ENTRY VI

FORM 620

Royal Air Force.

NOTE BOOK

FOR

Workshop & Laboratory Records.

T. 7243. Wt. 11871. 250m. Bks. 2/4. W. & S. Ltd. (2340 T.)

Home Work.

1 State the principle of the English Micrometer.

B By sketch show a reading of the last three figures of your service number.

2 How would you test your square for accuracy

B How would you test V-ee Blocks for accuracy.

3 Why are surface plates made of cast iron.

B Why are the supported on three legs.

4 When are Key ~~Squares or~~ Box Squares used

B How ~~would~~ would you test same for accuracy.

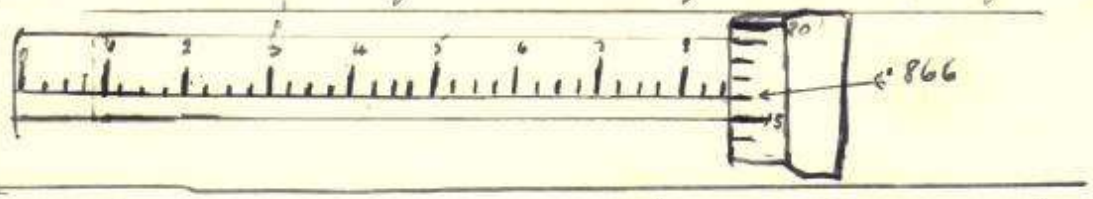
5 State the principals of the English Vernier

B Show a Sketch the reading .337.

Answers

1. Generally known as the English micrometer Caliper it's perneciple of working is on a thread of .40 to an inch. this was a scale on which it is divided into 10 parts which is again divided into 4 parts each of these equals .025 "Gauge" this is known as the Datum line. on this works the thimble this again is divided into 25 parts when this is rotated it will in one complete turn by turning the spindle measure to .001 of a inch which equals 1000th part of a inch

B.



2. By placeing on a true edge drawing a line reversing Square draw another line if they dont correspond measure by Vernier which will show how much it is out of Square.

B. By placeing on surface table laying across them both a parallel bar and test across this with the dial test indicator.

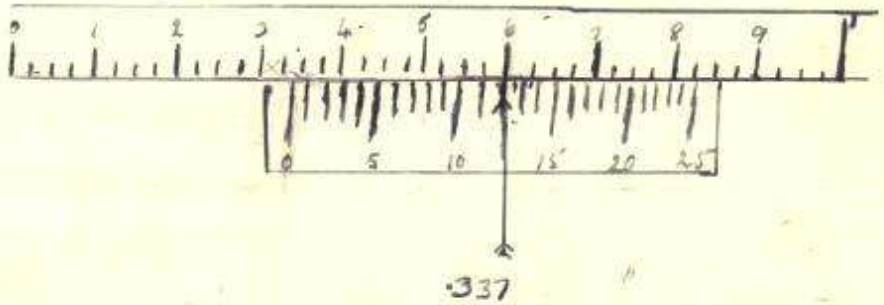
3. Surface plates are made of cast iron because it dose not work so much with weather and atmosphere it is also ribed under the face for extra strength.

B. They are supported on three legs so they will stand firmer and not Sag in the middle.

4. They are used for marking out chasing on circular Bars or axels

B. Test them on a parallel bar marking on one side then reverse round the Bar Square and if the lines correspond the Square is true

5. The principal of working of the English Vernier Caliper is that the main scale is divided in inches, tenths of inches, and the tenths in fourths each division of the main scale equals .025" The Vernier scale is 24 parts of the main Scale divided into 25 parts so that 1 Vernier scale is 24/25th which equals .001 or 1000th of a inch



Lecture I Files

Files are made from high Carbon Steel. The blades are made dead hard the tang is tempered to prevent it snapping under pressure of work.
Kind of Files:- are derived from Square, circle, & Triangle.
Kind of Cuts:- Single cuts double cut rasp cut dreadnought, bastard.
use:- single cuts for soft metals. Double cuts for general work.
Rasp cuts for wood, leather, and very soft metals.
Length of a file does not include tang.
Order of Coarseness, Rough. Bastard. Second cut. Smooth, dead smooth.
Parallel files usually have a safe edge which prevents damage being done to another face while another surface is being filed.

Cold Chisels. are made from High Carbon Steel hardened and tempered
The cutting angle average is 60° but may be 40° for soft metals or 75° for hard metal Types & uses flat chisel for all flat or convex faces
Cross cut chisel for Key ways or grooves.
Diamond point - for clearing Keyways corners, or rectifying drilling.
(curved) Round nose chisel for cutting oil channells along the curved surfaces of bearings
(straight) Round nose for cutting oil channells along flat or convex surface
Side chisel for cutting the vertical sides of Key ways ect:
Cow mouth for removeing projections inside of core holes.

Hammers: made from High carbon Steel. faces hardened and tempered centre soft.
Types of Hammers. Ball Pane. Straight Pane. Cross Pane.
Soft hammers. Hide face lead & Copper face are used to avoid damaging finished faces.
Sizes of Hammers are known by weight and type.

Vices. made of cast iron or Steel casting. Jaws of High Carbon Steel
Screw of low carbon steel with buttress thread.
Sizes by weight & length of Jaw.

Pliers. High Carbon Steel Jaws hardened and tempered
Types Flat nose. Round nose. Side cutting. Gas. ect.
Size overall length and type.

Hacksaws. Frame fixed or adjustable made of Low Carbon Steel
Blades High Carbon steel. Size of blade in Metric between holes centre if in inches overall length.
Coarseness fine 22 to 32 teeth to the inch Coarse 14 to 18 teeth per inch.
the saw only cuts one way as to the teeth are set.

Vee Blocks. are made in actual pairs the Vee angle being 90° and are made Low Carbon Steel case hardened or Cast Iron. Size by the size of cylindrical work they will take. To test for truth of Vee blocks lay in a mandrell bar and ~~place on~~ test table then check with D.I.

Lecture 11. Micrometer.

Type. English Micrometer Calipers. The scale on the sleeve is divided into tenths of a inch, each of which is divided into into four parts so that each division is 1/400 of an inch = .025, This is known as the datum line. on this works the thimble which is divided into 25 parts one turn of the thimble registers .025 or 1" one complete turn of the division on the thimble registers 1/25th of .025 inch = .001 inch.

Calipers. Outside! for checking and keeping 2 objects the same Size.
Inside! for checking inside of Bores ect.
Odd leg: for getting centre of round bar or for marking chasing.
Wide Tips. for reading threads ect.

Centre Squares. may be used in place dividers & odd leg. for finding centre or Circular work.

Box Square used for marking chasings on ends ect.

Protactors for setting work out at any angle.

Scribing Block. use of the marking off table will give dead accuracy in any work especially clamping work the pins in the base also allow it to be used for marking off a finished edge.

Lecture A.

Straight Carbon Steel.

These steels composed of iron and Carbon and owe there properties to the percentage of Carbon in them.

High Carbon Steel	.7 to 1.0%	of Carbon
Middle " "	.25 - .7%	" "
Low - -	up to .25%	" "

Hardening & Tempering a Cold chisel normalise the chisel first. Heat about 1½" of chisel to Blood Red (750°C) ~~agitating~~ quench ½" of chisel in Water agitating the chisel to prevent local heating of Water for about 4/5 of Sec Remove and polish tips with emery paper and when the colour is Brown Purple quench all of chisel in water.

Tempering is carried out to relieve extreme hardness & Brittleness and to introduce a little Toughness.

Normalising is carried out to refine Crystalline Structure and relieve stress and Strain. Steel is heated to U.C.R. (upper Critical Stage) 750°C and allowed to cool in still air.

annealing (means Softening) heat to Blood Red cool as slowly as possible by burying tools in Lime or hot ashes.

Tempering Chart

Straw	is	235° C
Brown	-	250° C
purple		275 C
Blue	"	295° C

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Low Carbon Steel.

L.C.S. cannot be hardened by the heat + plunge method because it does not contain sufficent carbon but it may be successfully hardened by case hardening.

Case Hardening L.C. + nickel steel. articles are heated and in parts to be case hardened dip in some carbonacious material such as this carbon penetrates the skin to a depth of 5 thou, converting it to H.C.S. when articles are reheated and quenched in water they become hard on the outside leaving a soft tough interior.

Carbon compounds:- 1 Kasenit. 2 charred bone dust. 3 charred leather + 60% woodcharcol + 40% Barium carbonate.

Alloy Steels

High speed steel:- contains 6% Tungsten as the chief alloy other minor alloys are Vanedium chromium + Molybidium is hardned from a white heat in oil or by air blast and is capeable of being worked at a dull red heat.

High Tencile steel owes it properties to the introduction of Nickle + Chromeum when Chromium contents exceeds 12% it becomes Stainless.

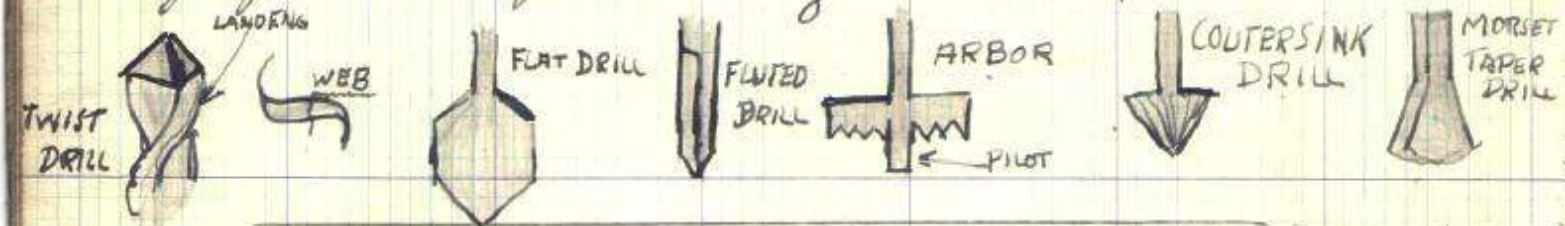
Hardness the ability to cut another metal and Resistance to penetration.
Toughness withstands shock or Bending.

Ductility. when a metal can be permately extended or Drawn into wire.
Malleability. when a metal can be hammered Rolled or flattened without undue early fracture it is said to be Malleable.
Tenstile Strength is the load in tons per Square inch that a metall will withstand when under the influence of a tensile or pulling force.

Lecture III

English Vernier Calipers. main scale divided in inches and 10ths of inch each 10th divided into four parts each division reads .025
the vernier scale is formed by taking 24 division of the main scale and dividing this by 25 parts so that the reading 1 vernier division is 24/25ths which equals .001 or 1000th of an inch. always read from 0 on the Vernier Sc.

Drills made of High Carbon Steel or High speed steel
the cutting angle is 59° the clearance angle 12°
the web angle is 130° types of drills twist drill
Straight fluted drill. flat. arboring. Counter sink



Reamers three class. Solid. Shell. expanding used for finishing a hole and to get the correct size. normally they have 6 cutting edges.

How to work Hexagons on a round bar get the centre of bar then draw a smaller circle inside take the radius measure this into the circumference which will be just six draw line through each point from the centre then draw from each point to point which will give you the largest hexagon possible from Bar.

Lecture B

Aluminium & Alloys

Aluminium is not strong enough as a metal without an alloy its tensile strength being 6 to 8 tons per Sq inch.

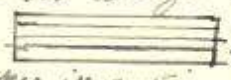
Duralumin is composed of alum base with Copper 3·5 - 4·5% Manganese ·5% and Magnesium ·5 to 1% it as a tensile strength of 25 to 28 tons per Sq inch. it has the property of age hardening during the period of from 3 to 4 days after suitable heat treatment it offers marked resistance to corrosion when fully aged hardened this is intensified by anodizing.

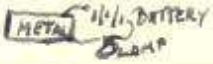
Annealing heated to a uniform temperature of 350° to 420°C in a salt bath and quenched in water.

Normalizing heated in a salt bath 50% Sodium Nitrate 50% Potassium Nitrate to a temp of 490 +or- 10° parts then quench in running water.

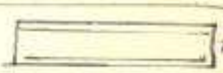
Soaking Rivets & Sheets 15 minutes thicker sections 30 minutes forgings 3 hrs always use tongs and protective clothing.

the rivetts harden in 1 hr and should be used before 45 minutes when they remain soft up to that time they may have their softness retained by keeping in cold storage at a temp of −25°C in solid CO2. Carbon Dioxide if boiled above a temp of 500° it will burn out the Copper and Magnesium and will become brittle.

anodizing Aluminium and its alloys as salt bath but using 97% Distilled Water 3% Chromic acid. with Electricity  at a temp of 40°C for 1 hr at 0 to 50 V last five minutes 50 V this makes it anticorrosive and test for same with lamp & battery if lamp lights shows it is defective.



Alclad is 90% Duralumin faced both sides with 5% Aluminium to test for type of metal use a Solution of 10% Caustic Soda in Water and the Alclad will turn white and Duralumin black. it is treated with Lamalin to prevent Corrosion Lamalin is made from sheep wool and is free from grease and is sprayed on used generally on Hulls & floats.



Alpax used for Castings 86% to 90% Aluminium 10% to 14% Silica

Y alloy for pistons ect.

Magnesium Alloy is lighter than Aluminium and is identified by its copperey glint to test what metal is fittings will burn if rubbed with copper sulphate will turn black with a fizz.

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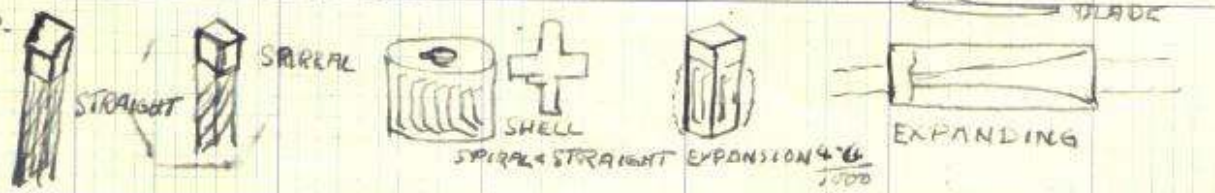
Lecture III

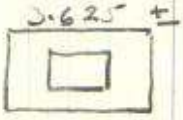
Reamers.



Brackes used as reamer by machines for making Keyways & Splines.

Tollerance limit & allowance
Reasonable amount of error allowed in workmanship and limit is the measurement at either extremity of tollerance.

allowance is the amount of clearance neccasery to obtain a certain fit.



HIGHEST LIMIT = 0.635
LOWEST - 0.615 = .020

Lecture IIII

Taps are used for making a hole to take a headless bolt
it is nownbered on top which is the size of the inside of thread
then are three taps first Tap. Taper Tap & Plug Taps.
the crest of a bolt is the hight of the thread at its top

the root is the narrowest part of the thread
to get exact tapping size is determined by.

Crest Diametre = 1.28 ÷ No of threads per inch
Root Diametre = Crest Dia - 1.28 ÷ No of Threads per inch

Stocks & Dies. two types Split round Dies & Two piece adjustable
Die nuts used for making Bolt threads the size of Die nuts are on the face of the nut. always note that when split dies are used there no are in line with no on stock.

Bolts & Studs are a bolt without heads and there are two kinds straight & waisted the waisted stud as the greatis Tenstile strength.
a Stud should never be screwed to bottom of hole and all the thread should be in hole. can be put in with Locknut or stud box.

To remove broken ~~taps~~ screws drill a hole and screw in left hand threaded tap.
Easy out drill a hole down centre use largest size Easy out and screw out.
if a Tap is broken in use a tubular peg spanner making Peg fit flutes and screw out.

Whitworths Threads are cut
BSW
BSFINE } 2 diam length of thread.
BA

Lecture VI. A & G S.

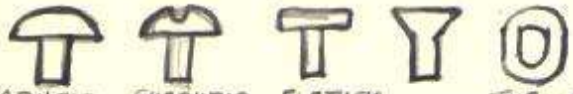
on aircraft as a rule the two general used typs of Bolts are B.S.F. B.A.
bolts are made as a rule from mild Steel.
all B S F are lettered & numbered on the head these denote the size the numbers are multiplyed by 10 which give the length
letters are size of bolt. for example N30 would be a 3" × 5/8 bolt
if a L is also on this denotes a left hand thread.

E	1/4"
G	5/16"
J	3/8"
L	7/16
N	1/2

High Tensile steel bolts have a ring on the side of the head if S.S is on the side too this denotes stainless steel. (High Tensile)

B A Bolts (British Association) are made just under 1/4 diameter.
the largest BA Bolts are noughts there usual nounber are 0. 2. 4. 6.
B.A. Bolts have material markings as B.S.F. 15/64 7/16 9/64 7/64
BA are Metric All nuts are also nounber. or lettered

Rivets. may be made in four different Styles and soy 6 diffrent Materials
the Styles are Snap head. Flat. Countersunk. Tubular.

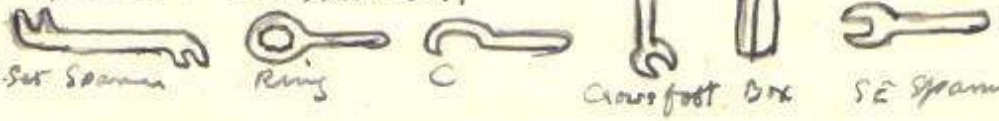


all Rivets are marked on the heads by four dashes for material used.

MILD STEEL	2 FLATS	
STAINLESS "	NO "	
NICKEL ALLOY	1 "	
ALUMINIUM	1 "	RIDGE
LIGHT ALLOY	2 "	TEST TWO FLAT WITH MAGNI

Locking devices. Double lock nuts:- Split Pins:- (split pins are made from mild Steel Stainless steel. Brass and must only be used once.) Split pin are used with Castle or castelation nuts.) Tab washer:- simons Locknut:- Wire circlips:- locking wire. Spring Washer:- Locking plate. simons Locknuts are useless if covered with oil. or if fiber is damaged.

Spanners. Double headed set Spanner. Ring Spanner. C Spanner. Crow foot Spanner
T&B× Spanner & S E Spanner.



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Prom. Engines Gipsy Moth.

Definitions:- T.D.C. (Top dead centre) when the piston is at the top of the Cylinder top of its stroke:- B.D.C. when the piston is at the bottom of its stroke:- Bore is the inside diameter of the cylinder usually measured in inches or millimetres:- STROKE the distance in inches or millimetres the piston travells from T.D.C to B.D.C.: CLEARANCE VOLUME, the Volume remaining at top of Piston when it is at T.D.C.: SWEEP VOLUME. S.V. the sweep or Displacement by moveing the piston from T.D.C to B.D.C.
Compression Ratio. C.R. the formula for same is $\frac{CV+SV}{CV} . CR.$
Horse Power H.P. one H.P. equals 33.000 ft LB per minute: I.H.P. Indicated horse power the H.P. developed in Cylinder.
Brake Horse Power B.H.P. the Horse power avaible at the air screw after mechanical loss has been deducted.
MECHANICAL EFFICIENCY, the amount of work actually done by the engine BHP divided by the amount of work developed in the cylinder I.H.P. usually expressed in percentage. usually appears

$$\frac{BHP}{IHP} \times \frac{100}{1}$$

The Otto or four Stroke Cycle

the cycle consist of 4 strokes

No 1 the inlet valve opens at T.D.C the piston decends from TDC to B.D.C inducing into the cylinder a combustable mixture during this stroke the exhaust Valves ~~opens~~ remains closed at BDC the inlet valve closes.

2. The Compression stroke. the piston accends and compresses the combustable mixture in the top of cylinder, both Valves being closed at T.D.C. an electric spark fires the mixture.

3 Power Stroke both Valves still keep closed and burning gases expand forcing the Piston from T.D.C. to B.D.C this is the only working stroke of the four stroke cycle.

4 Exhaust Stroke the exhaust valve opens at B.D.C. and the piston accending to T.D.C. forces out the burnt gases at T.D.C. the exhaust valves closes the inlet valve opens and cycle starts again. The whole cycle (4 strokes) takes place in 720° or two revolutions of the crankshaft.

The Practical Cycle of Operations

In order to obtain greatly power certain modifications to the ideal "Otto" cycle are necessary this involves the introduction of Valve lead. Valve lag and advance ignition.

Valve Lead (inlet Valve) the period in crankshaft degrees that the inlet valve opens before T.D.C. this is to ensure that the Valve will be sufficiently open by the time the piston starts its downward travel to B.D.C.

Valve Lead. (Exhaust Valve.) The period in crankshaft degrees that the exhaust valve opens before B.D.C. towards the end of the power stroke. The pressure on the piston has been considerably reduced and ~~there~~ is the ineffective crank angle very little power can be imparted to the crankshaft. This pressure being above atmospheric will cause a rapid movement of the exhaust gases imediately the exhaust valve is open Thus the scavenging of the exhaust gases is commenced before the piston reaches B.D.C.

Valve Lag (Inlet Valve.) The period in crankshaft degrees that the inlet valve remains open after B.D.C owing to the rapid ascent of the piston the mixture cannot enter the cylinder with sufficient speed in consequence at B.D.C. the pressure in the cylinder is below atmospheric ~~at~~ the cylinder is undischarged. By leaving the inlet valve open after B.D.C. the gases will continue to flow into the cylinder because of the difference in pressure between the cylinder & induction pipe and the momentum of the mixture.

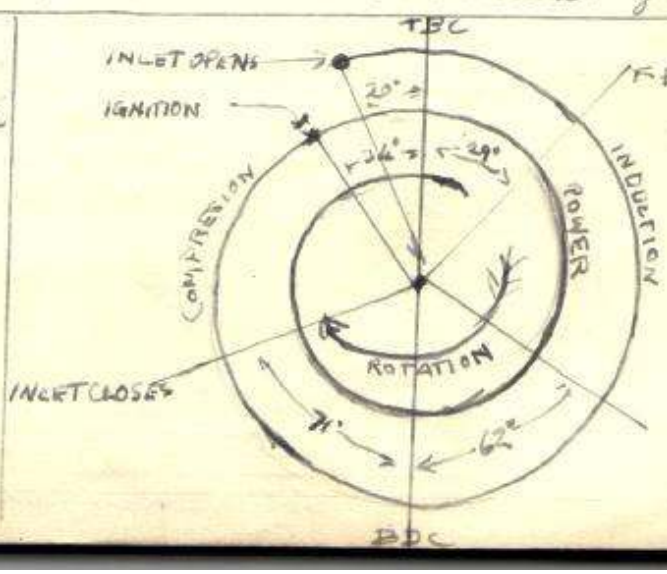
Valve Lag Exhaust Valve. The period in crankshaft degrees that the exhaust valve remains open after T.D.C in order to finally & completely the scavenging of the exhaust gases. The exhaust valve remains open after T.D.C and the gases flow out due to the momentum gained by them.

Advance Ignition The amount in crankshaft degrees that the ignition occurs before T.D.C on the compression stroke. This is introduced because the mixture takes time to burn and until fully burnt does not reach its maximum pressure the maximum pressure occuring just after T.D.C. The time taken for complete combustion of mixture is known as the flame time

Retard Ignition at slow piston speed the ignition is sometimes timed to take place nearer to T.D.C. this is known as Retard ignition:-

Variable Ignition. this indicates that the amount of ignition can be varied (either by hand or Automatic to suit various Speeds of Engines

INLET VALVE	OPENS	20° before TDC
" "	CLOSES	71° PAST BDC
EXHAUST "	OPENS	62° BEFOR BDC
"	CLOSES	34° ~~PAST~~ TDC



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An Internal Combustion Engine. I.C.E is an engine which burns its fuel inside the engine cylinder.
a normal aspirated engine is an engine which relies soley upon atmospheric pression for filling cylinders with combustible mixture on induction stroke.

Points to be observed on dismantling an Engine:-

1. complete cleanliness of engine bays
2. components to be placed in suitable racks & stands.
3. all parts not belonging to engine to be removed from bay
4. all markings either stamped or etched should be noted in order that parts may be correctly reassembled.
5. correct tools should always be used.
6. components should not be allowed to come in contact with one another while being stored.
7. Crankshafts must be supported on special stands (suitably lined with lead) to prevent sag.
8. Cylinders to be stored vertically to prevent distortion.
9. Valves to be kept as complete units (springs cotters ect).
10. Pistons to be stored on their crowns with gudgeons pins in position.
11. Gear wheels should be stored to prevent damage to bearing surface & teeth Mating wheels should be kept together.
12. Con Rods to be stored to prevent damage to Big ends bearings floating gudgeon pins must be attached to rods.
13. Crankcase, Sumps ect to be supported in three or four places on their Joint faces to prevent distortion.

Gypsy Engine

Air Screw Hub. made of Forge Steel. is carried by 8 Taper Splines the hub is fastened unto the crankshaft by a feather Key. on the back is a thread of a different pitch to stop oil leaking also on back of Hub is a points for timing Valves a brush washer is also plate on back for timing with.

Cam Shaft made of Low Carbon Steel Cam and Journals case hardened or shaft made of High Tensile steel. The speed of the cams is half the speed of C.shaft. its carried on five bearings the front bearing is flanged all bush closed on outside with a detach cap. the 3 centre ones are Phosphor Bronze. and the rear one of Duralin. on this end is the Layer of the Spur gear wheels.

Cam Shaft Vernier gear Wheel. the inner teeth no 24 - $\frac{360}{24} = 15°$
the holes in side number 21 = $\frac{360}{21} = 17\frac{1}{2}°$
the minimum adjustment is $17\frac{1}{2} - 15° = 2\frac{1}{2}°$

Simms Vernier adjustments Coupling.

Driving Side as 19 serrations each sessation is $\frac{360}{19} = 18\frac{18}{19}°$

Magneto side: 20 " " " " $\frac{360}{20} = 18°$

so the minimum adjustment is $18\frac{18}{19} - 18 = \frac{18}{19}°$

Mag. drive made of Case harden Steel and has a spur gear for drive a Skew gear to drive mag. & a worm gear to drive Tachometer.

Types of Bearings

Bush a cylandrical one piece bearing either fixed in it's housing or fully floating very often made of Phosphor Bronze and used for Valve guides Tappet guides & Small end con Rod bearing

Plain Split bearing similar to a bush but split has a very large surface area to withstand heavy load usually used for main or Big end bearing are made from a anti friction metal such as White metal, Lead, Bronze etc.

Plain Ball bearing, made of case harded mild steel & consist of a outer & inner race having a row of balls between. used in place of a bush to withstand a greater load. it will also withstand a small amount of End thrush sets up a minimum of friction.

Self Aligning a special type of ball Bearing having two rows of Balls instead of one and the inside of the outer race ground on a Radius it will allow any misalignment between the two bearings supporting a shaft.

Thrust bearing. a special Type it will only withstand the axial Load on a Shaft.

Roller Bearing similar to Ball but having roller in place of Ball and will withstand a much larger load because the rollers have a larger area of contact and is usually used in Radial Engines.

Crankshaft: Nickle Chrome Steel. transports the pulse power from the piston to the air screw. is made hollow for lightness the throw is equal to half the stroke. fillets are left on Journals & Web stop weakness of parts. Collar at the front is known as the thrust collar at the rear is a gear but this is not part of Crankshaft. it is lubricated by the oil leaveing through the hollow shafts.

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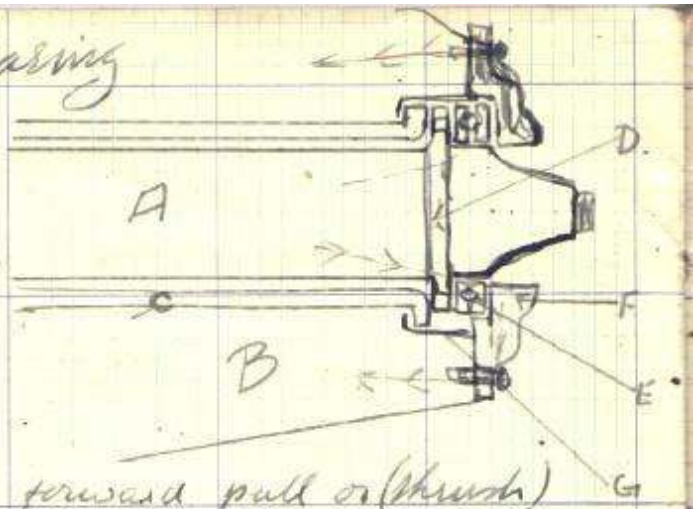
The Thrush Bearing

A CRANKSHAFT
B CRANKCASE
C FRONT MAIN BEARING
D THRUSH COLLAR
E THRUSH BEARING
F THRUSH COVER
G ADJUSTING SHIM,
→→→→ PATH OF THRUST.



