AIR BOARD

TECHNICAL NOTES.

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120 H.P. BEARDMORE.

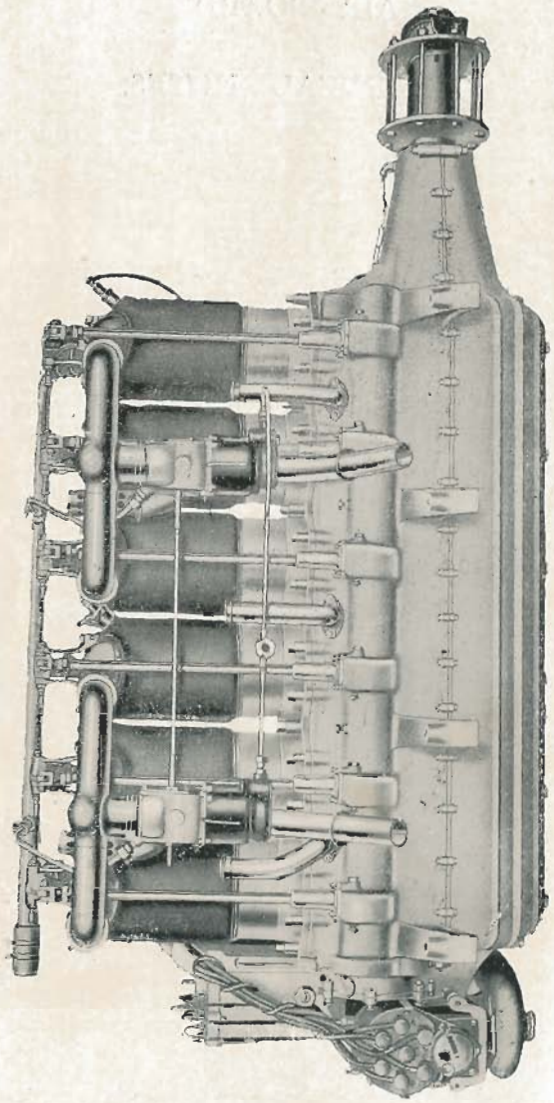


FIG. 1.

) H.P. BEARDMORE.

NERAL DESCRIPTION. This engine is of the stationary ter cooled vertical type with 6 cylinders, 130 m.m. by 175 n., rated at 120 H.P. but capable of developing some 130 P. at 1,200 R.P.M. It is fitted with a double thrust ball e which enables it to be used either as a pusher or as a ctor. Its chief points of difference from other stationary gines are :—

(1) The cylinders are off-set.
(2) The inlet and exhaust valves in each cylinder are operated by 1 tappet rod.
(3) The propeller is direct driven.

e direction of rotation is anti-clockwise as seen from the opeller end of the engine. The angle through which the ankshaft turns between any 2 consecutive explosions is 120°.

Approximate oil consumption = 3½ pints per hour.
„ petrol „ = 9½ gallons „
„ weight of engine (including radiator and cooling water) = 630 lbs. or 5·25 lbs. per rated H.P.

RANKSHAFT. The crankshaft is made of chrome nickel eel.* It is hollow and has 6 throws arranged in pairs at 120° umbering from the propeller end, cranks 1 and 6 form one ir, 2 and 5 a second pair, and 3 and 4 a third pair. Viewed om the propeller end, cranks 1 and 6 are downwards to the t, when cranks 2 and 5 are vertical, and cranks 3 and 4 are wnwards to the right. The crankshaft runs on 7 white metal arings, 1 at either side of each crankthrow, and 1 radial ll bearing in the thrust box at the propeller end of the shaft. the end of the crankshaft, opposite to the propeller end, e 3 gear wheels :—

(1) A spurwheel with 24 teeth for driving the camshaft,
(2) A large bevel wheel for driving the oil and water pumps, and
(3) A small bevel wheel for driving the magnetos.

AMSHAFT. The camshaft runs in 4 phosphor bronze ushes at the side of the crankcase, and is driven from the ankshaft at half the engine speed. The drive is through an termediate or idle wheel, so that the camshaft rotates in the me direction as the crankshaft. The 6 inlet and 6 exhaust

* Superseded by Beardmore special steel.

cams are arranged in pairs, each pair operating the val
1 cylinder through the medium of 1 bellcrank lever
tappet rod.

