

PACKING AND UNPACKING

PACKING.

Engines are packed either for road transport on a stand, or for rail or ship in packing cases, and are inhibited and treated with Sozel or a similar protective grease before despatch.

Propeller spinners, exhaust stubs and similar fittings are packed separately on the stand or in the case and care should always be taken to see that they accompany the engine in the event of transfer from place to place.

Every care should be taken to close all openings to the interior of the engine to prevent foreign matter getting into the various ducts, ports, etc. When they leave the manufacturer's works blanking discs or dust caps are fitted to ensure arrival of the engine in good condition.

UNPACKING

Inspect the case and contents to see that no damage has occurred in transit.

Care should be exercised when unpacking to make sure that the attachment bolts are clear and any components attached to the inside of the stand or case removed.

Attach a two-hook sling with a spacing bar to the lifting eyes on the crankcase so that a straight upward lift is obtained.

THE LIFTING EYES MUST NOT BE TURNED TO ACCOMMODATE AN UNSUITABLE SLING.

Ensure that projections such as controls, pipes, etc., do not foul the supporting brackets or case and lift the engine clear.

Remove any blanking disc or cap and fit any connection which will be awkward to make with the engine in position in airframe and proceed with installation.

Check items, accessories, etc., with engine log book.

INSTALLATION INSTRUCTIONS

The airscoop is attached to the crankcase and to the cylinder head adjacent to the exhaust flange on the cylinder head. A single plate is fitted the whole length of the engine between the exhaust stub flanges and the cylinder heads to prevent the escape of air, and a backplate at the rear of the engine directs the air round the rear cylinder and blanks off the rear of the scoop (see Fig. 22).

No restriction is permitted to the open (front) end of the side chute and it should be a good joint with the machine nose cowl to prevent loss of cooling air.

Baffles are fitted on the starboard side of the engine consisting of plates which are located between the cylinders, causing the airflow to circulate round each cylinder before escaping. A front baffle is also situated in front of the cylinder nearest the propeller. The air cooling system should ensure that the maximum cylinder temperature during climb should not exceed that laid down in the "Leading Particulars."

COWLING.

Provision must be made for the escape of hot air from the engine bay by louvres or gills formed by "standing off" the cowling from the side of the fuselage. A total outlet area should equal 100 square inches on an aircraft with normal speed of 90 to 135 m.p.h., but on faster aircraft may be reduced slightly if cylinder head temperatures are within the prescribed maximum or if the aircraft will be permanently operated in a very cold climate. All new types of aircraft or cowlings should be subjected to flight tests and careful readings taken of cylinder head temperatures to check the installation before finally approving same. Cylinder heads have provision for Sangamo Weston type thermo-couples.

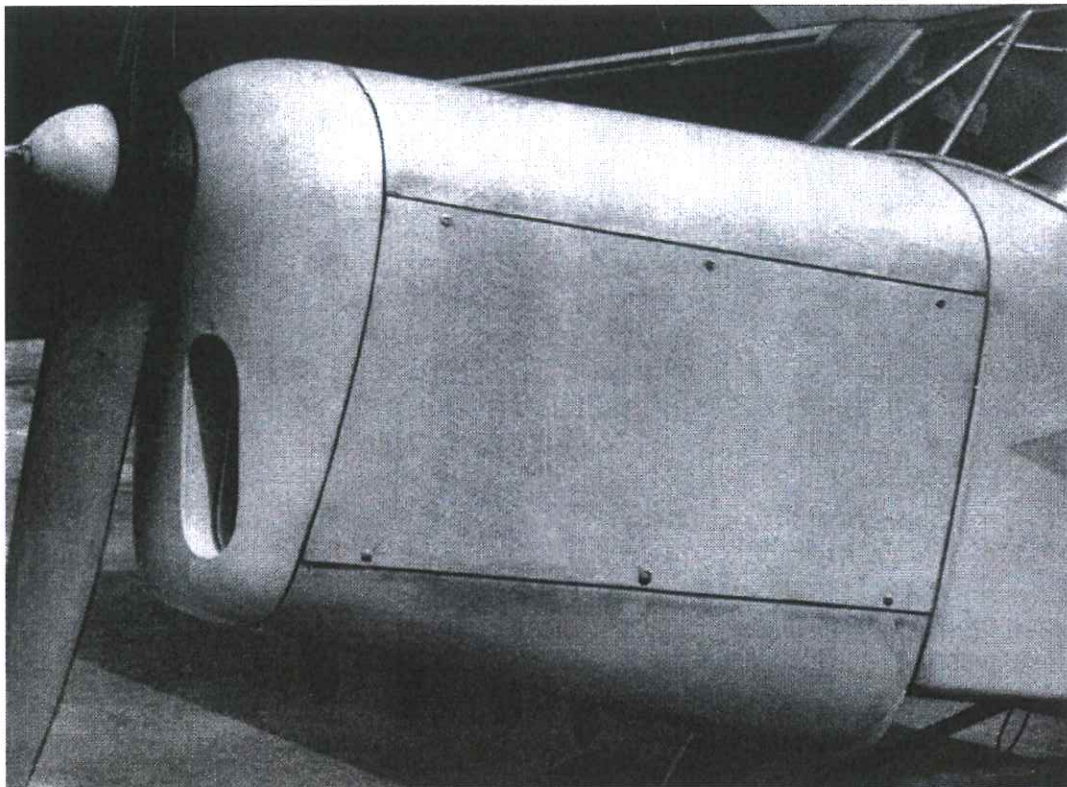


Figure 23.—Typical cowling arrangement.

The critical test is the maximum climbing test with full throttle when a good cowling should produce readings not in excess of 190°C . The maximum reading should not exceed 200°C .

The oil inlet temperature should not normally exceed 80°C . and on no account exceed 90°C . using oils specified. (*See Leading Particulars*).

An overheated engine will result if these figures are exceeded and denotes that the cowling and installation are unsatisfactory.

Whilst dealing with cowling, in order to give easy access to the front cylinder rocker box cover and valve gear for replenishing the oil bath and adjusting clearances (often neglected due to bad cowling design), it is suggested that the bottom cowling be split along the rocker box line and hinged at front or made easily detachable (see Fig. 23).

FUEL SYSTEM.

The engines are normally supplied to operate from a gravity tank feed, but if required for installations which place the engine above the petrol tank, provision is made by fitting two Amal fuel pumps.

In the case of direct gravity feed the petrol pipe from tank is connected direct to the carburettor union, but if pumps are used the pipe from the tank connects to a junction piece connecting the two pumps through the pipe lines. The pumps are then connected to the carburettor. The drain connection on the induction manifold must be connected to a small pipe and carried outside of the cowling.

All fuel pipes, filters and cocks should have a clear bore of not less than $\frac{1}{4}$ " diameter. When rigid fuel pipes are used, they must be well supported against vibration.

In no circumstances should the depression on the inlet side of the fuel pump, caused by restriction or low fuel tank position, exceed $1\frac{1}{2}$ lb. per sq. in. Should the depression be greater than this figure, trouble will occur due to vapour lock in the fuel pumps. The degree of depression to which the fuel can be subjected before the formation of vapour commences is determined by temperature, altitude and the vapour pressure of the fuel. Should it be intended, therefore, to operate the aircraft under conditions which tend to the formation of vapour, the depression at the fuel pump inlet should be kept to the absolute minimum, or if possible, even less than the figure quoted.

For gravity feed the head of petrol at the carburettor inlet should not be less than 18 ins. at the steepest angle of climb, and the flow of petrol should not be less than maximum engine requirements plus 25% measured with carburettor disconnected.

If pumps are fitted no gravity tank is necessary and the carburettor can be flooded by means of priming levers fitted to them for this purpose.

The normal pressure of these pumps should be between $1\frac{1}{2}$ to 2 lb. per sq. in., and each pump should be tested by operating the priming lever. A petrol pressure gauge can be temporarily inserted for test purposes if required.

FITTING PETROL PUMPS.

In the event of it being decided to fit Amal fuel pumps to an engine not so fitted by the manufacturers, first remove blanking plate, then should there be a shim or shims under this plate these should be left in position, as they adjust the length of the stroke of the pump plunger.

A plate, part No. FB.745, carrying the pump plunger assembly should now be placed in position, a washer, part No. FA.738, is fitted between the plate and the pump, and the pump can then be placed in position and secured.

The drain connection on each pump should be connected to a small pipe and carried outside of the cowling to carry away any excess petrol.

IGNITION.

The earthing terminals on the magneto contact breaker covers should be first connected to a standard twin knob switch to enable the magnetos to be earthed independently. The common earth connection on the switch must

be connected directly to some part of the engine and not to the airframe. Failure to observe this point will result in the ignition being "on."

To ensure safety to personnel when starting the engine by swinging the propeller, occasionally check the low tension earthing wires for continuity. For this operation removal of the contact breaker covers will be necessary, rendering the earthing switches inoperative; it should be noted that this is a dangerous condition since actuation of the impulse starter may start the engine should the propeller be turned. In no circumstances, therefore, should these tests be made without either (a) disconnecting the H.T. leads from the sparking plugs, or (b) removing the distributors.

After completing the tests, replace the contact breaker covers and leave both switches in the "off" position.

IGNITION SCREENING HARNESS—INSTALLATION.

1. Remove wrapping and fit the base plate under the distributor moulding on the studs provided.
2. Place distance pieces on studs and fit union support plate. Push the cover along the conduits out of the way while this is being done and temporarily tighten nuts on studs.
3. Remove half the split supporting clamp on the exhaust side of the engine and feed the conduits through the plate with No. 4 on top, then No. 3, 2 and 1 below. Replace clamp plate and support conduits by clips provided. Support inlet side conduits by clips provided.
4. Remove protecting caps from insulators and attach elbows to their respective spark plugs by means of the coupling nuts.
5. Cut distributor ends of leads as required, leaving sufficient slack wire for trimming at overhaul periods, fit tube terminals and attach to respective distributor terminals.
6. Remove nuts on studs, slide cover into position and re-tighten nuts. The conduits can be made to lie neatly by slackening the coupling nuts at the distributor end.

OIL SYSTEM.

A union suitable for fitting a direct type oil pressure gauge, is provided on the side of the oil system pressure filter.

The oil supply pipe to the engine is connected direct to a union on the oil pump body by a flexible pipe connection; the bore of this pipe should be at least $\frac{1}{2}$ in. diameter. The oil drain from the engine is provided by a flanged pipe connection at the front of the crankcase to which a large moulded rubber T-piece is fitted. One branch of the T-piece is connected by a pipe to the forward drain and the remaining branch provides the attachment for *the oil return pipe* to the tank. This return pipe should be preferably 1 in. diameter and should have a normal swaged beading to suit the hose connection on the T-piece. The minimum bore of the oil return pipe is $\frac{7}{8}$ in. diameter.

The relief valve is adjusted before the engine leaves the manufacturers' works and should not be interfered with.

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The oil pump should be primed before the engine is first tried out. To do this inject oil into the pump whilst turning the engine by hand.

Rocker box covers on cylinder head should be filled with engine oil to the level indicated on the cover.

Oil pressure registered on starting up the engine should not be less than 30-35 lb. sq. in.

LUBRICATION OF MAGNETO DRIVING GEARS ON ENGINES BEFORE USE AFTER HAVING STOOD IDLE.

Lubrication of the magneto driving gears on Cirrus "Minor" I and II Engines is carried out by splash, which is collected in an oil channel in the rear of the top cover and fed directly on to the gears. The two driven gears are deeply recessed and oil which is collected in the recesses is fed directly to the gear teeth through holes which are drilled radially in the gears for this purpose. In some cases it has been found that where an engine has not been run for some time there is a tendency for the oil to drain from the gears, and under these circumstances a short period of time elapses after the engine is first started up before the oil feed to the gears commences, and during this period wear may take place due to this lack of lubrication.

In order to overcome this the following procedure is recommended and may apply to engines in one of the following categories :

- (i) New or overhauled engines received for installation in aircraft.
- (ii) Engines already installed in aircraft which have not been run for some time.

Before starting up an engine which falls into category (i) or (ii) above, it is advised that the following operation be carried out :

- (i) Remove the 2 6-mm. nuts and spring washers securing the tachometer drive to the top cover and withdraw the drive.
- (ii) Through the orifice in the top cover exposed by the removal of the tachometer drive pour in $\frac{1}{2}$ pint of engine lubricating oil. This oil will flow directly on to the gears.

Refit the tachometer drive and start up the engine.

NOTE.—It is not sufficient to remove the blanking plate located on the opposite side of the top cover since the breather baffle in the top cover will prevent any oil introduced at this point from reaching the gears.

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CONTROLS.

A separate magneto advance and retard control is not fitted as the magnetos are interconnected with the throttle.

In the event of an independent mixture control being fitted, it must be so arranged that on closing the throttle lever in the cockpit the altitude control becomes interconnected and closed by the same movement. Failure to observe this will result in the engine cutting out when coming in to land.

