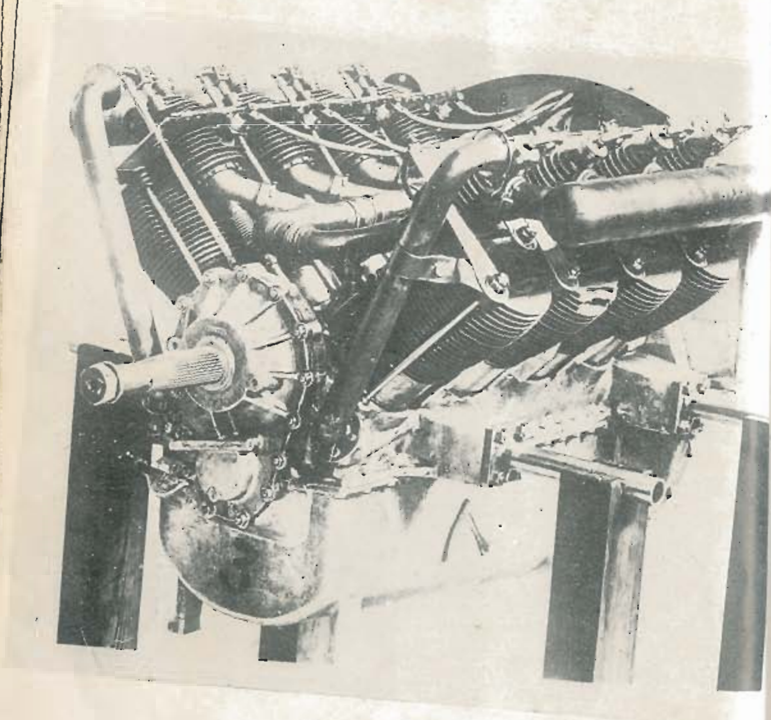


Fig. 1.

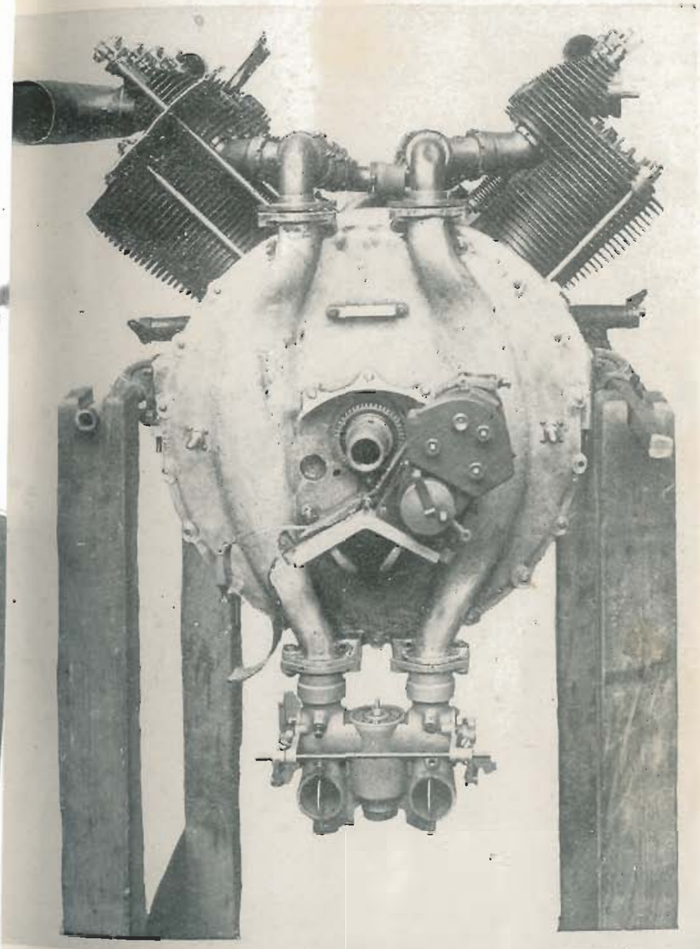
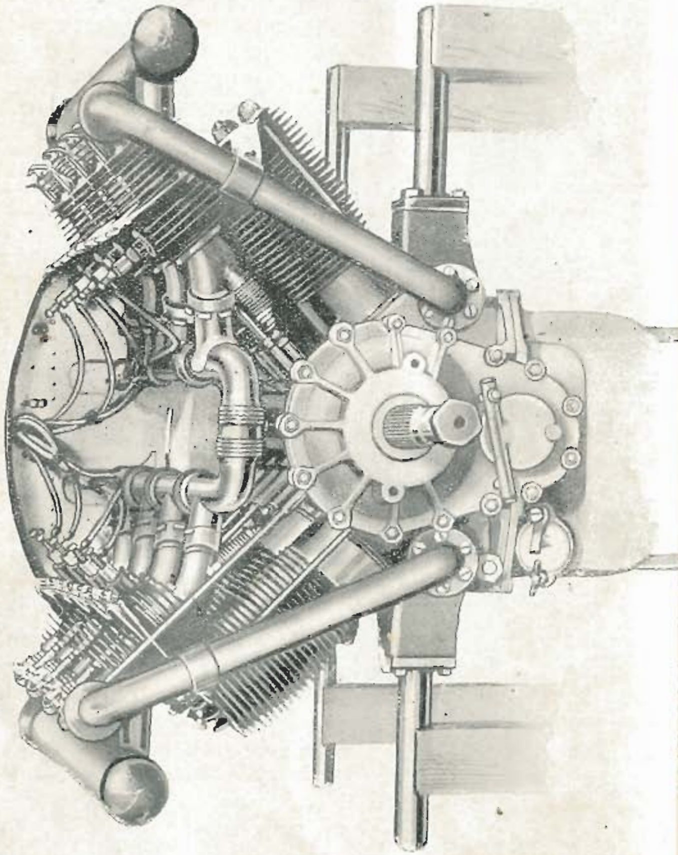


