LAC TWELLS

Form 714.

ROYAL AIR FORCE.

Rough Notebook for use in Laboratories and Workshops.

01020 Wt. 2807 125,000 Bks. 7/42 KJ Ltd.

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$5\frac{11}{35} + \frac{4}{15} + \frac{1}{4} + \frac{1}{35}$

$= 5\frac{11}{35} + \frac{4}{15} + 11\frac{9}{40} + 16\frac{3}{21}$

$= 32\ \frac{264\ 504\ 180\ 520}{840}$

$= 32\ \frac{1468}{840}$

$33\ \frac{628}{840}\ \frac{13}{21}$

$23\ \frac{64+32+40+27}{120}$

$= 23\ \frac{183}{120}$

$= 24\ \frac{63}{120}\ \frac{21}{40}$

$4\frac{9}{20} + 12\frac{4}{15} + \frac{9}{40}$

$= 23\ \frac{105\ 32\ 4}{120}$

20 4×5
15 3×5 $= 23$
12 3×4
40 $4\times5\times2$
$4\times3\times5\times2 = 24$
120

$23\ \frac{2}{120}$

$= 24\ \frac{114}{120}$

$4\frac{13}{14} + 4\frac{29}{51} = 13\ \frac{623+491}{867} = \frac{1114}{867}$

$= 1\frac{247}{867}$

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~~$15\frac{3}{8} - 3\frac{1}{2} = \frac{123}{8} - \frac{28}{8}$~~

$15\frac{3}{8} - 3\frac{1}{2} = 12\frac{3}{8} - \frac{4}{8} = 11\frac{7}{8}$

$\frac{7}{9} - \frac{2}{3} = \frac{7}{9} - \frac{6}{9} = \frac{1}{9}$

$15\frac{1}{8} - 4\frac{3}{11} = 8 - \frac{48-24}{88} = 7\ \frac{75}{88}$

$23\frac{1}{4} - 10\frac{9}{10} = 13\ \frac{10\ \ 61}{40}\ \frac{20\ \ 68}{40} = 12\ \frac{14}{40}$

$10\frac{1}{19} - 5\frac{3}{20} = 5\frac{420\ \ 54}{380} = 4\ \frac{343}{380}$

~~$8\frac{1}{2} - 3 \times 1\frac{1}{2} - 4\frac{1}{3} = 5\frac{3}{6} \times 6\frac{3}{6} - 4\frac{2}{6} =$~~

~~$5\frac{3}{6} \times 2\frac{1}{6} = \frac{23 \times 13}{6} = 49\frac{5}{6}$~~

$6\frac{1}{3} - 3\frac{2}{5} = \frac{80-51}{15} = \frac{29}{15} = \frac{4}{15}$

$\frac{1}{2} + \frac{3}{4} + \frac{5}{6} \div \frac{2}{3} + \frac{1}{4} + \frac{4}{6} = \frac{6+9+10}{12} \div \frac{8+3+14}{12}$

$= \frac{25}{12} \div \frac{25}{12} = \frac{25}{12} \cdot \frac{12}{25} = \frac{1}{1} = 1$

$\frac{3}{4}$ of $\frac{4}{23}$ of $\frac{13}{18} \times \frac{17}{42} - \frac{1}{3} + \frac{19}{117}$

$\frac{4}{28} \times \frac{4}{3} = \frac{28}{64}\quad \frac{13}{18} \times \frac{69}{28} = \frac{897}{504}$

$\frac{17}{42} - \frac{1}{3} = \frac{34}{216} \cdot \frac{17}{108} +$

475 14 6 285 9 294

$6\frac{1}{15} - 4\frac{3}{20} = 2\ \frac{4-9}{60} = 1\ \frac{55}{60} = 1\frac{11}{12}$ -

$1\frac{2}{11} \times 1\frac{1}{10} \div 1\frac{1}{5} = \frac{13}{11} \times \frac{11}{10} \times \frac{5}{6} = \frac{13}{12}$