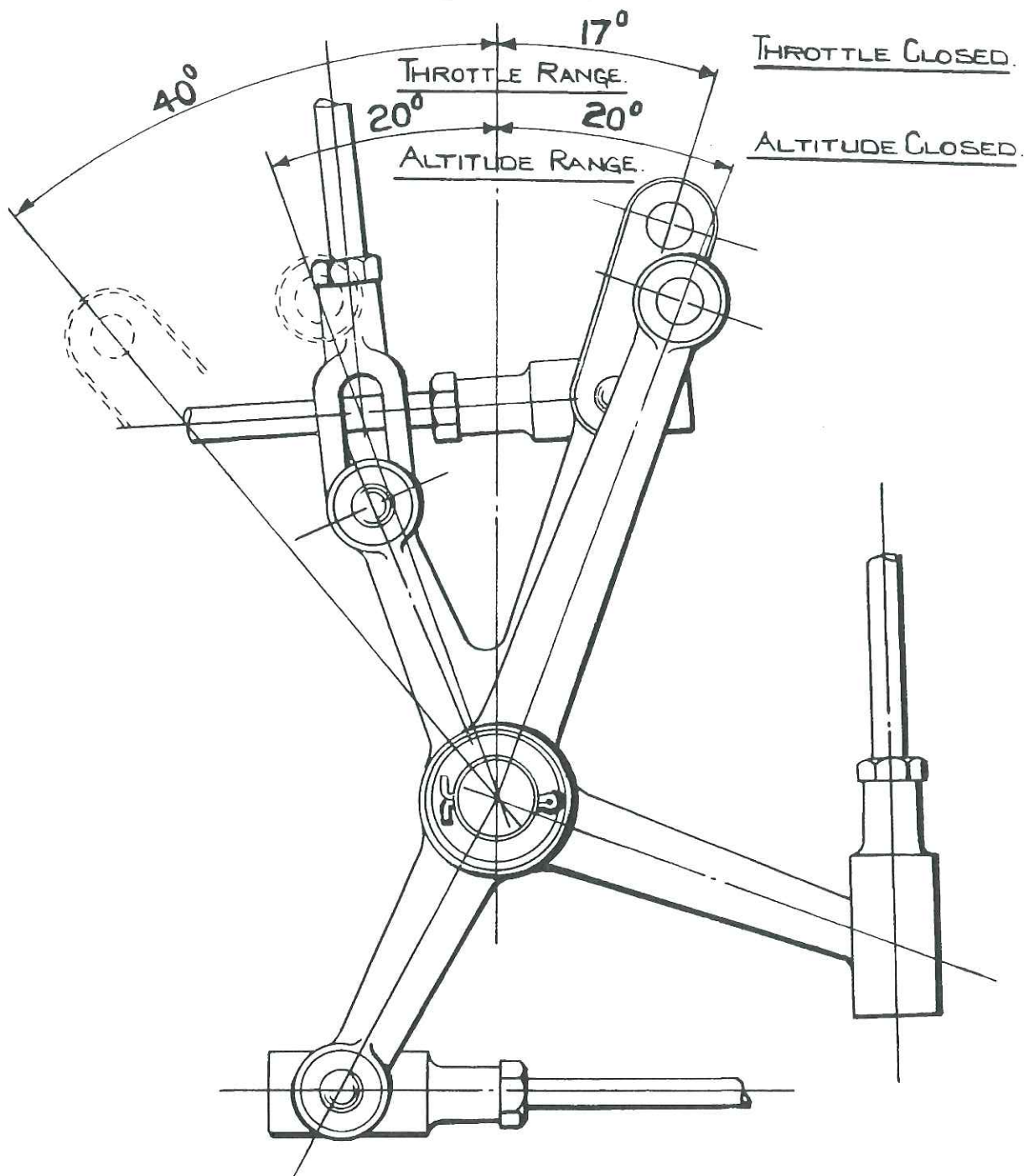


Figure 24.—Diagram for setting engine controls

It is important that the controls in the cockpit have slightly more travel than is necessary to ensure that the control levers on the engine make positive contact against the stops on the carburettor, noting that adjustments at slow-running stop will cause slight variations of travel. The throttle and magneto are interconnected so that when the throttle is closed the ignition is fully retarded, and as the throttle is moved through the first part of its travel the ignition is also moved to the fully advanced position, where it remains throughout the whole of the cruising range up to full throttle.

A direct cold air intake is fitted and is so arranged as to come into operation at 9/10ths to full throttle setting and closing again as soon as throttle opening is reduced to below 9/10ths, when the engine again breathes warm air from inside the cowling. See Fig. 24 for setting engine controls.

A small air scoop should be fitted to the outside of cowling to provide direct cold air to the air intake opening which carries a flange to enable a suitable duct to be fitted.

Care should be taken when fitting propeller (particularly if wooden type) that the nuts are evenly tightened.

The propeller hub should not be removed from the crankshaft to remove the propeller, unless this is of variable pitch type with integral hub.

STORAGE OF ENGINE

If the engine has not been operated on leaded fuel special precautions need not be taken, but if the engine is to be stored or not operated for any length of time, the instructions given in the following paragraphs should be observed.

If leaded fuel has been used then the following additional precaution is necessary to prevent internal corrosion.

The engine should be run on an unleaded fuel of the correct octane value for a period of 15 minutes to remove the lead deposits, after which the engine should be inhibited, etc., as described below.

Before laying up the aeroplane and storing the engine for any length of time, the engine should be warmed up until the oil is circulating freely. The engine should then be stopped and the oil drained from the system, including the oil tank. The tank should then be filled with clean filtered oil and the engine started up to circulate the new oil. After allowing time for the oil to reach all parts, the engine should be stopped and all sparking plugs removed and replaced by dummy plugs. If the engine is not being removed from the aeroplane a general external inhibiting process should be carried out. As the crankcase and top cover are of electron, special care should be taken to ensure that they are adequately coated with anti-corrosion treatment, as the protective coating may be chipped, leaving the metal exposed. Nos. 1 and 4 cylinders should now be turned to "bottom dead centre," the dummy plugs removed and the inhibitor sprayed up into the cylinder and down into the heads. Approximately 20 c.c. of inhibitor should be used for each cylinder. Repeat the process with Nos. 2 and 3 cylinders. Before replacing the dummy plugs, the engine should be turned over slowly to spread the inhibitor. The dummy plugs can now be fitted and screwed firmly home. The rocker covers should be removed and drained, and after being cleansed should be filled with clean filtered oil.

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If, however, the aeroplane is to be idle for a period exceeding three months' duration, the rocker adjusting screws should be removed to allow all valve springs to be relieved of load. The exposed valve gear should have a liberal coat of oil applied by brush. The push rods can be inhibited at this stage and reassembled.

If it is proposed to remove the engine from the airframe, the procedure to be followed before removal is identical to that detailed in the previous paragraph. A stout wooden stand should be provided and the engine placed in an upright position, *i.e.* cylinders uppermost. External and internal inhibiting should be carried out as stated in the previous paragraph, noting the instructions regarding removal of rocker adjusting screws to relieve the load on the valve springs. The rocker gear should be given a liberal coating of oil, applied by brush, and if the proposed duration of storage necessitates the removal of rocker adjusting screws, the push rods should be taken out and inhibited. The rocker covers should be cleaned internally and externally and inhibited, after which the push rods and rocker covers can be assembled. Where leaded fuel has not been used, as an alternative to spraying inside the cylinders, half a pint of clean, filtered engine oil can be poured into each cylinder, turning the crankshaft slowly to spread the oil over the cylinder walls.

The engine must be stored in a dry, clean atmosphere as damp will cause deterioration, especially to the bushes on the contact-breaker make-and-break arm rocker lever. In this case, the engine should be turned fortnightly and an inspection made for any deterioration.

GENERAL.

Please assist us in giving service by ordering all replacement parts promptly and quote their Part Nos. with the prefix letters which are found stamped or etched on the parts.

ALWAYS QUOTE ENGINE NUMBER ON YOUR REQUISITIONS.

RUNNING INSTRUCTIONS

OPERATIONAL AND SERVICING INSTRUCTIONS.

Assuming that the installation instructions have been complied with, the following procedure should be carried out.

PRELIMINARY GROUND CHECK.

In the case of new engines, or those which have been standing for prolonged periods, the oil which has been injected into the cylinder for maintenance during storage should be drained. To do this the exhaust valve to each cylinder should be opened for a short time, otherwise an oil lock will probably occur when the engine is turned, with resultant damage to the engine.

Before starting the engine, ensure that the rocker casings are filled with oil to the correct level. In addition prime the filter by removing the cap and filter element and pouring in clean oil.

The following points should also be observed :

Check the tightness and locking of all external bolts, nuts, etc., on the engine mountings.

Check the operation of all engine controls to ensure that they work freely and give full movement of the throttle, magneto advance and retard mechanism and the mixture control unit if operative.

Check the connections of the tachometer drive.

Check all cowling components and their fixings.

See that the propeller bolt nuts are tight and that the locking plate is properly positioned.

Check and, if necessary, adjust tappet clearances.

Examine the sparking plugs for cleanliness and the gaps.

Rotate the crankshaft to check the clearance between the propeller and the engine cowling.

Check the connection of the oil pressure gauge and pipe.

STARTING.

Before actually starting engine, take special note of the following important points :—

1. If the oil pressure does not rise to between 30 to 40 lb. sq. in. within one minute the engine must be stopped and the cause investigated.
2. If the oil pressure is correct the engine should be run at 800 to 1,000 r.p.m. for 15 minutes to allow the oil to warm up and circulate freely.
3. The oil inlet temperature will probably not be recorded on the thermometer immediately, but it will be assumed that after the run specified the oil temperature and circulation are satisfactory and the engine can be safely opened up to full throttle.

4. The running of the engine on the ground at full throttle must be carried out with discretion; in no circumstances should it exceed a period of 30 seconds. Under tropical conditions, this period should be proportionately less.

To start engine by swinging propeller :

Turn on fuel cocks.

Prime carburettor flooding device, at the same time operating the priming levers on the fuel pumps if fitted.

In cold weather, or if the engine fails to start by priming as above, and if Ki-gass or other primer is fitted, turn on the priming system cock and operate the priming pump. In connection with the use of the priming pump, care should be taken not to over-prime. See "Priming Procedure." See that the priming cock is returned to the OFF position (*i.e.* screwed right down).

Turn the propeller vigorously in its direction of rotation to carry the engine over four compressions with the throttle closed with magneto switches in the OFF position.

Switch on the right-hand or starboard magneto only. This is a precautionary measure against backfires. Set the cockpit throttle lever in the recommended starting position. On engines which are fitted with the mixture control operative (*i.e.* not locked in the RICH position) the mixture control should be interconnected and at RICH before starting and ground running.

Turn the engine over sharply. The engine should now start, but if it fails to start after a few attempts the procedure should be repeated.

On a cold day it will be found necessary to use a slightly bigger throttle opening than on a warm day.

If the engine is already warm it will not be necessary to "suck in" as otherwise it will get too rich and it will be necessary to expel the petrol by turning the propeller backwards with the throttle open and switches OFF.

To start the engine with electric starter :

Turn the engine by means of the starter and at the same time prime the induction system as rapidly as possible. The quantity of priming given should not exceed that defined in this section. At temperatures below 0 degs. C. the priming will probably need to be continued to assist the engine to pick up on the carburettor, and it may be necessary to make at least two attempts to start to ensure that the necessary quantity of atomised fuel reaches the cylinders. In addition it will be found that an easier start can be obtained if the turning period is prolonged to 20 seconds with a 30 seconds wait between each attempt.

Note.—In order to save the aircraft battery, it is advisable to turn the propeller by hand when priming.

PRIMING PROCEDURE.

The following tabulation relates to starting a cold engine and gives an approximation of the amount of priming that will probably be required for

different temperatures before the correct mixture is obtained within the cylinders and the engine may be expected to fire. An additional quantity of fuel will be required to fill the pipeline between the priming pump and the engine and this must be determined beforehand for the installation under consideration.

<i>Air Temps.</i>	<i>Priming in c.c. of Fuel</i>	<i>No. of Strokes*</i>
+ 30° C.	0	
+ 20° C.	10	
+ 10° C.	20	
0° C.	30	
- 10° C.	40	
- 20° C.	60	

* Two types of Ki-gass priming units are in use having the following delivery capacities :

<i>Types</i>	<i>Approximate Capacity per Stroke in c.c.</i>	<i>Dia. of Plunger Rod in.</i>
A.M. type B.	10	0.563
K.40	45	0.870

The type of priming unit may be recognised by the diameter of the plunger rod. A simple estimate with the aid of the tabulation will give the number of pumpfulls necessary. The blank column may be filled in by the operator, after the precise number of strokes for the particular installation under consideration has been ascertained. With a warm engine in winter about 20 c.c. of priming fuel will be required. Do not "suck in."

STARTING DIFFICULTIES.

In the case of new installations ensure first that the fuel is reaching the carburettor and that the magneto earthing wires are not shorting.

Ascertain also that :

1. The port magneto impulse starter is functioning. (If this is so, an audible "click" will be heard on turning the engine near the T.D.C. and B.D.C. positions.)
2. The engine is not overprimed. Adherence to the "Priming Procedure" should avoid this, but if in doubt *switch off*, open the throttle, and turn the engine to expel any excess mixture.
3. The sparking plugs are functioning satisfactorily.
4. The slow running mixture adjustment is suitably set. Correct jets are fitted before the engine is despatched, but slight adjustments may have to be made to this screw (situated on the side of the carburettor) to suit particular tick-over speeds and climatic conditions. Screw adjustment out to richen.

INITIAL GROUND TEST.

After the engine has been warmed up in the manner described so that satisfactory circulation of fuel and oil is ensured, the engine should be throttled down and the slow running stop for the throttle control lever on the carburettor

adjusted to the required position. This adjustment should be carried out to give a practical engine speed, commensurate with picking up and steady, even firing, which will ensure the minimum vibration at low r.p.m.

When correctly set the engine should respond without misfiring when the throttle is moved sharply from the "idling" speed to "full throttle."

Also, when the throttle is smartly moved from the "full throttle" to "idling," the engine should respond immediately and not cut out or stop.

