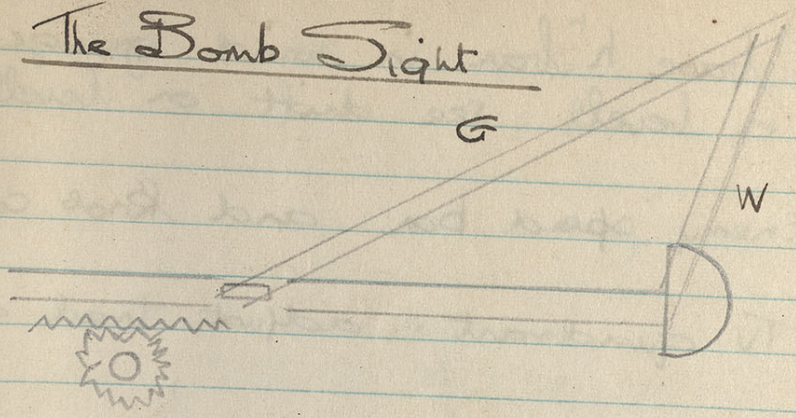
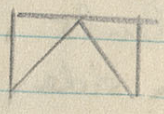
The Bomb Sight



Front to Rear

Parts



i. Drift wire extension
ii. Auxiliary drift wire

Ground Speed bar
G/S cursor which carries foresight
G/S cursor pos. by end of wind speed bar
In w.s.b. - a cursor rides up & down a hollow in bar - Positioned by w.s. knob
W.s.b. carried on end of A.S bar adjusted by A.S. drum.
Ht. bar and base on the end of G.S.b
On . . carried back sight adjusted by ht. setting knob at top
Ht bar and indicated on a detached ht. scale.

At base h^r bar in wind gauge bar
- a bevell, see drift on bevell + cursor

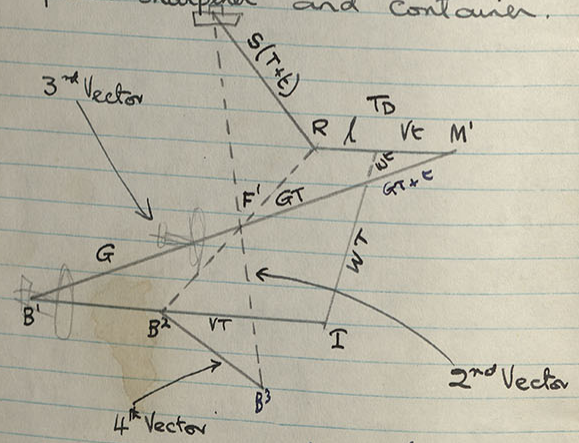
Enemy speed bar and Knob control

TV quadrant. adjust trail angle

Plan -:

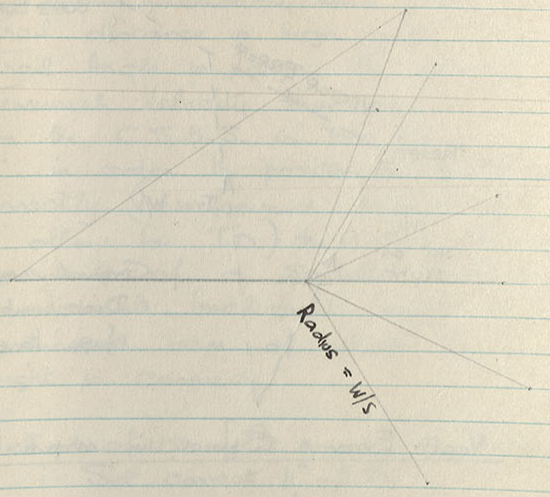
Bearing plate and Knob - cross levels, magnetic compass
On side bomb sight catch

Drift scale on top
Pencil sharpener and container.



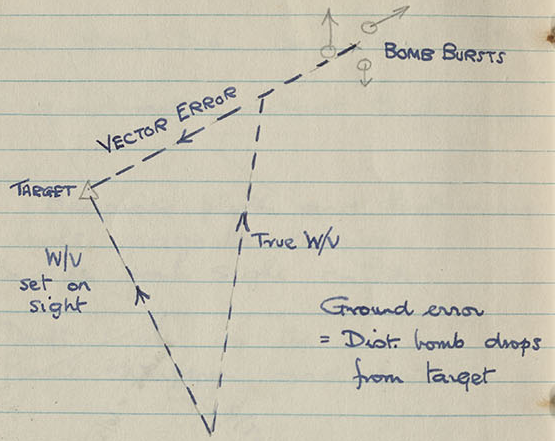
B', B², B³ : Backsight
F : Foresight
V : A/c. speed
I : Point of Impact (Ideal Bomb)
R : " " (Real ")

WT = Wind
l = Air Lag
Vt = Air speed for Time Lag
S = Enemy Speed



Probable results of bombing with out Keeping 'Red on Red'

If you do not keep 'on' while bombing, the wind direction bar will not be parallel to the wind, and the bombs will drop along the track instead of the Course. Thus they will tend to drop in a circle, the results will be a st line group, ~~with an arc~~ the st line being an arc of the circle, the radius of which will be the W/S.



Vector Error = Speed in m.p.h.

Use of The L.T.V. Attachment

Necessity —: On account of the low T.V. of the incendiary bomb (420 f.p.s.) Trail distance is high, and consequently Trail Angle is large. The minimum Terminal Velocity that can be set on the C.S.B.S. is 750 f.p.s. ∴ in order to position the back sight correctly (i.e. forward along heading to allow for T.D.) the L.T.V. attachment is used, consisting of a saddle, replacing the normal back sight, and carrying a hinged arm of which the back-sight is carried.

Method of use [Put correct H^r on H^t Scale]

i. Set correct H^r + A.S.
ii. " T.V. to 'INFINITY'
iii. " correct H^t. index mark against correct A/S curve on the hinged arm.

During run up

i. Keep hinged arm parallel to heading
ii " Backsights in line with foresights, &
iii Release bomb when in line with sights

Storage of the C.S.B.S.

i. Set A/S to max.
W/S to zero
E/S to "
ii Set Enemy direction to 90° or 270°
iii Set Hᵗ. on RED SCALE to 7000'
iv Set T.V. to 'INFINITY'
v. Fold Auxiliary Drift Bar over to left
vi Lower Hᵗ. Bar
vii. Fold Wind Guage Bar on to Bearing Plate
viii Slide bombsight on to spigot ensuring that Hᵗ. bar enters slot
ix Replace bracket if not installed in a/c taking care not to foul drift wires

N.B. Bombsights should be stored on wooden floors or battens not more than two high. A card bearing no. of a/c to which the Bombsight has been fitted should be placed in card holder.

Check other side
(d) Repeat with hᵗ bar in vert. position

(iii) Wind Guage bar

(a) Set zero E/S
(b) " " W/S
(c) " " drift should be indicated

(iv) Moving Parts

(a) set W/S to maximum
(b) " A/S = to W/2 x2
(c) Check max. drift in both directions (i.e to P. & S.)
(d) Max drift should be 30°

(V) Back Lash -

(a) Set max. W/S
(b) " " A/S
(c) Rotate compass bowl Knob until G/S - A/S
(d) unlock - set N. against lubber line
Lock
(e) Rotate bearing plate - clockwise 180°
(f) Reverse rotation until G/S-A/S
Check back lash (° degrees)

(a) – Unlock – put N. against lubber line and lock
(b) Rotate bearing plate anti clockwise 180° – Reverse rotation until G/S = A/S.

Check back lash° (degrees)

vi H^t Bar
(a) Set TV to infinity
(b) Test h^t bar vertically with incidence protractor – fore + aft. and laterally

---

H^t. 19600, A/S 150 m.p.h
Trail angle or λ = 2°
ℓ : 220 f^t.

Required Time lag
Trail Dist.
Length of h^t bar

Scale 50 f.p.s. = 1"

$$\frac{TD}{1} = \frac{\lambda H}{60} = \frac{2 \times 19600}{60} = 653\tfrac{1}{3} \text{ ft.}$$

Trail dist = $653\tfrac{1}{3}$ f^t

Data H^t. 12,100', A/S. 180 m.p.h
G. 270°, W/S 25 m.p.h, W/D 180°
E.S. 15 m.p.h.
Scale 50 f.p.s. = 1"

Find length of h^t bar in inches
Repeat for A/S, W/S + E.S, G/S bars.

Time of fall = $\frac{\sqrt{H}}{4} = \frac{\sqrt{12100}}{4} = \frac{110}{4} = 27\tfrac{1}{2}$ secs

Av. speed = $4\sqrt{H}$ = 440
OR $\frac{12100}{27\frac{1}{2}}$

Length of h^t bar = $\frac{440}{50}$ = 8.8"
. . A/S = $\frac{180 \times 22}{50 \times 15}$ = 5.28"
. . W/S = $\frac{25 \times 22}{50 \times 15} = \frac{110}{50 \times 3}$ = .734"
. . E/S = $\frac{15 \times 22}{50 \times 15}$ = .44"

Bomb Sight

Care of Maintenance

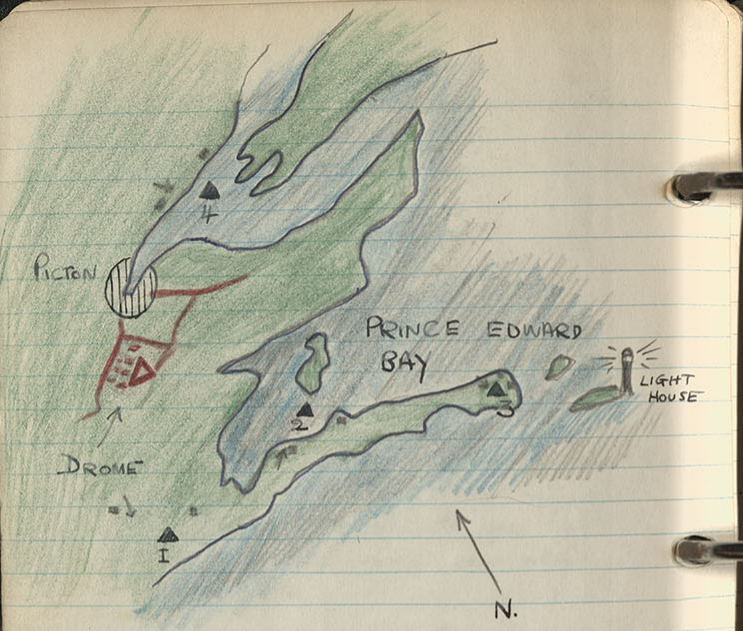
Points before flight

i. Check drift wires
ii Examine foresights
iii Check wind speed bar
iv Check ht setting knob
v " backsight
vi " locking and unlocking of bearing plate
vii Compass - check for bubbles in liquid and discolouring of same.

Mechanical Tests

(i.) Foresights (a) Adjust A/S until foresight is vert. over a pair of beads on one side
(b) Check that foresight is vert. over on opp. side

(ii) Backsights (a) Set zero E/S
(b) Lower ht bar
(c) Adjust back sight until in line with foresight & bead on one side



Note Targets on land are painted white
" " water " " orange

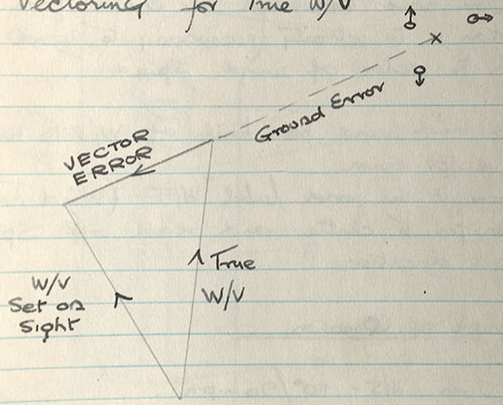
→ White arrow points to target.
▪ Huts.

PILOT'S ACTION	B.A's ACTION	PILOT'S ORDERS	B.A's ORDERS
Levels a/c flies at const. Hᵗ & A/S			
		Hᵗ & A/S 'STEADY'	Repeat
	Levels sight & checks settings		Ready to bomb
Turns towards Target		Turning on	Repeat
Straightens out			
Levels a/c Steadies Hᵗ & A/S	Keeps 'r on r'	No.... bomb selected	Repeats
Notes ground signal, selects bomb (BATTLE)	selects bomb (ANSON)	(BATTLE)	No.... bomb etc No.... bomb selected (ANSON)
Adjusts course to track over Target			
	Keeps 'r on r'	Attack ←	Repeat "Target sighted"
	Directs Pilot Keeps 'r on r'		
		Left, left or Right STEADY	
Corrects 5° at a time Not by steady turn			
	Releases bomb plots bomb on T32		No.... bomb gone No.... " plotted OR Time

PILOT'S ACTION	B.A.'S ACTION	PILOT'S ORDERS	B.A.'S ORDERS
Turns off on next circuit			

All steps in computing and position of bomb bursts to be recorded and the actual form handled in to the Plotting Office after the exercise.

"Vectoring" for True W/V



(a) Before bombing draw a vector of W/V set, on the T32, in towards the centre of rose and mark it W/S (Wind Speed)

(b) After bomb release set compass rose so that compass direction points ahead

(c) Plot bomb burst in correct dist. and direction assuming centre of rose to be target. Do this for first three bombs keeping sight settings the same. Mark centre of group M.P.I. and join to centre of rose with dotted line

This is average ground error in yards

(d) Refer to table at bottom of form and convert ground error to vector error drawing in thick

(e) You have converted the error from distance to velocity necessary to work in with the vector of wind Speed

True wind runs from tail of W/S to tail of vector error
Draw it in and label "W/T" (Wind True)
Transfer to centre and read off Speed and direction

Example of Question

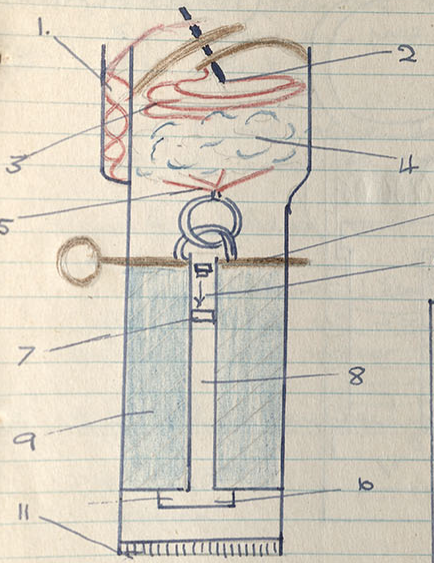
Given W/S = 110°/20 m.p.h
H^r = 7000 ft.

Bombs fall —:
i. 100 yds on a bearing of 225°
ii. 100 . . . . . 210°
iii. 110 . . . . . 220°

Plot bombs on chart (ie. form T32)
Find Vector error. & True wind

◇

4 INCH TRAINING FLARE

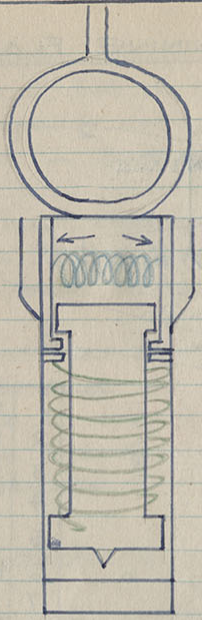


1	Static Cord
2	Retain pin
3	Parachute Cord
4	Parachute
5	Wire Cable
6	Pull Percussion Igniter
7	Percussion
8	Instantaneous Fuse
9	Candle Composition
10	Priming
11	Fusible Alloy Disc
12	Safety Pin.

Length of flare = 29"
Wt. of whole = 19 lbs
Diameter of Chute = 11 ft.
Duration of light = 3¼ Mins.

The whole is painted black with red band

PERCUSSION IGNITER ON 4" Training Flare



4½" Reco.
(No. 35 FLARE)

W/T Procedure for Aldis Lamp

VE = AAA (Plain lang
K = Carry on – pass your message
Q = Wait

Send 1 word at a time & switch lamp out at completion of each word

Receiver Acknowledges each word received by sending 'T'
IMI = Repeat (Send this immediately after word if not received clearly)
On last word receiver sends R = Message received

E.G. (Plain language)

A		B
VE AAA		K
Return		T
to		T
base + = A.R.		R

A.R. = End of message

E.G. (Sybo)

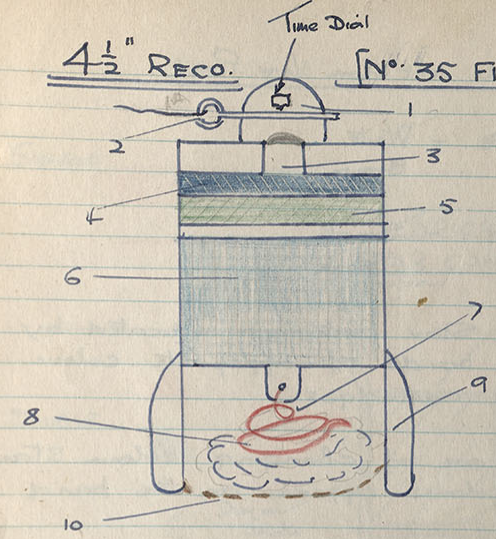
A.	to	B.
VE BT		K
VLFH		VLFH
C = correct (sent after each group repeated by B)		
BDGN		BDGN
C		
AND3 + C +		AND3

'W' : I am unable to read you - you are out of focus - may be due to bad background or out of alignment.

"LL" : Your light is too bright - diminish your light.

M.H. : Move higher up or further away
M.R. : . . to the right
M.L. : . . . left
M.O. : . lower down OR nearer in.
O.L. : Open light (used on when a station needs a mark to align its lamp
VE : General call

4½" RECO. [N° 35 Flare]



1. Fuse N°35
2. Firing plug of fuse
3. Magazine
4. Electric Charge
5. Priming
6. Candle Composition
7. Parachute Cable.
8. Parachute
9. Stabiliser
10. Closed Dome

Signals sent from Very Pistol

Smoke – White
Brown

Stars – Single
Double

Single Star cartridges indicated by single bands of appropriate colour round cartridges

In case of changing colour stars both colours appear on the band

Single Star Cartridges

Red
Green
White

Changing colour
White to Green
White to Red

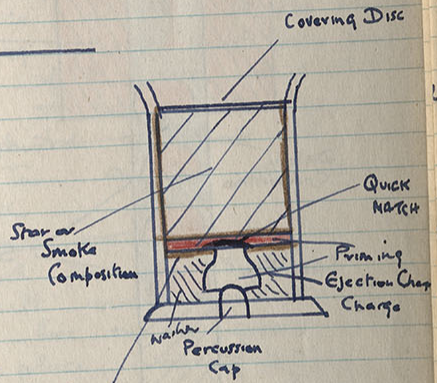
A RUBY coloured star cartridge has a 1½" band of same colour on the outside.

SINGLE

DOUBLE

SMOKE

TYPICAL STAR CARTRIDGE

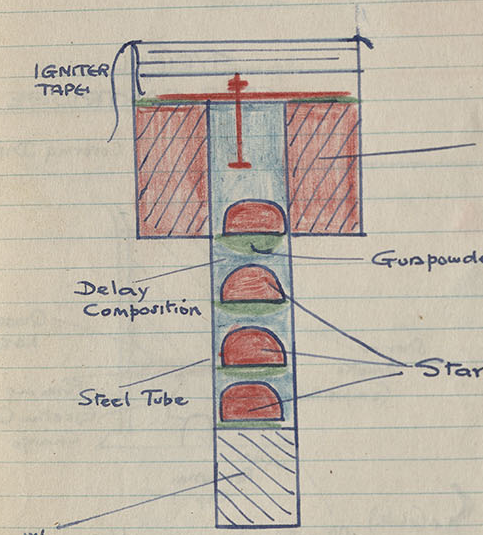


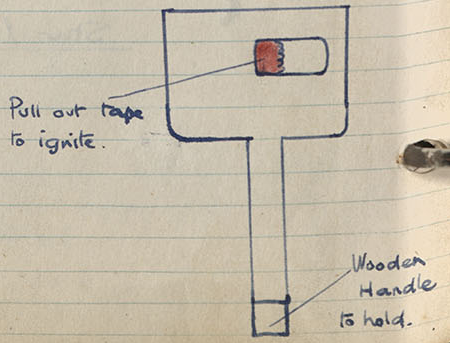
(White)

All within brown line blown out

Star lasts for 10 sec

SIGNAL DISTRESS
MARINE Mark III





Installation of C.S.B.S in Aircraft

i. Check for serviceability.
ii. Fit the levelling bracket inside the aircraft and sight to the aircraft.
iii. In the air damp out vibration by tightening up rubber pads.
iv. After damping out vibration land place a/c in flying position and drop plumb bomb bobs from the centre of the nose and tail.
v. Draw a st. line on the ground from plumb bob to plumb bob and if in a Twin engined a/c produce it forward
vi. Set Wind and E/S. to Zero and level the bomb sight
vii. The drift wires should now be parallel to line on the ground. If they are not place washers between the levelling bracket and the a/c as required to bring them parallel Recheck

N.B. Special laminated washers are supplied

viii. Swing the Compass

Azimuth Bracket
Method of use with steering indicator

1. With C.S.B.S located in central position the Bomb Aimer ensures that all the manual settings are correctly set on the bomb sight

2. When the target is located, the Bomb Aimer switches on the electrical supply disengages the locking latch and rotates bomb sight on the bracket until target is in the drift wires with red on red

3. As soon as the angle of turn is established the Bomb Aimer depresses both buttons, this is the executive signal to the Pilot to turn through the angle required The amount will be shown on the indicator

4. During the turn the Bomb Aimer repositions the bomb sight in the central position

5. As soon as the turn is completed the target should be on or near the drift wires with 'r on r'

Any minor steering corrections can be made by pressing either, the red (Port) or green (Starboard) button.

Bombing crews should devize a simple code of signals

Note:

As an alternative to the steering indicator the Bomb Aimer can transmit verbally to the Pilot the angle of turn required after reading its magnitude on the scale

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The Use of the Azimuth Bracket

The Azimuth bracket possesses certain tactical advantages, in that long st. approaches are not required. The major turn may be made within 40 secs of the time of release. The approach may be intentionally wide for tactical reasons, or the target may be identified later in the run.

For bombing under cloudy conditions change of heading can be made after target has disappeared under cloud, with a reasonable expectation of being in the correct track when the target is next seen.

Bombing Errors

Symbols

T	=	Time of fall in secs.
V	=	Air speed in f.p.s
v	=	Airspeed Error
W	=	Wind speed in f.p.s
w	=	Windspeed Error
G	=	Groundspeed in f.p.s
g	=	Ground error
H	=	Height in ft. (Correct)
h	=	Height Error
α	=	Any small angle
c	=	Correct
i	=	Incorrect
Δ	=	Target
	=	Bombburst

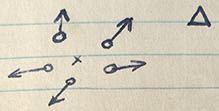
Systematic Bombing Errors

Group A

Wind Errors

i. Wind speed incorrect
ii. Wind direction incorrect
iii. Wind S. & D. incorrect

Typical Pattern

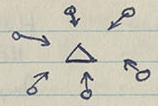


Group B.

Fore and Aft Errors

i. H^t incorrect
ii. A/S incorrect
iii. F+A levels incorrect
iv T.V. incorrect

Typical Pattern



Group C

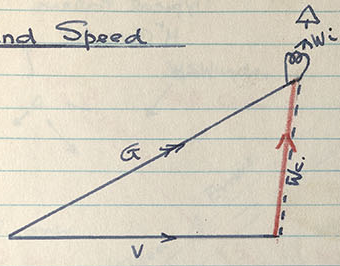
Lateral Errors

i. Lateral levels incorrect
ii. Installation incorrect

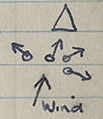
Typical Pattern

---

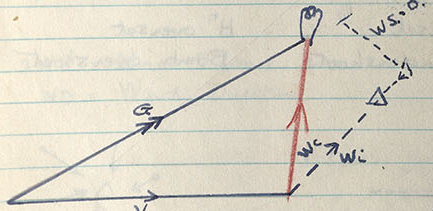
i Wind Speed

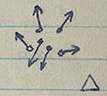


W S overset
Bomb falls upwind of △



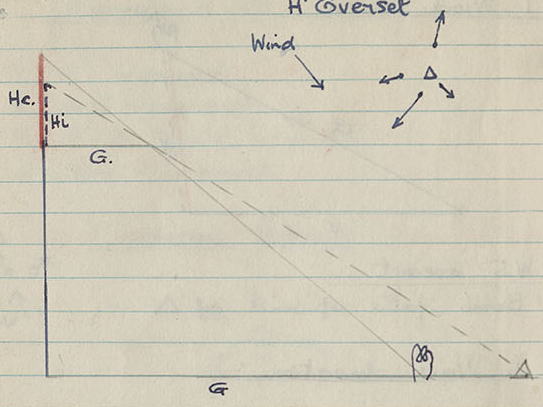
ii. Wind direction





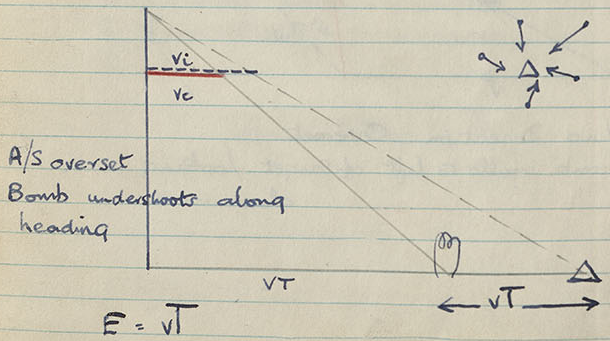
Wind Direction Overset
Bomb falls to left of target looking downward

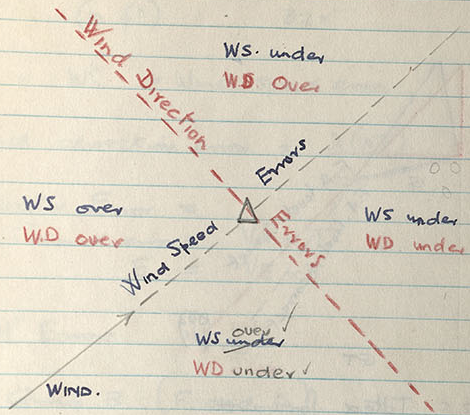
Typical Pattern
Hr Overset



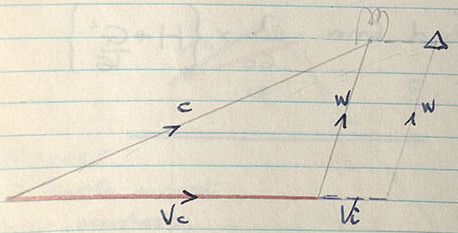
Hr underset
Bomb undershoots

Hr overset
Bomb overshoots along Track

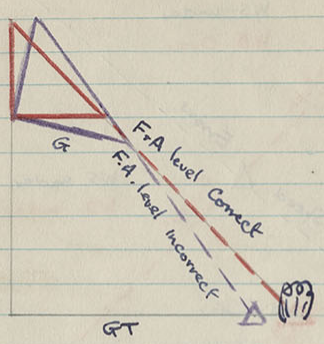




WS : Wind Speed
WD : Wind Direction



Bomb falls short back along heading



C.S.B.S. Tilted forward
Bomb overshoots along Track

Fore and Aft. levels

Ground Error $= \frac{\lambda}{60} \times \left\{ H + \frac{G^2}{16} \right\}$

E = Ground error (in ft.) $= \frac{G \times h}{32 \times}$

E = Wt + Wind speed error

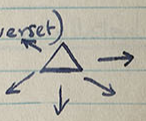
Wind direction error $= \frac{\lambda (WT)}{60}$

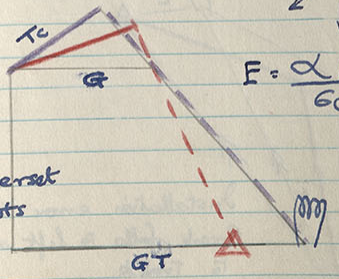
Vector Error =
Ground error = V.E. x T
E = $V_E \times T$.

H^t Error

Group B (F. and A.)