$\frac{23}{12} \times \frac{12}{13} = 1\frac{10}{13}$

$\frac{105}{2} \times \frac{1}{100} \times \frac{216}{5} = 21 \times 24 = \frac{504}{25} = 504 \div 25 = 20\frac{4}{25}$

50 4 50 / 4

$\frac{45}{2} \times \frac{96}{60} = \frac{230}{1} \times \frac{12}{5} = 5)\ 2544 \quad 508\frac{4}{5}$ 127 254 508

$50\frac{4}{5}$ miles $\frac{254}{5} \times \frac{294}{6}$ 1141 = 254 15)37398(2 19 19 171

$\frac{95}{2} \times \frac{19}{6} \div \frac{96}{60}$ 810 $\frac{19}{1} \times \frac{19}{6} - \frac{8}{2}$ 43 19 6)7616(761 60

95/2 ×

1,10000s

1 | 324
28 224
21
1400
1224
176

1 | 324
28 224
224

220
1356
1476
305
245
1225

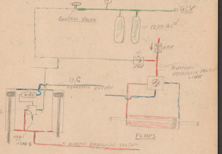
Airscrew Efficiency $\frac{\text{Thrust HP}}{\text{Brake HP}} \times 100\%$

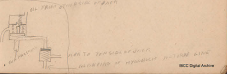
E.G. Engine develops 1000 HP
Airscrew develops 800 HP

Airscrew Efficiency $\frac{THP}{BHP}$ 100% = $\frac{800}{1000} \times 100\%$ = 80%

EMERGENCY AIR

~~[illegible]~~ Air bottle on rear of front spar filling point in the bomb compartment. Pressure 1,200 lbs □" Works the U/C when valve is turned on but not the flaps until selected control valve on starboard at front of front spar





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Hydraulic System

Two Dowty gear type pumps fitted on inboard engines. Supply the high pressure oil necessary for the following services A/C B D FLAPS Fuel jet Hot and Cold air for bark. The following selector with valves fitted in the system direct the high pressure oil independantly to each service. 1 U.C control valve

Fitted on right hand side of Pilots seat and has only two pos for lever up or down

2 BOMB DOORS Fitted on left hand side of Pilots and is a similar valve as U.C

3 FLAPS Fitted in front of the trimming tab pedestal right hand side of pilots seat the plunger moves up or down for the opperation of flaps this valve however is provided with a neutral position which forms a hydraulic lock to both pressure and return lines of flaps so enabling flap to be set in any given angle

Hydraulic Accumulators

This is fitted in the system charged with a initial air pressure of 220 lbs □" to absorb the increasing pressure caused by the opperation of either the Fuel jet or Hot and cold air and so prevent chattering at the valve in the A.C.O

When the hydraulic is velling sufficient pressure (i.e 850 lbs □") is stored in the elect to opperate the Hot and Cold Fuel jets will cut, the A.C.O cutting in. This also will also maintain any small leak at the system jacks or in the ret line after the cut out to lost initial air pressure. Make a selection of one of the services so allowing the oil in pressure to become slack and the air pressure only will register on the gauge

Emergency Air System

Compressed air at a pressure of 1200 lbs □ is stored in a bottle fitted on the rear face of the front spar and controlled from a valve on the starboard side of the spar will opperate ~~both~~ the U/C or Flaps should the Hydraulic system fail.

Lower U/C Open control ~~valve~~ valve the air will be directed to via the emergency air valve and non return valve to the down side of the jack as the air does not pass through the normal hydraulic lines or selector it is not necessary to select U.C down when using this system.

