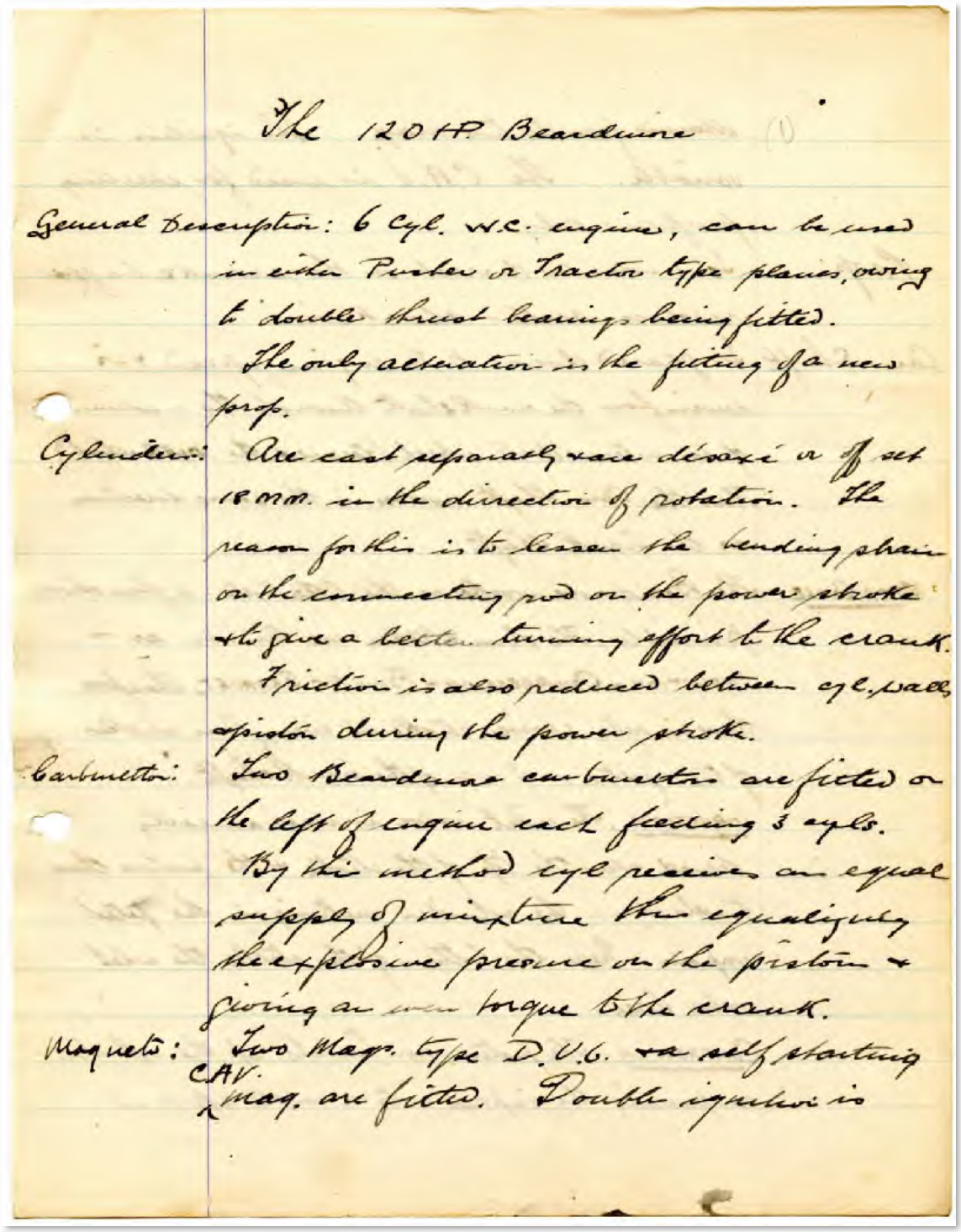
The 120HP Beardmore



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General Description: 6 Cyl. W.C. engine, can be used in either Pusher or Tractor type planes, owing to double thrust bearings being fitted.
The only alteration is the fitting of a new prop.

Cylinders: Are cast separately and are désaxé or off set 18 mm. in the direction of rotation. The reason for this is to lessen the bending strain on the connecting rod on the power stroke & to give a better turning effort to the crank.
Friction is also reduced between cyl. wall, & piston during the power stroke.

Carburettor: Two Beardmore carburettors are fitted on the left of engine each feeding 3 cyls.
By this method cyl receives an equal supply of mixture thus equalising the explosive pressure on the piston & giving an even torque to the crank.

Magneto: Two Magn. type D.V.C. & a self starting C.A.V. Mag are fitted. Double ignition is

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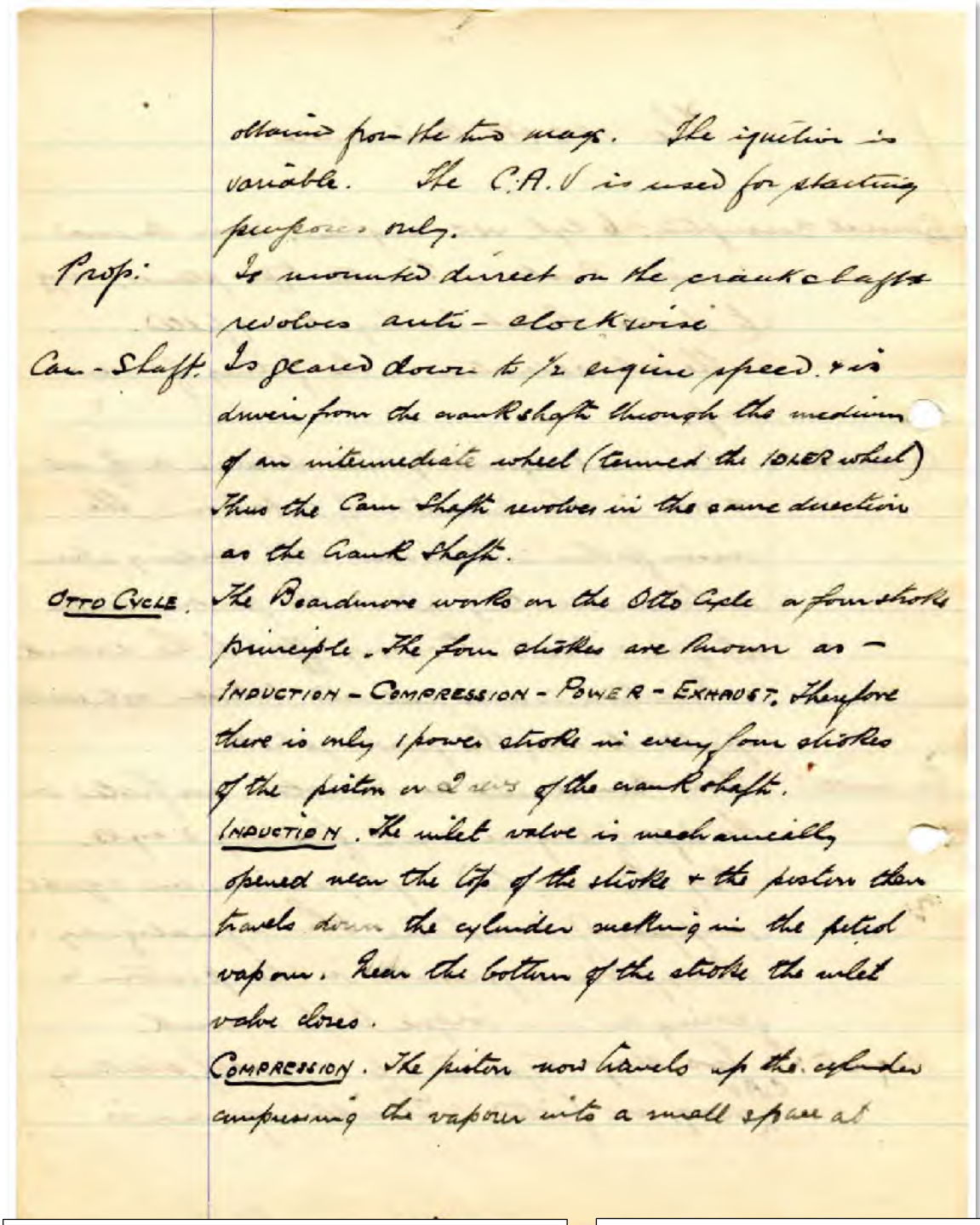

obtained from the two mags. The ignition is variable. The C.A.V is used for starting purposes only.

Prop: Is mounted direct on the crankshaft revolves anti-clockwise

Cam-Shaft. Is geared down to ½ engine speed. & is driven from the crankshaft through the medium of an intermediate wheel (termed the IDLER wheel) Thus the Cam Shaft revolves in the same direction as the Crank Shaft.

OTTO CYCLE. The Beardmore works on the Otto Cycle a four stroke principle. The four strokes are known as – INDUCTION – COMPRESSION – POWER – EXHAUST. Therefore there is only 1 power stroke in every four strokes of the piston or 2 revs of the crankshaft.

INDUCTION. The inlet valve is mechanically opened near the top of the stroke & the piston then travels down the cylinder sucking in the petrol vapour. Near the bottom of the stroke the inlet valve closes.

COMPRESSION. The piston now travels up the cylinder compressing the vapour into a small space at

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(Beardmore 2)

the top of cylinder known as the combustion chamber.

POWER. The compressed vapour is now ignited & the explosion which takes place drives the piston down the cylinder.

EXHAUST The Exhaust valve is opened near the bottom of the stroke thus allowing the burnt gases to escape to the air. The piston now travels up the cylinder ejecting the remaining gases. The exhaust valve closes at the top of the stroke.

This OTTO CYCLE also applies to the CLERGET Engine.

GENERAL DATA.

Weight of Engine & radiator	= 630 lbs.
Weight per H.P.	= 5¼ lbs.
Oil Consumption	= 4 to 4½ pts ph.
Petrol "	= 8 to 10 gallons ph.
Bore	= 130 MMS.
Stroke	= 175 MMS.
Compression	= 95 lbs to sq in
Normal revs:	= 1200 p min:
Max: "	= 1400 " "
Order of firing	= 153624.

The cylinders are numbered from Prop. end of engine.

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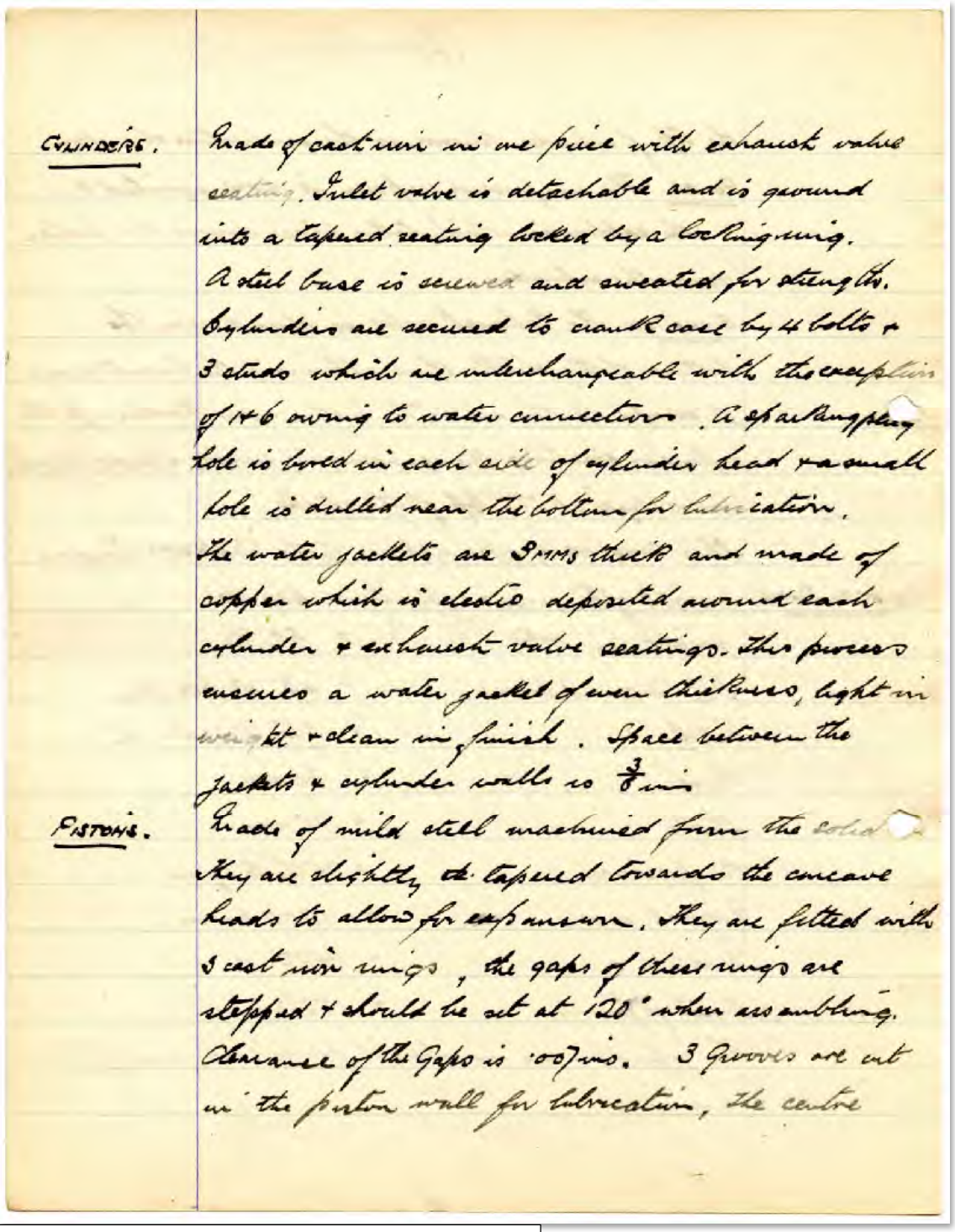

CYLINDERS.

Made of cast iron in one piece with exhaust valve seating. Inlet valve is detachable and is ground into a tapered seating locked by a locking ring. A steel base is screwed and sweated for strength. Cylinders are secured to crank case by 4 bolts & 3 studs which are interchangeable with the exception of 1 & 6 owing to water connectors. A sparking plug hole is bored in each side of cylinder head & a small hole is drilled near the bottom for lubrication. The water jackets are 3 MMS thick and made of copper which is electro deposited around each cylinder & exhaust valve seatings. This process ensures a water jacket of even thickness, light in weight & clean in finish. Space between the jackets & cylinder walls is $\frac{3}{8}$ ins.