The engine should be stopped for the purpose of inspecting for fuel and oil leaks. If this inspection is satisfactory, start the engine and after warming same up accelerate the engine steadily until full throttle is reached, paying special attention of any engine vibration that may become apparent. The r.p.m. obtained should be between 2,180 and 2,300 and will depend upon the propeller and the barometric pressure.

TESTING MAGNETOS.

With the engine running steadily at full throttle the magnetos should be tested. Each magneto should be switched OFF alternately and the resulting drop in r.p.m. noted. This drop should not exceed 115 r.p.m. at full throttle.

STOPPING THE ENGINE.

The engine should be stopped in accordance with the following sequence :

1. Move the throttle back to the slow-running position to allow the engine to cool down.
2. Turn "OFF" the fuel cock.
3. After a few moments open the throttle to approximately 1,000 r.p.m.
4. Switch "OFF" the magnetos and simultaneously move the throttle to the wide open position.

IN FLIGHT

OIL PRESSURE.

The normal working pressure should be steadily maintained under normal flying conditions. At idling and low speeds the pressure may fall slightly. If, during flight, the oil pressure falls below 25 lb. per sq. in. the engine must be throttled down and a landing effected as soon as possible to investigate the cause.

OIL INLET TEMPERATURES.

Oil inlet temperatures should not exceed those given below :

The throttle must not be opened nor the aircraft take-off until the oil temperature has reached the minimum of 30° C.

Oil inlet temperatures :

Minimum for take-off	.	.	.	.	.	30° C.
Maximum for cruising	.	.	.	.	.	80° C.
Maximum for climbing	.	.	.	.	.	90° C.
Maximum level flight	.	.	.	.	.	90° C.
Emergency cruising	.	.	.	.	.	90° C.

ENGINE OPERATION DURING FLIGHT

TAKE-OFF AND CLIMB.

The throttle control lever should be moved to the fully-open position, which should give approximately 2,180 r.p.m. The climb can be continued at 2,300 r.p.m. The mixture control should not be operated at altitudes below 5,000 ft. When climbing or in level flight at full throttle it must be set to give the richest possible mixture that will maintain the approximate r.p.m. and to ensure that there is no possibility of a weak mixture at full throttle.

CRUISING AND LEVEL FLIGHT.

The maximum cruising r.p.m. of 2,300 is based on a propeller which will not allow the engine to exceed 2,600 r.p.m. at full throttle at sea level. When cruising above 5,000 ft. the mixture control should be set so as to maintain an economic mixture commensurate with satisfactory running of the engine. (See Fig. 25.)

DIVING SPEED.

The engine r.p.m. in the dive must not exceed the maximum permissible r.p.m., i.e. 2,600 at full throttle for five minutes duration.

LANDING.

When coming in to land care should be taken to see that the mixture control lever has been returned to the FULLY RICH position if it is not already inter-locked in this position. This will ensure immediate pick-up from the normal throttle position for landing to "full throttle" in case of emergency.

RUNNING DEFECTS

In the following paragraphs are detailed the more common causes of faulty running that may be experienced in the operation of the engine.

FAILURE TO START.

Failure to start may be due to disregard of precautions regarding priming and flooding mentioned earlier in these notes. In the cold weather it is almost impossible to have too rich a starting mixture. In hot weather, however, or with a hot engine, a rich mixture is likely to cause failure to start. In this case switch "OFF," open the throttle fully and turn the propeller backwards to expel the rich gases. Then set the throttle to the best starting position and with the starboard magneto switched "ON" swing the propeller or engage the starter, when the engine should start.

Incorrect functioning of the impulse starter coupling may also cause failure to start. To check this item, the propeller should be turned slowly with the ignition switched "OFF," whereupon, if the mechanism is in order, a distinctly audible click will be heard from the impulse starter coupling near the top dead centre position of any piston. The actual arrest and rotation of the magneto armature after release can be observed by removing the starboard magneto contact breaker cover.

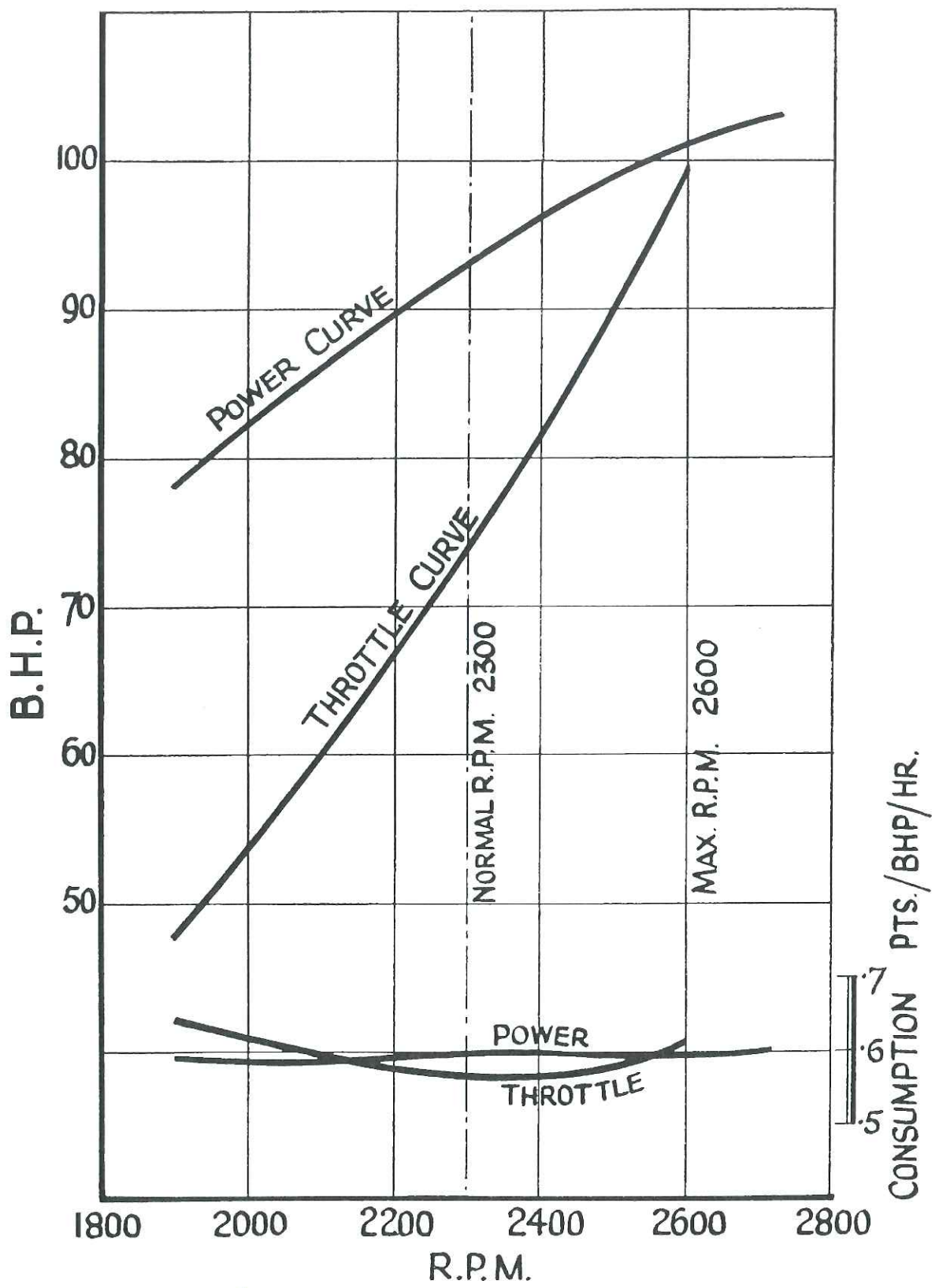


Figure 25.—Power, throttle and consumption curves.

N.B.—With the cover removed, it is most important to note that the earthing switch for this magneto will be inoperative so that the magneto is permanently switched ON, creating a potentially dangerous situation since the engine is liable to kick when the propeller is turned unless the H.T. leads are disconnected.

Failure to start may also be due to the presence of water in the carburettor, in which case the main and power jets should be removed and the carburettor flushed through by turning on the fuel cock. See that the slow running jet is not choked.

Special precautions are necessary when assembling the piping connecting the fuel pump units, since air leaks, which are difficult to detect, are a possible cause of engine failure.

If the engine has been standing in a damp atmosphere or overnight during frosty weather, it may be necessary to wipe the insulators of the sparking plugs and the distributors of the magnetos in order to reduce the possibility of a high-tension leakage which might otherwise take place under these conditions.

FAULTS IN THE IGNITION SYSTEM.

After installing a new engine, or before running an engine which has been idle for a prolonged period, it is essential that the ignition system should be tested. Check the magneto low-tension earthing brushes, the wires and switches for continuity, correct connections and functioning.

When using any form of synchroniser it is necessary to remove the contact breaker covers thus rendering the earthing switches inoperative. Before carrying out the test, it is therefore essential that the high tension leads are disconnected from the sparking plugs in order to prevent accidental starting of the engine whilst turning the propeller, or alternatively remove one sparking plug from each cylinder to obviate the engine moving due to compression whilst being synchronised.

After the test has been made see that both switches are in the "OFF" position.

IMPORTANT NOTICE.

The hardened cam ring and sleeve are not interchangeable from one magneto to another. Each is numbered by the manufacturers for its particular magneto and if replaced will invariably destroy the timing of the magneto. These parts seldom wear and should only be replaced by the manufacturers or thoroughly competent repairers having electrical or other reliable apparatus for resetting the magneto timing.

When checking for wear make sure that the cam rings are held well down on to the back plate (known also as the end plate) or misreadings will be given causing a false impression of excessive wear. Less than one in a thousand have ever been replaced through wear.

Defective ignition provides many symptoms of imperfect running which are difficult to diagnose and are similar in certain cases to other sources of

trouble. The first check that should be made in cases where the ignition is suspected is to test each magneto separately and see whether one magneto gives a better result than the other. If either magneto causes excessive drop in r.p.m. or rough running when the other is switched off, it may be assumed that the trouble lies in the magneto, the leads or the plugs that it serves.

Sparking plugs which are suspected of being faulty should be removed and tested in the approved manner. The condition of the high-tension leads should be checked. If there are signs of deterioration of the rubber, the lead should be replaced by a new one. Ensure that all connections are in good condition and are making good contact.

The magneto distributors, high-tension lead terminals and the sparking plug insulators must be kept clean and dry. Any moisture present on these parts may lead to failure to start as stated in this section.

Care must be taken to ensure that the magneto contact breakers are not dirty or out of adjustment. An excessively small gap may produce defective or rough running and may cause a complete cut-out of the magneto. The presence of dirt or oxidation on the points will produce similar symptoms.

See that the contact breaker arm is working freely in its bush. Damp atmosphere may cause the bush to swell, in this case the arm should be removed and the bush carefully eased out, using a fine grade of emery cloth and carefully removing all traces of emery afterwards. Apart from the above-mentioned adjustments, no repair should be attempted on the magnetos except by fully-qualified repairers.

POSSIBLE ENGINE FAULTS.

The following is a list of the possible engine faults :

1. Misfiring. Should any one cylinder misfire or cut out when running, locate the defective sparking plugs and clean and test them, or fit new ones.
2. Engine misfiring on one magneto. Check and test all plugs and the magneto. If the trouble is traced to the magneto or distributor and no fault can be detected which can readily be rectified, fit a new magneto. If the engine cuts right out on one magneto, examine the switches and low-tension wiring as well as the magneto ; also ensure that the high-tension leads are connected to their correct terminals on the distributors.
3. Engine cutting out in flight. Make sure that the switches have not been inadvertently switched "OFF." Test the engine on separate magnetos since a fault in one magneto or distributor may upset the running of the engine.
4. Low oil pressure. This may be due to air leaks or air locks in the suction pipes, choked filters, stuck release valve, defective pressure gauge or defective pipe-line to gauge.
5. Carburettor flooding. Possible causes may be as follows :
Dirt under the needle, worn needle and seating or sluggish toggle mechanism. If the needle face or seat is worn, both should be renewed.

6. Engine runs slowly but will not open up. Possible causes are : water in the carburettor, main or power jets blocked, air-lock in the fuel pipe lines, or choked filter. Check the jets for stoppage by removing them, cleaning if any dirt is present, and flushing out the jet chambers, ensuring that all orifices are clear. Sharp-edged articles must not be used for clearing obstructions or the calibration may be upset. If there is any reason to suspect faulty calibration, fit new jets.

ROUGH RUNNING.

Apart from defective ignition, rough running may also be due to the following :

1. Propeller loose or out of balance. Check the hub nut and flange nuts for tightness and the propeller for track and balance.
2. Valve tappets incorrectly adjusted. Reset the tappets to the required clearances.
3. Engine mounting or holding down bolts loose. It is essential that the rubber mounting blocks are correctly fitted.
4. Weak compression. If the compression of any cylinder is found to be weak, first check the tappet clearances and, if these are in order, or their adjustment does not rectify the trouble, remove the cylinder with head in question and investigate the cause. Before doing this verify that loss of compression is not due to a faulty plug washer, oil or particles of carbon between the valve and its seating in the head, or stuck valves. Faulty compression may be due to defective valves, stuck piston rings, or a faulty joint between the cylinder head and barrel.
5. Induction manifold leakage. Inspect and test the induction manifold for leakage. Note that the joints between the carburettor and the induction manifold and also those between the induction manifold and the cylinders are in good condition. If the throttle spindle bearing is badly worn it may cause an air leak.

INSPECTION AND OVERHAUL PERIODS

BETWEEN FLIGHTS INSPECTIONS.