CRANKCASE. The crankcase is of aluminium alloy
divided horizontally along the line of the crankshaft.
bottom of the lower half, which forms the oil sump, is d
into 6 chambers, each of which is fitted with a drain plu
the removal of oil. At the propeller end is the lower h
the thrust box and 1 end white metal bearing. At the
end is the lower half of the gear wheel housing and the
end white metal bearing together with 2 magneto plat
Cooling fins, which also act as strengthening ribs, are c
the outside of the sump. The top half of the crankcas
6 circular openings for the 6 cylinders, 5 webs or part
for supporting the 5 white metal bearings between the c
and 4 projecting lugs or feet on either side for supportin
engine in the aeroplane. At the propeller end, are th
halves of the thrust box and 1 end white metal bearing
the other end, is the top half of the 7th white metal be
The openings for the cylinders are not on the centre li
the crankcase, but are off-set 18 m.m. in the directi
rotation. This arrangement reduces the obliquity o
connecting rods during the power strokes and resul
increased mechanical efficiency. On the carburetter si
the crankcase are 3 brass breather pipes fitted with
gauze strainers. The primary object of the breathers
maintain atmospheric pressure in the crankcase. The
also used for pouring oil into the crankcase.

CYLINDERS. The cylinders are of cast iron with ele
lytically deposited copper water jackets. A flanged steel
is screwed and sweated to each cylinder, and the cylind
held in position on the crankcase by 3 screwed studs and
and 4 crankcase bolts which engage with this flange. A
bolts, with the exception of those at the ends of the en
pass through the crankcase webs and serve as holding
bolts for the bearing caps. The remaining 4 bolts pass
through the sump. The cylinders are numbered 1 to 6
secutively, starting at the propeller end. The order of
is 1, 5, 3, 6, 2, 4.

PISTONS. The pistons are of mild steel with slightly con
heads, and each carries 3 cast iron rings fitted in grooves
to the piston head. The pistons are attached to the con

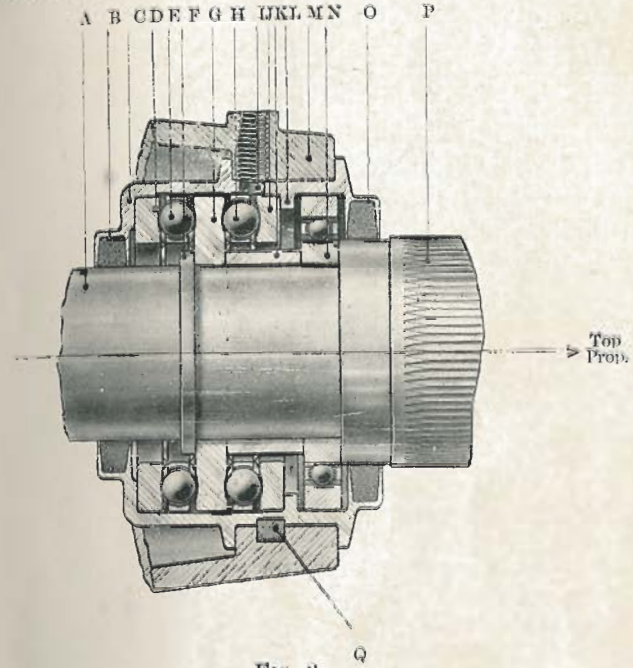
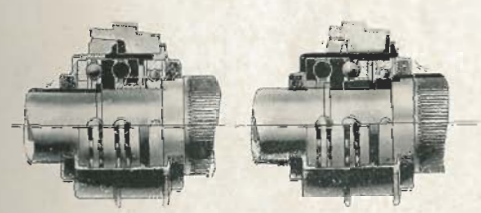


FIG. 2.



Tractor.
FIG. 3

Pusher.
FIG. 4.

A Crankshaft.
B Felt Oil Retainer.
C Thrust Box.
D Steel Washer.
E Thrust Ball Bearing.
F Shoulder on Crankshaft.
G Steel Washer.
H Thrust Ball Bearing.
I Oil Lead to Thrust Box.
J Steel Washer.
K Distance Piece.
L Shoulder in Thrust Box.
M Extension of Crankcase.
N Radial Ball Race.
O Felt Washer to retain Oil.
P Propeller Mounting.
Q Pin to prevent Thrust Box from turning.

Pusher Thrust - P N K G F D C M.
Tractor Thrust - A F G H J L M.