PISTONS.

Made of mild steel machined from the solid. They are slightly tapered towards the concave heads to allow for expansion. They are fitted with 3 cast iron rings, the gaps of these rings are stepped & should be set at 120° when assembling. Clearance of the gaps is ·007 ins. 3 Grooves are cut in the piston wall for lubrication, the centre

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(Beardmore 3)

(PISTONS Cont'd) groove intercepts the Gudgeon Pin and conveys oil through this hollow pin to the small end bearing.

GUDGEON PINS. Made of C.N. steel, case hardened and hollowed out for lubrication. It is secured to the piston lugs by the ends being tapered & by being a driving fit. It is locked in position by a key fitted to the larger tapered end and by a grub screw, screwing partly into the gudgeon pin & partly into the piston lug at the small tapered end.

CONNECTING RODS Made of "H" section C.N. steel. A phosphor bronze bush is fitted in the small end & a whitemetal bearing in the other end.
The ~~Big~~ big end bearing is in halves, on the bottom half is a scoop which picks up oil from the sump, lubricating ~~Big~~ big end bearings.

Crank shaft: Made of C.N. steel machined from the solid & hollow for strength & lightness. It is built up in 3 sections. (1) Prop. sleeve. (2) Main shaft. (3) Driving shaft.

Prop. sleeve: Is fitted to the front end of the main shaft, by a taper, key, locking nut & grub screw. The sleeve is serrated on the

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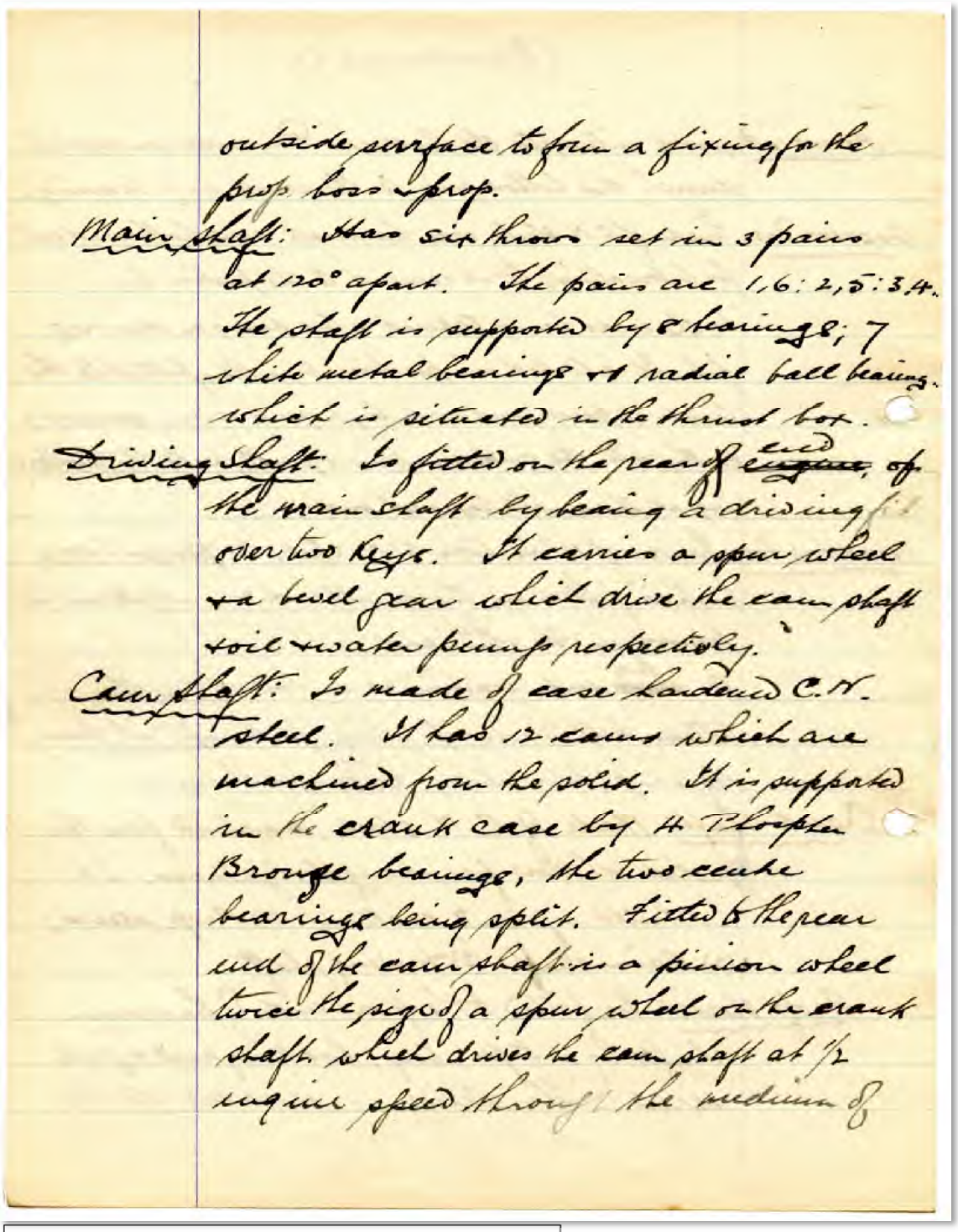

outside surface to form a fixing for the prop. boss & prop.

Main shaft: Has six throws set in 3 pairs at 120° apart. The pairs are 1,6: 2,5: 3,4. The shaft is supported by 8 bearings; 7 white metal bearings & 1 radial ball bearing. which is situated in the thrust box.

Driving shaft: Is fitted on the rear end of the main shaft by being a driving fit over two keys. It carries a spur wheel & a bevel gear which drive the cam shaft & oil & water pumps respectively.

Cam shaft: Is made of case hardened C.N. steel. It has 12 cams which are machined from the solid. It is supported in the crank case by 4 Phosphor Bronze bearings, the two centre bearings being split. Fitted to the rear end of the cam shaft is a pinion wheel twice the size of a spur wheel on the crank shaft. wheel drives the cam shaft at ½ engine speed through the medium of

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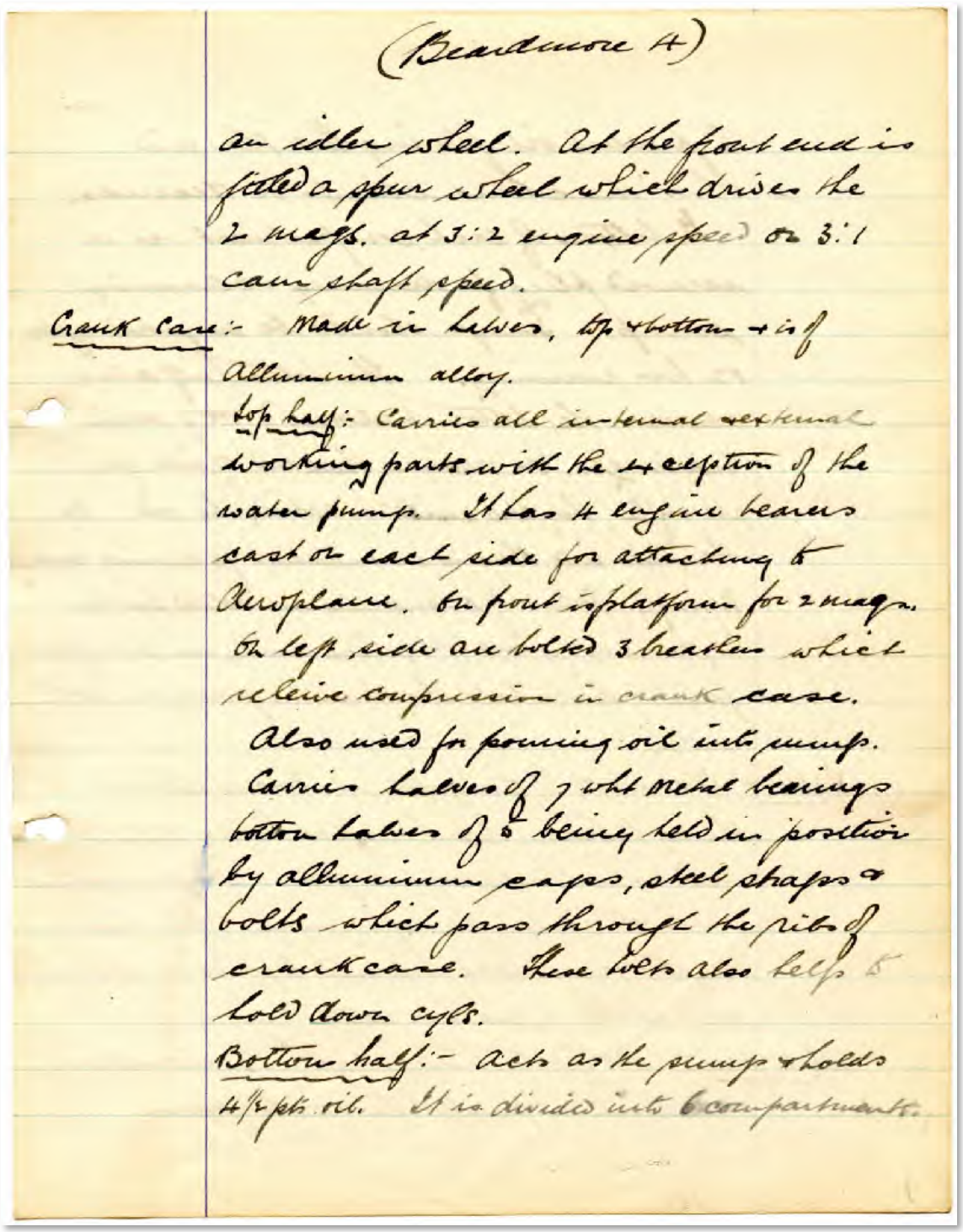

(Beardmore 4)

an idler wheel. At the front end is fitted a spur wheel which drives the 2 mags. at 3:2 engine speed or 3:1 cam shaft speed.

Crank Case:- Made in halves, top & bottom & is of Alluminum alloy.

Top half:- Carries all internal & external working parts with the exception of the water pump. It has 4 engine bearers cast on each side for attaching to Aeroplane. On front is platform for 2 mags. On left side are bolted 3 breathers which relieve compression in crank case. Also used for pouring oil into pumps. Carries halves of 7 wht metal bearings bottom halves of 5 being held in position by alluminum caps, steel straps & bolts which pass through the ribs of crank case. These bolts also help to hold down cyls.

Bottom half:- acts as the pump & holds 4½ pts. oil. It is divided into 6 compartments.

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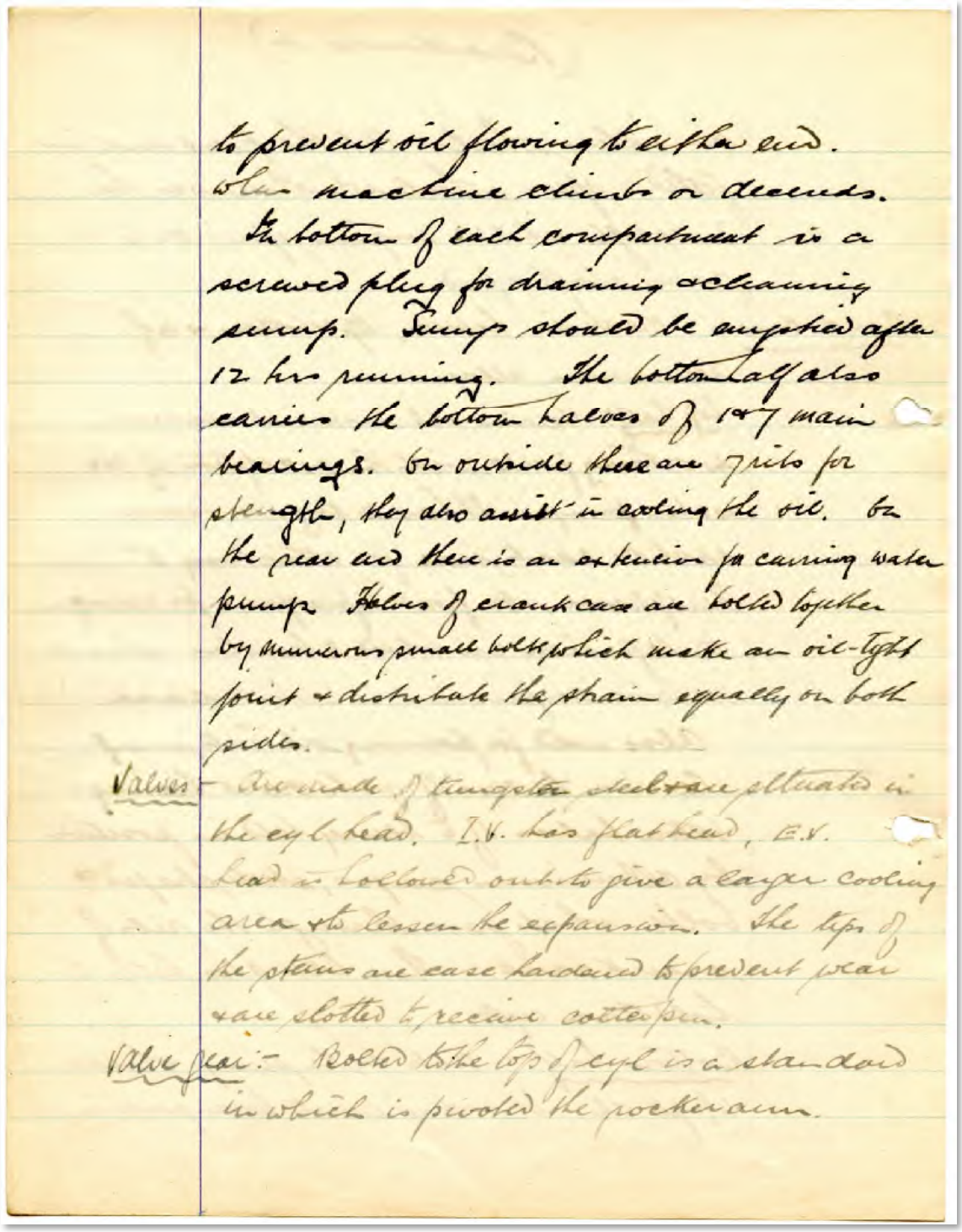

to prevent oil flowing to either end.
when machine climbs or descends.
The bottom of each compartment is a screwed plug for draining & cleaning sump. Sumps should be emptied after 12 hrs running. The bottom half also carries the bottom halves of 1 & 7 main bearings. On outside there are 7 ribs for strength, they also assist in cooling the oil. On the rear end there is an extension for carrying water pump. Halves of crank case are bolted together by numerous small bolts which make an oil-tight joint & distribute the strain equally on both sides.