The Thrush bearing transfers the forward pull or (thrush) of airscrew from the crankshaft to the crankhouse with a minimum of friction.

Push Rod made of Dural tubing forced on to case hardened ends. The tubes are annodally treated to stop corrosion. small holes in top prevent the heat causing expansion.

Manifold Induction made of Welded Steel. the carburettes arms are of double strength there are four priming plugs incorporated in this manifold two prim plugs to start ~~Engine~~ also a by pass pipe is in to allow water in to circulate round Carb.

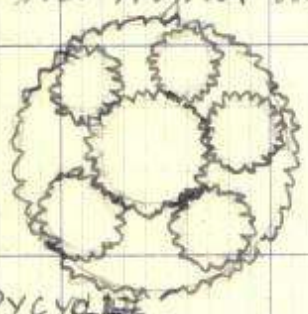
Gear Cover is made of Aluminium alloy and is fix to the case with 3 dowels it enclose the gears for the Camshaft 48 mag shaft & Tachometer 24 Crankshaft 24 Oil pump 35 teeth.

Crankcase made of aluminium alloy. Casted on the Port side is the galley pipe for the oil feed on the side is also a breather to keep the pressure inside the same as outside.

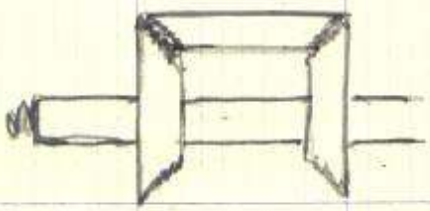
Main Bearing is die casted in solid white metal always see there is 12 thou clearance between bearing & crankcase and 2 thou on front bearing

Reduction Gear. Spur type: epycyclic:- Differential: a reduction gear maintains the airscrew at its most efficient speed together with the higher and most efficient speed of Engine

EPYCYCLIC



EPYCYCLIC



DIFFERENCIAL

Jointing Materials.

1 Hallite (Graphite + asbestos) for Induction Manifold
2 Copper & Asbestos " Exhaust Manifold.
3 Solid Copper Crankshaft sealing plug.
4 Fiber for oil pipe banjo unions
5 Liquid Jointing for all faces Joints IE { Cylinder Sump Rear cover etc }

Locking devices.

1 castellated slotted nut } & cotter pins — Rocker arm shaft
2 Spring Washers — Crankcase to Sump bolts & nuts.
3 Spring Clamps + Bolts — Rocker arm Shafts.
4 Bearing — Rocker arm case hardened Pad
5 Locknuts — " " adjustable Ball
6 Split Taper or Cotter — Valves
7 Circlip — Gudgeon pins Camshaft gear nut
8 Tab Washer — airscrew hub nut.
9 Locking Wire — Induction pipe Priming Plug Airscrew Hub

Location

Cylinder :- by a flange and spigot machined on the skirt of cylinder.

Airscrew hub by a taper on the crankshaft and the feather Key.

Gudgeon Pins by a chamfered washer and circlip at each end of the pin

Crankshaft by the thrush collar machined on c/shaft the front main bearing the thrust bearing assembly and thrust collar.

Oil pump by the spigot on the pump casing & five Securing Bolts

Big End bearing by a dowell fixed in the Con Rod & flange on one side of bearing

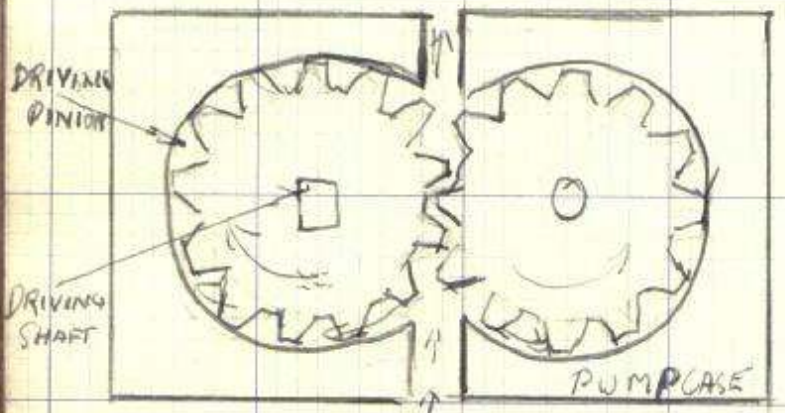
Location Continue:-

Main bearing by a dowel cast in the lower half of the bearing & flanges on the seat of bearing

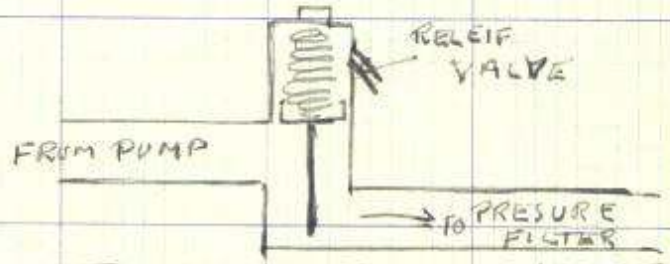
Rear Cover. - by the dowel fixed in crankcase.

Cam Shaft:- by the flange machined on rear end of the shaft the rear bearing and the flange on the cam shaft gear by dowel screws screwed through the crankcase.

Lubrication.



OIL PUMP



PRESURE RELEIF VALVE

Oil filter relief valve in top of filter to allow oil to pass through for if the oil is starved or filter made up with dirt.

The object of a lubrication when two objects are pressed together the resistance to the sliding of one over the other is known as fuctional resistance.

The amount of friction present is controlled by the

1 Speed of the parts in contact.
2 The Material of the parts in contact
3 The Loading on the parts.

This friction reduces the efficency of the engine and ultimatly destroys the bearing surfaces. To reduce the friction to a minimum a lubricant is interposed between the bearing surface.

The usual lubricant for aero engines is Mineral oil.

System of Lubrication

1 Wet Sump this is when oil is splashed around the interior of the crank case by revolving the C/shaft the oil reservoir in this case being the lower half of the crankcase or Sump.

2. Dry Sumps in this system the oil is stored in a seperate tank and is withdrawn from it with a pressure pump. It is then forced to the principal bearing surface under pressure. The oil having first oiled the principal bearings surface then oils the rest of the engine by splash & mist. The splash oil then drains to the sumps from where it is pumped by a scavenger pump via the oil cooler (Radiator) to the oil tank. The scavenger pump(s) is of a suffcent large capacity to maintain a dry sump. To ensure the cleanliness of the oil it is filtered before entering and upon leaving the engine. The dry sumps principal is used on all areo engines.

The Ideal Lubricant for an areo engine is one that possesses the correct Viscosity at its lowest temperature and retains its Viscosity at its Highest temperature under working conditions. It must also resist carbonization and any tendacy to acidify when exposed to the atmosphere.

Viscosity is 1. its resistance to flow
2 " " shearing face
3 " " change of shape by external pressure.

Path of oil on Gypsy.

SUMP
PUMP
PRESSURE RELEIF VALVE
PRESSURE FILTER
SUPLY PIPE
GALLEY PIPE

SMALL PIPE TO JET OVER MAG

CRANKCASE WEBS
WASTED STUD
MAIN BEARING
INSIDE No 2&4 JOURNELS
CRANKSHAFT WEBS
CRANK PINS No1-2 FED FROM 2 JOURNALS & 3&4 FED 4 JOURNALS
SPLASH & MIST REST OF ENGINE

SCAVENGER FILTER
ACROBATIC TRAY
SUMP

18

Causes of Loss of Oil Pressure.

1 Worn bearing. (main or Big)
2 Weak pressure 'Relief Valve'
3 Leak on Suction side of Pump.
4 overheating causing Viscosity of oil to drop.

Causes of excessive oil consumption.

1 Worn or Broken piston rings (scraper ring in particular)
Worn cylinder. worn Piston. leak on external oil pipe
oil return holes in pistons choked.

Causes of Loss of Compression

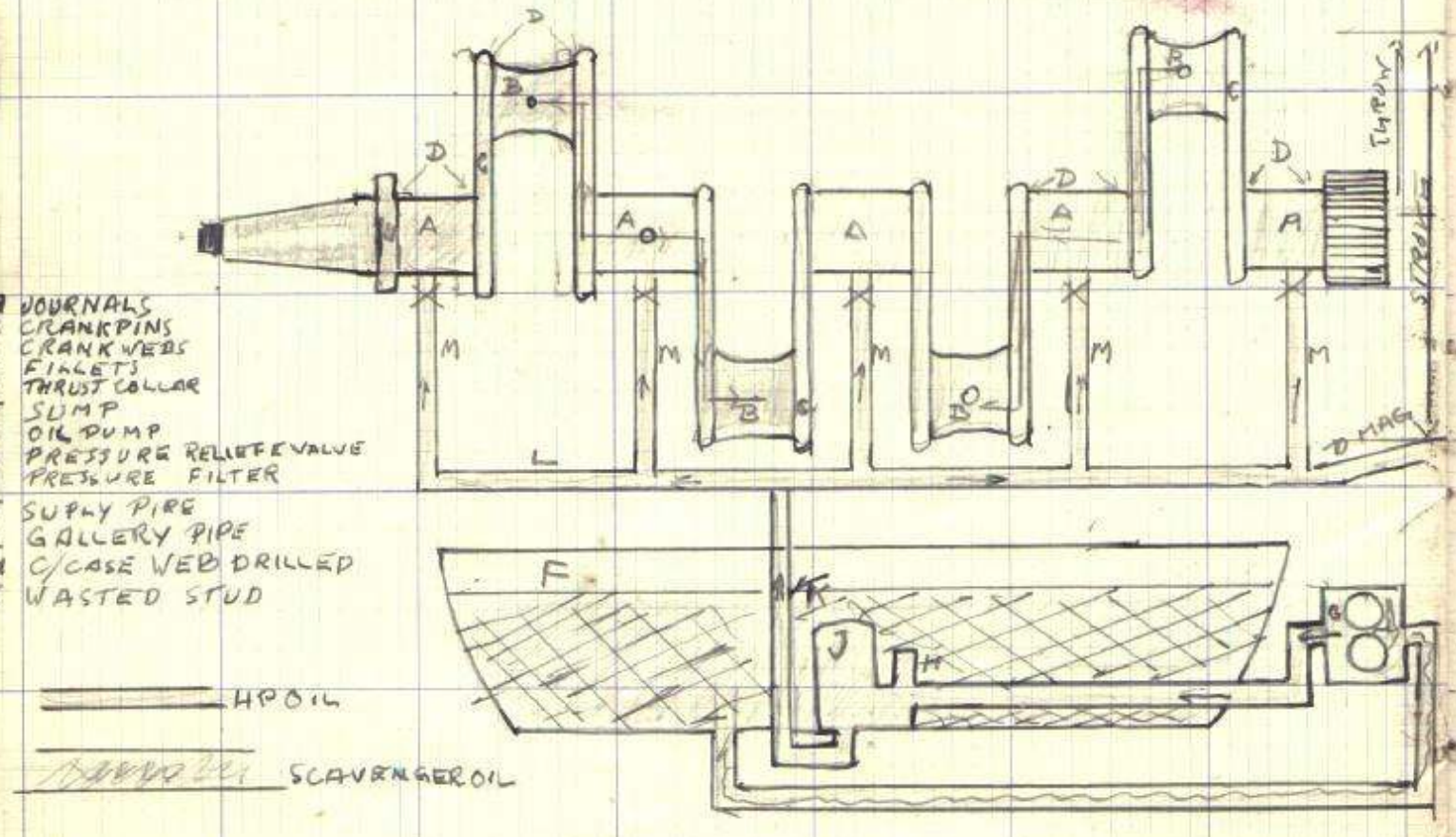
Valve or Valve seats pitted or burned — insufficient tappet clearance
Broken or worn piston rings, scored cylinder.
leaking cylinder gasket — Loss on leaking Sparking plugs

Causes of Overheating.

Retard ignition :- weak mixture :- lack of lubrication
inefficient cooling.

Causes of Excessive Vibration

Lose engine bearing — Worn main bearings or Airscrew shaft
incorrect mixture Strength :- Airscrew out of ballance



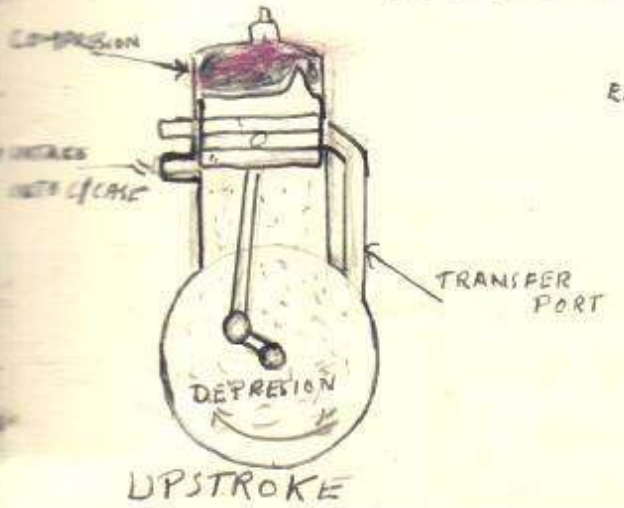
Cleaning Parts.

The following is the method of cleaning Engine Components

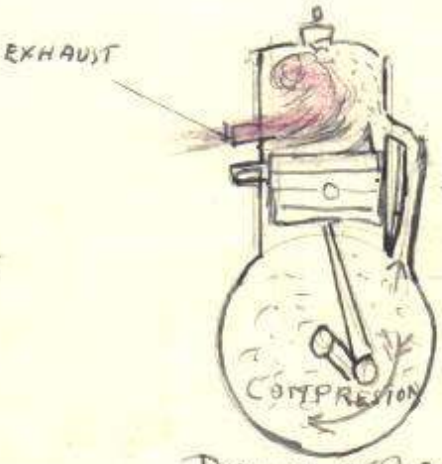
	1st	2nd	3rd	4th
1. Ferrous Metals / Brass & Bronze	Hot Soapy bath	Clean hot Water	Paraffin	Paraffin
2. Aluminium Alloys	NO	"	"	"
3. Magnesium Alloy.	NO	NO	"	"

all parts should be dried with a napless cloth and coated with oil or Rust preventive to prevent corrosion hot Water tanks should be maintained up to 200°F. do not use soft soap as it contains Caustic Soda but used a good Yellow soap do not use chlorinated Water Scrapers emery cloth ect Wire Brushs should only be used in a emergency and then with discretion.

2 Stroke Cycle. Operations



UPSTROKE



DOWN STROKE

Two stroke cycle of operation takes place in one revolution of the crankshaft or 360° degrees. On the upward stroke of the piston mixture all ready in the cylinder is compressed and as the crankcase is sealed the rising piston causes a depression in the crankcase and Combustable mixture flows into it. When the piston uncovers the inlet port. The mixture compressed in the top of the cylinder is ignited at T.D.C. and the burning gases expand and force the piston down to B.D.C.

At approx half way down the stroke the exhaust port is opened and the burnt gases flow out due to their own pressure as the piston is decending the mixture induced into crankcase is compressed and when the transfer port is uncovered (just after the exhaust port) mixture flows into the cylinder due to the difference in pressure between crankcase & cylinder the piston has a deflector head and the incoming gases strike the deflector and are directed to the top of cylinder and assist in the scavenging of the exhaust gas.

Cooling

There are two types of cooling Liquid & air.
Cooling is necessary to prevent overheating. if the cylinder temp is to high it adversely affects the Volumetric efficiency of the engine also excessive heat would be detrimental to engine parts. The heat dissipated by cooling is approx 28% of heat produced by the fuel.

System I Liquid cooling pressure is similar to the Thermo-Syphone system except that a pump is used to increase the rate of liquid circulation the pump is situated in the lowest point of the system this type is used on aero engines because of the high temperature which they run and also to ensure a positive liquid circulation the heat carried away by the liquid is dissipated by the radiator which is situated in the air stream
Liquids used for cooling are Water & Ethlene Glycol depending on the engine Type (Ethlene Glycol) has a very high boiling point also a very low freezing point.

Air Cooling

cylinder & cylinder heads are very heavily finned to give a large surface area over which the air stream passes carrying the heat away with it. The fins around top of cylinder & heads are usualy deeper as these are the hottest parts of cylinder are screwed & shrunk to the head as this method dissipates heat rapidly.

Baffles & screens are used to direct the air stream right round all cylinders and so ensure uniform cooling.

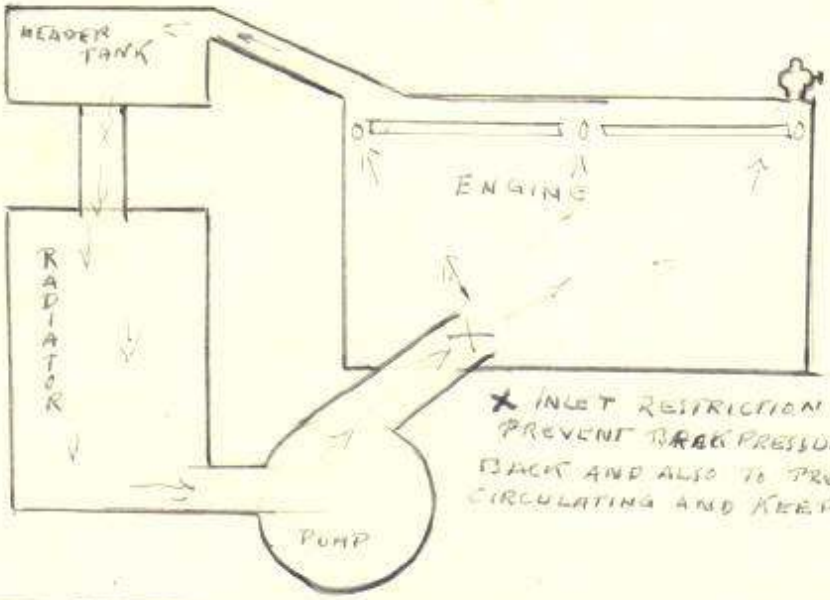
Advantages of Liquid cooling.

1 cooling is even
2 a lower normal running Temperature
3 easy to streamline

advantages of Air cooling.

1 Less weight
2 No maintainer of cooling System
3 Less liable to damage either accidently or through enemy action
4 Warms up quickly to normal running temperature

O OUTLET RESTRICTION WASHER FITTED NEAR TO ~~ENGINE~~ COOLANT CIRCULATES EVENLY ROUND ALL CYLINDERS



X INLET RESTRICTION WASHERS FITTED HERE TO PREVENT ~~BACK~~ PRESSURE WHICH SUDDENLY THROTTLES BACK AND ALSO TO PREVENT TO MUCH COOLANT CIRCULATING AND KEEPING ENGINE COOL

Assembly Precautions.

1 Cleanliness
2 Observe all marking on components to ensure correct assembly.
3 Put a film of oil on all moving parts before assemble.
4 Make ~~Sure~~ all devices are secured and correctly fitted.
5 Use correct tools
6 Renew all Jointing Materials
7 Examine & make sure that all threads are in good condition
8 Cylinder head nuts must always be tightened down evenly & ~~diagonally~~ also engines that have cylinders seperate must have cylinders lined up before tightening down.

order of operating Gypsy Valve Timing.

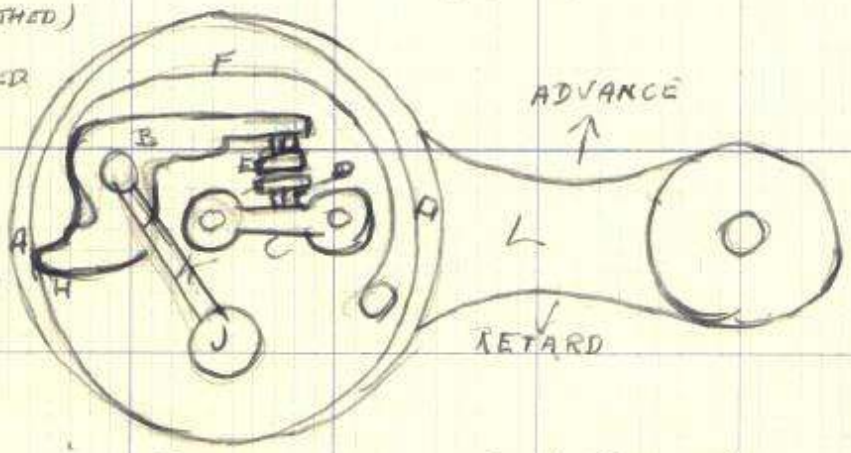
1 Turn crankshaft until the pointer on the airscrew hub points to 10 (inlet opening 20° T.D.C.
2 Turn crankshaft until the tappets are resting on the negative or lowest part of camshaft.
3 Set tappet clearance on both Valves at .005.
4 Remove exhaust push Rod.
5 Turn camshaft in direction of rotation until the inlet Valve is just about to open i.e:- The clearance just taken up.
6 Holding camshaft gear wheel still couple it to the crankshaft by means of the magneto drive shaft.
7 Replace exhaust push rod.
8 Turn crankshaft back a little and tap forward. check that the inlet Valve just commences to open when the pointer is opposite T.D.C.
9. if correct check other opening & closing E.C.I.O.E.O.
10 if incorrect adjust with vernier on camshaft gear the minimum adjustment is 2½°

Gypsy Tappet adjustment

1. Turn crankshaft until the cylinder on which the tappets are being adjusted is on compression stroke and the piston is at T.D.C. The cams are then in their negative position.
2. insert feeler gauge between rocker arm pad and Valve stem
3. if incorrect slacken Locknut and adjust adjustable ball until a correct clearance is obtain relock locknut & check
4. Proceed on each cylinder in turn correct clearance .005" on both Valves when cold.

Tappet clearance is necessary to ensure that the Valves will seat correctly under all conditions.

A CAMS
B ROCKER ARMS (EARTHED)
C FIXED ARM INSULATED
D ADJUSTABLE POINT
E FIXED POINT
F MAIN SPRING
G AUXILIARY SPRING
H FIBER HEEL
J ROCKER ARM (CUP)
K PRIMARY WINDING
L TIMING LEVER



Correct gap at points to .012 ± .001 with fiber heel on the highest part of cams.

Order of Operating Dep^ty Magneto Timing

1. Turn crankshaft in direction of Rotation until the points at rear of airscrew hub points to M.A. Magneto advance 34° TDC.
2. Insulate primary winding by insulating primary Binding (Screw.
3. adjust contact breaker point .012 ± .001"
4. Fully advance timing lever.
5. Turn Magneto so that the distributor rotor is opposite Segment Serving No 1 cylinder with the contact breaker points about to open.
6. Fit Magneto to engine.
7. Fit Lamp & battery by connecting one lead to earth and the other to fixed arm of contact breaker
8. Test timing by turning engine backwards to take up all backlash & tap crankcase forward slowly.
9. When lamp is extinguished note error in timing if any this will be indicated on Airscrew hub.
10. Any error in timing can be rectified by the Systematical manipulation of Simmons Timing coupling minimum adjustment 18° .19

Definitions

General Engineering Terms.

Backlash the clearance between meshing gear teath or splined members which must be taken up before driving in Reverse direction.

Bearing. is the part of a Mechanism intended to support Rotating Shaft.

Cam. A Projection from a revolving shaft for controlling the rate and extent of movement of other parts pressed against it.

Clearance. The space provided between two working parts for:-

1 Freedom of Movement
2 Lubrication
3 Variation of Size or Position due to heat distortion

General Engineering terms cont.

Housing: a hollow case the main purpose of which is to carry bearings + support for working parts.

Journal: is the part of a shaft intended to rotate in a bearing

Shim a thin piece of metal sheet cut to shape used for packing between two surfaces as to adjust accurately their distance apart.

Splines. a series of axial ridges on the outer surface of a shaft seperated by grooves of rectangular section to fit into a similar groove and ridge counterpart.

Serrations similar to splines but closely spaced + smaller

Throw (of a crank) the distance from the centre line of the crankshaft to the centre line of crankpin: equals half the stroke in an engine mechanism.

Internal Combustion Engine Terms

Boost Pressure. the amount by which the pressure in the induction pipe of a supercharged engines exceeds standard atmospheric ground level pressure.

Detonation is the instantaneous explosion of part of the mixture caused by too high a compression ratio excessive boost pressure or over advance ignition timing

Flame Rate. is the average speed of travel of the flame which originates at the sparking plug through the rest of the mixture.

Mean Effective pressure: - (M.E.P) the average pressure acting on the piston during the working stroke.

Pre-ignition. is combustion starting before the passage of the spark caused by some overheated part in cylinder incandescent carbon deposit valve head or plug point.

Thermal Efficiency: is the ratio between the heat equivalent of the work produced + the total heat content of the fuel used (often expressed as a %)

Volumatic efficiency: is the weight of mixture actually drawn into the cylinder divided by the weight of a cylinder stroke volume full of air at normal pressure + temp (often expressed as a %)

Atmospheric Pressure. is the pressure due to the weight of all the air above a given point - at ground level it is about 14.7 lbs sq" at 20000 ft (because there is less air above) it is about 6.4 lbs sq" it varies slightly with weather condition

Magnets

Electric Currant. a flow of electricity measured in amperes (amps)

Electric Motive force. Electric Motive force (EMF) an electrical force which produces or tends to produce an electric current.

Electric pressure — measured in Volts.

Resistance. — opposition to the flow of a currant measured in Ohms

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Ohms Law The currant flowing in a circuit is directly proportional to the applied E.M.F and inversely proportional to the Resistance :

E = E.M.F. Electric motive force in Volts
R = Resistance in Ohms
I = current in amps

Then I equals $\frac{E}{R}$ E equals I × R

R " $\frac{E}{I}$ Watts. = E × I

Conductors a material which offers a low resistance to the flow of current is called a conductor.

Insulator. a material which has a resistance so high that no current can pass through it is call insulator.

Magnet. Have the property of attracting pieces of ferrous metal this attraction being greatest at their ends or poles.
if freely suspended magets will always point to North and South poles. The end pointing towards the North is known as the North seeking or North pole and the other the South pole.
similar poles of magnets repel each other but unlike poles attract.

The Magnetic field of force acts along lines known as lines of force and the force acts in a direction from the North pole to the South pole.
lines of force can pass through ferrous metals very much easier than through air or other Metals.
pieces of ferrous metals can be magnatised when the magnatising force is removed some types of iron & steel lose their magnetism, others will retain it indefinetly these are called permanent magnets

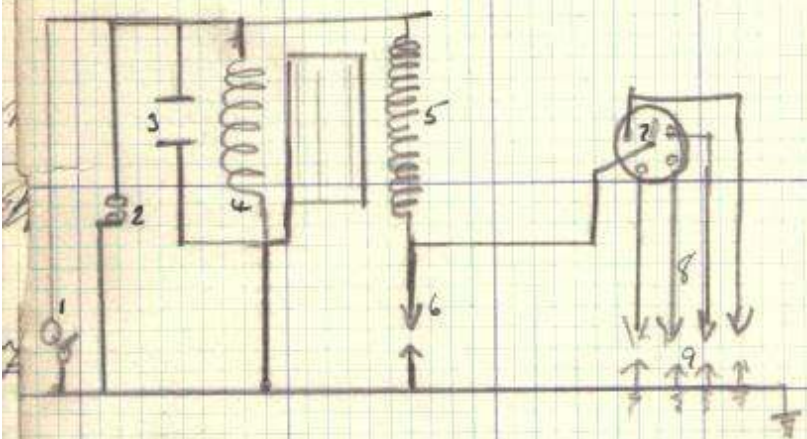
Permanent magnets may be made of Tungsten, Cobalt Steel, & alloys of iron, nickle, Aluminium & cobalt.

Magnetic effect of an electric current when a current flows through a wire a magnetic field is built up around the wire the lines of force being concentric with the wire acting in a clockwise direction in which the current is flowing. This effect can be made very much stronger by bending the wire into a coil, and can be still more by placing a iron core inside the coil the strength of the magnetic field depends upon the strength of current flowing & the number of turns of the wire.