1. See that all switches and fuel are "OFF."
2. Inspect propeller for damage.
3. Make general inspection of the fuel and oil systems for leaks.
4. Replenish fuel and oil systems and ensure that filler caps are properly secured.
5. Check security of engine cowlings.

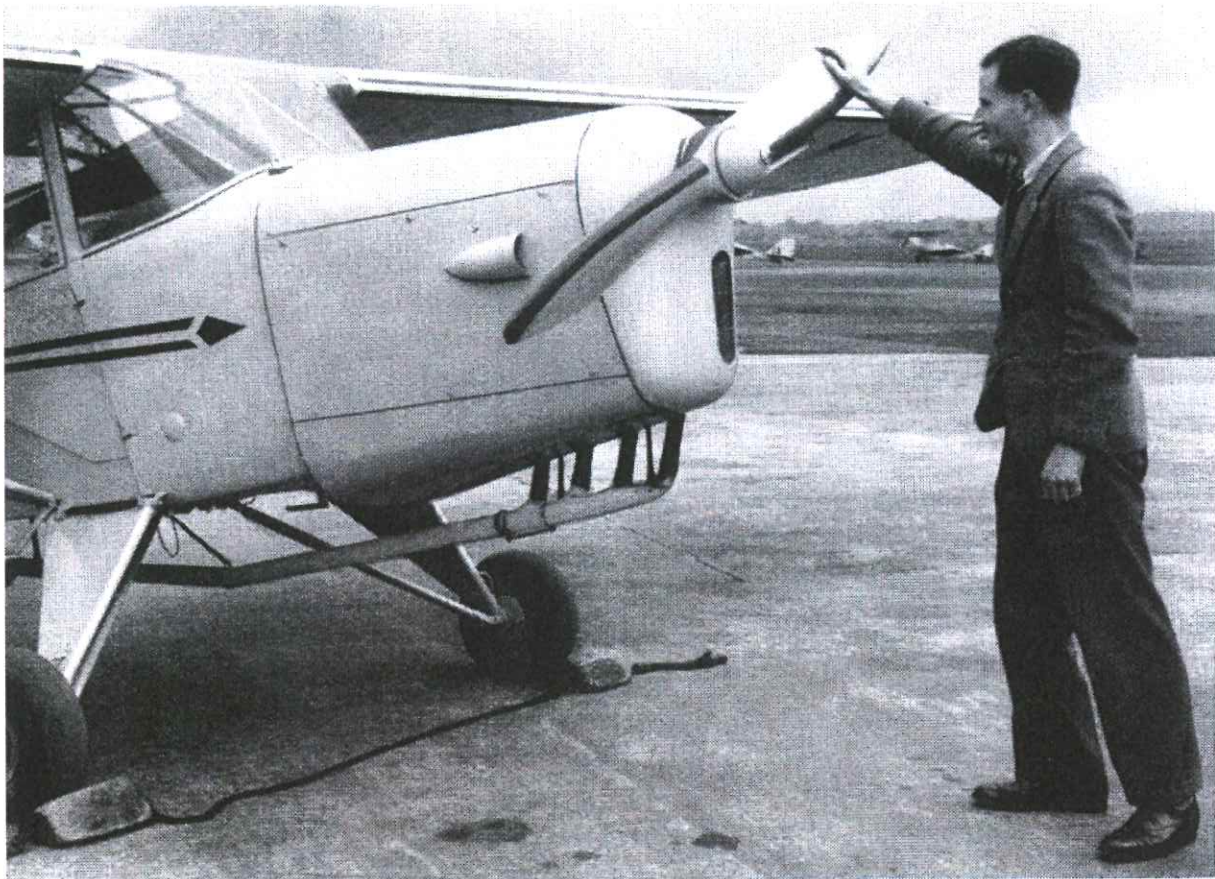


Figure 26.—Compression should be checked by turning propeller. When starting, the propeller should be in the position shown.

DAILY INSPECTION.

1. Inspect propeller for damage to sheathing.
2. Inspect sparking plugs and ignition leads for security.
3. Inspect exhaust and induction systems for signs of blowing and cracks in the exhaust pipes.

DAILY INSPECTION—*continued*

4. Inspect magnetos for security and see that the L.T. cables are properly attached.
5. Check fuel and oil pipes for security.
6. Check fuel and oil tanks for security.
7. Check fuel and oil levels—replenish as necessary.

If wooden propeller is fitted, check propeller securing nuts at approximately 25 hour intervals. If new wooden propeller is fitted check securing nuts after first two or three flights, and then at 25 hour intervals.

When Screened Ignition Harness is fitted.

- (a) Inspect ignition cables ; cables should be replaced if they are damaged or charred.

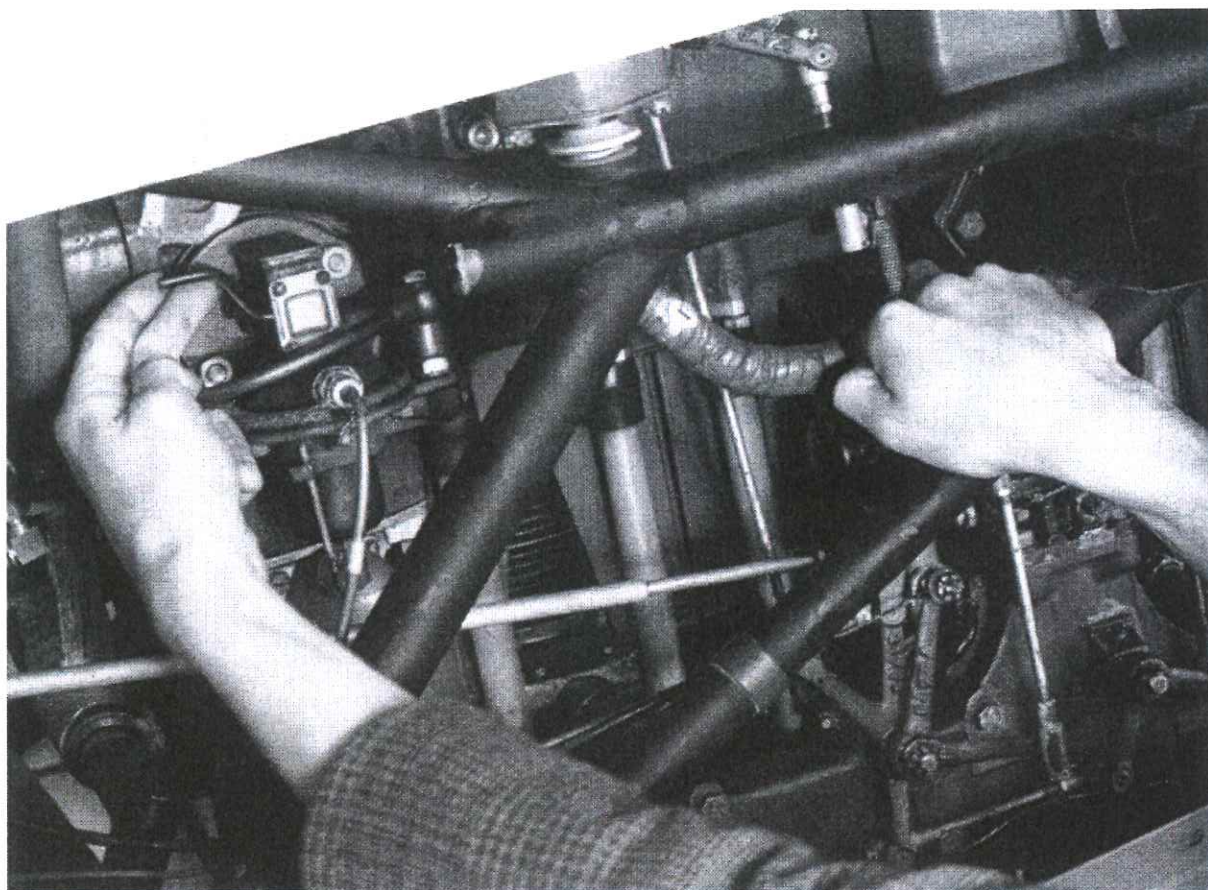


Figure 27.—Operating fuel pump lever and carburettor tickler prior to starting.

- (b) Inspect flexible conduits for signs of fracture or broken or badly-frayed metal braiding. Renew if found damaged.
- (c) Check terminal fittings for signs of damage. Any faulty fittings should be replaced.
- (d) Sparking plug elbows or ferrules should be replaced when showing either damaged threads, signs of collapse, or a difficult spring contact.

- (e) Inspect distributor case ; case should be replaced if badly dented or buckled, or if any screwed nipples show signs of fracture or bad threads.

To start engine.

Turn on fuel cocks.

Prime the engine either by the Ki-gass cockpit primer if fitted, or by operating a fuel pump priming lever and depressing carburettor tickler. Take care not to overprime. (See Fig. 27.)

Open throttle slightly, put switch connected to right hand magneto in running position and operate electric starter. If starter is not fitted, shut throttle and turn engine sharply over four compressions with ignition switched off. Open throttle very slightly and put switch connected to right-hand magneto in running position. (See Fig. 28.) When engine has started put switch connected to left-hand magneto in running position. Failure to start may be due to overpriming. To clear engine, switch off ignition, open throttle fully, turn engine backwards over a few compressions and then proceed as previously instructed.



Figure 28.—When starting, the impulse starter is brought into operation by using the right-hand ignition switch.

Run engine for 4 or 5 minutes at between 800 and 1,000 r.p.m. Open up to full throttle and check oil pressure and r.p.m. drop on each magneto. This should not exceed 115 r.p.m. Engine should not be run on ground for more than 30 seconds at full throttle.

Give Autoklean filter one turn (see Fig. 29).

Make appropriate entry in the logbook.

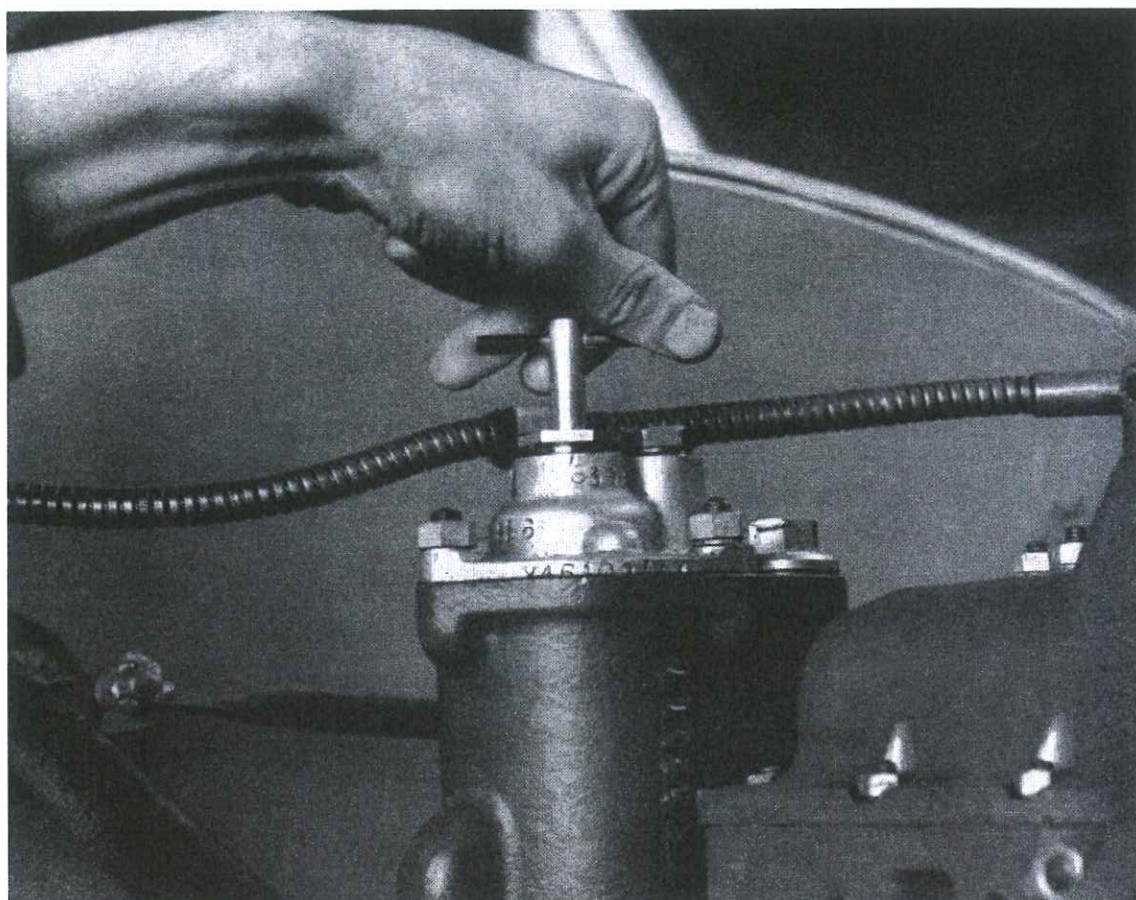


Figure 29.—The Autoklean filter should be turned once or twice.

INSPECTION AFTER 50 HOURS' RUNNING.

1. Examine propeller for signs of fracture.
2. Remove sparking plugs, clean, reset the points to .015 in. and test. See that the insulation is free from cracks.
3. Inspect the magneto contact breaker springs for deterioration.
4. Clean the contact breaker points, and adjust the gaps to .012 in. if necessary.
5. Clean the distributor and contact breaker covers and examine for cracks.
6. See that distributor segments are not pitted.
7. Ensure that the H.T. cables are secure.
8. Lubricate the contact breaker rocker arm bush.
9. See that all bonding is secure.
10. Lubricate impulse starter.
11. Remove valve rocker covers, and inspect valve gear including valve springs for wear and breakages.
12. Reset valve clearances to .004 in. if necessary (see Fig. 31).
13. Check compression of each cylinder.
14. Clean rocker covers and refill with clean oil (see Fig. 32).
15. Drain oil from the system and flush tank and pipe lines. Refill systems with clean oil.