Valves:- are made of tungsten steel & are situated in the cyl head. I.V. has flat head, E.V. head is hollowed out to give a larger cooling area & to lessen the expansion. The tips of the stems are case hardened to prevent wear & are slotted to receive cotter pin.

Valve gear:- Bolted to the top of cyl is a standard in which is pivoted the rocker arm.

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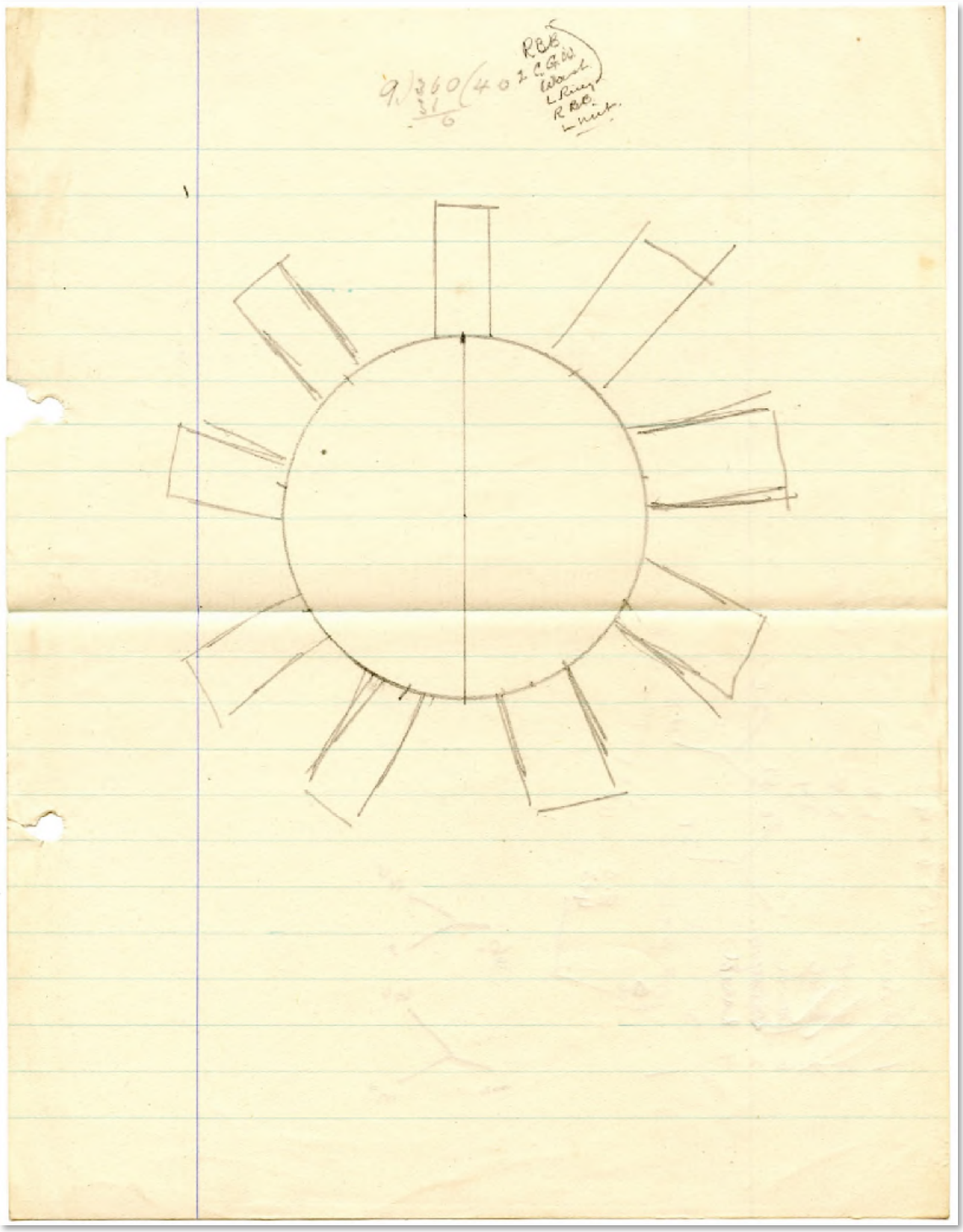
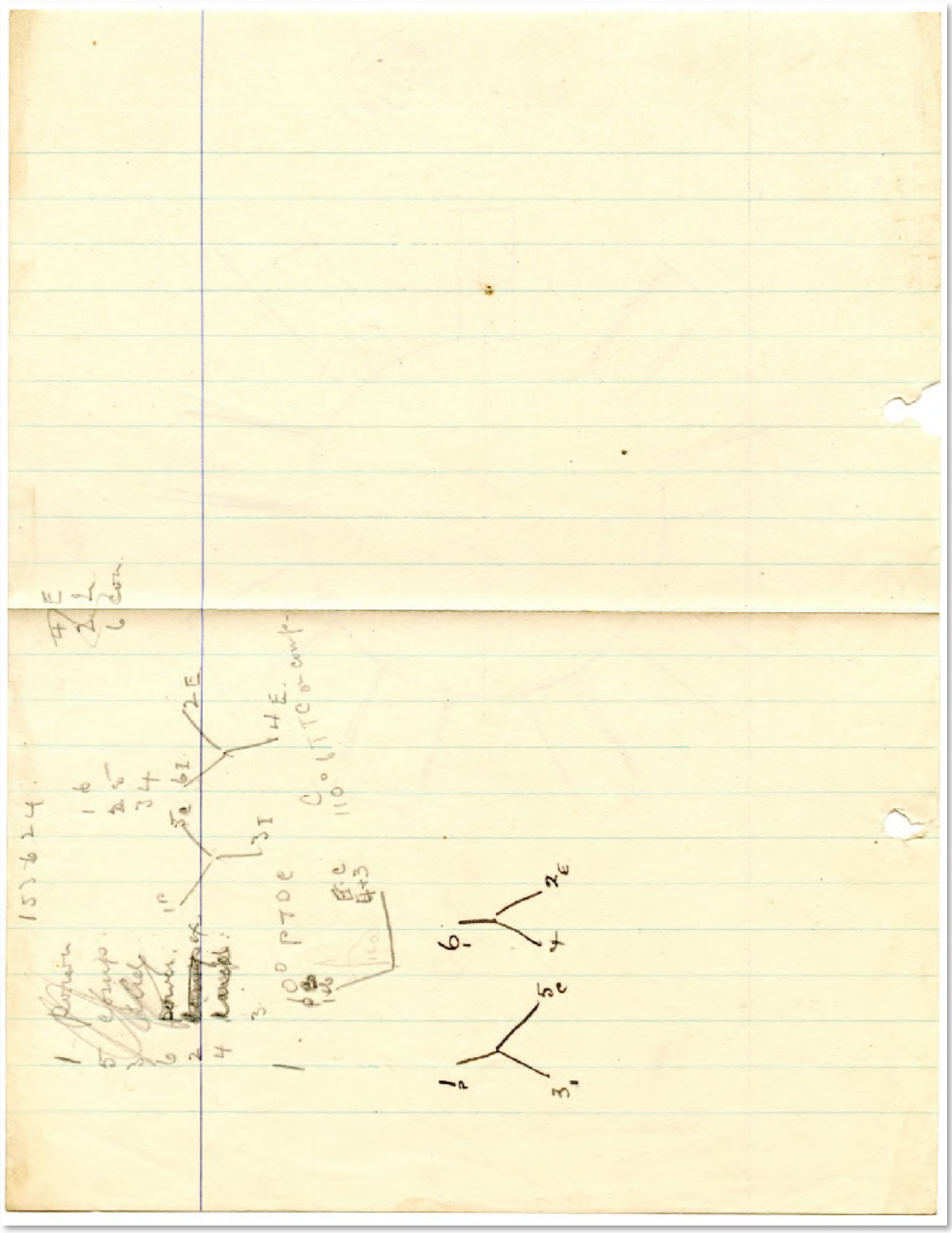
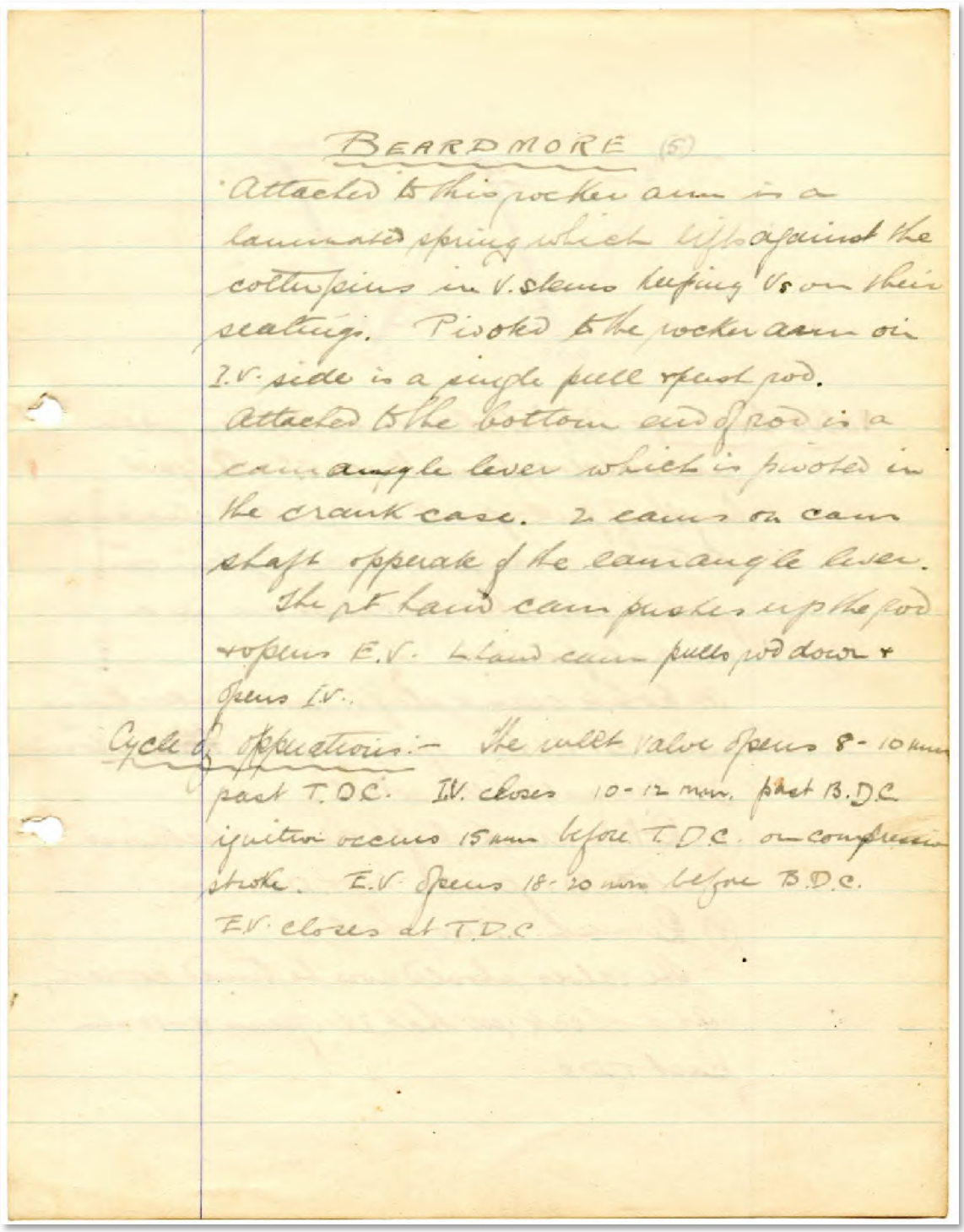
(Illustration of cut through engine & cyls].



[Calculation of cyls firing and degrees thereof]





BEARDMORE (5)

Attached to this rocker arm is a laminated spring which lifts against the cotter pins in V. stems keeping Vs on their seatings. Pivoted to the rocker arm on I.V. side is a single pull & push rod. Attached to the bottom end of rod is a camangle lever which is pivoted in the crank case. 2 cams on cam shaft operate of the camangle lever. The rt hand cam pushes up the rod & opens E.V. L hand cam pulls rod down & opens I.V.

Cycle of operations:- The inlet valve opens 8-10 mm past T.D.C. I.V. closes 10-12 mm. past B.D.C. ignition occurs 15 mm before T.D.C. on compression stroke. E.V. opens 18-20 mm before B.D.C. E.V. closes at T.D.C.