Fig. 2.



) H.P. R.A.F. 1.a.

ENERAL DESCRIPTION. This engine is of the stationary r cooled vee type with 2 sets of 4 cylinders arranged at ght angles. The cylinder dimensions are 100 m.m. by 40 m.m., and the engine is rated at 90 H.P. but is capable of eveloping some 100 H.P. at 1800 R.P.M. Its chief points f 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 pump.
(5) The engine has no double thrust bearing, and cannot be used as a pusher.

'he direction of rotation of the propeller is clockwise as seen rom the propeller end of the engine. The angle through vhich the crankshaft turns between any 2 consecutive explo- ions is 90°.

Approximate oil consumption	=	5 pints per hour.
,, petrol ,,	=	9 gallons per hour.
,, weight of engine	=	450 lbs. or 5 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 cranks are of larger diameter than the end roller bearing, and their inner races are supported by split bushes. One half of each split bush 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 so placed in position. A helical groove around the fly wheel boss serves as a baffle to prevent oil from escaping where the crankshaft passes through the flywheel cover.

PROPELLER SHAFT. A short hollow propeller shaf mounted above the crankshaft at the end opposite the flywl and is driven direct through the spur gearing at half the en speed. The propeller shaft runs on 2 radial ball beari and is fitted with a thrust bearing arranged for tra working.

CAMSHAFT. The hollow steel camshaft has 1 plain phosp bronze bearing at its centre, and a radial ball bearing at rear end. Its other end fits into the hollow propeller sh is held in position by a cross pin which passes through b shafts, and driven by means of a series of vee shaped cas lations which engage in corresponding castellations in propeller shaft. As stated above, the propeller shaft rota at half the engine speed, which is the correct speed for camshaft. There are 8 inlet cams, 8 exhaust cams and 1 pump cam, all cut solid with the shaft. The inlet ca actuate the inlet valves through the medium of adjusta hardened steel tappets sliding in phosphor bronze bush The exhaust valves are operated by overhead rocker ar through the medium of adjustable hollow steel push rods wh are connected to their corresponding tappets by ball socket joints.

CRANKCASE. The crankcase is of aluminium alloy and is 3 main parts, the upper portion, the lower part or sump, a a large end plate or flywheel cover. At the propeller end of t crankcase is a smaller end plate which forms a cover for t gear box and a housing for the front propeller shaft rad ball race and the thrust race. The bottom of the oil sur slants downwards towards the flywheel end, where is chamber communicating with the bottom of the flywh casing. This chamber is screened by an inclined wire gau cover, and fitted with a drain plug for the removal of oil. pivoted float, at the centre of the sump, indicates the oil lev by means of a pointer outside the crankcase. The top h of the crankcase has 8 circular recesses for the 8 cylinde 5 webs or partitions for supporting the 5 crankshaft bearin and 4 brackets for the flanged steel tubes by means of whi the engine is attached to the aeroplane. At the propeller en is the reduction gear box, which also forms the housing for t rear propeller shaft radial ball race. At the flywheel end the top half of the flywheel casing, which is connected to t flywheel cover by a series of studs and nuts. At the front