Faraday's law. If a magnetic field around a conductor be made to change an E.M.F will be induced into the wire and if the circuit is complete a current will flow If the magnetic field around a coil of wire changes the induce E.M.F is proportion to the rate of change of the magnetic field and the number of turns on the coil.

Self Induction :- When a current flowing in a wire is made to change the resulting change of magnetic field induces an E.M.F into the same wire this is called a self induced E.M.F.

Mutual Induction a change of current in one coil of wire will induce an E.M.F into another coil of wire close to it this is called a mutual induced E.M.F.



1 EARTH SWITCH
2 CONTACT BREAKER
3 CONDENSER
4 PRIMARY WINDING
5 SECONDARY "
6 SAFETY SPARK GAP.
7 DISTRIBUTOR
8 SPARKING PLUG LEADS
9 SPARKING PLUGS.

CONDENSER made from alternate tinfoil & mica.

Core of iron is laminated to stop E currents

Action of Magneto

Rotation of the main shaft of the magneto causes periodic reversal of the magnetic field of the permanent magnet through the armature core.

Each reversal induces an E.M.F. into the primary winding and the contact breaker being closed a current flows into the primary winding building up a magnetic field.

When this current reaches its maximum value the contact breaker is opened by a cam stopping the flow of primary current and causing the magnetic field associated with the current to collapse suddenly.

This sudden change of magnetic field induces into the secondary winding a very high E.M.F. (several thousand volts) sufficient to cause a spark at Sparking plugs.

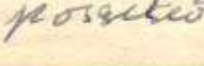
The same sudden change in magnetic field induces into the primary winding a self induced E.M.F much weaker than that in the secondary because of the fewer turns but strong enough to cause arcing at the C.B. Points as they seperate.

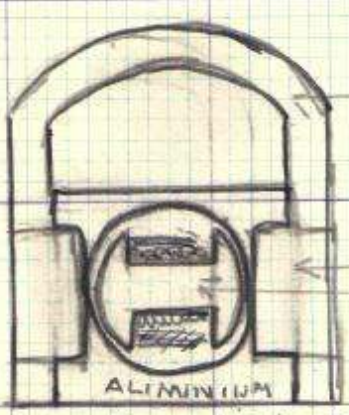
This is prevented with connecting a condenser in parallel with C.B. points to absorb the self induced E.M.F. & stops current without arcing at the points.

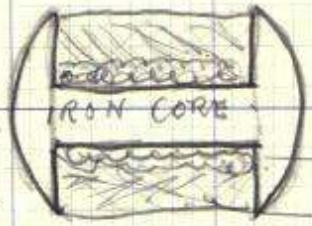
The distributor connects the secondary winding of the magneto to each sparking plug in turn.

The safety spark gap provides a path across which the E.M.F in the Secondary winding can discharge should a sparking plug lead become disconnected thus preventing damage to insulation.

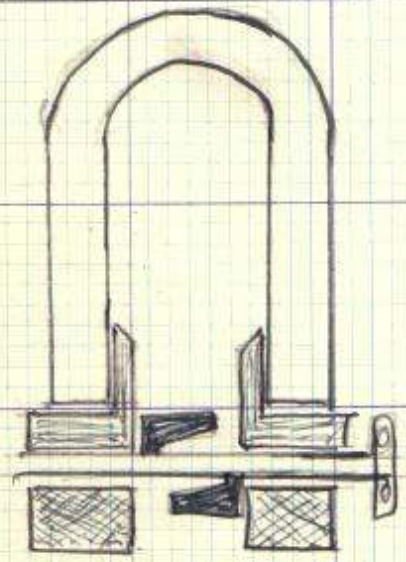
Earthing Switch. This switch connects the insulated end of primary winding to earth when it is in closed position (marked off) in this position the primary current can flow to earth through the switch wire & switch. Whether the contact breaker is open or not and when the C.B opens the primary current does not stop flowing. The Mag will not generate sparks with the switch in the off position

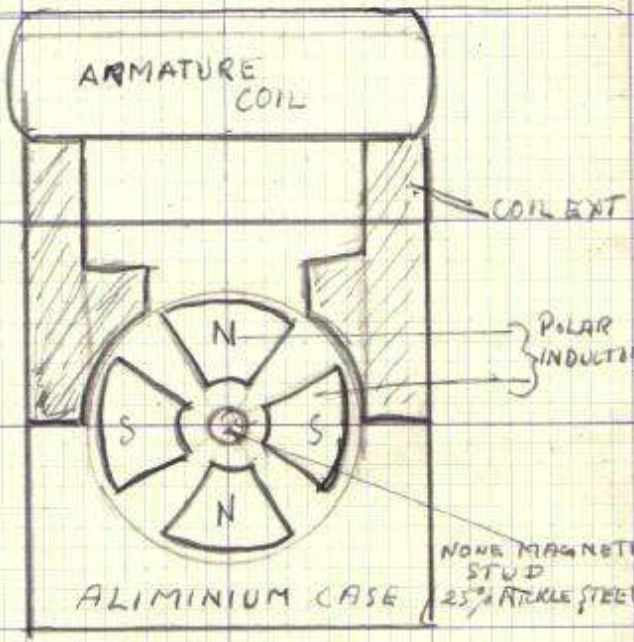




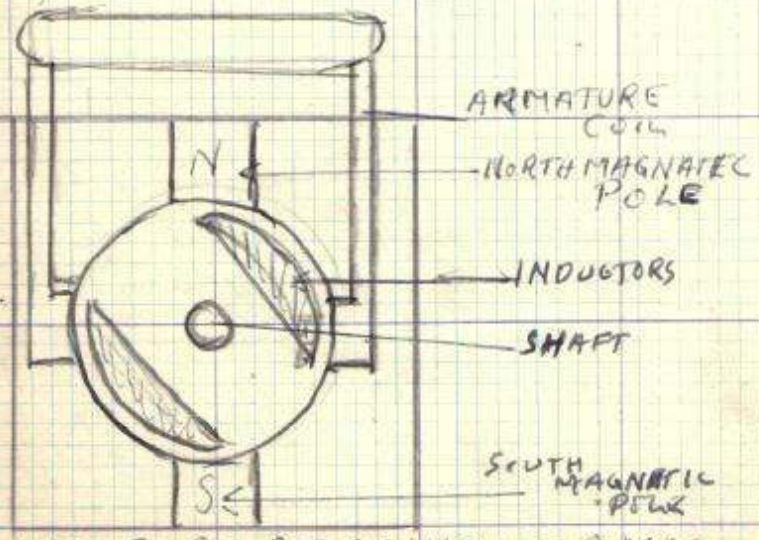


Rotating armature type of Magneto made of aluminium case with soft iron bit on side for magnet to fit on, inside the armature rotates making a contact on these magnets.

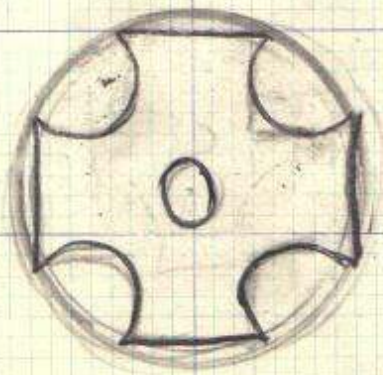




B.T.H 4 BAR POLAR INDUCTOR MAGNETO.



WATFORD 2 BAR INDUCTOR MAG



B.T.H. ROTATING MAGNET.

Limitations of Rotating Armature Magneto

As the most delicate parts (winding ect) all rotate + have to withstand the Mechanical stresses produced by centrifugal a limit is upon the maximum speed at which the magneto may be rotated without risk of a Mechanical breakdown in addition only 2 sparks are produced per revolution this limiting the number of sparks which the magneto is able to produce per minute this number is less than that required by large aero engines (Eg:- Merlin needs 1800 Dagger 1800 sparks per minute) 3000 R.P.M.

Advantage of Stationary Armature Magnetos.

The Windings do not rotate and are not subjected to Mechanical stress. The rotating parts are very robust and can withstand high speeds without risk of breakdown. By suitable arrangement of the inductor + magneto any reasonable number of sparks can be produced per revolution usually 4 on aircraft Mags. Magnetos of these types can produce enough sparks per minute for modern aero engines.

Contact Breaker Gaps.

To Large:- advances ignition timing possibility of misfiring when timing control lever is in fully advanced position.

To Small:- Retards ignition timing
Possibility of misfiring in fully retard position of timing control greater tendancy to arcing of contact points.

Inspection of Contact-Breaker.

1 Inspect cleanliness + condition of contacts. Slight pitting can be cleaned by used of equalising file or contact stone. Bad pitting or Burning of contact is a sign that condenser is faulty and the Magneto must be changed.

2 Examine Springs for sign of rusting, cracks, Blueing Replace if necessary.

3 Check gaps and adjust if necessary.

4 Check clearance between rocker arms + Buffer spring (·018 - ·020) with contacts closed. (·006 - ·008) contacts open.

Inspection of Contact Breaker.

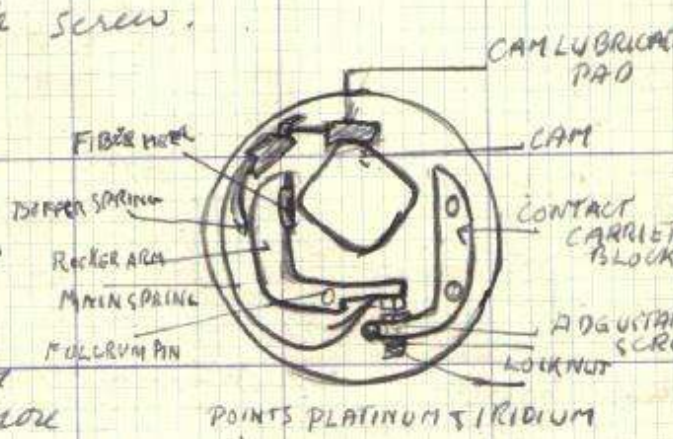
30 5. Clean C.B. spigot & housing & smear spigot with a little H.M.P. Grease.

6. Lubricate cam pad & fulcrum pin (if necessary)

7. On B.T.H. Magnetos check fit of Peg in socket in cover if Cone peg must be replaced not opened out.

Adjusting C.B. GAP.

1. With C.B. cover removed & control fully advanced rotate magneto untill contacts are fully opened.
2. measure gap with clean feeler guage .012 and if adjustment is necessary.
3. Slacken Locknut on adjustable screw.
4. Slacken clamping screw
5. adjust gap to .012"
6. Tighten clamping screw
7. Tighten locknuts on adjustable screw
8. Recheck gap
9. Check gaps on all peaks of cam Reject Magneto if gaps vary by more than .001 above or below .012"



Internal LT Lead.

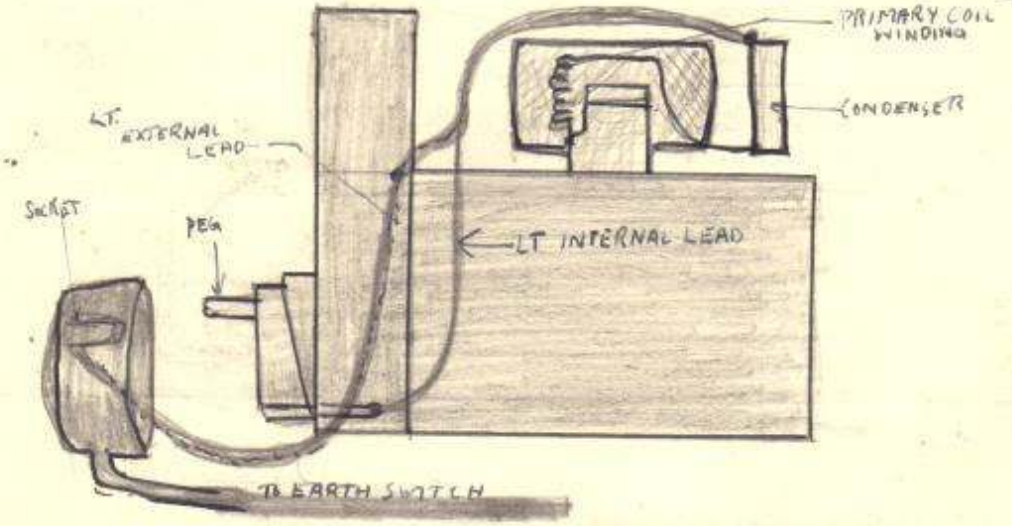
Primary winding is connected to contact breaker by a lead inside the magneto & spring blade connection to insulated contact carrier. the earthing switch lead is connected to a terminal in the C.B. Cover is in position this connection is broken when the C.B. cover is removed & the switch can only put the magneto out of action when the C.B. cover is in a fitted position

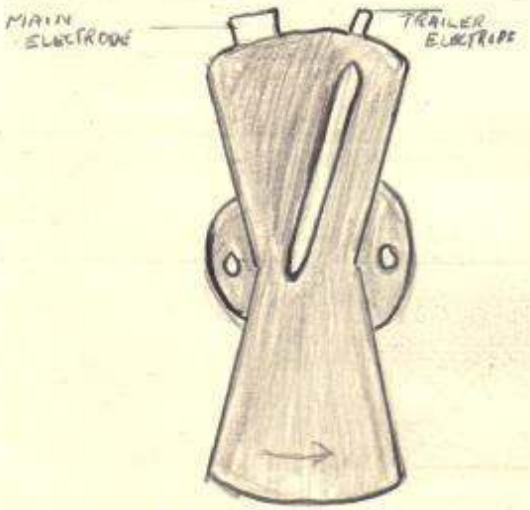
Whenever the C.B cover is removed the magneto must be prevented from causing sparks at the plugs by removing the distributor cover when ever checking timing using Lamp & battery. to find opening point of contacts the primary winding must be insulated from C.B. by inserting a piece of oil silk .004 thick in spring connection.

LT. Lt Leads used on all magnetos except some B T H Polar inductor Types.

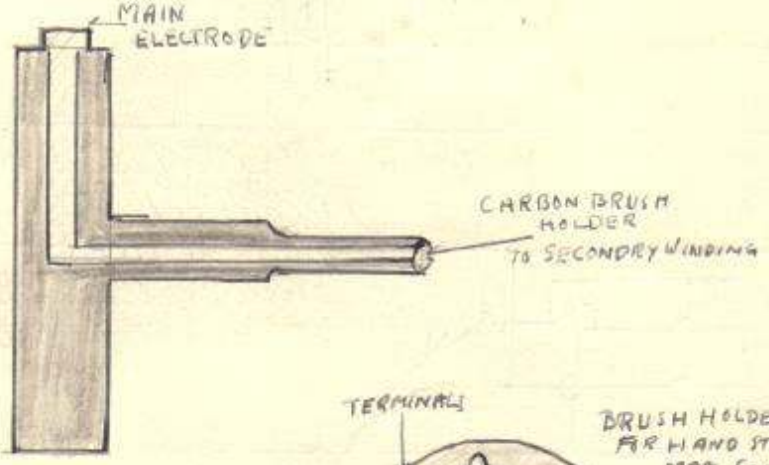
External L.T. Lead.

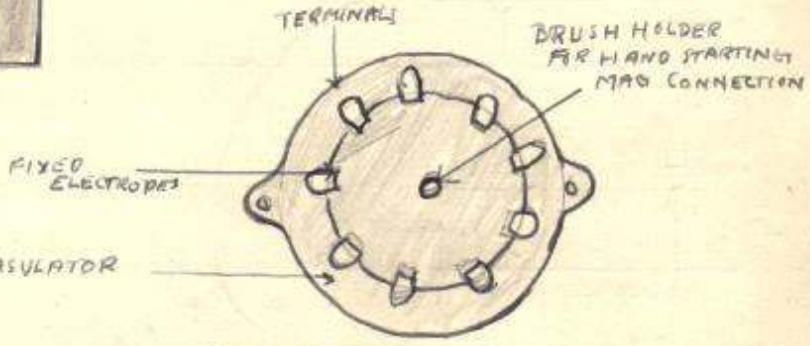
Primary Winding is connected to contact breaker by a lead brought outside magneto + connected to a terminal in C.B. cover at the same point as the lead to earthing switch. The primary Winding is disconnected from the contact breaker when the C.B. cover is removed + the Magneto will not operate with the C.B. cover off.
(used on some BTH polar Inductor Mags.)





DISTRIBUTOR ROTATOR

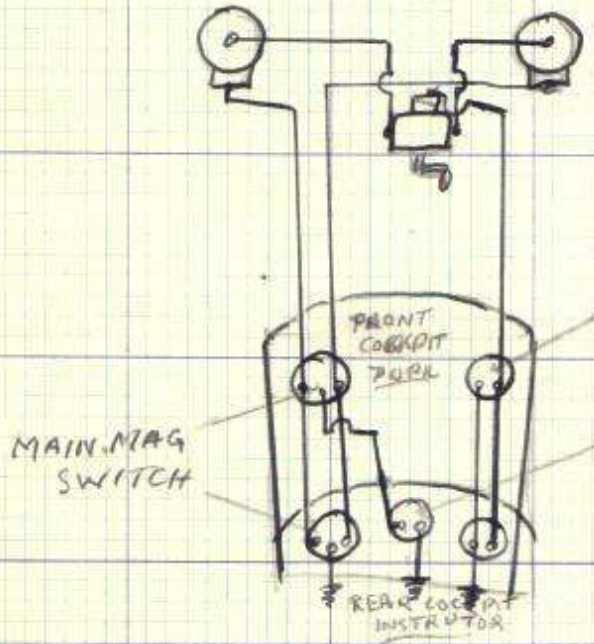




DISTRIBUTOR

Inspection of Distributors.

1 Remove distributor cover & rotor examine for signs of corrosion superficial damage & condition of gauges.
2 Wash in lead free petrol to remove any oil or grease.
3 Wash in warm water 75°C ± 5 and dry thoroughly
4 Test insulation of rotar between main electrode & trailing electrode with megger.
5 Test insulation of covers between each adjacent pair of Terminals & between each terminal & Brush holder with megger



WIRING SWITCHES ON DUAL-CONTROL TRAINING AIRCRAFT.

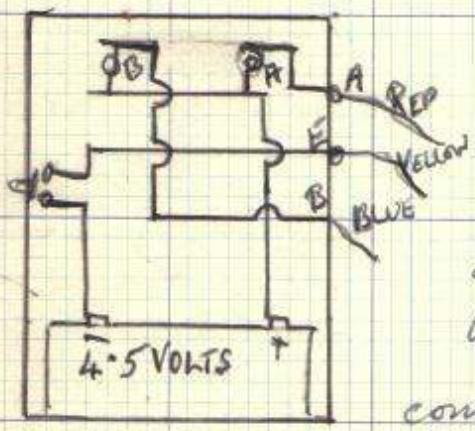
HAND STARTING MAG SWITCH

MASTER SWITCH

MAIN MAG SWITCH

Use of Continuity Testers.

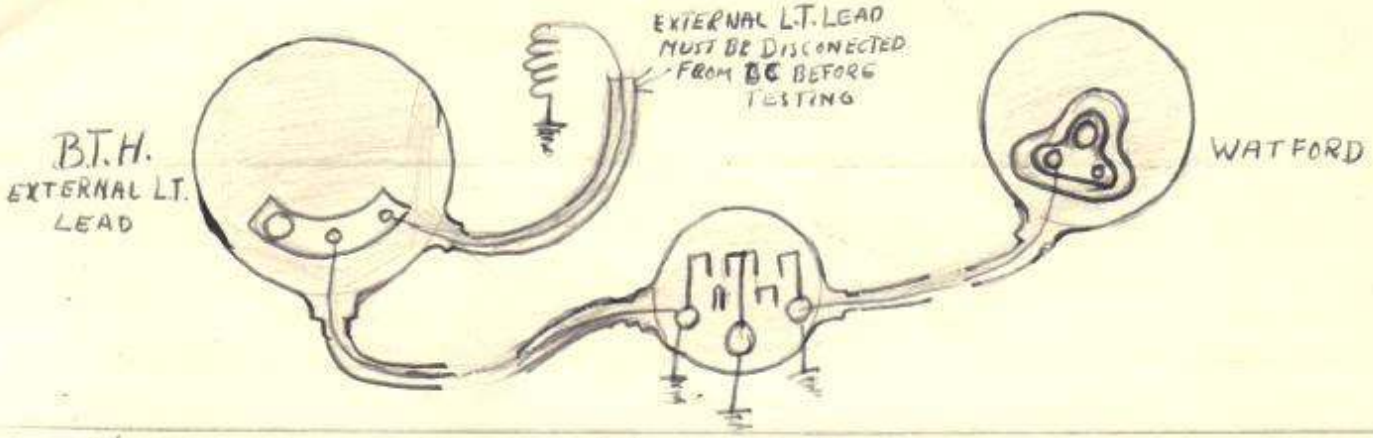
1 connect yellow lead to red or Blue lead mag switch & note brightness of light that ensures tester is in good order.
2 connect yellow lead of tester to one end of wire or circuit to be tested & Red or Blue lead to other end. Lamp should light brightly when switch is pressed. No light or dim intermittent light indicates a faulty wire or connection.



CONTINUITY TESTER.

Use of a Megger for testing insulation connect leads from the two terminals of the megger to the two points between which the insulation is to be tested when the handle is turned at 160 R.P.M. the instrument should read infinity any lower reading indicates faulty insulation.

EARTHING SWITCH WIRING



Testing Switch Circuit A (for Continuity Lamp)
Remove C.B cover (if may has external L.T. lead this lead must be disconnected before testing) connect one lead of continuity tester to earth the other to insulated terminal inside C.B cover, Lamp should light when earthing switch is off & go out when on.

No light indicates a fault which must be located by testing between earth & earthed terminals of switch (to test Earth Lead.).

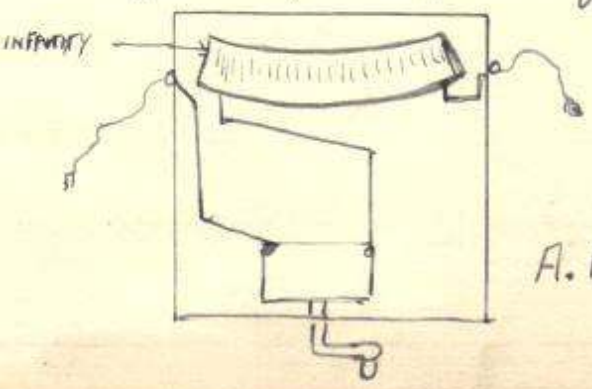
Each insulated side of switch (to test switch) & so on until fault is located.

Faulty parts to be replaced.

B Insulation Test with Megger one terminal of megger Connected to earth & the other to insulated terminal in C.B cover.

When handle is turned at 160 (RPM) instrument should read infinity any lower reading indicates a fault.

Disconect lead from switch, & test lead & switch seperately. Replace faulty parts.



A. MEGGER

Lubrication of Magnetos

all magnetos need lubricating at the following points

1. The two mainshaft bearings.
2. The distributor gear wheel ball bearing.
3. Cam or felt heel.
4. The Rocker arm fulcrum pin (on BTH only)
5. The C.B spigot (variable ignition types only)

On the latest types of magnetos the bearings are packed with sufficent grease during assembly to last the interval between overhaul.

The cam lubricating pad & the fulcrum pin wick are impregnated with grease & changed at overhauls.

This provision is made for additional lubrication.

On early types the lubricant used is oil. (Winter Grade 3 LA/33)

wells under flaps on top of magneto have small pipes leading to the bearings & oil is dropped into these wells by hand.

The amount of oil used is.

6 Drops in each well

1 " on cam lubricating pad.

1 " on felt wick inside fulcrum pin

This is carried out when the magneto is first installed on the engine. Before starting an engine which has not been run for 2 weeks or more at intervals laid down in the maintenance Shecule for aircraft (usualy 30 hrs)

On all types. if ignition timing is varied by moving the C.B in its housing. The C.B base is removed & the spigot & housing cleaned & lightly smeared with H.M.P greast before replacing :- (30 hrs inspection)

Changing Magneto.

1. Remove U/S magneto from engine and take of all fitting, ect not part of magneto The coupling must be remove by use of the correct extractor.
2. Check type & direction of rotation of new mag against old one.
3. Inspect for superficial damage.
4. Check for sparking
5. Lap in coupling with crocus powder & oil.
6. Check fit of woodruff key & see that it has top clearance.
7. Fit coupling to shaft, fit control levers ect
8. Check C.B. gaps & carry out lubrication.
9. Time & fit magneto to engine according to correct procedure for engine.

Screening.

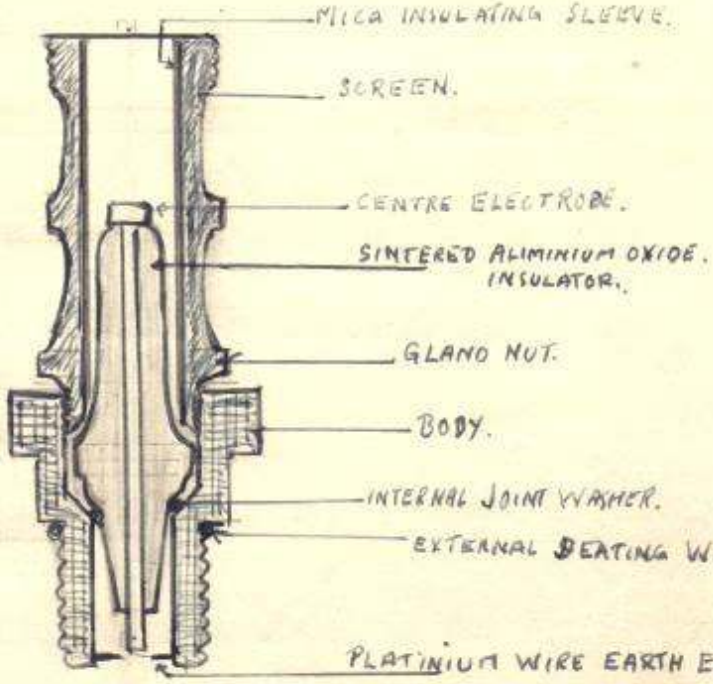
In order to prevent the ignition System from causing interference with the aircraft radio receivers. The whole of the ignition system is surrounded by earthed metal conductors this is called screening:-

Bonding

All metal parts of an aircraft are connected together by good electrical conductors to prevent "Static" Charges of electricity from causing Sparking between Various parts of an aircraft this is bonding.

Testing High Tension Leads & Lamess

1. Remove distributor covers & disconect all plug Connectors.
2. Test all H.T. leads for continuity by connecting one lead of continuity tester to each distributor terminal and other lead to the appropiate plug connectors in turn lamp should light brightly in every test.
3. Test each lead for insulation by connecting one terminal of the Megger to earth (screening) & the other to each distributor terminal in turn. When handle is turned 160 R.P.M. the instrument should read infinity in every case.



SPARKING PLUG.

Sparking Plug Dismantling Tools.

2 Sand blast type sparking plug cleaner.
3 Insulator testing device.
4 Constant torque fixture.
5 Gas leak tester. use lead free petrol.
6 Gap setting tools (various type) set to .012 to .015"
7 Gap gauge.
8 Sparking plug tester.

Maintenance of Sparking plugs.

Sparking plugs are given 2 types of inspection 30 hrs + 60 hrs after. 180 hrs ~~use~~ they are to be returned to a maintenance unit as time expired.

two complete sets of plugs are provided for each engine, one in use, and the other kept in special storage box in flight stores ready to be fitted to the engine whenever necessary

30 hr inspection.

1 Remove plugs from engine useing correct tools.
2 examine mica insulation inside screen and reject plug if it is flaked or damaged. if in good condition clean mica with a camel hair brush moistened in lead free petrol and dry thoroughly.
3 check tightness of gland in constant torque useing the correct weight.
4 Test for gas tightness in gas leak tester at a pressure of 150 lbs/□"
5 check gaps and adjust if necessary to .012-.015" using the correct gap setting tools.
6 Dry plug for sparking in the plug tester at a pressure of 100 lbs/□"
7 mark with electric etcher to indicate inspection.
8 Fit a good external sealing washer fit dust cap place in storage box. before fitting plug to engine smear threads with a little graphite.

60 hrs inspection.

1 & 2 as in 30 hr inspection
3 dismantle the plugs with the plug dismantling tools
4 Wash all parts in lead free petrol & dry thoroughly.
5 Clean insulator in sand blast cleaner using cleaner adaptor
6 clean inside + mouth of plug body in sand blast cleaner useing correct adaptor + protecting sleeve of threads

60 hr inspection continued

7. Remove all traces of sand from all parts of the plug.
8. Test insulator on insulator testing service.
9. Reassemble plug, fitting a good internall Joint washer tighten in constant torque fixture useing the correct weight.