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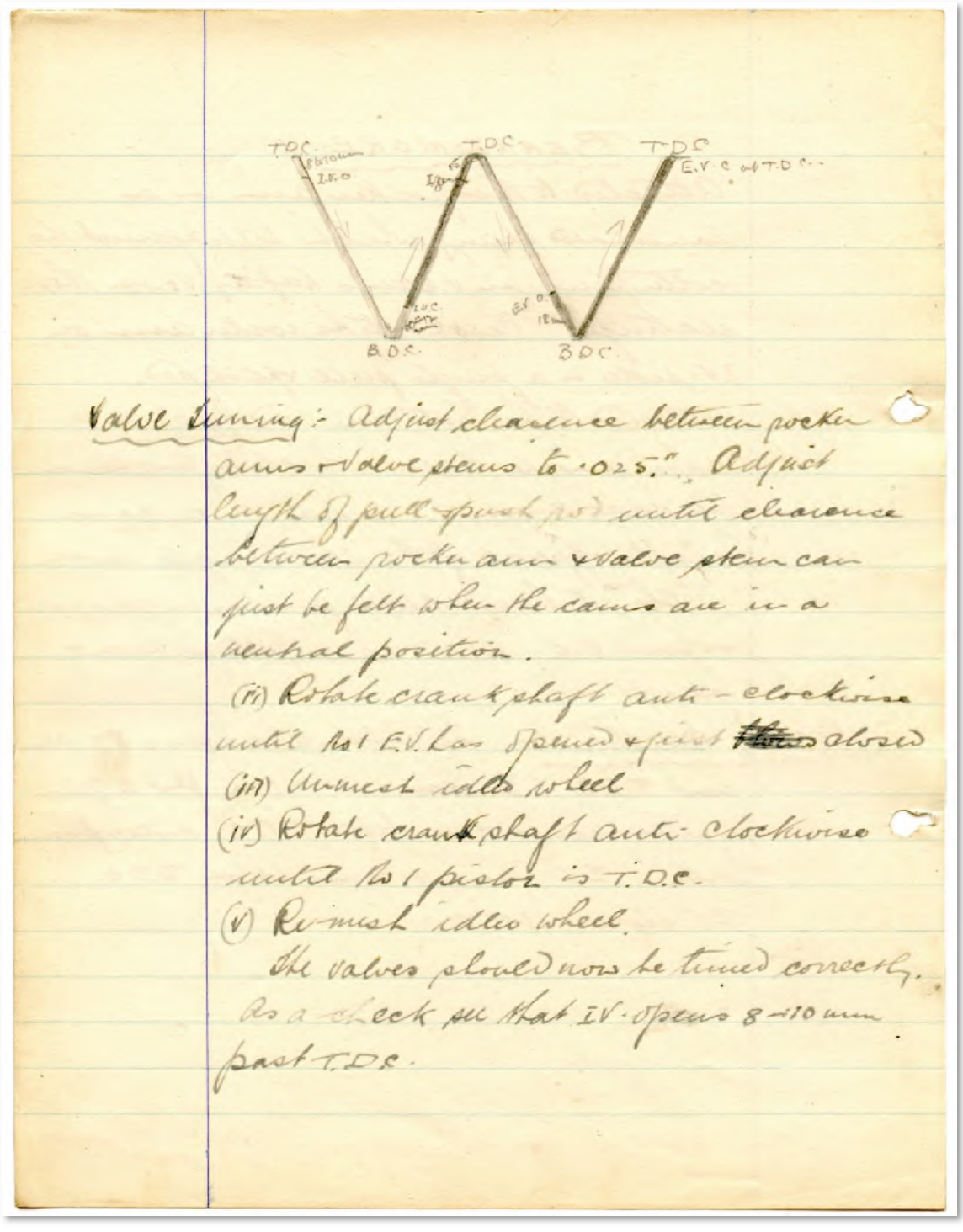

Valve Timing:- Adjust clearance between rocker arms & valve stems to .025". Adjust length of pull push rod until clearance between rocker arm & valve stem can just be felt when the cams are in a neutral position.

(i) Rotate crankshaft anti-clockwise until No1 E.V. has opened & just closed

(ii) Unmesh idler wheel

(iii) Rotate crankshaft anti-clockwise until No 1 piston is T.D.C.

(iv) Remesh idler wheel.

The valves should now be timed correctly. As a check see that I.V. opens 8-10 mm past T.D.C.

(Illustration of cycle of operations)

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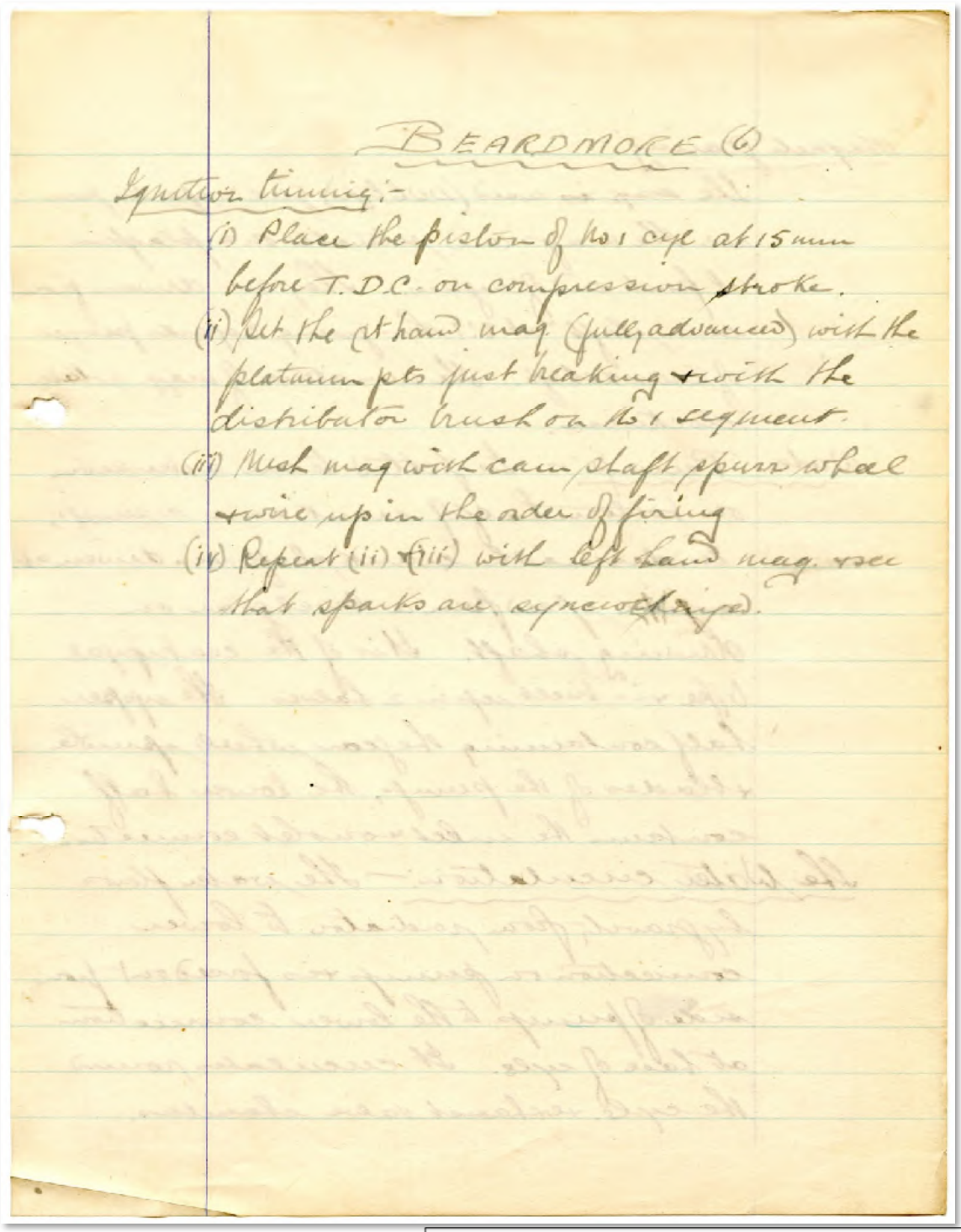

BEARDMORE (6)

Ignition timing:-

(i) Place the piston of No 1 cyl at 15 mm before T.D.C. on compression stroke.

(ii) Set the rt hand mag (fully advanced) with the platinum pts just breaking & with the distributor brush on No 1 segment.

(iii) Mesh mag with cam shaft spurr wheel & wire up in the order of firing

(iv) Repeat (ii) & (iii) with left hand mag. & see that sparks are synchronised.

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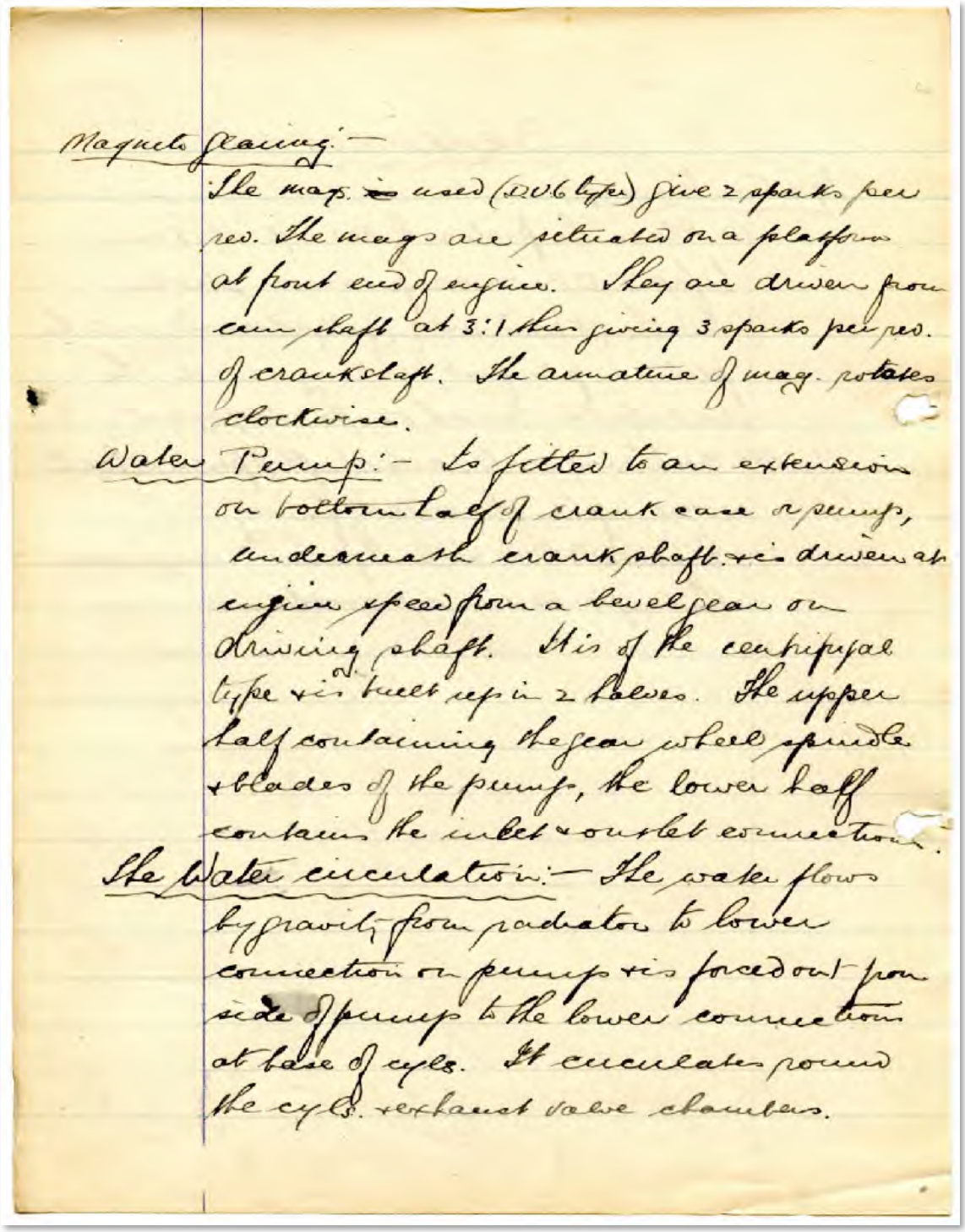

Magneto gearing:—
The mags. ~~is~~ used (D.V.C. type) give 2 sparks per rev. The mags are situated on a platform at front end of engine. They are driven from cam shaft at 3:1 thus giving 3 sparks per rev. of crankshaft. The armature of mag. rotates clockwise.

Water Pump:— is fitted to an extension on bottom half of crank case or sump, underneath crank shaft. & is driven at engine speed from a bevel gear on driving shaft. It is of the centrifugal type & is built up in 2 halves. The upper half containing the gear wheel spindle & blades of the pump, the lower half contains the inlet & outlet connections.

The Water circulation:— The water flows by gravity from radiator to lower connection on pump & is forced out from side of pump to the lower connection at base of cyls. It circulates round the cyls. & exhaust valve chambers.

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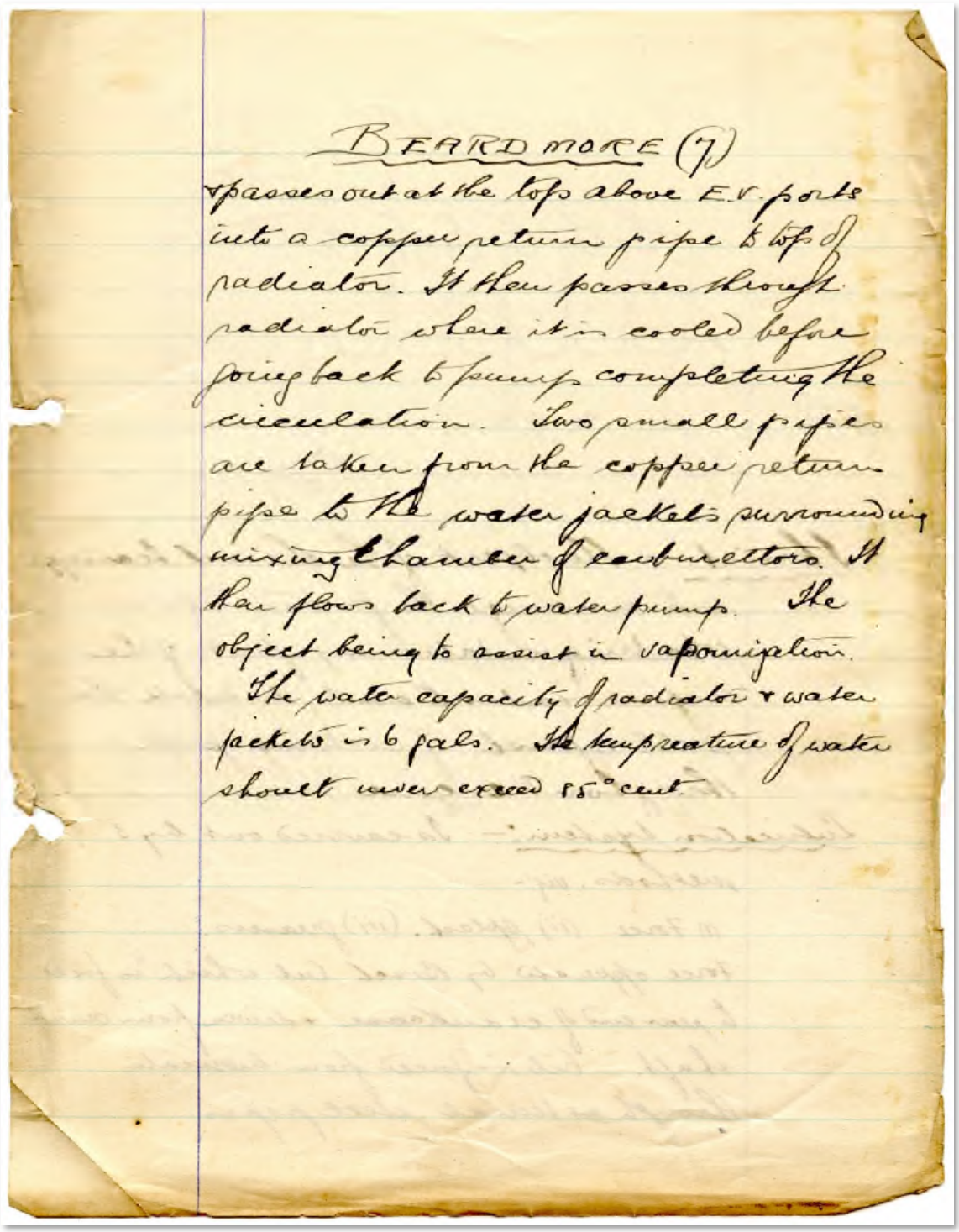

BEARD MORE (7)

& passes out at the top above E.V. ports into a copper return pipe to top of radiator. It then passes through radiator where it is cooled before going back to pump completing the circulation. Two small pipes are taken from the copper return pipe to the water jackets surrounding mixing chamber of carburettors. It then flows back to water pump. The object being to assist in vaporisation.