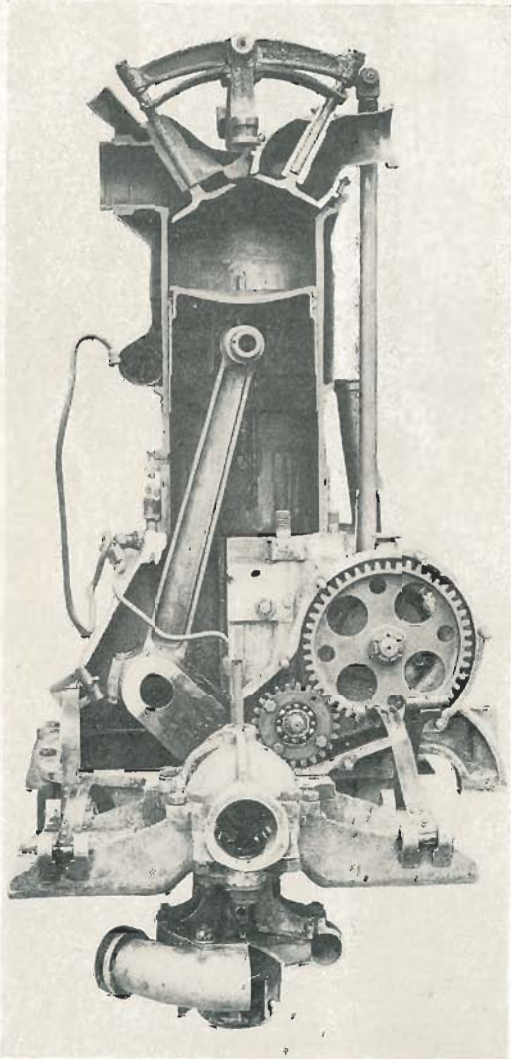


FIG. 5.

g rods by hollow steel gudgeon pins. One end of the dgeon pin is parallel, and the other end is a taper fit in the dgeon pin boss. A dowel at the parallel end engages a tch in the piston and prevents the gudgeon pin from turning, grub screw, in the joint between the tapered end and the ss, locks the pin in position.

Piston clearance = 0·89 m.m. to 0·74 m.m. at top,
0·46 m.m. to 0·36 m.m. at bottom.

Piston ring gap = 0·17 m.m. to 0·23 m.m.

ONNECTING RODS. The connecting rods are of chrome ckel steel, " H " section, bronze bushed at the small end, id lined with white metal at the big end. The big end cap, lower half bearing is removable, and is secured to the nnecting rod by 4 steel bolts. It has a small lip or scoop n its underside which picks up oil from the sump and con- eys it to the crankpin. The upper half has a small hole at ach side of the connecting rod which conveys oil splashed om the sump to the crankpin. 2 larger openings at the sides f the big end expose the crankpin to splashed oil.

ALVES. The inlet and exhaust valves in each cylinder are echanically operated by means of a hollow steel tappet rod nd an overhead rocker arm which is mounted on a fulcrum ost or bracket at the head of the cylinder. The exhaust alve seating and guide are cast integral with the cylinder, and his part is efficiently water jacketed. The inlet valve seating nd guide is removable. It is of castiron and is held in position y a phoshpor bronze ring which screws into the cylinder ead and engages with a flange on the seating. The inlet valve is perated by the inlet cam pushing down the lower arm of the ellcrank lever. This lever pulls down the tappet rod which epresses the inlet end of the rocker arm and opens the inlet alve. The exhaust cam raises the upper arm of the bell- rank lever which pushes the tappet rod and raises the inlet nd of the rocker arm so that the exhaust end is lowered and he exhaust valve opened. Both valves ar e returned to their eatings by 1 laminated spring which is fixed at its centre on he fulcrum post and has each of its ends passing under a ross pin in 1 of the valve stems. The total clearance etween the valve rocker arm and the valve stems should be s follows :—

Engine cold, inlet + exhaust = 0·7 m.m.

CYCLE OF OPERATIONS. Consider the case of cylinder, for example No. 1, starting with the piston at top of its stroke (T.D.C.) and the exhaust valve just clos The suction stroke is commenced as the exhaust valve cl and the piston travels downward, creating a slight vacuu the cylinder, until it has moved through 8 to 10 m.m. w the inlet valve opens. The piston, continuing its down motion, draws the explosive mixture into the cylinder, reac the bottom of the stroke (B.D.C.), and moves up through to 12 m.m. of the return stroke before the inlet valve cl and compression commences. When the piston is 12 to 15 m from the top of the compression stroke, i.e., 12 to 15 m.m. bef T.D.C., ignition takes place, and the stroke is comple while the flame is spreading through the mixture. Dur the succeeding power stroke, the piston is driven downw by the force of the explosion, and the exhaust valve op when the piston has reached a point 18 to 20 m.m. before end of the stroke, i.e., 18 to 20 before B.D.C. The exha valve remains open during the whole of the return stroke, until the cycle has been completed.

Admission of explosive mixture	8 to 10 m.m. past T.D to 10 to 12 m.m. past B.D
Compression (Ignition 12 to 15 m.m. before T.D.C.)	to T.D.C.
Power - - - - - -	to 18 to 20 m.m. before B.D
Exhaust - - - - - -	to T.D.C.

