling and ensure that the following openings align correctly with the appropriate engine parts and controls:—

(1) Where engine-driven fuel pumps are fitted, the door or opening in the port engine cowling for the fuel pump priming levers.

(2) Where engine-driven fuel pumps are fitted, the second door or opening in the port engine cowling for the carburettor flooder cable.

(3) The opening in the nose cowl with the open front of the airscoop on the port side of the engine, as described in para. 35.

(4) The opening in the starboard engine cowling with the duct bolted to the carburettor air-intake on the starboard side of the engine.

35. The gap left between the inner edge of the opening in the nose cowl and the forward edge of the engine airscoop must be only sufficient to permit the engine free movement on its rubber mountings. Any excessive gap at this point will adversely affect the cooling airflow. If flexible sealing strips are provided, care must be taken that they are positioned and fixed correctly. On certain aircraft, an adjustable plate is provided on the inboard edge of the nose cowl entry duct. The position of this plate must be carefully adjusted so that the gap between its inboard edge and the adjacent cylinder fins is within the limits of 3·5 to 6 mm.

36. It is essential to check that movement of the engine on its mounting rubbers, does not allow contact between relative parts of the engine or structure. In general, the minimum clearance at any point should be

$\frac{3}{8}$ in. when stationary and a further examination should be made during initial ground run throughout the range of r.p.m. before the installation is finally approved.

Fuel flow or fuel pump check

37. If it is required to check the fuel supply to the carburettor on installations which rely on gravity feed, or to prove the correct functioning of the engine-driven fuel pumps, where fitted, proceed as described in page 84 of Chapter 9.

Mounting the propeller

38. Refer to the appropriate propeller handbook, for the correct method of fitting the propeller and spinner. It is important to ensure that the propeller is mounted at the correct angle for hand swinging. To do this, rotate the propeller hub in the normal direction until the 'click' is heard in the impulse starter. With the crankshaft in this position, mount the propeller on the hub so that its lower blade is between 30 and 40 degrees to port of the vertical position.

Prevention of corrosion

39. When the complete installation has been passed as satisfactory, a close scrutiny must be made for any damage done to the anti-corrosive protective coating. Any such damage must be rectified by brushing with Anaco "B" air-drying varnish to specification D.T.D. 4053. At the same time, all nuts, bolts, or other parts fitted during installation must be coated with the lanolin resin protective wherever the surface is exposed.

40. If, for any purpose, it is necessary to turn the crankshaft during or after installation, and it is known that the engine will not be run for a period of more than three days, the cylinders must be inhibited in accordance with the instructions given in Chapter 18.

Removing the engine

41. In order to remove the engine from the airframe, a portable crane and lifting sling will be required. A transit stand must be available to receive the engine, and a complete set of blanks and transport spares as listed in para. 7 should be available.

42. Before removing the engine, the airframe should be placed in the rigging position and the rear end of the fuselage anchored as instructed in para. 10.

43. Remove the spinner and the propeller as described in the propeller manual. The propeller hub normally remains with the engine and should not therefore be removed.

44. After the cowlings have been removed, both the engine and airframe oil systems should be drained. Ensure that the main fuel cocks are OFF. It is advisable to remove the main and power jets from the carburettor and to allow the fuel to drain. If the jets are replaced by blanks, the jets must be attached to the engine in a linen bag, and clearly labelled.

Disconnections

45. Reference should be made to para. 14 to 33 inclusive, each paragraph being read in the reverse order; i.e., read the words "connect up" and so forth as "disconnect" and "remove the blanking cap" as "fit the blanking cap", and reverse the sequence of operations.

Withdrawing the engine

46. Ensure that all connections have been disconnected, and that all pipes, wires, etc., are securely stowed out of the way so that they will not foul as the engine is withdrawn.

47. Attach the engine-lifting sling to the top cover lifting eyes as described in para. 4. Take the weight of the engine on the crane and remove the engine bearer cap bolts.

48. Make a final check that all connections have been broken and that nothing is liable to hinder withdrawal of the engine. Carefully lift the engine clear of the airframe and avoid letting the engine swing, otherwise damage will be caused through contact with the airframe parts.

Removal of airscoop

49. Instructions for removing the airscoop are given in page 82, Chapter 9.

Blanks and transport spares

50. It is advisable to fit blanks and aperture covers immediately the relevant component is removed from the engine or a connection is "broken" and the airframe portion of the connection should be blanked off at the same time. If this policy is followed the majority of the blanks and transport spares will have been fitted, at this stage, but a check must be made to ensure that all the items listed in para. 7 have been correctly dealt with.

Fitting transport bearer arms

51. With the engine suspended from the crane, replace the engine bearer arms with four transport bearer arms.

Placing engine on transit stand

52. Remove any fittings necessary, and ensure that the transport bearer arms are correctly and securely fitted, then lower the engine carefully on to the transit stand.

53. Securely bolt the transport bearer arms to the transit stand; release the lifting sling from the engine and remove the crane.

Anti-corrosion treatment

54. If it is anticipated that the engine will stand for a period longer than seven days, it must be inhibited in accordance with the instructions given in Chapter 18.

Fitting and removing electric starter (Mk. 7)

55. The starter adapter which is secured to the mounting face on the timing gear cover, by four studs, spring washers and plain nuts, is regarded as part of the engine and should always be transferred with it. Remove the transport blank from the rear face of the starter adapter, and retain the six bolts, nuts, and spring washers. Remove the transport blank from the electric starter. Before fitting the electric starter, check that the clearance between the engine starter-dog jaws and the starter jaw, when the latter is fully retracted, is not less than $\frac{3}{32}$ in. Ensure that the mounting faces of the starter and the adapter are clean. Apply a film of approved jointing compound to the mating faces, and secure the starter to the adapter with its six bolts, nuts, and spring washers; tighten the six nuts evenly.

56. Removal of an electric starter is largely a matter of reversing the sequence given in the foregoing paragraph. Where a starter is being changed on an engine which is installed in an aircraft, it will first be necessary to disconnect the two electrical leads, and to reconnect these leads after the replacement starter has been fitted. If after removal, a replacement starter is not being fitted, the correct transport blank must be fitted to the mounting face on the engine. The mounting face on the starter must also be blanked off.

Chapter 6

STARTING AND GROUND RUNNING

LIST OF CONTENTS

General

1. This chapter gives brief notes on the technique of handling these engines on the ground, i.e., starting the engine, stopping the engine, and making the required ground checks while the aircraft is in service. It will be necessary for certain specific information, to refer to the Leading Particulars at the beginning of this volume.