Continue as in para- 4.5.6.7.8. in 30 hr inspection

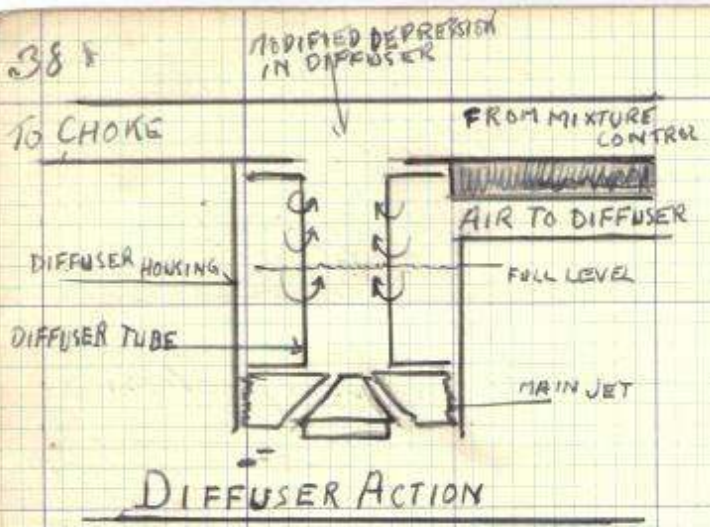
Carburation

1. Carburettors may be briefly described as a device for supplying the engine with the correct mixture of Petrol & air at all Speeds & conditions.
2. The Simple carburettor is based on the U Tube principal one leg of the U is the float chamber and the other is in the air intake. As the rate of air flow increases so the pressure in the air intake falls. A restriction is formed in the air intake which increases the air speed and further decreases the pressure. As there is always atmospheric pressure in the float chamber, the difference of pressure in the leg of the U tube will cause petrol to flow from the float chamber, to the air intake and mix with the air Stream.
3. The Petrol in the float chamber is kept constant by means of a float and a needle and valve & Toddle mechanicism. The needle valve making a petrol tight Joint. As the petrol level falls so the needle valve opens sufficently to maintain the level.

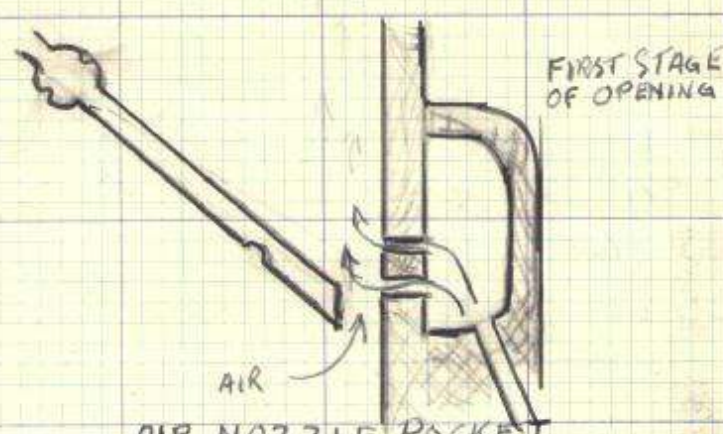
The disadvantages of the Simple Carburettor

To obtain the maximum efficiencii from a I.C.E a mixture of strength must be maintained throughout at all engine speeds. With the simple carburettor this is not possible for the laws which goveren the flow of fuel from the Jet and the air flow through a choke are different one being a liquice and the other a gas. As the air flows through the tube so does the flow of fuel from the Jet but a considerable greater rate and so with engine speed the mixture would become progressivly richer.

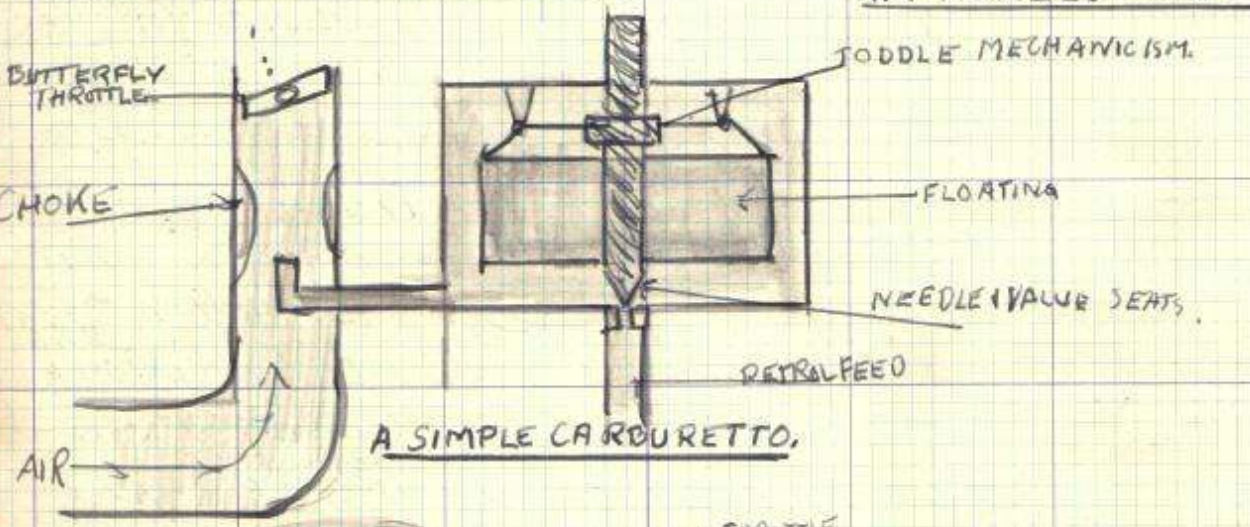
38



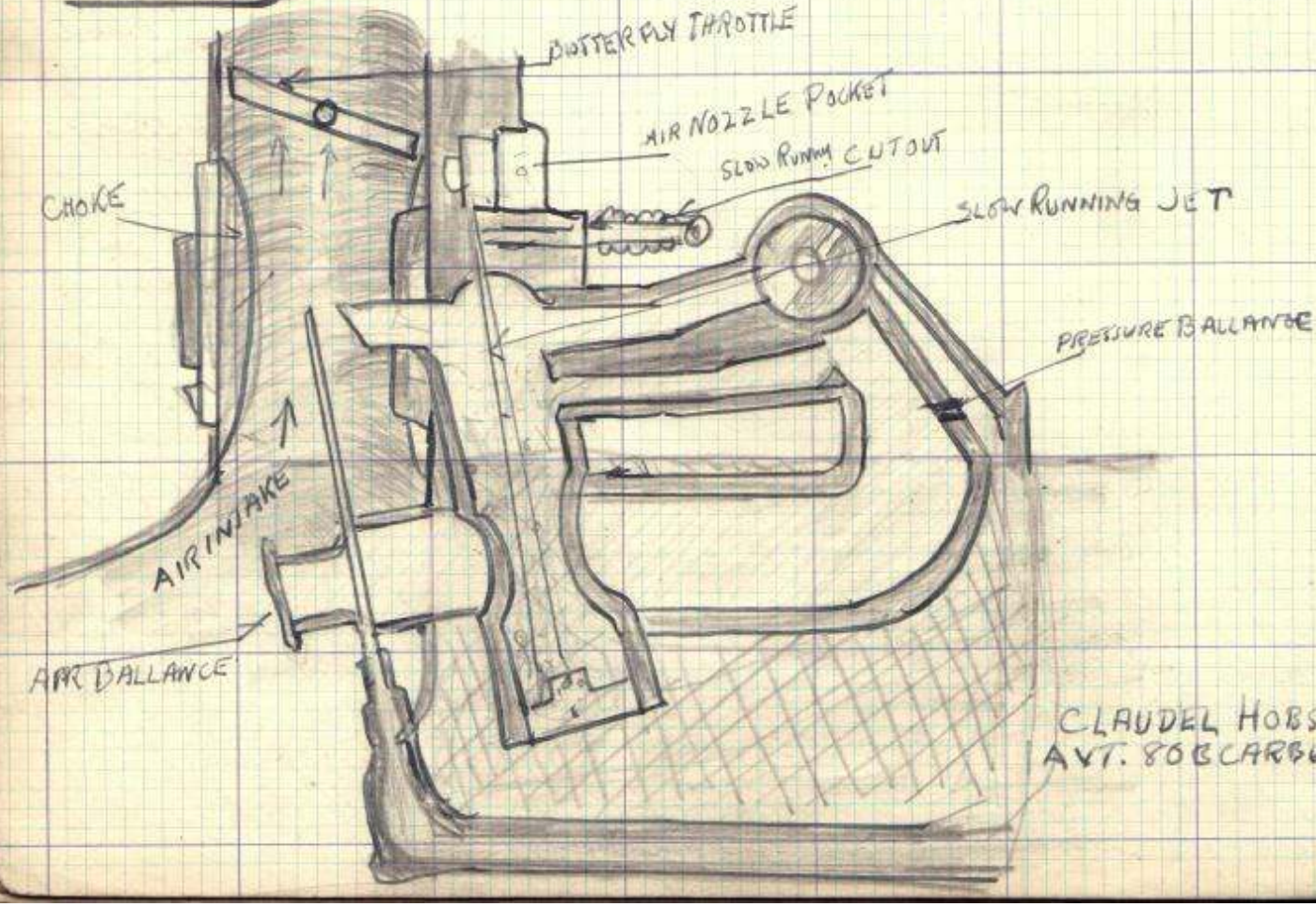
DIFFUSER ACTION



AIR NOZZLE POCKET.



A SIMPLE CARBURETTO.



CLAUDEL HOBSON
AVT. 80 CARBURETTO

Diffusers.

Gives economical mixture for cruising speed.

The diffuser overcomes the mixture difficulty by.

1 ensures correct proportions of petrol and air (15 to 1 by W) for all engine speeds & Varying loads except slow running.

2 Commences adomisation of petrol before it reaches the main air Stream.

3 Provides a slight reserve of fuel for acceleration.

Floats.

1 metal containers Consist of a small chamber made from very thin sheet brass. The chambers are airtight & depends for their bouancy on the impressed air.

2 Cork floats are built of close grained cork laminated & Riveted to a lever & treated with a special fuel resisting Dope to prevent ingress of fuel. When the float would become heavy and the mixture Richer.

Pressure ballance.

This provides for equality of presure between the float Chamber and air intake condition.

Jets.

These may be of a fixed or variable type with the former, the petrol is governed by the size of jet. The latter type provides a method of adjusting the flow. before a fixed sight jet is fitted to a carburettor it must be inserted in a Jet calebrator and the petrol flow checked. The flow will be measured in Cubic Centimeters per minute.

The Acceleration Pump.

The action of opening the throttle causes the plunger to be depressed and a quantity of extra petrol is delivered by suitable ducts (Post delivery Tube) to the Vicinity of the choke, Thus compensating for the inertia of the fuel.

Delayed action pump. This is coupled to the main plunger of the pump by a shaft & held apart by Spring pressure. This ensures that the supply of extra petrol dose not cease abruptly when the throttle lever ceases to move.

Power Jet Valve. On high powered aero engines the diffuser only supplies sufficient petrol for economical cruising. When full power is required a additional Jet known as the power Jet is brought into operation by the remaining forward movement of the Throttle lever. A cam operated Valve connected by linkwork to the throttle controlling shaft uncovers the power Jet orfice in the float chamber and so allows extra petrol to be delivered at the choke. Similar condition may be brought about by increasing the normal supply of petrol from the main Jet when this is of the variable type. (starts in operation 40° to 42° before full open throttle)

Mixture Control. as the altitude increases the density of air decreases and within heights reached by aircraft this decrease in density has a marked affect on the carburettor. although the weight of a given Volume of air passing up the air intake decreases the weight of petrol remains the same and the mixture thus becomes proportionally richer. To compensate for this a hand operated mixture control is fitted which permits the pilot to cut down the supply of petrol without affecting the Volume of petrol supplied. The mixture is thus brought back to its correct proportion. On the mixture control lever is a stop which prevents it being left open at closed throttle position. Following methods of mixture control are employed.

1 Air Bleed. air from the pressure ballance system is diverted to the depression existing over the diffuser. The depression is thus relieved and fuel supply is cut down.

2) Vacum Type. further openings of the cock brings the float chamber into communication with the depression existing in the choke thereby causing a reduction in pressure in the chamber.

3 Variable Jet. consist of some type of Variable Jet which controls the amount of fuel passing to the diffuser.

Supercharging. The increase of altitude due to rarefied atmosphere the power output of an aero engine decreases in direct proportion to the decrease in atmospheric pressure. To overcome this loss of power, a high speed centrifugal blower, gear driven from the crankshaft, is fitted between the carburettor & induction system.

By means of the blower and discriminate use of the throttle, the desired induction pressure may be obtained up to greater altitudes after which the power output will fall off as in a normal aspirated engine. The pressure in the induction system is indicated on the boost gauge which is graduated in lbs □". The pressure registered is known as boost pressure and may be above or or below atmospheric pressure. Standard atmospheric pressure is indicated by 0 ton".

Types of Boost Pressure control.

With a supercharged engine designed to sustain a given pressure up to 10000 ft if the throttle is opened fully at ground level the combustion pressure will rise far above normal with disastrous results. It is therefore necessary to employ some form of boost control of which there are two at present in use.

1 Gated throttle. The early type when the throttle is moved in a gated quadrant which is set to get the correct boost pressure at ground level as altitude is gained the throttle must be opened progressively so that the required boost pressure may be maintained. The correct manipulation rest entirely with the Pilot and for military aircraft where rapid changes of altitude take place this is not entirely satisfactory.

2 Automatic Boost control. The later type of boost control is wholly automatic and so relieves the pilot from the responsibility of maintaining the boost pressure within the prescribe limits. The control limits the maximum opening in the induction System the desired pressure is not excided the control itself consist of an air tight chamber so that any alteration in pressure will affect the length of the aneroid in the chamber,

The aneroid is connected to a pistol Valve which admits oil from the oil pressure system of the engine to one side or the other of the Servo piston. This servo piston operates the linkage interposed between the throttle & pilots throttle lever.

Enrichment Device. This is fitted to enrich the mixture when the override is in use to prevent detonation which would otherwise occur. The extra flow of petrol is supplied slightly in advance for the boost override thus the extra petrol reaches the induction System before the boost pressure increases thereby preventing momentary detonation.

Rated Boost. is the maximum boost pressure which can be maintained at a RATED altitude.

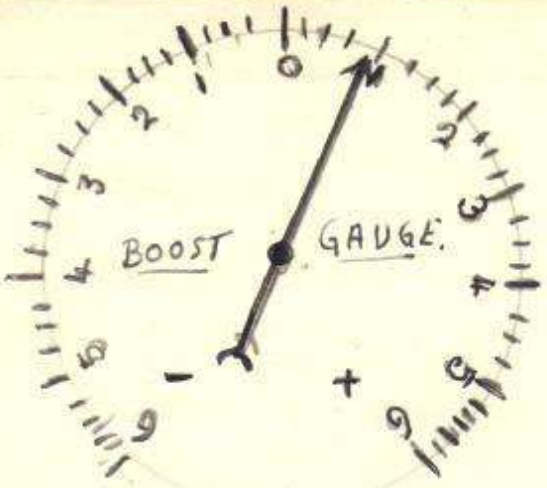
Rated altitude This is the lowest altitude at which full throttle is possible, and the highest altitude at which a maximum boost pressure for level flight condition can be maintained in the induction System.

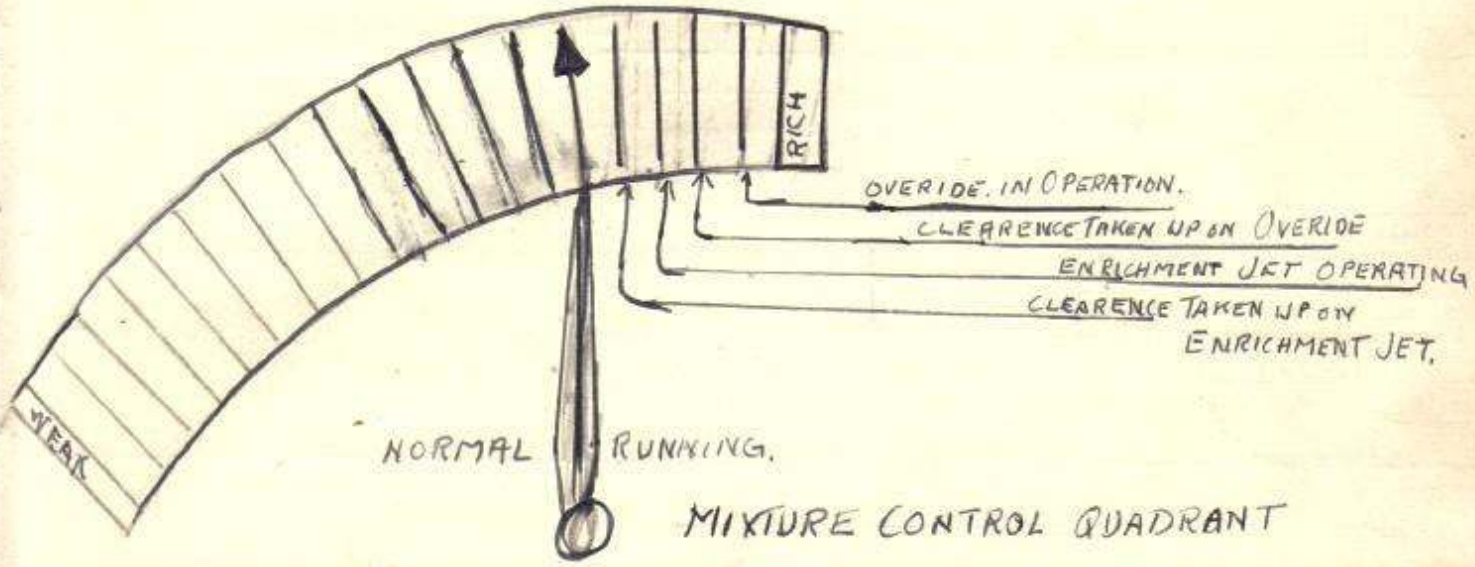
Detonation This is spontaneous combustion of some portion of the charge in such a manner that a extremely sudden & high pressure wave is generated within the Cylinder.

Cautions for dismantling & cleaning.

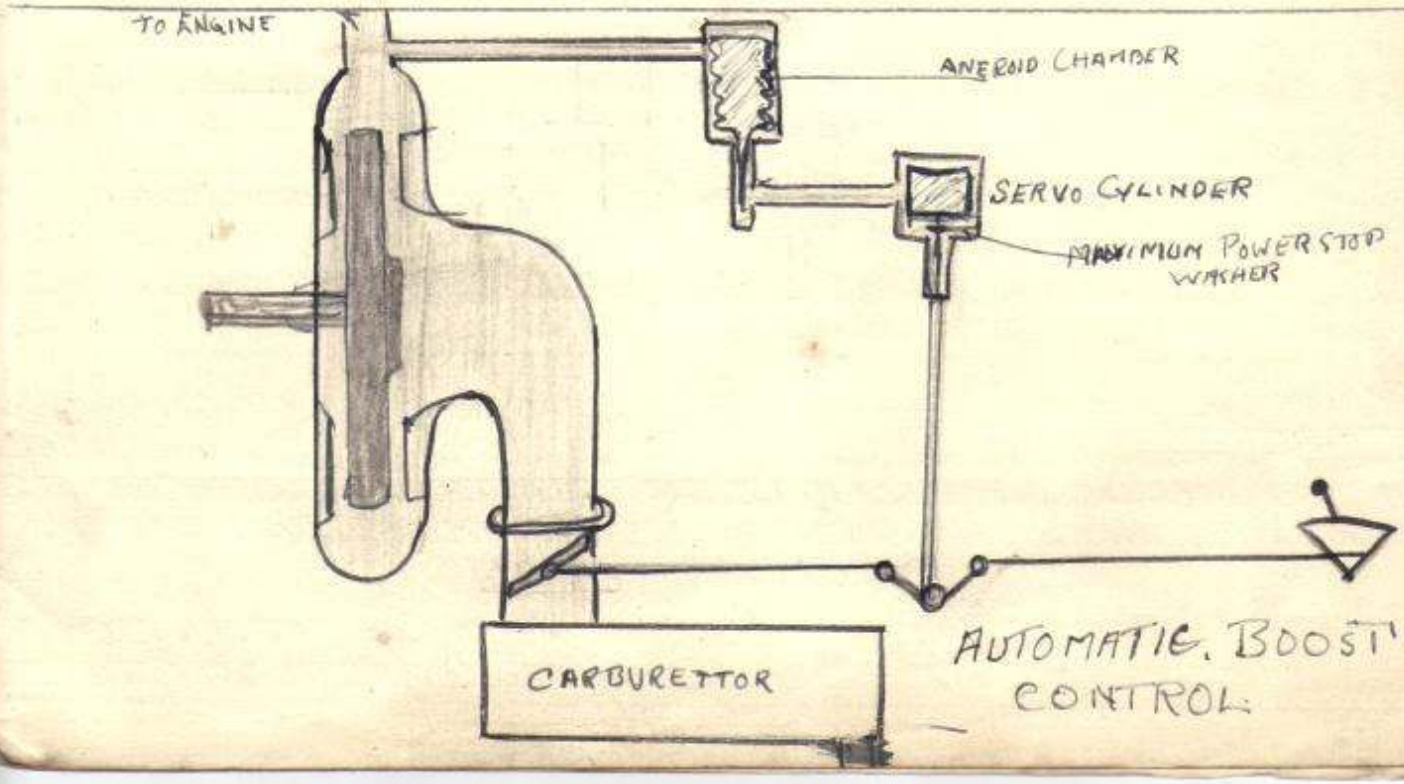
Before dismantling & cleaning a carburettor adhere strictly to the rules laid down in the appropriate hand book making external examination before cleaning as frequently cracks bruises ect will be visible owing to the presence of dust & dirt. Close attention must be paid to warnings laid down for marking components with assembly markings for erection:- So that jacking Settings are not lost. First clean all parts with paraffin & then petrol never use Rag or waste.

Cleaning Jets. use appropriate Jet spanners at all times when removing or replacing Jets. Carefully examine threads of the Jet body before refitting, do not use force but proceed much in the same way as in tapping. Jet orifices should be cleaned by AIR PRESSURE only. Where necessary ensure replacement of fibre washer under Jet heads and if possible test for petrol leaks past heads. Use only the correct gauge of copper wire for locking Jets. make certain that all parts are reassembled in their respective positions (PORT & STARBOARD)





MIXTURE CONTROL QUADRANT



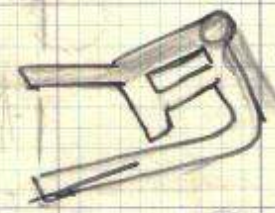
AUTOMATIC. BOOST CONTROL.

CARBURETTOS DEFECTS + PROBABLE CAUSES	FAIL TO START	STALLS	OIL PRESS HIGH	OIL PRESS LOW	BOOST PRESS HIGH	BOOST PRESS LOW	ROUGH RUNNING	LOW POWER	M. MISS	PINKING	BLACK EX	PRE IGNITION	OVER HEAT	NOISES	
TANKS EMPTY															NO SUPPLY TO CARBURETTOR
TANK VENTS MADE UP															
COCK IN OFF POSITION	•	•													
LEAKS IN CIRCULATING SYSTEM															
DEFECTIVE FUEL PUMP															
" " DRIVE															
FOREIGN MATTER IN FUEL															INTERMITTENT SUPPLY
FLOAT NEEDLE STUCK		•						•		•			•		
DEFECTIVE PIPE JOINTS.															
PIPEING SYSTEM OR FILTERS DIRTY															
ALT CONTROL OPEN		•					•	•		•		•	•	•	INSUFFICIENT SUPPLY
FUEL PRES NOT SUFFICENT															
LEAKS IN SYSTEM															
CARBURETTOS TURNED TO WEAK															
TO RICH															
EXESIVE PRESS			•				•	•			•				
UNSUITABLE FUEL															
WATER & DIRT IN FUEL															
FAULTY OR BROKEN PRESURE PIPES.															
CONTROL INCORECTLY ADJUSTED															
EXESIVE PRIMARY															
AIR INTAKE OBSTRUCTION															

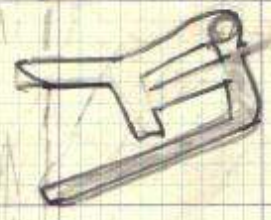
AIR BALLANCE

DIFFUSER ACTION

BLEEDING



VACUM



BALLANCE PRESSURE.

Pegasus engine

For all fits and clearance see part 2 sheddule 2.

Dismanling (all radial engines) remove master Rod cylinder last and dysmantle clockways. ballance always rebuild with master Rod in possition first.
always have pistons at T.D.C. when dismanling cylinder.

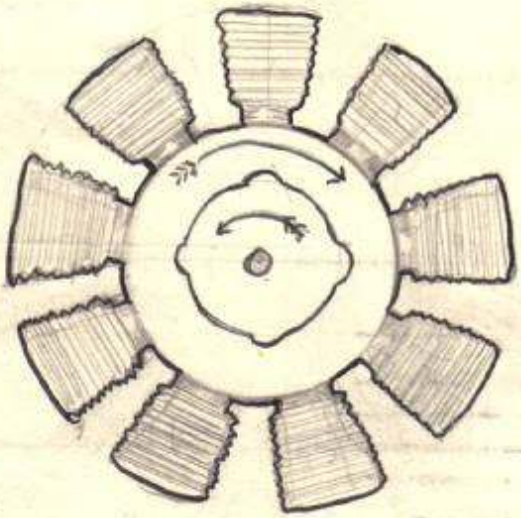
½ pt of oil placed in cylinder through plug hole will keep cylinder from corrosion Rust ect.

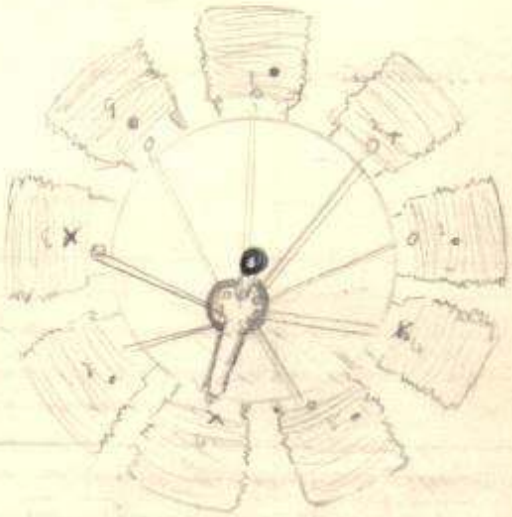
Dismantling sequence of a Pegasus. Remove Magneto distributor cover up:- Magnetos place in proper compartment:- gas Starter pipes. Remove A.B.C:- inertia Starter claw:- cross drive shaft:- oil pump. remove nuts of rear cover and withdraw rear cover.

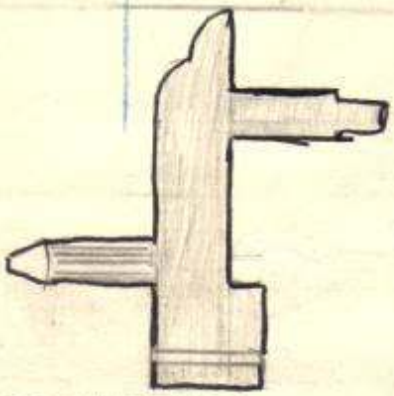
Reduction gear cover Remove nuts & withdraw cover. of Reduction gear unit. Remove Rocker Box covers withdraw Ticrod Bolt. remove push rod cases Slacken off the lower induction pipe joints.

Remove the 8 locating nuts on cylinder turn piston to T.D.C. and remove cylinder. Master spleen always point T.D.C.