4. Trail Angle



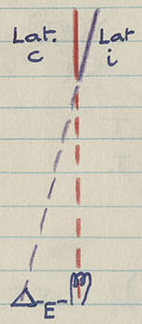


$F = \frac{\alpha H}{60}$

{TV Underset
Trail Angle overset
Bomb overshoots

Group C. Lateral Errors

Typical Bomb Pattern

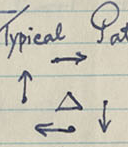


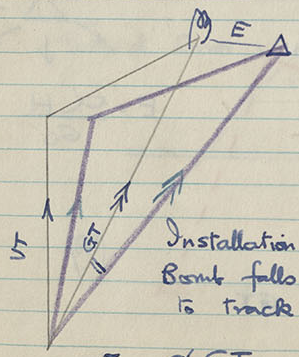
$E = \frac{\alpha}{60} H$

CS.B.S. Tilted to right
Bombs fall to right

Installation Errors

Typical Pattern



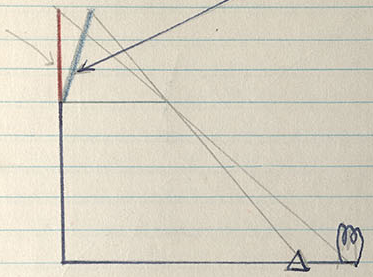


Installation error to right
Bomb falls to left of Δ at rt∠ to track

$E = \frac{\alpha GT}{60}$

Pattern

λ as TVC



$E = \frac{\gamma H}{60}$

Camera Gun C.G.16

As fixed gun – parts removed

Barrel, sights, traversing handles and trigger in lieu of trigger a solenoid is fitted at rear of gun, and connected to electric circuit of a/c.

Rate of exposure – is 16 f.p.s. and can be reduced to 12 per sec, last exposure of each burst shows the watch and data tablet.

Exact time of any exposure can be maintained by counting back from watch exposure and allowing 1/6 sec. for each exposure.

Main features.

Size of film - 16 m.m.
Length . . . (700 – 750 exposures)
Graticule has 4 rings representing 50, 100, 150 + 200 m.p.h. respectively focussed on infinity - Sights of (relative Spead) 100 m.p.h.

Harmonization

(a) Remove camera unit and insert bore sight.

(b) Press trigger to raise movable prism, focus bore sight microscope

(c) Select a suitable aiming mark at required range and align the graticule of the bore sight on to it.

The bore sight can be adjusted both vertically and laterally and should be aligned on the same mark and locked in position.

Note. No allowance made for gravity drop.

Points before flight

(a) Set numerator to zero. Be sure that sufficient exposures are left in magazine for the practice.

This may be done by leaving magazine in the camera between practices and noting the amount of film used in each practise.

(b) Wind and synchronise the watch and make identification record on the data

(Camera gun continued)

tablet.

(c) Wind main spring of camera unit fully, and replace handle in folded position, turning it back if necessary. The handle should not be forced forward to correct position.

(d) Set lens diaphragm to correct setting for light conditions

(e) Press trigger for about 1 sec. and check correct functioning of mechanism

Points after flight

(a) Press trigger for two or three secs. to ensure that last watch exposure is preserved.

(b) Note amount of film used.

(c) Remove film magazine for developement.

(d) Reload camera unit with fresh magazine and if gun is to be used immediately, place the camera unit correctly in camera gun

◇

BROWNING GUN (·303 Calibre).

Length of gun overall with flash eliminator, ft. 3 . ins. 8½

. . barrel. 2 . 0

Wt . gun. 21 lbs 14 ozs

Rifling — Left hand.

Twist — 1 in 10 inches.

No. of grooves — 5.

Ammunition — all types of Mark 7. S.A.A.

Speed of fire = 1150 rounds p.m. (approx)

Sequence of Stripping.

i. See that gun is unloaded and that breech block is forward.

ii. Remove the flash eliminator.

iii. . . back plate.

iv. . . return Spring.

v. Raise . breech cover, remove cocking Stud and breech block.

vi. Remove lock frame and barrel assembly and separate lock frame from barrel extension

vii. Separate barrel and locking piece from barrel extension

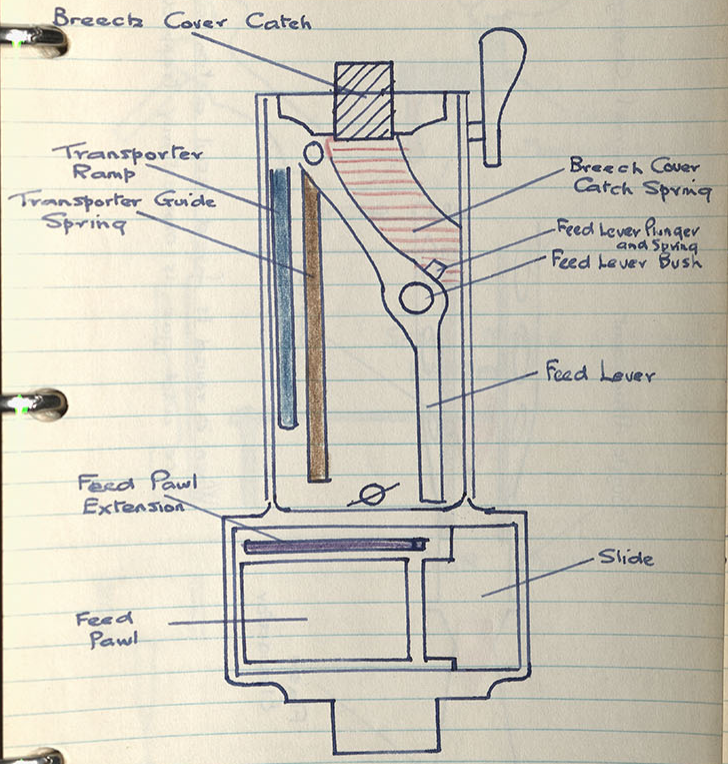
viii. Remove barrel locking Spring

To Re-assemble.

i. Raise the breech cover
ii. Re-assemble locking piece, barrel, and barrel locking spring to barrel extension (Locking piece :- chamfered edge uppermost and to the front
iii. Insert barrel assembly with lock frame attached
iv. Insert breech block with cocking lever fully forward.
vi. Insert cocking stud
vii. Depress rear sear and push the parts forward.
viii. Replace return spring.
ix. Replace back plate and close breech cover
x. Replace flash eliminator

[When replacing barrel, care is to be taken to avoid damaging polished bearing surfaces].

BREECH COVER

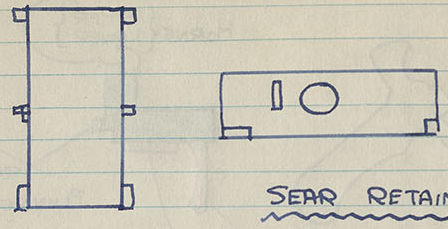


When a round is fired, recoil action takes place and gas is momentarily trapped

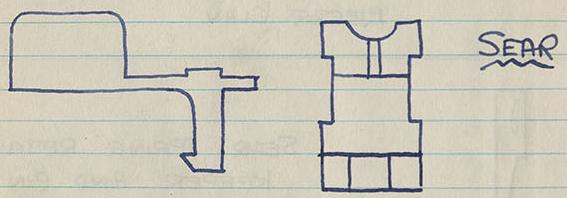
TRANSPORTER

SEAR SPRING RETAINER KEEPER AND PIN

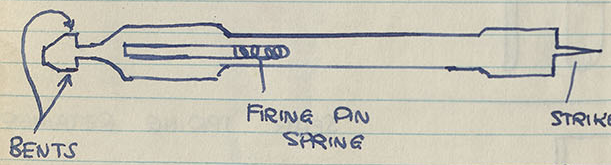
SEAR SPRING RETAINER



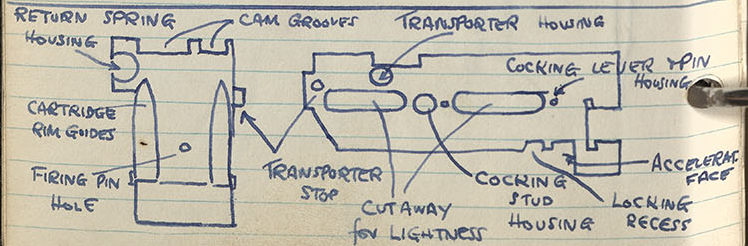
SEAR RETAINER



SEAR



FIRING PIN

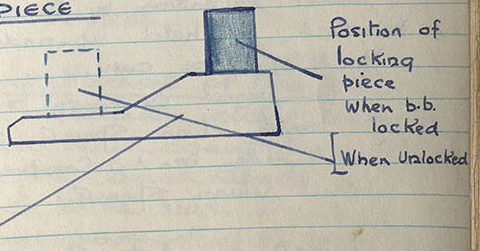


To Strip the Breech Block

i. Ease the firing pin Spring
ii. Remove the Transporter
iii. " Switchplate, plunger [and spring]
iv. " Cocking lever axis pin and Cocking lever
v. " Sear spring retainer keeper
vi " Sear spring retainer
vii. " Sear spring
viii " Sear retainer
ix " Sear
x " firing pin.

To Reassemble reverse the above proceedure. Test by cocking and firing

LOCKING PIECE CAM



LOCKING PIECE CAM.

Mechanism Backward Action

(a) Recoil action
(b) Unlocking of Breech Block
(c) Backward rotation of accelerator
(d) Backward movement of Breech Block
(e) Backward action of Transporter
(f) Extraction and Ejection
(g) Cocking action
(h) First action of bolt feed

Recoil Action

When a round is fired, recoil action takes place and the gas is momentarily trapped in the muzzle attachment. The combined forces drive the barrel to the rear.

The barrel carries with it the barrel extension and breech block. The latter being locked to the barrel extension by the locking piece which is held upwards by the locking piece cam.

The barrel extension boss forces the barrel return spring plunger backwards and compresses the barrel return spring.

Unlocking of the Breech Block

As the barrel moves backwards, the locking piece pin strikes the slanting surfaces of the lock frame projections and forces the locking piece down the slope of the locking piece cam. The locking piece is thus withdrawn from the locking recess in the breech block. and the breech block is unlocked from the barrel extension

Backward Rotation of Accelerator:-

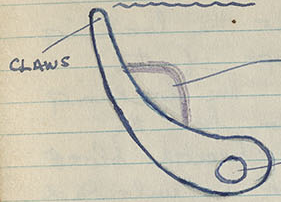
During recoil action, the barrel extension bears against the front of the accelerator and rotates the accelerator backwards as far as the accelerator stop.

During this movement the shoulders of the accelerator engage in front of the boss on the barrel extension lang and hold the barrel extension and barrel to the rear.

Backward Movement of Breech Block

As the accelerator rotates backwards its claws bear against the accelerator face of the Breech Block, and drive it to the rear. During the backward movement of the breech block the return spring is fully compressed

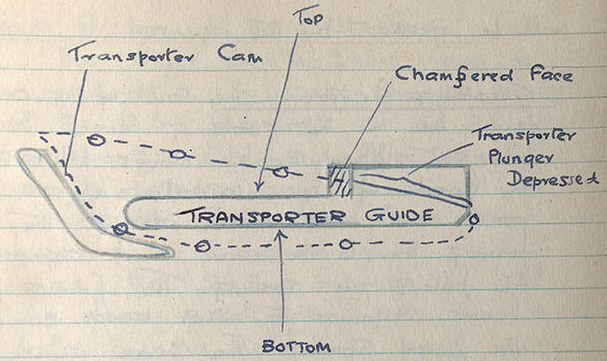
Accelerator.



Backward action of the Transporter

When the gun is in the fired position the claw on the transporter is engaged in front of the rim of the cartridge up against cartridge and bullet stops. As breech block and transporter travel backwards this round is withdrawn from the belt and carried to the rear being supported by the ejector. On reaching the chamfered face of the transporter guide the plunger is depressed.

The transporter ramp on the cover then forces the transporter down which which carries the live round on to the cartridge face of the breech block.



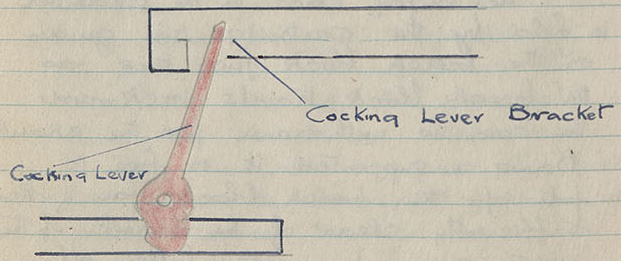
[-----] Various positions of plunger when in action

Extraction and Ejection.

The empty case in the chamber is held by the cartridge rim guides on the breech block face thus as the breech block travels backward the case is withdrawn from the chamber. Being unsupported, it is free to fall off the breech block face when sufficiently clear of the barrel. If the empty case has not fallen off already, positive ejection will take place during the downward movement of the transporter. The rim of the live round bears against the rim of the empty case and forces it off the face of the breech block. The last round in the belt

will be ejected by the ejector.

Cocking Action :- The tail of the cocking lever lies in the cocking lever bracket. When the b.b. moves back, the cocking lever is rotated on its axis and its nose draws the firing pin to the rear and compresses the firing pin spring. The firing pin bears against the sear and compresses the sear spring. The sear under the influence of its spring returns ready to engage the bent when the cocking lever rotates in the forward movement.



First Action of the Belt Feed.

The stud on the feed lever is engaged in a cam groove on top of the b.b. Therefore as the b.b. travels backwards the feed lever is rotated on its axis.

The nose of the feed lever being engaged in a recess of the feed slide, moves the slide across the belt. The feed pawl rides over the round held by the retaining pawl and by action of the pawl spring, engages that round ready for feeding. During the whole of this action, the belt is prevented from leaving the gun by the retaining pawl & spring.

Forward Movement

1. Action of the Return Spring and Buffer

On completion of the backward movement, the return spring is fully compressed, and any surplus energy from recoil is absorbed by the buffer discs. Thus the force of recoil is expended and return spring is able to drive the b.b. forward.

Second Action of the Belt Feed.

As the b.b. moves forward the stud on the feed lever runs in its cam groove and rotates the feed lever. This causes the feed slide to feed in the belt so that a live round is brought up against the cartridge and bullet stops. During this movement the retaining pawl and spring are depressed by the next live round and then under pressure from its spring rises and engages behind that round.

Dw

Return of the Cocking Lever.

During the forward movement of the c.l. the tail of the c.l. engages in the cocking lever bracket which causes it to rotate. This rotation resets the lever for cocking, engages the bents of the firing pin with the Sear and at the same time gives clearance for the firing pin to travel forward when released

Forward Action of Transporter.

As the b.b. travels forward, the transporter plunger rides down the sloping face of the transporter guide until the transporter arm reaches the transporter stop. During the downward movement, the live round is brought into line with the chamber and the firing pin hole. The round is still supported by the ejector. As the b.b. moves forward the live round is fed into the chamber.

N.B. When the ejector is brought abreast of the ejector side clearance in the barrel extension, the Transporter plunger rides up the transporter cam. This raises the transporter and so lifts the ejector clear of the live rounds, the ejector being forced outwards by the contour of the cartridge case. When clear of the round, the ejector spring returns the ejector to its normal position. As the transporter reaches its fully forward position, its claw rides over the rim of the live round in the belt and under pressure from the transporter guide spring, engages in front of it. At the same time the ejector under the influence of its spring, embraces the case of the round ready to support it when later it is withdrawn from the belt

Forward Rotation of the Accelerator

When the accelerator face of the b.b. strikes the claws of the accelerator, the latter is rotated forward. The accelerator shoulders become disengaged from the barrel extension lang and the barrel and barrel extension are driven forward by the barrel return spring

Locking of the Breech Block

As the barrel moves forward driven by the barrel return spring, the locking piece pin is carried away from the lock frame projections When the breech block is home and the breech closed the locking

piece is forced upwards by the slope of the locking piece cam, enters the locking recess on the b.b. and locks it to the barrel extension.
The b.b being fully locked before the recoiling portions are fully forward.

Firing of the Cartridge.

When the b.b. is right forward i.e. the breech closed, the lower lug of the sear is brought into line with the rear end of the 'f & s' unit plunger slot.
The plunger is thus able to strike the sear and drive it inwards. The sear bent disengages from the firing pin bent, the firing pin is driven forward by its spring, and strikes the cap of the cartridge

Operation of the Rear Sear.

On ceasing to operate the controls the rear sear lever is released allowing the rear sear to ride.
Thus on the backward movement of the breech block obtained as a result of firing the last cartridge the rear of the b.b. depresses the rear sear which is then forced upwards again by its spring when clear of the accelerator face.
On the b.b. being forced forward by the return spring, its forward movement is arrested by the accelerator face engaging the bent of the rear sear.
The stock of engagement between b.b and rear sear is absorbed by the buffer spring.

N.B. Should the b.b. strike the rear sear before it has fully arisen, resulting in a partial engagement of the bents, as the rear sear is carried forward in this low position, a projection towards the rear strikes an inclined ramp and forces the bents into full engagement.

—o—

Breeching Up

Definition :- The correct positioning of the breech end of the barrel in relation to the front of the b.b., when the locking piece is fully engaged in the locking recess

(a.) Strip the gun keeping barrel extension in fact.
(b) Remove transporter, switch plate and plunger from b.b. Assemble barrel and b.b. to the barrel extension.
(c) Invert to allow locking piece to engage in locking recess, and holding it in this position screw up barrel until its breech face can be felt to bear up against the cartridge rim guides
(d) Re-engage barrel locking spring into opposite notch turning back if necessary, never forward
(e) Test by inserting recoiling part into gun and pushing fully forward There should be no fore and aft play in the b.b.

Changing Feed Direction

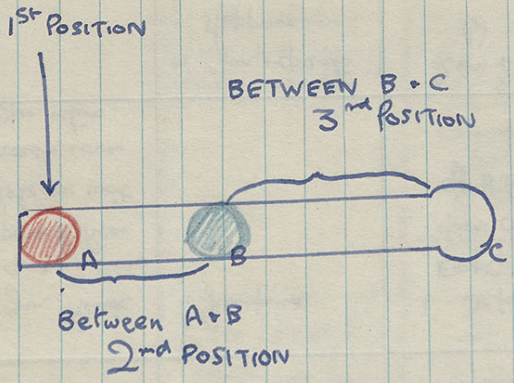
For RIGHT hand feed, the undermentioned components are positioned as stated. Positions are reversed for left hand feed

i. Ejector nose + spring on left hand side of transporter.
ii. Switchplate groove corresponding with groove "R" on the b.b.
iii Retaining pawl + spring on right of feedway
iv. Filling piece on left of feedway
v. Cartridge and bullet stops on left of feedway
vi. Feed pawl on right of slide (Feed pawl extension irrespective of direction of feed always on that side of feed pawl nearest rear of gun with breech cover closed
vii. Slide facing to right of feed way
viii. Feed lever plunger and spring in lower hole at side of feed lever with breech cover raised

---

Posn. of cocking stud	Immediate Action	Result	Cause	Remedy
1st.	Cock gun, fire and watch feed	1. Gun fires	1. Misfire – faulty ammunition	1. Nil
		2. Feed takes place but gun does not fire	2 (a) Defective firing pin or spring (b) Dirt, chips congealed oil in F.P. hole (c) Defective firing Control mechanism or insufficient press.	2. Unload a. Change B.B. b. " or clean B.B. c. Examine and test Firing Control Mechanism.
		3. No feed, Gun does not fire	3. (a) Defective Transporter (b) Defective feed pawl spring (c) Defective belt retaining pawl spring	3. Unload a, b, c } Change defective part
2nd.	Cock gun fire	1 Gun repeats stoppage	1(a) Transporter fails to lift due to defective plunger or spring	1. Unload (a) Change Transporter
			(b) Loose link jammed in feedway (c) Cross feed centrally Jammed in feedway (d) Separated Case (e) possibly also first position	(b) Clear link. Ensure undamaged Feed Pawl Leg (c) Adjust belt Check belt filling (d) Remove with cleaning plug Check breeching up.
3rd	Cock gun. Raise breech cover. Clear gun. Operate Rear Sear Release unit Close breech cover Cock gun fire	1. Gun fires	1 Defective ammunition Empty case not extracted from chamber or ejected off B.B.	1. Nil
		2. Gun repeats stoppage	2 (a) Defective B.B. (b) " Ejector	2. Unload (a) Change B.B. b. " Transporter

How position of stoppage may be determined by use of cocking stud.



Vickers Gas Operated Gun .303

General Description :—

Wt complete with sights and deflector - 20½ lbs
" without " " " - 19½ lbs
Overall length with Flash Eliminator - 40"
" " of Barrel - 20"
Rifling — left hand / No. grooves - 5
Bore .303" / Rate of fire - Approx 950 rounds p.m.
Capacity of Magazine - 60 and 100 .
Wt. " 60 r. mag when empty - 4 lbs
" " " " full - 7½ .
" " 100 " " empty - 5½ .
" " " " full - 11 approx
Sights used - 50 m.p.h relative speed sight - reflector sight
Muzzle velocity - 2440 f.p. sec.
Control of fire — The gun is automatic, in the sense that sustained pressure on the trigger will fire all the rounds in the magazine
Cooling System - The gun is cooled by air flow over the barrel
Operation - The gun is magazine fed and gas operated
Moving portions - The moving portions of the gun are the piston and breech block

◇

Sequence of Stripping Gun

1. Remove magazine if fitted.
2. See the gun is unloaded.
3. Remove sights and deflector bag.
4. Press out body retaining pin and remove body extension.
5. Remove return springs and rod.
6. Pull cocking handle sharply to rear remove piston and breech block and return cocking handle forward.
7. Remove deflector.
8. Remove gun pivot, nut and bolt. and remove barrel strap.
9. Separate body from barrel group.
10. Remove gas cylinder.
11. Remove flash eliminator.
12. Remove gas plug.
13. Barrel.
14. Strip Breech block and clean.

x

Loading and Unloading Gun

To Load :— Put safety catch to 'safe'

(b) Pull cocking handle to rear to cock gun and return cocking handle forward

(c) Place loaded mag. rear catch first in position on the gun, and give an upward pull to ensure security

(d) Set the safety catch to 'fire'

The gun is now ready to be fired.

To Unload :— (a) With palm of hand press forward the rear mag. catch lever, and with fingers of the same hand, grasp the leather handle and lift the mag. (rear end first) from the gun.
Before unloading - set safety catch to 'safe'.

(b) If the breech block is held to the rear, press the trigger, cock and fire the gun again

(c) If the breech block is in the forward position, cock then set to 'fire' and fire the gun.

The gun is now unloaded.

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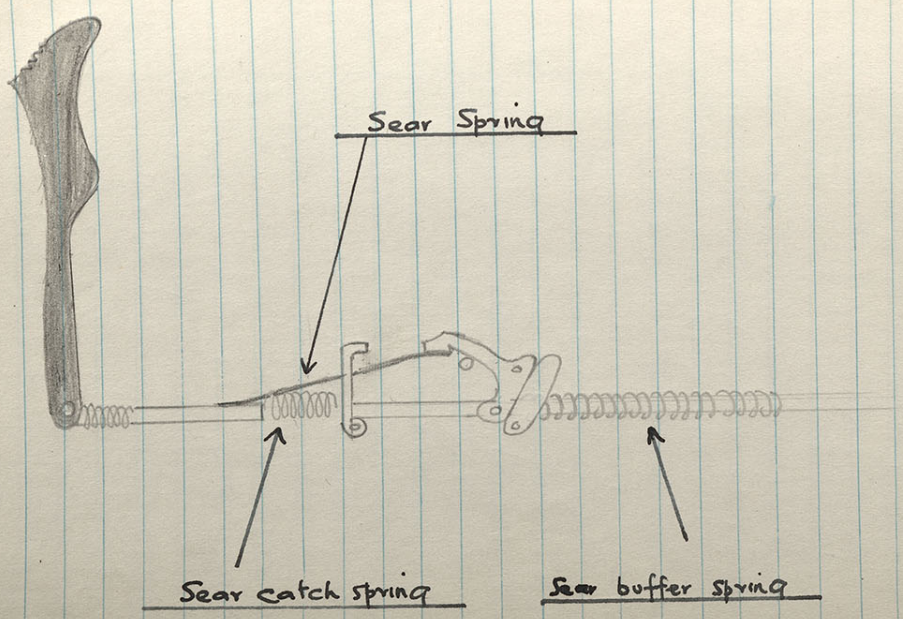


Stoppages

Immediate Action – is the immediate application of a probable remedy for a stoppage based on the position of the piston and condition of the gun.

It must not be considered complete until the gun is again firing satisfactorily

Various positions of the piston

i. When rear end of piston is immediately below or slightly in front of rear magazine catch lever

ii. Rear end of piston is at the rear of rear magazine catch lever & still visible

iii. Rear end of piston to rear of magazine catch lever but not visible

In pos i. Cocking handle is fully forward
" ii. " " to front of rear mag. catch
" iii. " " below or to rear of rear magazine catch.

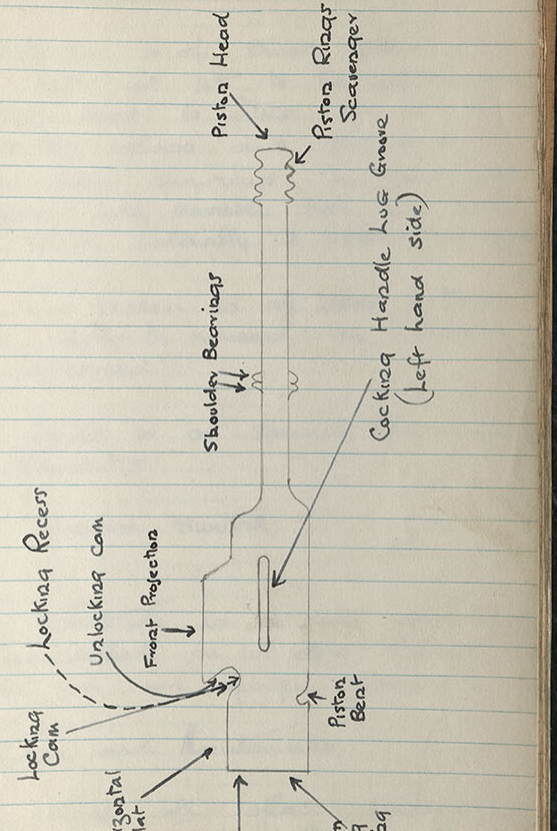
◇

IMMEDIATE ACTION

	RESULTS	CAUSE	REMEDY
Lock gun fire watch the magazine top-plate	1. Gun fires	Misfire due to defective ammunition	Nil
	2. Gun fires but repeats stoppage	No feed due to (a) Sluggish Mag.	(a) Change mag Continue to fire
		(b) Incomplete backward Movement due to either (i) Friction, dirt or chips	(b) i Cock gun sharply and fire. If stoppage repeated, remove mag, clean gun wipe away any chips visible. Oil piston – replace mag continue firing
		(ii) Dirt or fouling in gas block or gas plug port	(ii) Correct maintenance of gun
	3. Top plate rotates but gun does not fire	(iii) Defective firing pin	(iii) Remove mag clear gun change breech block. Replace mag. – continue firing

IMMEDIATE ACTION	RESULT	CAUSE	REMEDY
	4. Top plate does not rotate and does not fire	No feed due to :- (a) Empty mag (b) Defective or dirty mag	Change mag. . mag Correct maintenance of magazine
	5. Stoppage repeated after changing mag.	Defective feed piece or feed Spring	Remove mag. Change breech block Replace mag. and continue firing.

PISTON ON THE V.G.O.



Reflector Sight Mark 3

The reflector is of sheet optical glass set at 45° to the optical axis. A metal hood is fitted over it to protect the glass and protect the system from sun rays. The hood and reflector are movable both fore and aft and laterally to obtain harmonization

The sun screen is of tinted triplex and may be raised or lowered as desired.

The lamp is of special type having two filaments.

The dimmer switch

The Graticule is a ring and bead pattern etched on a deep orange filter on an opaque ground

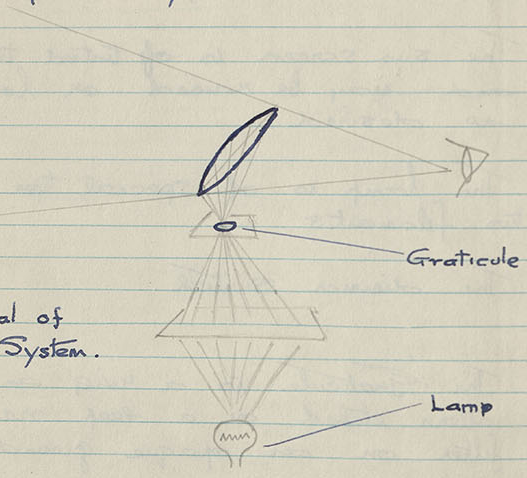
Care and Maintenance

i. Keep all glass surfaces clean i.e. Lamp bulb - exposed lens surfaces both sides of reflector and Sun Screen.

ii. Do not burn lamp longer than can be avoided.

Fit a new lamp as soon as blackening is apparent, or after 1500 rounds have been fired.

iii Do not attempt to adjust the optical system.



Principal of Lens System.

Theory of Sighting.

Muzzle Velocity. –: is the velocity imparted to a bullet by combustion of the Cordite in the cartridge case.
Usually measured in f.p.s.
(Approx. 2440 f.p.s for a .303)

Line of Sight. –: is the st. line from the gunner's eye through the sights to the pt. aimed at

Angle of deflection. – the angle contained between the line of sight and the line joining the gunner to the target.