WARNING

When either of the contact-breaker covers is removed on engines without Mod. No. 2010 embodied, it is important to note that the ignition switch is inoperative and it is stressed that the propeller must not be turned under these conditions, unless the H.T. leads have been disconnected or a sparking plug removed from each cylinder.

Preliminary instructions

2. The following instructions and checks should be carried out before any attempt is made to start an engine that has been newly installed or standing idle for any considerable time; thereafter the engine must be periodically maintained in accordance with the relevant Maintenance Schedule.

(1) Open the cowling and remove the engine airscoop. Remove the eight sparking plugs, thus enabling the crankshaft to be turned easily by hand.

(2) It is essential, to avoid the risk of hydraulic locking, that any oil or inhibitor fluid which has accumulated in the cylinder heads should be drained from the combustion spaces. To do this, turn the crankshaft by hand and allow each exhaust valve to remain open until any oil or fluid that may be present has escaped. Also check that the induction manifold drain is clear.

(3) Check the tightness and locking of all external bolts, nuts, unions, etc., on the engine and its mounting. The relevant airframe parts in the engine bay should be similarly checked.

(4) Examine the ignition leads, or harness, and magnetos. Remove any oil, grease, or protective covering and ensure that all electrical connections and bonding joints are tight.

(5) Examine all engine controls and check them for freedom of operation and full travel between stops.

(6) Check the magneto L.T. wiring and the ignition switches for continuity, correct connections, and operation. Aftee completion of these tests, ensure thar both ignition switches are left in tht OFF position. Remove the contact breaker cover from each magneto in turn and check the contact breaker for correct gap and condition and refit the covers.

(7) Remove the four rocker covers, check the tappet clearances against the figures specified in the Leading Particulars, and adjust if necessary. Fill each valve rocker cover to the level indicated by the collar on the breather pipe with the approved oil.

(8) Check the connections of the oil pressure and temperature gauges and the tachometer drive or drives.

(9) Examine the fuel system and clean the filters; if necessary drain the tanks before filling with the approved fuel specified for the mark of engine concerned.

(10) Examine the oil system and, after removing and cleaning the suction filter and in the case of a Mk. 7, the two scavenge filters, drain and if necessary clean the tank. Give the handle on the Auto-Klean filter one complete turn, then replenish with the approved oil.

(11) Check that the electric starter fitted on the Mk. 7 and its adapter are securely mounted on the engine, and that the electrical connections are correct and tight.

(12) Attach the cowling and check that all parts fit correctly and that the fastenings are in proper working order.

(13) Ensure that the propeller and nuts are tight on the crankshaft and are correctly fitted for hand swinging. Check the spinner for security and concentricity. Turn the propeller by hand through at least one complete revolution to ensure that it is clear of the cowling at all points. The track of the propeller should be within $\frac{1}{8}$ in.

(14) Open the cowling. Ensure that the sparking plugs are clean and of the correct type. Check the gaps and lightly smear the threads with graphite grease. Refit the eight sparking plugs and the airscoop, and securely fasten the cowling.

(15) Turn the engine by hand to check that there is compression on each cylinder.

Priming the lubricating system

3. After the oil tank has been filled and the filters cleaned and refitted, the lubricating system should be primed with oil to the correct specification heated to about 60 deg. C.

4. If heating facilities are not available it is permissible to use oil diluted with fuel in the following proportions.

(1) 15 per cent fuel with winter grade oil which must only be used in winter.

(2) 5 per cent fuel with summer grade oil when used in summer.

(3) 20 per cent fuel with summer grade oil when used in winter.

5. Scrupulous cleanliness must be observed whilst making this mixture which must be stirred vigorously for several minutes and used immediately after preparation. Although the following points are more normally applicable where an oil dilution system is used, they should also be borne in mind when diluted oil has been used for priming the lubricating system.

(1) Before opening the throttle to take-off conditions, the oil should be allowed to attain at least the minimum temperature of 15 deg. C.

(2) Over dilution of the oil may result in loss of oil pressure. Should this occur, the engine should be run at low r.p.m. until the oil pressure is regained.

6. To prime the lubricating system proceed as follows:—

(1) Break the lock-wire and remove the oil suction filter cap.

(2) Pour in sufficient oil, prepared in accordance with the requirements of para. 3 or 4 above, to fill up the suction filter casing.

(3) Having ensured that the ignition switches are in the OFF position, turn the engine through several revolutions to circulate the oil through the engine.

(4) Top up the filter with a further quantity of oil. Refit and wire-lock the cap.

(5) The oil tank level must be checked after running the engine.

Fuel priming

7. The amount of fuel priming required depends on the prevailing conditions and no definite rules can be given. Under priming is preferable because it is easier to prime a little more than to dispose of the surplus fuel resulting from over priming. Priming should be carried out with discretion in hot weather, otherwise the mixture will be too rich. If the engine is over primed, fuel will drip from the induction manifold drain and no attempt should be made to start until the draining has ceased.

8. The only method of fuel priming the engines installed in Tiger Moth 2 aircraft which has a gravity fuel flow system is by the carburettor flooder but where engine-driven fuel pumps are fitted, (Magister 1 and Auster T7, aircraft) there are, in effect, two controls affecting fuel priming.

(1) The hand priming levers on the fuel pumps.

(2) The carburettor flooder.

9. The first is used by operating the lever through its full range of travel, to ensure that the fuel pumps, pipe line to the carburettor, and the carburettor float chamber are filled with fuel. The second, which is operated by depressing the flooder (tickler) valve knob on the carburettor or by a pull wire according to the particular installation, enables the carburettor to be flooded and thus provides the required rich mixture for starting; on gravity feed installations this is done by depression of the carburettor flooder after turning ON the main fuel cock; where engine-driven fuel pumps are fitted this is done by operating the fuel pump priming lever whilst holding OUT the carburettor flooder pull wire or whilst depressing the flooder valve knob.

Note . . .

Where engine-driven fuel pumps are provided, if the eccentric on the camshaft is at full lift, movement of the hand priming lever will not actuate the pump. When movement of the hand priming lever encounters no resistance the second pump priming lever should be operated; alternatively, the propeller may be rotated to bring the eccentric to a suitable position.

Starting and ground running precautions

10. The precautions detailed in the following paragraphs should be strictly observed whenever the engine is started up and run on the ground.

11. The aircraft should be turned into wind to reduce the risk of overheating and as the engine does not receive its normal cooling airstream until in flight, the period of running at large throttle openings for each ground check must be restricted to an absolute minimum. It must however, be continued long enough to ensure steady running and an accurate reading on the instruments.

12. After making any full-throttle checks and before stopping, the engine should be run at 700 to 800 r.p.m. for a short time to allow it to cool gradually.