VALVE TIMING. With gears unmeshed turn the camsh and check all the tappet clearances. Remove the spark plug, and in any cylinder, for example No. 1, insert a stiff w or gauge, by means of which the position of the piston may ascertained. Turn the engine in its normal running direct until No. 1 piston is 8 to 10 m.m. down the stroke, and t the camshaft in its normal running direction until the roc arm just touches the inlet valve spindle and is about to op the inlet valve. Mesh the gears by placing the idle wheel position and fixing the timing wheel to suit the holes in the fla and the teeth on the idle wheel. Continue turning the eng until the rocker arm just touches the exhaust valve spin and is about to open the exhaust valve. At this point the pis

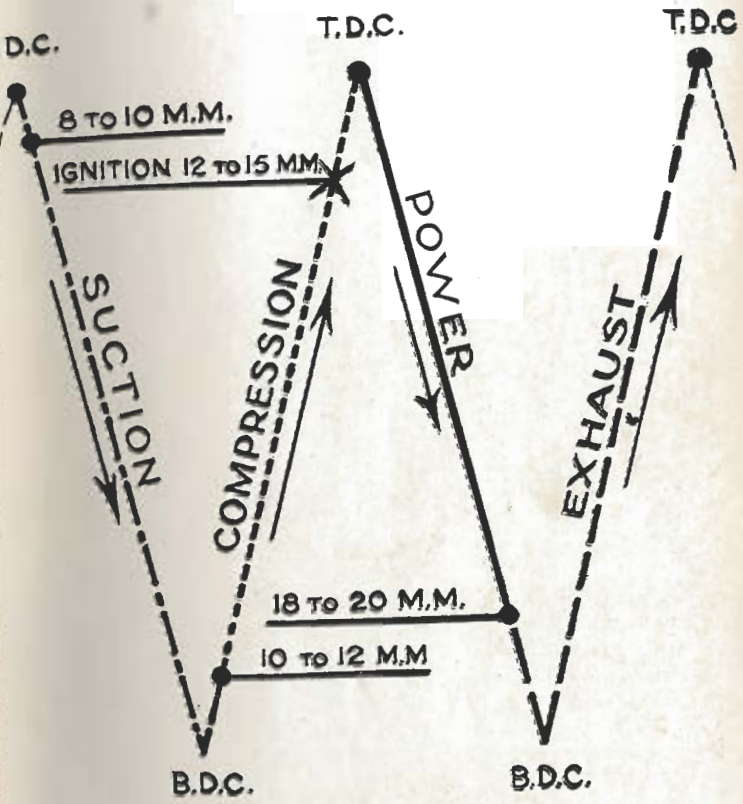


FIG. 6.

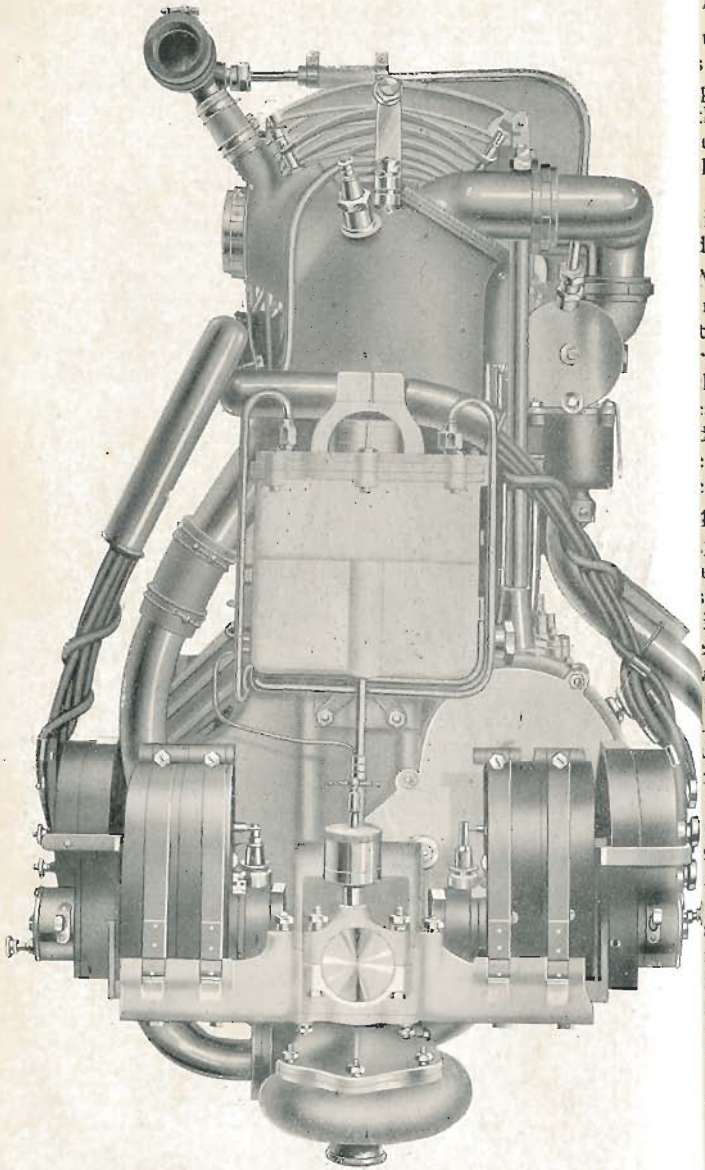


FIG. 7.

uld be 18 to 20 m.m. from the bottom of the stroke. If
; than 15 m.m., fit a washer under the shoulder of the
pet at the exhaust end of the rocker arm. The presence
his washer may necessitate alteration of the clearances by
ustment of the tappet rod, and it should be noted that
h adjustment will affect the inlet valve timing.* Check
remaining points in the cycle, and if necessary correct the
ing of the other cylinders by adjusting their tappet rods
l rocker arms.

