HP. R.A.F. 12.

REVIEW DESCRIPTION. This engine is of the stationary type, with two sets of cylinders arranged at right angles. The cylinder dimensions are 100 mm. by 100 mm., and the engine is rated at 80 H.P., but is capable of delivering some 100 H.P. at 1800 R.P.M. Its chief points of difference from other stationary engines are:

1. The cylinders are staggered in order that independent connecting rods may be used.
2. 4 of the main bearings are of the roller type.
3. A light steel flywheel is fitted which also acts as an oil circulating pump.
4. There is no oil pressure gauge.
5. The engine has a double thrust bearing, and cannot be used as a pusher.

The direction of rotation of the propeller is clockwise as seen from the propeller end of the engine. The angle through which the crankshaft turns between any 2 consecutive explosions is 90°.

Approximate oil consumption: 5 pints per hour.

- petrol: 8 gallons per hour.
- weight of engine: 650 lbs. or 3 lbs. per rated H.P.

CRANKSHAFT. The crankshaft is made of forged steel. It is hollow and has 4 throws arranged in pairs at 180°. Cranks 1 and 4 form 1 pair, and these are vertically upwards when cranks 2 and 3, the other pair, are vertically downwards. The crankshaft runs on 4 roller bearings and 1 ball bearing. The ball bearing, which is at the flywheel end, centres the crankshaft and prevents any floating motion. Three of the roller bearings are between the 4 crankthrows, and the fourth is at the end of the crankshaft between No. 1 crank and the spur reduction gearing. The bearings between the crank throws are of larger diameter than the end roller bearing, and their inner races are supported by split bushes. One half of each split boss is keyed to the crankshaft, and is held in position by a flange and a set screw. The other half is held in position by a flange and the crankweb. The crankwebs are shaped in such a way as to allow these bearings to be threaded over the crank- shaft and not placed in position. A helical groove around the flywheel boss serves as a baffle to prevent oil from escaping where the crankshaft passes through the flywheels cover.
PROPeller Shaft. A short hollow propeller shaft mounted above the crankshaft at the end opposite the flywheel and is driven direct through the spur gear at half the engine speed. The propeller shaft runs on 2 radial ball bearings and is fitted with a thrust bearing arranged for thrust working.

Cams. The hollow steel camshaft has 1 plain bronze bearing at its centre and a radial ball bearing at its rear end. Its other end fits into the hollow propeller shaft held in position by a cross pin which passes through 1 shaft, and driven by means of a series of Vee shaped cuttings which engage in corresponding castellations in the propeller shafts. As stated above, the propeller shaft runs at half the engine speed, which is the correct speed for camshafts. There are 8 inlet cams, 8 exhaust cams and 1 pump cam, all cut solid with the shaft. The inlet valve actuates the inlet valve through the medium of adjust hardened steel tappets sliding in phosphor bronze bushed valve guides. The exhaust valves are operated by overhead rockers through the medium of adjustable hollow steel push rods with needle joints.

Crankcase. The crankcase is of aluminium alloy and is 3 main parts, the upper portion, the lower part or sump, a large end plate or flywheel cover. At the propeller end of the crankcase is a smaller end plate which forms a cover for the gear box and a housing for the front propeller shaft ball race and the thrust race. The bottom of the oil stream slants downwards towards the flywheel end, where it chamber communicates with the bottom of the flywheel casing. This chamber is screened by an inclined wire mesh cover, and fitted with a drain plug for the removal of oil. The oil feed, at the centre of the sump, indicates the oil level by means of a pointer outside the crankcase. The top of the crankcase has 8 cylinder recesses for the 8 cylinder heads and 4 brackets for the flanged steel tubes, by means of which the engine is attached to the aeroplane. At the propeller end is the reduction gear box, which also forms the housing for the rear propeller shaft ball race. At the flywheel end, the top half of the flywheel casing, which is connected to the flywheel cover by a series of studs and nuts. At the front
The cylinders are of cast iron with cooling ribs on the sides, and surrounding the valve pockets and exhaust ports. Each cylinder has a small water jacket around it. The cylinders are held in position by long mild steel rods or "studs," which are screwed into the crankcase and pass through projecting lugs at the top of the cylinder. The nuts of these rods are screwed to take castellated nuts, which are upon the lugs at the ends of the cylinders up to the crankcase, where they pass through small flanges turned on the cylinder base. There are two sliding rods per cylinder, and they are arranged in pairs which are diagonal in regard to the lines of cylinders. The engine cylinders are numbered in the order in which they are fixed, and the openings in the crankcase are marked with the corresponding numbers, as follows:

Propeller

8 4 6
Flywheel

1 7 5

Intake: The pistons are of cast iron with slightly convex ends, and each carries 3 cast iron rings fitted in grooves cast into the piston head. A fourth groove, around the piston, is the seat of the centre of the gudgeon pin, and communicates with holes through the piston wall and screws to spread oil over the cylinder wall. The pistons are attached to the connecting rods by hollow steel gudgeon pins, which are divided in order of the usual type, and are fixed in position by a tapped pin or set screw. This pin screws into the upper side of the gudgeon pin boss, and passes through the end of the gudgeon pin, which is slotted longitudinally so that it may be expanded in the boss by the action of the taper pin. A plate fitting between the piston wall and the gudgeon pin in position, and a split pin passing through the set screw secures the lock plate.

Piston clearance = 0.4 mm. to 0.6 mm.