13. On the majority of the engines covered by this Publication, the air-intake unit contains a flap valve which 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. In these cases, increased resistance will be felt to throttle lever movement beyond the normal cruising position as the interconnected spring-loaded air-intake flap changes the carburettor air supply from warm to cold air. On Gipsy Major Mk. 7 engines in which Gipsy Modification G.1483 has been embodied a separate manual air-intake control is provided and this control should be set to the cold-air position for starting and ground running. In cold weather, directly the engine is started the hot-air position may be used to assist steady running then returned to the cold-air position when a satisfactory temperature has been reached. Similarly, if the installation provides cowling gills and/or an oil cooler shutter, the closed position should be used to assist warming up.

Starting by swinging the propeller

14. The sequence of operations given in this paragraph must be carefully observed:—

(1) Ensure that all oil cocks, if fitted, are turned ON.

(2) Ensure that both magnetos are switched OFF.

(3) Turn ON the fuel cock.

(4) Set the throttle lever in the FULLY CLOSED position.

(5) Set the mixture (altitude) control in the FULLY RICH position. On some installations a catch on the throttle lever ensures that the mixture lever is automatically returned to RICH as the throttle is closed.

(6) Where a manual air-intake control is fitted (Mk. 7 embodying Mod. G.1483) set the hot-and-cold air intake control in the COLD AIR position.

(7) Where the fuel supply is by gravity (Tiger Moth 2 installation) depress the carburettor flooder valve knob. Where engine driven fuel pumps are fitted (Magister 1 and Auster T7 installations) operate one of the hand priming levers on the fuel pumps through the full range of travel whilst holding OUT the carburettor flooding device.

(8) Turn the engine through several revolutions by the propeller in order to prime the cylinders.

(9) Move the throttle lever forward about ½ in. from the fully closed position.

(10) Switch ON the starboard magneto.

(11) Swing the propeller cleanly through the compression stroke to start the engine. When the propeller is being

swung, it is advisable for a second operator to be ready to adjust the throttle lever setting if required, as the engine starts.

(12) When the engine is running switch ON the port magneto.

Starting by use of the electric starter

15. When starting a Mk. 7 fitted with an electric starter, the sequence of operations given in this paragraph must be carefully observed. If the engine is to be started from a starting trolley, set the ground/flight switch in the aircraft to GROUND; otherwise set the switch to FLIGHT. Although the initial turning to prime the cylinders can be done with the electric starter, hand turning is preferable.

(1) Ensure that all oil cocks, if fitted, are turned ON.

(2) Ensure that both magnetos are switched OFF.

(3) Turn ON the fuel cock.

(4) Set the throttle lever in the FULLY CLOSED position.

(5) Set the mixture (altitude) control in the FULLY RICH position. In the Auster T7 aircraft a catch on the throttle lever ensures that the mixture lever is automatically returned to rich as the throttle is closed.

(6) Where Gipsy Mod. G.1483 is embodied, set the hot-and-cold air intake control in the COLD AIR position.

(7) Operate one of the hand priming levers on the fuel pumps through the full range of travel whilst holding OUT the carburettor flooding device.

(8) Turn the engine through several revolutions by the propeller in order to prime the cylinders.

(9) Move the throttle lever forward about ½ in. from the fully closed position.

(10) Switch ON both magnetos.

(11) Press the starter push button. Turning periods should not exceed 20 seconds with a 30-second interval between periods.

(12) When the engine is running smoothly, if a ground starter trolley has been used, disconnect the battery and set the ground/flight switch to FLIGHT.

Subsequent attempts to start

16. If the engine fails to start at the first attempt it is not necessary to repeat the complete starting sequence given in para. 12 or 13 as applicable. When using the electric starter it is only necessary to check that all controls, etc., are correctly set and to press the starter push button again. In cold weather or with a cold engine, a little additional fuel priming may be advisable before making a subsequent attempt to start the engine.

Starting a hot engine

17. When starting a hot engine that has only been standing for a short period since the previous ground run or flight, the operations detailed in sub-para. 7 and 8 in either para. 14 or 15 as applicable may be omitted.

Failure to start

18. The engine should start easily in normal weather. The most likely cause of trouble is over-priming. If this occurs, switch OFF both magnetos, and with the throttle fully open turn the engine backwards by hand. If the engine still fails to start after two or three successive attempts reference should be made to Chapter 8 and a systematic investigation made.

Ground running and checks

19. If the oil pressure does not rise almost immediately to at least 30 to 40 lb. per sq. in. the engine must be shut down and the cause investigated. The oil pressure may rise considerably above this figure, particularly in cold weather. If diluted oil has been used for priming the lubricating system, attention is drawn to para. 5, sub-para. 2. When the oil pressure is correct proceed as follows:—

(1) Run the engine at 1,000 to 1,200 r.p.m., selecting the r.p.m. at which the engine runs most smoothly, for about four minutes to allow the oil to warm up and circulate freely. Under winter conditions eight minutes or more should be allowed. The oil temperature should then be at least 15 deg. C.

(2) With the cowling open, run the engine at 1,000 r.p.m. and make a quick visual check for fuel and oil leaks. If any leaks are observed shut down the engine and investigate.

(3) When the engine is running satisfactorily open up steadily to full throttle, check the oil pressure and observe carefully for any indication of unusual behaviour. The engine should not be held at full throttle for more than 30 seconds, and under tropical conditions this period should be reduced. The full-throttle r.p.m. on the ground will vary slightly with the propeller fitted.

(4) With the engine running at full throttle switch OFF each magneto in turn; the resultant drop in r.p.m. should be approximately 50 r.p.m. and in the case of Mk. 1 variants should never exceed 100 r.p.m., or 120 r.p.m. in the case of a Mk. 7. Whilst making this check there should be no excessive vibration.

(5) After the engine has been stopped make a detailed inspection for fuel and oil leaks and any other visible defects.

Stopping the engine

20. When stopping the engine take care to avoid a backfire. This sudden reversal of rotation causes a shock load throughout the engine, particularly on the gear trains within it, and may seriously damage the half speed gears in the magnetos. The risk of backfiring can be minimised by idling the engine at between 800 and 1000 r.p.m. for a few minutes before shutting down, so that the engine cools gradually. This precaution, particularly following flight, taxying, or prolonged ground running, when cylinder head temperatures have reached a near maximum limit, will also avoid cylinder head cracking caused by too rapid cooling. After observing these precautions, stop the engine:-

(1) Switch OFF both magnetos and open the throttle fully.

(2) Turn OFF the fuel cock.

(3) When the propeller has stopped rotating, close the throttle.