Flaps When lowering the flaps by this system a selection of the control valve must be made as the air enters the normal hydraulic pressure line ~~before~~ the control valve and is then directed along the normal lines to the jack

Note When lowering the U/C the flap selector must be kept in ~~neutral~~ neutral Flaps to be opperated once

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A AND B 1 pts TAKES 3 HRS $= \frac{3}{3} - \frac{1}{3} = \frac{2}{3} = \frac{3}{2} = 1\frac{1}{2}$

A + B + C FILL $\frac{1}{8}$ A B $= \frac{1}{12} = \frac{3}{24} - \frac{2}{24}\ \frac{1}{24} = 24$ MI

$4\frac{3}{4} + 9\frac{7}{8} + 1\frac{2}{3} = 14\ \frac{18+21+16}{24}\ 14\ \frac{49}{24} = 19\frac{7}{24}$

$\frac{5}{8}\ \frac{7}{12}\ \frac{17}{24}\ \frac{13}{16}$ $\quad \frac{5}{8} + \frac{7}{12} = \frac{28+30}{48} = \frac{34+30}{48}$

$= \frac{\cancel{46}\ \cancel{58}}{24} - \frac{73-58}{48} = \frac{15}{48} = \frac{5}{16}$ ANS $\frac{5}{16}$

$\frac{5}{16} \times \frac{12}{25} \times \frac{5}{9} = \left(\frac{1}{3} + \frac{1}{8}\right) = \frac{1}{4} \times \frac{1}{3} \div \frac{11}{24}$

$= \frac{1}{12}\ \frac{24}{11} = \frac{24}{132} = \frac{2}{11}$ ANS $\frac{2}{11}$

$\frac{220 \times 1760 \times 36}{4840}$ $\quad \frac{55 \times 176 \times 36}{121}$

$= 5 \times 16 \times 36 = 1152$

$\frac{220 \times 1760 \times 36}{4840} = \frac{5 \times 16 \times 36}{} = 2880$

$\frac{918 \times 58}{612 \times 812} = \frac{13804}{6902}$

$\frac{54 \times 40}{1285 \times 15} = \frac{18 \times 8}{1285}\ \frac{144}{1285} = T - 49$

$T = 49\ \frac{144}{1285}$

$\frac{350}{1} - \frac{1}{7} = 350 - 50 = 300$

72 MRC

$\frac{60}{156} = \frac{5}{13}$ $\quad \frac{27}{981} = \frac{3}{109}$ $\quad \frac{54}{60} = \frac{9}{10}$ $\quad \frac{28}{42}\ \frac{2}{3}$

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$\frac{1 \text{ INS}}{2 \text{ MILES}} = \frac{1}{126720}$

·250 ·345 ·5625

1 STARTING AND TAKE OFF BRIEF

1 Fuel cross balance cock to be shut for normal use

2 Switch on Fuel contents gauge and leave on during flight

3 Test each emersed pump by ameter before starting reading 2 to 4 amp otherwise ~~pump~~ pump U S leave immersed pump in 1 and 2 tanks on until after take off

4 Start engines on No 2 Tanks

5 Warm up run up and Take off on No 1 tanks

6 Watch for Fuel pressure warning lights during take off and if red light appears turn the appropriate tank selector cock to No 2 tanks on hand as convenient

7 If take off is OK change over to No 2 tanks and switch off emmersed pump in No 1

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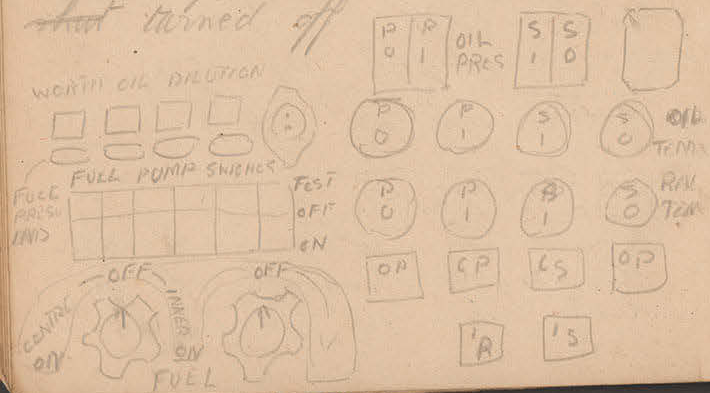
Transfer fuel from No 3 tanks to No 2 as soon as space is available. Switch of immersed pump when No 3 tank is empty