Deflection. – is the dist. moved by the Target during the time of flight of the bullet.

The pt. of intersection. is the place where bullet and target meet

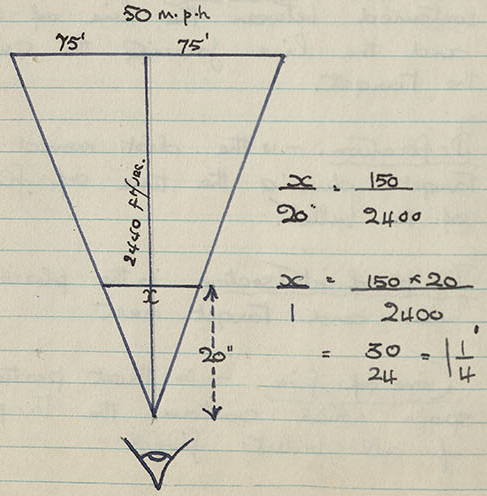
Cone of fire. – is that portion of space which contains the trajectories of all bullets fired

Point of harmonization. is the pt. at which the line of sight intersects the trajectory

Sight base -: is the dist. from the gunner's eye to the ring sight

Relative speed. is the actual speed of the gunner's aircraft relative to the target aircraft (or vice versa)

Apparent Relative Speed. - is the speed at which the E/A. appears to cross (at ⊥ to) the gunner's sights.



$$\frac{x}{20'} = \frac{150}{2400}$$

$$\frac{x}{1} = \frac{150 \times 20}{2400}$$

$$= \frac{30}{24} = 1\frac{1}{4}'$$

Construction of a 50 m.p.h ring sight.

Method of relative speed sighting.

i. Recognise e/a.

ii. Aim point blank at e/a. and holding gun still observe speed and direction of enemy across your sight

iii. Overtake enemy with sights and position him correctly in relation to the 50 m.p.h ring sight so that his flight path will take him through the centre of your sights.

Apparent Speed is the speed at which the e/a appears to cross your ring sight

Bullet Trail :— is the amount a bullet trails back from original path opposite to the heading of the gunner's a/c due to the lateral force of the slip stream on the bullet.

Since bullet trail tends to bring the bullet back towards the tail of the gunner's a/c he must allow for bullet trail by moving his gun towards the nose of his a/c.

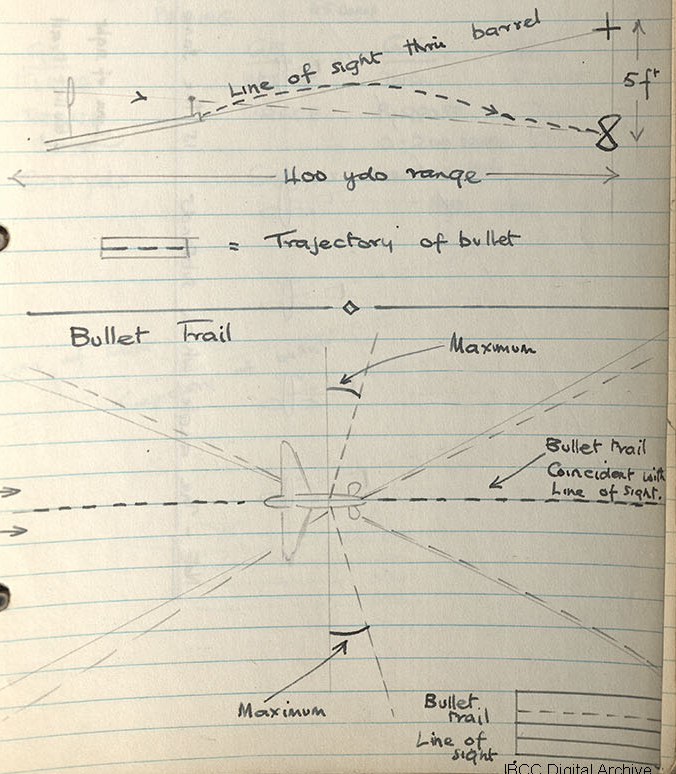
Methods of Harmonization

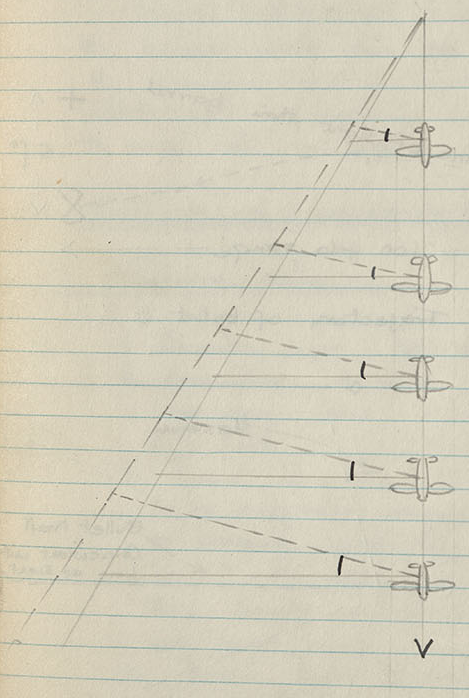
General Rules :-

i. Decide upon harmonization range.
ii. Ascertain amount of bullet drop for gun and ammunition from official M.M. table
iii. Mount gun on stand, and add harmonization range. Erect a screen or board with two sighting marks on it, the vert. distance between them being equal to the bullet drop at that range
iv. Train gun barrel (either by looking down barrel, or by using periscope {gun aligning}) on to the top mark

Harmonization (continued)

v. Adjust sights until they line up with the bottom mark





Note - The angle which subtends is the same in every case

{ Line of sight
{ Bullet trail

DAY

LEAD

G2. Composition

PRIMING.

NIGHT

G5 Comp

G2 Comparison

G5 comp

EITHER

DAY

G2 Composition

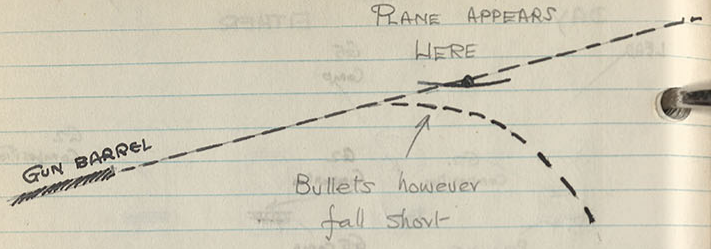
G.4.	G.5.	G.6.	G.2.
FLAME	WHITE	DUAL	FLAME
TRACE	TRACE	PURPOSE	TRACE
RED		0-200 WHITE	RED
600 yds	600 yds	200-600 RED	1200 yds

300 400 500 600

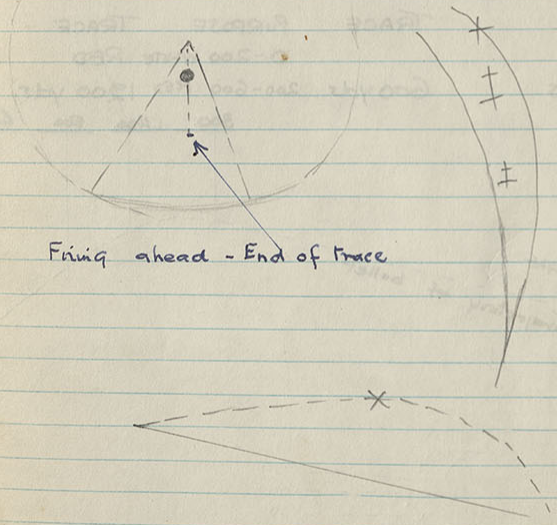
Line of sight

Trajectory of bullet

150
300
450
600



Side elevation



Firing ahead - End of trace

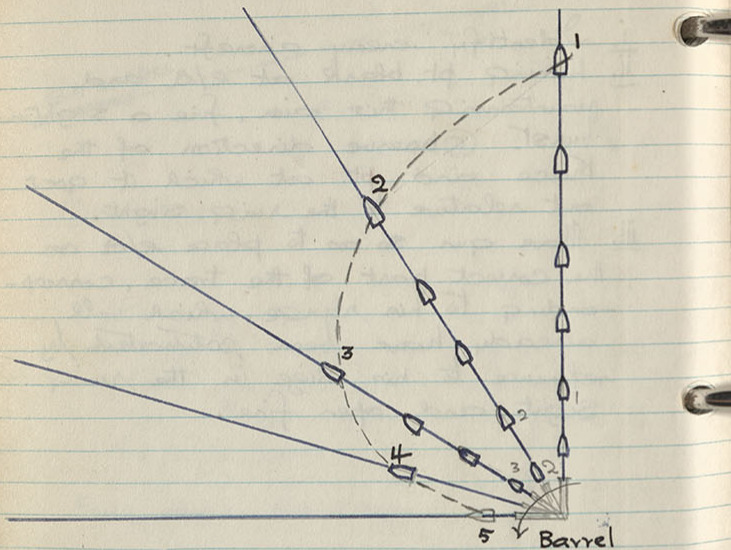
General Rules Governing the use of Tracer As an Aid to Sighting

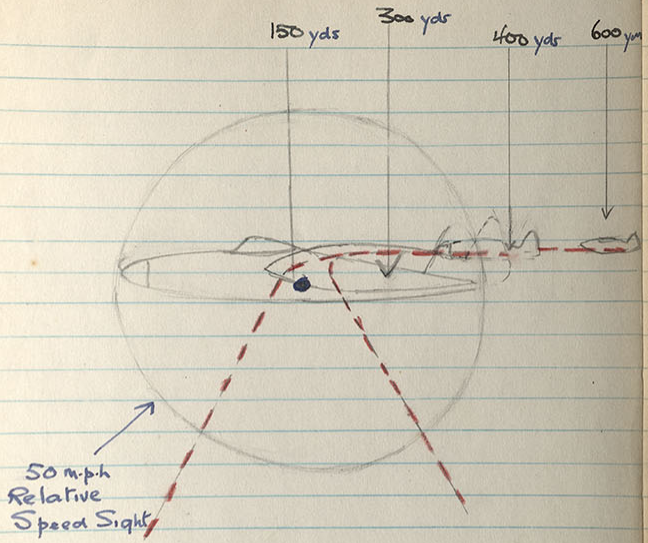
i. Identify enemy aircraft.

ii. Aiming pt. blank at e/a and maintaining this aim, fire a sighting burst. Observe direction of the trace and pt. at which it goes out relative to the ring sight.

iii. Move gun so as to place e/a on the correct part of the trace, corresponding to his range, which will already have been estimated by reference to his size in the ring sight, and open fire.

Why bullets appear to trail in a curve.





---- BULLET TRACE

Using an ME109, the wing span of which is approx 30', the diagram shows the plane in four positions i.e. passing on beam and where it must be placed in relation to sight at those various ranges.

Bomb Carriers

Service requirements of a bomb carrier

A bomb carrier must be light yet strong enough to withstand all strains put upon it by sudden manoeuvres of the aircraft. It must hold the bomb rigid in all directions, be reliable in action, release the bomb simultaneously and be easy to instal

Universal Bomb Carriers

No. 1. Mk 1 and 2 E/M and E/F
No 2, " " " "
Mk 3. " " " "

No 1 carries up to 250 lbs
No 2 " " " 550 lbs

The universal bomb carrier Mk 3. is of different construction but may be used in place of the No 1 and 2 in most instances.

Difference between No 1 and 2
No. 1. length : 4 ft. 4½ inches
No. 2. " : 5 ft. 7¼ "

Types of E.M. unit - Type C.

Stores carried.

All bombs from 50 lb to 500 lb

1. 250 lb Small Bomb Container
1. 160 lb " " "
1. 4.5" recco flare
1. 4.5 photographic flash
1. 8" " "
1. Supply dropping apparatus
1. 250 lb S.C.I
1 500 lb S.C.I
1. 250 lb Water ballast container

When Loading the bomb to carrier
Before ~~use~~ carriers are used they must be tested with a dummy bomb

i. Place crutches in the highest position
ii See all switches are off
iii Cock the E.M. release unit
iv. Press the test plunger
v. Open the bomb hook
vi Offer up the bomb so that the suspension lug engages in the bomb hook
vii Screw down on nose and tail crutches so that bomb is held rigid and parallel to flight
viii Adjust fuze settings control links and fuze boxes

Bombs and Components

Fuzing Precautions:

i. Only small number of bombs necessary to be worked on at a time in fuzing area

ii. Components must not be inserted into, or withdrawn from bombs whilst in the aircraft.

iii Fuzing must not take place in any building other than the one specially constructed
This building must be at least 75 yds. from all other buildings such as Petrol storage & hangars etc.

iv. Fuzing must not be done at the rear of a/c in order to avoid dust from slipstream

v. Bombs must always be fuzed over soft ground

vi Nose and tail adapter threads must be clean and in perfect working order.

Vii Nose and tail pistols and fuzes must be tested before assembling.

Viii Components should be protected against elements particularly against rays of the sun.

ix. When bomb has been fuzed it must be marked with chalk to that effect.

o

Types to be learnt

PRACTICE	DUMMY	H.E.	INCENDIARY
11½ lb		A.P.	4 lb
		S.A.P.	
Smoke (Day)		A.S.	
		G.P.	25 lb
Flash (Night)		20 lb	35 lb
		40 lb	40 lb
		250 lb	
		1900 lb	

o

Definitions —: A bomb is a container for high explosives, smoke or incendiary mixture complete with a means of detonating or burning it

A High Explosive., is one whose body is filled with high explosive(s) material it may either —: have —:

(a) a heavy case; (cast or forged does damage by blast or fragmentation

OR

(b) a light case; (welded sheet metal, main damage by blast)

Armour Piercing.— One whose body is designed to penetrate substantial protection without breaking up.

Its body is relatively thick, the nose being thicker in proportion than a non armour piercing bomb and the explosive content is small i.e. 10%

N.B. Tail fuzed only

Semi-Armour Piercing bombs are similar in construction to armour piercing bombs. Metal of the body is not so thick and the explosive content is proportionally larger i.e. 20%

It is similar in contour to the G.P. Series and has less penetrative power than the A.P. bomb.

It is fuzed in the tail only

G.P. Bombs — has a body of fairly thick metal & enclosing a sufficiently large main charge to produce a

27N 287

Combination of the maximum blast and shrapnel effect i.e 25-30%

N.B. Fuzed both nose and tail

Anti Submarine bomb - similar in external contour to G.P. except for a blunt nose. The metal body being of light construction

Affords a proportionally larger explosive content. In this case up to 40-50%

It is designed to give maximum blast effect on or immediately under the water

Nose Pistols — Tail

No.	27	28
	29	30
	34	37 Fuze
	33 Parachute	
	38	

Smoke bomb :- is one whose container is relatively thin and this is burst to produce the smoke, or the smoke may be produced by combustion

Gas bombs - consists of a hollow body into which the mixture is poured and a small bursting charge to scatter it.

Incendiary :- One whose container is filled with incendiary mixture which burns with sufficient heat to melt it and so assists to spread the incendiary action.

The main burning material is magnesium.

Armour Piercing - heavy case - shellite filled 2000 lb (Has a 37 fuze)

Semi-Armour Piercing - heavy case (250 to 500 lb)

G.P. - heavy case (20 lb F - 40 lb G.P.)

G.P. 250, 300, 1000, 1900 lbs

A.S. Becoming obselete tendency now to be replaced by depth charge 100, 250 & 500 lbs.

'B' Bombs -: a form of mine dropped ahead of moving aircraft and designed to shed its nose & tail fairings at a pre-determined depth and rise towards surface by buoyancy chambers.

Fitted with horns which when fractured by the underpart of a ship will complete

an electrical circuit and detonate the bomb.

Most successful when used against slowingly moving transport or supply ships, for the bow wave of fast moving craft might sweep it away.

Smoke - 11½ lb practise
Gas - 30 lb light case - 3" band to show contents
Incendiary - 4 lb, 25 lb, 35 & 40 lb
Only difference between these is the weight of the fairings

Miscellaneous
Depth Charges (V in no.)
'B' Bombs
'W' "
Incendiary leaves
Anti-tank bombs - (Between 30 and 250 lbs).

The 250 lb. Small Bomb Container.

1. Purpose

To allow a number of small bombs to be carried on one bomb carrier and released in salvo.

2. Description

(a) An open box that is suspended from the No. 1 Universal Carrier.

(b) On one side three E.M. release units capable of being set at various positions marked "A", "B", "C" and "D".

(c) On the other side are three "Drop Bar Brackets" also able to be set at the marked positions.

(d) Inside are two bulkheads which can be fixed at A, B, C, or D.

3. Loads Carried

LOAD	No.	COMPARTMENTS	LETTER
25 lb Incendiary	8	2	A
30 lb Light Case	6	2	A
40 lb G.P.	6	2	B
20 lb "F"	12	3	C
4 lb Incendiaries	60	3	D

4. The Auto-Selector Switch

(a) This is on top of the container and automatically arranges the firing of the E.M. units in their correct sequence. It must be set by hand before the take off. Firing order is:-

2, 3, 4 or Rear, Front, Middle

It is always set to No. 2.

5. The Adaptor Box.

This fits in the front fuzing slide and has a plug which must be inserted in the bomb carrier socket on the a/c. The bomb carrier plug is inserted in a socket on the adaptor box. Two sockets are provided on the adaptor box, ~~including~~ into which are inserted the two leads from the container.

6. Jettisoning

A special 'Type H' jettison switch is fitted, and pressures on this will release all containers bodily

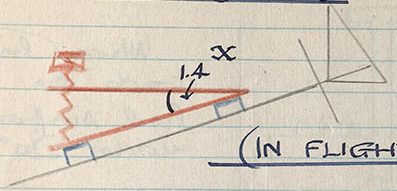
(a) To jettison mixed load 'SAFE'

i. Press Type H switch first (once or twice)

ii. Press normal jettison switch.

(b) To jettison mixed load 'LIVE', press normal jettison switch not less than THREE times

Ground Levelling

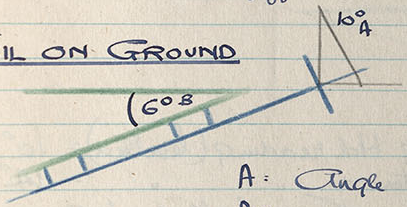


58000 lbs

(IN FLIGHT)

∠x: Angle of attitude all up wt 58000 lbs
OR " " Rigger's Datum line

TAIL ON GROUND



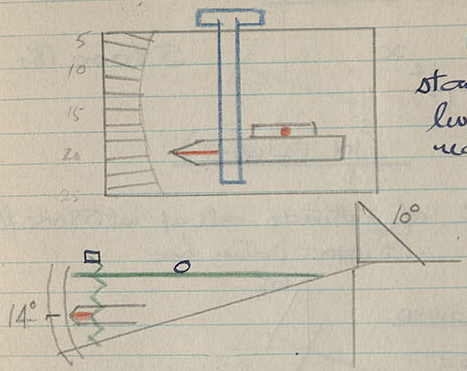
A: Angle on Sighting Head
B: " of Riggers Datum Line

∴ Levelling figure for Sighting Head for all up weight of 58000 lbs
= A − B + X
= 10 − 6 + 1.4 = 5.4

PRINCIPLE

Practical Ground Levelling

CLINOMETER MK XIV



When Clinometer stands on level surface it reads 20°

A = Sighting Hd reading (levelled) = 10°
Y = Clinometer — " " = 14°
If 20° when Clino levelled it shows 14° a horizontal surface when levelled it shows 20° — the angle of the Riggers Datum line must equal 6°

(For comparison see fig. 2 part i)

∴ A − (20 − Y) + X = Levelling fig for S.H.
∴ A + Y − 20 − X = " " " "

As 20 − X is always constant it is known as K — This is given but differs with each type of a/c.

A + Y − K = 10 + 14 − 18.6 = 5.4.

EXAMPLE.

MARKINGS OF BOMBS

Nose H.E. – G.P.
Pistol 27 – Tail P. 28.

A.P.
N° 37 Fuse, 2000 lbs

S.A.P.
Tail fused only N° 28 } or 30.

ANTI SUB.
Tail Pistol 30.

Components

Name given to parts used to detonate explode or ignite the main filling

(a) Pistols
(b) Fuzes
(c) Detonators (may have a delay)
(d) Exploders

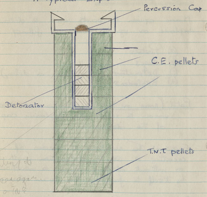
Pistol (nose or tail) - mechanical means used to ignite the explosive cap of the detonator

Fuzes -: The mechanical means of creating a small detonation (with or without delay) which is insufficient by itself to function the main charge

Detonator -: The unit used for causing the detonation of the exploder or relay (may have a delay)

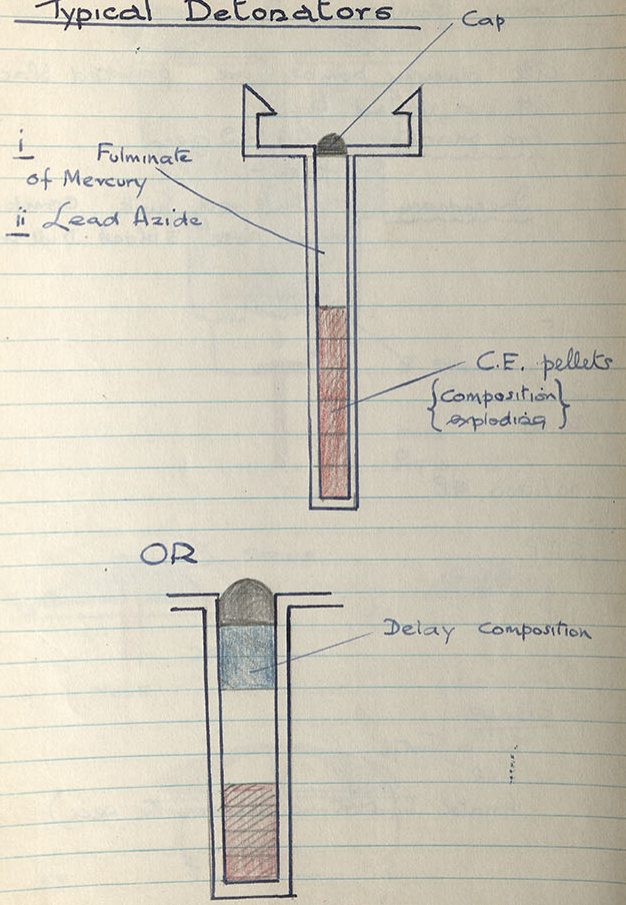
Exploder -: The unit causing the detonation of the main charge in any type of bomb

A Typical Exploder



No.	Delay	Colour
28	Instantaneous	Red
Mark i 35	11 secs	Blue
ii 35	13 secs	Blue
37	$\frac{1}{40}$ sec.	Black
38	1 sec.	Yellow
	May be used on any G.P.	
39	1 sec.	Yellow (Igniferous)
	Used on anti sub. bomb	
43	Instantaneous	White
44	1 sec.	Yellow
	used on all G.P. bombs	
47	$\frac{1}{10}$ sec.	Brown
	used for ~~S.A.P.~~ bombs	
49	$\frac{1}{40}$ sec. G.P.	-

Typical Detonators



Dummy Bombs.

All dummy bombs are painted black with a yellow band

For practise - white - 2 green
flash - 2 red.

Incendiary. - Dull red with compound round nose ½. ½ black. Dull red ½ ½ black

HE.

20 F.

40 GP.

100/1900 G.P.

S.A.P.

A.P.

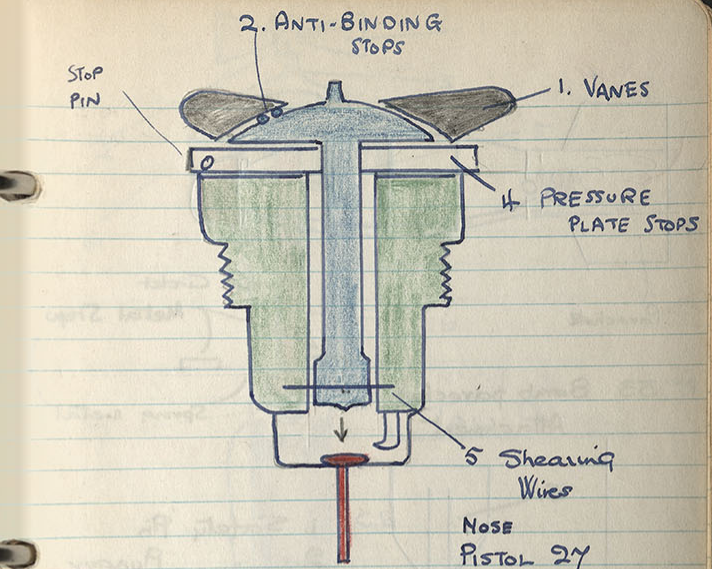
A.S.

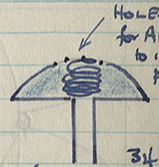
Fillings.

TNT or Trotyl

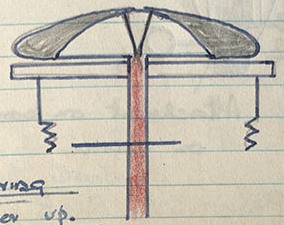
BAR

Amatol (Not used over the sea)



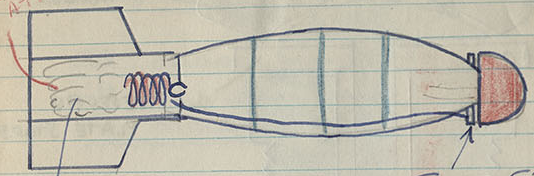


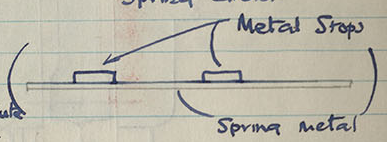
SOFTER SHEAR WIRE
STRONGER SPRING
Than 29



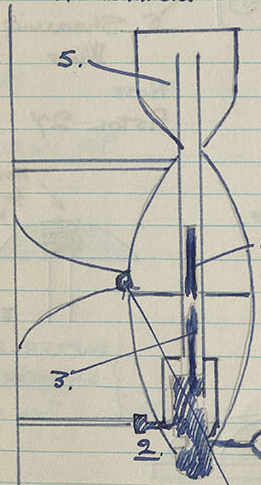
Note shearing wire higher up.

STATIC CORD ATTACHED TO CAMÉ.