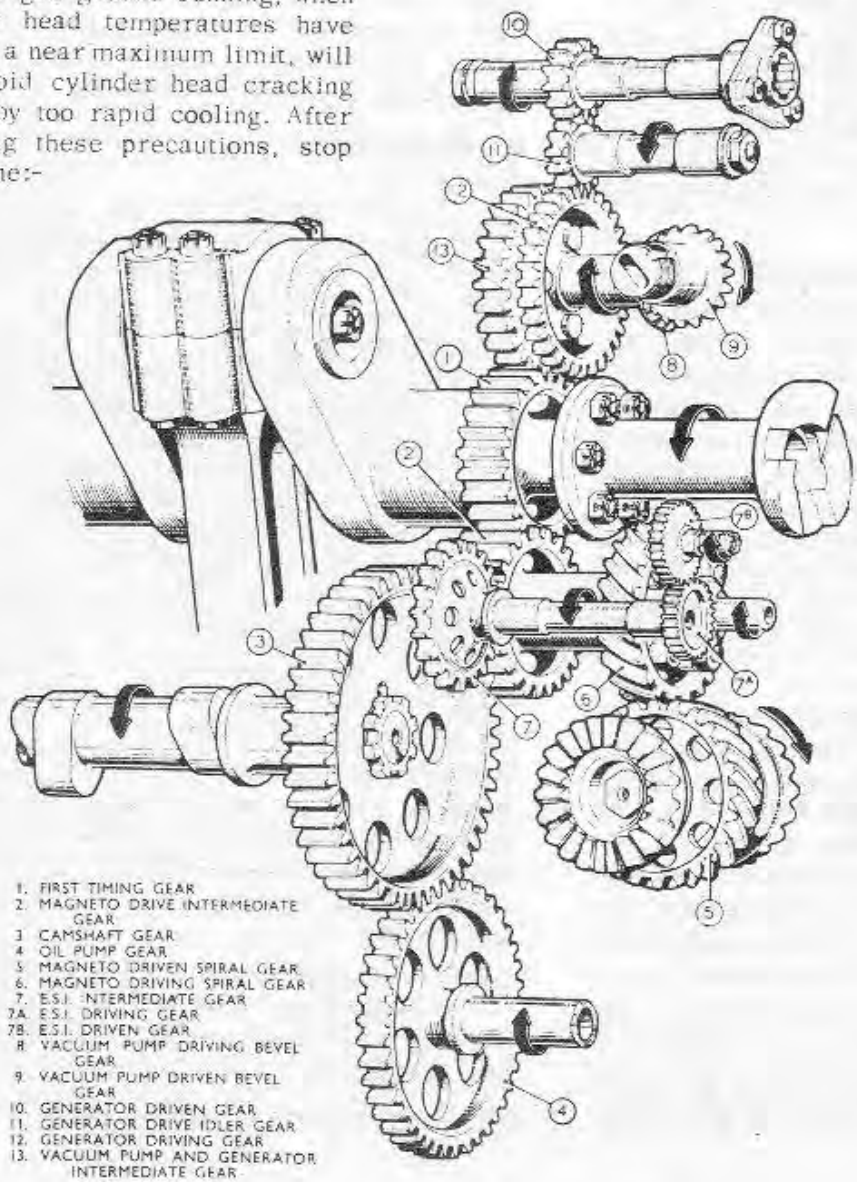
21. In tropical or hot climatic conditions, as an added precaution against fire risk, the following procedure for stopping the engine is recommended.

(1) Move the throttle to the slow-running position and allow the engine to idle for a few minutes to cool.

(2) Turn OFF the fuel cock.

(3) Open the throttle slightly and allow the engine to run in order to drain the carburettor.

(4) When the engine ceases to rotate, switch OFF the magnetos and close the throttle.



Timing and accessory drive gears, 1G engine

Chapter 7

FLIGHT OPERATION

LIST OF CONTENTS

General

1. This chapter is concerned with flight operation and control of the engine only, and does not include specific information peculiar to individual aircraft or installations. When such information is required, reference must be made to the relevant Pilot's Notes and aircraft maker's handbook. Instructions for starting, ground running, and stopping are given in Chapter 6.

2. The Operating Limitations given at the beginning of this volume are those for which these engines have been approved for service use. Infringement of these limitations may lead to defects which will render the engine unserviceable before the normal period between reconditioning has been completed. Since a fixed-pitch propeller will not allow the engine to obtain its maximum permitted r.p.m. under all conditions, the r.p.m. stated in the Operating Limitations for take-off and/or operational necessity, may not be obtainable.

3. Constant check should be made of the pressure and temperature readings and the limitations specified for each operating condition must not be exceeded. This is of particular importance when a new or re-conditioned engine is being flown for the first time. If the oil pressure falls below the minimum value specified in the Leading Particulars, the flight should be terminated.

4. When a long period of idling is unavoidable, as for instance when waiting for the runway to clear, the aircraft should be turned into wind to reduce the risk of overheating. The engine should be allowed to run at a speed of 700 to 1000 r.p.m., selecting the r.p.m. at which the engine runs most smoothly and occasionally increasing the speed to about 1200 r.p.m. to assist in keeping the sparking plugs free from oil.

Operation of controls

Throttle

5. Smooth operation of the throttle is an important factor in conserving the life of the engine and coarse movement of the throttle lever should be avoided. On Mk. 1 series engines and on the Mk. 7 when Mod. G.1483 has not been embodied, increased resistance will be felt to throttle lever movement beyond the normal cruising position, because the throttle is interconnected with a spring-loaded air-intake valve, which opens immediately after the cruising position to change the carburettor air supply from hot to cold air. The magneto advance and retard control is also interconnected with the throttle control in such a manner that the ignition is fully advanced when the throttle has reached the one-third open position.

Mixture (altitude) control

6. The mixture (altitude) control must be in the FULL RICH position for starting, ground running, and take-off. This control may be employed to weaken the mixture for two purposes:—

(1) To rectify rough running caused by over-richness due to operation at a higher altitude, or changes in climatic conditions.

(2) For economy in cruising flight.

7. To obtain increased smoothness and economy at altitude, move the control carefully towards the WEAK position until a slight drop in r.p.m. occurs, then bring the lever back towards the RICH position just sufficiently to restore the original r.p.m.; the distance the lever is moved back towards RICH is approximately half that moved towards WEAK. The engine must not be run longer than necessary when the engine speed has been decreased by the use of the mixture control. The control is then set in the correct position for all throttle settings at that particular altitude. Whenever any change in altitude occurs this control must be immediately re-adjusted. There is, however, little gain in using this control below 2000 feet. The mixture control must always be in the Rich position when diving and approaching to land. On some aircraft, e.g., Tiger Moth 2, this control is locked in the RICH position but on the Auster T7, the lever operates in a quadrant adjacent to the throttle and a catch on the throttle lever ensures that the mixture lever is automatically returned to RICH as the throttle is closed.