The water capacity of radiator & water jackets is 6 gals. The temperature of water should never exceed 85° cent.

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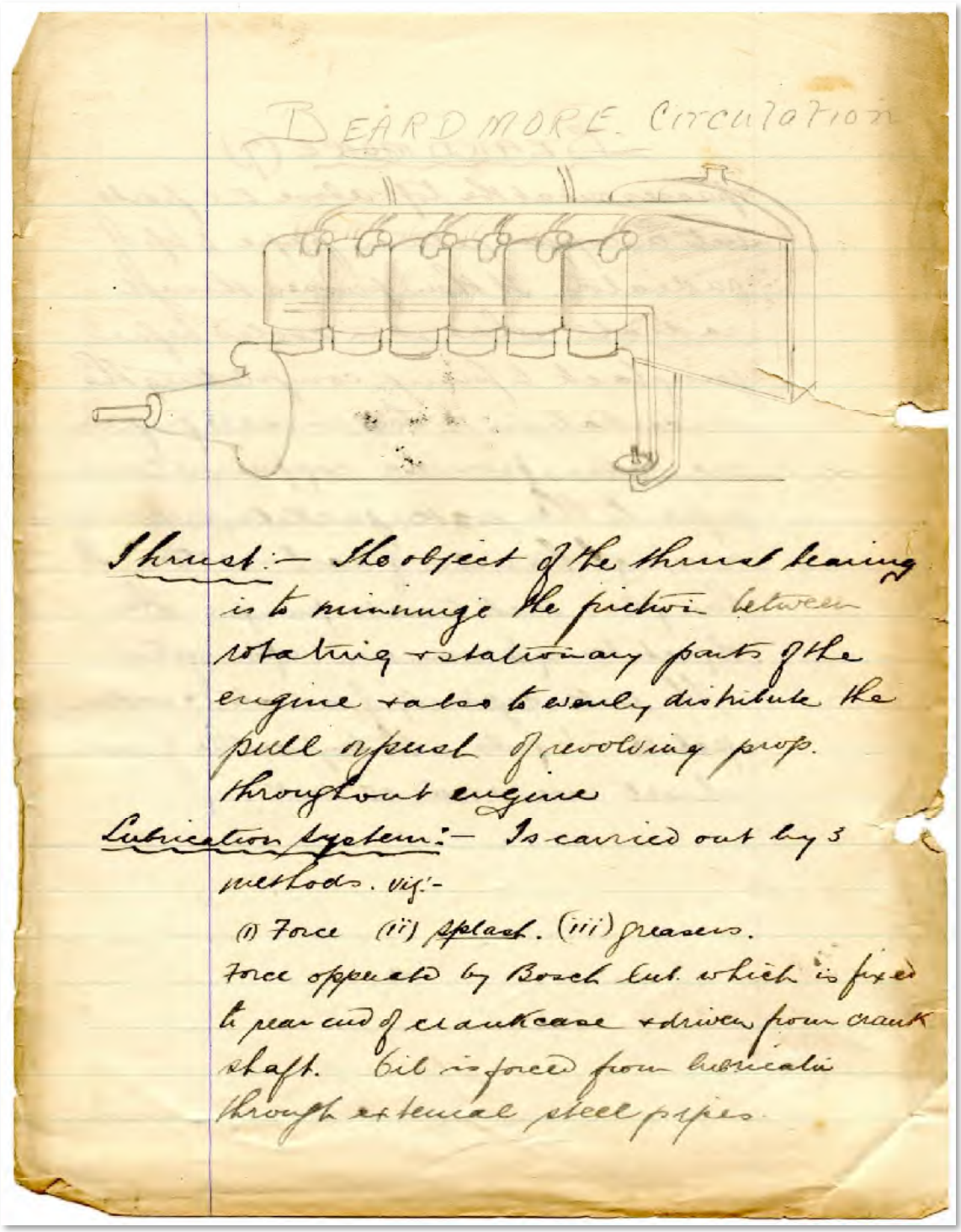
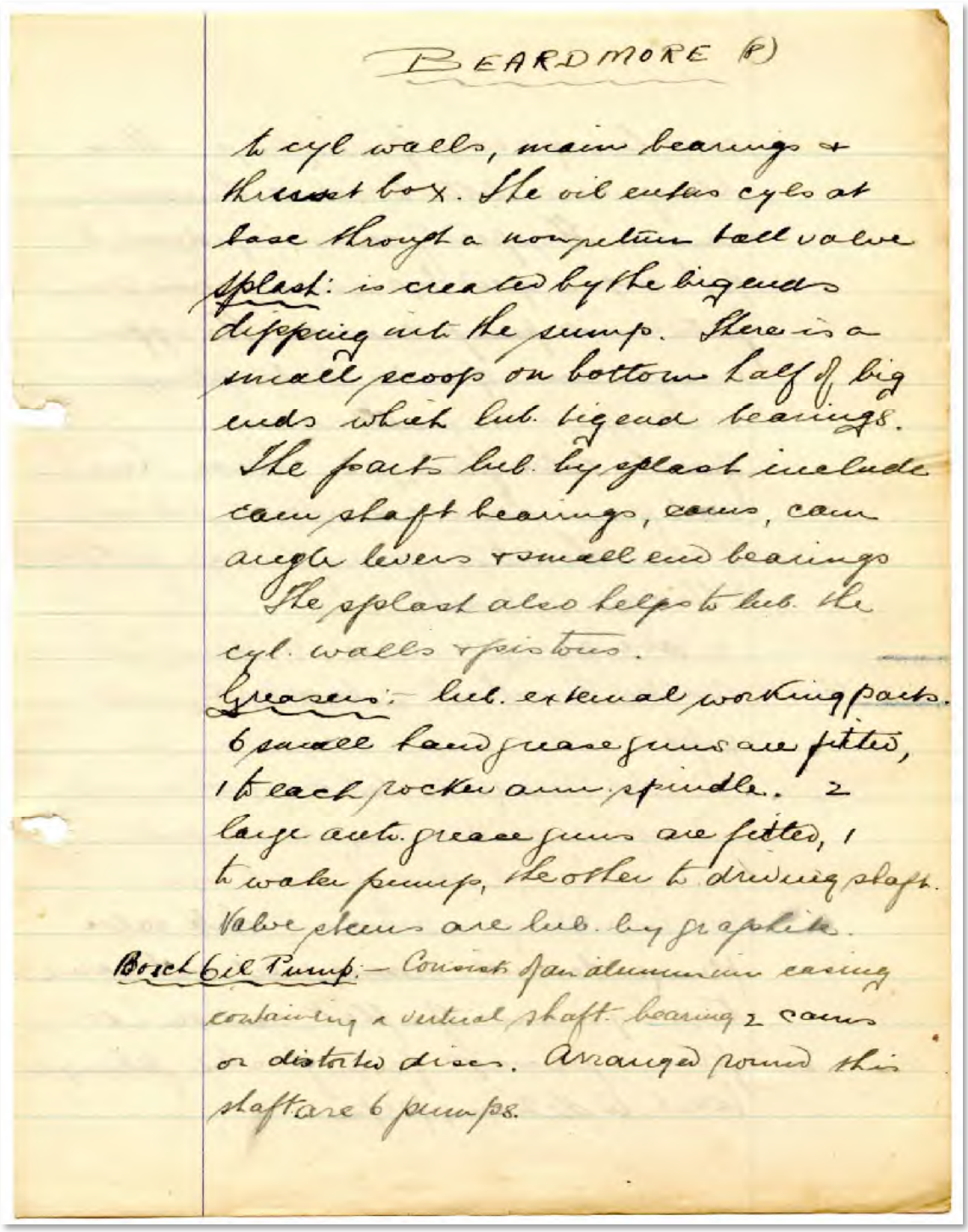
[Illustration of Beardmore water circulation]



Thrust:
The object of the thrust bearing is to minimise the friction between rotating & stationary parts of the engine & also to evenly distribute the pull or push of revolving prop. throughout engine.
Lubrication system:
is carried out by 3 methods via:
(i)Force (ii) splash(iii) greasers
Force opperated [sic] by Bosch lub. which is fixed to rear end of crank case & driven from crank shaft. Oil is forced from lubrication through external steel pipes . . .



BEARDMORE (8)

to cyl walls, main bearings & thrust box. The oil enters cyls at base through a non return ball valve

Splash: is created by the big ends dipping into the sump. There is a small scoop on bottom half of big ends which lub. big end bearings.
The parts lub. by splash include cam shaft bearings, cams, cam angle levers & small end bearings
The splash also helps to lub. the cyl. walls & pistons.

Greasers: lub. external working parts.
6 small hand grease guns are fitted, 1 to each rocker arm spindle. 2 large auto. grease guns are fitted, 1 to water pump, the other to driving shaft.
Valve stems are lub. by graphite.

Bosch Oil Pump: — Consists of an aluminium casing containing a vertical shaft bearing 2 cams or distorted discs. Arranged round this shaft are 6 pumps.

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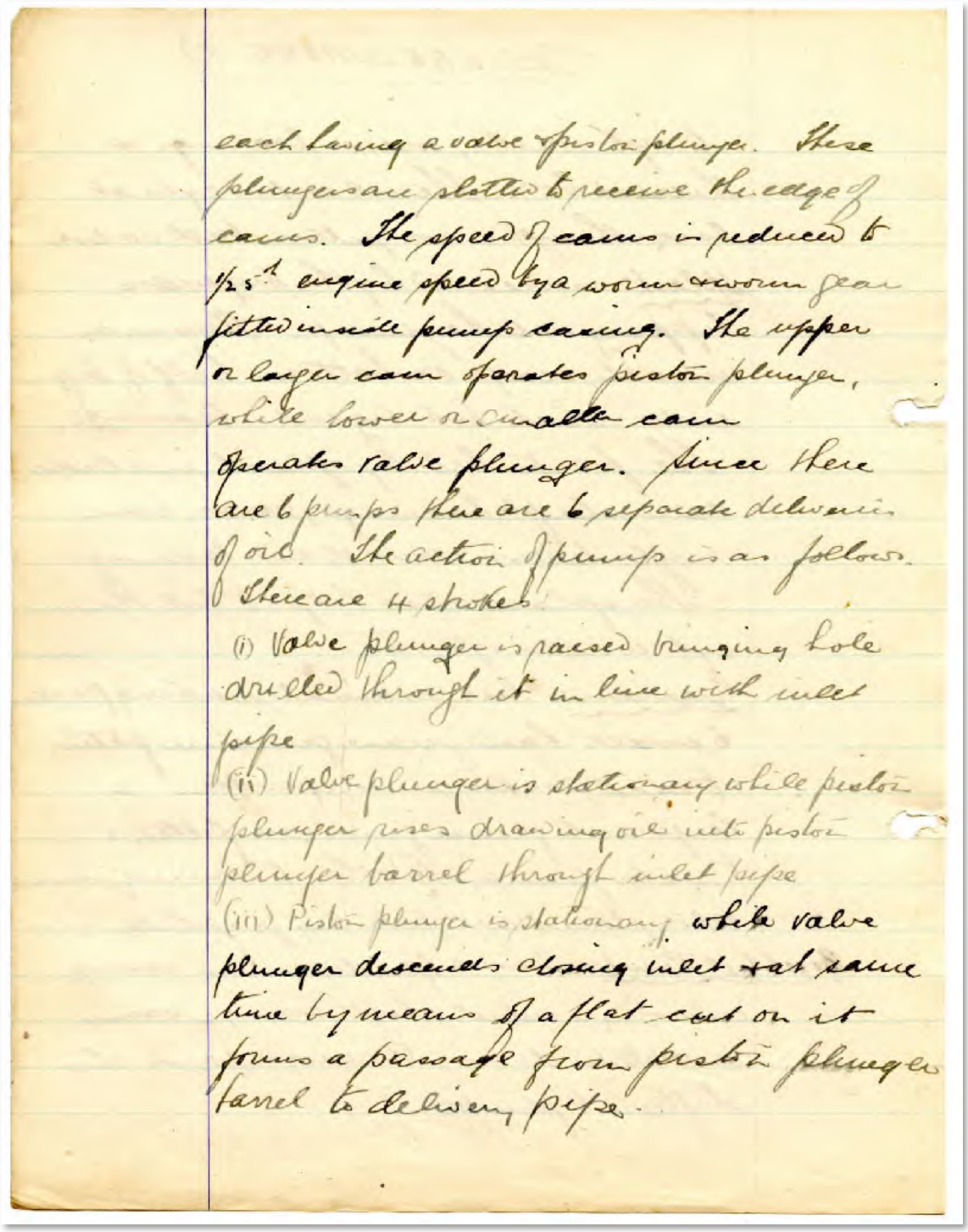

each having a valve & piston plunger. These plungers are slotted to receive the edge of cams. The speed of cams is reduced to 1/25th engine speed by a worm & worm gear fitted inside pump casing. The upper or layer cam operates piston plunger, while lower or smaller cam operates valve plunger. Since there are 6 pumps there are 6 separate deliveries of oil. The action of pumps is as follows. There are 4 strokes

(i) Valve plunger is raised bringing hole drilled through it in line with inlet pipe

(ii) Valve plunger is stationary while piston plunger rises drawing oil into piston plunger barrel through inlet pipe

(iii) Piston plunger is stationary while valve plunger descends closing inlet & at same time by means of a flat cut on it forms a passage from piston plunger barrel to delivery pipe.