Cross balance cock is for emergency use only. Under it is required to run all engines from one tank only one tank is to be on when cross balance cock is open and engines for that tank must also be on

If a prop has been feathered or and engine failed it inside fuel cock must be ~~shut~~ turned off



Action to be taken if damage to Fuel Tanks

Should slight damage be sustained the gauge should show a slow leak run all engines of leaking tank

1 Switch on immers pumps in damage tank
2 Open cross balance cock
3 Turn appropiate selector cock to leaking tank
4 Turn the other tank selector cock off. When the leaking tank has been emptied run all engines on off the same tank on opposite side in order to balance A/C

SERIOUS DAMAGE

Indicated by needle dropping quickly and will not be possible to run all engines of leaking tank. To maintain balance of A/C how ever it will be necessary to run the engines on the off the same tank on the opposite side

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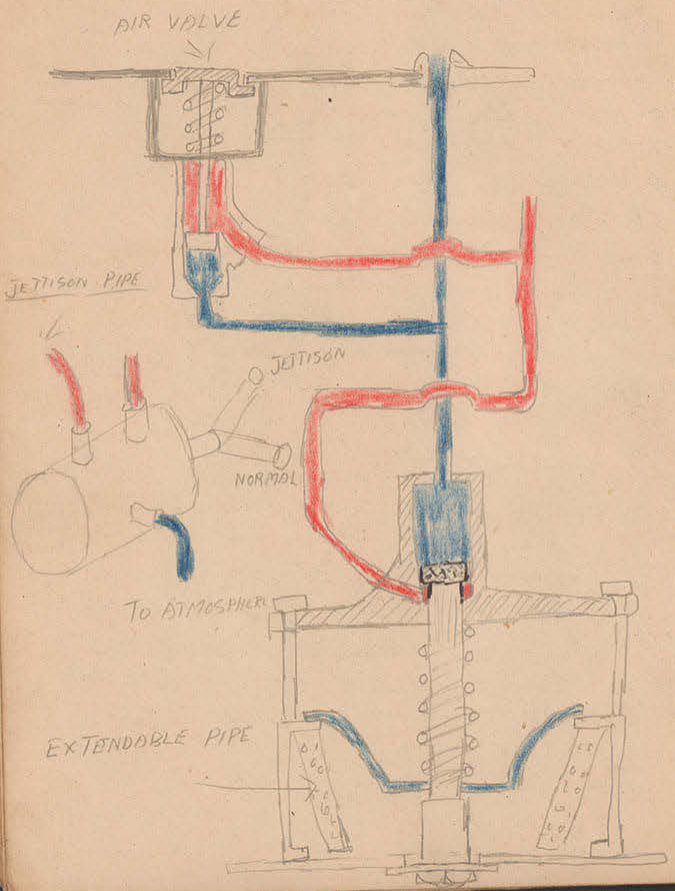
FUEL JETTISON SYSTEM



Fuel Jettison

2 Valves are fitted in each No 1 tank for the purpose of jettisoning fuel they are Hydraulic opperated and controlled by a rotary valve sealed on the port side of pilot seat (RED HANDLE) Opperation of this control allowers Hyd pressure to open the air vents and fuel jettison valves Fuel is then jettisoned through a colaspable tube which extends when the jettison valve opperates When the required amount of fuel has been jettisoned the CONTROL valves should be returned to its original position Thus allowing the springs to return the valves to the closed position the oil displaced being directed to atmosphere during the action of jettisoning the following instructions must be carried out speed reduced to 150 to 115 M.P.H and flaps lowered 15° 20°