Hot-and-cold air intake control

8. On the Mk. 1 variants and on the Mk. 7 when Mod. G.1483 has not been embodied, the hot-and-cold air intake valve is interconnected with the throttle to permit the intake of "hot" air for cruising and cold air for maximum power. The hot air intake is provided with a flame trap. On Mk. 7 engines where a separate manual control has been fitted by the embodiment of Mod. G.1483, two positions enable either cold air from the duct through the cowling or heated air from the flame trap adjacent to the cylinders to be selected; this control is completely independent of the throttle control. In cruising flight "hot air" should be used continuously unless the ambient temperature exceeds 30 deg. C. This is done automatically on the Gipsy Major engines with interconnected air-intake and throttle controls without regard to the ambient temperature. Observation of this instruction should ensure freedom from carburettor icing in flight. Where, however, due to the use of cold air at lower ambient temperatures ice has been permitted to build up on the throttle, the selection of hot air alone may not be sufficient to ensure rapid dispersal of the ice, and some manipulation of the throttle may be necessary to assist in rapid de-icing. If the humidity is high, carburettor icing can occur with an ambient temperature as high as 15-20 deg. C. and these conditions may exist even though the air is clear.

9. Where a manual air-intake control is provided, cold air must be used for starting but to assist the engine to run steadily in cold weather, hot air may be selected immediately after the engine has been started and is running steadily; the control being returned to the cold air position when the engine has reached a suitable temperature and before any attempt is made to take-off. Take-off and climb should normally be made with the control in the COLD air position but should icing conditions be suspected hot air may be used. Whilst the manual control is operated at the discretion of the pilot, the effect of the hot air reduces the full-throttle power obtainable and this reduction may be as much as eight per cent under unfavourable conditions.

Take-off

10. For take-off ensure that the oil temperature is at least 15 deg. C., and set the controls as follows:—

(1) Air-intake control (where manual control is provided):—cold air.

(2) Mixture (altitude) control (unless locked in the rich position):—full rich.

(3) Throttle lever:—full throttle.

The maximum permissible take-off r.p.m. stated in the Operating Limitations may not be obtainable with a fixed-pitch propeller; refer also to para. 2.

Climb

11. Climb at full throttle to approximately 1000 ft., or for five minutes, whichever takes the shorter time, then throttle back and continue the climb at normal climbing r.p.m. On no account must the duration of the climb or the operating conditions exceed those permitted by the Operating Limitations.

Cruising

12. Whilst the engine may be operated at the engine speed, oil pressure and temperature stated in the Operating Limitations, it is inadvisable to do so continuously; furthermore, with a fixed-pitch propeller, the permissible limiting r.p.m. is not necessarily obtainable in level flight without moving the throttle lever into the rich-mixture range. As described in Chapter 3, the power jet in the carburettor is brought into operation by a cam on the throttle valve spindle at a fixed angle before full throttle, therefore at a corresponding point in the throttle lever travel, the power jet is brought into operation automatically. If, on the ground, the throttle lever is moved steadily towards the full throttle position and at the same time a second operator observes the point at which

the cam on the carburettor commences to lift the power jet valve tappet, the throttle lever quadrant can be marked to indicate the point of change-over from weak to rich. The engine should be throttled down to the engine speed recommended in the relevant Pilot's Notes (below 2000 r.p.m. in the case of a Gipsy Major Mk. 1 or 2100 r.p.m. in the case of a Gipsy Major Mk. 7) whenever maximum conditions are unnecessary, and the mixture (altitude) control, if operative, adjusted to give best economy consistent with smooth running as described in para. 6.

Diving

13. Whilst diving, the throttle must be at least one-third open and the use of maximum permissible r.p.m. limited to 20 seconds duration. Ensure that the mixture control, if operative, is placed in the FULL RICH position, before commencing to dive the aircraft.

Gliding

14. When gliding from any considerable altitude, the throttle should be opened at intervals to keep the engine warm, and the mixture control lever, if operative, placed in the FULL RICH position.

Landing and shutting down

15. When coming in to land, the mixture (altitude) control, if operative, must be set in the FULL RICH position in order to obtain maximum power in the event of a baulked landing.

AVOIDANCE OF SPARK PLUG FOULING

On engines using leaded fuels, the attendant problems of spark plug fouling can be alleviated and the periods between spark plug servicing increased if due attention is given to the following maintenance and operating instructions.

Maintenance Instructions

1. When cleaning plugs, make certain that all traces of lead deposit are removed from the nose insulator and plug body over the full flashover length, as well as from the points.
2. Keep gaps up to the maximum approved limit i.e., ·015 in. Do not exceed the maximum limit.
3. Make quite certain that mixture settings are correct, for all conditions of operations.
4. Avoid excessive use of the priming pump at starting. Over-doping leaves too much fuel in a cold engine and can start bromide precipitation.
5. It is recommended that plugs be serviced at an initial period of 25 hours and if the conditions warrant, this period may be extended to 50 hours or even higher.

Operating Instructions

1. Avoid over-doping.
2. As soon as r.p.m. builds up, open up to 1200 r.p.m. for warming up. Carry on with run up or taxying as soon as oil temperature reaches 15 deg.
3. During ground running, never idle engines at less than 1,000 r.p.m. except when necessary in taxying.
4. For general cruising, the higher the engine speed (within the scale of approved limitations) the less prone will the plugs be to leading. If it is necessary to cruise at low engine speed for any length of time, it is advisable to clear the engine periodically (say at 20 minute interval) by opening up to maximum weak mixture r.p.m. for about a minute.
5. On letting down from cruising height it is desirable to keep the throttle as near to cruising position as possible, and not throttle back more than is necessary to maintain airspeed at a reasonable figure. If a rapid throttled descent should be unavoidable the engine should be cleared periodically by levelling off and opening up to full power.

Chapter 8

RUNNING DEFECTS

LIST OF CONTENTS

General

1. Running defects will be reduced to a minimum if requirements of the Maintenance Schedule are conscientiously fulfilled. In this chapter an attempt has been made to list, in an alphabetical table, all known and possible defects which may effect the running of the engine. It is impossible to forecast the peculiar defects that may occur in individual engines; this chapter is therefore not intended to supersede the knowledge of an experienced operator, but to assist those who are unfamiliar with this particular type of engine.

2. The remedial action to be taken to correct many of the running defects listed is self-evident, e.g., cause "defective gauge" remedy "fit new gauge", and in such cases no entry has been made in column 4 of the table.

3. Para. 6 to 48 give brief instructions for the correction of a number of defects, the remainder being dealt with in other chapters of this volume, or covered in relevant aircraft or accessory publications.