Piston ring gap = 0.4 mm. to 0.8 mm.

In some engines, aluminum pistons are used. In such cases the clearance should be 0.15 as shown.
CONNECTING RODS. The connecting rods are of steel, nickel steel, "H" section, bronzed bushed at the small end, and lined with white metal at the big end. The big end or lower half bearing is removable, and is secured to connecting rod by 2 steel studs and nuts.

VALVES. The inlet and exhaust valves, which are made of nickel steel, slide in bronzed bushed guides, and open into pistons adjoining the combustion chamber and seated in the highest parts of the inclined cylinders. The exhaust valve seating and wedge are cast integral with the cylinder, and this part is above and opposite to the inlet valve seating, which is removable together with its valve and guide. The exhaust valve has a cone shaped head of light section and hollow stem. The head of the inlet valve is also cone shaped, but is of heavier section than the exhaust valve, and the seat is solid. A short length of the induction pipe is 1 in.

A short length of the induction pipe is 1 in. with the cast iron inlet valve seating, which is held in position by a screwed steel ring, known as the inlet valve seating or which screws into a recess under the valve pocket and is engaged with a flange on the valve seating. The inlet valve spring of the ordinary helical pattern encircling the valve stem. The exhaust valve spring is of the volute type. It is made of rectangular section spring steel, wound spirally in the form of an inverted cone. The lower end of the spring presses against a shoulder on the bronze valve stem guide, and the upper end against the inner side of a small flanged steel disc or circlip held in position by a split collar screwed on the trunnion of the valve stem. A steel pin is fitted to raise the inner end of the rocker arm. The contact clearances should be adjusted to the following values:

<table>
<thead>
<tr>
<th>Engine cold</th>
<th>Inlet</th>
<th>Exhaust</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.005&quot;</td>
<td>0.014&quot;</td>
<td></td>
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</tbody>
</table>

CYCLE OF OPERATIONS. Consider the case of any cylinder, for example No. 1, starting with the piston at the top of the stroke (T.D.C.) and the exhaust valve open. When the piston has moved 2 m.m. down the stroke, the inlet valve begins to seat, and as the exhaust valve closes, there is an overlap of 2 m.m. The piston continues its downward motion draws the explosive mixture into the cylinder, reaching the bottom of the stroke (B.D.C.) and moves up through 2 to 16 m.m. of the return stroke before the inlet valve closes and compression commences.
from the top of the compression stroke, i.e., 12 m.m.
T.D.C., ignition takes place, and the stroke is completed
while the flame is spreading through the mixture. The
 succeeding power stroke, the piston is driven down
by the force of the explosion, and the exhaust valves
openings, at the side and base of the jet, flows
exhaust valve remains open during the whole of the re-
stroke, i.e., until the cycle has been completed.

Admission of explosive mixture
Compression (Ignition 12 m.m.)
Power
Exhaust

2 m.m. past T.D.C.
14 to 16 m.m. past B.D.C.
28 to 30 m.m. before B.D.C.
4 m.m. past T.D.C.

to
T.D.C.
to
T.D.C.
to

AIR FLOW TIMING. The large and small wheels of the
reduction gear are marked to indicate the correct position
for all wheels, taking care not to disturb the setting of the driving
and contact breaker points are just "breaking." Mesh the
wheels to mesh, and contact before in doing. Repeat with the
second m.m. 2 m.m. past B.D.C.
MAGNETO. The magnets are mounted on brackets
projecting from the flywheel cover, and are driven at engine
speed by a spur wheel which is keyed to the crankshaft. They
and the revolution armature type, giving 2 sparks per revolu-
so that the 2 magnets give 2 sparks in 2 revolutions
of the engine, during which time each of the 8 plungers con-
1 cycle. In some engines, 1 magnet of the rotating armature

12
1. **Plunger.**
2. **Flange for attaching Pump to Crankcase.**
3. **Spring for keeping Plunger in engagement with Cam.**
4. **Pump Barrel.**
5. **Air Inlet Port.**
6. **Non-return Delivery Valve.**
7. **Valve Spring.**
8. **Pressure Outlet to Petrol Tank.**

**H.P. R.A.F. 1.0.**

The object of supplying oil to the roller bearings is to ensure that oil shall be supplied to the collector rings at adequate pressure, the chamber or reservoir, supplied by the vacuum passage from the flywheel, is provided with a bypass, from which the oil overflows into the sump when the required level is reached. The remaining internal parts of the engine including the pistons, connecting rod ends, mainshaft, cam, tappets, air pump, and ball and roller bearings are lubricated by splash. The external parts are lubricated by hand. The effective lubrication of the parts in an engine of this type is a matter of some difficulty. To prevent excessive lubrication of the cylinders, the openings for the connecting rods in the crankcase are specially covered by baffles plates which are cast with the crankcase. These baffle plates are slotted to allow the connecting rods free play, and, in order to adjust the supply of oil to the best value, a suitable number of holes are drilled in the baffle plates. The upper sides of the port side cylinders and the lower sides of the starboard cylinders are accessible so that the splashed oil, if the upper sides of the starboard cylinders must of necessity remain relatively dry.

**H.P. PUMP.** The air pump, which maintains the pressure in the petrol tank, is operated by a cam on the camshaft. There is no suction valve as the inlet is through the sides of the pump barrel, and a non-return delivery valve is at the upper end of the barrel. The pump is single acting and the plungers is kept in engagement with the driving chain by a spring.