N° 33 Bomb parachute Attachment

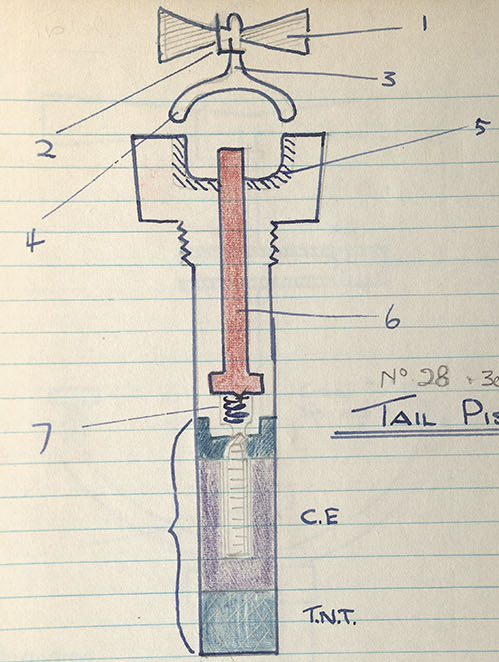


1. Safety Pin
2. " Plunger
3. Shearing wire
4. Detonator Burster
5. Hollow Tail [Smoke composition or magnesium Composition]
6. Solid Nose

Carrier

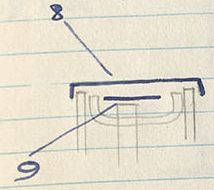
Attachment on bomb for holding on camé

1½ lb PRACTISE BOMB



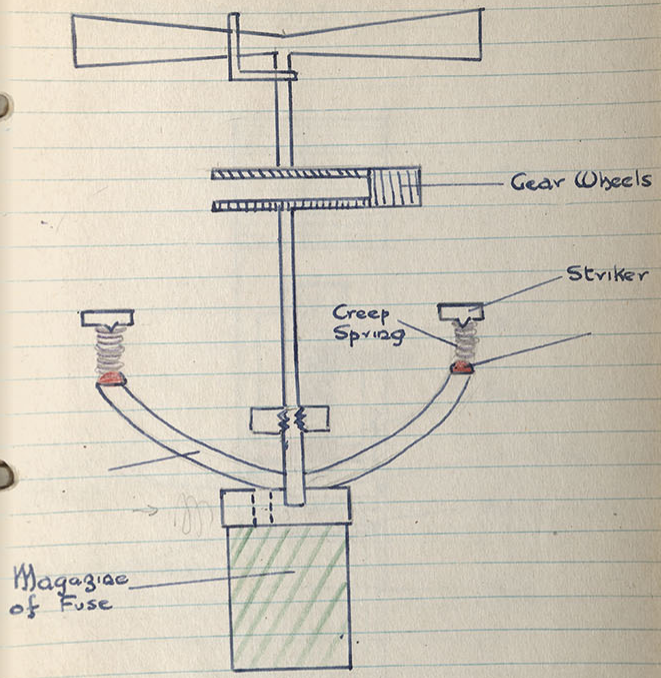
N° 28 & 30

TAIL PISTOL



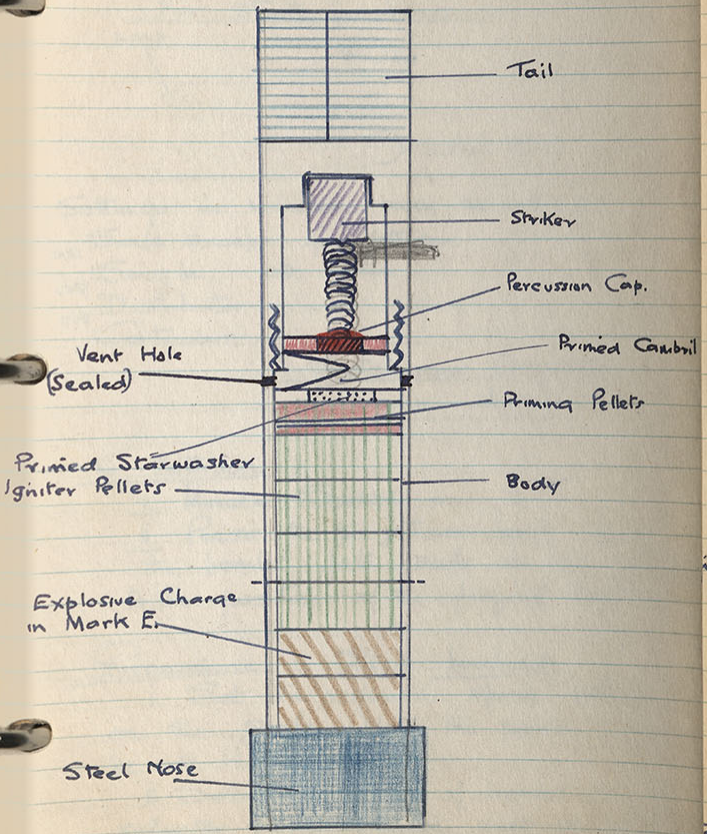
1. x	1.	Arming Vanes
1. x	2	" " Stop
	3	" Rod
	4	" " Fork
3 x	5	" nut
	6	Striker post (Spindle pellet
3 x	7.	Creep Spring
2 x	8.	Safety Cap
2 x	9	" Plate

[x = Safety Device]



No. 37 FUSE

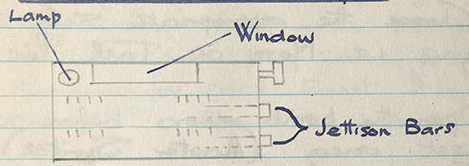
4lb Incendiary



Automatic Bomb Distributor Mk. VI.

Use :–

For stick bombing



Settings in window may be either :–
Safe except for Jettison
OR Single OR Salvo
OR Distributor
OR Containers

Switchgear Assembly
[diagram above]

To Jettison.

i. Master Switch on
ii. Press the two jettison bars and the bombs fall safe or live according to the position of the fuzing switches

Procedure Stick bombing.

i. Set the required space setting on the scale (Note the pointer must be at H).
ii Select the stick of bombs on the selector panel (These must be consecutive numbers of switches

iii. On switchgear assembly See that setting reads 'Distributor'

iii.a Depress the resetting plunger and move the distributor arm until it is pointing to the first number in the stick of bombs to be released

iv. Choose the appropriate selective fuzing i.e. Nose OR Tail live.

v. Open the bomb doors before reaching Target area (Master Switch) The pilot lamp will light Press firing button when the target is in line of sight and bombs fall one after the other. When the last bomb has fallen the lamp goes out.

TURRETS.

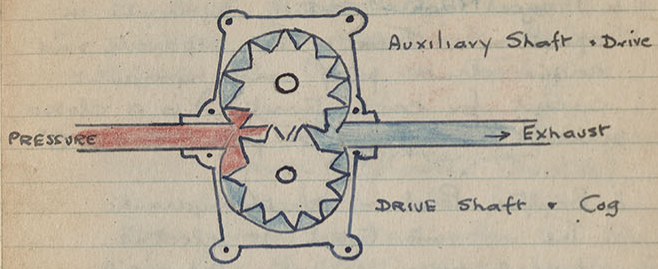
Different Types of Systems employed.

i. Frazer Nash – entirely hydraulic in operation. There is a separate petrol engine driven pump and hydraulic circuit for each turret. It is a closed circuit Operating press - 300 lbs □"

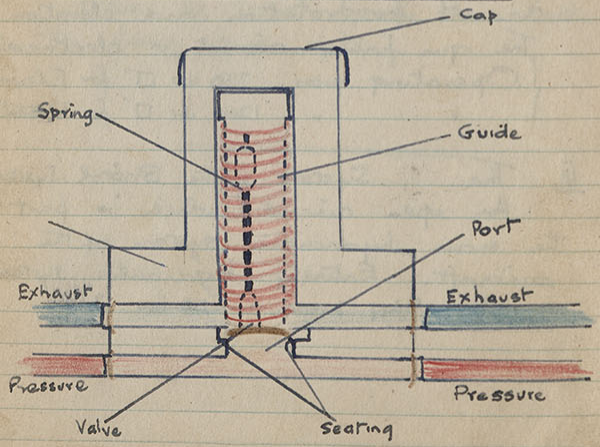
ii Boulton Paul – electro-hydraulic The into turret is electric. Hydraulic power is generated inside turret. There are separate closed circuits for rotation and elevation The gun firing circuit is electrical
{ Operating press. 750 lbs □" for Elevation
" " 1200 lbs □" for Rotation }

iii. The System is the Bristol System An open circuit which is part of the main hydraulic system of the aircraft. Entirely hydraulic System. Operating press. - 600 lbs □"

FRAZER NASH



The Beachams Pumps.



Relief Valve.

J. A DELLOW

1391826

Fall of an Ideal Bomb in still air

Factors effecting
i. Air speed of aircraft ie V (f.p.s)
ii. Height " " ie. H ft.
iii Gravity

S (Dist) = U (Initial Vert. Velocity) × T (Time) + 16T²

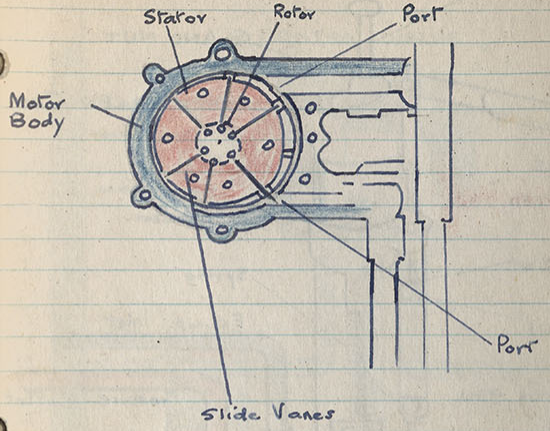
$\frac{I^2}{1} = \frac{S}{16}$ ∴ T. $\frac{\sqrt{S}}{4}$ (Ht. fallen). $\frac{\sqrt{H}}{4}$

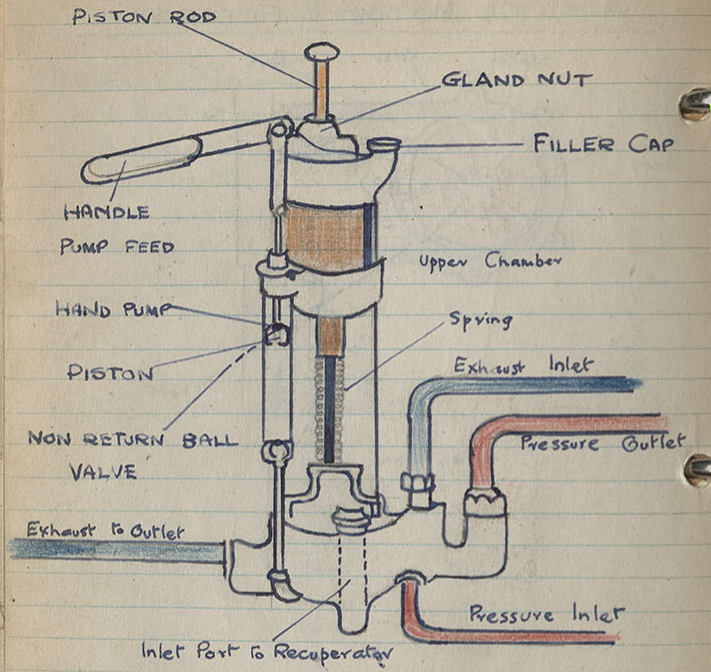
$S = UT + \frac{aT^2}{2}$ (a = 32 f.p.s)

HTS	T	VT
100	2.5	500
400	5.	1000
900	7.5	1500
1600	10.	2000
2500	12.5	2500
3600	15.	3000
4900	17.5	3500
6400	20	4000
8100	22.5	4500

Ht. fallen / Time of fall = Average Speed of Fall

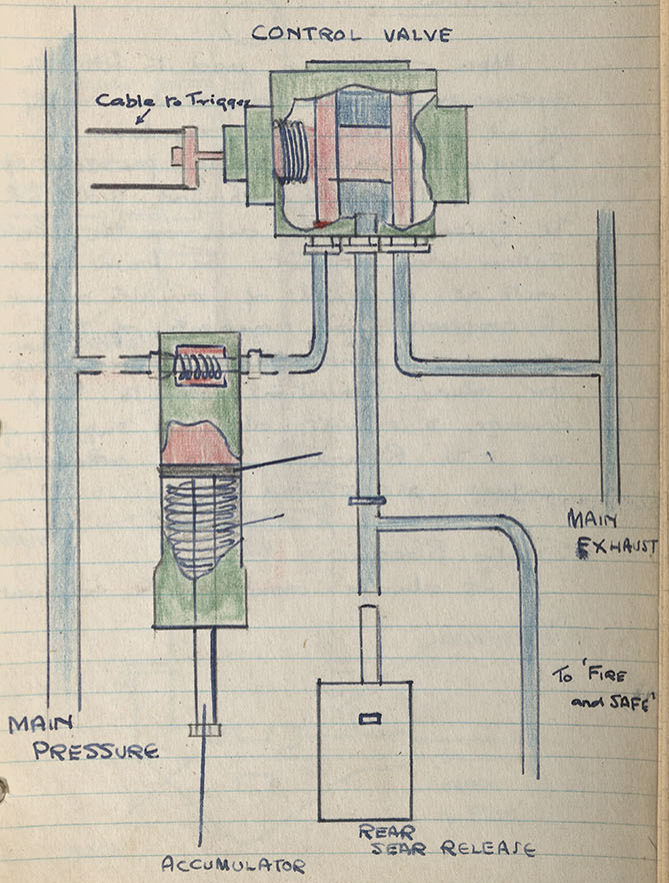
Vane Oil Motor & Filters





RECUPERATOR

PALMER HYDRAULIC FIRING GEAR



Recuperator

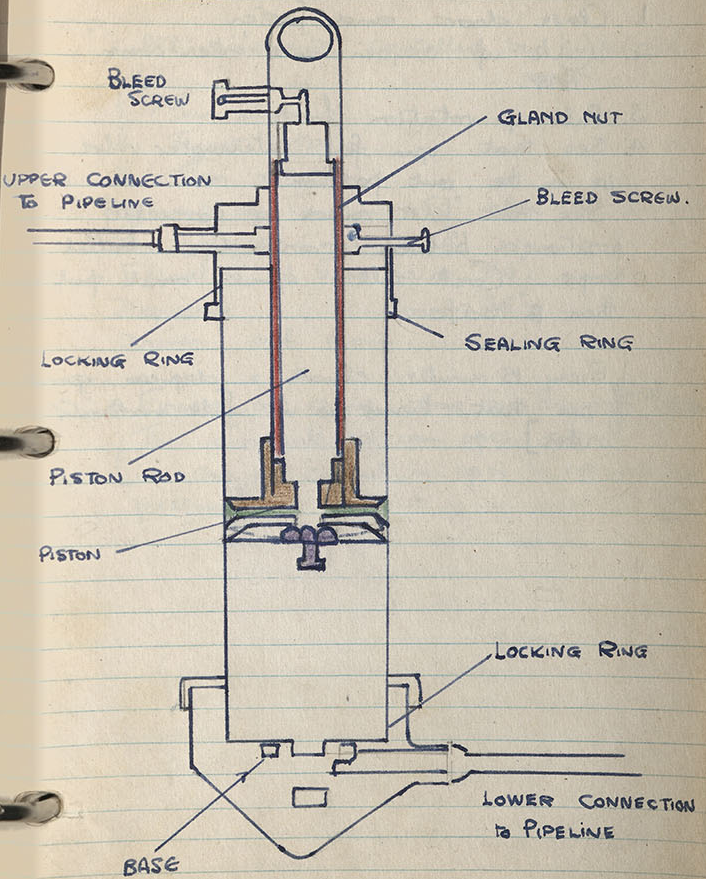
Functions

Upper Chamber is used to fill the System and store a reserve supply of oil to make good any loss. Recuperator exerts static pressure of 15 - 20 lbs □" on the exhaust side when the System is in use and on the whole System when at rest. The lower chamber acts as a vessel of variable volume to compensate for movements of the gun mans and to a lesser degree for volume variations due to temp. change & ensures also a supply of oil the Beacham Pump when the engines are started up.

Static Bleeding

Is always done on the exhaust side

GUN ELEVATION RAM



Turret Drill

1. Close doors and fasten
2. Link up oxygen and 'inter-comm' Test.
3. Pull up rotation lock
4. See that gun fire interrupter valve is in the out position
   See that first round is correctly positioned between cartridge & bullet stops – Cock all guns and put them to safe.

[Every 15 minutes elevate & depress guns rotate turret to see that turret is in full working order]

The Bristol Turret

Op. Press. = 600 lbs □"

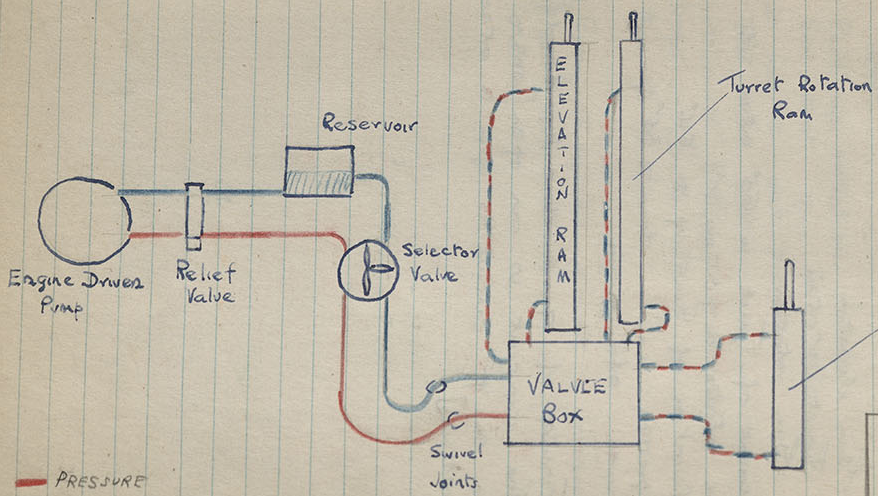
All movements controlled by hydraulic rams.

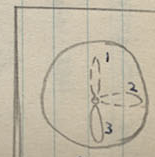
i Gun elevation
ii Turret rotation
iii Gun rotation

Movement of Turret is 60° either side fore & aft.
Gun rotates a further 40° . . . .
Elevation of Guns up to 64°.
Depression . . down to 35°.
Driven off main.

Firing of guns done by Bowden cable
The circuit is an open one
[i.e. One pt. circuit is open to atmospheric pressure]

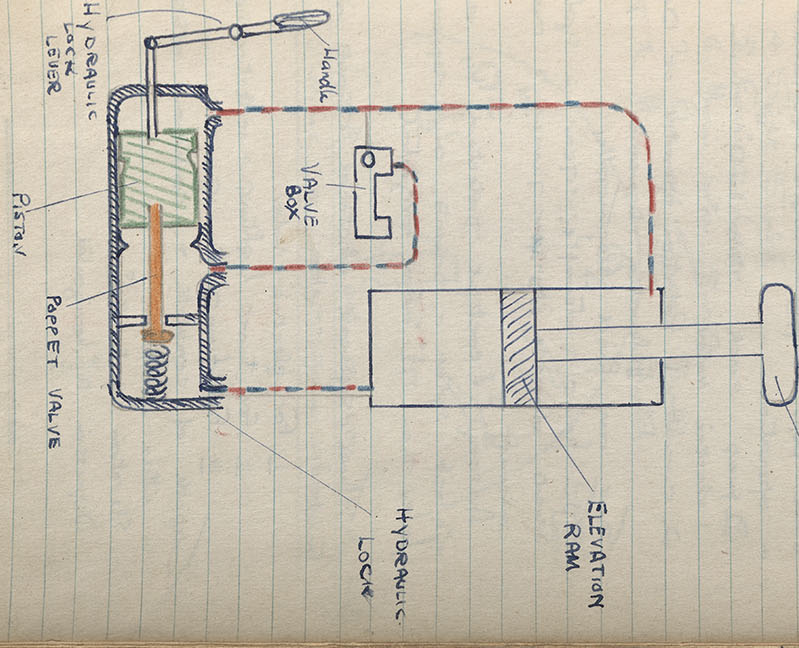
HYDRAULIC LAYOUT [BRISTOL]





1. Pos. to operate flaps - undercarriage
2. Pos OFF
3. Turret on.

Hydraulic lock Lever System



Boulton Paul Turret

Bolted to airframe - electrical supply from main a/c supply - electro-hydraulic in operation

2 pump each 1200 lbs □" driven by 1 electric motor

2 circuits i Rotation operates at 1200 lbs □"
ii Elevation + Depression 750 □"

Guns are fired electrically

Gun firing interrupter gear in system prevents damage by gun gunner to own aircraft

Airscrew + cockpit protected by an interlock system - prevents any depression lower than 17½° above horizontal

Three separate electrical circuits in turret.

i For electric motor
ii For turret lighting + reflector sight
iii For firing the guns

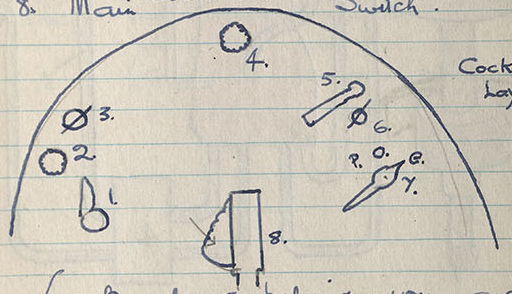
Capable of complete + continuous rotation in either direction

Elevation up to 84°

Depression to horizontal

Method of Bringing B.P. Turret into Operation

1. Free + Engaged Lever
2. Cockpit Light
3. Main Sight Switch
4. Sight Switch
5. Fairing Lever
6. Main motor Switch
7. Pilot off Gunner Switch
8. Main armature Switch.

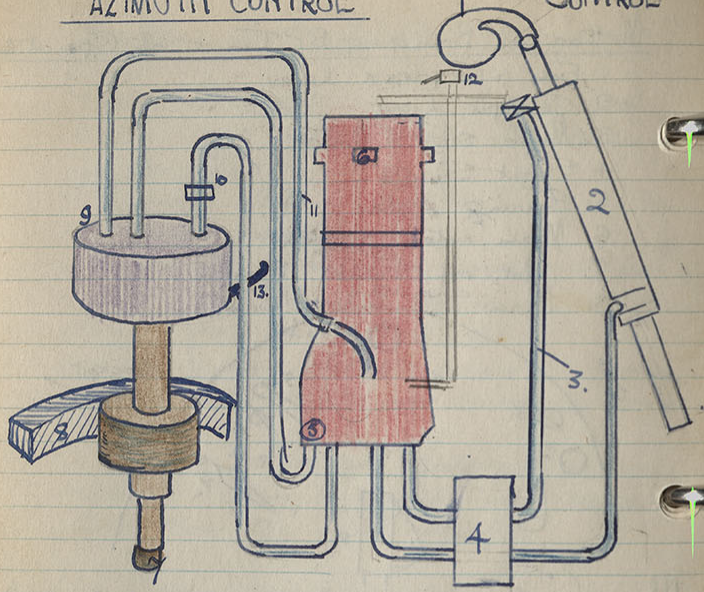


Cockpit Layout.

N.B. Lock door behind you and make Switches in order given above

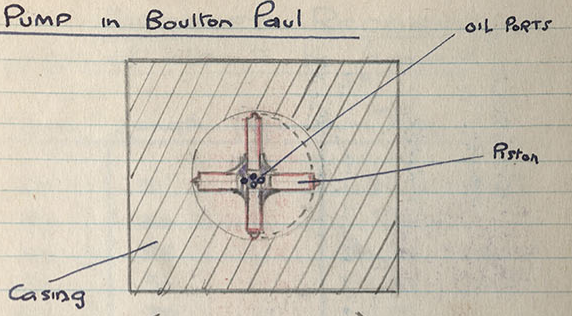
AZIMUTH CONTROL

GUN ELEVATION CONTROL



1. Elevating Lever
2. Hydraulic Ram
3. Flexible Pipes
4. Pressure Regulator
5. Hydraulic Generator
6. Electric Motor
7. Pin for Fine Interrupter Drive
8. Gear Ring
9. Hydraulic Motor
10. Bleeder Valve
11. Drain to Sump
12. Control Column
13. Locking Plunger

Pump in Boulton Paul



(Casing may be moved either way by Control Column.)

AIRCRAFT RECOGNITION

Types of a/c to be learned

Span	Length (Approx)	Type
40'	31'	Hurricane
37	30	Spitfire
32	28	ME 109 E
33	30	ME 109 F
42	32	Tornado
42	32	Typhoon
31	27	H.E 113
39	35	Defiant
58	42	Beaufighter
52	40	M.E. 110.
52	40	M.E. Jaquar
61	47	Havoc
51	40	Boston
37	32	Tomahawk
37	32	Kitty hawk
45	35	J.U. 87 B.
46	36	Skua
46	36	Roc
59	55	Do. 17
59	53	Do. 215
65	54	Hampden
86	62	Wellington
74	54	He. 111 K. M.R.T.
84	68	Whitley
56	44	Blenheim Mk I-V
59	46	J.U. 88.

Span	Length (approx)	Type
90	69	Manchester
99	70	Halifax
99	87	Stirling
110	64	Liberator
103	74	Fortress I+2
113	85	Sunderland
81	64	Lerwick
58	44	Beaufort
35	26	Macchi 200
37	26 (Falco)	Caproni Re 2000
81	60	Cant Z 1007
38	29	Martlet
35	25	Buffalo
34	30	Air cobra
54	30+11=41	Mosquito
54	38	Lightning
46	40	Fulmar
65	44	Hudson
61	41	Maryland
61	41	Baltimore
65	58	Marauder
108	78	Condor
108	78	Kurier
115	86	Ju. 89.
115	86	Ju. 90.
97	64	Blohm + Voss
35	25	Fiat G. 50
51	38	Breda 88
69	54	Savoia 79

Span	Length (approx)	Type
79	57	Savoia 81
69	59	" 84
52	41	" 85
62	45	Caproni Ca 135
53	44	" 310
53	34	" 311
64	45	" 312
53	42	" 316
36	29	(float plane) Vanguard
42		Skyrocket
78	63	Do. 18
89	72	Do. 24
98	80	Do 26.
104	64	Catalina
89	65	Ha. 138
69	58	Ha. 140
73	57	He. 113
32	27	Fiat Cr 42
40	31	Breda 65
42	29	A.P.1. bis
71	53	Fiat Br 20
105	73	Piaggo P. 108
70	45	F.W. 58 Weihe
44		Fiesela, Fi 187
45	31	Whirlwind
56	42	Anson
81	64	Ha 142
81	64	Ha 139 floater

	Span	Length (approx)	
Warwick			
Henschel H.S.129	56	38	
ME 210	53	36	
F.W. 190	37	29	
Dornier 217	62	56	
Heinkel 177	103	64	
Wellington Mark VI	86		
F.W. 187	51	40	

F.24. CAMERA

Unit system all interchangeable

i Camera body
ii Lens & Lens Cone
iii Gear box
iv Shutter unit
v Film Magazine

Auxiliary equipment for use with the camera

i. Electrical leads & motor
ii. Flexible camera drive
iii. Watch or Veedor counter
iv Remote control push switch
v. " " type 35
vi Camera mountings 16, 21; 24. 25. 26
vii Box spanner
viii Protective cover
ix Canvas cover and carrying bag.

The Camera can be used in appropriate mounting for all three types of air photography
i. Hand held obliques
ii Fixed "
iii " Verticals

The power supply may be 12 or 24 V. Cameras and accessories supplied for both - all are clearly marked

Camera Body

Details of units N°. I Camera Body

i. Metal casing – housing shutter unit
ii. Detachable plate, also plate at top forms the local plane, three holes in base for bolts securing lens cone.

iii. Lens and Lens Cone

3¼"	f 5.5
5"	f 4
8"	f 2.9
8"	f 5.6
14"	f 4.5
20"	f 5.6

(Note :- 3¼" not interchangeable)

The following points should be carefully noted

BEFORE FLIGHT

i. Study the route carefully with Navigator
ii. Note any prominent land marks lights etc. which will aid Navigator
iii FILL IN FLIGHT PLAN
iv Synchronize watches

iii Gear Box – houses mechanism for winding shutter and film, lifting the pressure pad and making the necessary electrical connections

iv Shutter Unit – Focal plane type fixed slit variable speed and auxiliary capping blind. Speed of shutter regulated by the tension of the spring roller which is in turn regulated by the micrometer adjustment.

Type A – Fixed slit of 1" ($\frac{1}{40}$ sec. to $\frac{1}{120}$)
" B – " " ⅜" ($\frac{1}{100}$ to $\frac{1}{300}$)
" C – " " $\frac{3}{16}$" ($\frac{1}{300}$ to $\frac{1}{500}$)

V. Film Magazine –
Max. capacity 125 exposures (also eight, twenty five – fifty)
Fitted with wind indicator consumption counter and pressure pad

Details of Auxiliary Equipment

i. Motor Unit – 12 Volt or 24 volt supplied, both clearly marked.
Fitted with friction clutch to prevent damage should mechanism jam

ii Electrical leads
N°. 1. – Power Supply to Control
2. Control to gear box

N° iii Control to Pilot's lamp
iv Gear box to Motor

N° 3 Wiring Disposition

(a) Hand held Obliques
N° 1 from supply to gear box

Seldom if ever used

(b) Hand operation Vertical
N° 1 from supply to push switch
N° 2 . push switch to gear box

(c) Semi-Automatic
N° 1 from Supply to push switch
N° 2 push switch to gear box
N° 4 gear box to motor
Camera drive from motor to gear box

(d) Fully automatic
N° 1 from supply to type 35 control
N° 2 . type 35 to gear box
N° 3 type 35 to pilot's lamp
N° 4 Gearbox to motor
Camera drive from motor to gear box.

Camera Faults

N° 1 Fault.
No GREEN light and film wind indicator fails to rotate

i. Meshing lever fouled by magazine (Ease away mag.)
2. Faulty spring in front gap wheel (Try to turn by hand)
iii Faulty push button (Try to rectify, otherwise use hand.)
iv. Disconnected Lead (Replace)
v. Fuse in aircraft (Replace)

N° 2 Fault.
GREEN light continuous and film wind indicator also continuous

i. Jammed push button (Remove power lead. and try to free button)

N° 3. Fault.
GREEN light continuous but film wind indicator fails to rotate.

i. A broken clutch spring (Work by hand)

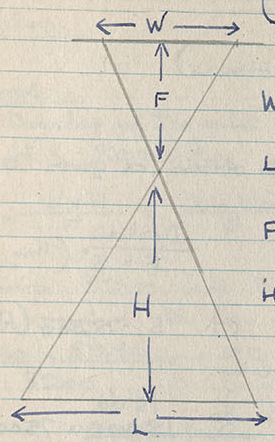
ii A broken pin on motor or worm
(Work by hand)
iii A broken flex drive.
(Work by hand)
iv. No. 4 lead off or not making contact
(Replace)

Magazine Faults.

GREEN light working normally, but film wind indicator fails to rotate.

i. Film in magazine entirely exhausted
ii " " " broken or torn
iii Bent or distorted film spools
iv. Film incorrectly loaded
(Replace with spare magazine)

N.B The magazine should NEVER be open.