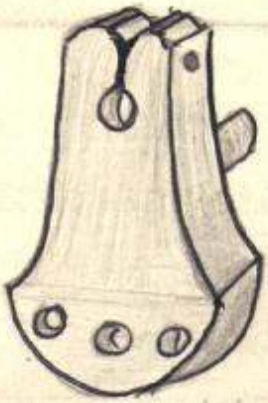
The cam rotates at half engine speed. and there are four cams on the cam wheel to get the correct: noumber of cams wanted for all Radial engines noumber of cylinders plus one if cam Rotates same as engine or minor one if cam Rotates opposite way. $\frac{NC+n-1}{2}$ divided by 2.







CRANKSHAFT

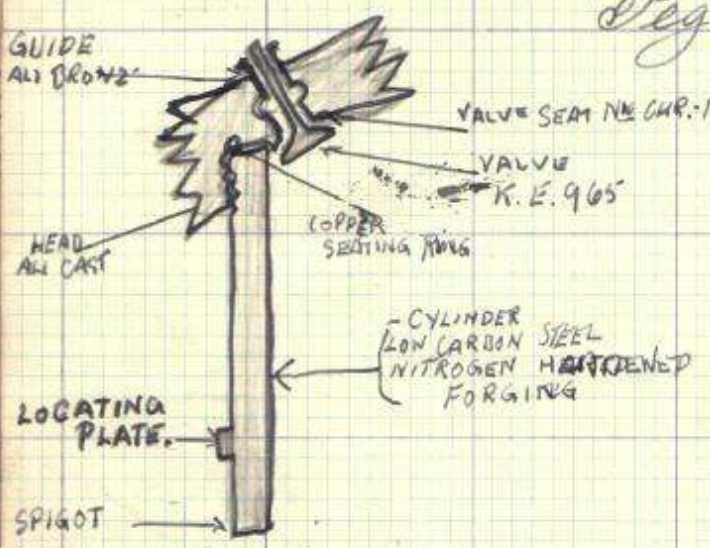


MANITON WEB

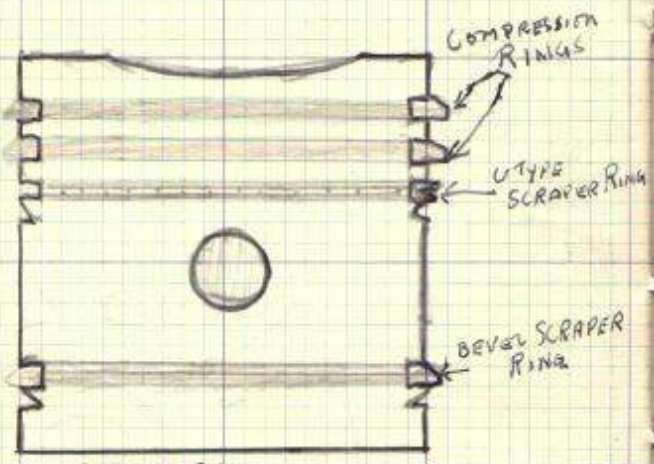
MASTER ROD

ARTICULATING ROD

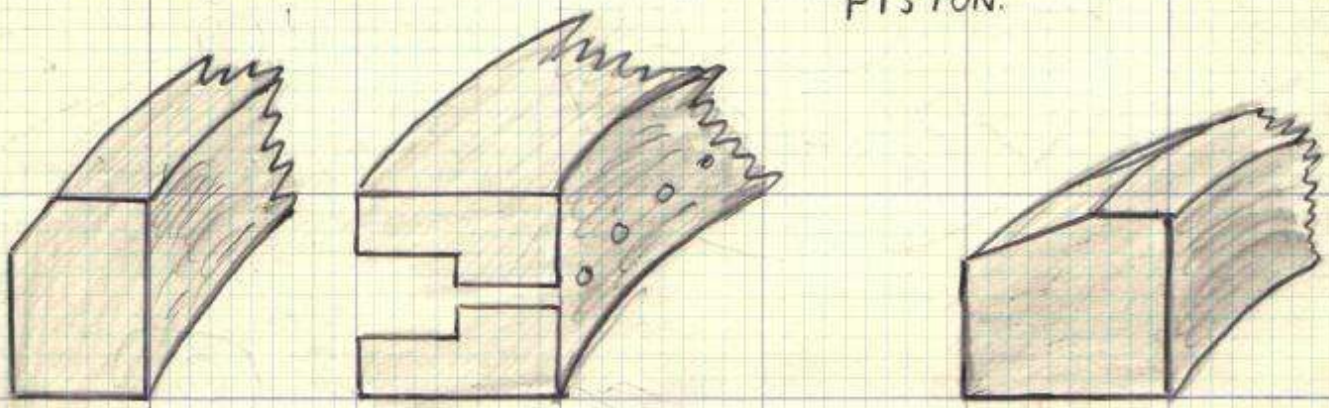
Pegasus Cylinders.



CYLINDER.



PISTON.



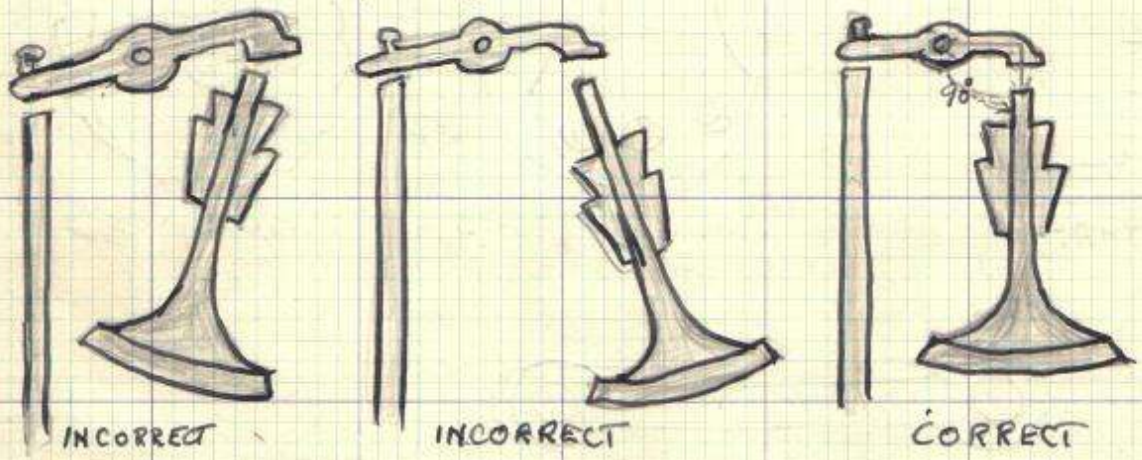
COMPRESSION

U. TYPE, SCRAPER.

BEVEL SCRAPER

SECTION OF PISTON RINGS.

ANGLE OF ATTACK



INCORRECT

INCORRECT

CORRECT

Cylinders made of Low C Steel Nitrogen harden forging (dropped).
The head of Cylinder made of Y alloy.
To test for cracks in Cylinder use a Magnaflux Tester.
There are four Valves two inducter, and two exhaust
under the exhaust port are plugs for thermal coupling for Temp

Plug adaptors. are let in the Cylinder head by heat & cold
the head is heated to about 300°c and the
plug frozen to (60°c -) screwed together so giving
a air light holder to screw plugs (ignition) in
they are also peaned & locked by a screw and are
made of ali Bronze.

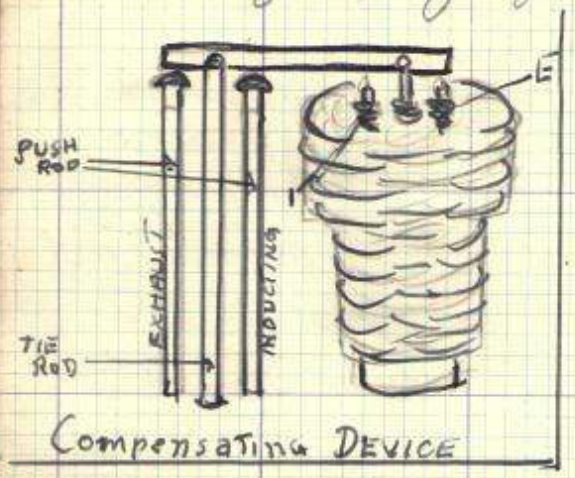
Valves Made of K.E. 965. exhaust Valve 91° overall 90° for Seat
inlet " 90° " 90° "

Piston Drop forging of Y alloy to test for cracks
use hot oil & French chalk, always weigh
Piston for weight before fixing and fix with
numbers facing air screw

Gudgeon Pin Made of air hardened Steel and fit
fully floating always fit new circlips & Plates.

Piston Rings. On Pegasus are four two compression with
a angle of 1° fitted in top two Chanels
a ll scrapers on the next and a Bevel Scrape
on the bottom.
To fix rings, first test size of Cylinder
bore for wear using a Maier gauge if in
order by checking with Part 2 Schedule 2 dry
ring in grove resting on the full circle 360°
and using the correct gauge if to large
rub down on sheets of glass with Crocus powder
until the fit with correct clearance.
Next place in Cylinder by pulling in Side
ways and push on with Piston for it to
be level then check for clearance on ends

Piston always filled with Bevel to the top.



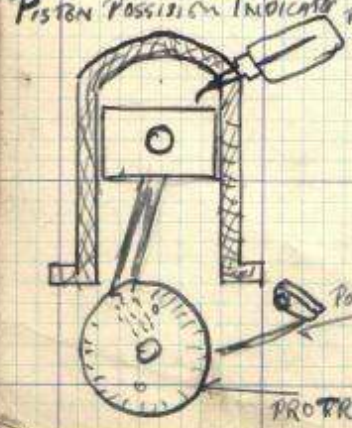
Compensating Device

Angle of Attack to get the correct angle for tappets first set tappets for clearance then get a instrument for finding the datum line then fix across top of Rockes box. the gage makes the correct datum line by lighting both Rods

Compensating device. by heat and expansion without this device all the Valve timing would become ineffective with employ this device it keeps them at correct timing at all temperatures of engine.

Finding Highest Dwell:- when number 2 cylinders is on compression set tappets to a clearance by gauge feeler of (say .004) then rotate the engine two turns of crankshaft this will move the next dwell to number two check this for clearance doing the same until all fours are checked. then set the highest dwell on number two cylinder and work back to no 1 by rotating the engine crank two revolutions. and so on until all nine have been set.

Oil Filter examination. In the Pegasus there are two filters. one in the sump for Scavenge oil the other in the rear case this is the main Pressure filter. Fillers are made lantern shaped.
to remove fillers first remove spring unscrew filler and with draw filler wash in L.T. petrol first then clean paraffin drying by air blast. If sediment is found in oil test in the following manner
Alu or Dura. 3% Caustic Solution Alu will be white Dura Black
Ferrous Metals Test for by magnet.
White Metals. Put on Hot plate and melts.
Magnesium Flame Test.
Other ferrous Colour Test by magnifying glass. & Vision



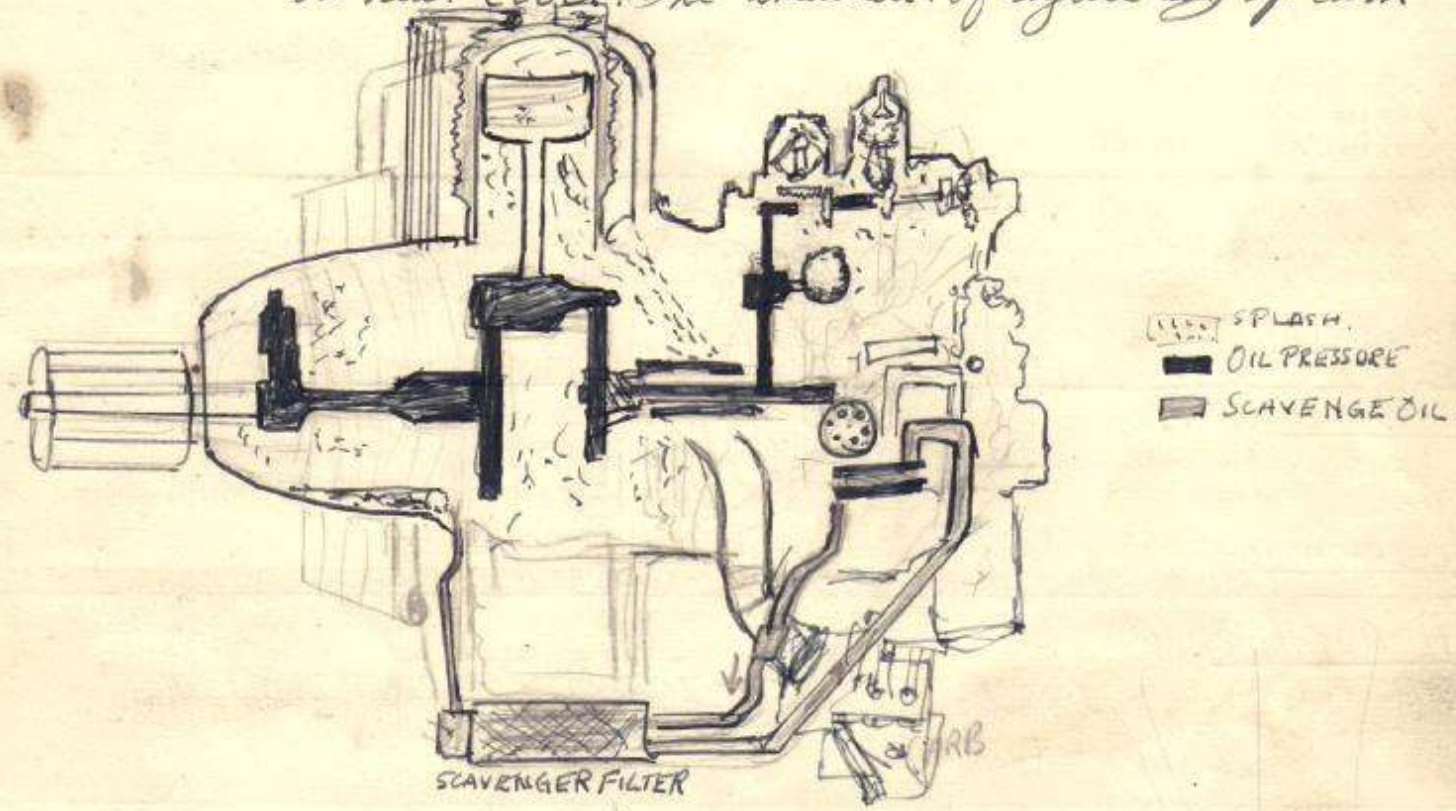
To find T.D.C insert P.P.I into plug hole fix protractor on crankshaft and pointer on frame pointing to the protractor rotate engine and as soon as P.P.I moves put (chalk) pencil or thin mark on protractor face keep on Rotating engine until the P.P.I. shows by going back to mark that piston is on down stroke mark protractor Head. Divide the difference between the two marks and then you have T.D.C. move marking to D° then timing may be 30° before T.D.C can be done.

Timing Magnetos

1. Find T.D.C of No 6 cylinder (with P.P.I & Rotascope.)
2. Turn engine BACK. 30° to 40° before T.D.C.
3. Set Mag Rotor to serve No. 6 segment.
4. Check contact breaker points & set at .012.
5. Insulate Primary circuit.
6. With special Clip, fully advance Ignition (AUTO)
7. If timing is out alter with Vernier adjustment on front of Automatic Advance & Retard unit.

Lubricating.

Dry Sump. Pressure fed to big ends of Master Rod & Wrist pins. cam sleeve Bush auscrew Shaft. tail bearings. The plain bearings of the auxiliary drives in Rear cover. The remainder of engine ~~by~~ Splash



IN-LINE KESTREL ENGINE.

TYPE - - - Geared water cooled V engine normally aspirated
NO CYLINDERS. Twelve
ARRANGEMENT OF CYL Two lines of 6 cylinders at an angle of 60°
BORE & STROKE 5" x 5½"

COMPRESSION RATIO 7 - 1
REDUCTION GEAR: Spur Cay shaft. Single reduction. RATIO .632 to 1
DIRECTION OF ROTATION. Airscrew R.H. Crankshaft L.H.
WIEGHT Engine (dry) 900 LBS Airscrew hub. 21 lb
CYLINDERS No. A1-2-3-4-5-6. B1-2-3-4-5-6

LIMITED OPERATIONAL CONDITIONS.

MAX TAKE OFF	480 B HP at 2,250 R.P.M. at sea level throttle at gate.
MIN " "	2050 RPM THROTTLE at gate
MAX CLIMBING.	2250 RPM throttle at gate up to 3000 ft full throttle for continued climb.
MAX ALL OUT FLIGHT LEVEL 5 MIN LIMITATION	2700 R P M. throttle at gate up to 3000 ft full throttle for altitudes above 3000 ft
MAX CONTINUAL CRUISING	480 B.H.P. at 2.250 RPM at sea level
MIXTURE STRENGTH FOR CONTINUAL CRUISING	equivalant to 3% drop in engine R.P.M. at altitudes over 3000 ft.
ECONOMICAL CRUISING	480 BHP at 2250 R.P.M at sea level
MIXTURE STRENGTH FOR ECONOMICAL CRUISING	equivalant to 3% drop in engine RPM at altitudes above 3000 ft.
MOMENTARY MAXIMUM SPEED FOR T.V. DIVE	3375 R.P.M.

CONSUMPTION.

OIL	pints per hour 4-10
FUEL	pints per B.H.P/HR .51

LUBRICATION

OIL SPECIFIED mineral specification D.T.D. 109 (Summer grade)

OIL PRESSURE

HIGH PRESSURE NORMAL	50 - 70 LB □"
" MIN FOR 5 MINUTS EMERGANCY	30 □"
LOW PRESSURE	4 - 10 LB □"

TEMPERATURES (°C)

IN LET (BEFORE FLIGHT) MIN	25°C
MAX	80°C note Temperature may be allowed to rise to 90°C if pressure does not fall below 40 LB □".
OUTLET MAXIMUM.	105
GREASE FOR WATER PUMP GLAND	STORES REF 34A/54.

IGNITION

NO OF SPARKING PLUGS PER CYLINDER 2.
TYPE LODGE A2 OR KLG V1 see also AP1260.
GAP .012-.016" see also AP1464A VI Part 3 Sect 1 chapter I

IGNITION. CONTINUED.

MAGNETOS

2

TYPE	B.T.H. S.C. 12/7C
PORT MAG OPERATES	EXHAUST PLUGS
STARBOARD. MAG. OPERATES	INLET PLUGS
CONTROL	INTERCONNECTED WITH THROTTLE
TIMING (FULL ADVANCE)	PORT 38° BEFORE T.D.C STARBOARD 36° BEFORE T.D.C.
CONTACT BREAKER GAPS.	SEE A.P. 1374 Section V Chap 1
FIRING ORDER	1A. 6B. 4A. 3B, 2A. 5B. 6A. 1B. 3A. 4B, 5A, 2B.

TAPPET CLEARANCE

FOR TIMING	.030 INLET	.030 EXHAUST
FOR RUNNING (COLD)	.020 "	.020 "

VALVE TIMING

Inlet opens 12° before T.D.C
Inlet closes 40° after B.D.C.
Exhaust opens 50° before B.D.C
Exhaust closes 2° after T.D.C.

INTRODUCTION

1 The Kestrel I.B. aero engine is of the 12 Cylinder V type and is, a geared, normally aspirated + water (liquid) cooled.

2 The cylinders which are in two blocks are mounted on top of the Crankcase at a angle of 60°.
The Crankcase houses the one piece six throw crank shaft. Each of the crank pins carries one forked & one plain connecting Rods.
Bolted to the front of Crankcase is the reduction gear Case, and mounted at the rear end of Crankcase is the Wheel case which houses the components transmitting the drive from the rear end of Crankshaft to the accessories and provides mountings for the lower cam shaft drive units, Magnetos, Water pumps, The idler gear which drives the oil pumps, Gun gear, fuel pump. The control pedestal, and in some engines the generator drive unit.
a Hand turning gear is also fitted in wheel case.
Driven from rear end of the B side Cam shaft is the engine speed indicator, While in some engines a gas distributor is driven from the rear end of A side Cam Shaft.

3 Carburation is provided by two water jacketed carburettors which with the induction manifold priming pipes & air intake form a unit that is secured to the inwardly facing inlet port of the two cylinder Blocks.

4 Lubrication of the engine is on the dry sump principal and two scavenge oil pumps & one pressure pump are employed These three pumps, with their respective Relief valves form a unit which is attached to the bottom & rear end of Crankcase.

CYLINDER ASSEMBLY.

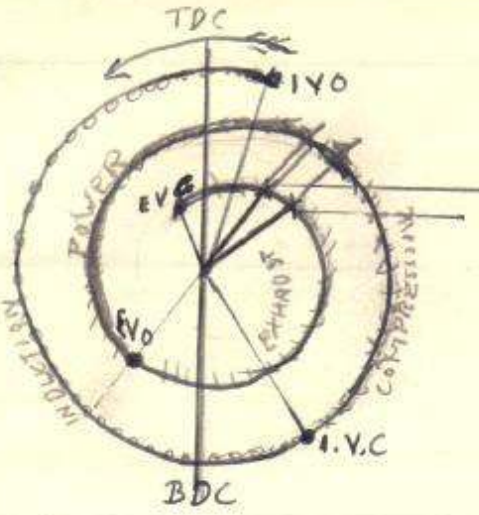
The starboard & port cylinder blocks are designated the "A" & "B" blocks respectively.
Each cylinder block is a single aluminium monoblock casting, comprising the head & Coolant Jacket.
"6" wet" steel cylinder liners are fitted heavily nickel plated outside, to protect from corrosion & provided with three concentric stiffening ribs the heads of cylinder are flat. a ali alloy. Joint ring is fitted to the top of cylinder and a spring loaded rubber jointing at the lower end 14 long studs hold the cylinder blocks to the crank case and all but the 4 end studs are enclosed in ali Duralumin tubes, to protect them from the coolant & form oil return ways from the Camshaft & convey oil mist upwards.

2 Inlet, 2 exhaust Valves, 2 sparking plugs & 1 gas Starter Valve are fitted to each cylinder,
2 springs are fitted to each Valve Ali Bronze Valve seats are fitted to inlet Valves & NCM (Nickle Chrome manganese) Valve seats for new type of Sodium Cooled exhaust Valve,
all screwed & shrunk in, Cast Iron for Inlet Valves Guides & Phosphor Bronze for new type of Exhaust V
Sparking plug adaptors are ali bronze screwed and pinned by three pins (NOT SHRUNK)
Valves are Trumpet type not interchangable later type of exhaust Valves are Stellite faced and have hollow stems are partly filled with Sodium Exhaust Valve have a angle of (COLD 44½°) Inlet Valve 45°, all Valve faces are 45°.

13	7	5	2	4	10	12	
11	9	3	1	6	8	14	

11	9	3	1	6	8	12	
13	7	5	2	4	10	14	

CYLINDER. NUT TIGHTENING SEQUENCE



	OPENS	CLOSE
INLET VALVE	12° B TDC	40° A BDC
EXHAUST VALVE	50° B BDC	2° A TDC

STARBOARD 36° } MAGNETO
PORT 38° } TIMING

KESTREL VALVE TIMING

Dismantling Engine

1 Reduction gear. 2 Supercharger Unit & carburetto.
3 Spring drive unit & compound gear wheels.
4 Coolant outlet pipes. 5 Priming pipes.
6 Ignition cables. 7 Magnetos. 8 Induction Manifolds & Trunk. 9, Cylinder Block covers & camshafts.
10 Cylinder Block & Pistons. 11 Lower half of Crankcase.
12. Wheel case. 13 Crankshaft & connecting Rods.

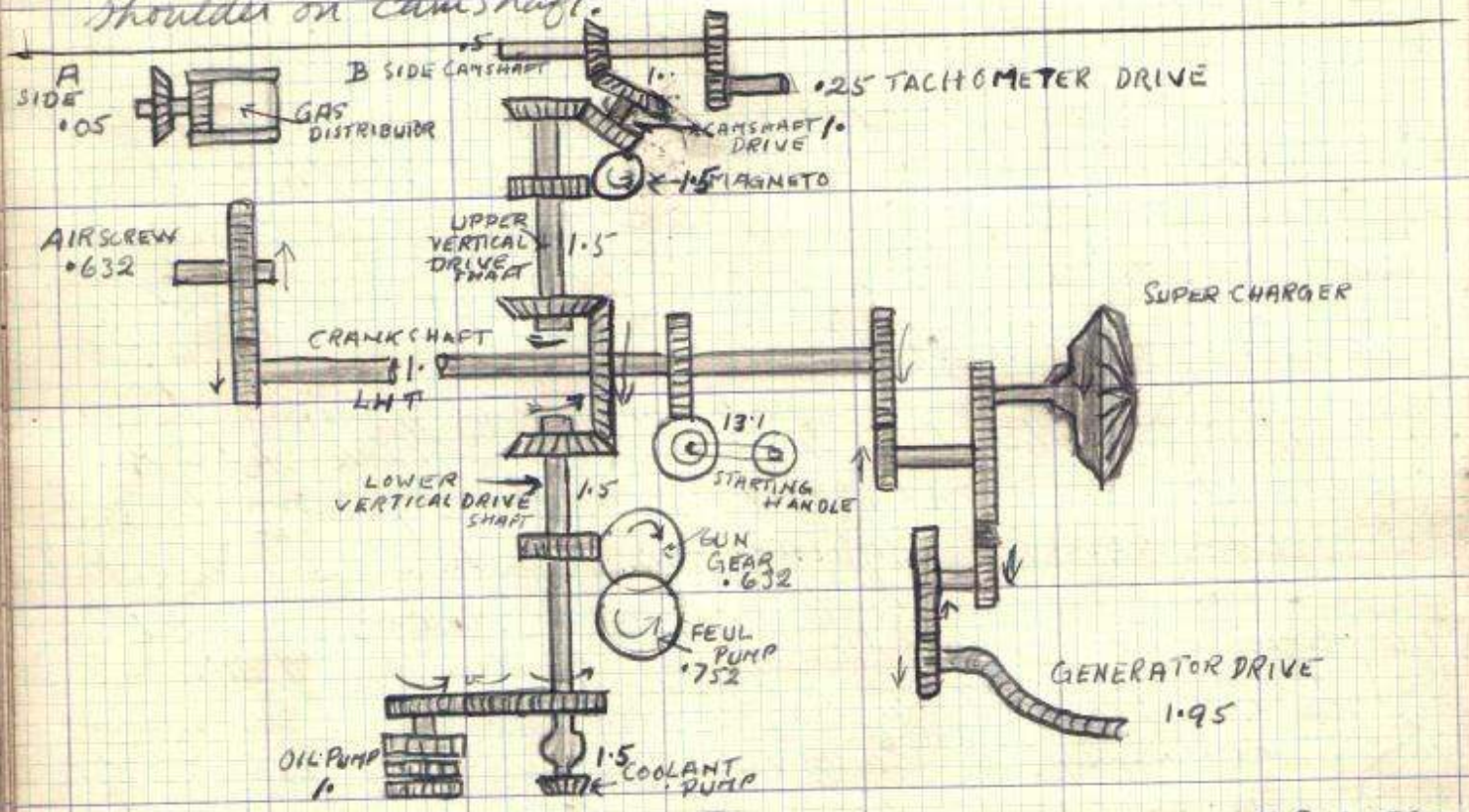
Removing Cylinder Block.

1. Remove all sparking plugs.
2 Turn engine stand so that Cylinder block to Be removed is vertical. 3. Remove nuts from retaining studs in correct sequence. 4 attach lifting bracket to studs of camshaft brackets No 4 & 5 so that lifting eye is nearer studs of No 4 bracket.
5, Take a Vertical lift & avoid tilting or this may cause damage to liners in their Sockets & so loosen head Joints. 6, Fit block when removed to Transportation base & tighten nuts in correct sequence.

Camshaft & Rocker Mechanism.

a single central camshaft is provided for each block, driven by bevel gearing, at ½ crankshaft speed in a clockwise direction. The inclined driving shafts are splined at each end for Valve timing

All alloy forged pedestal brackets support the camshafts centrally & a rocker shaft on each side.
Exhaust rockers are fitted with 2 bushes each & one fully floating bush carries 2 inlet rockers.
The hollow camshafts is made from a nickle steel forging machined all over & case hardened externally throughout except the tapered rear end & extreme front end.
Each end bracket carries a one piece flanged bush alm front & Phos Bronze at rear the 5 intermediate bushes are split & all.
'B' or Port side camshaft carries engine speed indicator.
'A' or starboard camshaft carries gas distributor drive (when fitted)
Location of Camshaft brackets longitudinal tenons & slots milled in top face of cylinder Location of camshaft bevel wheel & thrust race & P.B bush, packing washers, against shoulder on camshaft.