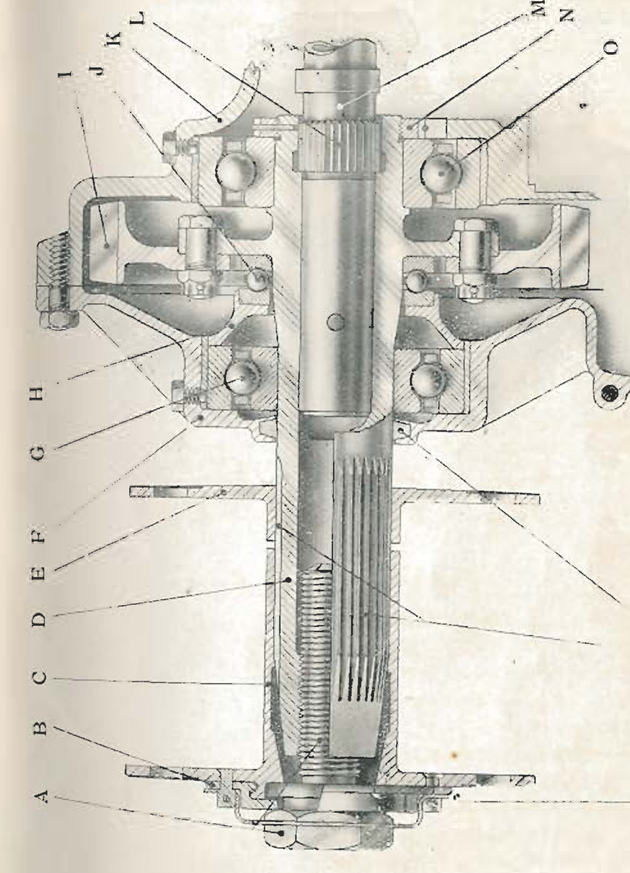


FIG. 4.

- A Propeller Boss Extractor Screw.
- B Extractor Collar.
- C Propeller Boss.
- D Propeller Shaft.
- E Propeller Boss Back Plate.
- F End Plate.
- G Propeller Shaft Front Radial Ball Bearing.
- H Distance Piece.
- I Reduction Gear.
- J Thrust Ball Bearing for Tractor Working.
- K Crankcase.
- L Serrations.
- M Camshaft.
- N Lock Nut.
- O Propeller Shaft Rear Radial Ball Bearing.
- Q Locking Plate.
- P Felt Oil Retainer.

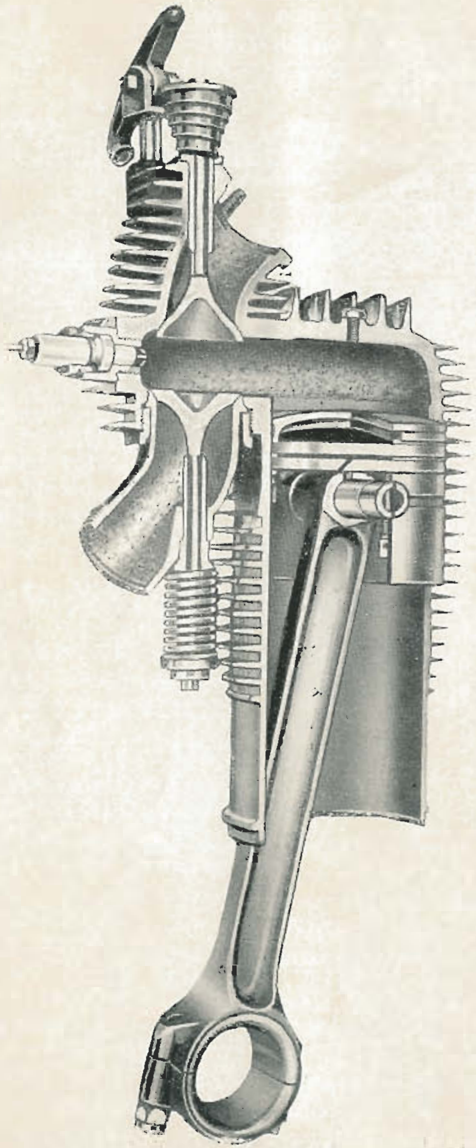


FIG. 5.

e crankcase are 2 long copper breather pipes fitted with re gauze diaphragms. The upper ends of the breathers e bent backward to direct the oil vapour on to the rocker ms.