NITION TIMING. Set the piston of No. 1 cylinder
m.m. before T.D.C. on the compression stroke. Set 1
the magnetos at full advance, and turn the armature in
mal running direction until the brush is making contact
h No. 1 segment on the distributor, and the contact
aker points are just "breaking." Mesh the gear wheels,
l repeat with the second magneto. It is essential that
magnetos be absolutely synchronised, i.e., that the 2
aks occur at exactly the same instant. †

IGNETOS. These are 3 in number. 1 is used for starting
y, and the other 2, with their corresponding leads and
rking plugs, form separate and independent ignition
tems each of which fires 1 of the 2 plugs in every
inder. The magnetos are mounted on the crankcase at
end opposite the propeller and are driven by the small
vel wheel on the end of the crankshaft. The magneto gear
eel has 14 teeth, and the driving wheel 21 teeth so that the
gneto makes 3 revolutions to 2 of the engine. The
gneto is of the revolving armature type giving 2 sparks
revolution, so that there are 6 sparks in 2 revolutions
the engine, during which time each piston completes
cycle. As is usual in the case of stationary engines,
distributor forms part of the magneto. The distributor
ish is driven from the magneto armature by spur gearing
$\frac{1}{3}$ the armature speed, i.e., at $\frac{1}{2}$ engine speed. The corres-
nding distributor contacts on each magneto are each con-
cted by high tension leads to separate plugs in the same
inder. A special hand driven magneto is provided for
rting the engine. This magneto which is usually referred

n later type engines the tappets are in the form of set screws and are continuously adjustable.

n later type engines a fine adjustment connection is provided between the magneto gear wheel and the armature.

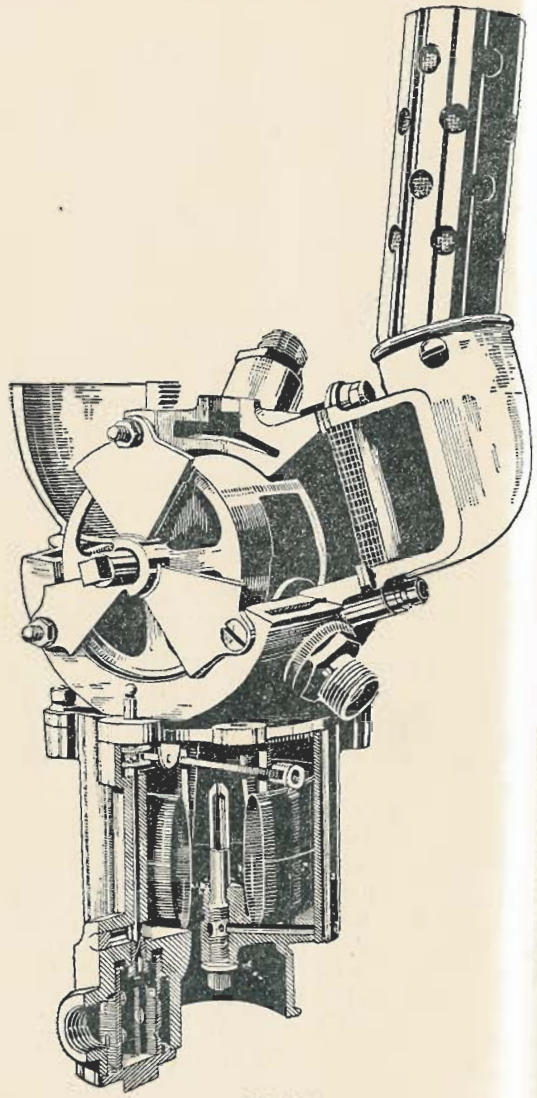


FIG. 8.

so as the "hand starting" magneto, is entirely self contained and carries its own contact breaker. 1 turn of the armature gives 2 sparks, and the armature is geared up to 4 to 1, so that there are 8 sparks to 1 complete turn of the handle. Rapid rotation of the handle therefore ensures a torrent of sparks such as would be obtained by the use of the old fashioned trembler coil. To ensure that the correct cylinder is fired, when starting the engine, use is made of the distributor of 1 of the ordinary magnetos, and the high tension lead from the starting magneto is connected to a special terminal at the centre of this distributor. This terminal is connected by means of a carbon brush and brass contact to a brass spike which projects from the rotating ebonite holder of the distributor brush and reaches to within about 2 m. m. of the distributor contacts. As the distributor brush passes over the contacts it is followed by the brass spike, which therefore reaches any given contact later than the brush. When the handle of the starting magneto is sharply turned, a series of sparks jumps from the spike to one of the distributor contacts and across the points of the corresponding sparking plug. This fires the charge behind the piston that is at rest, about halfway down its power stroke, and so turns the engine. As the engine moves around, the distributor *brush* passes over the next contact, and the corresponding cylinder is fired by the ordinary magnetos which now come into action. It should be noted that there is no electrical connection between the starting magneto circuit and the high tension circuits of the ordinary magnetos.