(While looking For Height

W = Width of film in inches W L F H

L = length of ground photographed, in feet

F = focal length of lens, in inches

H = height from which photograph is taken, in feet

Scales

Ordnance maps are usually drawn to one of the following scales

1" = 1 mile ($\frac{1}{63360}$)
1" = 2 miles ($\frac{1}{126720}$)
1" = 4 miles ($\frac{1}{253440}$)

Photographic Scales in use with the R.A.F.

1. Large $\frac{1}{6,000}$ to $\frac{1}{10,000}$
2. Medium $\frac{1}{10,000}$ to $\frac{1}{14,000}$
3. Small $\frac{1}{14,000}$ to $\frac{1}{20,000}$

Formula for finding Scale, Ht + Focal Length

is: F. 12. S. H
(For 12 Short Hours)

Example

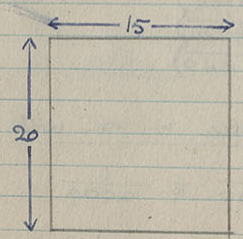
To find Ht. to obtain a given scale

Data.
F = 5" (This is to be chosen)

S = 1/18,000 (Required Scale)

$$H = \frac{F}{12 \times S} = \frac{5 \times 18000}{12 \times 1} = 7500'$$

Line Overlap (Mosaic Calculation)



To find no. of photos required to cover a given length of ground allowing for the 60% overlap
(2" is therefore the effective width of film)

First find the length of ground covered by one exposure allowing for the 60% overlap

Example

Overlap of 20 miles, Focal Length = 5"
Ht = 8,000 ft.

$$L = \frac{W \times H}{F} = \frac{2 \times 8000}{5} = 3200 \text{ ft.}$$

Divide 3200 into the total length of the ground to be covered then

$$\frac{20 \times 5280}{3200} = 33 \text{ exposures required}$$

to cover the run.

Time Interval

Divide the effective length of ground covered by one exposure by the ground speed in ft. per sec. In this case the speed is 150 m.p.h.

Then $\frac{3200 \times 15}{150 \times 22} = \frac{160}{11} = 14\frac{6}{11}$

14 secs. i.e. is Time Int.

To calculate T.I. in the air use:-

$$\frac{W \times H}{V \times F} = \frac{2 \times 8000 \times 15}{150 \times 22 \times 8} = \frac{160}{11} = 14\frac{6}{11}$$

To find no. of runs required to cover the area

The effective width of film this time is $3\frac{1}{2}$", the lateral overlap being 30%.

The shorter side of the area is 15 miles.

$L = \frac{W \times H \times n}{F} = \frac{7 \times 8000}{2 \times 5} = 5,600'$ Covered by one exposure

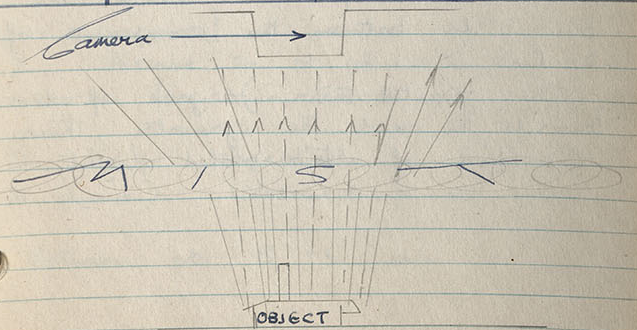
Divide 5600' into the total length of the SHORTER side. Then :—

$\frac{15 \times 5280}{5600} = \frac{99}{7} = 14\frac{1}{7} = 15$ runs.

Colour Filters

Photography

Filter Type No.	Colour of Filter	Factor
1.	Pale Lemon	Negligible
2.	Medium Yellow	Twice normal exposure
2. Water Proof	Medium Yellow	Twice normal exposure
4.	Deep Yellow OR Orange	Four times normal exposure
5.	Red	Six times normal exposure
6.	Infra-Red	Considered normal with Infra-red material (Never used with any other)



{ - - - - → Red rays and Infra-Red
{ ——→ Violet rays " Ultra-Violet

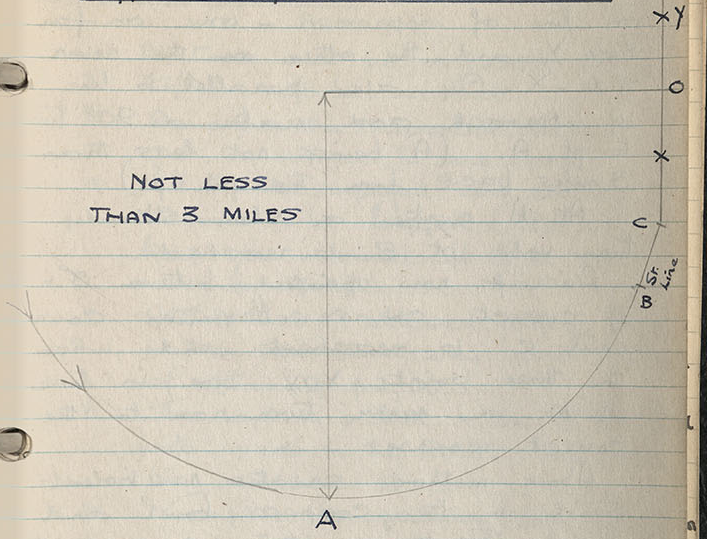
Atmospheric haze presents a serious obstacle in aerial photography for it tends to flatten or eliminate the detail of distant objects. It may consist of dust, smoke and minute water droplets which scatter light imposing a luminous veil between the camera and the object. The haze effect in photographs is more pronounced than it is visually because all films are sensitive to ultra violet light but it is invisible to the eye.

Common haze scatters u.v. & v. light but allows the i.r. and r. red rays to pass.

Haze can be penetrated if only the light which is passed by it is used Filters are therefore used and are placed in between the components of the lens

The greater their degree of density towards the red the greater their absorbtion of ultra violet light.

Approach for a Vertical Pin Pt.



[See diagram]

Y. Observe the pt. of continuation of approach line (i.e. track line in mosaics)

O. Pin pt. objective.

X (Lower) Observed pt. on approach line

Between pts B & C. a/c. st. and level

[Continued]

Letters refer to diagram on other side of page.

Identify pin pt. O., identify two landmarks on line of approach. – one on far side – 'Y' and the other on the near side – 'X'. Fly a/c. parallel to line of approach and make a 90° turn to pt. 'A'. ('A' being not less than 3 miles back from the pin pt)

At A make a slow steady turn until pt. B. is reached

Aircraft now pointed between 5° & 10° of correct course. Maintain course until 'C' is reached and when the three points XOY are in line make a minor turn on to the correct course

Above method creates no violent swirl in the compass bowl and a final 'Steady' on the correct course will be easy and accurate

DURING FLIGHT

i. All times must be accurately entered
ii. G/P.s must be accurate
iii. Remember the Navigator does not get a chance to map read
iv. All tracks required and courses steered to be logged (Pilot will keep you informed of Co. M. & any change of A/S.
v. All W.S. & D.s obtained will be logged in the conventional way and method of obtaining put in.
vi. The naut. m. & knot. & are the standard units used in the R.A.F. & these must be adhered to.
vii. Complete co-operation with Navigator is absolutely essential
viii. Neatness in compiling logs is necessary to facilitate working back & also to avoid wasting time at the interrogation after flight
ix. Always sign your log.

92. COURSE LIST.

PILOTS.

"A" SQUAD.

150003 F/O.Walgate.F.
150656 F/O.Underwood.H.G.
AUS17354 F/S.Berriman.V.G.
178789 P/O.Witchell.S.P.
1544305 F/S.Duck.R.H.
AUS427897 F/S.Dimond.D.M.
AUS436327 F/S.Bennett.R.S.
AUS427992 F/S.Gunner.G.K.

"B" SQUAD.

133368 F/O.Ruff.W.F.
1390484 F/S.Bell.J.J.
1234505 F/S.Holditch.R.W.
1550709 F/S.McKindlay.D.F.
1801485 Sgt.Packer.V.S.
1801180 Sgt.Pool.K.R.S.
1586788 Sgt.Glanville.R.
1622256 Sgt.Orry.D.G.

NAVIGATORS.

1323703 Sgt.Edom.J.S.
1604101 Sgt.Hagan.A.J.
16244200 Sgt.Thompson.P.A.
1566191 Sgt.Boyd.J.
1398165 Sgt.Westacott.G.E.R.
1804542 Sgt.Gilbert.C.H.
1565763 Sgt.Alexander.A.
1511965 Sgt.Whitelock.W.

1397276 Sgt.Prance.K.F.
1802789 Sgt.Bottrill.W.S.
1623913 Sgt.Green.G.G.
1622147 Sgt.Duerden.H.
164034 P/O.Wood.P.A.
164713 P/O.Williams.C.
165283 P/O.Evans.H.J.
171404 P/O.Smith.W.D.

AIR BOMBERS.

1569330 Sgt.Lawson.D.
1795472 Sgt.Hayden.J.P.
1807094 Sgt.Niederman.P.
1804382 Sgt.Neaves.L.
1673392 Sgt.Newbigging.J.P.
1399866 Sgt.Curtis.L.A.
1582927 Sgt.Bailey.T.O.
1584053 Sgt.Hamer.A.R.

1586576 Sgt.Humphrey.J.W.
1607203 Sgt.Boiko.
1623826 Sgt.Diggle.
1801703 Sgt.Goulding.
180071 Sgt.Peck.
1802347 Sgt.Fraser.
1581066 Sgt.Ashmore.
1351556 Sgt.Annetts.

WIRELESS OPERATORS.

1894292 Sgt.Pearce.
1867255 Sgt.Warsfold.G.D.E.
1890709 Sgt.Rouse.A.C.
2209785 Sgt.Wrench.T.A.
2209706 Sgt.Walker.S.H.
1893256 Sgt.Leach.R.F.S.
1853314 Sgt.Smith.E.W.
1876300 Sgt.Walker.E.A

1894274 Sgt.Tylcoat.D.K.
1853373 Sgt.Callan.E.J.T.
1875727 Sgt.Payne.E.S.
1330399 Sgt.Brooks.C.A.
177835 P/O.Morris.N.C.
177834 P/O.Govier.F.M.
177829 P/O.Aptroot.B.
178378 P/O.Wright.G.D.

AIR GUNNERS.

1450678 F/S.Wrigley.D.
1583744 Sgt.Williamson.J.
1755334 Sgt.Thomas.P.A.
1605326 Sgt.Culling.E.G.
911503 Sgt.Aldrich.O.N.
1608602 Sgt.Best.G.R.
1803681 Sgt.Azoor.A.
901878 Sgt.Arnold.A.N.
1698526 Sgt.Cunliffe.F.J.
SR.710344 Sgt.Lavine.A.E.
1568885 Sgt.McDougall.M.
1584121 Sgt.Bunn.A.H.
NFD798810 Sgt.Stowe.S.C.
1804936 Sgt.Wesborn.T.H.
1655181 Sgt.Lloyd.J.D.
3030360 Sgt.Bower.F.

3030032 Sgt.Leigh.E.G.
1862343 Sgt.Tullett.L.E.
1614174 Sgt.Jones.A.W.
1580771 Sgt.Felton.N.L.G.
1587399 Sgt.Jones.P.T.
1605308 Sgt.Pierce.D.P.H.
164648 P/O.Morse.A.J.
164647 P/O.Tipple.B.H.
117405 F/Lt.Rankin.R.A.
171718 P/O.Freeman.F.J.
1350824 Sgt.Griffin.C.E.
914222 Sgt.field.R.P.
1683486 Sgt.Burrows.W.
914799 Sgt.Christmas.R.F.H.
1603630 Sgt.Little.G.O.

28 A.B.I.s Course Entrance

Answer 5 Questions — 2 hour paper.

1. What do you understand by the following Terms
   (a) Trail Distance (b) Time Lag (c) Ground Lag.
   (d) Trail Angle

2. (a) What types of Groups do you get when bombing
   (b) How would you assess these Groups.
   Close
   Open Radial
   Open Tangential
   Line Group.

3. What do you understand by the following terms as applied to (a) Bombs – (Pistol – Exploder)
   (b) Fuzes – (Fuze – Delay (capsule))

4. You are required to drop a stick of 5 bombs what formula would you use to bring the centre of the stick on to the target using the C.S.P.S..

5. What fuses would you use in the following types.
   (a) Photo Flash?
   (b) Recco Flare?

6. What is the error due to height.
   Ground Error = 50 yds G.S. = 200 ft. p. sec.
   Time of fall = 20 secs
   Formula for Ground Error = $\frac{Gh}{32t}$.

Air Photography

Maps and Charts

A map is a representation of the earth's curved surface on a flat plane. It is impossible to do this without distortion. Thus it possible to represent correctly one or two but not all of the following

i. Shapes
ii Type of bearing (Gt. ⊙ or Rhumb Line)
iii Areas

If only a small part of the earth's surface is taken at one time, a general compromise may be possible

The Necessary Qualities that an Air Navigatorn Map should possess

(a) Preservation of Shape
(b) Whether Gt. ⊙ or Rhumb Line bearing
(c) Scale of distance.

The preservation of true area is of no concern to the air navigator

There are two types of maps, or rather two types of projections which serve the air navigator

i. Topographical projections (for map reading)
ii. Navigational projections (for plotting)

Topographical Projections

These maps are designed solely to show features of the earth with a minimum of distortion. A country or area which is to be mapped and extends N. & S. more than E. & W. presents a different problem to the map maker than one that extends E. & W. more than N. & S.

Each calls for special treatment. The kinds of projections which take care of the above differ from each other in such very minor details that the Air Navigator is unable in practice to distinguish between them.

They are :—

(a) International Modified Polyconic (1:1000000
(b) Conical Orthomorphic - used for mapping a continent
(c) Transverse Mercators being used in the new $\frac{1}{4}$" Series of Gt. Britain
(d) Cassini's old $\frac{1}{4}$" of Gt. Britain.

These maps should not be used for plotting purposes, not so much because they are covered with detail that makes plotting difficult to see, but because st. lines drawn on them earth don't represent Rhumb Lines on the earth.

The main properties of topographical maps in use are :—

i. The scale of distance can be considered as constant over the whole Sheet.

ii. A st. line is very nearly a Gt. ⊙ and therefore bearings and distances along a st. line are very nearly Gt. ⊙ bearings and distances

Scale of Maps

Methods of indicating Scale

The ratio between a given length on the map and the actual distance this represents on the earth is called a Scale on a map.

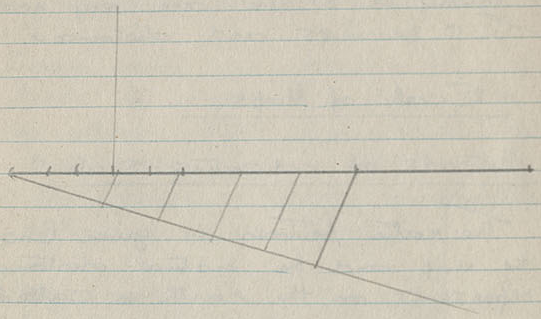
i.e. Scale = $\frac{\text{Map Length}}{\text{Earth Distance}}$ $\left\{\begin{matrix}\text{In same}\\ \text{UNITS}\end{matrix}\right.$

Representative Fraction e.g. 1/500,000. Expresses ratio of a unit length on the map to its corresponding number of similar units on the earth.

Statement of Words e.g. $\frac{1}{4}$" Map. Gives the corresponding values of two different units of length one on the map and the other on the earth.

For large scale maps the length on the map corresponding to a mile on the earth is usually stated.

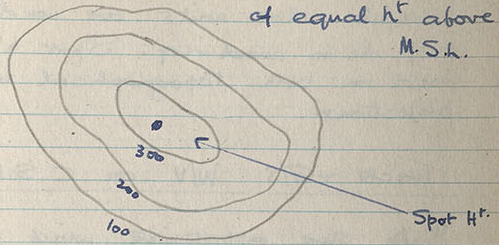
iii. Graduated Scale Line :- is always given showing the actual lengths on the map corresponding to various distances on the earth.



N.B. It should be noted that a scale of nautical miles is nearly always provided by the graduation of the marginal meridians. On small scale maps e.g. 1:1,000,000 a certain distortion is necessary to make the maps at all readable, for if the details were recorded true size, they would be imperceptible on all but the largest scale maps. Thus as the scale decreases, features become less true to form and increasingly conventionalised.

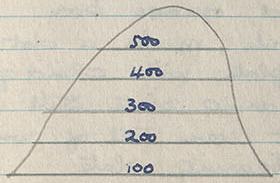
Methods of Indicating Relief

i. Contours - are lines joining all places of equal h^t above M.S.L.



When only approximately drawn they are called "form lines"

Contours are found mainly on large scale maps and are used on most topographical maps available to the R.A.F.



VERTICAL INTERVAL

Spot Hts: Indicating the highest points on the map either in ft. or metres. The air navigator should be very careful what units are used on the map he is reading. Spot hts are used on both topographical & Navigation projections.

Track & G/S W/V on C.S.B.S

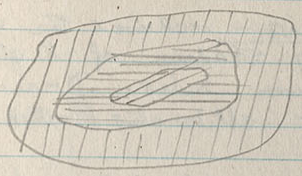
Make sure appropriate wind guage bar is on bombsight to allow for the airspeed of the a/c in which it is being used.

i. Find G.S. Eliminate drift
ii. Unlock bearing plate, put r. on r.
iii. Set A/S on cursor against G.S. in seconds found (1 mile = x secs.) on wind guage bar
iv. Down rule, make a dot on bearing plate with chinagraph pencil
v. With bearing plate still unlocked place dot over tail of wind arrow
vi. Lock bearing plate
vii. Read off wind direction
viii. Turn wind speed bar at rt. angles to Airspeed bar
ix. Turn wind speed knob till hole in cursor is directly over wind point on bearing plate

x. Read off wind speed on wind Speed bar.

Methods of Indicating Relief (continued)

Layer Tinting

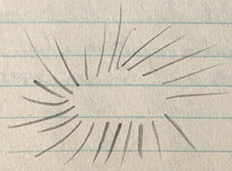


Tinting all areas the same ht. the same colour, the colour getting darker as the ht. increases or different colours between contours to indicate rising ground.

Used on a topographical maps to give a vivid picture of relief. Sometimes different hts difficult to distinguish between or see tints in artificial light.

Special colour schemes and inks are sometimes used

4. Hachures



Short tapering lines drawn on map and radiating from peaks and high ground

They only show shapes. Not used.

on topographical maps because of their indefinite nature. Used only on navigational maps.

5. Hill Shading – achieves the effect of casting shadow of high ground on its lower sides. Draw back is that it obliterates other details on map.

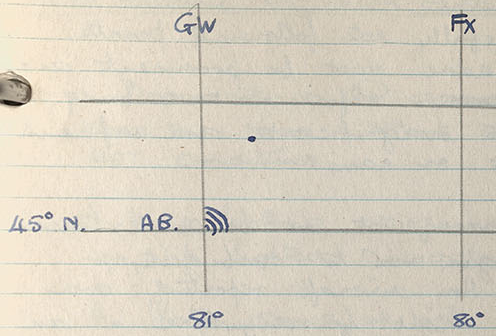
Thus it is not extensively used Used on topographical map of Continent of which some are still available to the R.A.F.

Methods of Reporting Position

Change of Longitude (Ch Long or d long) The ch. long. between two places is smaller arc of the equator intercepted between their respective meridians. It is named E. or W. according to direction of change.

Change of Latitude = the arc of the meridian intercepted between the equator and Observer's position.

Lettered Co-ordinates



AB GW 4020

Each whole degree of lat. between 70° N & 70° S
. . . . long. is allotted a pair of letters that are secretly changed from time to time.

The intersection of these lettered Co-ordinates may ∴ be expressed by a group of four letters representing latitude always named first.

The position of a place is first referred to the nearest intersection of the meridian and parallel of latitude for whole numbers of degrees S.W of the place, this being a four letter group. Then the ch. lat. & long between the place & this intersection is expressed in minutes – ch. lat always being given first.

Place Names

Carefully note following points.

1. Place name must be prominent and well known. Reference never being made to insignificant and unfamiliar features or names.

2. The place must not be so extensive as to give rise to ambiguity
   e.g. An aircraft reported over LONDON might be anywhere in an area of about 200 square miles.

3. If the a/c. is not actually over the place named, its bearing & distance from the place should be reported. Thus the position of a Navigator who observes HAMILTON to be North and distance 5 nautical miles is reported :-

   180° HAMILTON 5 miles

Ground Position

At any time the position on the earth directly beneath an a/c is known as its ground position It may also be referred to as a "fix" or pin.pt.

Map reading at Night – High & Medium Altitudes

i. Dependent on the amount of light shed by moon & stars and upon MET. conditions

ii. Keep looking at ground don't go into lighted Navigator's Cabin

iii. Water shows up well and coastlines (swift) rivers, lakes, etc are easily distinguished. Confusion may be caused by camouflaged waterways

iv. Woods (shape of) show up black and are of assistance. Their reliability symbol should always be looked for. On target maps, no symbol is used unrevised woods shown by black cross ruling and revised woods by solid black.

v. When in target area, flares may be used, and G.P.s obtained

vi Railways are not much help as lines are usually painted to stop reflection.

vii. Canals are deceptive on the Continent due to their multiplicity

Map reading at low altitudes

This is the most difficult of all forms of map reading for the following reasons

i. Pilot unable to fly steady courses and airspeeds

ii Drifts unable to be taken ∴ D.R is impossible

iii H.F.D.F ranges severely restricted and trailing W/T aerial cannot be reeled out. Thus close up pin pointing is alone possible

The following pts will assist in Low Level map reading

i. In preparation for a flight route must be very carefully studied for map reading checks

ii Physical features must be noted and anticipated during flight

iii Dangers such as cul-de-sac valleys or fjords - H.T. cables sharply rising ground etc must be foreseen. The apparent increase of ground speed when flying at low altitudes should be overcome by looking ahead of your G.P. on the map and anticipate features before they actually are in view.

Aids in Low Level Map Reading

i. Tunnels and railway intersections

ii Viaducts

iii Rivers (Bridges and Islands)

iv. Chateaux, water towers etc

v. H.T. Cables (Posn. line only)

Note. Canals deceptive due to their multiplicity on the Continent

Map Reading by Day at High - Medium Altitudes.

i. Orient map.

ii. Full understanding of the map used is essential

iii Understanding of the picture presented by the ground (representation)
This only comes with experience

iv. Don't jump to conclusions

v Keep as wide an area of ground as possible under Surveyance

vi Time the approx. pos. of a/c must be known at all times. The D.R. circle of error is 10% of dist. travelled from last fix for radius of circle
Useful when flying over broken cloud

vii Anticipate features before they come into view

viii Accurate estimation of distance is essential

Fixed Square Search

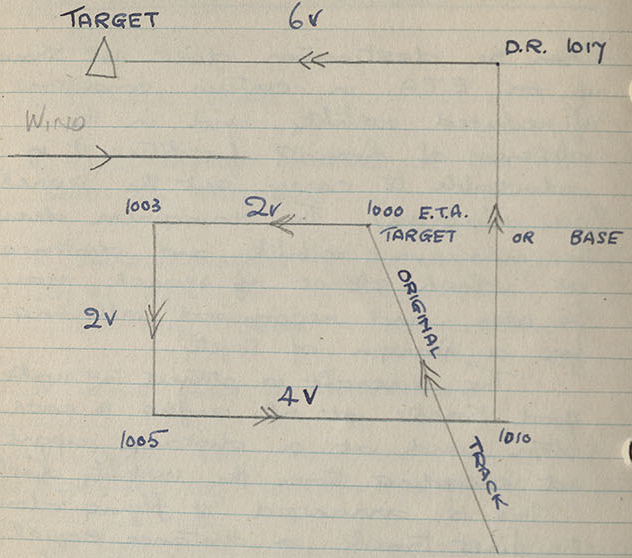
When the destination does not show up on E.T.A. in certain conditions of reduced visibility, and in the absence of homing facilities it is advisable to carry out the search (see diagram). The Navigator decides the maximum visibility and distance at which object of search may be seen and recognised allowing for a margin of safety.

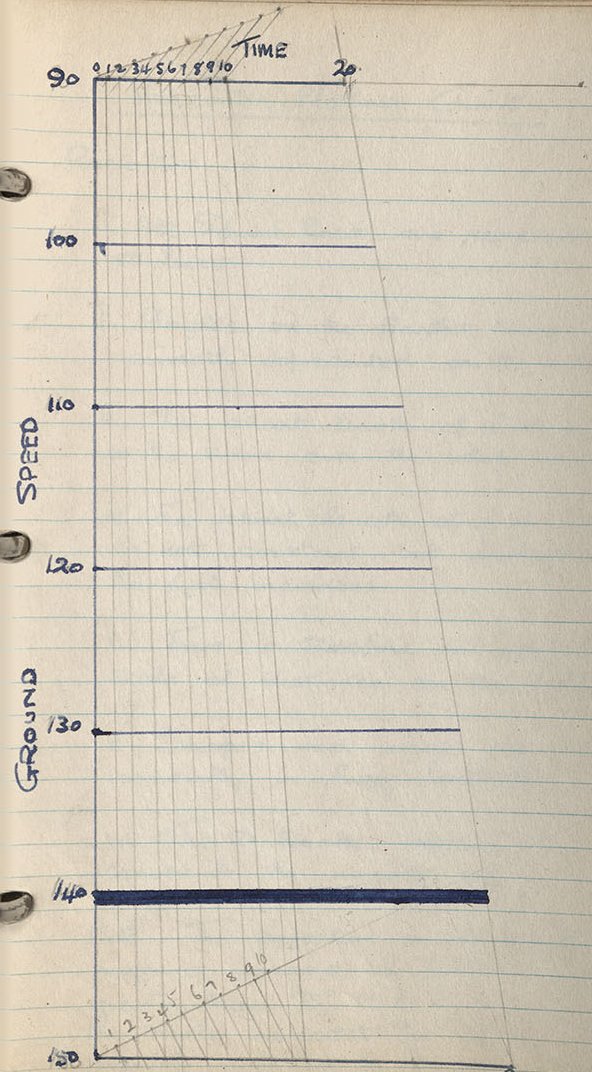
The aircraft is steered to make good tracks at rt. angles to each other and at a distance apart not exceeding twice the visibility dist (2V)

This is arranged by flying along the first track a distance equal to 2V, and increasing the track length by 2V on every alternate track

In order to avoid pre-computing the courses of making last minute calculations the tracks are best arranged up, down and across wind.

The first track of the search should be in the direction most nearly a continuation of the original track of the aircraft.





Mercator Plotting Chart

Properties

i. All Rhumb lines are represented as st. lines

ii. Angles on the Earth's surface are correctly represented on the chart

iii The chart length of 1" of Longitude is the same over the whole chart

iv. The chart length of 1' of Latitude is not constant but increases as the Lat. increases

v. There is therefore no constant scale of distance on the chart

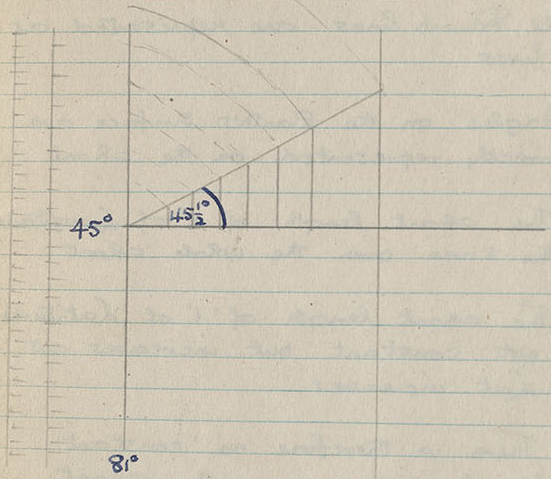
vi Shapes and areas are distorted especially in high latitudes

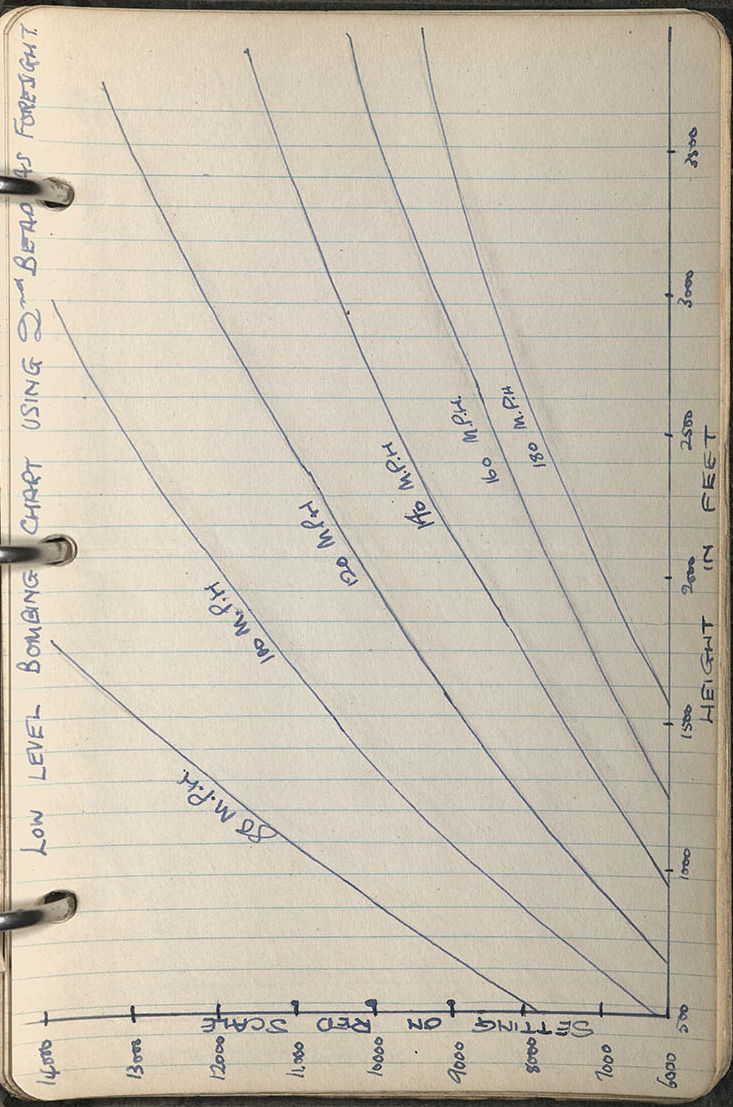
vii Grt. ⊙ tracks appear as curves convex to the nearest pole

Note. The projection is not suitable for mapping areas in latitudes much greater than 75° N. or S. because thereafter the scale increases too rapidly becoming infinitely great at the Poles.