'LINDERS. The cylinders are of cast iron with cooling ps, of the usual type, extending over the whole of the cylin-ical surface, and surrounding the valve pockets and exhaust lve guides. Each cylinder has also 5 small cooling ribs ranged longitudinally at the top of the cylinder head. The linders are held in position by long mild steel rods or "studs," hich are screwed into the crankcase and pass through pro-cting lugs at the top of the cylinder. The tops of these rods e screwed to take castellated nuts, which bear upon the lugs nd draw the cylinders up to the crankcase, where they rest pon small flanges turned on the cylinder base. There are 2 olding down rods per cylinder, and they are arranged in ositions which are diagonal in regard to the lines of cylinders. n this engine the cylinders are numbered in the order in hich they are fired, and the openings in the crankcase are arked with the corresponding numbers, as follows:—

Propeller	2	8	4	6	Flywheel
	5	3	7	1	

'ISTONS. The pistons are of cast iron with slightly convex eads, and each carries 3 cast iron rings fitted in grooves lose to the piston head. A fourth groove around the piston, t the level of the centre of the gudgeon pin, communicates ith holes through the piston wall and serves to spread oil ver the cylinder wall. The pistons are attached to the onnecting rods by hollow steel gudgeon pins, which are arried in bosses of the usual type, and are fixed in position y a tapered pin or set screw. This pin screws into the ower side of the gudgeon pin boss, and passes through the nd of the gudgeon pin, which is slotted longitudinally so that t may be expanded in the boss by the action of the taper pin. A plate fitting against the piston wall locks the gudgeon pin n position, and a split pin passing through the set screw ecures the lock plate.

Piston clearance = ·4 m.m. to ·5 m.m.*
Piston ring gap = ·08 m.m. to ·10 m.m.

* In some engines aluminium pistons are used. In such cases the clearance should be 0·5 to 1·0 m.m.

CONNECTING RODS. The connecting rods are of speci alloy steel, "H" section, bronzed bushed at the small en and lined with white metal at the big end. The big end ca or lower half bearing, is removable, and is secured to t connecting rod by 2 steel studs and nuts.

VALVES. The inlet and exhaust valves, which are made nickel steel, slide in bronzed bushed guides, and open in pockets adjoining the combustion chamber and situated the highest parts of the inclined cylinders. The exhau valve seating and outlet are cast integral with the cylinde and this part is above and opposite to the inlet valve seatin which is removable together with its valve and guide. T exhaust valve has a cone shaped head of light section and hollow stem. The head of the inlet valve is also cone shape but is of heavier section than the exhaust valve, and the ste is solid. A short length of the induction pipe is in 1 pie with the cast iron inlet valve seating, which is held in positi by a screwed steel ring, known as the inlet valve seating nu which screws into a recess under the valve pocket and engag with a flange on the valve seating. The inlet valve spring of the ordinary helical pattern encircling the valve stem. T exhaust valve spring is of the volute type. It is made rectangular section spring steel, wound spirally in the for of an inverted cone. The lower end of the spring presses again a shoulder on the bronze valve stem guide, and the upper en against the under side of a small flanged steel disc or cu washer held in position by a split collar screwed on the to of the valve stem. A steel pin is fitted to take the impa of the rocker arm. The tappet clearances should be adjuste to the following values:—

Engine cold	-	Inlet = 0·006″
,, ,,		Exhaust = 0·004″

CYCLE OF OPERATIONS. Consider the case of any cylin der, for example No. 1, starting with the piston at the top o the stroke (T.D.C.) and the exhaust valve open. When th piston has moved 2 m.m. down the stroke, the inlet valv opens, and at 4 m.m. the exhaust valve closes. There is thu 2 m.m. "overlap." The piston continuing its downwar motion draws the explosive mixture into the cylinder, reache the bottom of the stroke (B.D.C.) and moves up through 1 to 16 m.m, of the return stroke before the inlet valve close and compression commences. When the piston is 12 m.m