CARBURATION. There are two carburetters of the Beardmore type, each supplying 3 adjacent cylinders through a 3 way copper manifold pipe. The Beardmore carburetter is of the float type, constructed in 2 main parts, the float chamber and the throttle housing or mixing chamber, both of aluminium alloy. The throttle housing is mounted on the top of the float chamber immediately above the jet and choke tube. It surrounds the throttle barrel which is cylindrical in shape and moves about a horizontal axis. The housing is water jacketted and has openings communicating with:—

(1) The choke tube, jet and main air intake.

(2) The extra air intake.

(3) The induction manifold.

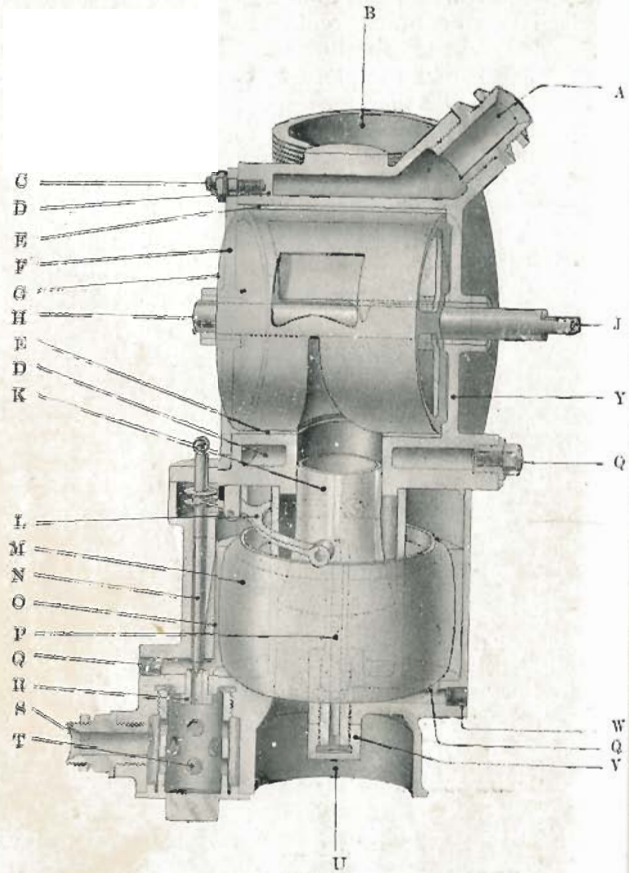


FIG. 9.

A Hot Water from Engine.
B Gas to Engine.
C Nuts for Cover of Mixing Chamber F.
D Water Jacket.
E Phosphor Bronze Liner.
F Cover of Mixing Chamber.
G Control Barrel.
H To fit Control Lever.
J To connect to Second Carburetter Control Spindle.
K Choke Tube to control suction on Jet.
L Needle Valve Control Lever.
M Annular Float.
N Needle Valve.
O Float Chamber.
P Jet.
Q Plugs used to fill holes used manufacture.
R Needle Valve Seating.
S Inlet for Petrol from Service T
T Gauze Filter.
U Air Intake Pipe.
V Locking Nut for Jet.
W Passage from Float Chamber to
Y Mixing Chamber.

effective area of these openings is determined by the on of the throttle barrel which has 3 specially shaped ngs corresponding to those in the housing. The jet and tube are surrounded by the float chamber in which is nular shaped copper float. The needle valve at the side float chamber is actuated by a spur shaped lever, the of which rest on a small rim at the top of the float. l is fed to the needle valve through a small filter at the of the carburetter. The arrangement of the jet at the e of the float chamber ensures that the petrol level at et orifice is maintained constant when the carburetter is through an angle.

RICATION. This is by pressure and splash. The pump ers oil through 6 leads, 2 of which supply the cylinders 4 the bearings. Each of the cylinder leads has 3 branches inating in non-return valves mounted at the sides of the ders below the water jackets. Each piston has 2 small ves, the function of which is to spread the oil over the der walls, and 1 large groove which carries oil into the w gudgeon pin from whence it passes through a small to the connecting rod small end bearing. Each of the ining 4 leads has 2 branches and supplies oil to 2 of the in bearings.* The camshaft bearings, cams, bell crank rs, etc., and the connecting rod big ends are lubricated by sh from the sump. This should contain 4 pints of good eral oil, which must be drained off and replaced by fresh fter 12 hours' running. The water circulating pump and valve rocker arms are fitted with grease caps, which must crewed down at intervals and refilled when necessary. other external working parts are oiled by hand.