ALLOWERS

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GRAVINER FIRE SYSTEM

A 3 pint Grav Fire Ext containing methyl bromide is mounted on the bulkhead behind the each engine when the Ext is operated the methyl bromide is sprayed in the form of a gas around the spark plugs and into the choke of carb. This gas has a smothering and cooling affect on the fire but has no detrimental affect on the engine

OPPERATION

1 Push button on the starboard of instrument panel. one per engine

2 Flame sw two of these switches mounted on each engine bulkhead if either of these switches are subjected to a temp of 140 to 150 C the ext for that engine is operated

INERTIA Mounted on starboard side of nose of fuselage this switch operates the ext for all engines when the deceleration of A/C exceeds 6G

GRAVITY SWITCH Mounted on Starboard side of nose of F.U operates when A C is upside down an U/C is locked down

1 Port Side of Nose ½ GALL
2 Port " of Pilot seat ½ GALL
3 Navigator Position Starboard side ½ GALL
4 Front Spar Starboard Side 1 GALL
5 Flare station Starboard side ½ GALL
6 Rear gunners station starboard side ½ GALL

ACTION TO BE TAKEN IN EVENT OF FIRE ON ENGINE

1 Turn off Fuel at c inertia on that engine open throttal fully. If fire does not go out. Switch of ignition feather the prop press button

2 for fire extinguisher of onboard turn off cabin heating system Do not attempt to restart engine

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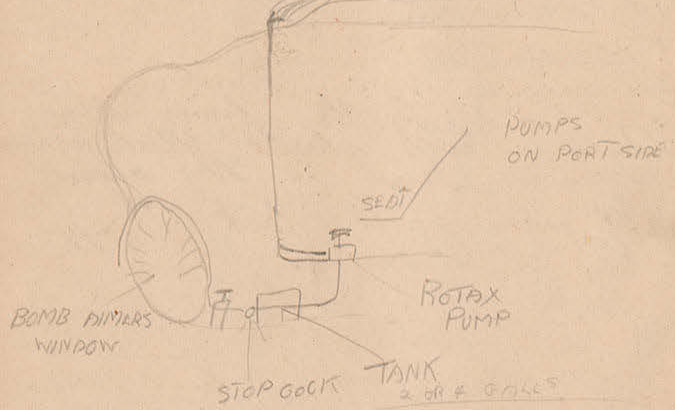
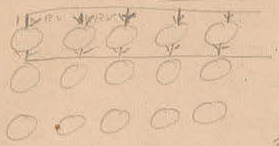
Action in the event of Fire in Tuselare

Warn the rest of crew on intercom to wear oxygen masks turn oxygen to counteract methyl bromide fumes attack fire with extinguishers with as many of the crew as are available. When fire is extinguished open windows to clear fumes

ANT-ICING



OXYGEN



PRESURE 18,000 □"

Ground test when flow indicator is not fitted Set regulator to 30 place end of thick rubber ~~pipe~~ tube near ear when if economiser is working normally slow puffs of oxygen will be felt and heard at 5 to 9 puff per minute

FLOW INDICATOR FITTED

Set regulator to 30 connect up mask and breathe slowly flow indicator needle should flick across with each breath as bag empties

If you suspect lack of oxygen turn to emergency

PORTABLE OXYGEN BOTTLE

7 cm it is supply last 10 mins amount indicated on gauge

10 - 15,000	+	OXYGEN / AIR
20 25000	++	
30 4,000	+++	

OXYGEN WILL LAST

20,000 4 HRS
30000 2½ HRS

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PYROTECHNICS A.P. 1661

FLAME FLOAT YELLOW AND RED
SMOKE FLOAT YELLOW - GREEN
ALUMINIUM SEA MARKER MARK IV
SILVER WITH YELLOW BAND
MARK V ALUMINIUM SEA MARKER
~~MARINE DISTRESS SIGNAL~~
MARINE DISTRESS SIGNAL

1½ INCENDIARY BOMB

Flare Float rec outer body painted red inner body or float yellow punch attached to tail vane ring uses Nav by night at sea airsea rescue work emmergency flare path when ditching Seting and launching Process sealing disc with punch and remove remove safty pin and nose cap launch tail first Precaution must be launch if sealing disc is moved

Smoke float
body green tail ring and four yellow half inch round nose. pistol adapter screwed in tail uses Nav and by day at sea air sea rescue work. seting and launching remove safty pin and launch tail first precautions ensure that arming vane is free to rotate replace pin if not used.