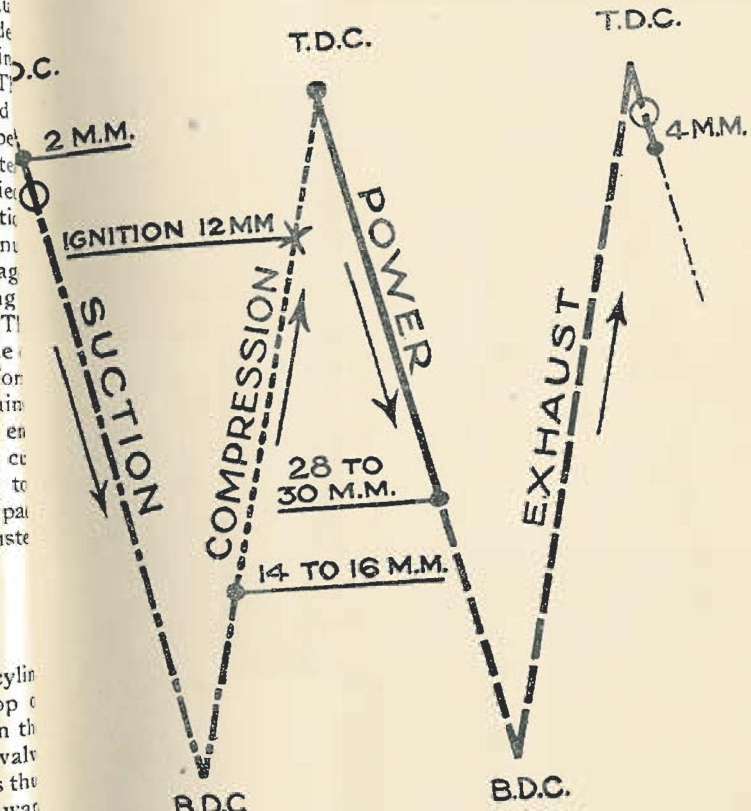


Fig. 6.

from the top of the compression stroke, i.e., 12 m.m. be T.D.C., ignition takes place, and the stroke is compl while the flame is spreading through the mixture. Du the succeeding power stroke, the piston is driven down by the force of the explosion, and the exhaust valve o when the piston has reached a point 28 to 30 m.m. before end of the stroke, i.e., 28 to 30 m.m. before B.D.C. exhaust valve remains open during the whole of the re stroke, i.e., until the cycle has been completed.

Admission of explosive mixture	2 m.m. past T.D.C. to 14 to 16 m.m. past B.
Compression (Ignition 12 m.m. before T.D.C.)	14 to 16 m.m. past B. to T.D.C.
Power	T.D.C. to 28 to 30 m.m. before B.
Exhaust	28 to 30 m.m. before B. to 4 m.m. past T.D.C.

VALVE TIMING. The large and small wheels of the s reduction gear are marked to indicate the correct positio meshing.

IGNITION TIMING. Set the piston of No. 1 cylinder 12 m before T. D. C. on the compression stroke by turning the cra shaft and inserting a plug through the flywheel cover into 1 series of holes in the flywheel. Turn the armature of 1 of magnetos in its normal running direction until the brus making contact with No. 1 segment on the distributor, and contact breaker points are just "breaking." Mesh the g wheels, taking care not to disturb the setting of the distribu and contact breaker in so doing. Repeat with the second m neto but timing this to No. 2 cylinder instead of No. 1.

MAGNETOS. The magnetos are mounted on brackets p jecting from the flywheel cover, and are driven at engine sp by a spur wheel which is keyed to the crankshaft. They of the revolving armature type, giving 2 sparks per revoluti so that the 2 magnetos together give 8 sparks in 2 revoluti of the engine, during which time each of the 8 pistons comple 1 cycle. In some engines, 1 magneto of the rotating sh type is fitted. This magneto, giving 4 sparks per revolution equivalent to 2 magnetos of the revolving armature type.

ARBURATION. The carburetter is a special double Claudel-Hobson" having 1 float chamber and 2 mixing hambers and jets. It is mounted at the base of the crank-ase under the magnetos. The supply of mixture is controlled y 2 cylindrical throttles operated by 1 lever. Air enters hrough openings at the side and base of the jet, flows ast the jet at a high velocity, and carries the sprayed petrol ith it up induction pipes or passages in the flywheel cover o a built-up manifold induction pipe, which is common to the cylinders. Special attention is required to prevent air leaks the induction pipe joints, which are of the usual rubber tube nd metal clip type. The insides of the induction passages n the flywheel cover are stove enamelled with the object of topping small air leaks due to porosity of the metal or faulty asting.