. . . each having a valve & piston plunger. These plungers are slotted to receive the edge of cams. The speed of cams is reduced to 1/25th engine speed by a worm & worm gear fitted inside pump casing. The upper or layer cam operates piston plunger, while lower or smaller cam operates valve plunger. Since there are six pumps there are 6 separate deliveries of oil. The action of pump is as follows.

There are four strokes:

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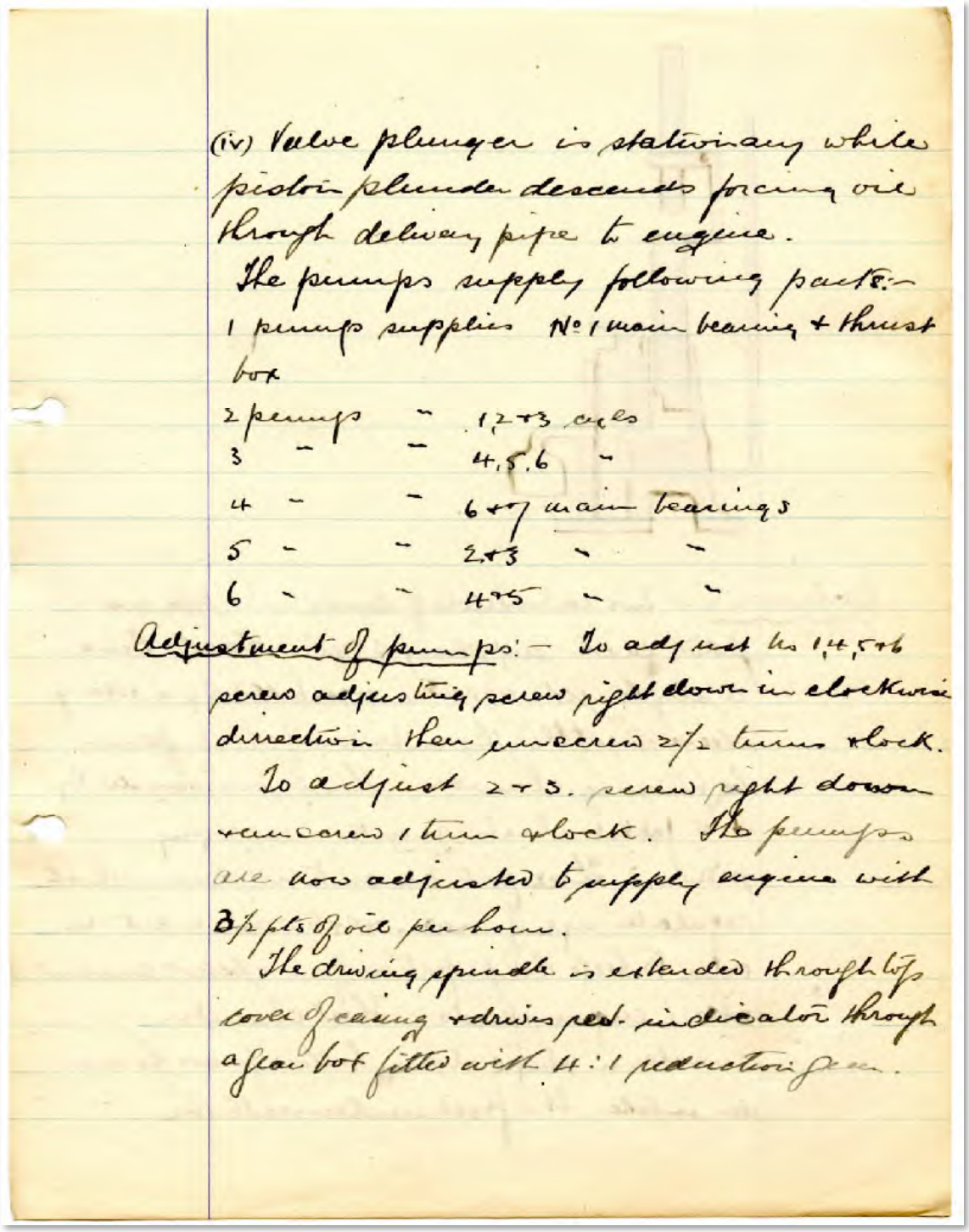
(ii) Valve plunger is stationary while piston plunger rises drawing oil into piston plunger barrel through inlet pipe

(iii) Piston plunger is stationary while valve plunger descends closing inlet & at same time by means of a flat cut on it forms a passage from piston to plunger barrel to delivery pipe.



(iv) Valve plunger is stationary while piston plunder descends forcing oil through delivery pipe to engine.

The pumps supply following parts:-

1 pumps supplies No 1 main bearing + thrust box

2 pumps " 1, 2 + 3 cyls

3 " " 4, 5, 6 "

4 " " 6 + 7 main bearings

5 " " 2 + 3 " "

6 " " 4 + 5 " "

Adjustment of pumps:- To adjust Nos 1, 4, 5 + 6 screw adjusting screw right down in clockwise direction then unscrew 2½ turns + lock.

To adjust 2 + 3. screw right down + unscrew 1 turn + lock. The pumps are now adjusted to supply engine with 3½ pts of oil per hour.

The driving spindle is extended through top cover of casing + drives rev. indicator through a gear box fitted with 4:1 reduction gear.

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1 pump supplies No1 main bearing & thrust box
2 pump " 1, 2 & 3 cyls
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5 pump " 2 & 3 " "
6 pump " 4 & 5 " "

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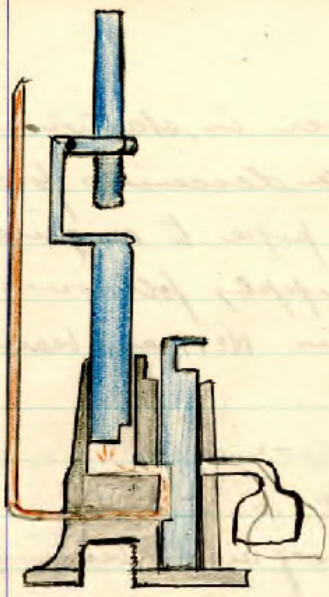

Carburettor:- Two carburettors of Beaudmore type are fitted, each suppling 3 cyl. Each have a single jet 1.75 mm. controlled by a rotary sleeve throttle the interior of which forms the mixing chamber. This is surrounded by H.W. jacket which assists in vaporising petrol. Three ports are cut in sleeve which regulate size of main & extra air inlet in order to keep the proportion of air & petrol constant at all engine speeds. Float chamber is annular in shape & being hollow forms the main air intake. It is fixed underneath the

(Illustration of Bosch oil pump)

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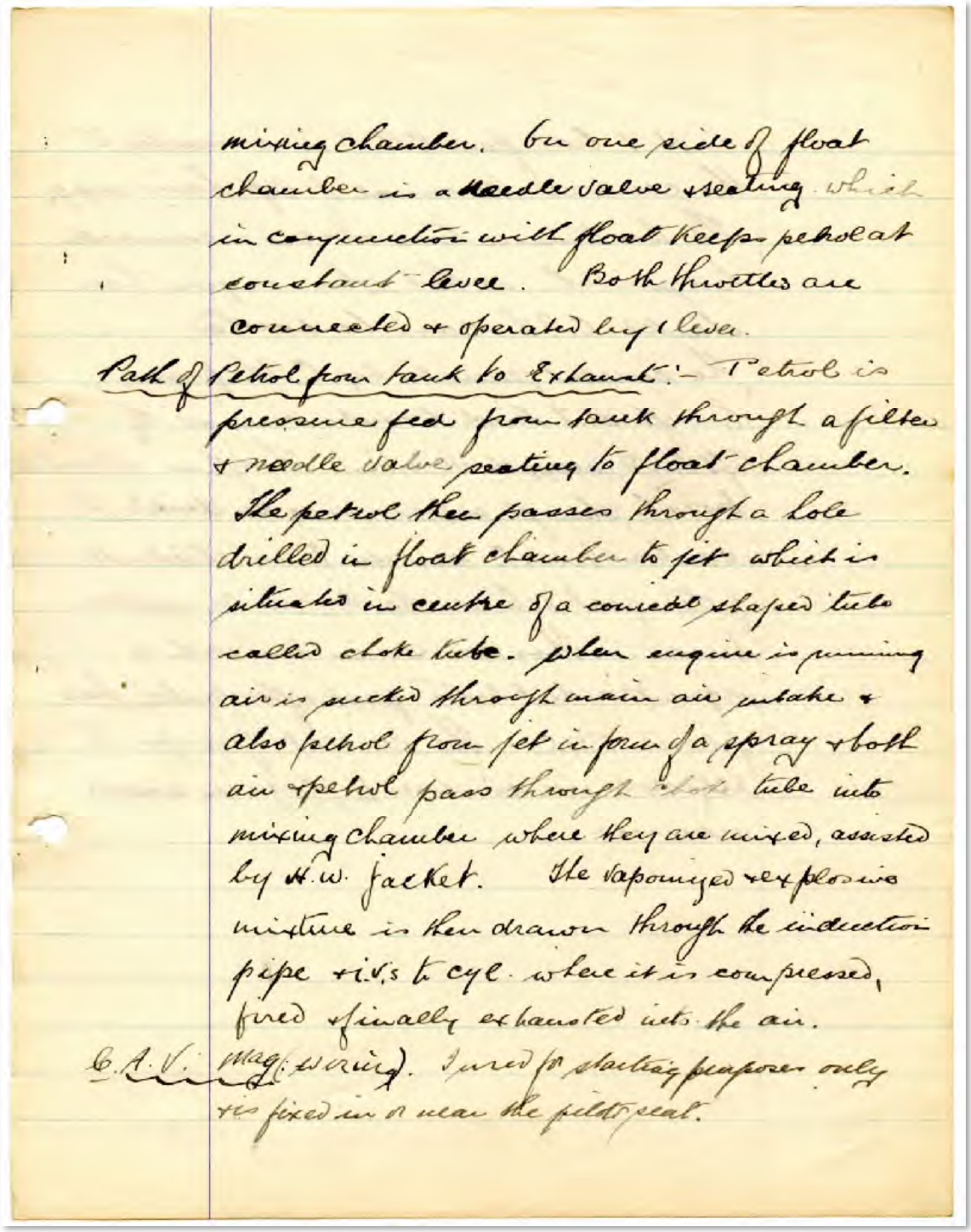

mixing chamber. On one side of float chamber is a needle valve & seating which in conjunction with float keeps petrol at constant level. Both throttles are connected & operated by 1 lever.

Path of petrol from tank to Exhaust:- Petrol is pressure fed from tank through a filter & needle valve seating to float chamber. The petrol then passes through a hole drilled in float chamber to jet which is situated in centre of a conical shaped tube called choke tube. When engine is running air is sucked through main air intake & also petrol from jet in form of a spray & both air & petrol pass through choke tube into mixing chamber where they are mixed, assisted by H.W. jacket. The vaporised & explosive mixture is then drawn through the induction pipe & I.V.s to cyl. where it is compressed, fired & finally exhausted into the air.

C.A.V. Mag. (wiring). Is used for starting purposes only & is fixed in or near the pilots seat.

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<u>C.A.V. mag</u> (wiring):

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The H.T. lead from C.A.V. is connected to the central terminal of left hand mag. The low tension terminal is connected to a switch so that when engine has started C.A.V. can be earthed. The current generated by C.A.V. passes through H.T. lead to centre terminal of left hand mag distributor. Through an attached brush, through a passing on distributor carbon brush carries to an electrode fitted just behind the distributor carbon brush. This comes in line with a segment on distributor just after piston has passed T.D.C. The current jumps to segment & is conveyed to plugs in usual manner.