AUXILARY SHAFT SPEEDS - RELATIVE TO CRANKSHAFT RR. KESTREL

Spring Drive. is made of nickle steel and has a outside housing which allows a give of 80 to 100 thou and so does away with all torsional oscillations and prevent the breaking of gear teeth by acceleration & Deaccelerations has a gear damper on one end plate also a clutch drive for hand starter and Dural gears to prevent damage in case of a back fire during the use of hand starter if clutch sticks Dural gear strips

Changing a broken Valve Spring.

1. Remove Cylinder block cover.
2. Place piston of Cylinder concerned at T.D.C. to prevent Valve dropping into Cylinder, Hang a notice, 'engine must not be turned' in prominent position.
3. Mark engaging teeth of camshafts upper drive bevels on both banks with a indelible pencil.
4. Lift camshaft & rocker assembly from block being worked on.
5. Insert Valve holding tool in S.P. adaptor on exhaust side to hold Valve.
6. attach spring compressing tool to studs on inlet side.
7. Place spring compression cage over spring & remove split collar, washer & spring.
8. Fit new spring after testing & note spring seat walls they must not ride over washer.
9. Remove tools & check freedom of Valves & rockers.
10. Noting marked teeth in mesh indicates engine is in original position. ***
11. Set tappet clearance on base of cam .020 (cold) in sequence of firing order of block being worked on 1.4.2.6.3.5 & check compression.
12. Open split pins & renew joints if necessary and fit covers.

NOTE:- It is possible to have one bank half a cycle, "out of step" with the other bank; hence the marking of both camshafts at the same engine setting.

*** Replace camshafts with marked teeth engaging, do not open split pins.

Reduction Gear is of the single spur layshaft type and housed in ali alloy casing bolted to the front end of the crankcase, located by a spigot & 2 lugs bolted together by a transverse bolt, these lugs also take the torque of the airscrew. A hollow driving pinion is mounted in two roller bearings & driven from the crankshaft by a hollow splined coupling shaft & located by a journal type ball bearing. The airscrew shaft is carried on two roller bearings & a ball thrust race is provided, to take either a pusher or tractor airscrew. This shaft is located by the thrust bearing. Timing marks are engraved on each end of coupling shaft, pinion & crankshaft & splined flange & these must be in the same place right through when assembling. The gear is lubricated by low pressure to two oil jets and then by splash
Driving pinion has 24 teeth & A/screw shaft gear wheel 38 teeth giving a reduction of .632 to 1
Coupling shaft has 28 & 46 serrations

Pistons. Trunk type. full skirt. - forged ali alloy - machined all over, 3 compression rings above gudgeon pin, and one grooved oil scraper ring at bottom of skirt.
Type. Top ring is free to rotate but 2nd & 3rd are pinned 180° apart.
NOTE when fitting. pistons to engine always fit upper stop to exhaust side.

Gudgeon pin hollowed nickle steel case hardened located by 2 steel spring circlips

Connecting rods Marine Type - H section - forged Nickle Steel machined all over.
Main rod forked & works in B of Port side line of Cylinders & carries a nickle steel block, lined inside & out with special lead bronze bearing mixture.
The auxiliary or plain rod works on the external surface of bearing block & in between the forked rod in A section Starboard cylinder block.
Fork rods "Lead" plain Rods "Trail".
Gudgeon pin bush fully floating. Phosphor Bronze.

Assembling Cylinder Blocks & Pistons.

Pistons. To minimise risk of damage assemble on con Rods 1&6, 2&5, 3&4, do not move Crankshaft unnecessary, before fitting a piston verify its weight, number, freedom of rings, gudgeon pins ect. Having fitted piston verify Securing of circlips fit with upper slop towards exhaust side.

Cylinder Block. When refitting Cylinder blocks make shure they have been Hydraulically tested first. Fit lifting bracket & see lifting tackle is square ect. Clean & oil all parts & remove transportation base Just prior to fitting Cylinder block to Engine.

NOTE. Put No 3&4 on T.D.C. before fitting block.

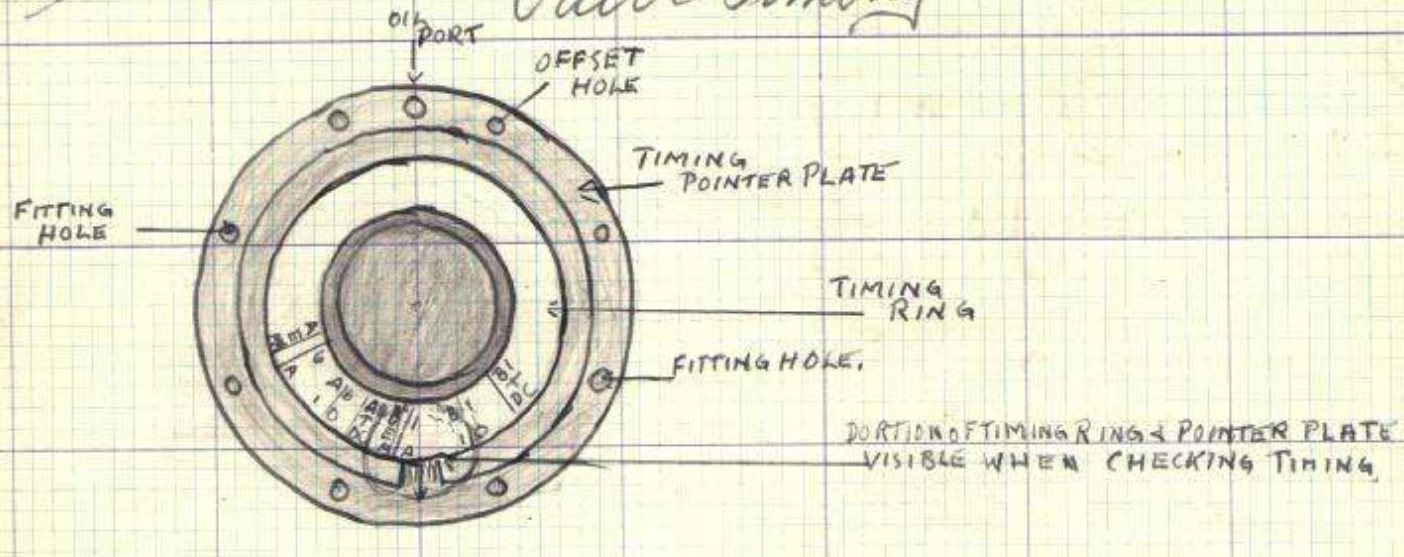
Fit wide bands on Compression rings, & Special narrow bands on old type of oil scraper ring. use special forceps for grooved type oil Scraper. Care must be taked to lift & lower Cylinder block square on to engine to avoid damage to rings Pistons ect.

Tighten nuts in correct sequence to prevent distortion of cylinder block & get a good even gas tight Joint in combustion chamber always fit new rubber Joints ring at lower end of guard tubes.

Valve Timing

1. Disengage the 2 serrated camshaft & drive shafts.
2. Set one inlet tappet of A 6 & one of B1 to .035" clearance. make certain that rockers are on base of Camshaft.
3. Turn Crankshaft in D. & R. untill the lines on timing disk makked "A" 6.1.0. registers exact with the pointer on central mark of Graduated dial.

Valve Timing



TIMING RING & POINTER PLATE.

4 With a .005 feeler gauge inserted in the A6 inlet tappet clearance. turn A side camshaft in D & R until feeler gauge is just nipped.

5 Engage A side drive shaft to its nearest setting

6 Without having moved crankshaft in the meantime turn in direction of Rotation until the mark B1. I.O. registers with the pointer. I.E.- Turn crankshaft foward 60°

7 With a .005 feeler gauge inserted in B1 inlet tappet clearance turn B side camshaft in D & R until feeler is just nipped,

8 engage B side drive Shaft to its nearest setting.

9 Secure both driver shafts casings to wheal case.

10 Finally set all tappets to .020.

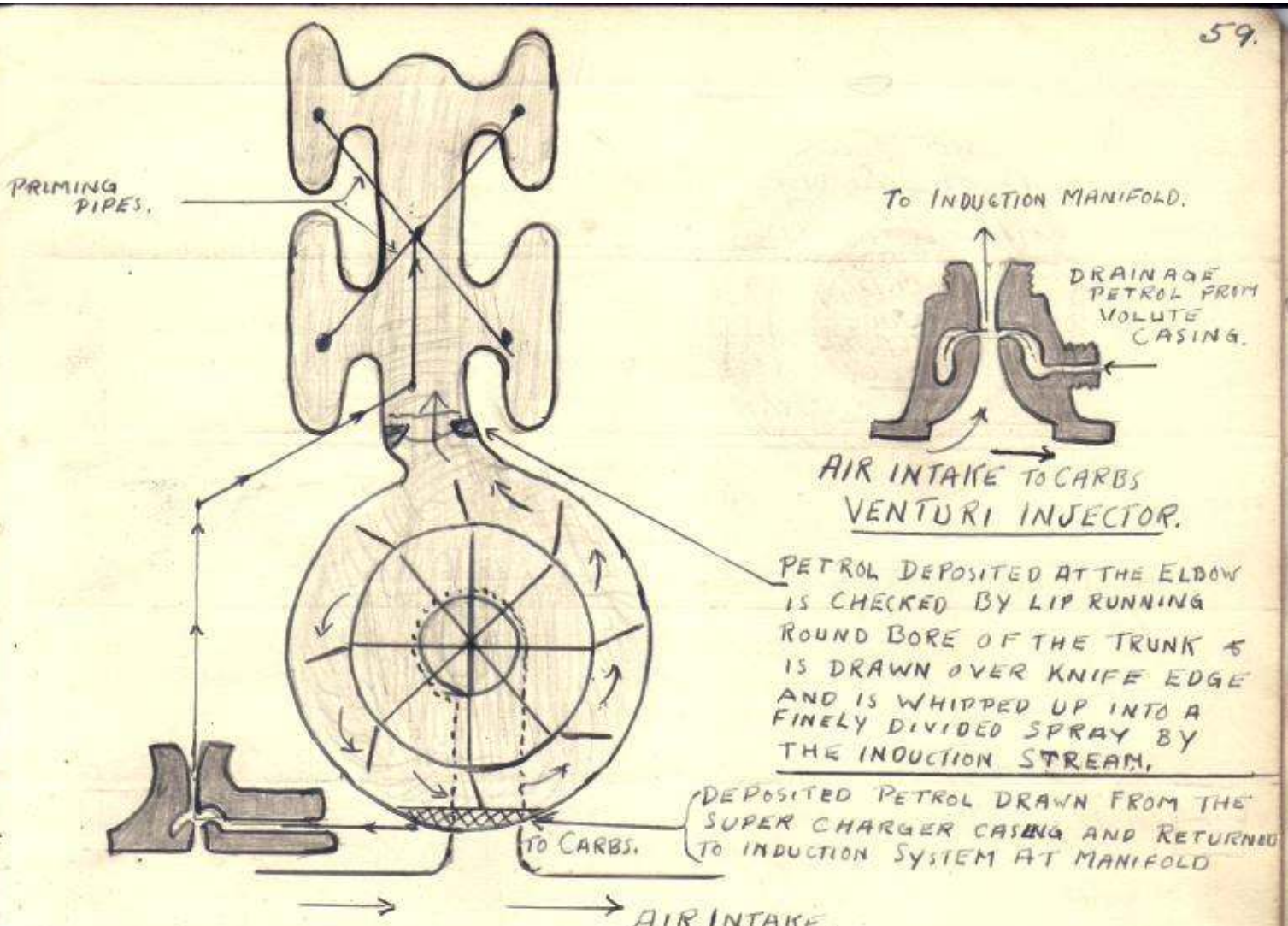
Vernier Adjustments

There are 21 serrations at the bottom end and 19 serations at the top end

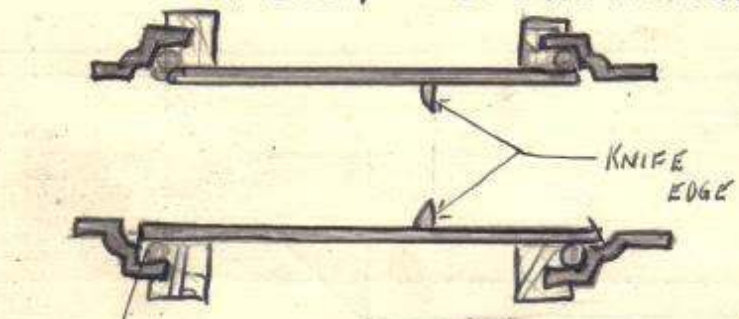
$$\frac{360}{19} - \frac{360}{21} = 18.94^\circ - 17.14^\circ = 1.8^\circ$$

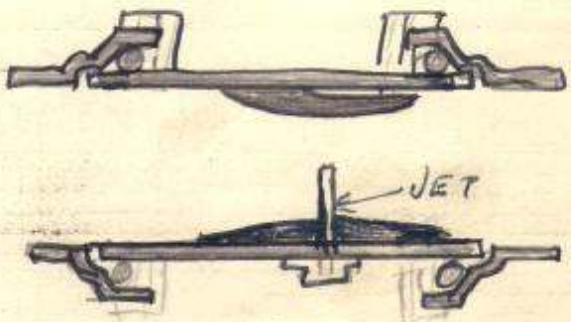
Thus a minimum adjustment of 1.8° may be made in respect of Camshaft to crankcase.

With magnetos already timed turn engine in D & R until the main brush on Rotar dist points to No 6 of distributor that serves (A1 Cylinder) the set of markings then visible on the timing cone are to be used in Continuing with Valve timing. N3 Correct timing on Correct Stroke



SECTION THROUGH JUNCTION PIECE
FULLY SUPERCHARGED



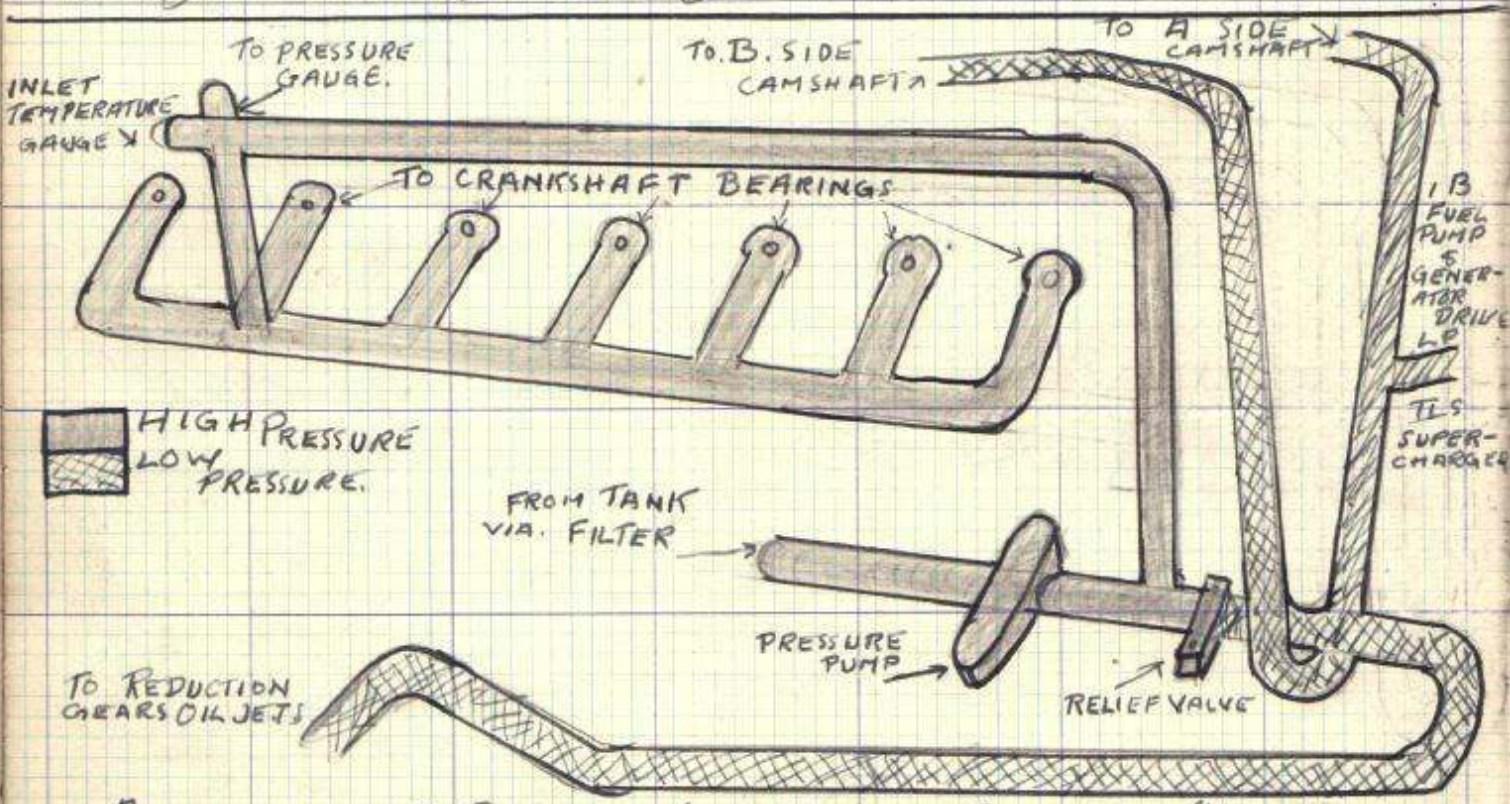


MODERATE. SUPERCHARGED.

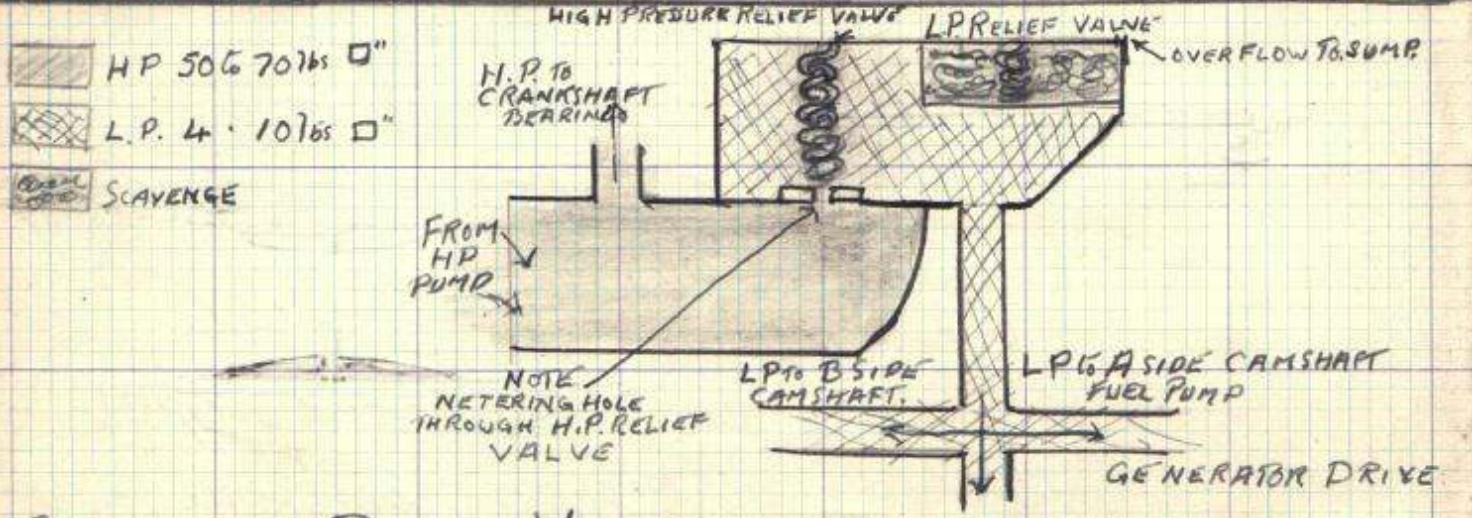
60.

Supercharge Drive.

The drive consists of a gear at the end of the spring drive & a trio of compound gear wheels, meshing with pinions on the impeller spindle. The compound gear wheels each incorporate an automatic clutch. This clutch consists of bronze segments pressing against the rim, due to centrifugal force. The impeller inertia, in combination with the friction drive, damps out the torsional oscillations of the spring drive shaft, driving camshafts, & auxiliaries.



ARRANGEMENT OF PIPING OF LUBRICATING SYSTEM (KESTREL)



COMPOUND. RELIEF VALVE.

(KESTREL)

Lubricating System.

There are 4 oil circuits 1. High pressure: 2. Low pressure 3 Front Sump Scavenge, 4. Rear Sump Scavenge. Lubrication is on the dry sump principal. The pressure pump receives oil from the tank. Via:- the filter & delivers it by a external pipe, to the port side of engine, an adaptor on this pipe carries a fitting for pressure gauge & Thermometer. Oil is distributed from this point to the 7 crankshaft main Journals, passing through the interior of the hollow crankshaft to the 6 crankpin & connecting Rod big end bearings. Oil released from the bearings form the splash element, Lubricating Cylinder Bores piston, gudgeon pin, Con Rod small ends & rear cover components. A Branch pipe conveys H.P. oil to the fuel pump Spindel Via a none return Valve A duct in the H.P. System leads to the H.P. relief valve which lifts at 50 - 70 LBS □". The oil which passes through this Valve, either due to its lift or through the metering Hole in the center of the Valve, forms the L.P. supply, feeding the camshaft, Rockers, reduction gear, Supercharger ect. Camshaft drive, timing gears are lubricated by oil draining back to crankcase through camshaft drive housing. A relief Valve is fitted to the L.P. system, lifting at 4 - 10 LBS □" Excess oil is returned to rear Sumps, 2 scavenge pumps are fitted one to front Sump & one to rear both pumps deliver into a common duct leading back to tank, an oil cooler is fitted in the System, a closed form of breather is now fitted to the crankcase to obviate discharge of oil during acrobatics or inverted flying.

Hand Lubricating.

Controls, (and freeing oil DT.D 44B.
coolant pump (Valve gear grease 3H A/54) & Magneto.
Always prime engines with warm oil. appro 50°C after installation, overhauls, or any period of 14 days idleness
Prime gallery pipe & both A & B camshaft connections at rear of Cylinder block.

Scavenge Pumps:- 2 in older engines these are coupled in series in later type engines in parallel

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Magneto Timing.

1. Turn crankshaft in direction of rotation until the centre line of timing mark "A"6. MA. is opposite the pointer, when No 6A cylinder is on firing stroke..
   In normally aspirated engines there are two timing marks of these, the one nearest the letter E must be used first
2. Set C.B points to .012 fully advanced Magneto of "B" side & connect magneto up, for a lamp test.
3. Fit driving coupling & turn magneto to CB points about to open whilst distributor main brush is serving cylinder No 6A" (No 12 segment).
4. Repeat above operation on second Mag, after turning crankshaft, so that the second timing mark for normal aspirated engine is opposite pointer.

NOTE:- Supercharged engines, both Magnetos Synchronised

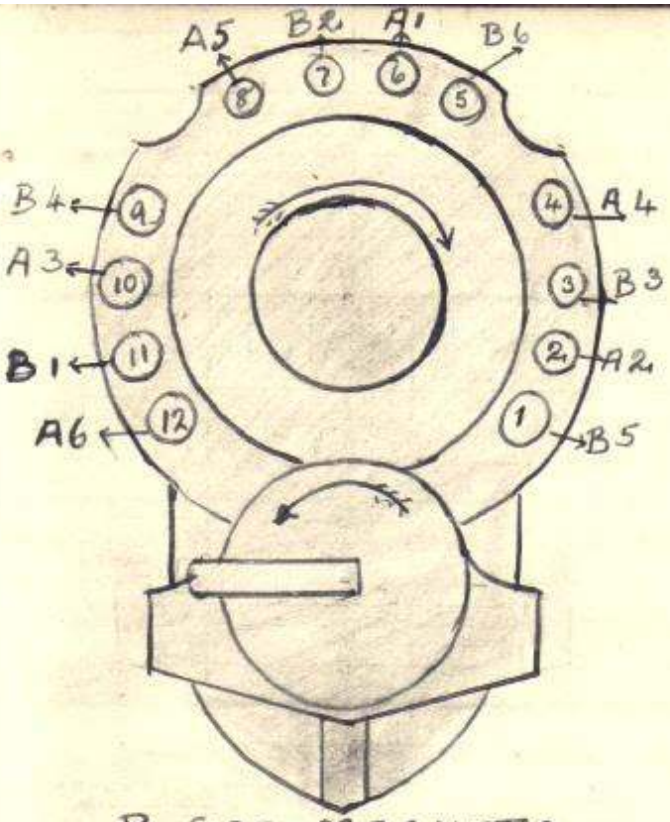
Each Magneto runs 1½ times engine speed, through the driving coupling having 12 & 11 splines (Vernier adj)
$\frac{360}{11} - \frac{360}{12} = 30° - 2.72°$ as mag Rotates at 1½ times engine speed: $\frac{2.72}{1.5} = 1.8°$ thus a adjustment of the mag timing may be made .9° late or earlier.

Firing order.

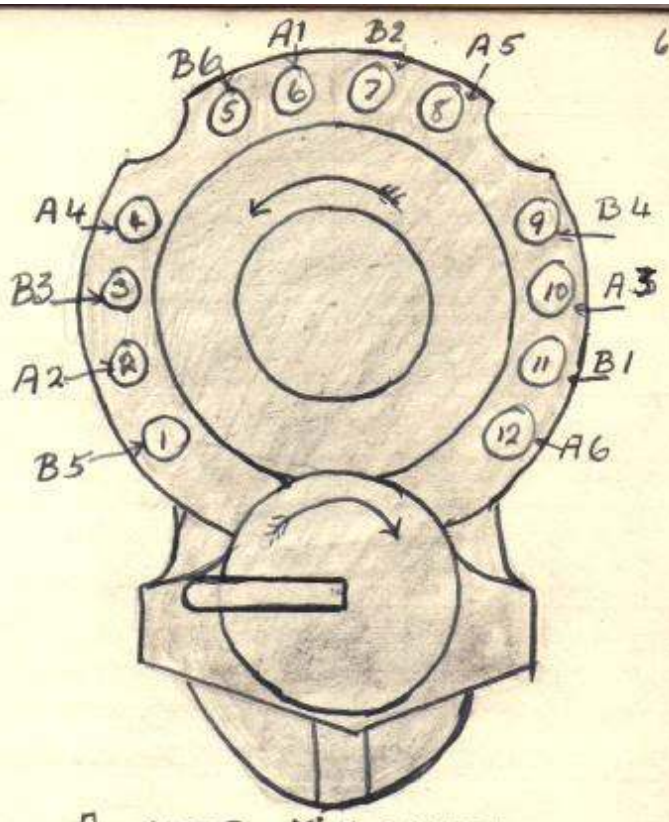
"A" UNIT 1 4 2 6 3 5

"B" UNIT. 6 3 5 1 4 2

MAGNETOS RUN. B on Port side, clockwise & fires exhaust plug at 38° advance. A on STARBOARD side fires 36° advance



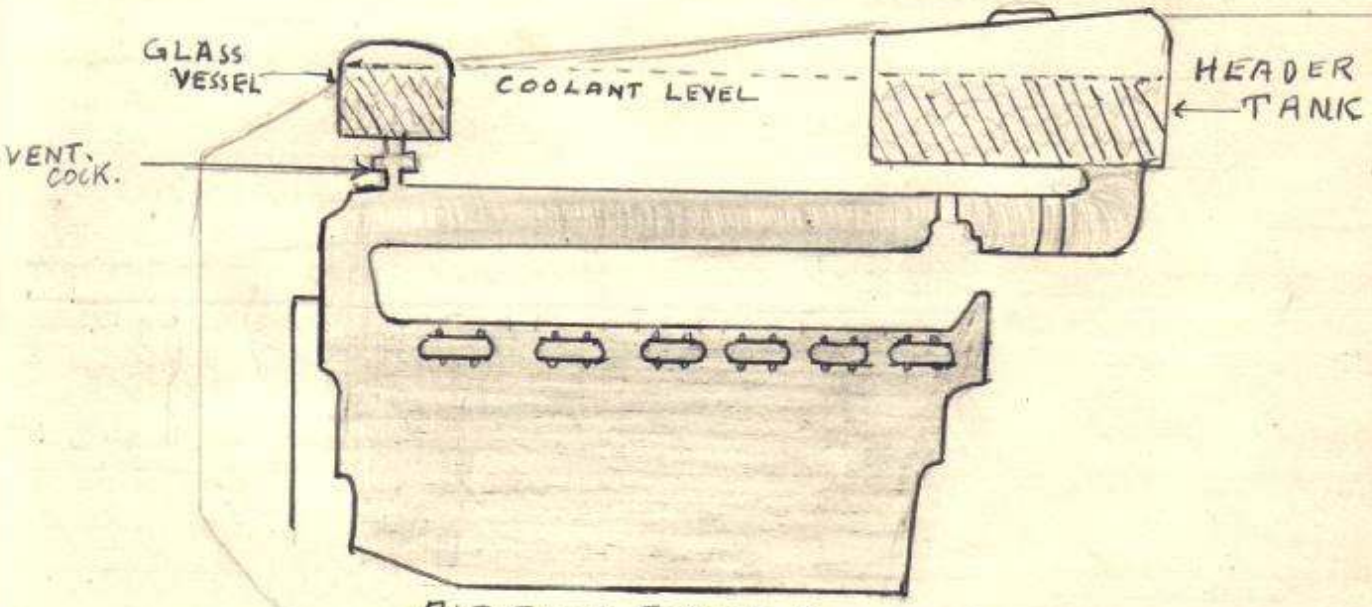
B. SIDE. MAGNETO
FIRING ALL EXHAUST PLUGS.