Aluminium sea marker MARK IV
Streamline in shape painted aluminium and half inch red band round nose uses to mark position at sea and provide a target for bombing at sea seting and launching remove transport pin and launch tail first replace pin if not used

MARK V. ~~send~~ round in shape telescopic and painted all aluminium uses same as MK IV

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Extend fully and launch nose first, collapse if rod used

14 lb destructor incendiary painted red with instructions on the side

Uses For the destruction of A/C down in enemy locality

Take off ~~all~~ Tape and remove cap and spike hard dispose of bomb as soon as nose is struck

Signal Cartridge $1\frac{1}{2}$"

Recognition classified in 5 groups

A double star identified by two coloured crayons on case

B Changing ~~coul~~ ~~color~~ colour bands on cartridge case

3 Single ~~colour~~ coloured identified by single coloured band on cartridge case cartridge case ~~or~~ has a milled band in the case of a red signal

D Smoke puff identified by a coloured serpentine on cartridge case

E ~~Illumina~~ Illuminating case longer than other groups wide white band round cartridge case uses Signaling and ~~recon~~ ~~Recognition~~ recognition

MK 1 TO 4 RECCO FLARE WITH MK II 42 FUSE

FT	FUSE NO
3,000	3
4,000	4
5000	6
6000	6
4000	8
8000	8

Mark 1 to 5 black case with $\frac{1}{2}$" red band ~~Four~~ Fins around body at tail.

MK 5 RECCO FLARE

Not to be droped below 5,000 ft

Fuse opposite marked in numbers

FEET	FUSE NO
5000	3
6000	4
7	6
8	6
9	8
10	8
11	10
12	10
13	12
14	12

To launch ~~[illegible]~~ connect static line to cable on fuse and launch tail first

Mark V has the words delay on side

uses for lighting up target area for the purpose of identification by night

No 42 MK2 Fuse is screwed into nose and the appropiate

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delay capsule inserted ~~that~~ on ~~the~~ Flares a delay capsule normaly for use at an altitude ~~2000 feet~~ a capsule 2000 feet less is used launching as for photo flash. precautions as for photo flash.

Photo Flash

Round in shape with four fins at tail body black fins and tail red half inch band round nose and the word flash in white. Uses lighting up of target for night photo.

Setting and launching the 848 fuse is screwed in to the nose and an appropriate capsule inserted all capsules preface with the letter P. Place photo flash or flare chute tail first and suspend by means of lug provided on the release mech. attach static line to arming vane cover and remove safety pin launch by tipping mech on either manualy or elect. Precautions ensure that the nessesary capsule is in position prior to launching, ascertain that release mech is cocked before placing flash in position replace safty pin and disconnect static line before removing from chute

~~65~~ ~~HYDRAULIC SYSTEM~~

ELECTRICS

~~240 - 3~~ .05
~~48~~ ~~2700~~

V = PRESSURE

I = AMPS CURRENT

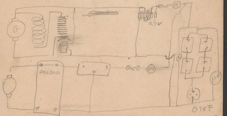
R = POWER (746W = 1HP) ~~Amps~~ 4. 7. 17. 37. 64

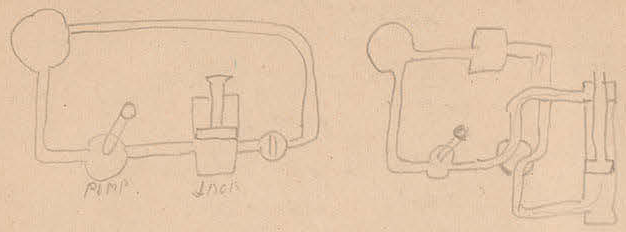
FUSES 5. 10. 20. 25. 40. 60.