UBRICATION. Lubrication is by gravity and splash, The lower part of the flywheel chamber being in communica-ion with the sump, the flywheel picks up oil during its rota-ion and projects it into an overhead oil gallery leading to a hamber or reservoir in 1 of the rear crankcase brackets, From which oil flows into a main duct or channel which runs he whole length of the base of the top half of the crankcase. At the end of this duct remote from the flywheel is a small hole registering with a corresponding hole in the gear box cover, in which is a passage terminating in an orifice from which oil flows into the teeth of the lower gear wheel as they move forward to mesh with those of the upper gear wheel. From the main duct, oil also flows by separate pipes to the under side of the 2 main bearing caps between cranks 1 and 2, and 3 and 4. Each of these pipes is "stopped down" at the lower end by a metal diaphragm drilled with a hole usually 5·5 m.m. in diameter, the size of which determines the quantity of oil that will flow through the pipe. Each of the pipes also has a small vent hole at its lowest point. The crankwebs, adjacent to the bearing caps supplied with oil, are fitted with steel oil collector rings the function of which is to convey the oil which flows from orifices on either side of the bearing caps, to the insides of the hollow crankpins. Each crankpin has 2 radial holes, through which oil passes to lubricate the connecting rod big end bearings. It should be noted that the 2 oil pipes are taken to the main bearing caps in order to provide for the lubrication of the connecting rod big ends, and

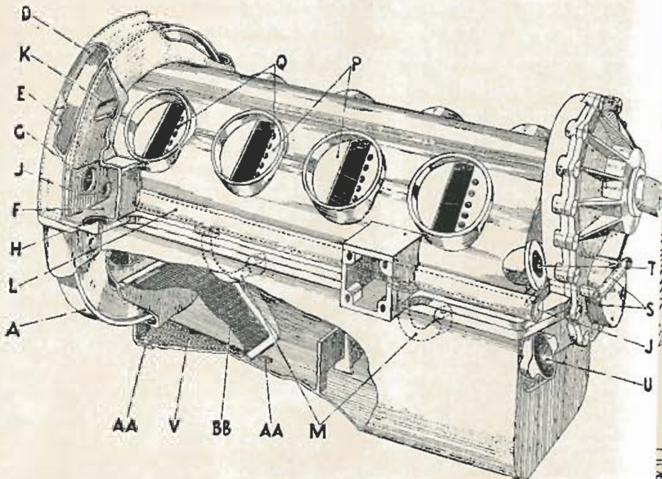
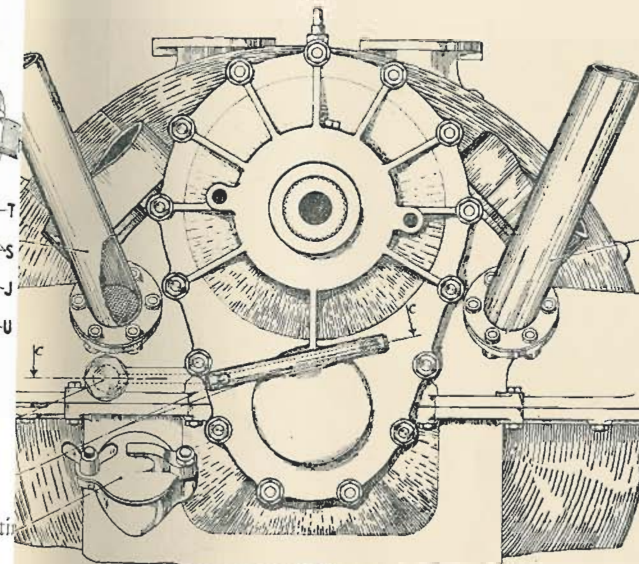


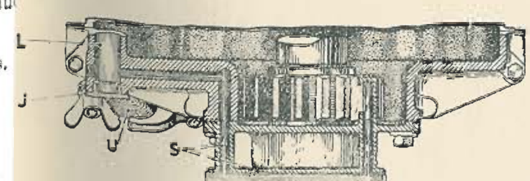
Fig. 7.

A Flywheel.
B Flywheel Chamber.
C Helical Groove serving as Oil Baffle.
D Overhead Gallery leading to Reservoir.
E Gallery Inspection Plug.
F Reservoir.
G Reservoir Inspection Plugs.
H Reservoir Drain Plug.
J Main Duct Inspection Plug.
K Byepass.
L Main Duct.
M Pipes leading to Main Bearing Caps.
N Collector Rings conveying Oil to Hollow Crank Pins.
O Radial Holes leading Big Ends of Connecti Rods.
P Baffle Plates.
Q Holes in Baffle Plates.
R Felt Oil Retainer.
S Passage leading to Redu tion Gearing.
T Crankcase Breather Pipes.
U Sump Oil Filler.
V Sump.
W Oil Level Indicator.
X Pivoted Float.
Y Vent Hole.
Z Diaphragms.
AA Drain Plugs.
BB Wire Gauze.
CC Air Pump.