Alphabetical table of running defects

4. The following table lists the defects in alphabetical order and indicates their possible causes. Where the remedial action to be taken is not self-evident, the column on the right-hand side of the table contains a cross-reference to a paragraph in this chapter, or to another chapter in this volume.

ALPHABETICAL TABLE OF RUNNING DEFECTS

Item No.	Symptoms	Possible defect	For remedial action refer to
1	Acceleration poor	Incorrect mixture	para. 23 to 32
		Ignition retarded	Chap. 10
		Defective sparking plugs	para. 8
2	Back-firing (firing in the exhaust system)	Excessively rich mixture	para. 23 to 25 & 32
		Two defective sparking plugs in one cylinder, unburnt gases in exhaust system	para. 8
		Ignition very retarded	Chap. 10
		Excessively weak mixture	para. 26 to 31
		Ignition leads crossed	Chap. 12

ALPHABETICAL TABLE OF RUNNING DEFECTS (*continued*)

Item No.	Symptoms	Possible defect	For remedial action refer to
3	Carburettor flooding	Flooder cable (if fitted) incorrectly adjusted	Chap. 10
		Stuck flooder valve	para. 32
		Dirt under needle valve	
		Worn needle or seating	
		Loose seating	
		Sluggish or seized float mechanism	
		Defective float	
4	Electric starter (if fitted) failure	Ground/flight switch incorrectly set	para 33
		Discharged batteries	
		Defective wiring	
		Defective starter	Chap. 5
5	Cutting out	Switches accidently switched off	
		Fuel cock inadvertently closed	
		Switch leads shorting to earth	
6	Cutting out (on sudden opening or closing of the throttle)	Incorrect mixture	para. 23 to 32
7	Cutting out (momentarily)	Defective ignition	para. 6 to 22
		Fuel build up in the induction system due to long idling period	
		Incorrect mixture	para. 23 to 32
		Defective fuel pump (if fitted)	Chap. 9 and Chap. 12
8	Excessive r.p.m. drop on single ignition	Defective ignition	para. 6 to 22
		Incorrect ignition timing	Chap. 10
		Incorrect mixture	para 23 to 32
9	Failure to start	Over priming	
		Insufficient priming	
		Induction manifold drain blocked	para. 24
		Defective ignition	para. 6 to 22
		Defective fuel system	para. 27 to 31
		Water in carburettor	para. 29
		Slow-running jet blocked	para. 23
		Defective impulse starter	Chap. 9
		Defective electric starter (if fitted)	Chap. 5
10	Failure to "pick-up" and continue running after starting	Incorrect mixture	para. 23 to 32
		Water in carburettor	para. 29
11	Lack of power	Loss of compression	para. 41 and 42
		Defective ignition	para. 6 to 22
		Incorrect ignition timing	Chap. 10
		Incorrect adjustment of aircraft or engine controls	para 43
		Incorrect mixture	para 23 to 32
		Two defective sparking plugs in one cylinder	para. 8
		Incorrect tappet clearance	Chap. 10
12	Loss of compression	Worn or broken piston rings	para. 42
		Defective cylinder-head barrel joint	para. 41
		Sticking valves	
		Defective valve seat or seating	
		Broken valve springs	

ALPHABETICAL TABLE OF RUNNING DEFECTS (*continued*)

Item No.	Symptoms	Possible defect	For remedial action refer to
13	Missing or irregular firing	Defective sparking plugs	para. 8
		Defective ignition	para. 6 to 22
		Incorrect carburation	para. 23 to 32
		Incorrect tappet clearance	Chap. 10
14	Oil pressure incorrect or fluctuating	Faulty pressure gauge	
		Insufficient oil in tank	
		Defective pipe lines	
		Faulty relief valve	para. 37 and 38
		Bearing failure	para. 39 and 40
		Air leaks or locks (particularly on suction side of pump)	para. 36 and 37
		Choked oil filter	Chap. 9
		Very low or very high oil temperature	
15	Overheating	Defective temperature gauge	
		Bearing failure	para. 39 and 40
		Cowling duct to airscoop obstructed	
		Weak mixture	para. 26 to 32
		Ignition retarded	Chap. 10
		Incorrect tappet clearance	Chap. 10
		Cowling duct to oil cooler (if fitted) obstructed	
		Lubrication defect	para. 34 to 40
16	Popping back (firing in the induction system)	Weak mixture	para. 26 to 31
		Defective ignition	para. 6 to 22
		Engine not warmed through	
17	Surging (fluctuating reading on tacho-meter)	Aircraft not headed into wind (on gusty days)	
		Faulty tachometer	
		Air leak in fuel system	para. 26 to 28
18	Smoking exhaust (persistently)	Rich mixture (black smoke)	para. 25
		Worn piston rings (blue smoke)	Chap. 12
19	Smoking exhaust (when starting or opening up)	Over priming	
		Induction manifold drain blocked	para. 24
		Burning excessive oil accumulated by prolonged idling	
		Burning corrosion inhibitor	
20	Slow-running faulty	Incorrect carburation	para. 23 to 32
		Defective ignition	para. 6 to 22
21	Vibration and rough running	Defective ignition	para. 6 to 22
		Incorrect carburation	para. 23 to 32
		Mechanical defects	
		Loss of compression	para. 44 and 45
		Engine loose on mountings	
		Induction manifold leakage	para. 27
		Induction blockage	
		Propeller hub loose on crankshaft	Chap. 9
		Propeller out of balance	
		Spinner out of truth	
		Reduced valve spring loads	

Correction of defects

5. It is essential to refer to the table given in para. 4 to obtain a knowledge of the symptoms likely to cause trouble and the following paragraphs briefly describe the correction of a number of the defects listed.

Ignition

6. If trouble is experienced with the ignition system it does not necessarily follow that the magnetos are at fault. Unnecessary work may be avoided if the sparking plugs, the L.T. wiring, ignition switches, and H.T. wiring or ignition harness are checked first. Defective carburation, and mechanical defects such as incorrect tappet clearance, can also cause erratic running which may appear to be due to the ignition system.

7. From a "single ignition" check it is usually possible to decide whether the defect is confined to the port or starboard ignition equipment, or whether both are defective. If the engine completely stops firing when one magneto is switched off, it indicates that the whole of the other ignition system is not functioning. This may be due to the L.T. wiring or ignition switch shorting to earth and this point should be checked first.