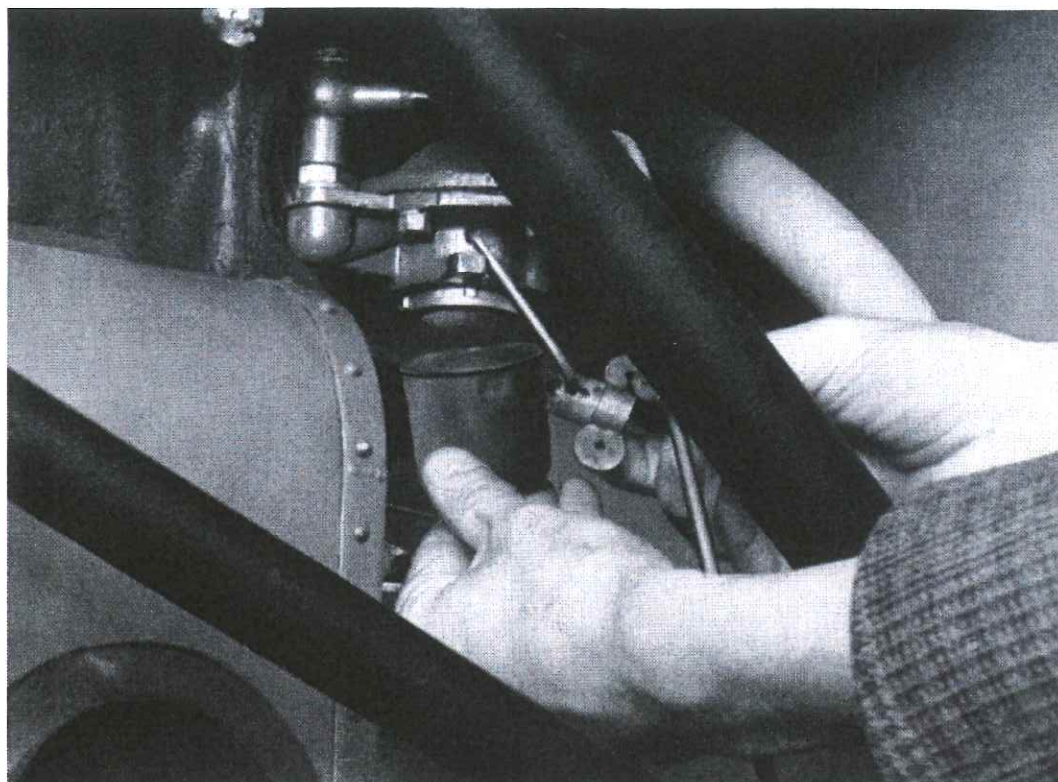


Figure 30.—Remove the petrol filter bowl and check for water.

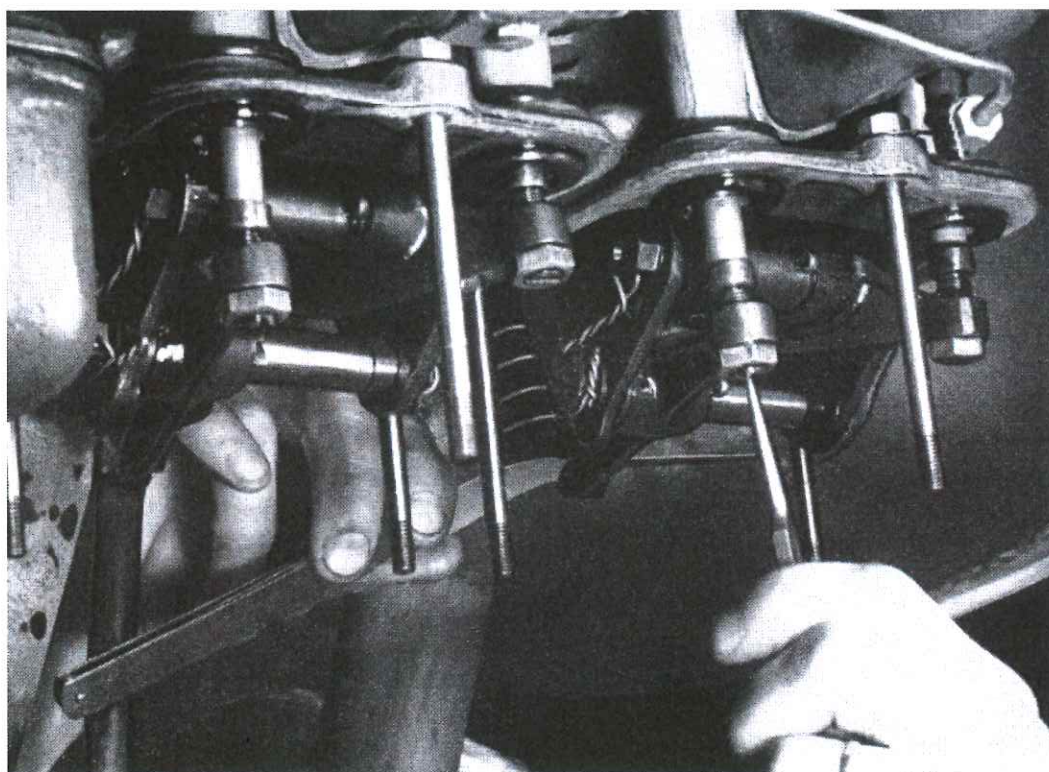


Figure 31.—Adjust the valve clearances when the engine is cold.

16. Give Autoklean filter element one or two full turns. Should filter element be difficult to turn, remove from pump housing and wash in petrol.
17. Remove fuel filters and flush through (see Fig. 30).
18. Remove jets from carburettor, clean, flush through and replace.
19. See that drain from induction manifold is clear.
20. Controls and ball ends should be given a little grease, and checked for wear.
21. Inspect for fuel and oil leaks.



Figure 32.—Refill rocker box covers with oil to the correct level before replacing.

MAJOR INSPECTION AFTER 400 HOURS' RUNNING.

Items laid down for Between Flights Inspection, Daily Inspection, and Inspection after 50 hours' Running to be checked and work to be carried out in addition to the following :

1. Remove propeller and inspect propeller hub for tightness on crankshaft, elongation of bolt holes and general serviceability of hub assembly.
2. Inspect engine bearer feet rubbers for deterioration.
3. Remove Autoklean filter and wash in petrol. (When removing filter element the drain plug (if fitted) situated immediately above the oil pressure gauge connection should first be removed and the oil allowed to drain.)
4. Inspect rubbers at top and bottom of push rod cover tubes for deterioration.
5. Inspect rubber joints on oil system for deterioration.
6. Make necessary entries in log book.

NO TOP OVERHAUL IS NECESSARY.

A COMPLETE OVERHAUL SHOULD BE CARRIED OUT AFTER 800 HOURS' RUNNING.

COMPLETE OVERHAUL INSTRUCTIONS

PARTIAL DISMANTLING WHILST IN AIRFRAME.

Prior to giving the sequence of operations necessary for removal of the engine from the airframe for complete overhaul, we give notes on partial dismantling in the airframe for the purpose of effecting any replacements due to accidents, etc., or carrying out servicing of parts scheduled for attention.

1. When necessary to remove propeller and nose cowl, take out the split pin, remove nut and conical washer on the spinner. Remove spinner and lockplate, unscrew nuts from propeller bolts and withdraw front plate and propeller. There is no need to remove the propeller hub. Nose cowling can be removed (see Fig. 33).

2. To remove rocker boxes, unscrew the three nuts securing same.

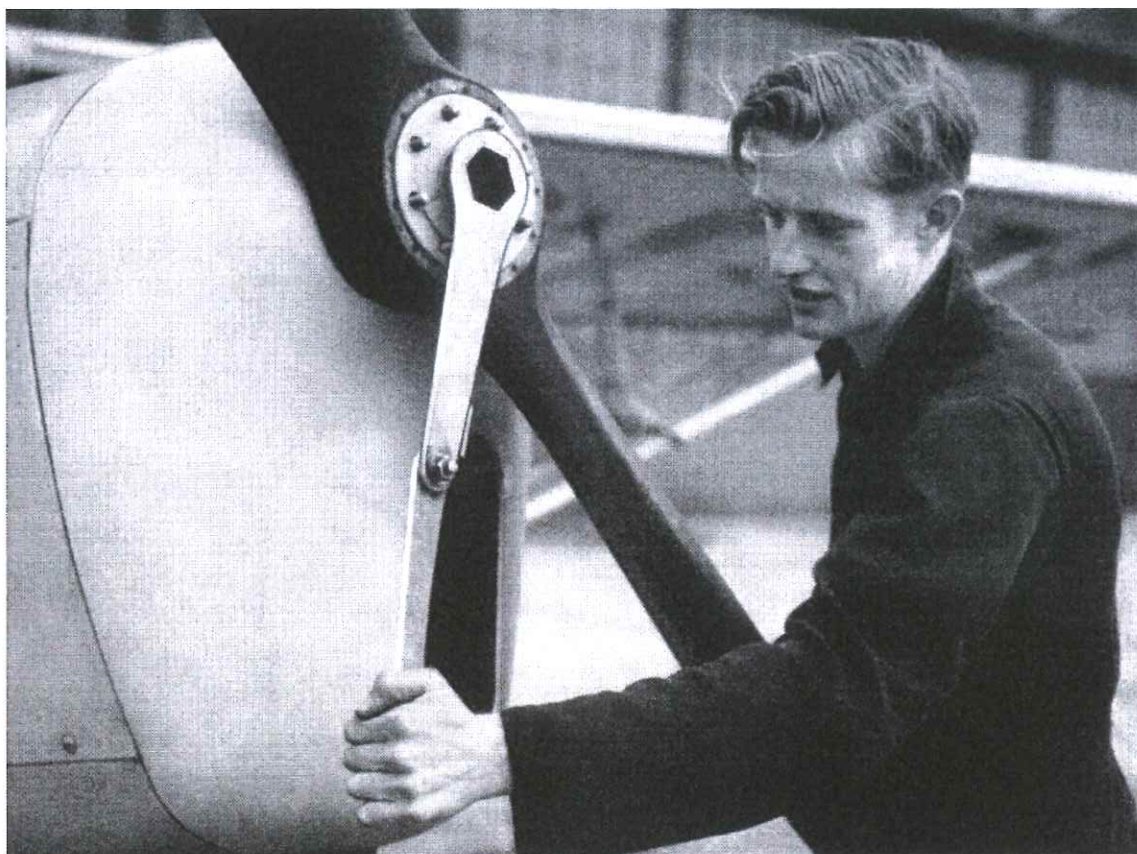


Figure 33.—Removing crankshaft nut with special spanner FB.807, using propeller to prevent the crankshaft turning.

3. To remove one or more cylinders or cylinder heads proceed as above. Next disconnect any exhaust system fitted, pull out pins securing air cooling chute and remove same.

To extract push rods remove end screws on side of rocker brackets and take out rocker and spindle leaving the rocker brackets undisturbed.

Rockers and spindles should be kept with their respective cylinder head.

The push rod cover tubes may now be removed ; slide the top rubber off the tappet guide and down the push rod cover tube ; ascertain that the tappet cup is not protruding beyond the tappet guide, and if it should be, turn the engine until it can be pushed back. Carefully ease the top of the cover tube away from the tappet guide towards operator, at the same time lifting it out of the rubber in the cylinder head, taking care not to damage the cover tube which is rather fragile.

Remove baffle plate. Unscrew the four nuts securing cylinder to crank-case and remove cylinder and head in one unit.

4. To dismantle cylinder and cylinder head, slacken the eight securing nuts, easing the head away from the cylinder. Should any difficulty be experienced in separating the two parts place a piece of wood on bench or in vice and holding cylinder over it bring the head down on to the end lightly but smartly, and the head will detach itself. Do not try to prise them apart at the joint or the joint faces will be damaged.

5. Depress valve spring collars and remove the split collets from valve stems, thus releasing valves and springs.

6. To remove the piston rings insert three narrow strips of thin metal under rings and slide rings over same. Take care not to expand rings more than necessary, and when removed place them in their respective cylinder already moved.

To extract gudgeon pin remove Seeger circlips ; extract gudgeon pin, using special drift (see Appendix "C"). Incorrectly fitting drifts should not be used.

REMOVAL OF ENGINE FROM AIRFRAME.

To remove engine from airframe proceed as follows.

Remove propeller as previously instructed, then take off machine cowl, air intake and exhaust system. Disconnect all oil pipes, petrol pipes and engine controls, tachometer drive, oil pressure pipe, switch wires from magnetos and earthing wire from engine. Remove the nuts securing the bearer feet to airframe and attach sling to lifting rings in top cover of engine. (These rings must not be turned.)

Hoist engine clear of airframe, taking care that nothing fouls the machine. Next remove the engine bearer feet from the engine and replace with workshop bearer feet, which may be made of steel or from angle iron, and place on an engine stand in the inverted position. DO NOT turn engine with cylinders uppermost at this point.

DISMANTLING THE ENGINE.

1. Remove rocker box covers and drain off oil. Remove propeller hub by taking off the sleeve, turning back the lock-tab securing the hub nut and placing propeller on bolts to prevent crankshaft from turning. Using special spanner (see Appendix "C") pass same through centre of propeller ; remove

the nut, and then take off the propeller. The next step is to screw the extractor (see Appendix "C") on to the hub as far as possible, then tighten up the centre screw of the extractor with special spanner until hub is withdrawn from crankshaft. A smart tap on the end of this screw will assist the operation once the screw has taken up full load (see Fig. 34).