PUMP. The engine is fitted with the "Bosch Lubrica- " which consists of 6 separate oil pumps driven from a tral vertical spindle and mounted in an aluminium casing communicates with the oil tank and is normally full of The pumps are arranged around the central spindle upon ch is mounted two inclined discs or cams. The larger cam ks the 6 pump plungers, and the smaller the 6 valves. The of the plungers is adjustable so that the amount of oil

* 5 crankshaft journal bearings, front crankshaft bearing, rear crankshaft bearing and thrust box.

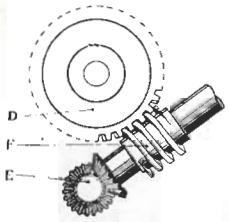


FIG. 12.

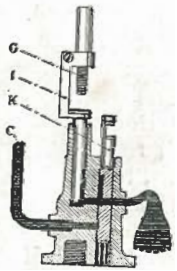


FIG. 11.

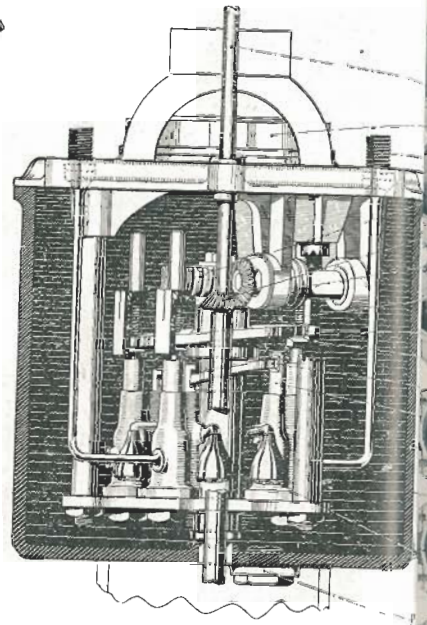


FIG. 10.

A Drive to Revolution Indicator.
B Cover.
C Delivery to Engine.
D Wormwheel attached to Cam Spindle.
E Bevel Wheel.
F Worm.
G Screw regulating length of Stroke.
H Cam operating Plunger Pistons.
I Plunger Pistons.
J Cam operating Valve Pistons.
K Valve Pistons.
L Aluminium Pump Casing.
M Oil Supply.
N Intakes.
P Drain.

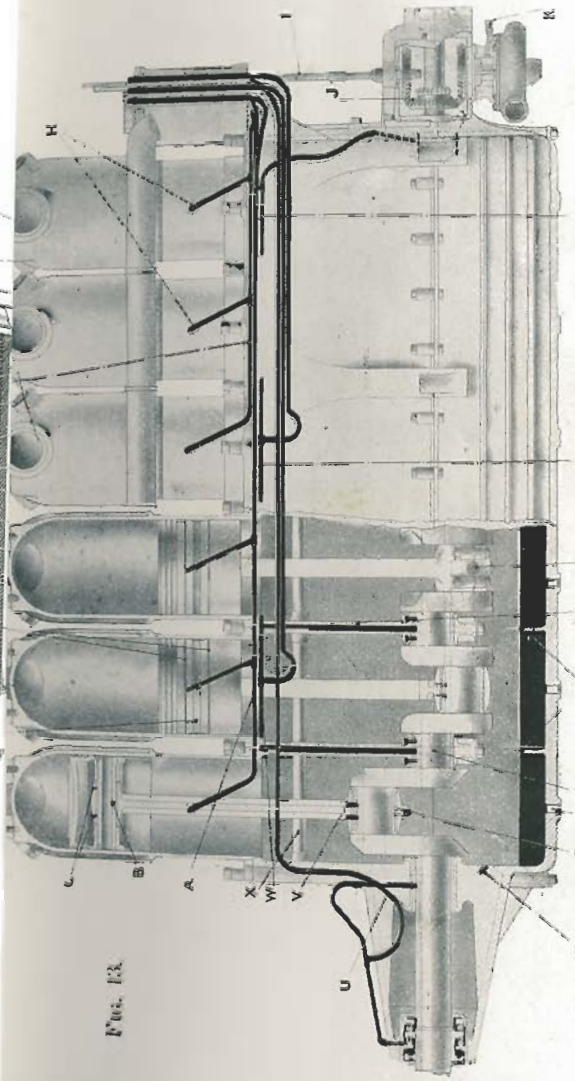


FIG. 13.