Fuses on Lancaster are ~~on~~ all in bottom of Electrical Panel just down wards of front spar

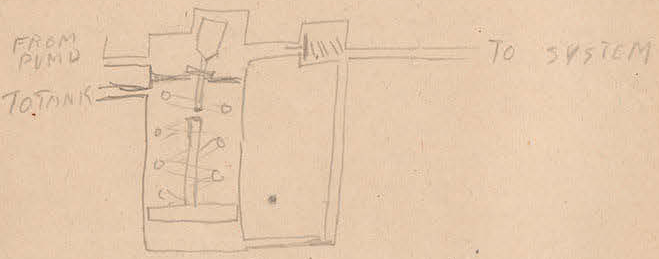
Battery are 12 volts 40 amperes ½ lead acid accum situated behind the rear ~~spar~~. ~~at~~ front spar 10 hour rate the rate that you can discharge accum will ~~ff~~ to test accum with voltmeter switch of at the 10 hour rate (8 amps) for 5 mins then take reading of voltage is ~~to~~ below 24 volts should be charged.

Two generators fitted to inner engines shunt wound 29 1500 W.





DOWTY AUTOMATIC CUT OUT



PRESSURE = $\frac{\text{FORCE}}{\text{AREA}}$ = lb □"

DENSITY MASS PER UNIT VOLUME

lb/cu ft gram / cc

WATER .62-5 lb/cF 1 gram / cc

(1 GALL WEIGHS 10 lb)

SPECIFIC GRAVITY $\frac{\text{DENSITY OF SUBSTANCE}}{\text{DENSITY OF WATER}}$

1C = NO OF TIMES HEAVIER THAN WATER

LAWS OF FLUID PRESSURE

1 PRESSURE TRANSMITTED ~~TH~~ ALL EQUALLY IN ALL DIRECTIONS

2 PRESSURE IS ALWAYS AT RIGHT ANGLES TO SURFACE

3 PRESSURE AT A POINT IN A FLUID = DENSITY x DEPTH / 144

4 LIQUIDS ARE ALMOST INCOMPRESSIBLE

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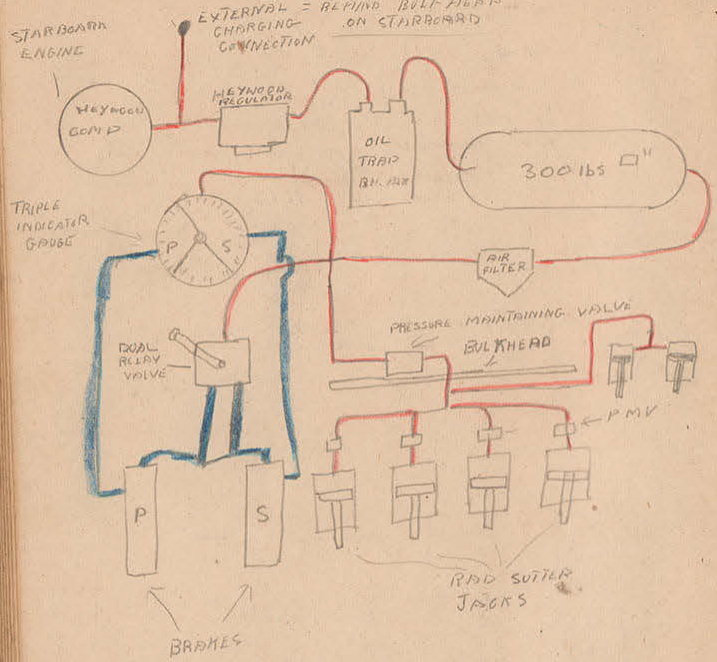
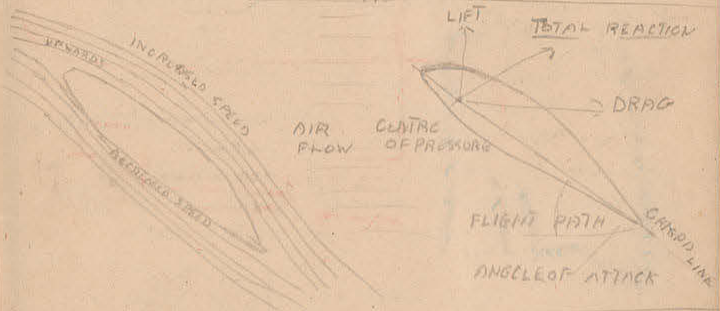
PNEUMATICS