2. Remove crankshaft cover plate at rear end of engine, and turn engine over so that the cylinders are uppermost.

Remove H.T. leads from the sparking plugs.

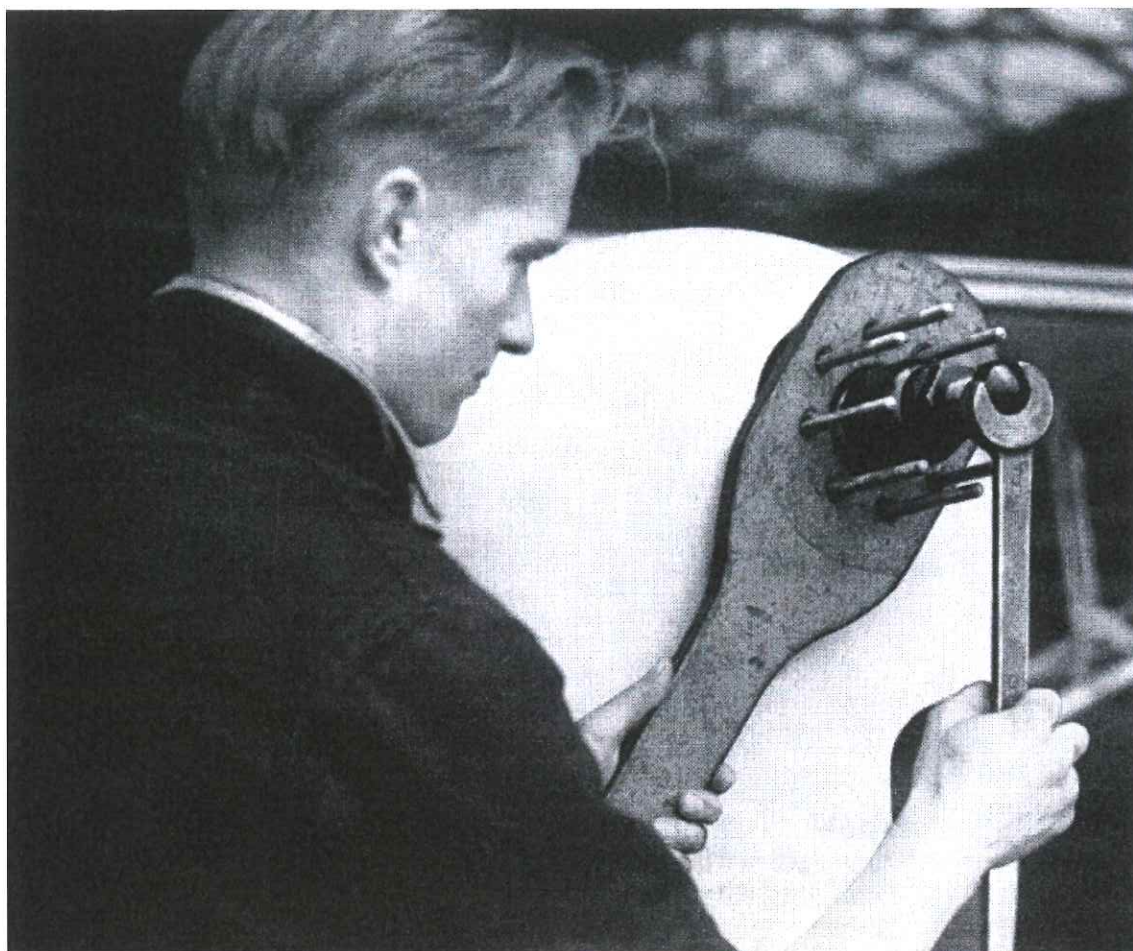


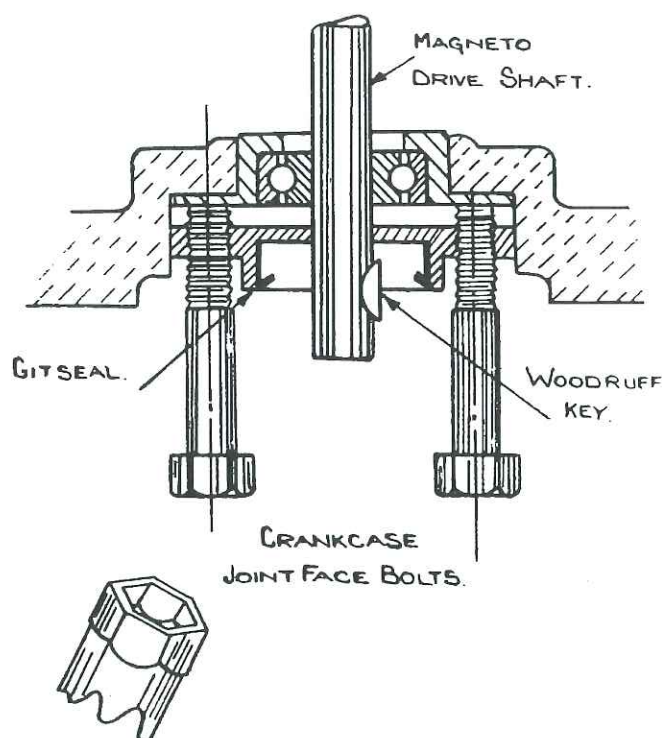
Figure 34.—Using the extractor to remove the propeller hub.

Remove all clips retaining these leads in cooling chute, or on induction pipe. Remove nuts holding distributor and lift each assembly complete with leads. Place on bench where they can be easily dismantled if required. In slackening or moving nuts of screening harness or the H.T. lead elbow nut (if screened plugs be fitted) great care must be taken not to twist the unit at elbows as the nuts tighten up after a period of installation. Remove side chute, placing pins and clips back into them to avoid loss or damage. Remove Petroflex (pump to carburettor) and disconnect controls. Remove induction pipe bolts and lift away the flame trap, carburettor and induction manifold assembly with controls complete.

3. Remove sparking plugs. Remove backplate of side chute, using special long spanner. Remove rocker arms, push rods and cover tubes as described in "Partial Dismantling." Remove cylinder baffle plates.

4. Cylinders and heads may now be removed as units by taking off the 4 nuts securing the cylinders to crankcase. Tie rags round connecting rods to prevent damage to them on crankcase wall.

5. Remove magnetos, Simms' couplings, and platforms; remove securing circlips and nuts on end of vertical magneto driving shaft, using special locking device (see Appendix "C") to hold shaft from turning.



Next extract oil seal housings (by means of the two extractor holes in them, using two crankcase bolts), and remove Woodruff keys. **DO NOT** remove ball race housings at this stage, as this would leave magneto driving shafts unsupported except at one end.

6. Remove the nuts securing tappet guides and extract tappets and guides.

Remove the three nuts securing Autoklean filter and lift filter. Remove petrol pumps and guide plates with their plungers.

7. Remove timing gear cover. Turn engine over on stand and remove all nuts securing the cover to the crankcase, and remove cover.

8. Remove oil pump by unscrewing the nuts arranged around the pump.

9. Next extract the split pins, nuts and washers from connecting rod big ends, take off cap and withdraw rods complete with pistons. To do this it is necessary to turn crankshaft to let rods and caps clear the oil retainers in the crankshaft. Remove piston rings and place them in their respective cylinders.

10. Unscrew crankshaft thrust nut with special serrated spanner. Next remove the oil thrower. Remove nut and bolt in centre of idler gear spindle. Withdraw idler gear taking care not to drop the needle rollers of which there are 48 in two sets forming races on which the idler runs. These needle rollers will probably fall immediately the wheel is withdrawn.

11. Unlock and remove the eight bolts securing the thrust ring to crankcase and front main bearing cap. Next unlock and remove nuts securing the main bearing caps. Remove crankshaft, and remaining halves of bearings. Take rear plate of thrust housing from crankshaft.

12. Remove lock wire and the four slotted nuts securing camshaft bearing and withdraw camshaft complete with bearing.

13. Magneto driving shafts may now be tapped out of crankcase and the oil throwers removed from shafts in the process. Note oil throwers are handed to throw oil off the shaft.

14. Dismantle the oil pump by lifting rear cover and removing gears. Unscrew cap nut and remove relief valve and spring.

15. Turn back locktab and unscrew bolt securing camshaft wheel and camshaft, remove washer and withdraw wheel from the shaft by means of the special extractor, and slide bearing from the wheel.

Remove split pins and slotted nuts and withdraw bolts and oil retainer plates from crankshaft. Remove hexagon headed plug (in main oil gallery) at front end of crankcase. Deal with carburettor, magnetos, and fuel pumps as in notes in special sections on these items.

16. Cylinder Heads.

To detach cylinder from head, take off the securing nuts, easing the head away from cylinder. If any difficulty is found, place a suitable block (wood) on bench or in vice and holding cylinder over it bring the cylinder head down on to the end lightly but smartly and the head will then detach itself. Do not try to prise apart at the joint or joint faces will become damaged.

Depress valve springs until collets are free; remove these and the collars, thus releasing the valves and springs.

INSPECTION OF PARTS

All parts after being thoroughly cleaned should be subjected to careful inspection and checked against the clearances permitted as laid down in table of clearances.

17. Decarbonise and clean all parts, inspect carefully for pitting of valves or valve seatings. If pronounced signs of pocketing are noticed, grind out, using grinder with correctly fitting pilot and stone faced at 30° to restore the face of the seating in the cylinder head before the valve is ground in. Should valve be pitted, lightly grind the face to the correct angle. Before grinding valve seat in cylinder head fit new valve guide if required, to get correct alignment from the new guide.

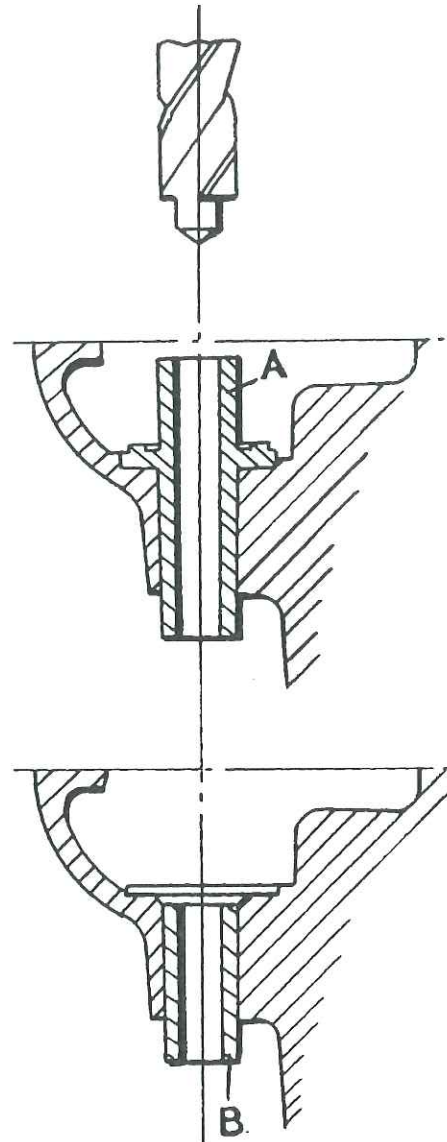


Figure 35—Method of removing inlet and exhaust valve guides. Using 14 mm. step drill for inlet guide and 17 mm. step drill (see Fig. 45) for exhaust guide, cut away portion with collar A, and use drift to remove portion B.

To remove valve guide (see Fig. 35) use special stepped drill to cut away the portion of guide indicated before drifting remainder out of head, otherwise guide may become collapsed and enlarged on diameter by action of drift and will damage the head, and cause difficulty as regards fitting replacement guide. New guides (cold) are fitted to the head after same is heated in oil bath or by

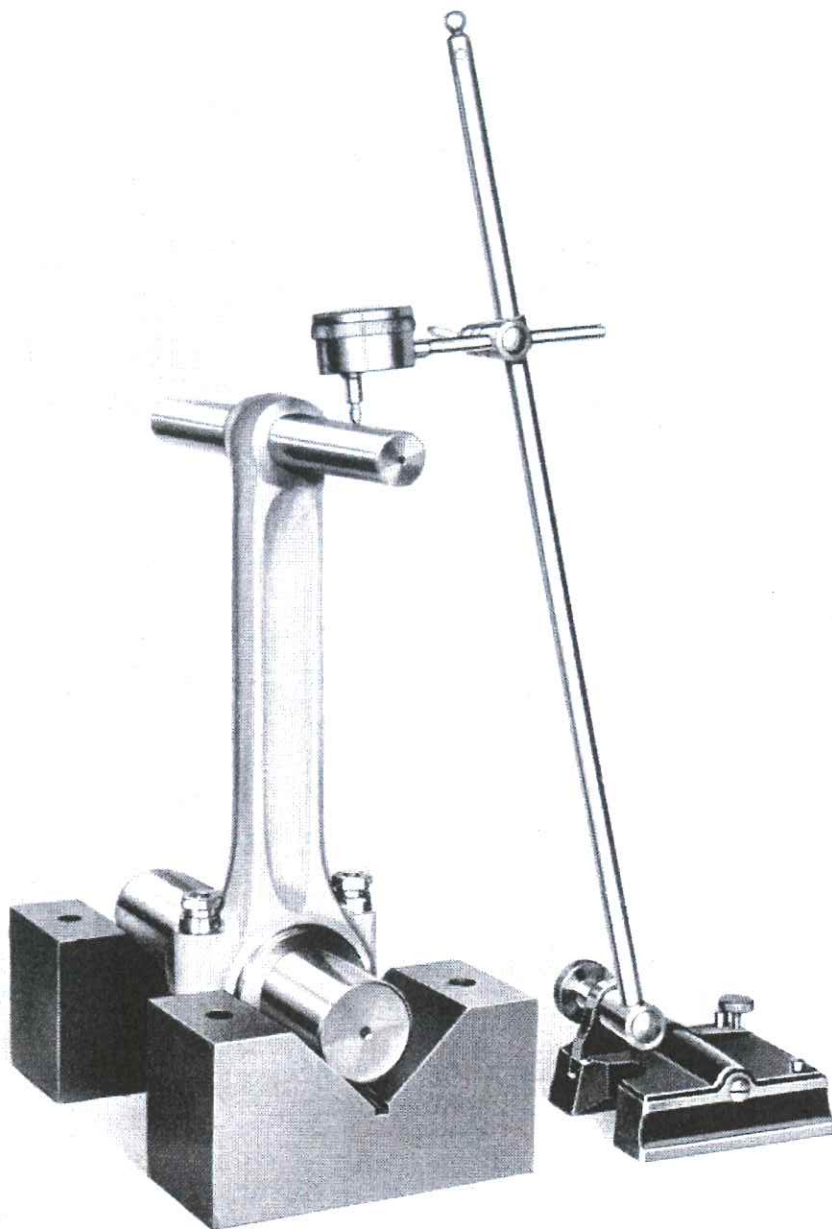


Figure 36.—Checking gudgeon pin hole for alignment, using clock indicator.

other suitable means. The interference for fitting guide in head is .00025 in. to .00125 in. Use a fine abrasive for grinding in of valves, and polish valve stem as necessary. Carefully clean away all trace of abrasive used before reassembling valve gear and to check efficiency of valve seating, insert valve and springs and fill port with paraffin or petrol and check for leaks. Clean and check remainder of parts for wear and reassemble head.