Sparking plugs

8. Where it is suspected that one or more of the sparking plugs is defective, the quickest check and remedy is to change the suspected sparking plug, a half or a full set according to the result of the single ignition test, for serviceable plugs of the correct type; instructions for removing and refitting sparking plugs are contained in Chapter 9. Sparking plug failure may be due to condensation of moisture, or fuel, on the electrode or, where leaded fuels are used, to deposits of lead bridging the electrodes. Carbon on the insulation and/or the interior of the sparking plug body may cause leakage of the H.T. current or internal sparking. Sparking plugs should be cleaned, the gaps reset, and tested.

H.T. cables and ignition harness

9. The unscreened H.T. cables on Gipsy Major Mk. 1 engines are carried in light alloy tubes alongside the cylinder heads and are threaded through a length of Systoflex sleeve between the rear end of the light alloy tubes and the distributors. The Gipsy Major Mk. 7 is fitted with standard screened ignition harness. In either case, the high-tension leads are very susceptible to the effects of moisture, and if the aircraft has been exposed to damp, a short circuit may occur which will produce partial or complete failure. If all the sparking plugs are known to be satisfactory any leakage experienced will be in the H.T. leads or in the magneto, which in this instance, includes the distributor.

10. Instructions for the removal and refitment of the H.T. cables or the ignition harness are given in Chapter 12.

11. Incorrect connection of the H.T. leads can cause back firing and other symptoms of defective ignition. Each H.T. lead in a screened ignition harness is marked with the number of the sparking plug to which it must be connected. Unscreened H.T. cables and the terminals in the distributor can be identified by reference to Chapter 4, fig. 1.

Distributors

12. Misfiring or poor starting may be due to dirt inside the distributor or on the surface of the brush holder. Instructions for cleaning the distributor are contained in Chapter 9.

13. Faulty sparking may also be the result of distributor electrodes, or the brush holder electrode, being burnt away. Failure to spark may be caused by a short circuit in the distributor, or the brush holder.

H.T. collector

14. Carbon dust on the H.T. collector moulding, or on the H.T. pick-up slip ring flanges may cause complete or partial failure to spark. Chapter 9, page 86, contains instructions for cleaning these parts.

Contact breaker

15. When either of the contact-breaker covers is removed the ignition switch is inoperative, and it is stressed that *the propeller must not be turned* under these conditions unless the H.T. leads have been detached or a sparking plug removed from each cylinder.

16 Chapter 9, page 86, contains instructions for cleaning the contact points. Chapter 10 at the same time describes the adjustment of the contact breaker gap and Chapter 12 the procedure for timing and the method of removing and refitting a magneto. Instructions for dismantling, re-assembling, and testing the magneto are contained in the relevant magneto publication.

17. Poor performance at low engine speeds may be caused by pitting of the contact faces (*para.* 19) or too small a contact gap. The

latter may be the result of incorrect adjustment or wear of the contact lever heel.

18. Poor performance at high engine speeds may be caused by too large a contact breaker gap, which may be the result of incorrect adjustment, or an excessive rate of contact wear due to one or more of the causes given in the following para. for pitted and blackened contacts.

19. Excessive arcing at the contacts resulting in poor slow-speed performance, and probable misfiring at high speeds if the arcing is very bad, may be caused by pitting or blackening of the contacts. This may be the result of oil or foreign matter on the contact faces, perhaps due to the use of dirty feeler gauges or to excess of lubricant on the contact breaker generally. Other possible reasons are weak contact breaker spring, sluggish contact breaker lever movement, or incorrect fit of the contact breaker lever on the pivot pin, contact faces out of line or the contact loose in either the lever or contact block, unsatisfactory connection between the primary winding and insulated side of the condenser or defective condenser.

20. The engine may "cut out" completely if the contact breaker spring is broken, or if the contact lever seizes on its pivot pin.

Impulse starter

21. Failure to start or symptoms of retarded timing may be due to the impulse starter sticking or to a broken impulse starter spring. The method of checking the impulse starter is described in Chapter 9, further information can be obtained from the relevant magneto publication.

Timing

22. Instructions for checking the magneto timing are contained in Chapter 10. If the timing is suspected, first check the contact breaker gap and, in the case of the starboard magneto, the impulse starter, before altering the timing. Also check that the magneto timing lever is as far forward as the stops in the magneto will allow when the pilot's throttle lever is in the full throttle position.

Carburation

23. Carburation defects can be reduced for all practical purposes to too much fuel or too little fuel. Too much fuel, i.e., over-rich mixture, results in laboured, heavy running, with a tendency for the engine to "hunt" and for black smoke to issue from the exhaust. Too little fuel, i.e., excessively weak mixture, causes the engine to spit back into the induction manifold, to lack power, and to overheat. The main and power jets can be removed without removing the carburettor from the engine and reference should be made to the instructions contained in Chapter 9. For further examination the carburettor must be removed as described in Chapter 12.

Induction manifold drain

24. If the defect is at slow-running or small throttle openings, it is advisable to check the induction manifold drain elbow, Part No. 1905-36, which has a 2 mm. diameter orifice calibrated to give a known air leak. The orifice may be obstructed or damaged. The Part No. should also be checked as a similar part intended for another engine would not have the same size orifice.

Over-rich mixture

25. Over-rich mixture may be due to flooding, the fitting of incorrect jet sizes, loose or damaged jets, alteration of the mixture control screw adjustment or leakage of the power jet valve at small throttle openings. The power jet valve should be closed at small throttle openings and open between half-way and two-thirds way before the full-throttle position. The first three can be dealt with as described in Chapter 9, but to deal with the remainder it will be necessary to remove the carburettor.

Excessively weak mixture

26. Before investigating the possible cause of weak mixture symptoms, ensure that the fuel supply cock is fully turned on and that the mixture (altitude) control valve is in the full rich position. Excessively weak mixture may be due to air leaks between the induction manifold and the carburettor, or between the induction manifold and the cylinder head joint faces. In gravity feed installations leaks may occur in the connections between the tank and the carburettor. In the case of engines fitted with fuel pumps, air leaks are most likely to occur at the filter bowl joints but may also occur at the fuel pumps or in the connections between the tank and the fuel pumps. Plugs blanking redundant primer and instrument connections in the induction manifold may also be a source of leakage. Other causes are fuel pump (if fitted) failure, foreign matter or water in the

fuel, partially blocked or incorrect jet sizes or a restriction in the fuel pipes.

27. Air leaks between the induction manifold and the carburettor, and the manifold and the cylinder head joint faces may be rectified by reference to the instructions contained in Chapter 12. The redundant connections may simply require tightening; if necessary, fit new joint washers.

28. If, where fuel pumps are fitted, the fuel pump filter bowl joint is at fault, remove the filter as described in Chapter 9, observing the precautions detailed in that chapter when refitting the parts. Air leaks in other parts of the fuel system can usually be remedied by remaking the joints concerned.