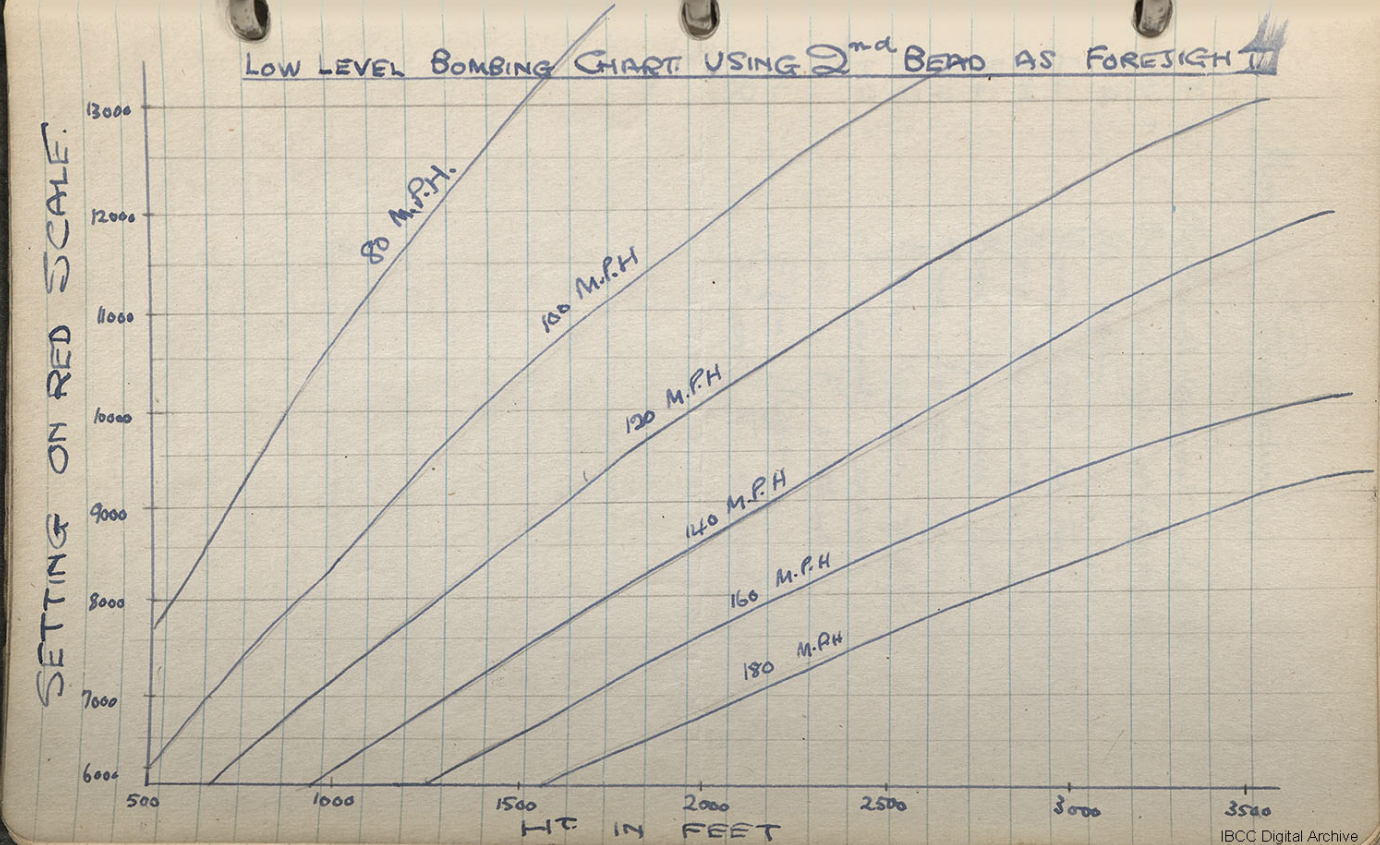
Construction of a Local Mercator's Graticule

Diagram Only.





LOW LEVEL BOMBING CHART USING 2nd BEAD AS FORESIGHT



Morse Procedure

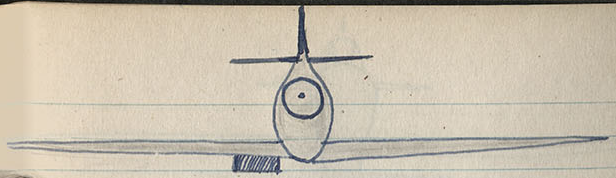
T = Acknowledgement Letter
W = Bad Lamp alignment
AA = All After
LL = Your light is too powerful
MH = Move the lamp higher up
ML = Move to your left
MO = Move lower down or nearer
MR = Move to your right
HA = I cannot answer (use 'F' Method)
OL = Open light
SR = Revert to normal proceedure.

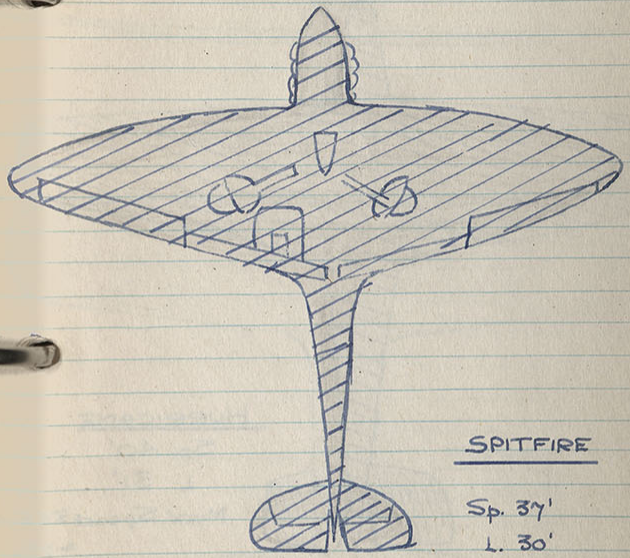
Time and Speed Scales

Dist = G.S. × Time

G.S = $\frac{\text{Dist.}}{\text{Time}}$

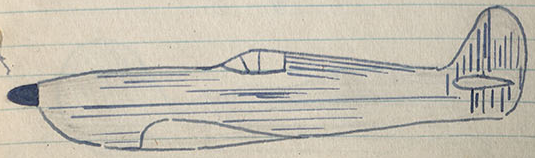
Time = $\frac{\text{Dist}}{\text{G.S.}}$

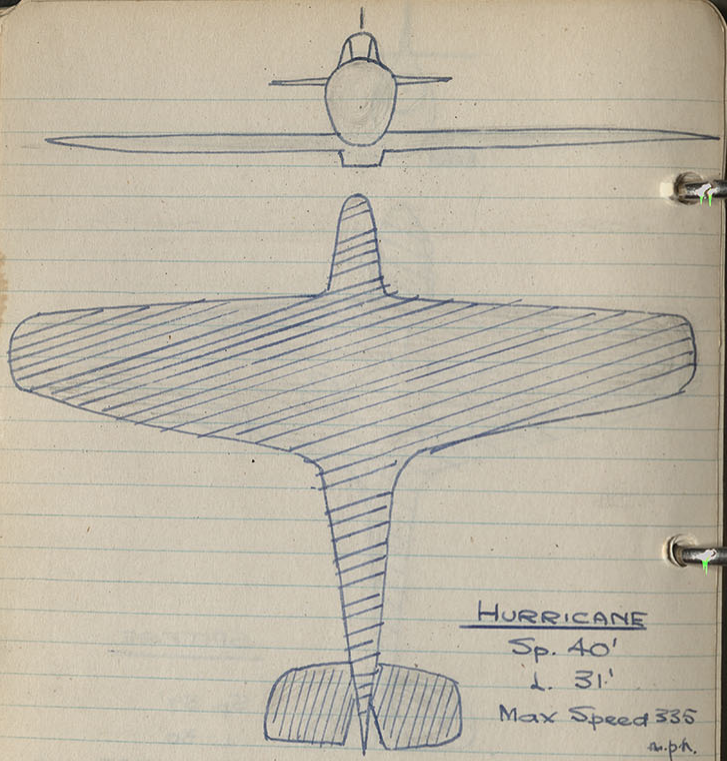




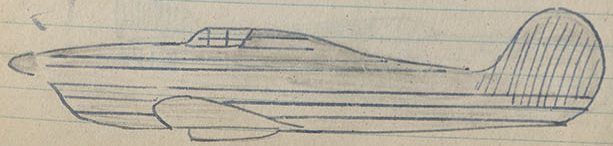
SPITFIRE

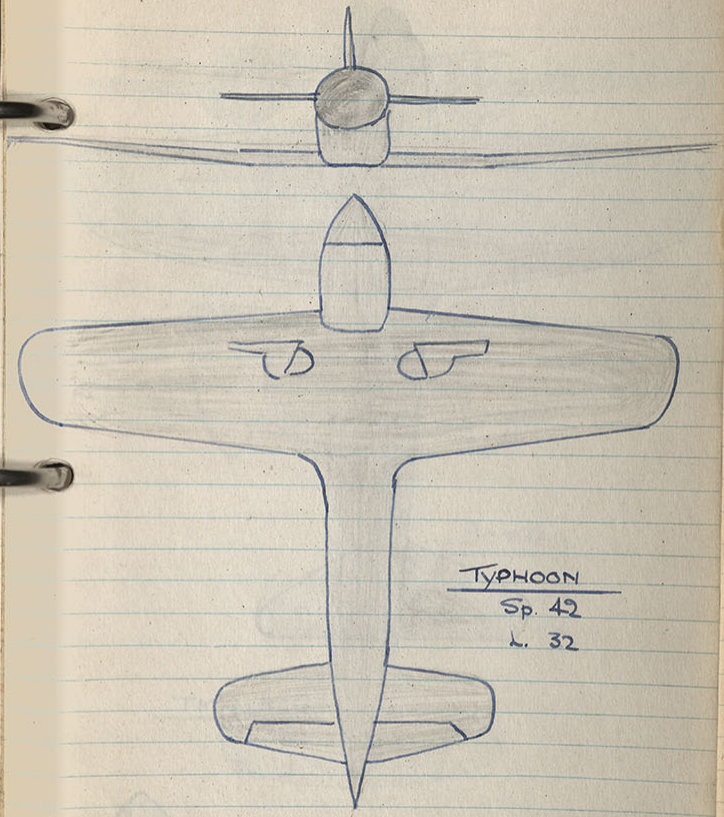
Sp. 37'
L. 30'
Speed 365 m.p.h.



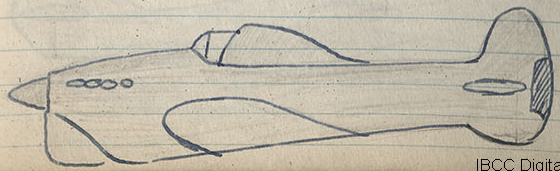


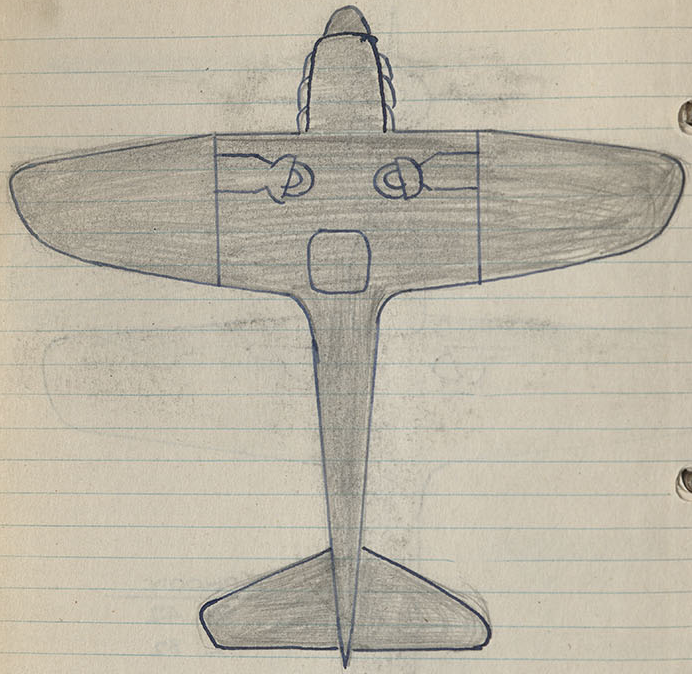
HURRICANE
Sp. 40'
L. 31'
Max Speed 335 m.p.h.
Range 730 m.



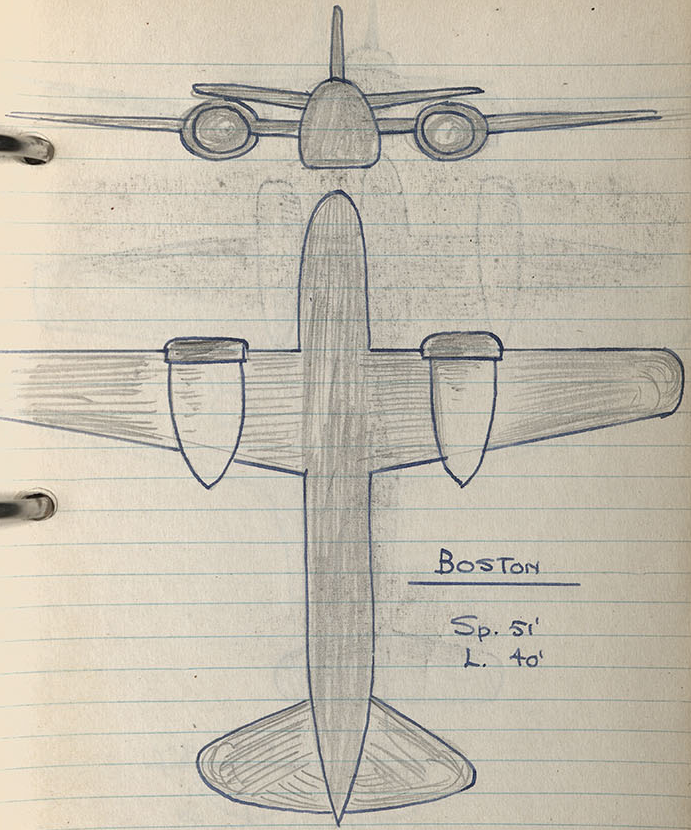


TYPHOON
Sp. 42
L. 32

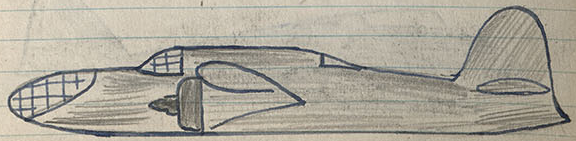


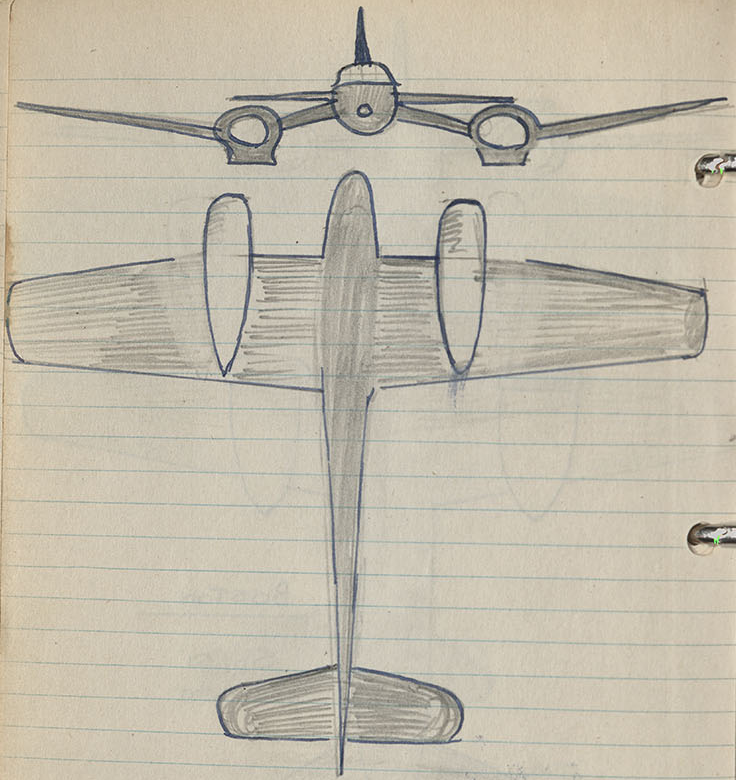


DEFIANT
Sp. 39'
L. 35'

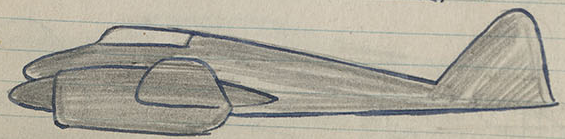


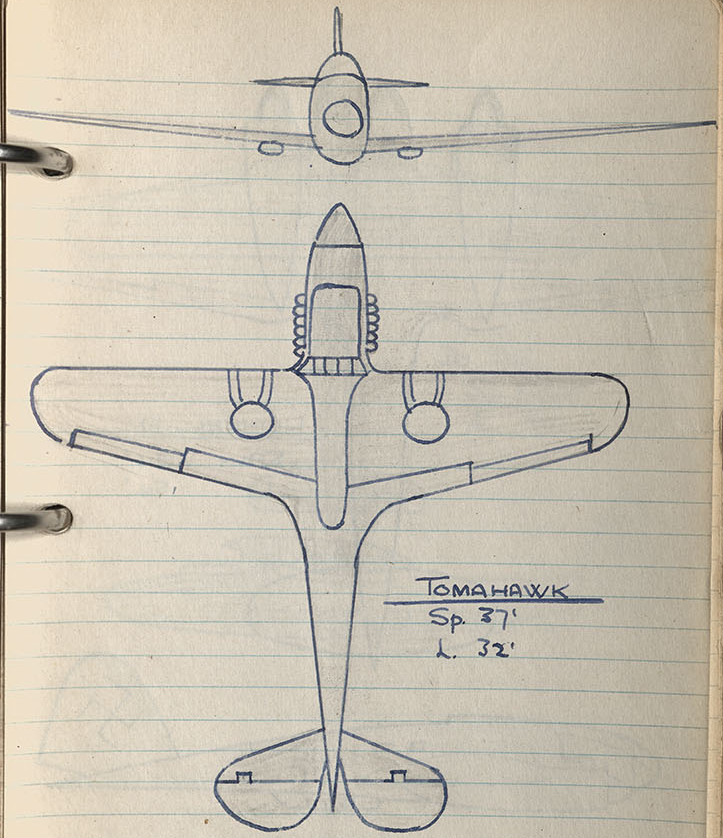
BOSTON
Sp. 51'
L. 40'



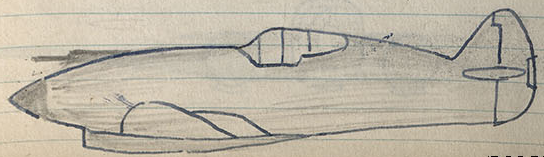


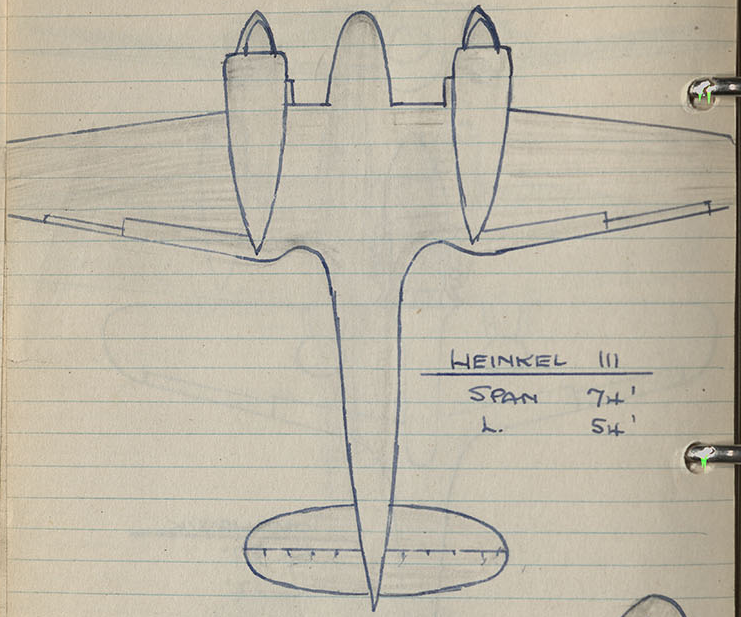
F.W. 187
Sp. 51'
L. 40'



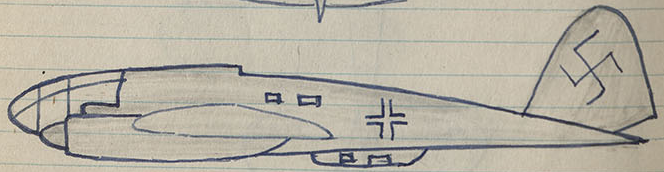


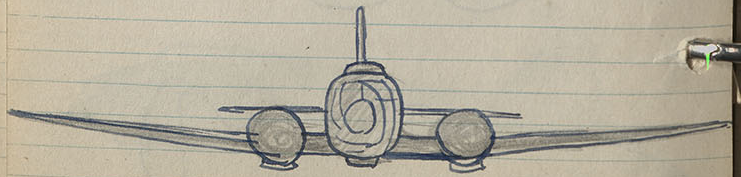
TOMAHAWK
Sp. 37'
L. 32'

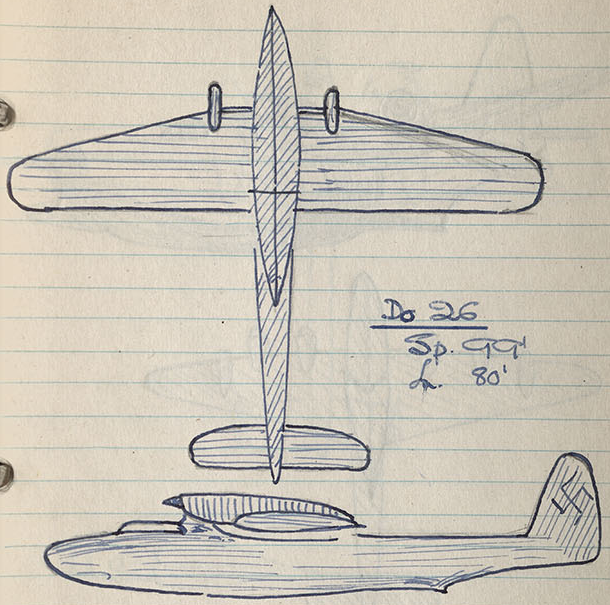




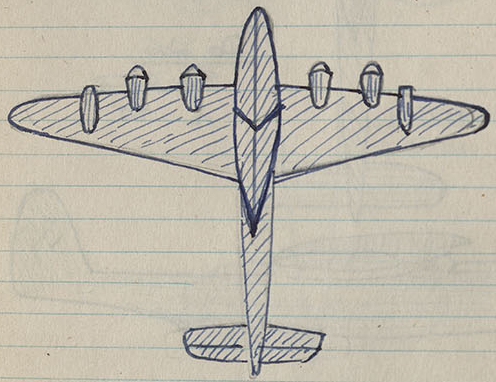
HEINKEL 111
SPAN 74'
L. 54'



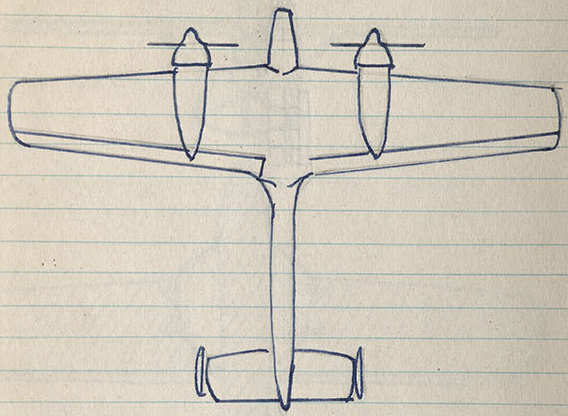


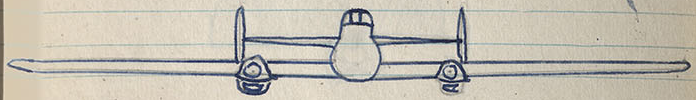


Do 26
Sp. 99'
L. 80'

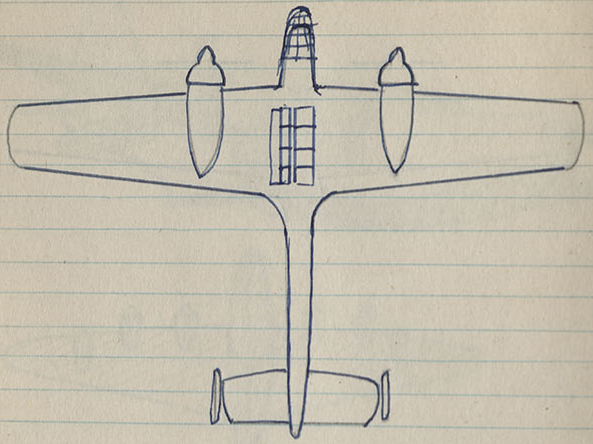


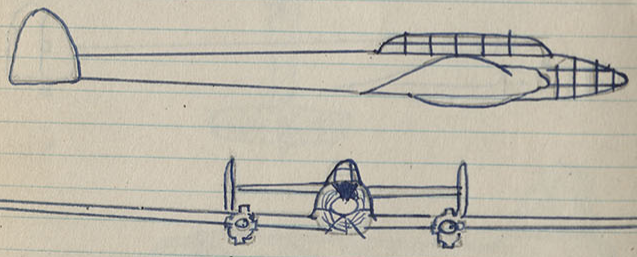
SUNDERLAND Sp 113'
L. 85'





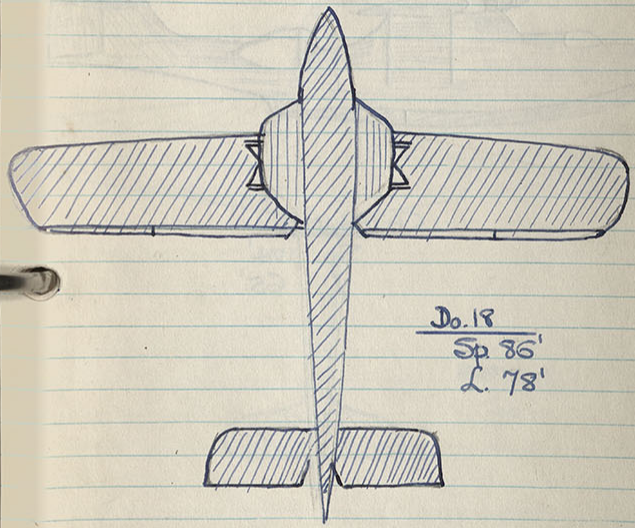
MESSERSCHMITT ME 110
SPAN 53 ft
LENGTH 41 ft.