18. Cylinders.

Check cylinders for wear and/or ovality and see that they are free from scoring. (See list of clearances allowed.)

19. Pistons.

Check pistons for ovality and signs of cracks and ring grooves for wear. Rings should be checked for tension. (Gap should be approximately 12 mm. when ring is free.) Look for signs of uneven wear or blowing. Place rings in their respective cylinders and use crown of piston to square up rings in cylinders, then check gap. Renew any rings which do not satisfy all requirements.

20. Connecting Rods.

To ensure that the connecting rod bolts are serviceable they should be tested to the following procedure:

- (a) After removal from the connecting rod all bolts should be cleaned up flat and square at each end so that an accurate measurement of length can be taken.
- (b) Check length of bolt and record.
- (c) Ensure that the nut runs freely down the full length of thread on the bolt.
- (d) Fit bolt to a suitable block, or to the connecting rod, and tighten the nut to a torque loading of 280 lb./in.
- (e) Remove bolt and re-check the length.
- (f) If there is any difference in the measurements taken at (b) and (e) the bolt must be considered unserviceable.

The small end bore of the connecting rod should be checked for wear and ovality, and also for alignment (see figs. 36 and 37). Check the big end

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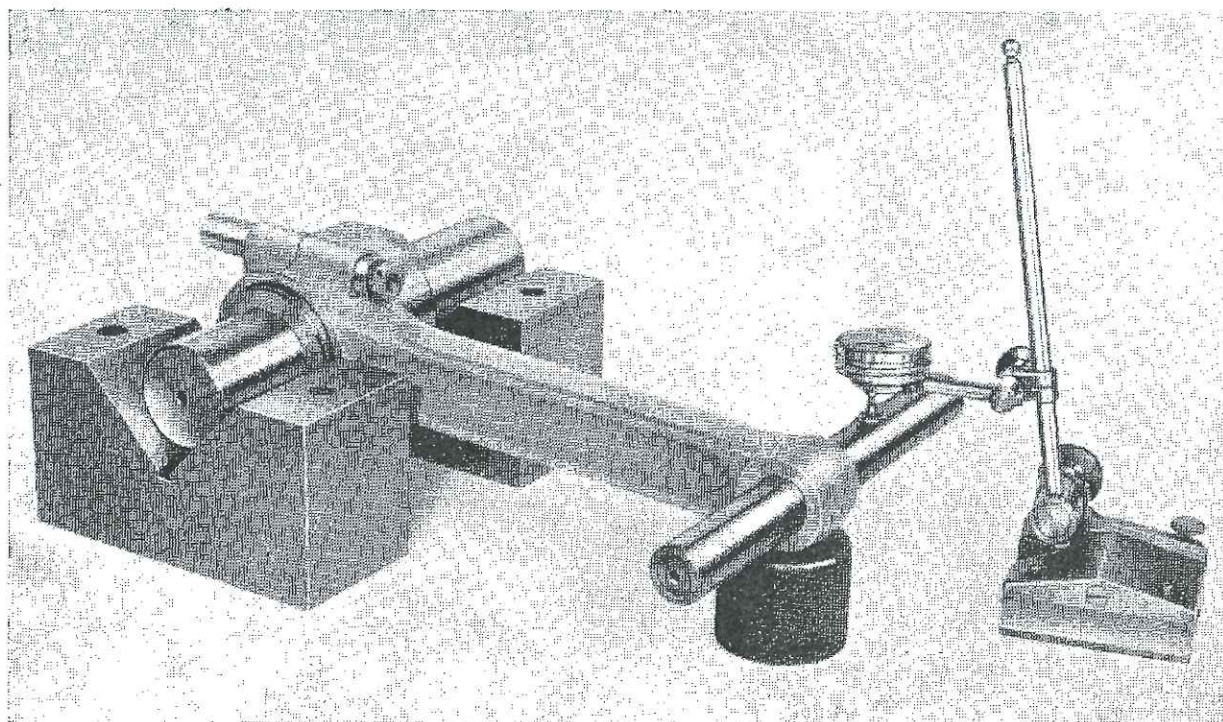


Figure 37.—Checking gudgeon pin hole for twist, using clock indicator.

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bearings for adhesion of white metal, cracks and/or scoring. Check the bore of each bearing to obtain its fit on its crankpin and also check the end float. The permitted figures are quoted in the schedule of Fits and Clearances.

The big end "nip" should be checked using the following procedure:

Tighten both nuts to a torque of 240 lb./in. after which slack off one nut and check that the other nut is tight to 240 lb./in. torque. The gap between the bearing cap and the connecting rod should permit the entry of a 0.004 in. gauge but not accept a 0.006 in. gauge.

Should the gap be too big it is permissible to lightly rub down the horns of the bearing on a surface plate.

Should the gap be too small new bearings must be fitted. The connecting rod or the cap must not be rubbed down.

21. Crankshaft.

Check for scoring and ovality on journals. Should the scoring be deep or ovality beyond the limits in clearance chart, the shaft should be reground. Check journals for alignment (see Fig. 38).

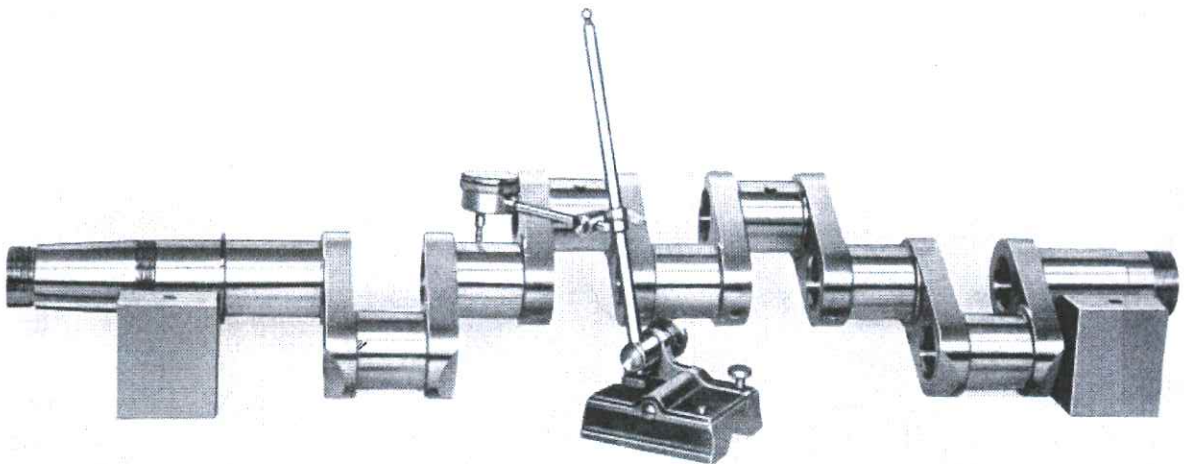


Figure 38.—Checking crankshaft for alignment of journals.

Check also the hub end of shaft for any signs of "picking up." Carefully ease off and refit hub, using a very fine abrasive, and taking care to remove all traces of the abrasive afterwards.

22. Crankcase.

Check over for general condition, chalk test for cracks, check tightness of studs, and after checking main bearings for cracking and scoring, assemble them in crankcase and check for clearance on shaft as per clearance chart.

Do not use excessive force when tightening cap and never "face off" cap to take up wear in the bearing. If worn beyond limits in clearance chart, replace with new.

23. Top Cover to Crankcase.

Check for general condition and chalk test for any signs of cracks.

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24. Camshaft.

Check for signs of undue wear on cams and general condition of bearing faces. Carefully stone any rough edges on cams.

25. Ball Races.

After washing thoroughly check for roughness, pitting or wear. Replace if any signs are present as they will rapidly become worse.

Needle Roller Race.

The idler gear wheel runs on needle roller races, and these should be carefully checked for wear or chipping of rollers and for dimensions of track on roller journals.

26. Tappets and Guides.

Check fit of tappets in guides and condition of tappet heels and bearing surfaces.

27. Gears.

Check for wear, chipping and pitting. Where chipping is only slight, stone smooth. If chipped on contact faces, or badly worn, replace. See clearance chart for backlash tolerances.

28. Induction Pipe, Carburettor and Flame Trap.

Check flame trap for slackness in housing, and clean same by washing out in paraffin or petrol. Check induction manifold faces for wear, and if uneven lapping may be carried out. Test for leakage, under water with an air pressure of 20 lb. sq. in. Dismantle, clean and inspect carburettor in accordance with Carburettor Appendix.

29. Magneto and Ignition Harness.

Inspect all H.T. leads for signs of chafing or broken wire which may be sharp enough to penetrate insulation and cause intermittent shorting. Check elbows and nuts, etc., for condition and fit, terminal ends for condition, tightness and cleanliness. Clean and inspect magnetos and carry out repairs necessary as per instructions in Magneto Appendix. The gaskets on magneto vertical driving shafts should be renewed as they have given their useful life.

30. Sparking Plugs.

Clean and reset points. If plugs are integrally screened the tubular extension of the gland nut is mica lined, and care should be taken not to damage this mica insulation as hidden short circuiting will prove difficult to trace. Follow instructions in Sparking Plugs Appendix or makers' instructions for the particular type of plug fitted.

31. Fuel Pumps.

Carry out cleaning and adjustments as per Appendix on Fuel Pumps, and renew diaphragms as they have given their useful life.

32. Filters, etc.

Clean petrol and oil filters.

All rubber joints and packings should be renewed as they have given their useful life, and good seals will result in a clean engine. Also replace all circlips, locktabs and jointings damaged by dismantling.

N.B.—The petroflex pipe from fuel pumps to carburettor will be found to carry a date tab giving date of manufacture. It is the practice in the R.A.F. to renew these after three years and this is recommended as a wise precaution to all operators and private owners, etc. The pipes are quite cheap and easily replaced.

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RE-ASSEMBLY OF ENGINE

After replacements have been obtained where necessary, all parts should be examined for cleanliness and laid out on a clean and preferably metal covered bench.

The crankcase having been washed clean, and all particles of dirt, etc., blown away by compressed air jets where available, assembly may be commenced.

If in good condition the laminated copper cylinder head washers may be annealed at 600° C., and taken into use again. Always place the side with joint towards the cylinder and the plain side towards cylinder head. See that they are perfectly flat and not damaged or turned up at the edges. Fit new washers between carburettor and induction manifold, and new inlet port washers to secure a gas-tight joint.

Assembly can now be carried out in the reverse order to that laid down for dismantling.

USEFUL HINTS FOR RE-ASSEMBLY.

During re-assembly all parts should be thoroughly oiled.

The oil throwers fitted to the magneto driving shafts *are not interchangeable*, being stamped left hand and right hand. These should be read as looking at the engine from the rear end with cylinders below crankshaft. The scrolls are arranged to throw oil "off" the shafts.

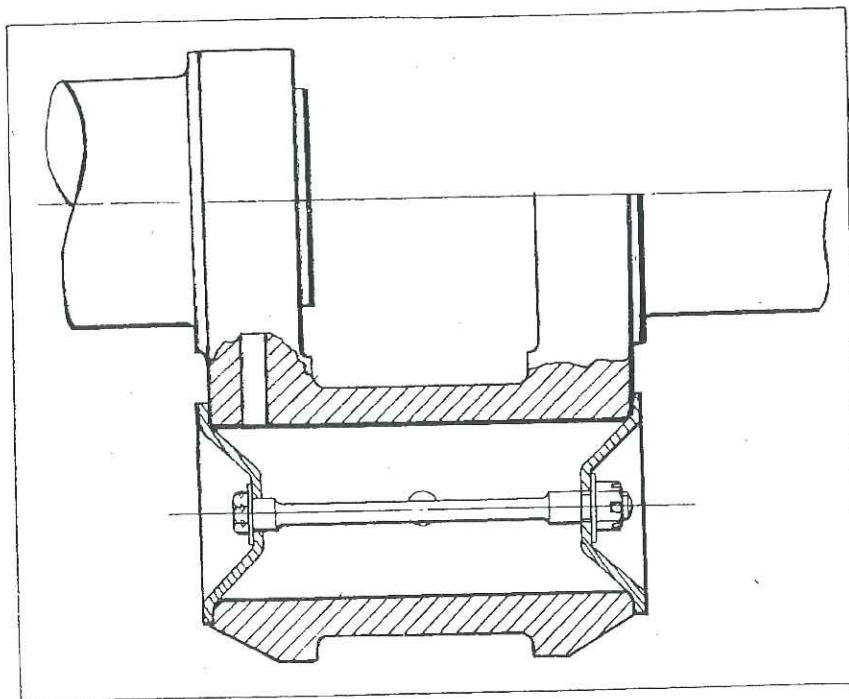


Figure 39.—Section of crankshaft oil retainers.