A SIDE MAGNETO
FIRING ALL INLET PLUGS

PORT SIDE

STARBOARD SIDE.



ALTITUDE TO GIVE DOWNWARD
SLOPE TO COOLANT OUTLET PIPE

TEST FOR LEAKY CYLINDER LINER TOP JOINT RING
ENGINE IN FRAME.

Leaking Cylinder head Joint.

Test with engine in airframe.
Fit glass vessel, by rubber connection, to air vent cock at front end outlet rail pipe.
Put machine in position to have approx 2" of coolant in vessel.
Remove all sparking plugs on outside (exhaust play) except that cylinder under observation.
Rotate engine over compression T.D.C. by hand turning gear (fuel & switches off & throttle open).
Air escaping past cylinder head joint ring will be forced into cooling system & manifest itself as bubbles in the vessel. Note should be made of faults cyl or cylinders & repaired.
NOTE give final Hydraulic test before fitting cylinder to engine.

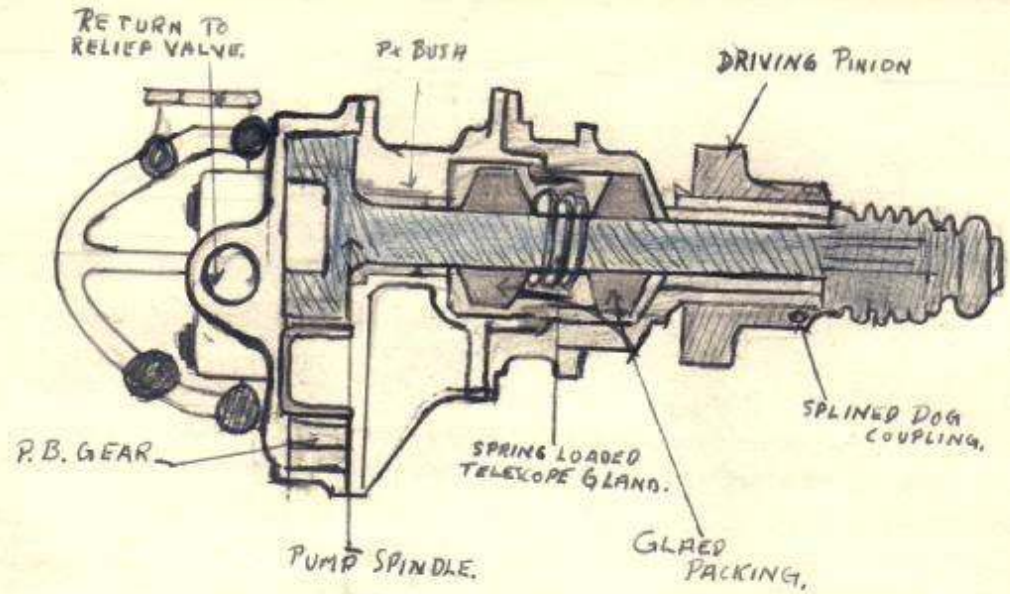
Leakage at Head Joints is generally caused by :-

1 Lack of compression.
2 Coolant in combustion space, noticed when S.P are removed.
3 Coolant discharged from exhaust pipes when engine is being turned prior to starting.

A. These leaks are often caused by rapid changes of coolant temperature after a long tick over & suddenly opening up throttles.
B. Incorrect filling causing air lock.
C. Impurities collecting at the hottest points :- I.E. Cylinder head, causing and insulating medium, thus preventing effective cooling often caused by having to much grease in coolant pumps. Impure coolant ect.

Fuel pump is of the gear type & has a relief valve on the pressure outlet side which bypasses fuel in excess of requirements to the suction side.

The pump spindle is fitted with two spring loaded glands to obviate leakage of fuel & oil.
Relief Valve pressure 5 ft head, 1 lb per □".
High pressure lubrication to spindle via none return valve. NB. located by a spigot on shaft.



FUEL PUMP.

Hydraulic Test for Cylinder Blocks before assembly.

1. Dry out interior of Cylinder coolant Jacket and examine for corrosion as far as possible.
2. Seal all coolant orifices with blanks & mount Cylinder block on Transportation base & tighten in correct Sequence.
3. Connect an air pump to a special attachment on one of the Blanks.
4. Submerge the block in hot water a Temperature 80°C.
5. After the block as been heated uniformaly throughout apply air pressure with pump at 30 lb □" for 5 minutes and note where leaks occur.
6. After testing dry thoroughly & spray with mineral oil to prevent corrosion & rusting, internally & externally.

Inspect following points for Leaks.

1. Top Seal ring.
2. Bottom rubber Joint.
3. Inlet & exhaust manifold studs.
4. Core hole plugs.
5. Cylinder Stud tubes. (guard tubes.)

Kestrel Coolant Pump.

Centrifugal Vane type :- Underfed

Speed 1·5 to 1 :- Capacity at Normal R.P.M appox 100 gals P.M.

Casing in 2 halves :- ali Alloy.

Joint between Casing :- Vellumoid

Pump spindle & Plain Thrust bearing } screwed &

Rotar - Phosphor Bronze - 8 Blades. } pinned together.

Upper Bush detachable Ph. Bz :- White metal lined

Lubricant - Grease - Valve Gear grease :- Stores Ref 34A/54

Lower Bush - fixture - Ph. Bz :- White metal lined lubricant Coolant.

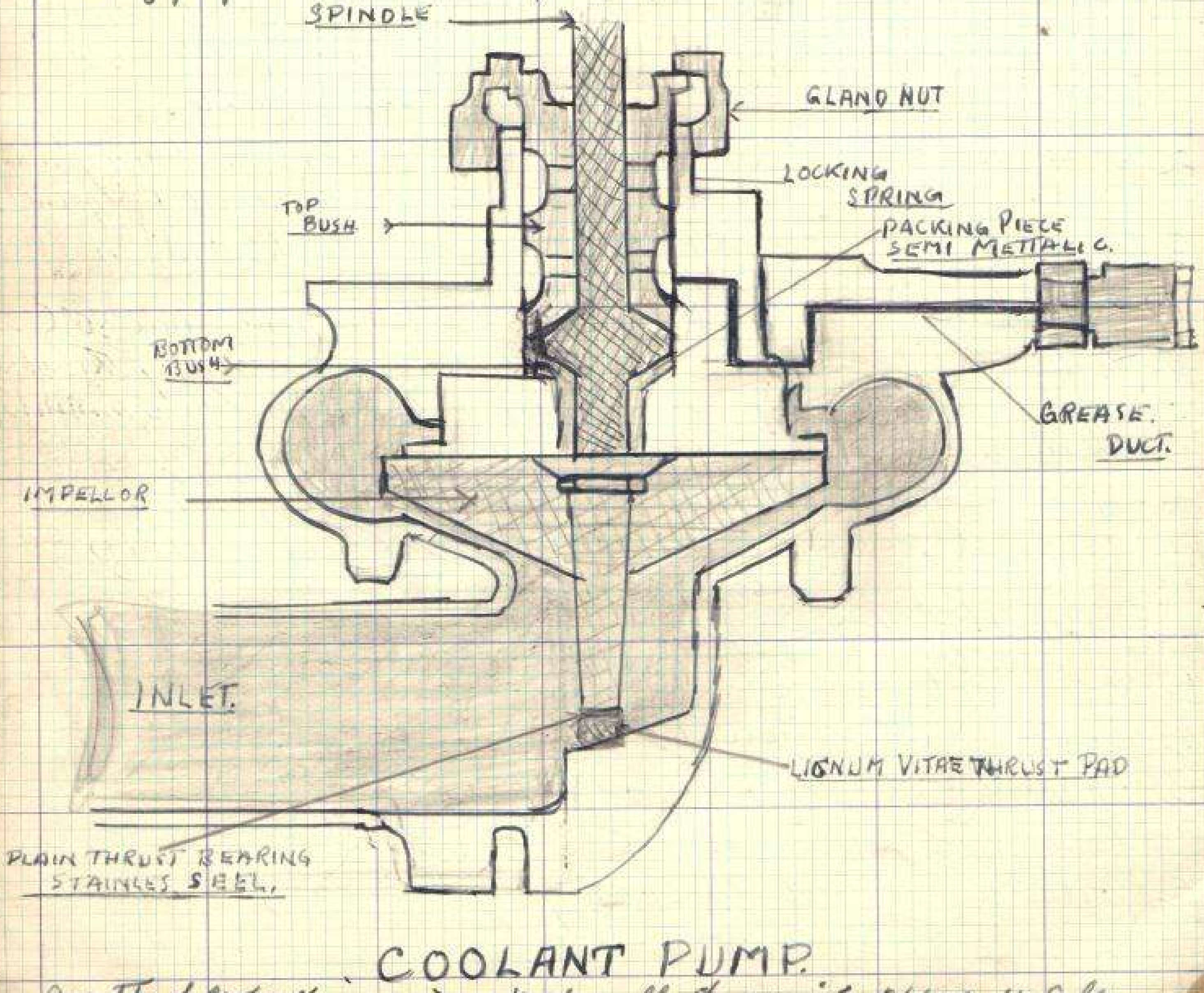
Gland packing - for pump spindle :- Semi Metallic.

Spindle thrust pad :- Lignum Vitae wood :-

Gland nut. Left hand thread.

Locking device :- Ratchet teeth on Gland nut & Locking Spring.

Located by pump mounting Sleeve & muff Coupling. Restriction Washer with 1/16 [illegible] end (Jubilee [illegible]

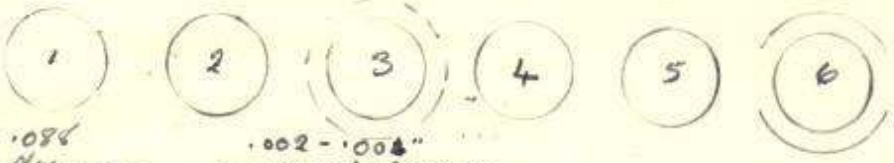


COOLANT PUMP.

Quantity of Coolant in engine 4½ gal all the circuit approx 14 galls

Locations.

Cylinder Blocks.



·002" on Sides
·063 Longitudinally.

1. 2. 4 5 ·077 - ·086 universal clearance.

·002 - ·004" universal clearance.

Cylinder Liners — spigot top end – Shoulder lower end.

Crankshaft: — centre main bearing.

Wheelcase. — slot in top face & P.B dowel in rear face of Crankcase.

Spring Drive. — master spline.

Reduction gear Case. — spigot & 2 lugs bolted together by transverse bolt. these lugs also take torque of air screw.

Camshaft Pedestal Bracket. — Longitudal tenon in base of bracket & slot milled in top face of Cylinder Block.

Camshaft Thrust bearing & shoulder on camshaft & Packing Washer

Lower half of Crankcase. — & hollow taper dowels.

Airscrew hub. — Rear split Pho-Bzy. Cone & front Cone Ring Nut.

Airscrew Shaft: — thrust race. driving pinion Journal, type ball bearing.

Coolant Pump. — pump mounting sleeve & Muff coupling

Gudgeon Pin — Steel Spring Circlips

Fuel Pump. — spigot.

Cylinder Block Covers. — Stepped Studs & lower part of holes drilled to fit.

Joints & Jointings.

Vellumoid: – Crankcase to Wheelcase: Cylinder Block covers Valves may to wheelcase. Crankcase upper & lower half. between halves of Coolant pump. Restriction Washers each side. Coolant pipe Flanges. lower camshaft drive faces. Compound relief Valve to Crankcase. Pump mounting sleeve to Wheelcase main oil pressure pipe (Portside) on normal aspirated engines Spring drive & end covers.

Heldite. reduction gear case to crankcase & between 2 halves Jointing compound each side)

Klingerite & induction pipes to cylinder block sheet ali Heldite (each end
" " " to central Trunk
"Pumic" and drain plugs each side of connections.

Ali Washers. Air vent cocks & Reduction gear oil Jets top Cylinder liners.

Spring loaded Rubber Joint Rig. & lower end cylinder liners.
& guard Tubes

Tape wound Rubber Joints Coolant pipe connections.

Rubber sleeves & Jubilee Rings. Coolant pipe to tanks & Radiators

Rolled Copper. Sparking plugs.

Rubber Gland Rings. Supercharge coupling pipe.

Vellumoid & Heldite Supercharge gear facing.

Copper Asb. Exhaust pipe. Scavenger filler caps & Cap nuts.

Semi Metallic Coolant pump gland packing.

Asbestos Tallow & String. } wound or Moulded to Size.

Components

Airscrews.

Summary of Opperations of Variable Pitch airscrews.

1. Oil pressure forces cylinder forward giving fine pitch by cam action of Spindle on Counterweight bracket.
2. Centrifugal force of Counterweight produces course pitch counterweight brackets attached to blades.

5° to 10° between Course and fine pitch.
35° on Latest Types.

Maintenance Inspection before flight

Test opperations when engine is warm. engine running about 1000 R.P.M. succesful change from fine to course pitch indicated by a steady increase of Rev P.M. and a steady movement of Cylinder forward time of change of Pitch from 4-5 seconds.

Daily examine 1 for Oil leaks 2 examine external locking devices. circlips in Cylinder head split pins ect. 3 Feel blades for slackness on Spindle hub. 4 Inspect blade surfaces.

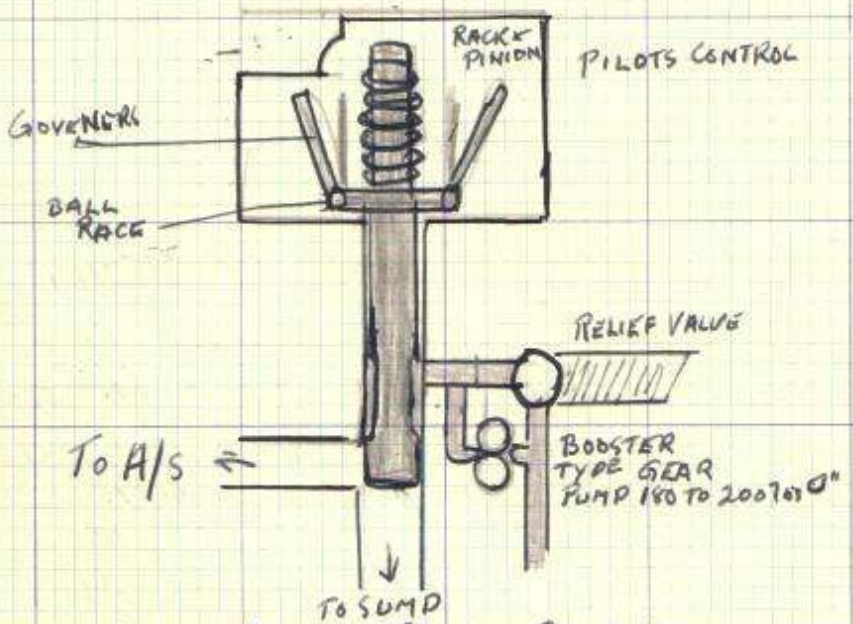
Removing Airscrew.

Turn engine so that No 1 blade is at bottom attach slings round shanks of other 2 blades protecting them with packing. unlock and remove circlip Cylinder head, take out split pins from piston locking plate, unscrew piston which with cone & snap ring will extract A/s from shaft. Place A/s on bench and fit dust cap to shaft. A/s must be in coarse pitch for this opperation and its weight must be completly taken by the sling and tackle care must be taken to avoid damage to end of shaft as A/s is swung clear.

Installation

Turn engine so that master spline is at bottom, inspect for fretting clean up with oil stone if necessary and smear with Whitmore's compound Remove dust cap & clean out oil ways Sling A/s by No 2 & 3 blades protecting shanks. Slide on shaft making master splines Screw up pistons avoid disturbing Cone washer with a tightening force of 800 lbs ft (4000 lb/ft) by fitting extention tube to tommy bar

and hang weight on end give sharp blow with 4lb lead hammer close CB spanner to overcome initial friction repeat until piston is tight fit + lock Cylinder split pin locking plate. check track. start engine when warm test pitch change several times above 900 R.P.M. noting rise & fall (app 100). smoothness and trend of change check max R.P.M. in fine pitch switch of in coarse check. track, unlock recheck tightness of piston as A/s will bed down relock and grease blade.



CONSTANT. SPEED. CONTROL.

Changing Leather Washers. Remove Cylinder head & leather securing nut. Remove leather useing 2. extractors insert new leather washer deep one first then shallow. tighten and pin securing nut fit new C.A washer on Cylender head + lock.

N.B Leather washers are soaked for 2½ hrs in hot oil.

Running faults Vibration due to shortage of oil grease, blades out of track, Blade handle out of angle.

Faulty Pitch change caused by failure of oil supply low engine oil pressure. Defective Control Valve. incorrect assembly.

Oil Leaks defective or incorrectly assembled leather washers:- lose cylinder head or defective cylinder head washer - Defective cone washer.

Starting Systems.

1. Airscrew swinging by hand or Hucks starter
2. Hand turning gear.
3. Hand or electric inertia starter
4. Gas Starter
5. Electric or combined hand and electric Starter.
6. Cartridge or combustion (coffman) starter.

Starting Procedure.

1. Prime engine & set throttles
2. Turn engine to draw mixture into Cylinder.
3. Switch on hand starter magneto or Booster Coil & operate starter
4. When engine runs steadily switch ON. main magneto and switch "off" hand starter magneto or Booster coil.

Hand swinging

For starting purpose this may only be carried out by persons certified as being fit.

Safety Measure

a second man is detailed to assist operator in getting away from airscrew.

Hucks Starter

Power from a motor Vehical is transmitted to airscrew through a clutch & suitable shafting. Ground staff connect shaft to airscrew but only driver of Vehical may operate starter

Safety Measure.

The clutch prevents damage to engine or starter by overload or Backfire

Hand Turning Gear. Gear shafts & clutches are built into engine & handles can be attached to shafts for purpose of turning engine, after use the handles must be stowed in aircraft.

Safety Measure. Clutches & automatic throughout devices are employed. to prevent damage to engine, Gearcase, or operator in event of over load or Backfire.

Gas Starter. a fuel air mixture is admitted under pressure (140-200 lbs/□") to engine cylinder.
mixture is obtained by passing compressed air from bottles through an atomiser and the mixture is fed to each cylinder on its normal timing stroke by means of a gas distributor and by way of none return valves in cylinder.
The hand starting magneto is used during rotation of engine, which should be turned before the fuel air mixture is admitted.

Safety Measure. The none return valves in cylinder prevent back pressure from engine to gas starting system.

Maintainance Daily check pressure in bottles by gauge in cockpit refill if below 150 lbs/□". Periodically examine pipes unions & gaskets for service ability. Remove none return valve from cylinders clean in (DTD 224) petrol, grind seats if necessary and lubricate lightly before returning to cylinder.

Electric Starters Small electric motors 1-3 H.P. are used the necessary current being supplied by the batteries in the aircraft assisted by portable batteries.
The necessary reduction gear is fitted at the end of motor in the form of a epycycle gear box & clutch, automatic devices are used to connect and disconect motor & engine. Some motors can be assisted by built in hand turning gear.

Safety Measure. Clutch prevent mechanical damage.

Maintenance Keep clean externally, check terminals for tightness. & starter for security to engine.

Cartridge Starter (Coffmann)

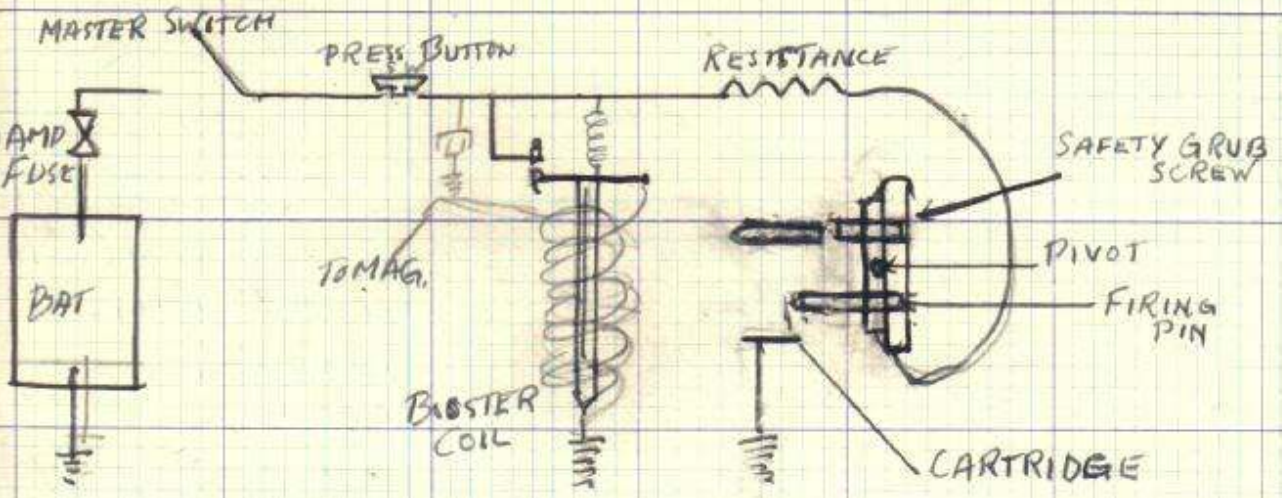
This consists of a multiple Breach situated near the engine and controlled from the cockpit; combustion pipes and starter fitted to engine.

A charge of cordite electrally ignited is propelled from Breach by way of combustion tube to combustion chamber where it burns and gives off a gas which passes through a filter enters the starter cylinder & builds up a pressure on the piston and forces it to move.

Under the piston helacaly splined gears or shafts converts the motion into rotary motion of the dogs which are put into engagement during the initial movement of the piston by the action of the jaw bolts pressure on the finger spring to which these dogs are fitted. As the piston nears the end of its stroke an exhaust Valve is opened this relieves pressure from the piston and a heavy spring which is compressed during the working stroke returns the piston to its original position. The jaw bolt dragging on the finger spring disengages the dogs and as the piston reaches the end of its stroke the exhaust Valves closes.

Faults. 1 Cartridge fails to fire + maybe due to faulty Cartridge or break in electric service or dirt on sealing piston may have put safety Grub screws into electric Safety position.

2. Cartridge fires starter fails to operate may be due to blown safety disk or failure of exhaust to return to its sealing owing to broken main spring.



COFFMAN ELECTRIC CIRCUIT.

3 Starter operates but fails to turn engine :- may be due to dog not engaging owing to broken finger spring or the splined gear may have seized in which case the safety disk would blow,

Safety Devices. 1 master switch which prevents accidental firing of cartridge.

2. Safety grub screw prevents cartridge from being fired unless sealing piston is seated

3 Safety disc or relief valve which blows and prevents damage to engine or starter in case of overload & B. fire.

Maintenance.

Daily inspection see that master switch is off check cartridge in breach reload as necessary seeing that new ones are of correct loading, close loading door and wipe down with Oil Rag.

After 25 ~~to~~ 50 S. cartridges, unlock and remove safety disc holder + renew safety disk with one bearing same Number.

After 80 cartridges inject into breach sealing piston about 1 teaspoonful of Combustion starter oil.

200 to 400 Cartridge inject through safety disc hole onto top of piston about 2 teaspoonfuls of Combustion S.O. after 500 or 150 flying hours remove starter from engine remove combustion chamber clean it in hot water and soda swill with Paraffin dry with air blast withdraw exhaust valve as far as possible

examine head for security and if sealing is slightly pitted grind with normide compound clean inside cylinder by same method as combustion chamber, undo clamp ring withdraw cylinder to limit of movement use soft scraper to remove grease from splines inspect them for damage and if O.K. repack with about ¼ lbs of combustion starter grease return cylinder fit clamp ring lightly fit combustion chamber return starter to engine seeing that vent holes are at the top fit pipes turn cylinder to line them up tighten clamp ring fit new safety disc and test by firing 2 cartridges

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Coolants

Distilled Water No treatment required

Rain Water In coastal area test it with silver nitrate for the presence of salt. If a precipitate forms water is unsatisfactory.

Domestic Water. Treated with tartaric acid to reduce temporary hardness. Quantities labeled in AP. 14.64 1 tablet (3½ grams) will treat 10 gal of 5° hardness

Ethylene Glycol :- Low freezing & High boiling point must be tested for density & preperation at Schedule inspection.

	WATER	E.G	EG MIXTURE
Boiling Point	100	196	120
operating temp	80	95	80
freezing point	0	-17	-14
Specified Gravity	1	1·143	1·043

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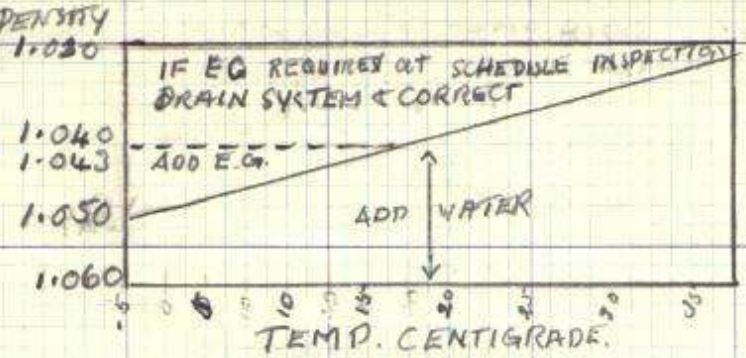


SPECIFIED GRAVITY 1·043 at 15° C
" " FALLS AS TEMP RISES

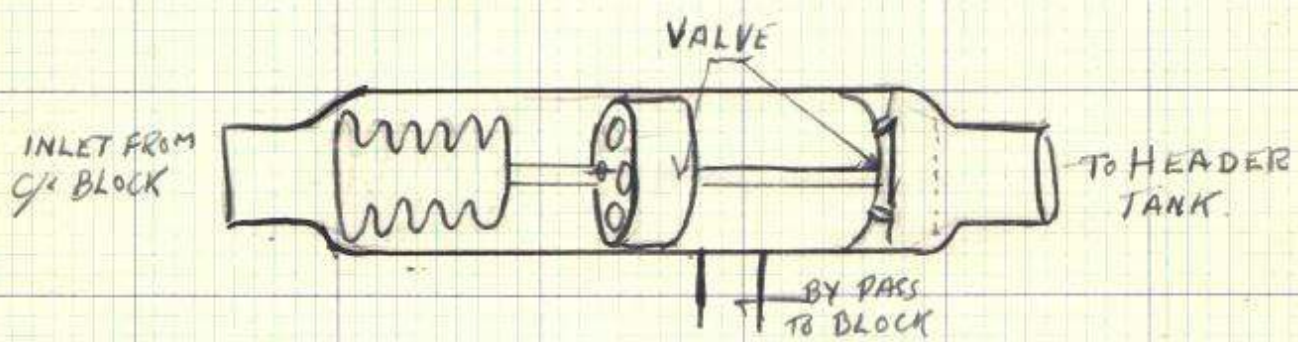
ETHYLENE GLYCOL

Preparing & checking EG Mixture.