AEROFOILS

BENOUILLIS THEOREM

The total energy of a fluid is constant, Thus since this is principally Kinetic energy and pressure energy then an increase in speed will cause a decrease in pressure and vice versa (Venturi Effect)



ANGLE OF ATTACK	~~ANGLE OF ATTACK~~ L	D	L/D
− 4°	20	9	2·2
− 2°	30	8	3·66
0°	48	9	5·33
2°	63	10	6·3
4°	76	11	6·9
6°	85	12	7·0
8°	103	14	7·4
10°	112	16	7
12°	126	20	6·25
14°	106	26	4·1
16°	100	32	3·125

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AIR RESISTANCE (DRAG)

Depends on 1 Shape and attitude
2 Frontal area 3 air density (.077 lb ft³ at sea level)
4 (air speed)²

Types of drag - Form drag - due to shape (streamlining)
(Eddy resistance) reduced by

Fineness Ratio = Length / Max width
Best at 4 or 3 to 1

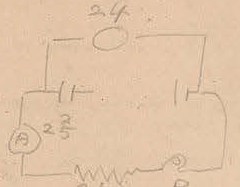
2 Skin Friction
Due to nature of surface
air viscosity = reduced by polishing and flash riveting etc

3 Induced drag - due to production of lift
reduced if by using high aspect ratio
tapering etc

TOTAL DRAG

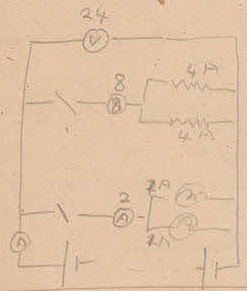
- Active Drag (due to lift surface)
  - Form Drag
  - Skin Friction
  - Induced Drag
- Parasite drag due to non lift surfaces
  - Form Drag
  - Skin Friction
- Interference drag due to interference between different parts

VOLTS = AMPS / OHMS VOLTS = AMPS × OHMS V × R = I



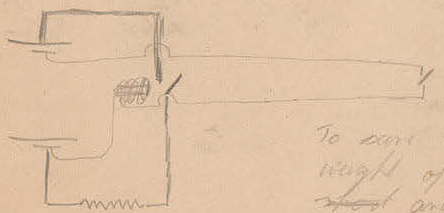
24/2.5 = 120/12 10 - 3 1/2
6 1/2 OHMS

PARALELS



A = A1 + A2

MAGNETIC RELAYS



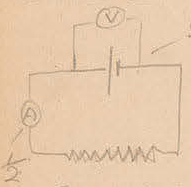
To save bulk and weight of cable and voltage drop and to keep the cockpit clear of heavy cable

The unit of E M F is the volt measured with a volt meter connected in parallel with the ~~circuit~~ circuit;

Current is measured in Amps by means of an ammeter connected in ~~series~~ with the circuit

Unit of res is the Ohm and depends upon length and gauge

OHMS LAW $\frac{V}{AMPS}$ = RES IN OHMS



For a current to flow in a circuit it is necessary to have 1 E M F 2. CONDUCTIVE MATERIAL COMPLETE CIRCUIT

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