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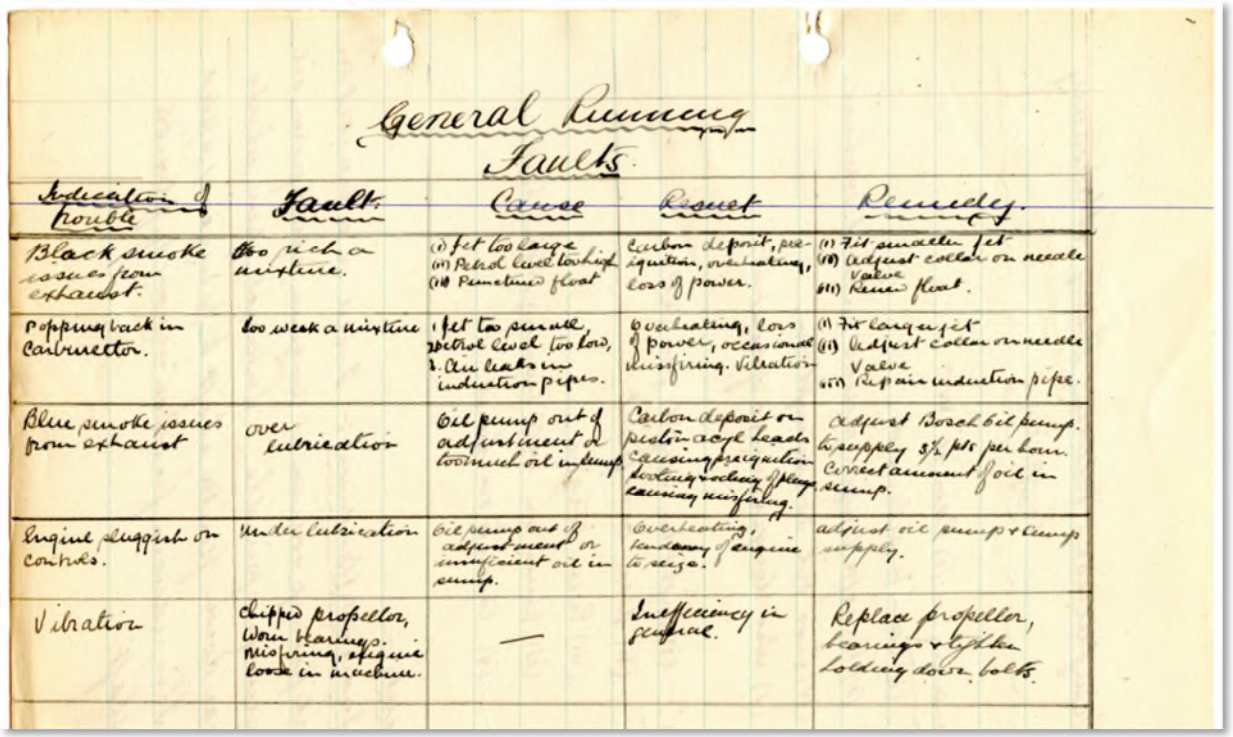
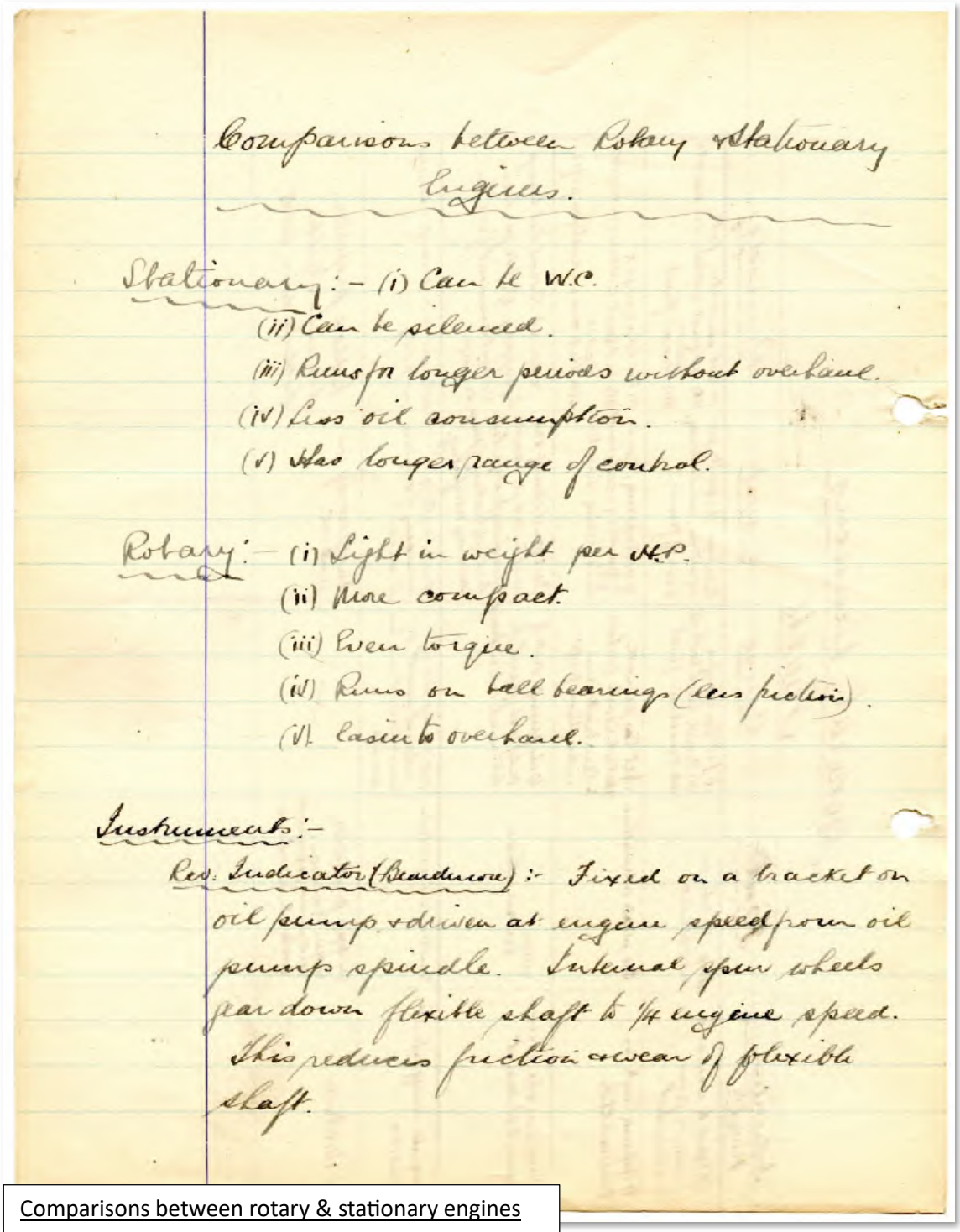
General Running Faults



General Running Faults

Indication of trouble	Fault	Cause	Result	Remedy
Black smoke issues from exhaust	Too rich a mixture	(i) Jet too large (ii) Petrol level too high (iii) Punctured float	Carbon deposit, pre-ignition, overheating, loss of power	(i) Fit smaller jet (ii) Adjust collar on needle valve (iii) Renew float
Popping back in carburettor	Too weak a mixture	1 Jet too small 2 Petrol level too low 3 Oil leaks in induction pipes	Overheating, loss of power, occasional misfiring. Vibration	(i) Fit larger jet (ii) Adjust collar on needle valve (iii) Repair induction pipe
Blue smoke issues from exhaust	Over lubrication	Oil pump out of adjustment or too much oil in sump	Carbon deposit on piston or cyl heads causing pre-ignition sooting & [illegible] of plugs causing misfiring	Adjust Bosch oil pump to supply 3 ½ pts per hour. Correct amount of oil in sump.
Engine sluggish on controls	Under lubrication	Oil pump out of adjustment or insufficient oil in sump	Overheating, tendency of engine to seize	Adjust oil pump & sump supply
Vibration	Chipped propeller, worn bearings. Misfiring, engine loose in machine	-	Inefficiency in general	Replace propeller, bearings & system holding door bolts.



Comparisons between Rotary & Stationary Engines.

Stationary:- (i) Can be W.C.
(ii) Can be silenced.
(iii) Runs for longer periods without overhaul.
(iv) Less oil consumption.
(v) Has longer range of control.

Rotary:- (i) Light in weight per H.P.
(ii) More compact.
(iii) Even torque.
(iv) Runs on ball bearings (less friction).
(v) Easier to overhaul.

Instruments:-
Rev. Indicator (Beardmore):- Fixed on a bracket on oil pump & driven at engine speed from oil pumps spindle. Internal spur wheels gear down flexible shaft to ¼ engine speed. This reduces friction & wear of flexible shaft.

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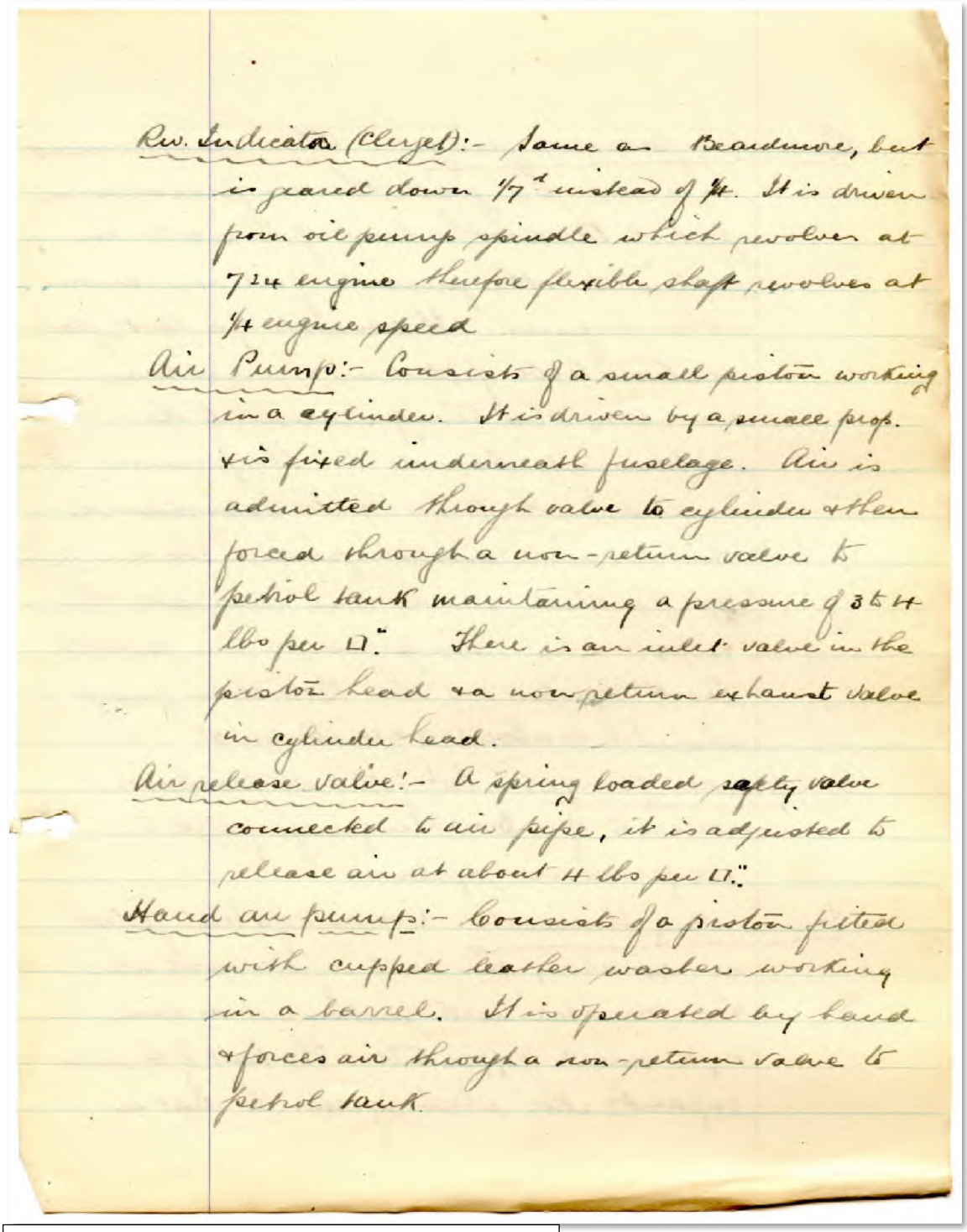

Rev. Indicator (Clerget):- Same as Beardmore, but is geared down 1/7" instead of ¼. It is driven from oil pump spindle which revolves at 7:4 engine therefore flexible shaft revolves at ¼ engine speed

Air Pump:- Consists of a small piston working in a cylinder. It is driven by a small prop. & is fixed underneath fuselage. Air is admitted through valve to cylinder & then forced through a non-return valve to petrol tank maintaining a pressure of 3 to 4 lbs per □". There is an inlet valve in the piston head & a non-return exhaust valve in cylinder head.

Air release valve:- A spring loaded safety valve connected to air pipe, it is adjusted to release air at about 4 lbs per □".

Hand air pump:- Consists of a piston fitted with cupped leather washer working in a barrel. It is operated by hand & forces air through a non-return valve to petrol tank.

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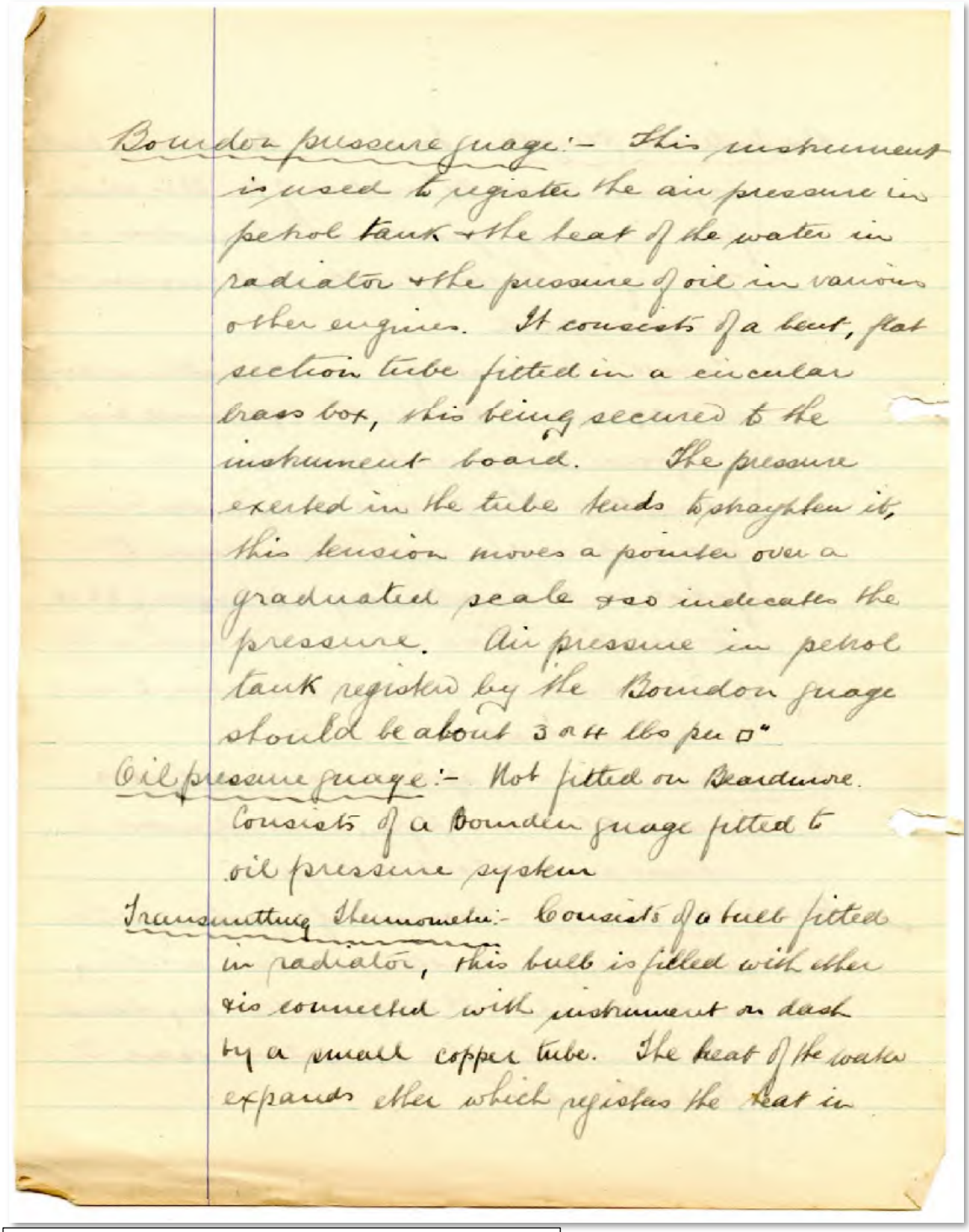