Prop. End View.

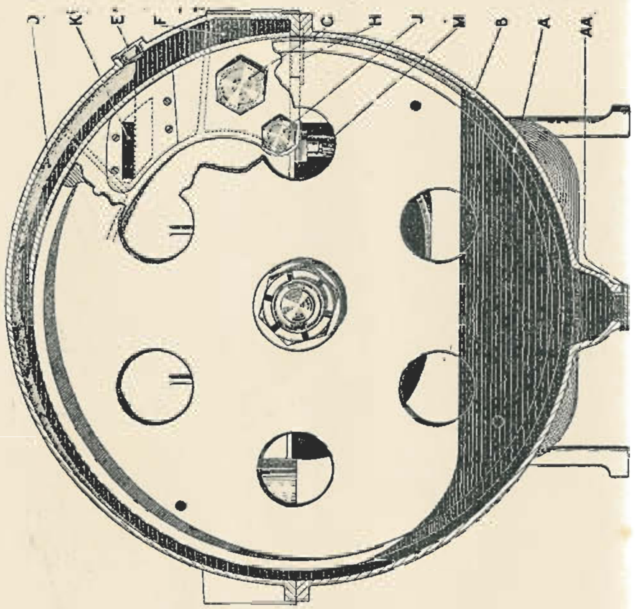
Fig. 8.