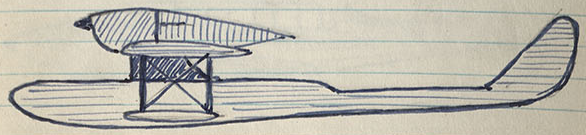


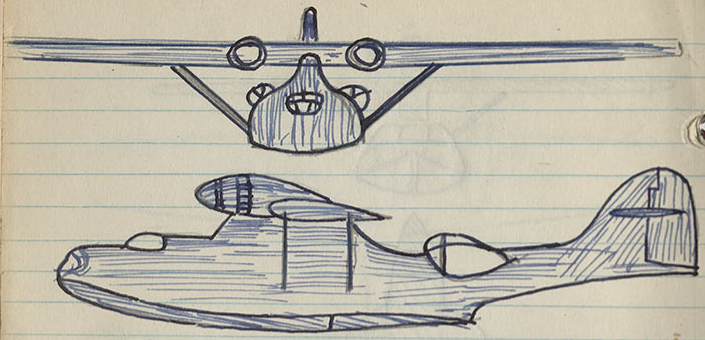
MESSERSCHMITT JAGUAR

SPAN 55 ft.
LENGTH 42 ft.

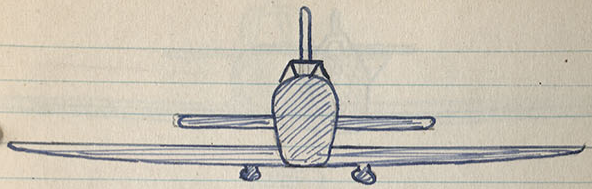


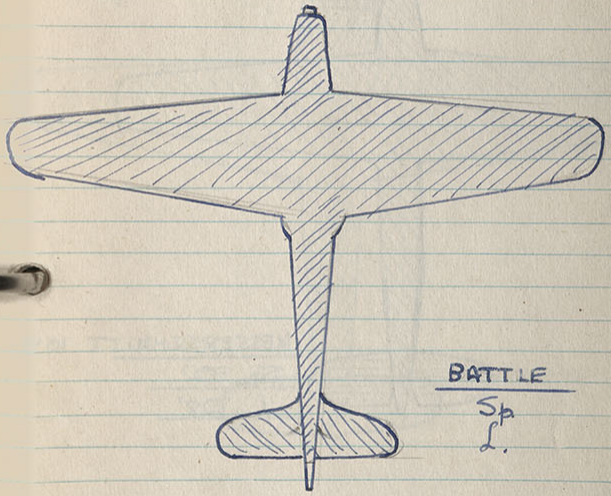
Do. 18
Sp. 86'
L. 78'



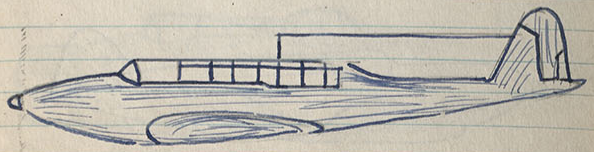


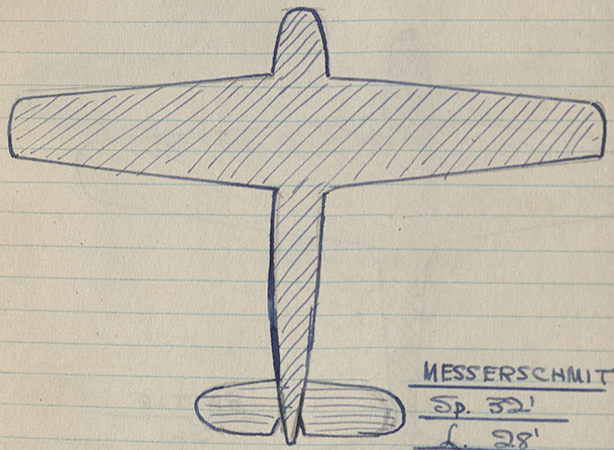
CATALINA
Sp. 104'
L. 65'



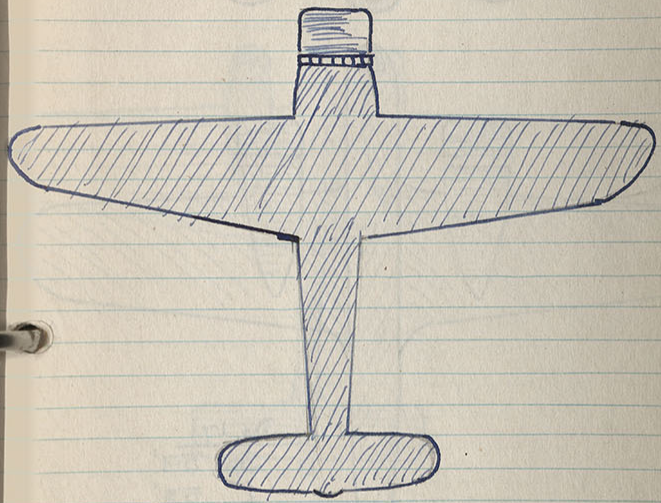


BATTLE
Sp
L.

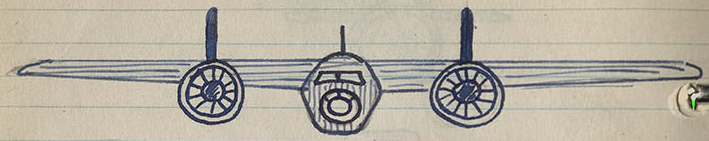


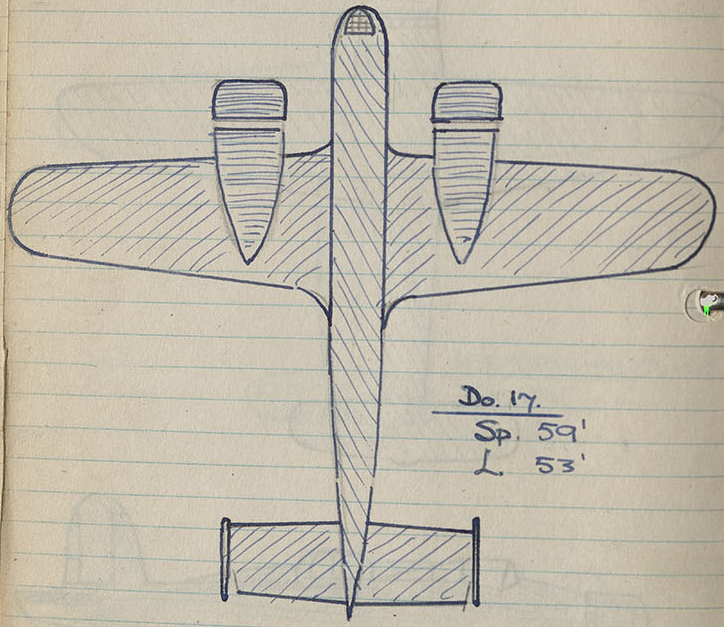


MESSERSCHMITT 109
Sp. 32'
L. 28'

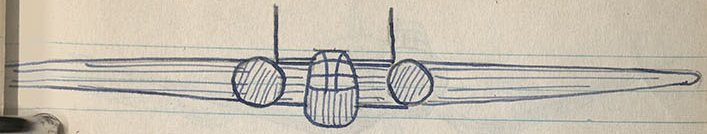


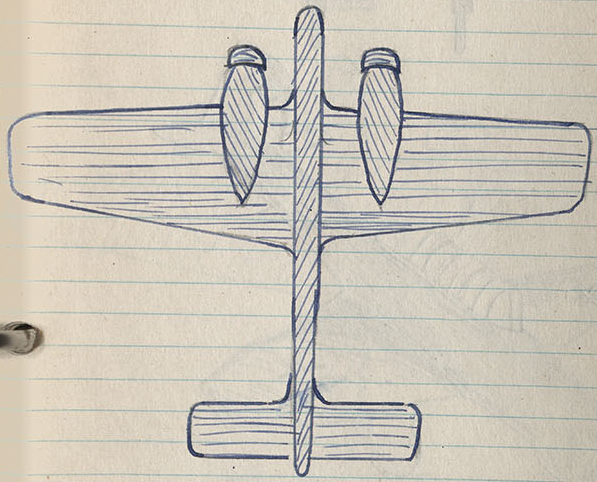
BLACKBURN ROC
Sp. 46'
L 36'



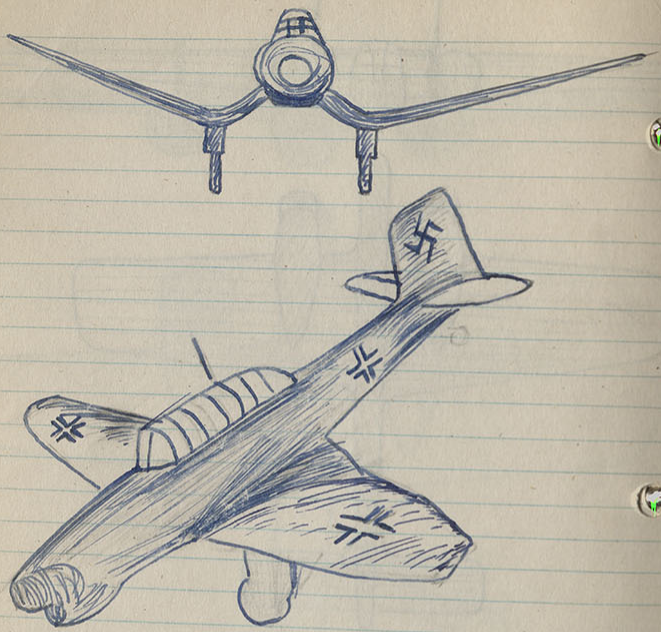


Do. 17.
Sp. 59'
L. 53'



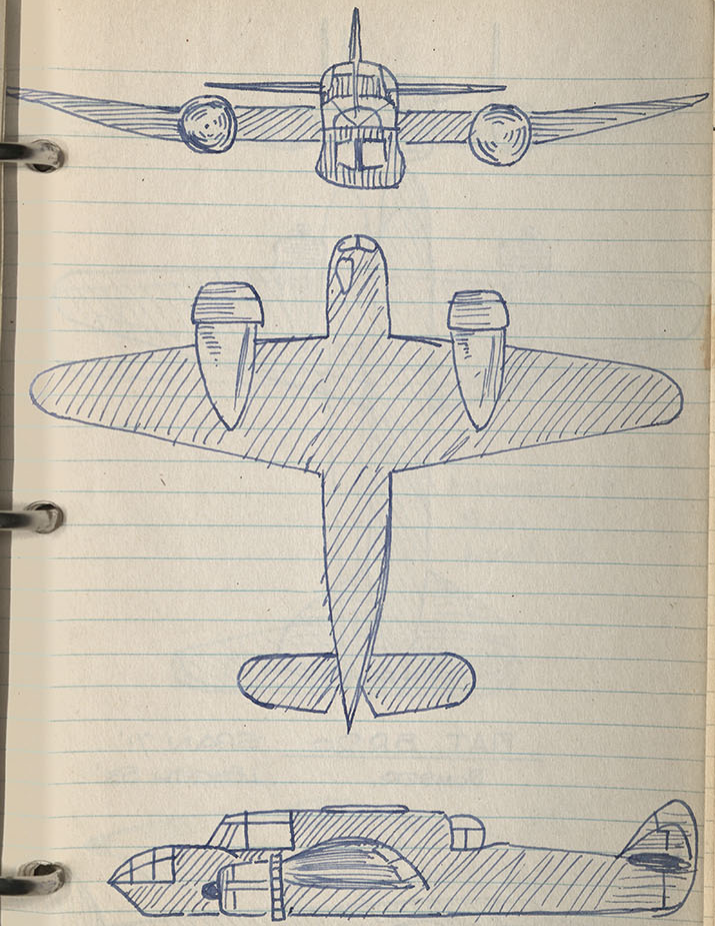


WHITLEY Sp. 84'
L. 68'

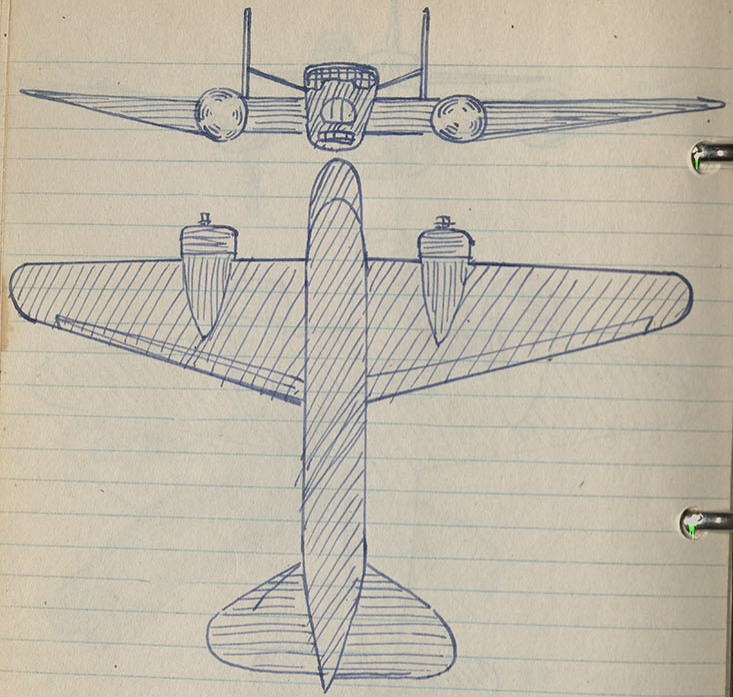


JUNKERS 87 DIVE BOMBER.

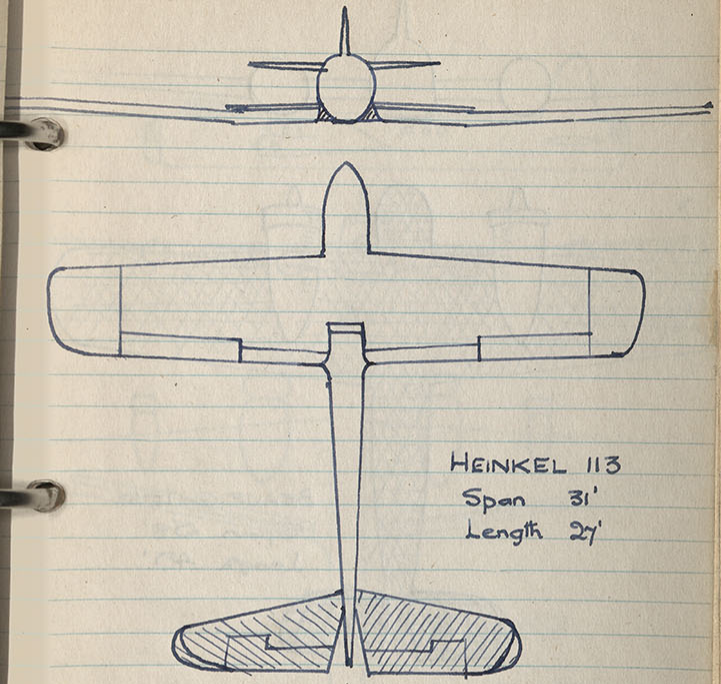
Span 45'
Length 35'



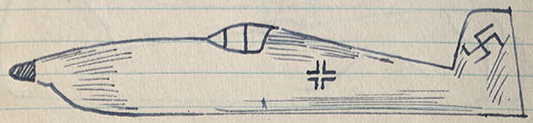
BEAUFORT SPAN 58'
LENGTH 44'

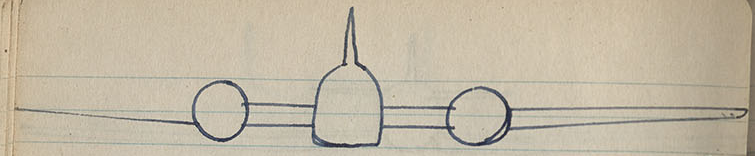


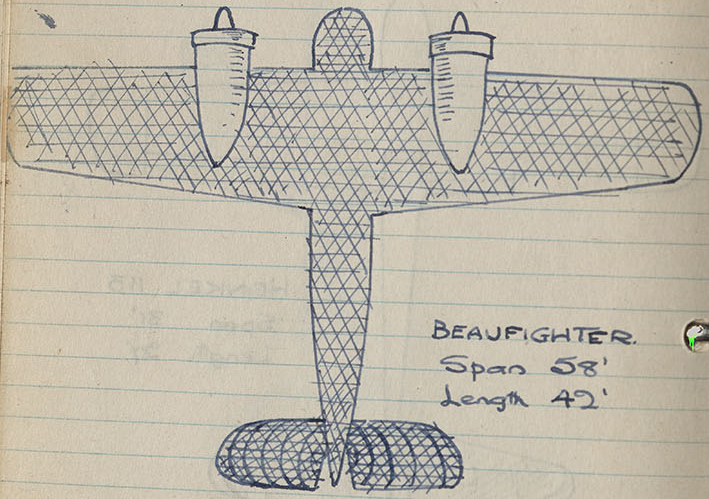
FIAT BR20 SPAN 71'
BOMBER. LENGTH 53'



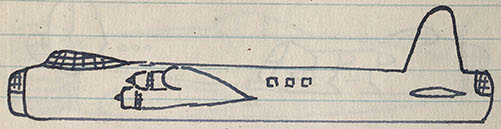
HEINKEL 113
Span 31'
Length 24'

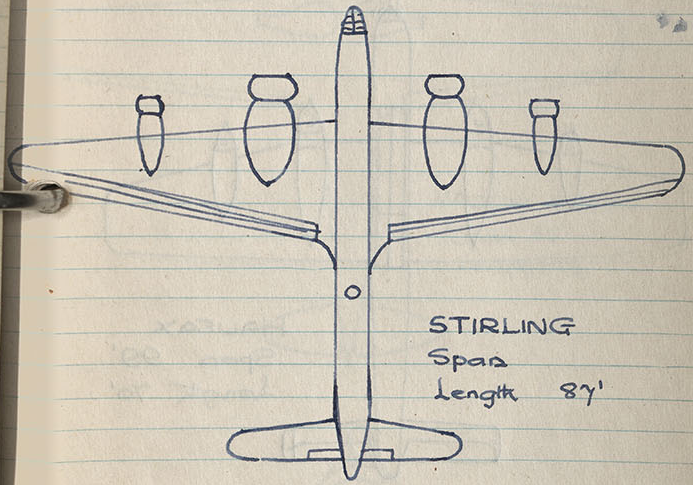




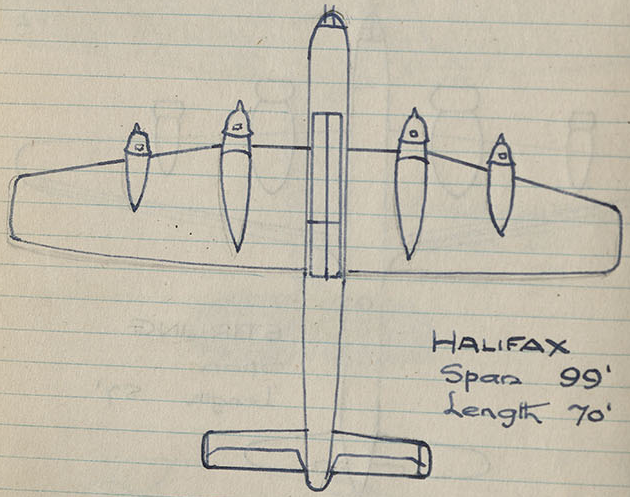


BEAUFIGHTER.
Span 58'
Length 42'

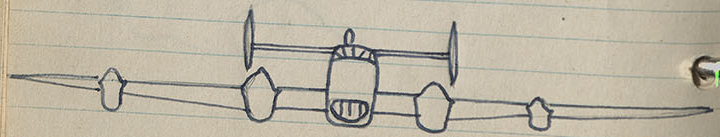


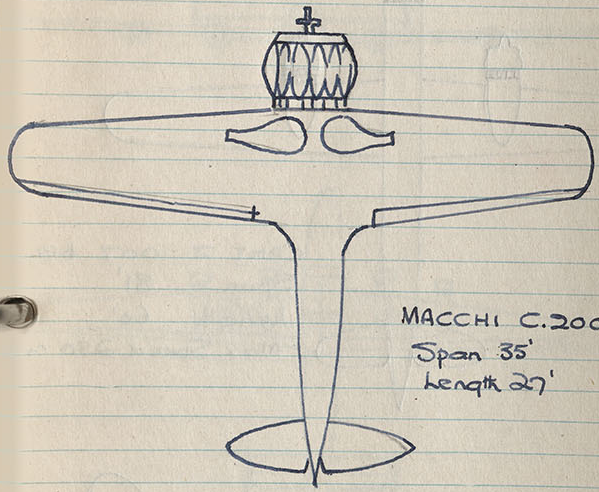


STIRLING
Span
Length 87'

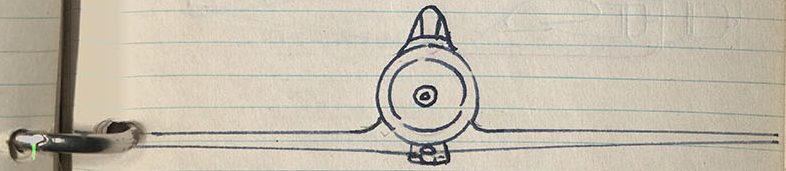


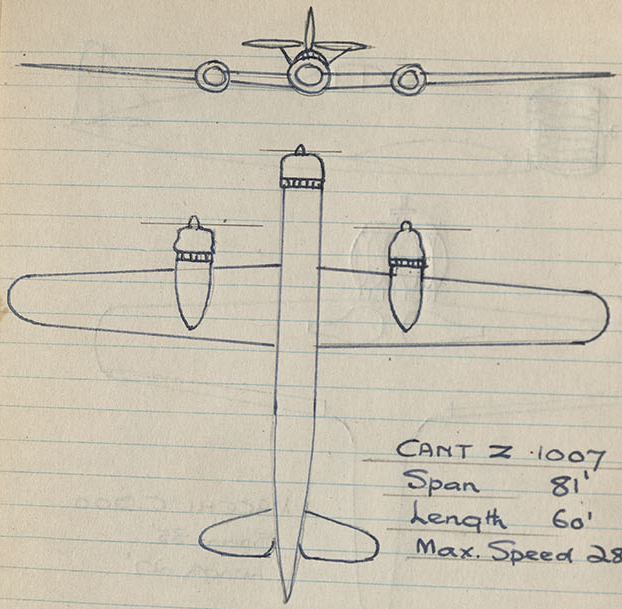
HALIFAX
Span 99'
Length 70'



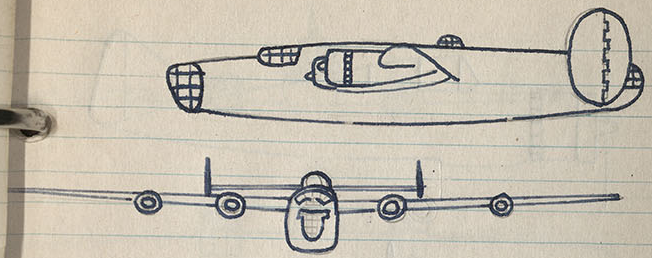


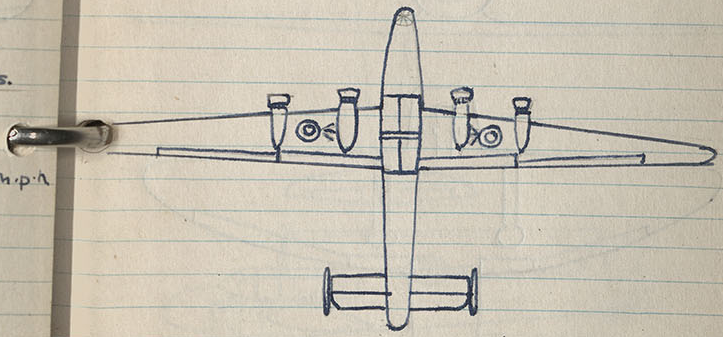
MACCHI C.200
Span 35'
Length 27'





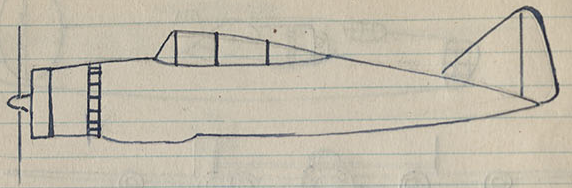
CANT Z 1007 bis.
Span 81'
Length 60'
Max. Speed 280 m.p.h

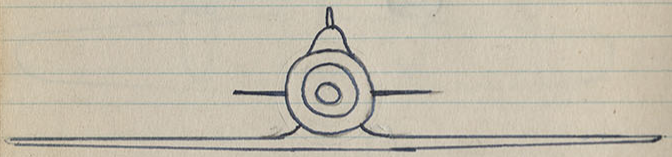


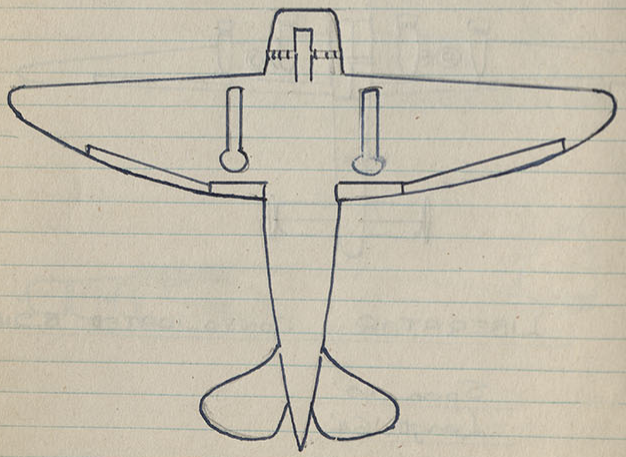


LIBERATOR CONSOLIDATED B.24.