Bourdon pressure guage:- This instrument is used to register the air pressure in petrol tank & the heat of the water in radiator & the pressure of oil in various other engines. It consists of a bent, flat section tube fitted in a circular brass box, this being secured to the instrument board. The pressure exerted in the tube tends to straighten it, this tension moves a pointer over a graduated scale & so indicates the pressure. Air pressure in petrol tank registered by the Bourdon guage should be about 3 or 4 lbs per □"

Oil pressure guage:- Not fitted on Beardmore. Consists of a Bourdon guage fitted to oil pressure system

Transmitting thermometer:- Consists of a bulb fitted in radiator, this bulb is filled with ether & is connected with instrument on dash by a small copper tube. The heat of the water expands ether which registers the heat in

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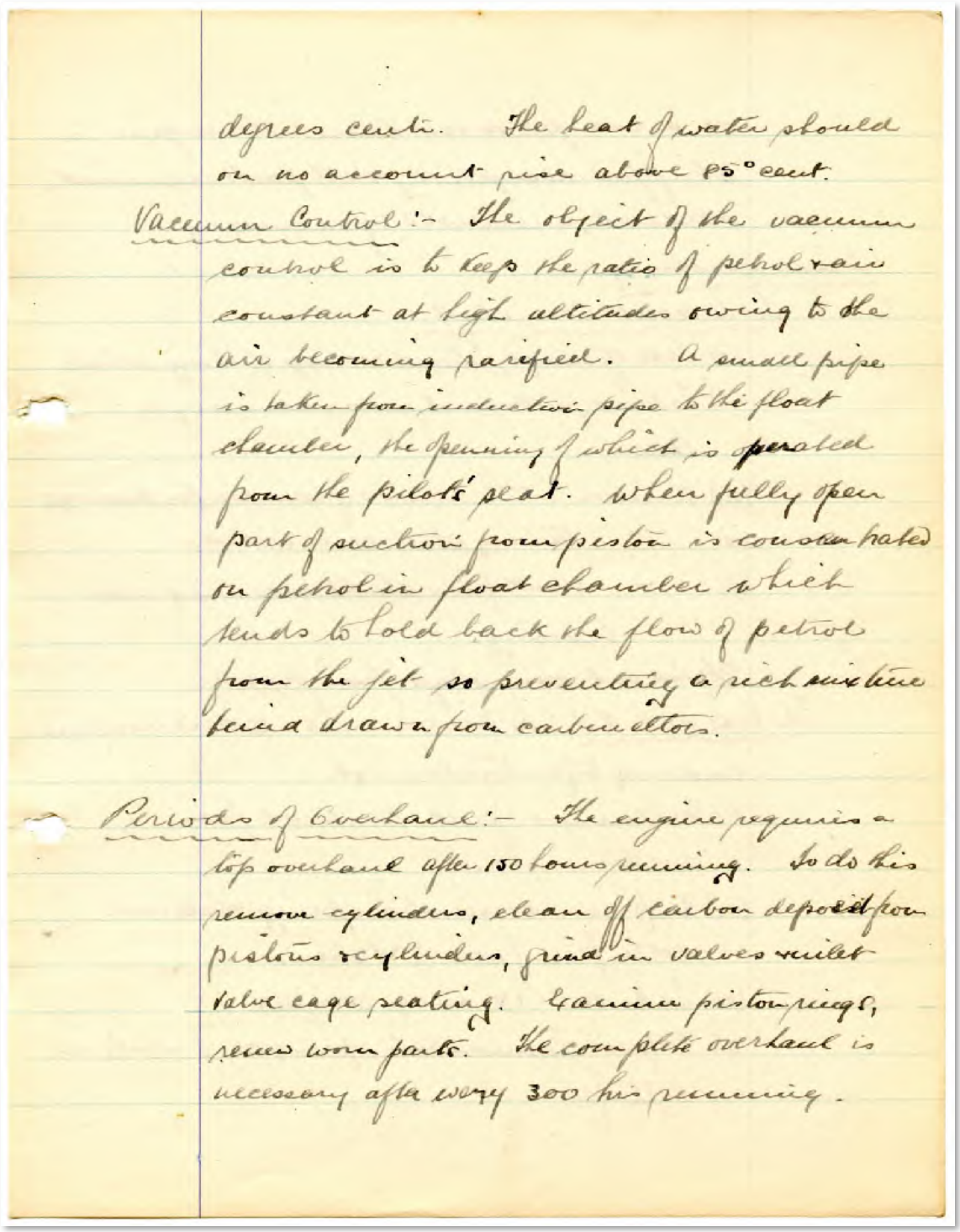

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Vacuum Control:- The object of the vacuum control is to keep the ratio of petrol & air constant at high altitudes owing to the air becoming rarified. A small pipe is taken from induction pipe to the float chamber, the opening of which is operated from the pilots seat. When fully open part of suction from piston is concentrated on petrol in float chamber which tends to hold back the flow of petrol from the jet so preventing a rich mixture being drawn from carburettors.

Periods of Overhaul:- The engine requires a top overhaul after 150 hours running. To do this remove cylinders, clean off carbon deposit from pistons & cylinders, grind in valves & inlet valve cage seating. Examine piston rings, renew worn parts. The complete overhaul is necessary after every 300 hrs running.

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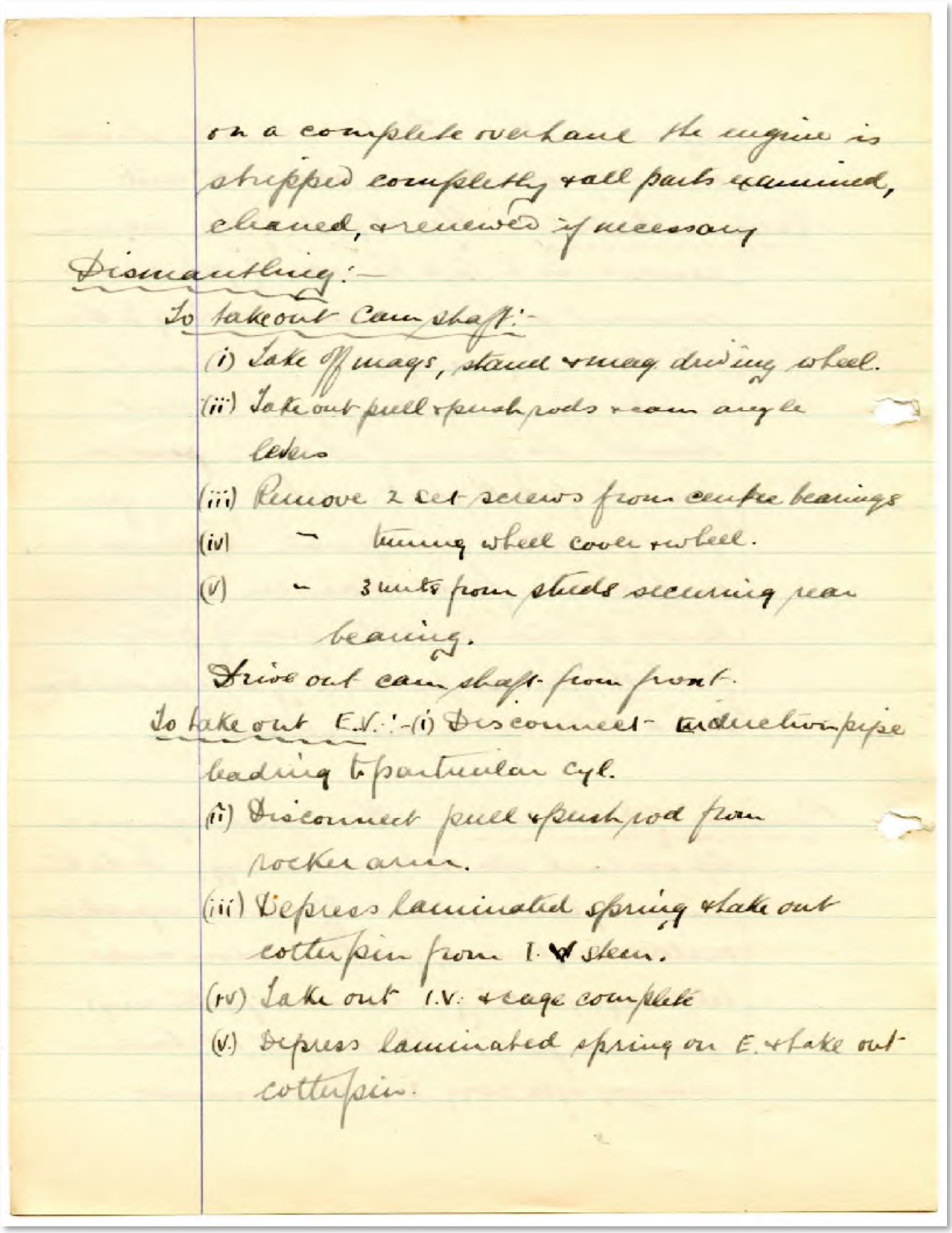

on a complete overhaul the engine is stripped completely & all parts examined, cleaned, & renewed if necessary

Dismantling:-

To take out Cam shaft:-

(i) Take off mags, stand & mag driving wheel.

(ii) Take out pull & push rods & cam angle levers

(iii) Remove 2 set screws from centre bearings

(iv) " turning wheel cover & wheel.

(v) " 3 nuts from studs securing rear bearing.

Drive out cam shaft from front.

To take out E.V.:-(i) Disconnect induction pipe leading to particular cyl.

(ii) Disconnect pull & push rod from rocker arm.

(iii) Depress laminated spring & take out cotter pin from I.V. stem.

(iv) Take out I.V. & cage complete

(v) Depress laminated spring on E. & take out cotter pin.

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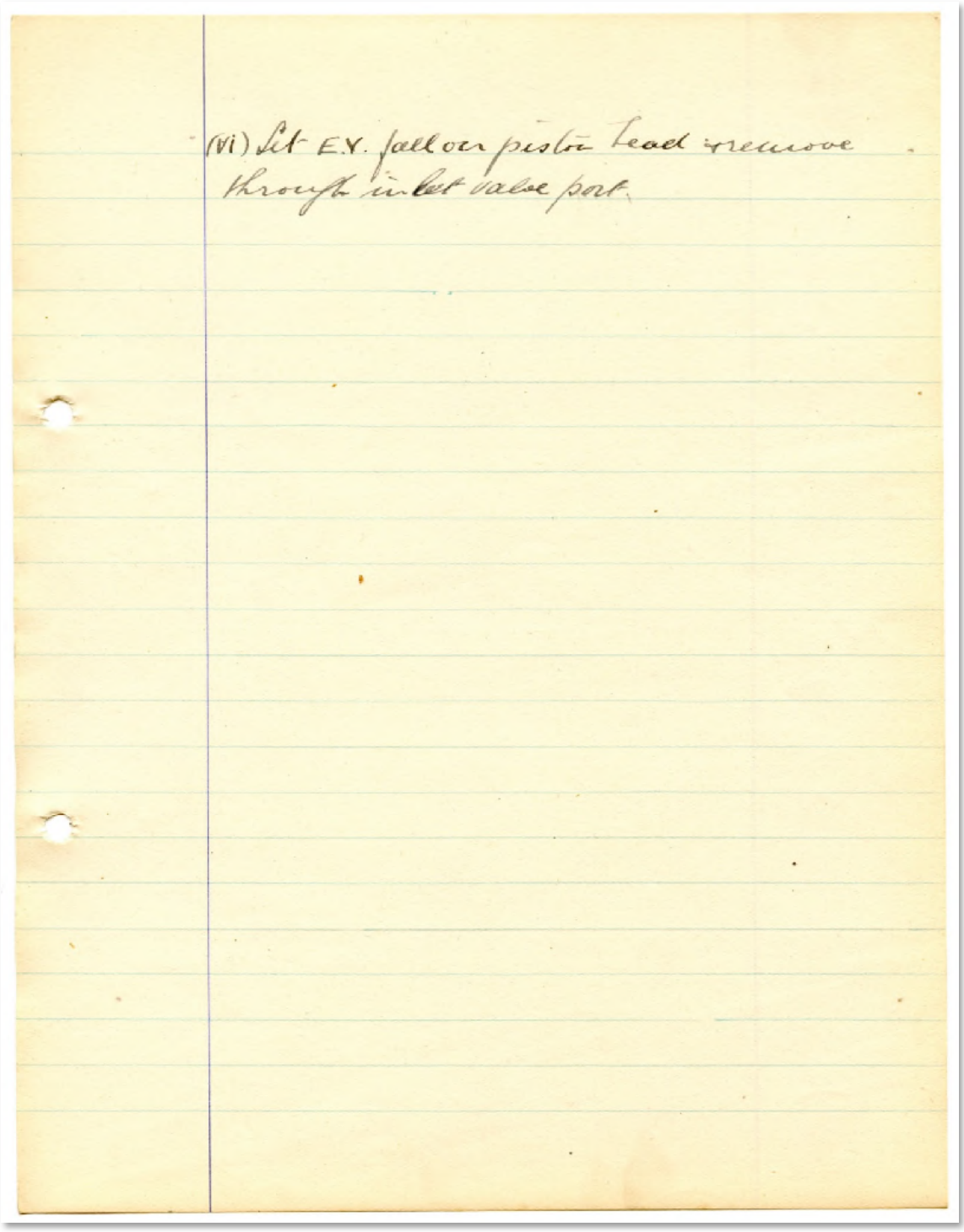

(vi) Let E.V. fall on piston head & remove trough inlet valve port.