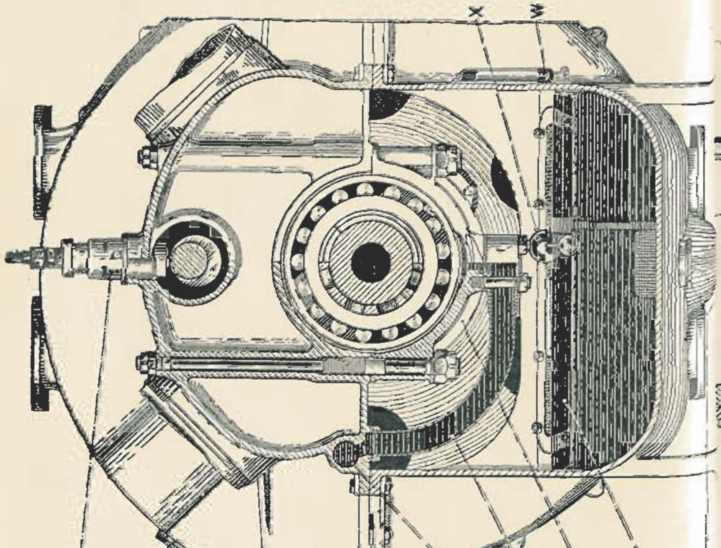


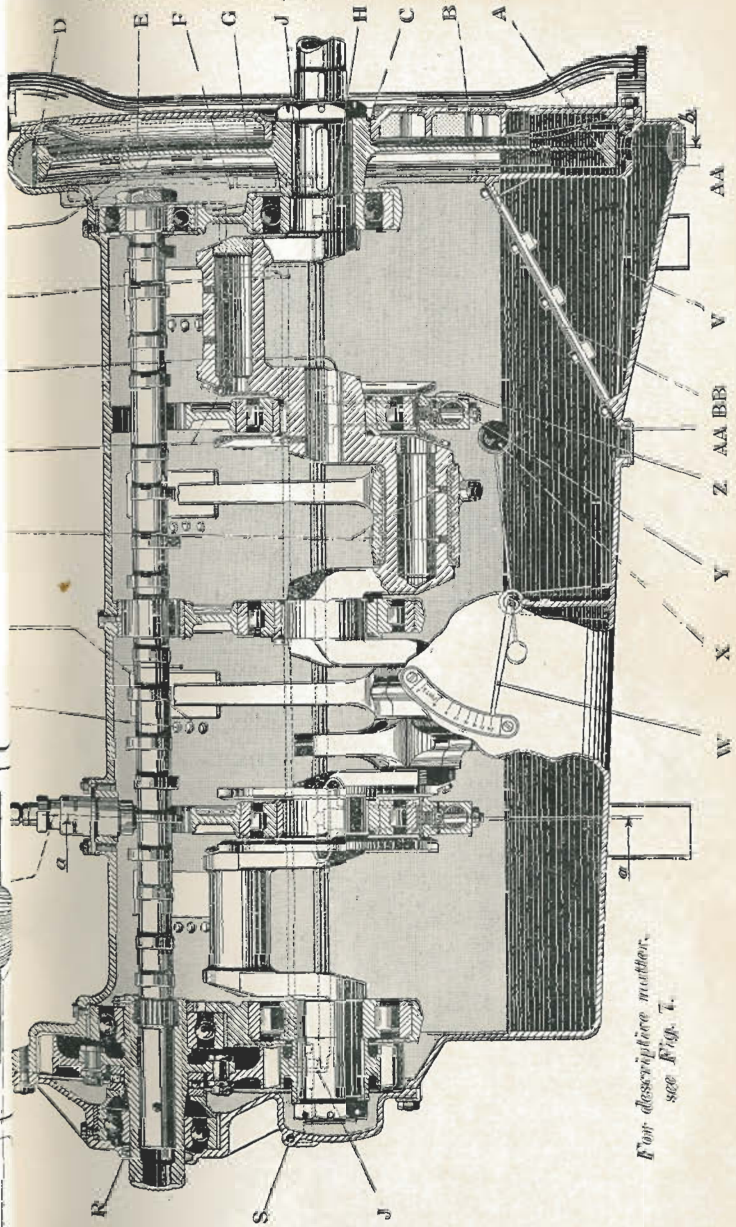
Plan Section at cc.

Fig. 9.

For descriptive matter, see Fig. 7.







For descriptive matter, see Fig. 7.

FIG. 12.

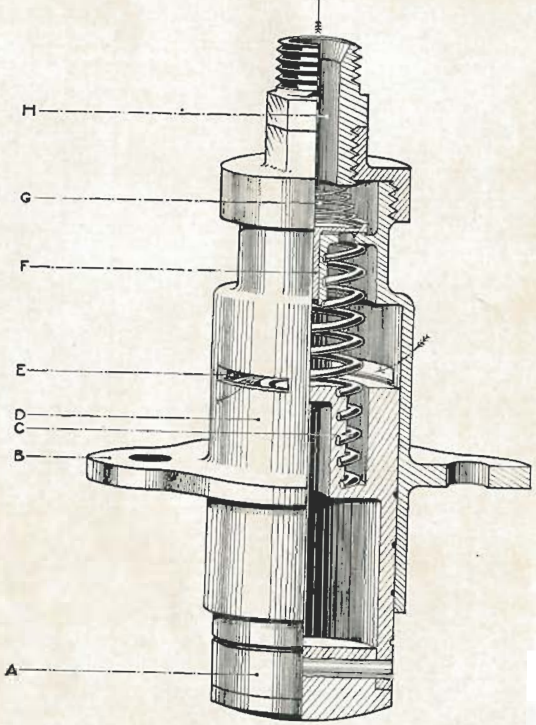


FIG. 13.

A Plunger.
B Flange for attaching Pump to Crankcase.
C Spring for keeping Plunger in engagement with Cam.
D Pump Barrel.
E Air Inlet Port.
F Non-return Delivery Valve.
G Valve Spring.
H Pressure Outlet to Petrol Tank.

)t with the object of supplying oil to the roller bearings. o ensure that oil shall be supplied to the collector rings at definite pressure, the chamber or reservoir, supplied by the verhead passage from the flywheel, is provided with a bye-ass, from which the oil overflows into the sump when the equired level is reached. The remaining internal parts of ie engine including the piston, connecting rod small ends, amshaft, cams, tappets, air pump, and ball and roller bear-ıgs are lubricated by splash. The external parts are ıbricated by hand. The efficient lubrication of the istons in an engine of the vee type is a matter of some ifficulty. To prevent excessive lubrication of the cylinders, he openings for the connecting rods in the crankcase are artially covered by baffle plates which are cast with the rankcase. These baffle plates are slotted to allow the con-ecting rods free play, and, in order to adjust the supply of il to the best value, a suitable number of holes are drilled in he baffle plates. The upper sides of the port side cylinders and he lower sides of the starboard cylinders are accessable to he splashed oil, but the upper sides of the starboard cylinders nust of necessity remain relatively dry.

IR PUMP. The air pump, which maintains the pressure n 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 s at the upper end of the barrel. The pump is single acting and the plunger is kept in engagement with the driving cam by a spring.