The clearances between these throwers and ball race housings is important and must be within the prescribed limits. A check on this should be carried out by assembling the shafts complete before fitting them to the crankcase.

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The nuts securing the magneto drive housing are locked by the flats arranged around the inside of the magneto platforms.

The camshaft must be fitted before the tappets and guides, or otherwise the tips of guides will probably be damaged or broken when inserting camshaft.

If a new bearing bush has been fitted, check end float according to table of clearances. When the oil pump is secured, rotate camshaft, which should turn very freely.

Fit oil retainers to crankshaft, placing the bolt heads to the front of each web (Fig. 39). (Front end of the crankshaft is tapered end.)

When fitting connecting rods to the crankshaft ensure that the rod numbers correspond with those on the crankshaft webs and the bleed holes in the connecting rods face towards the camshaft. The big end bearing bolts should be tightened to 240 ± 40 lb./in and the connecting rods should be free on their crankpins.

If it is not possible to split pin a particular nut within the torque tolerance selective assembly should be used. If it is still not possible to fit the split pin a small amount of metal may be removed from the abutment face of the nut in which case it is most important that the face is kept true and square.

Assemble the backplate of thrust housing to crankshaft BEFORE laying the shaft in the main bearings. The crankshaft should be free to rotate by hand when all bearing caps are fitted and nuts tightened. The bolts securing thrust housing must be tightened evenly, pulling up on each bolt in turn.

Figure 40.—Valve Timing Diagram is now obsolete and therefore has been deleted.

Fit cylinder heads to cylinder, taking care that the joint washer is correctly fitted over the spigot with the joint on the washer next to the cylinder, and pull all nuts up uniformly tight, taking a turn on each one in sequence. New Shakeproof washers should be used under the nuts.

Do not attempt to tighten nuts on one side before the others.

Refit pistons on connecting rods, oiling these parts in the process and see that the gudgeon pin circlips are snugly fitted in their grooves. Fit piston rings after filling grooves with oil. Oil piston all over the walls before fitting cylinder.

Fit joint ring to cylinder base and see that it is not stretched too much in the process or it will not allow cylinder to fit correctly to crankcase. Oil cylinder bores, arrange piston ring gaps equally round the piston and gently slide cylinder over piston, holding the rings compressed until covered by cylinder. Tighten nuts holding cylinder, evenly and diagonally.

An oil pressure test is recommended to prime the oil system and at the same time to ascertain if there is any unusual leakage through the crankshaft oil retainers or oil gallery.

Test with a pressure of 60-80 lb. rotating crankshaft slowly and verifying that the bleed holes in connecting rods are clear.

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To time the camshaft, fit the idler temporarily with the rear set of rollers, keeping them in position by using thick grease and turn engine until both inlet and exhaust valves are shut on No. 1 cylinder (numbered from rear end) and adjust clearances to .065 in. Turn engine until both valves balance (*i.e.* inlet opening, exhaust closing). Then remove idler gear (taking care not to drop any needle rollers into the engine) and turn the crankshaft until the piston of No. 1 cylinder is at cylinder head end of cylinder and timing pointer is at T.D.C. Now, without disturbing setting of gears try inserting the idler gear in various positions (without front rollers) until a position is found where the wheel is concentric with spindle. When position is determined ascertain that none of the 24 rollers have fallen out and proceed to fit front set, fit bolt and washers (head of bolt inside of case) and put on the nut to secure. The rollers rely on this grease for lubrication until the oil is freely circulating. Check valve timing with .065 in. clearance on each valve; both should balance at T.D.C. (*i.e.* inlet opening, exhaust closing). Tighten idler bolt and split pin.

Note.—Split pin to be turned around nut and not up and down or it may foul front cover.

If the spindle, which acts as the inside track for the rollers, is changed at any time a check must be made of end float (see table of clearances).

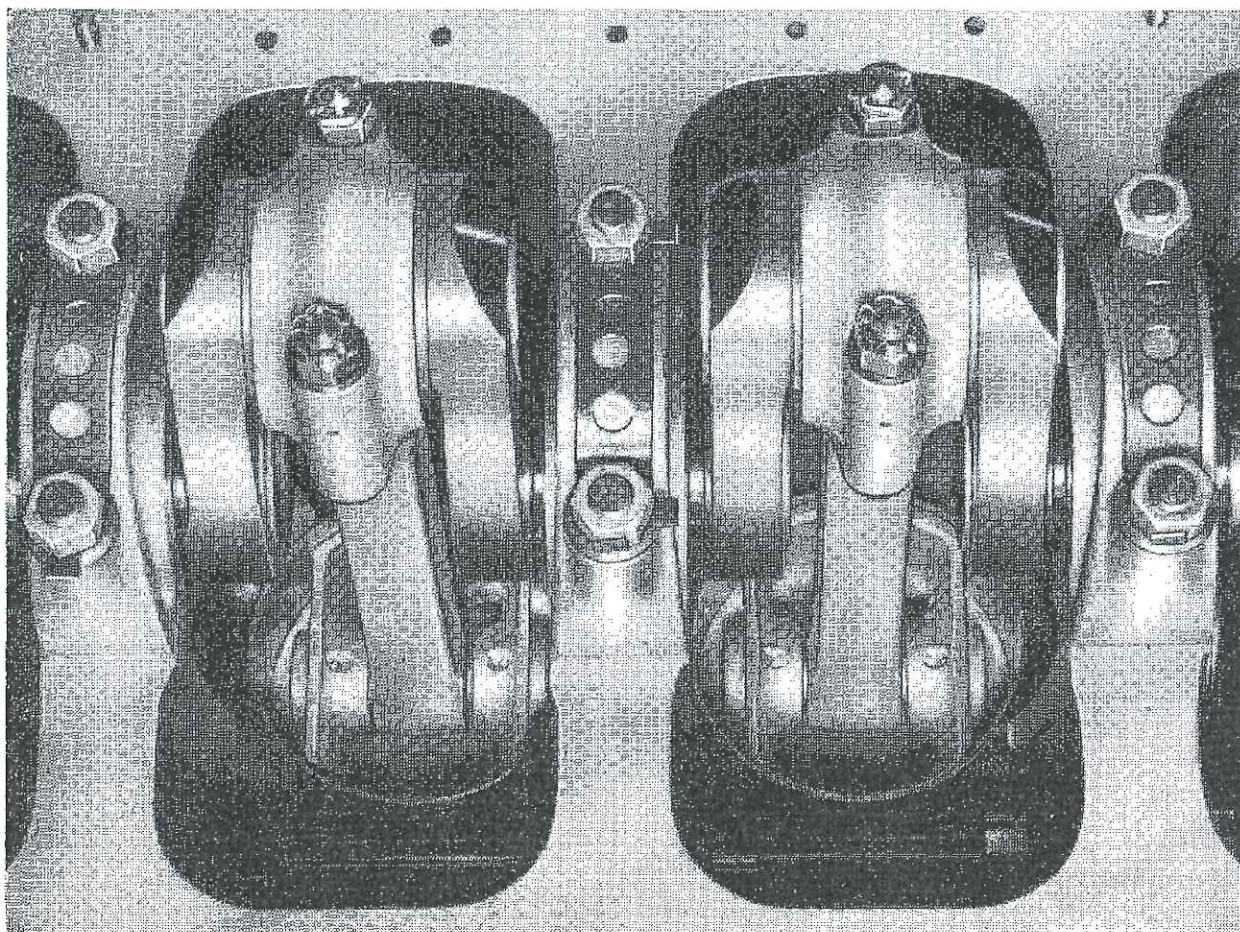


Figure 41.—View looking into cylinders from crankcase showing clearances of gudgeon pin bosses.

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Check end float of idler gear and make a final check on all internal locking before top cover to crankcase is fitted. Also check connecting rod small ends for alignment in cylinder bores (Fig. 41). On viewing the small ends it should be observed that there is approximately an equal amount of end clearance on each side of the rods between small end bosses and gudgeon pin bosses. Now fit the top cover, taking care to see that the joint washer is evenly displaced over the crankcase. It should be pulled slightly to the front. When the crankcase cover is bolted down the joint washer must come right flush with the front and rear faces of the flange in order to make good oiltight joints when the front and rear cover plates are fitted. Tightening the nuts should be commenced in the centre of the crankcase walls and the remaining nuts tightened alternately, working towards the front and rear of the engine. Failure to do this will result in a gap being left between the joint faces of the front cover and/or the rear cover plate and the crankcase, and an oil leak will occur.

Now fit the front cover; the cover must be centralised by inserting feelers between the bore of the cover and the crankshaft nut.

See that the magneto contact breaker points are adjusted to .012 in. The magnetos may now be fitted and timed. The inlet magneto is timed to spark 33° and the exhaust side magneto 35° before T.D.C. Appropriate markings will be found on rear of propeller hub, thus MAG. IN/ /EX. To time the

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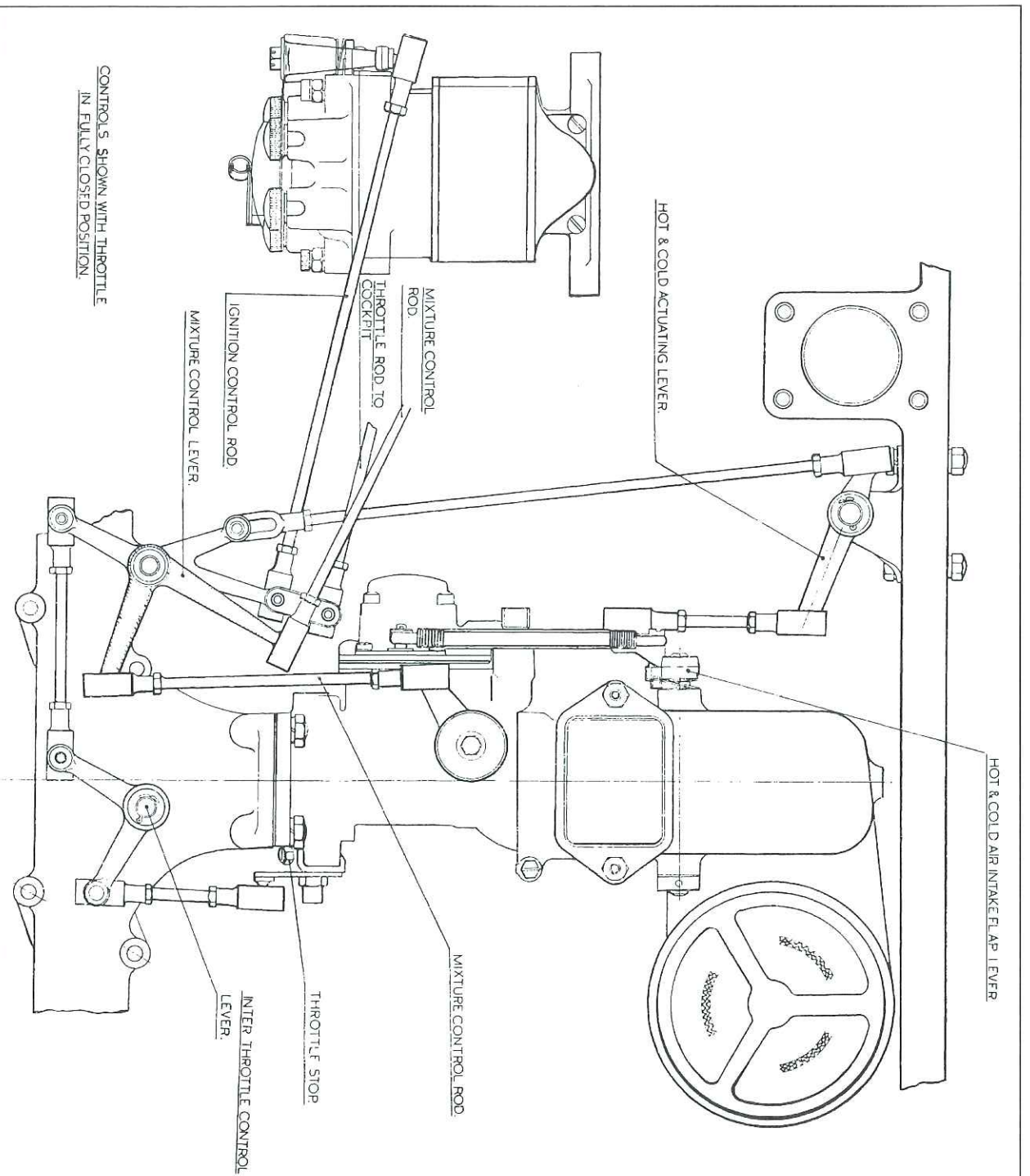


Figure 42.—Diagram of magneto and carburettor controls.