Mix a sufficient quantity of 30% EG. & 70% distilled or filtered rain water.
Take a sample & measure the density with a hydrometer
Take Temperature by means of thermometer
Check these readings with the density temperature Van chart
If density to high add water
" " Low " E.G.. check another sample
If additional EG. is required when checked on Schedule inspection drain cooling system & correct in Suitable Container

Radiators.

Honeycombe Type:- built of Hexagon brass tubes.
Galley Type built up of Cupro Nickle pressings forming a section of 3 squares.



THERMOSTATIC VALVE

Cleaning Radiator.

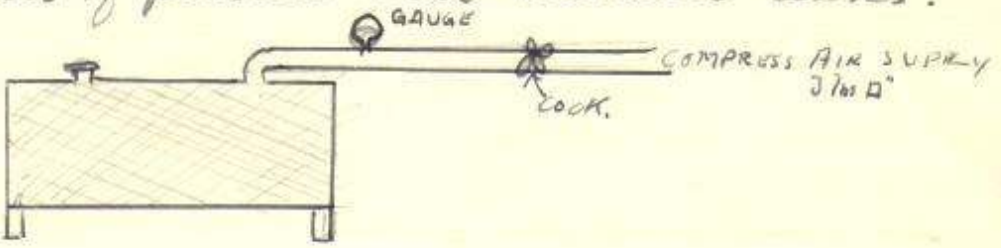
Flush in reverse direction with a hot solution of 2% Caustic Soda
Neutralise with flushing by a warm solution of ·75% Chromic acid & ·5% phosphoric acid & water finally flush with cold water. If Chemicals are not available soak radiator for ½ hr in hot water flush in reverse direction with clean cold water until Radiator is Clean

Pressure test for leaks and distortion

all pressure 6 lbs □" unless otherwise stated

1. Blank off.
2. Fill with cold water = apply pressure for 30 min
   Drain + fill with hot Water 85°C " " " 10 "
   " " " Cold " " " " 5"

During each phase check principal dimensions for distortion Loss of pressure will indicate leaks.



Quantity of flow.

Carried out to ensure flow of coolant through radiator equals.

Normal rate of flow 15 gal Per Minute per 100 B.H.P

Minimum " " " 12½ " " " " "

Temporary Repairs.

Casing - Plastics

Tubes - a Long bolt compressing Rubber washer at each end.

Galley type. Whole section of three covered using two bolts.

Leak stopping Compound

Radiator to be flush out as soon as possible after use.

Permanent repairs to be carried out as soon as possible & according to A.14.64

Tanks.

Stainless steel, tinned steel, Al. Dural. alclad. Brass for header tanks.

Sumps are usually detachable to collecting foreign matter & with petrol tanks for condensation.

Air Space provided in all tanks except petrol tanks to allow for expansion of contents and with oil tanks for the return of oil from sumps when engine starts.

Vents to maintain atmospheric pressure within tank.

Anti Vortex. device. fitted to shallow header tanks a conical drain having radial fins to prevent swirling & the passage of air into coolant system.

Bonding Sockets. petrol tank to maintain electrical contact between filler & tank earths any frictional electrically generated during high speed filling.

Cleaning. Petrol tank self cleaning sump to be cleared of water caused by condensation.

Header No attention necessary.

Oil Tanks. due to formation of sludge. require attention remove tank & sump clean with Parrafin and with compression air jet on napless cloth.

Test for Leaks. chalk test. blank off. fill to full of parafin coat suspected part with meth & french chalk agitate tank to completely wet inside and then examine for stained mark on chalk.

Submersing test. blank off. submerge in water and test with pressure 1½ to 2 lbs/□" bubbler will indicate leak.

Seams or Stalled rivets plastic or plugs to be self locking or mechanically locked.

Remove tank & carry out permanent repairs at the earliest possible moment.

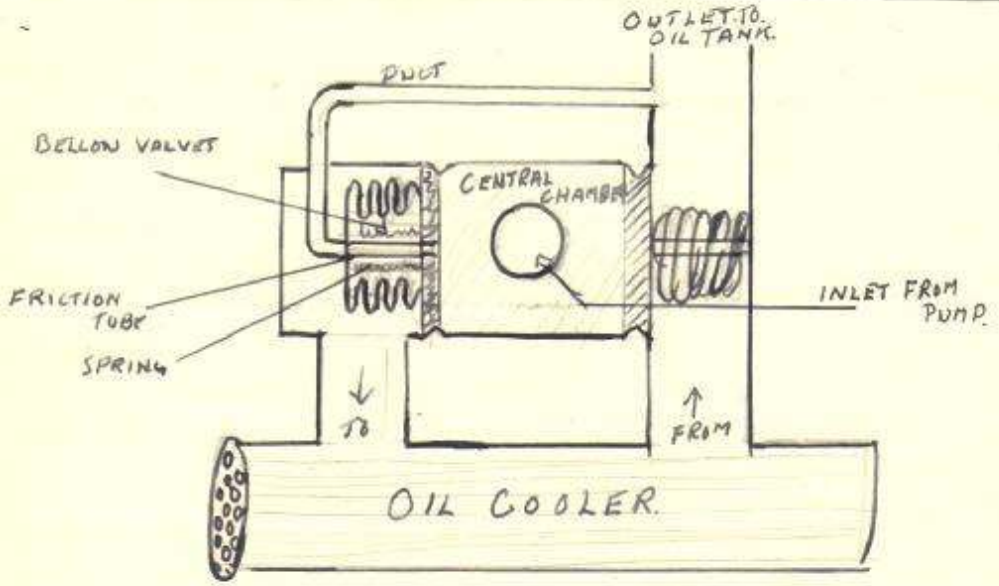
Self Sealing

Provides protection to aircraft against loss of petrol due to shock or gunfire. Consists of layers of of special types of rubber enclosed in an outer casing of textile netting and also fabric.

protection depends on the swelling action of some of the rubber layers

when in contact with fuel.
If the tank is punctured fuel escapes the rubber swells pressure is built up around the hole as the rubber is enclosed by the strong outer covering the hole closes up and is sealed.

Inspection. The tank is examined for any signs of bulging of the self sealing covering. a bulge will indicate a leak.



VISCOSITY VALVE.

Oil Coolers

Function to maintain the lubricating oil at normal working temperature.
Construction. Built of brass tubes enclosed in a cylindrical cover. Two connections are fitted to the cooler one a inlet admitting oil from the sump via a scavenger the other an outlet to the oil tank a Relief Valve is incorporated with the cooler to allow cold oil to be bypassed to the oil tank instead of passing through the cooler. There are two types of Valves
1. Spring loaded only for pressure operated
2 Viscosity types which is operated by the Viscosity of the oil.

Viscosity Valve.

Oil from the sumps enters a central chamber which is closed at one end by a spring loaded valve & at the other end by a Bellows type Valve. The oil enters the bellows valve & if it is cold & thick the pressure exerted on the valve is greater than that of the spring loaded V. which will open and allow oil to be by-passed straight back to the oil tank a small duct through centre of bellows valve allows a small quantity of oil to continually pass through this regulates the pressure of the oil inside the bellows. When this becomes normal the pressure on the valve decreases and falls below that of the spring loaded valve the incoming oil therefore lifts the bellows valve and lets oil go through tube to the oil tank.

Instruments

Mechanical engine speed indicator.

Function to indicate the number of revolutions P.M. of the crankshaft.
centrifugal governor type.
Flexible drive consist of a shaft enclosed in a flexible brass sheath.
Fitting support with clips throughout its length
Have as few bends as possible
Shaft not to bear hard on washers or stand clear more than ¼".

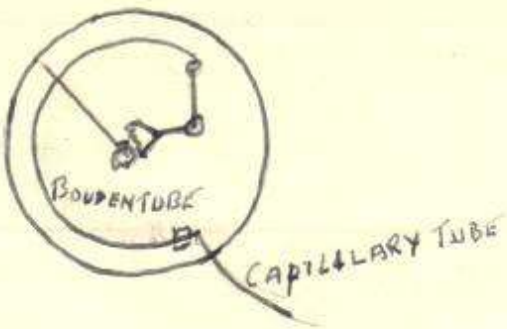
Maintenance.
Inspect Flexible drive & grease

Electrical Rev Indicator. consists of 2 components
Small generator giving an output of 1 Volt per 100 RPM.
Indicator Moving Coil

Maintenance Inspect flexible drive commutator & Brush worn brushes to be replaced.

Radiator temperature Guage. to indicate the temperature of coolant.
consists of Thermometer bulb
capillary tube
Bourdon tube
Test calibrated with master thermometer at 90°-80°-70°.

Oil temperature gauge as radiator
System filled with mecury.
Test at 80° 70° 60°



Oil Pressure Gauge Pressure on capsule transmits through capillary to bourdon tube system filled with Ethyl Alcohol. to indicate the pressure in lbs □"

Fuel pressure gauge. Direct type.
The fuel under pressure is carried direct to the bourdon tube by a small diameter pipe line registers pressure of fuel in lbs □".
Calibrate with portable calibrator.

Boost Gauge. fitted to supercharged engine to indicate the boost pressure in the induction system above or below atmospheric pressure. (i.e. 7 lbs □") Limit set by a moveable rubber line on gauge indicates maximum permissable boost as laid down for the type of engine.
Testing check with Standard barometer
testing for air leaks Apply air pressure not exceeding the maximum reading on gauge, seal off source of pressure note if pointer returns to initial reading (not to exceed ½lb in 1 min)

Petrol Contents Gauge Float type.
Position of float is registered on a gauge dial graduated in gallons
Maintainence Grease.

Preperation of Airframe.

Check alignment of engine mounting
engine Controlls for wear, correct action. Locking & Grease.
Inspect :- switches & switch boards. with lamps & battery
hand. starting Magneto & drive.
Drain & inspect. oil Tank, coolant drain & replace if necessary.
Inspect rubber joints, fuel system check flow of fuel
Test all Temperature & pressure gauges.

Preperation on Engine

Check tightness of all nuts and unions
Remove from each Cylinder the anti corrosive oil.
and replace Blanking plugs.
Remove and clean all fillers drain oil from
sumps replace fillers and lock the caps.
Remove Destributor covers wipe clean, inspect Carbon brush
replace covers.
inspect & adjust C.B & lubricate mags.
adjust Tappet clearance.
Remove Carburettor jets and see that petrol runs
through chambers & clean all dirt from same.

Pipe Lines.

Copper Tubing.

Is supplied for use fully annealed and
can only be bent once, and no heat treatment
can be given. When bending the tube should
be filled with. Sand. Liquid filling. and bend
in a Bender machine. All rubber joints to be
bonded.

Stainless Steel

Pipes of this material are made to size &
can not be altered by heat or force.
If corrosion occurs this. appears as little pin holes
and can be soldered using Phosphoric acid as a flux

Duragum made lighter than copper and used for
the same purpose also. is worked the same
is made of Copper 80% - Zinc 14% . Alu. Silicon. Nickle.

Dural Tubing. used for Vent pipes & for conduits
treat in a salt bath & reanodised & Varnish inside and

Rubber Joints

Bead each end of pipe & pull Rubber tube over fasten with Jubilee clips, & Bond same.

All Joints of pipe should not be mixed & each type of Tubing should only be used together.

Identification Colours.

Fuel	Red
oil	Black
Coolant	Blue
air	Yellow
Engine Starting	Green
Auto Controls	Brown
Misc Service	White
Hydraulics	Grey

Airscrews.

Wood constructed of Laminations of Walnut & Mahogany, usualy fabric covered with brass leading on leading edge and coated with Varnish

Schwarz.

Wooden airscrew fabric covered except for leading edge. this is protected by gauge of phosphor bronze. and fastened with tacks, given a coat of Cellulose at a temp of 60° and under press forcing cellulose into grain of wood through fabric and gauge

Metal Airscrew

Forged Al alloy. anodically treated, should never be handled between marks

Fitting check. Type. Drawing no. Pitch. Diameter engine & airframe type.

Balance:- Test for static balance on every testing machine correct with thin coat of dope.

Assembly. inspect hub ect, put hub on master spline centralise before fitting nave plate ensure good bedding screw nuts up diagonly do not lock nuts until after first test.

Inspect for cracks burrs signs of chafer & condition of retaining nut for centering cone ~~screw hub on~~ tighten with a few taps with 2lb hammer and spanner

After First run make sure nuts are tight and lock with Tab washers or Split pins
Test tracks with straight edge and trestle
Limits of track are issued in AP 1464 A. Vol I

Limits of balance for wood airscrews
2" ozs for airscrews up to 6 feet
2 in ounces for A/S plus 1" oz per 2 feet increase over 6 ft
fractions of 2 ft to count as 2 ft.

Limits for Metal A/s.
5" ounces for all airscrews or according to plans

Cracks limit 1½" long × .002 by ½" deep. only on boss.
Metal U/S If a crack anywhere.

Small pits may be removed with a file (fine) and coated with Lanaline.

Controls.
carburettor control fully closed. hand lever ½" from closed position, operate open and closed position; with .002 feeler on throttle stops. if a gate coincide it with rubber line. To adjust do so between engine & bulkhead. ½ clear for open & closed position.

Coolant.
1 Tail down wind out radiator open all cocks & vents
2 Pour coolant into header tank until steady flow out of cocks
3 Shut & lock cocks & fill until coolant reaches Brass rail in filler
4 raise tail until steady flow comes from front cock.
5 lock cocks lower tail & fill up to brass rail
6 Run engine at 400 R.P.M. Raise & lower Radiator note Temp remains steady.
stop engine and replenish coolant
irregular Temp denotes air locks.

Instruments

Engine Mechanical Indicator - centrifugal governers driven by a flexible drive at ½ engine speed.

Electric a small D.C Dynamo Voltage varies with its speed.

Fuel pressure gauge bourden tube principle. 0-5 or 0-10 Lbs"

Air pressure gauge. " " " 0-250 lbs"

Oil Pressure gauge " " " pressure with Ethyl Alchol

Boost gauge Aneroid in air light case works as a barometer.

Thermometer Radiator thermometer bulb. Calipary tube and bourden (ethel ether) as a Volatile Liquid.

Thermometer oil as above only using Mercury as a liquid

Cylinder Temp. Thermo Coupled with milli Volt.

Fuel Content gauge Electric work on a coil and 12 Volts.

Indentification Colours Petrol

1	Fuel	Red
2	Coolant	Blue
3	Oil	Yellow

Running faults

Ignition Defective hand starter Switch
" H.T. Lead from H.S. Mag
Dirty slip ring
faulty Carbon brushes
Internal fault in Magneto

Firing ineffective primer pump
Primer pipes block
engine over or under primed

Engine Starts but fails to pick up on main Switch

Ignition defective Switch or Switch circuit.
Fuel incorrect setting of throttle
" position of fuel cocks
air lock in fuel supply pipe
Water or Dirt in Jet wells

Incorrect Oil Pressure.

High Very low temperature
Faulty relief Valve setting
Faulty Pressure Gauge.
Low Air leak on Suction side of oil pressure
Restriction in pipe lines on Suction side.
Dirty pressure side filter.
insufficient oil in tank.
Oil Cock Position incorrect.
Faulty pressure Gauge.

Engine Cuts out when run on one Mag.

Defective Switch
" Contact breaker
Faulty Magneto

Excessive Drop in R.P.M.

Defective Sparking Plugs
" H.T. Leads
Dirty or worn C.B. Points.

Engine Vibrates.

Misfiring on one or more Cylinders or any cause due to Ignition Carburation. Air leaks on Induction or otherwise incorrect Mixture
Mechanical Tappet clearance or adjustment.
uneven Compression
worn Reduction gears.

Airscrews.

Lose on hub. or shaft
out of Track
Out of balance.

General

Lose bearer bolts
Lose engine mountings
Lose bearings in engine bays

Running faults Contd.

unsteady Engine R.P.M

Faulty Rev drive due to.

" installation - sharp bends

Frayed Drive Shaft

insufficient lubrication

faulty R.P.M indicator

misfiring from any cause.

Incorrect Boost gauge Reading.

Loose bezel on gauge

incorrect adjusted gate or boost control

faulty boost control

Leaks in pipes

Dirty filter in gauge

Faulty gauge.

Excessive Coolant Temps

Radiator in incorrect position (or Shutters)

incorrect filling causing air locks

obstruction in pipes.

Damaged pumps.

Faulty radiator temps gauge.

Incorrect oil Temps.

High insufficient oil in Tank

Cooler blocked or Dirty.

Engine overheated

High or Low Faulty Gauge.

Flying & Operational.

1 Run up as little as possible.
2 Low speeds should be avoided as much as possible
3 if Running for a while on Slow Rev up to 1200
4 air cooled engine should never be run up without cowling fitted
5 engines should never be stopped by turning Petrol off and running until carburettor is dry.

Fuels & Filling instructions

name of fuel	Specifications	Colours
70 Octane	R.D.E/F/70	Colourless
77 "	D.T.D/224	Faint Blue & Red, Colourless
87 "	D.T.D./230	Blue or Red
90 "	No number	No Colour.
100 "	"	Green

To ensure fuel & oil tanks are filled with correct fuel and oil appropriate to the engine affixed to type of plane. The specification and number of fuel & oil are stenciled in white letters not less than 1" high near the filling orfices.
All tanks of oil & fuel to be numbered & lettered.

Filling instructions

Look for number and type of fuel if no number look at travelling Form 700 in cockpit or 1464. Take Zwicky bowser to plane and also fire extinguisher. Earth Bowser and plane bond petrol pipe with wire affixed to same and fill right up. all planes must be filled to full before putting in hangar all windows doors ect in cockpits to be fully open during the filling when finished form 700 to be filled & signed. Aircraft shall not be filled in hangars or any smoking done during filling.

Instruments	Colour Bezel	Normal Reading	To rise in 30 Sec
oil Pressure	Yellow	60 Lbs/□"	minimum
" Temp	"	25° C to 60° C	
Coolant	Blue	75° to 80° C	
Fuel Pressure	Red	2½ Lbs/□"	
Boost "	Red	1·75 Lbs/□"	maximum pressure of Gas
air Pressure	Black	200 Lbs/□"	air Bottle Starter.
Cyl Head Temp	"	180° C	Thermo Coupled
R.P.M. indicator	"	2000 Revs	50/70 Drop with Mag
Fuel Content Gauge	"		

when Running up plane between 600 900 Revs

Storage of Engines. engines run on T.E.L. suffer to the excess with corrosion if engine is to be stored: -

1. Run off all fuel & oil swill out with L.F.P. refill with DTD 224 and fresh oil enough to run engine for 20 minutes to half a hour at 1000 R.P.M.
2. Drain oil system & fuel cleaning filters ect and seeing that all condensation is removed from Cyl. with a Syringe and Piston at T.D.C.
3. Place piston on B.D.C. on Power stroke & Spray Cylinders out with anti corrosive inhibitor.
4. Replace fillers.
5. fit dummy plugs and blanking off Plates
6. Turn engine every 28 days. say treat like above for anticorrosion every 6 months

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JUNE 30TH 1941

MAINTENANCE

Publications issued with Aeroplane.

Form 700 aeroplane maintenance form
" 171 Pilots forced landing report form.

Engine Log book - Airframe log book.

ENGINE PUBLICATION.

Vol I Engine handbook.
" II. PART I. General. orders & modification.
" II. " II. Maintenance Schedule
" II " III. Instructions for Repairs

~~Vol III. " I. List of Spares & Stores Ref Numbers~~ ✓
~~" III " II. Appendix "A"~~
~~" III " III. Weights Sheet Summary~~

Engine Vol II part I General orders of Modification
" " 2 Schedule of Fits & Clearance
" " 3 Instructions for Repairs
Vol III List of Spares in Stores & Ref No

AEROPLANE PUBLICATIONS

VOL	I		aeroplane handbook.
"	II	PART I	General orders & Modification
"	II	" II	maintenance Schedule
"	II	" III	Instructions for Repairs
VOL	III	" I	List of Spares & Stores Ref No.
"	III	" II	Appendix "A"
"	III	" III	Weight sheets Summary.

M/AINTENANCE comprises :—
Inspection, cleaning & anti corrosive treatments. Lubrication Repairs VOL II PT III. Replacement embodiment of modifications Testing to ensure maximum serviceability with the least expenditure of time - Labour & spares.

PERIODICY OF INSPECTION For inspection purpose aircraft are divided into Groups "A" & "B". Group B is Training Command. & group "A" is Operational. The inspections are carried out at definite intervals as follows.

GROUP "A"

Daily inspections in between flights 10 hrs if necessary.

MINOR	40 hrs after		40 hrs
	40 x 40*	after	80 hrs
	40 x 40**	"	120 "
	40 + 40*	"	160 "
	40	"	240
	Major		240 hrs
Lastitude	Daily or	minor Repair	4 hr
"	"	max -	10 "

GROUP "B"

Inspection before flights I.B.F.

MINOR	30 hrs	after	30 hr
	30 + 30*	"	60 "
	30 + 30**		90
	30 + 30*		120
	30		150
	Major		180 hrs
Lastitude	minor		3 hr
M	Major		6 "

To facilitate the inspections of aircraft it is divided into assembly groups.
Power plant P.P. airscrew A/S. Cockpit C.O.
Fuselage F.V. Main plane P.L. Gun turrets G.T. undercarriage U.C.
Tail unit T.A. General G.E.

By the further use of numerals the inspection & items can be indentified - IE

P.P	301	1st ITEM	30 hrs inspection	of Power plant
C.O.	411	11TH "	40 hrs "	" Cockpit
G.E	419*	19TH "	40* hr "	General
P.L	1823	23rd "	180 "	main plane.

UNIT MAINTENANCE ORDERS (U.M.O.S.)

U.M.O.S. are issued in two parts. Part 1 is issued by the Station commander & Part 2 by the Squadron Commander

PART I These orders describe the unit maintenance organisation coordination the technical work on the Station. Define individual responsability. ensures maximum serviceability of aircraft & equipment covers the procedure to be adopted by the workshops ensures the adequacy of the maintenance records & the safety of flying personal.

PART II These are based on Vol II Part II (Aeroplane) The maintenance schedule. The squadron Commander amends the Vol II Pt II by additions necessary to suit local conditions U.M.O.S. Pt 2 are therfor the maintenance Schedule for the A/C at that particular Station.

THE MAINTENANCE ISPECTION RECORD FORM M.I.R.F.

This form is used when carrying out minor or major ~~Repairs~~ Inspection on the aircraft it is prepaird by the N.C.O i/c of flight from U.M.O.S. PART 2 and is in fact a abbreviated maintenance schedule.

The items listed in the form inspection by the Flight/Mech/ if found to be in order a ✓ is placed against the item and initialed. if the item is faulty a ✗. After all the items have been dealt with in this manner the form is given to the servicing Party consisting of fitters I & II who rectify the faulty items & put their initials in the rectifying column. The completed form is then Kept in Squadron Engineers office

INBETWEEN FLIGHT INSPECTION D.I.

1. See any Reports on Form 700
2. See the Switches are in the OFF position
3. Replenish the tanks as necessary & see that filler caps are secured.
4. examine the fuel, oil & coolant systems for obvious leaks
5. See that engine cowling is correctly secured
6. Report to Pilot

Modifications

A modification is a change in design or material authorized by the air ministry. Four main class of mods are issued

I modifications of the first importance, and allows for the safety and limitations of flying:

II urgent modification for full efficiency in all service equipment

III These are simples for work which comes within the Squadron Maintenance Personel, and are fixed by the Local Commander.

IIIA These are mods of improved design for fitting a interchangeable modified part.

IIIB simple & do not involve the supply of Parts.

IV used only at makers works & when specially instructed by maintenance unit repair depots or civilian Repair organisation

IVB. modifications are for improved designs & will be embodied by makers during Construction

DOCUMENTS TAKEN ON CROSS COUNTRY FLIGHTS	DOCUMENTS TAKEN ON DETACHMENTS	DOCUMENTS ESSENTIAL T.O.A. PERIODICAL INSPECTION
F700 TC F171 UMOS PRT 2 *SOMETIMES AEROPLANE HDK IS CARRIED.	F700 TC. F171 VOL I AERO HDK VOL 2 HJ ARCO VOL I ENGINES HA M.I.R.F. UMOS PT 2	F 700 UMOS PT 2. VOL I AERO VOL I ENG M.I.R.F. *ANY OTHER NECESSARY PUBL WILL BE INDICATED IN UMOS PRT 2

FORM 700 Travelling Copy.

To enable a Record of Work done on a aircraft to be kept whilst it is on a Detachment flight it carries with it a F.700 known as the travelling Copy. This is a standard F700 with travelling Copy written across the front page. Any entries that are made in the T. C. are copied into the original F700 on the M/C's return & entries are certified by the pilot.

When preparing a T.C. the following entries are necessary

1 Type of aircraft engine series
2 Capacity of tanks & type of fuel
3 When next 2 inspections are due
4. Total hours flown to date
5 any peculiarities.

BATTLE 30 hr inspection

P.P. 301 Remove & clean Sparking plug reset gaps & test.
" 302. examine Cyl sides for signs of gas leaks.
" 303 See that the induction manifold flang nuts are tight.
" 304 Examine exhaust flange nuts for tightness & for cracks & burning.
" 305 Lubricate control shafts at rear of Engine.
" 306 " coolant pump spindle
" 307 See that the air intake pipe is secured.
" 308 examine unions at pressure pump inlet & Scavenge pumps outlet.
" 309 test tightness of engine holding down bolts see rubber packing is not perished for pitting & burning
" 310 Check gaps between mag C B point in fully advance position check
" 311 examine C.B. Springs for discolouration.
" 312 See gauze Vents on Mags are cleaned.
" 314 examine throttle & boost controls for security wear & excessive play in links lubricate pivot joints & check settings.
" 315 Remove & clean filter in fuel pipe line
" 316 " " " oil pipe lines
" 317 " " the front & rear filter (Scavenge)
" 318 examine flexible fuel pipes for crushing & damage.
" 319 examine Oil & coolant pipe see unions are properly locked.
" 320 examine flexible hose at the Hydraulic System driven engine pump
" 321 Lubricate boost control
" 322 examine Coolant Tank & system for leaks
" 323 Examine HT & LT. Leads for serviceability
" 324 " engine Cowling fastened for security.

C.O. 301 Check setting of throttle & economical boost control hand lever
C.O. 302 Check position of fuel cocks remote control & ensure that position of cock agrees with position of control.
F U 301 See that the fuel pipes vents are clean
N.B. the outlet of vent pipes face forward in the Arial mast
P.L. 301 examine fuel & oil tanks for leaks & security.
" 302 " Flexible fuel pipes for cracking & damage.

Ionisation.

When a electric Spark Jumps across a air gap. Splitting up small % of the air to form Ozone & Nitrate oxide this process is called Ionisation the Soluble nitrate oxide dissolves in any moisture that condenses in the mag so causing corrosion.

AIR PUBLICATION.

A.P. 1464 Engineering manual of the R.A.F.
This is in 3 VOLUMES as follows.
1464 A. VOL I. General Workshop principles & practice
1464 B VOL I Description of Workshop & aerodrome Equipment
1464 VOL 2 General Orders & Modification
AP 1374 Aero engine magneto
A.P. 1275 Instrument Manual.
A.P. 1574 Maintenance Regulation 3
AP 1538 Airscrew Manual

FLIGHT DESK.

AIRFRAME MODS	ENGINE MODS	FORM 700
VOL I AEROPLANE	VOL I ENGINE.	UMOS PRTS 1 & 2
VOL II PRT I	" II PRT I	AP 1464 VOL I & II
" II " II	" II " II	A.P. 1374
" II III	" II " III	A.P. 1574
Sometimes modification of extra forms such as coolant charts etc.		

PAGE	ITEM.
3 to 9	Basic
3 " 5	Tools.
5	Straight Carbon Steel
6	Low Carbon Steel
6	Alloy steels
7	Aluminumum + Alloys.
9	A.G.S.
10 To 24	Prebom engines
25 - 36	Magnetos.
37 " 44	Carburettors
45 " 49	Pegasus engines
50 68	Rolls Royce Kestrel Engines
6 8 70	Augers
71 75	Starters
75 77	Coolants
78 79	Tanks
79.	oil coolers.