A Lead to Cylinders, 1, 2 & 3.
B Oil Hole in Gudgeon Pin.
C Oil Holes in Small End.
D Large Oil Groove in Piston.
E Small Oil Grooves in Piston.
F Grease Cups on Rocker Arms.
G Lead to Cylinders, Nos. 4, 5 & 6.
H Non-return Valves.
I Oil Pump Driving Spindle.
J Bevel Gearing Driving Oil Pump.
K Grease Cup on Water Pump.
L Lead to Rear Crank-shaft Bearing and 1 Crank-shaft Journal Bearing.
M Lead to 2 Crank-shaft Journal Bearings.
N Openings Exposing Crankpin.
O Crankcase Webs.
P Divisions in Sump.
Q Crank-shaft.
R Drains.
S Lip Leading to Crankpin.
T Overflow from Thrust Box.
U Lead to Front Crank-shaft Bearing and Thrust Box.
V Holes Leading to Crankpin.
W Lead to 2 Crank-shaft Journal Bearings.
X Camshaft.

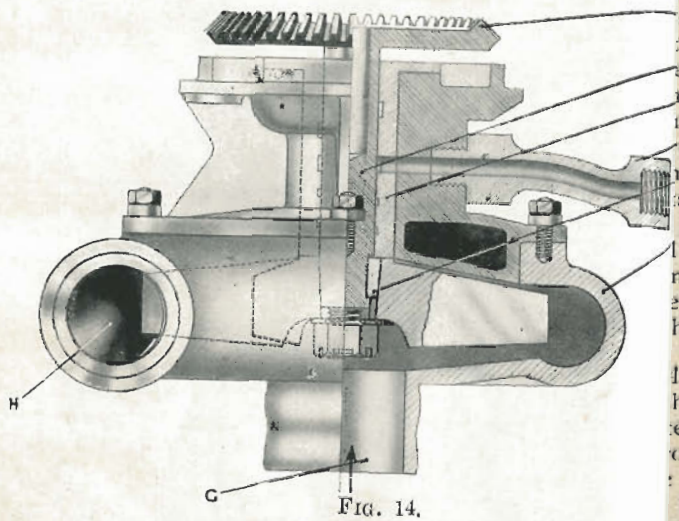


FIG. 14.

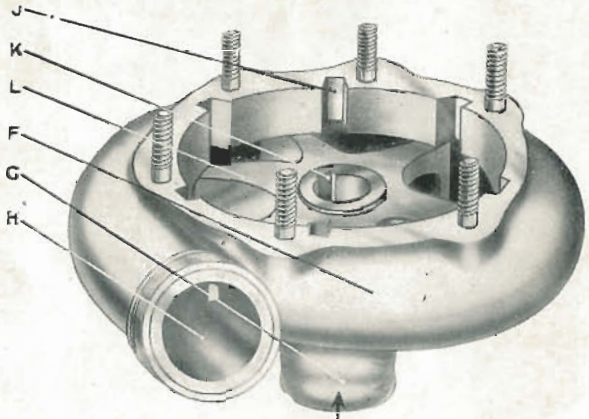


FIG. 15.

A Bevel Wheel driven from Engine Crankshaft.
B Steel Spindle.
C Bronze Bush.
D Lubricator Connection.
E Key.
F Aluminium Casing.
G Suction.
H Delivery.
J Slots to allow removal of Im
K Keyway.
L Impeller (6 blade, Aluminium

plied to the different leads may be controlled.‡ The pump riven by a vertical spindle, which passes through the pump ng and also drives the engine speed indicator. At the om of this spindle is a bevel wheel meshing with the large el wheel on the crankshaft, and inside the casing it carries nall bevel wheel which drives the pump cams through a rt horizontal countershaft. The countershaft carries a m which engages with a worm wheel on the vertical cam ndle. The whole of the pump mechanism is supported by table brackets and pillars from the pump casing cover, and be removed with the cover, after the 6 oil pipe unions l the speed indicator drive have been disconnected. The mps should be removed from the casing and cleaned out er about 100 hours running. The pump casing is fitted h a glass oil gauge of the usual type.

ATER CIRCULATION. The water jackets are constructed h openings at the base through which the cooling water ers, and at a point at the top adjacent to the exhaust valve ough which the water flows, by way of a manifold pipe, to radiator. The circulating pump, which is of the centrifu- type with a vertical spindle, is mounted under the gear eel housing at the end of the crankcase remote from the peller, and is driven through bevel gear from the crank- aft. It delivers the water through a copper pipe to a rizontal water passage formed of a series of 6 short pipes, ch of which has a lateral opening leading into the base of of the water jackets. These pipes, which are electrolyti- lly deposited with the water jackets, are jointed together by e section rubber packing rings and metal clips. The out- s, which are also electrolytically deposited with the jackets, e in the form of short projecting pipes, which are connected the branches of the manifold by short lengths of rubber he and metal clips in the usual way. The radiator should in such a position that its top will, under all normal flying nditions, remain 8 inches above the top outlet pipe of the gine and it must be of such a size as to ensure that the mperature of the cooling water during a flight does not ceed 180° Fahr.

‡ The adjustment recommended for the 2 pumps that supply the cylinders is full oil less 1 turn of the adjusting screws, and for the other 4 pumps full oil less 2½ turns of the adjusting screws.