29. To remove foreign matter or water from the carburettor, remove the main and power jets. In gravity feed installations flush the system by turning ON the main fuel cock, and, where fuel pumps are fitted by operating the fuel pump priming lever. If this is ineffective the complete fuel system will have to be dismantled and cleaned out.

30. Restricted or incorrect jets may be dealt with as described in Chapter 9.

31. Gravity feed installations may be checked as described in Chapter 9. To check if fuel pump (when fitted) failure is responsible, carry out the fuel pump check described in the same chapter. If a fuel pump is found to be faulty, a replacement pump should be fitted as described in Chapter 12, page 102.

32. Mechanical defects in the carburettor such as a stuck flooder valve, dirt under the needle valve, worn needle valve or seating, loose needle valve seating, sluggish or seized float mechanism, or a defective float, can only be dealt with by dismantling the carburettor.

Electric starter

33. Where an electric starter is fitted, failure to operate may be due to incorrect setting of the ground/flight switch which must be set to GROUND when the engine is to be started from a ground starter trolley or FLIGHT if the battery in the aircraft is to be used. Failure to plug in the ground starter trolley socket securely, discharged batteries, faulty wiring or switches, or a faulty starter may cause failure to operate. The actions necessary to remedy most of these defects are self-evident. Wiring and switches must be checked in conjunction with the instructions contained in the relevant Aircraft Publication. A defective electric starter must be removed and replaced as described in Chapter 5.

Lubrication

34. Any serious lubrication defect will necessitate removal of the engine from the aircraft as described in Chapter 5, as it is not possible to change an oil pump without major dismantling of the engine. Other than complete failure, high or low pressures are the defects which may occur.

35. Before investigating incorrect oil pressure, check that the oil pressure gauge is registering correctly, replacing it by a serviceable gauge if necessary.

Low oil pressure

36. If the observed oil pressure fluctuates or is very low, check the pipe line joints on the suction side of the pressure pump, the suction filter cap and drain plug for airleaks. If diluted oil has been used, reference should be made to the remarks in Chapter 6. The cause may be due to restrictions in the pressure filter; give the handle one or two complete turns to remove any sediment from between the filter plates. If necessary, remove and clean the filter as described in Chapter 9. When the possible causes have been checked, prime the lubricating system as described in Chapter 6.

37. If the oil pressure is still low, it may be due to foreign matter holding the relief valve open, or the relief valve spring may be weak or broken. Dismantle the relief valve as described in Chapter 10, wash the parts clean in kerosene, examine and reassemble. Do not adjust the oil pressure relief valve setting unless quite certain that it is necessary as low oil pressure, particularly if accompanied by high oil temperature, may be caused by bearing failure. When dealing with a Gipsy Major Mk. 7, remove the scavenge filters and examine for particles of bearing metal, which if present will necessitate rejection of the engine.

High oil pressure

38. When starting a cold engine, particularly in cold weather, the oil pressure will rise to a much higher figure than normal and pressures as high as 100 lb. per sq. in. may be registered. An investigation should be made if the oil pressure does not settle down to the normal value when the engine has warmed-up. A slight possibility is that the relief valve has stuck, in which case proceed as in para. 37. If a bearing has failed, particles of bearing

metal may be restricting the oil circulation. When dealing with a Gipsy Major Mk. 7, remove and examine the scavenge filters; if particles of bearing metal are found in either filter the engine must be rejected.

High oil consumption

39. High oil consumption, normally indicated by blue smoke from the exhaust, may be due to oil leaks on the outlet side of the pressure pump, oil leaks in the oil drain pipes (Gipsy Major Mk. 1 variants), air leaks on the suction side of the scavenge pumps or choked scavenge filters (Gipsy Major Mk. 7), or worn or damaged piston rings.

40. Oil leaks on the outlet side of the pressure pumps, or in the oil drain pipes (Gipsy Major Mk. 1 variants), will be obvious on visual examination and rectification will depend on the location of the leak. With a Gipsy Major Mk. 7, air leaks on the suction side of the scavenge pumps might occur around the scavenge filter covers, or at either end of the pipes from the scavenge filters. Choked scavenge filters are unlikely owing to periodic examination, the exception being when diluted oil is used for the first time in an engine which has been operated for a large number of flying hours since the previous reconditioning.

Loss of compression

41. Faulty compression may result in difficult starting, serious loss of power, and overheating. The most likely causes are weak or broken valve spring, burnt or damaged valve or valve seat, valve sticking in valve guide, faulty cylinder head/cylinder barrel joint, sticking or broken piston rings; valve springs can be changed without removing the cylinder head.

42. Worn or damaged piston rings will be evidenced by excessive quantities of smoke from the exhaust and will necessitate removal of the cylinder heads and barrels as described in Chapter 12.

Incorrect adjustment of controls

43. If it is suspected that the controls are incorrectly assembled or adjusted, check the adjustment of the engine control linkwork, and adjust if necessary as described in Chapter 10. The aircraft part of the control system should be checked, and adjusted if necessary as described in the relevant aircraft Publication.

Valve timing

44. The valve timing cannot be altered except when the engine is dismantled, as it is necessary to remove the timing gear cover in order to obtain access to the camshaft driving gears. If it is required to check the valve timing when investigating a defect for which no apparent cause can be found, this may be done as detailed in the following paragraphs.

45. Remove the four sparking plugs from one side of the engine to facilitate turning the crankshaft and remove No. 1 rocker cover. If, due to the valve-spring loading on the camshaft, difficulty is experienced in holding the crankshaft at a set position, remove the three rocker covers and the push rods and the valve stem thimbles from No. 2, 3 and 4 cylinders as described in Chapter 12.

46. Using feeler gauges inserted between the end of the rocker and the thimble on the valve stem, adjust No. 1 cylinder exhaust tappet to the correct value plus 0·005 in. This will enable a 0·005 in. feeler gauge, which will be nipped and freed respectively, to be used to determine the opening point of the valve. An alternative method with the tappet clearances set to the normal value, is to rotate the push rod with the fingers on the exposed portion of the push rod immediately above the rocker. The push rod will be free up to the instant the valve commences to open and will remain nipped until the instant the valve closes.

47. Turn the crankshaft forwards in the normal direction of rotation and observe whether the timing pointer attached to the propeller boss coincides with the mark EO on the front cover when the exhaust valve on No. 1 cylinder opens. The valve timing figures for each type of engine covered by these instructions will be found in the Leading Particulars at the beginning of this volume.

48. When the valve timing has been checked refit any push rods and valve stem thimbles that have been removed. Check the tappet clearances, and if necessary adjust to the correct value. Replace the rocker covers. Refit the four sparking plugs and reconnect the H.T. leads.