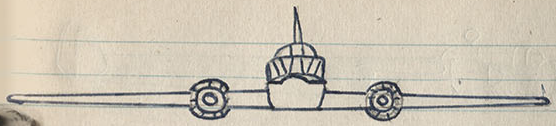
Span 110'
Length 64'

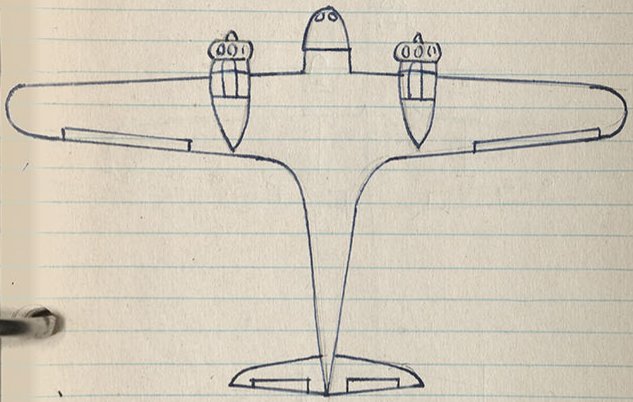


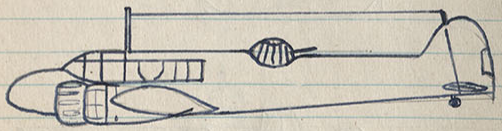




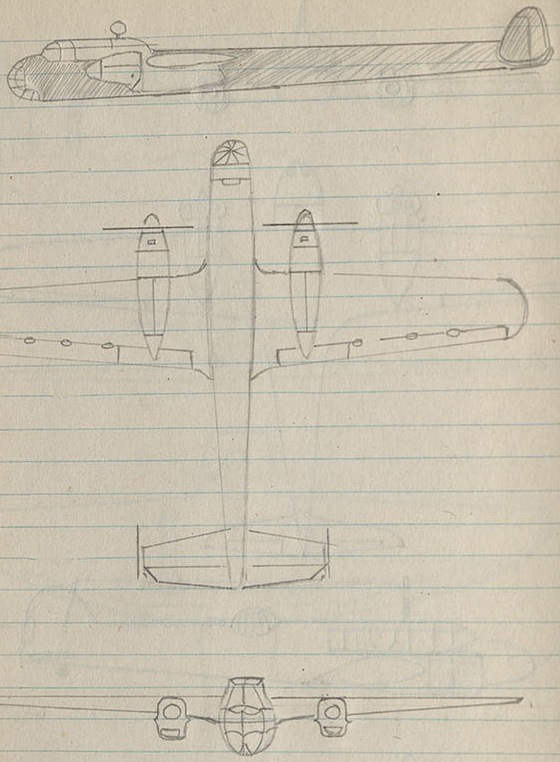
CAPRONI REGGIANE RE. 2000.
Span 37'
length 26'



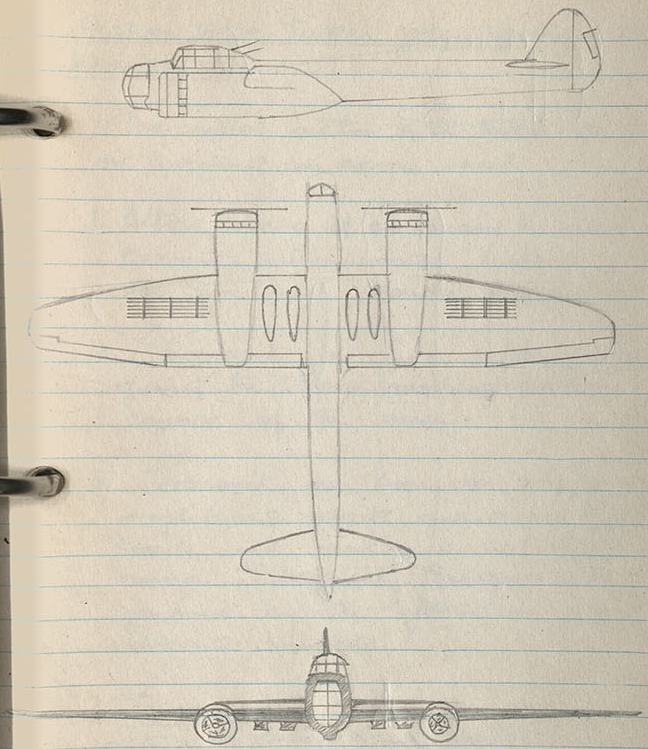




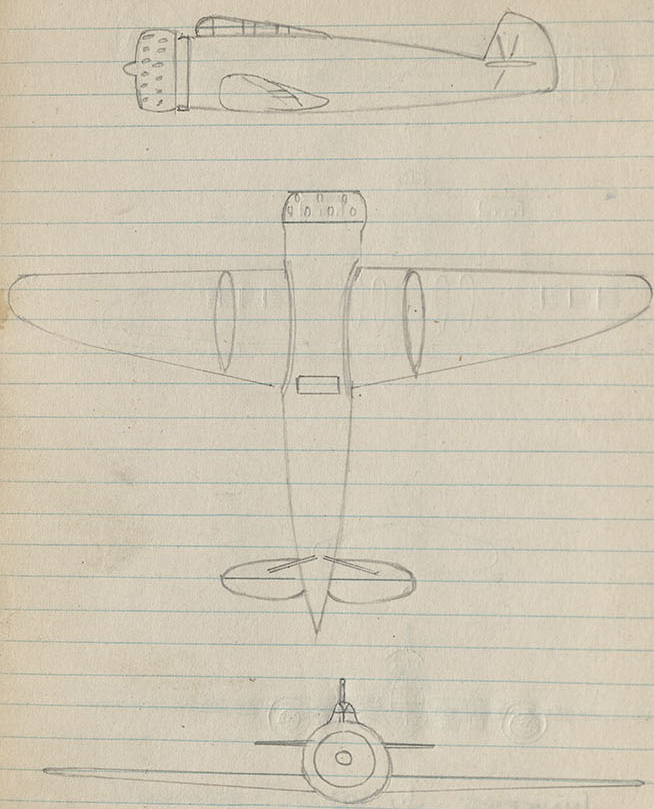
ANSON
Span 57'
Length 42'



DORNIER 215.
Span 59'
Length 54'



JUNKERS Ju 88
Span 59'
Length 47'



BREDA 65
Span 40'
Length 32'

Action to be taken on sighting Enemy Warships.

The initial action to be taken by an a/c on sighting an enemy vessel

1. Alter course if necessary to avoid coming within range making use of Sun and Clouds whenever possible.

2. Transmit a first sighting report giving the type, numbers, position and course of the enemy.

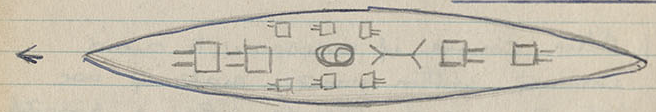
3. Transmit as soon as possible an amplifying report giving estimated speed and identifying the Ships by name. Subsequent action will be governed by the instructions issued during briefing

Shadowing. - Can be defined the act of observing and reporting the movement of the enemy without as far as possible being engaged by him.

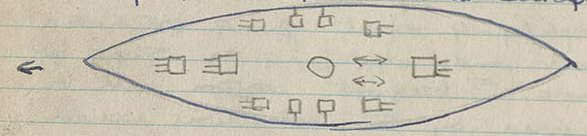
Complete Fleet Operations - When the approaching opposing each other shadowing merges into shadowing observation This will normally be carried out by the Fleet Air Arm.

GERMAN NAVAL VESSELS

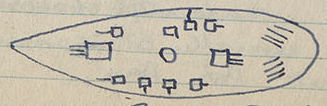
Type. Battleship (Bismark Tirpitz Class – Tirpitz only Refit)
Displacement Approx 40,000 tons
Armament 8–15" guns (4 twin turrets)
Sec " 12–5.9" " " "
4 planes – two catapaults – Designed Speed 35K.



Type Battle Cruiser (Scharnhost – Gneisenau Class)
Displacement 26,000 tons
Armament 9–11" guns (Triple turrets)
Sec. " 12–5.9" " (Twin + Single)
Carry 4 aircraft + 2 catapaults



Designed Speed 27 knots
Pocket Battleships (Lutzow & Admiral Scheer)
Displacement 10,000 tons
Arm. 6–11" guns (Triple turrets)
8–5.9" " ( )
Carry aircraft catapault.
8–21" torpedo tubes in quadruple



Speed 30 knots

Type – Heavy Cruiser (Hipper Class) Prinz. Eugen.
Displacement. 10,000 tons.
Armament. 8 8" guns in double turret
No visible secondary arm.
12–21" torpedo tubes amidships
4 aircraft – catapault.

Type Light Cruiser.
Displacement. 6,000 tons.
Armament. 9–5.9" guns (triple turrets)
12–21" tubes amidships
Nürnberg Class (1 funnel)

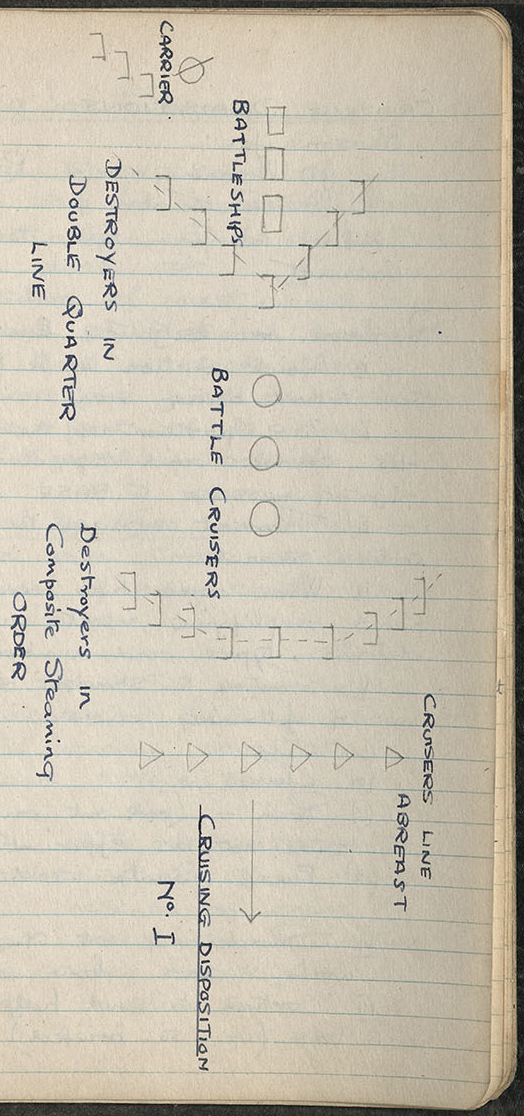
Köln Class (2 funnels)

2 aircraft Catapault.

Karlsruhe

Type – Destroyers (Bitzen) Class.
Displacement. 1600 tons.
Armament. Not exceeding 5"
Always mounted in Single turrets.

Speed Approx. 40 Knots.



CRUISING DISPOSITIONS

Reasons for:

(a) Warning and Protection
(b) Tactical

Similar to formations taken up by aircraft.

Procedure on Sighting Enemy Fleet

i. Avoid action to be taken (to see without being seen)

ii. D.R. position of the enemy His course and Speed. First sighting message to BASE (Frame)

iii. Transmit message to base and continue Search

iv. When area has been searched Send amplifying report: giving full details, types and number.

V. Continue to shadow making use of following aids.

(a) Sun
(b) Clouds
(c) Rain – Look out on windward Side not as efficient
(d) Funnel, Smoke and gases.

Vi. Shadowing at Night, use wake and bow wave

Vii Continue to send half hourly message to base (if so briefed.)

Reporting on Shipping

1. Size, Shape, colour of hull
2. Is ship low in water (loaded)
3. What type. Flush decker, 3 island with deck aft.
4. Position of mast, funnel, bridge
5. Flags or National markings.
6. Is there a deck cargo?
7. Where you fired on, and from what part of the ship.
8. Photograph if possible

Recco. of two types – i. Waters adjacent to our own coast or bases.
ii. Recco. of enemy coasts, harbours and bases.

SEARCH :– is the organised employment of aircraft to look for or seek out the enemy, and is of an offensive nature

PATROL is the organised employment of aircraft to give warning of the presence of enemy in a specified area, or the approach of the enemy to an area, or across a line.

Information required before naval recco:-

i. Object and nature of operation
ii. Position and movement of our own Forces in area
iii. Present position and details of enemy
iv. Object of the recco.
v. Detailed instructions for flight
vi Latest met. information
vii. W/T. instruction
viii. Recognition signals in force.

RECONNAISANCE

A Reconnaisance is defined as an expedition for the purpose of obtaining information of the enemy. It is essential to success in war for all services

Sources of Information

Neutral and Enemy presses, radio and agents. Interrogation of prisoners captured documents and maps.
Reports from aircraft – air photographs
Reconnaisance by Naval & Military Forces

Advantages of Air Reco over Sea & Land

1. Grt. Range & Speed. 2. Visibility
3. Ability of a/c to make use of h^r & cloud
4. No barriers

Disadvantages of Air Reco.

1. Weather conditions
2. Enemy defences – ground and air
3. Negative information. 4. Identification
5. Continuous observation

Reporting Information
General Considerations

During a flight notes should be made in the navigational log on all points of strategic importance, showing the position and time. This must be entered as soon as the information is gained otherwise details may be forgotten or confused. Sketches will be made where necessary. Where a number of pts are noticed in rapid succession it may be of assistance to mark their position on a map, and then as soon as possible write a report in the Navigation log.

This is where memory training may be of great value.

All information should be as detailed as possible. It is not sufficient for instance to say that balloons were seen at a certain pt. Important details are :- their numbers, their Alt, close hauled or flying etc. The Observer should be remember that things seen during the heat and stress of action may seem of unwarranted importance.

Deductions and assumptions are not a matter for the Observer but for the Intelligence Officer on the ground who has the opportunity of comparing information from other sources with that which you have obtained.

REPORT ONLY WHAT YOU SEE.

Framing of W/T. Messages to BASE

Bomber Command Sequence in framing Message

KDR45 (1) Raid serial no of a/c.

A1 (2) Letter of a/c. and serial no. of message

3 (3) Number or size of body reported (i.e. a numeral group)

DESTROYERS (4) Designation of body reported coded where possible

270°/20 (5) Action of body reported

{ SHIP - course & speed
A/C - course & height }

(6) Position of body reported

ABXQ possibly letter co-ordinates)

(7) Time of Origin (actually the time of sighting)

1824

CODE For abbreviation purposes

SYKO " Security

1 Card of the day for 24 hrs. only therefore two carried on night operations. Change at 2400 hrs.

2. Consists of synthetic Strips carried on wire, Strips marked letters of alphabet, numerals, barred P.

3. Letter by letter of message is brought down. uncovering on Card of the day the corresponding letter to be sent in message.

4. Send in 4 letter groups.

Transmitting message to BASE in Bomber Command.

1. Write out M.T.B in plain language refer to Captain of a/c for appro.

2. Use A.P. 1927 Code where possible

3. Put whole message through SYKO (except time of origin)

4. Make a note of M.T.B. in your log, hand to W/OP for transmission

ARMY Co-OP. RECCO.

Object - to obtain information which will assist the Army Commander to deduce the enemy's intentions and probable plans.

STRATEGICAL RECCO - to obtain information upon which the Army Commander can make necessary adjustments to the plan of campaign and decide the policy of the Army as a whole

TACTICAL. - which is concerned with the movements and dispositions of forward troops, reserves and material in the battle area.

Strategical recco:-

// Aim and Scope, to obtain information as follows:

i. Signs of occupation
ii. Volume and direction of traffic rail and road
iii Refugees on roads, villages in flames
iv. Demolitions and Fires
v. Enemy Main Body
vi. Harbours (report vessels in stream or alongside)

7. Aircraft activity (air and ground)

Duties of Intelligence Officer

1. Recording and display of intelligence for crews
2. Briefing
3. Interrogation and Forwarding of material to HQ.

Crew room (or Operations room)

1. Display of enemy maps, targets, potential targets
2. Enemy defences, - AA guns, Search-lights, balloons, fighters
3. Silhouettes and photographs of enemy a/c

Commanding Officer outlines nature of Flight

Gives Target, secondary, last resort Target

Intelligence Officer

1. Photograph of target
2. Importance of target
3. Type of production (in case of industrial target)
4. Vulnerable points in target
5. Land marks in target area
6. Square search may be necessary.
7. Enemy defences in target area
   (a) AA guns
   (b) Enemy fighters
   (c) Balloons
8. Route and Height to fly.

Met. Officer

1. Clouds, type height
2. Fronts
3. Visibility in Target area
4. Temparature
5. Icing risk.

Signals - W/T frequencies
Homing, Aerial Lighthouses beacons.

Bombing Leader - Bombs carried
Fusing
Selection
Flares

Interrogation and Procedure After Flight

~~[illegible]~~

Gauge of Reliability

i. Reputation of Squadron as a whole and Observer in particular

ii. Hr. of a/c

iii Visibility and time of day

iv. Topography (type of country over which recco. made)

v. Interference by enemy air and ground

Systems of Lights

In war, particulars of operation of lights are secret and are only made known to Navigators immediately prior to an intended flight.

In peace, characteristics of lights are published in the "Admiralty list of Lights" - fog signals and visual time signals.

They also appear cryptically on maps and charts.

F. Fixed, a continuous light

FL. Flashing, showing a single flash at regular intervals

GPFL. Group flashing, showing at regular intervals, a group of two or more flashes

GP.OCC = Group occulting, a steady light with a regular group of total eclipses.

OCC. Occulting, a steady light with a regular total eclipse

F.FL = Fixed and flashing, a continuous steady light varied at regular intervals by a group of two or more flashes of relatively brighter light. The group may, or may not be preceded or followed by an eclipse.

REV. Revolving light gradually increasing to full brilliancy then decreasing to an eclipse

ALT. Alternating - Light changes colour White to Red - Red to Green

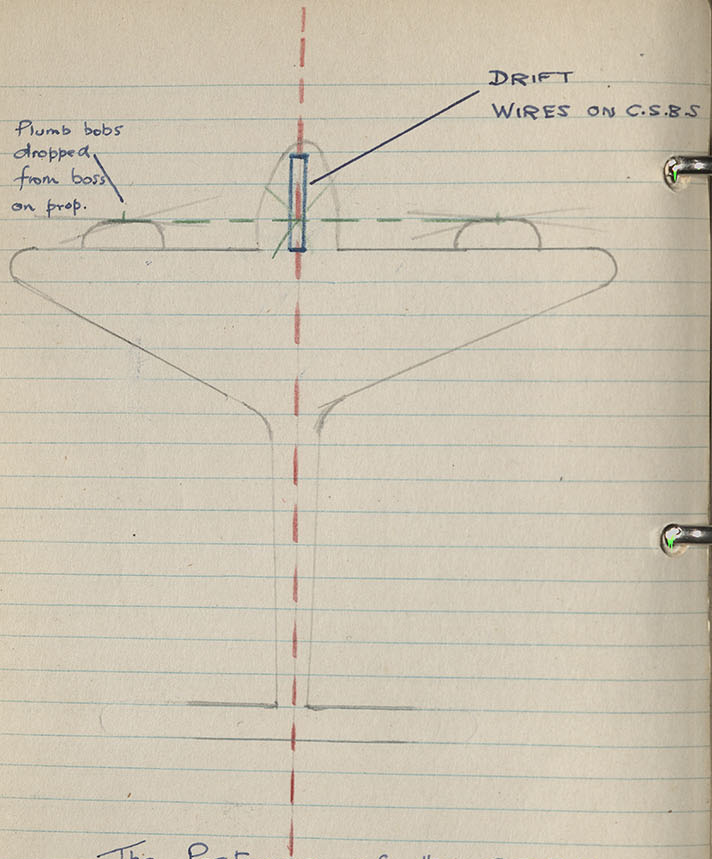
(U). Unwatched - Such a light cannot be relied on implicitly

The Period of a light is the time elapsing between two successive identical parts of its characteristic

e.g. LT. ALT. FL. WR. ev 30 sec (U)
Vis 11 m.

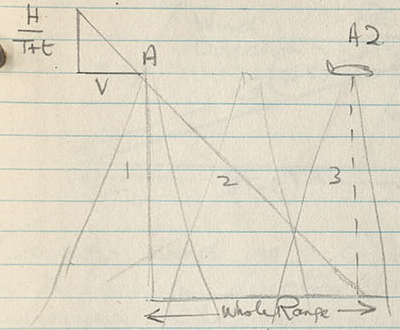
Such a light would show every 30 secs. 1 white & 1 red flash. It would be visible for 11 miles but uncertain of operation.

This Visibility distance of a light is calculated for a Ht. of eye of 13 ft.



The Positioning of the C.S.B.S in an aircraft.

Day Simulation Bombing.



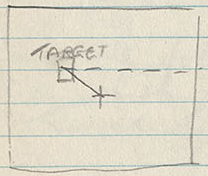
250 lb GP Height Bar

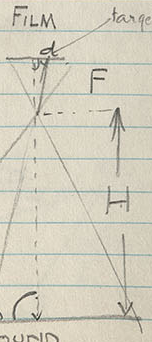
$\frac{T+t}{2}$ secs.

3 Photos = ½ Time of Fall

Whole Range Point Sighted.

PRINT JR.



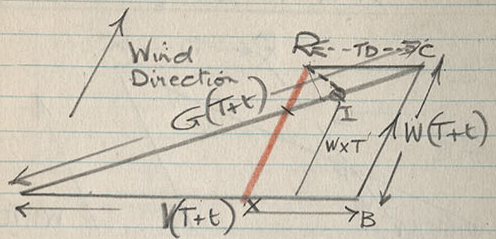


$\frac{H}{F} = \frac{D}{d}$

$\frac{Hd}{Fx3} = D$

Error in Yards = $\frac{H(\text{in ft.}) \times d}{Fx3}$ ~~or inches~~

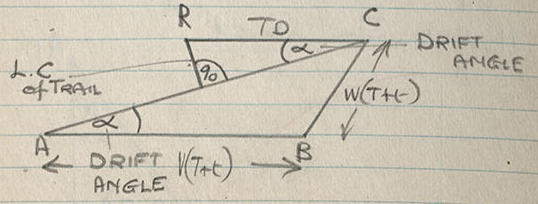
BOMBING IN A WIND.



Consider wind as a column of air moving at W f.p.s. in direction shown. Then the behaviour of the bomb in relation to the a/c is not affected by the wind.

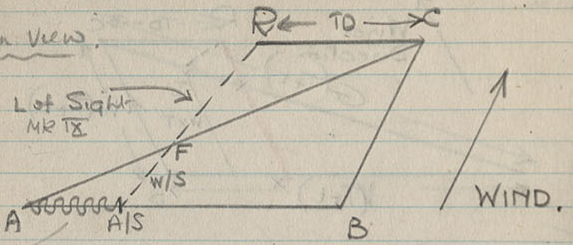
Time Lag, Trail Distance and Trail Angle remain unchanged. In time (T+t) a/c will be at C such that AB = V(T+t)
BC = W(T+t)

Bomb will fall at R where C.R. = Trail Distance which is parallel to a/c's heading
RI = Ground Lag

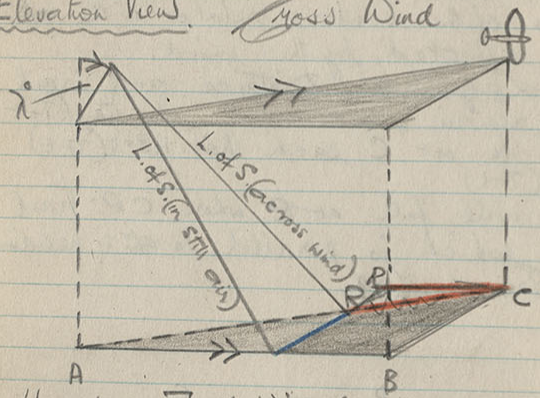


Bombing in a Wind (continued)

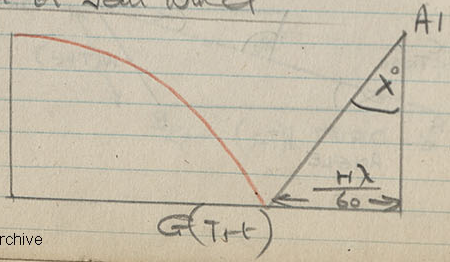
Plan View.

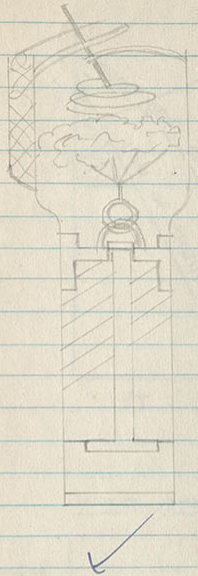


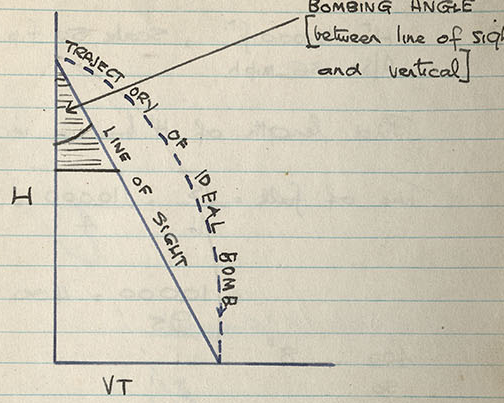
Elevation View. Cross Wind



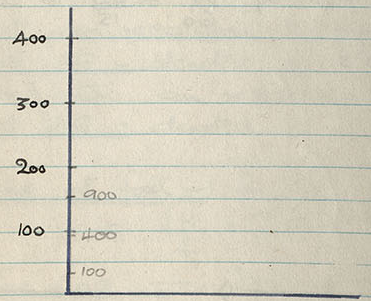
Head or Tail Wind







Using previous table



VT or speed $= \frac{H\,H}{\sqrt{H}} = H\sqrt{H}.$

Given –:

Hᵗ. 10,000 ft. , Scale 50 f.p.s = 1"
A/S = 136 m.p.h

Find length of Hᵗ bar in inches

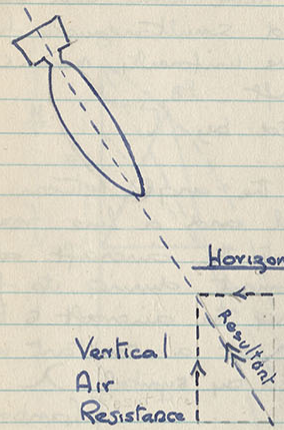
Time of fall = $\frac{\sqrt{S}}{4} = \frac{\sqrt{10000}}{4} = \frac{100}{4} = 25$ secs

$= \frac{10,000}{25} = 400$ f.p.s.

$\frac{400}{50} = 8"$

~~88~~ ft.p.s. = 60 m.p.h.

Multiply m.p.h by $\frac{88}{60}$ or $\frac{22}{15}$ to convert to f.p.s.



Vert. air resistance produces TIME LAG – denoted by 't'.
Horizontal air resistance produces AIR LAG – denoted by 'l'

Time of fall –: for Ideal bomb
$= \frac{\sqrt{H}}{4} = T$

Time Lag –: Diff. in Time of fall between a REAL and an Ideal bomb Released simultaneously from the same uniformly moving aircraft – denoted by 't'

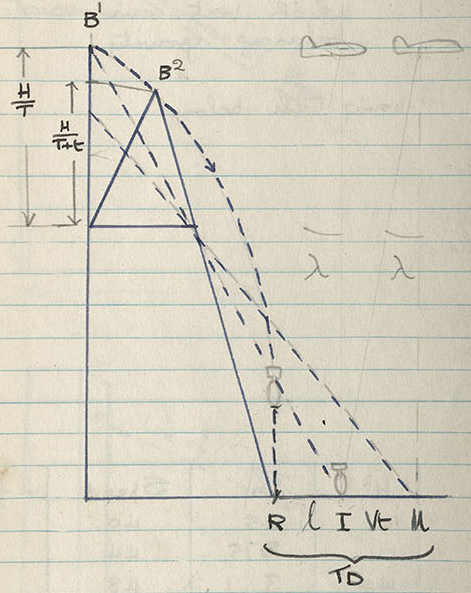
Air Lag :— is the horizontal distance between trajectories of an IDEAL and a real bomb both being released simultaneously from the same uniformly moving aircraft.
Denoted by 'l'

Trail angle :— is the angle between vertical and a line from the bomb to the aircraft at any moment during its fall. Assuming the aircraft to be moving at a constant velocity
Denoted by symbol λ
[Lambda]

Trail distance :— is the horizontal distance bomb trails behind in the vertical dropped from an aircraft

Formula for Trail distance :—

$$TD = l + Vt \cdot \frac{\lambda H}{60} = H \tan \lambda^{\circ}$$

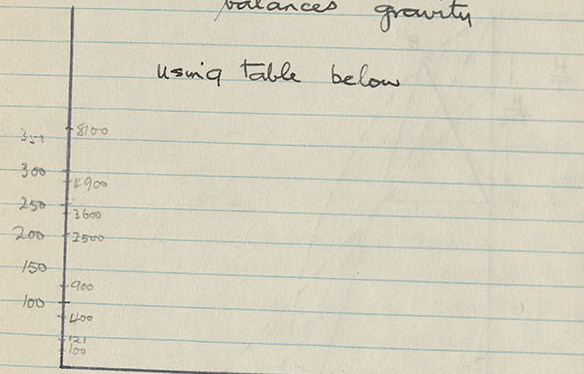


Ground Lag —: Is the vector sum of Wxt + l and is the distance on the ground between pts of impact of an IDEAL and a REAL bomb both released simultaneously from the same uniformly moving aircraft

Wxt = Air lag at ground level in still air.

Terminal Velocity :— Is the max. vertical velocity arrived at by any bomb and is the pt. at which vert. air resistance balances gravity

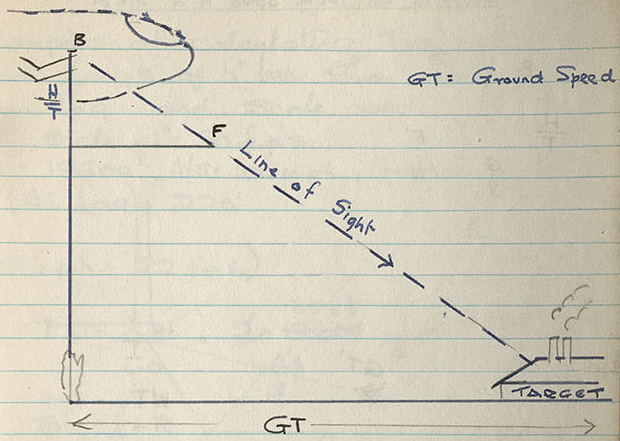
Using table below

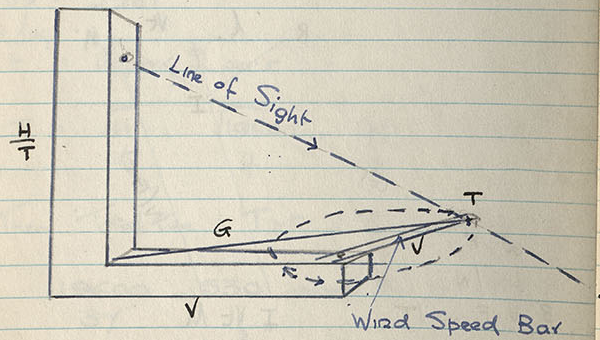


Ht.	Time	Speed [in f.p.s]
100	2.5	40
121	2.75	44
144	3	48
400	5	80
900	7.5	120
2500	12.5	200
3600	15.	240
4900	17.5	280
8100	22.5	360

H/T F.P.S

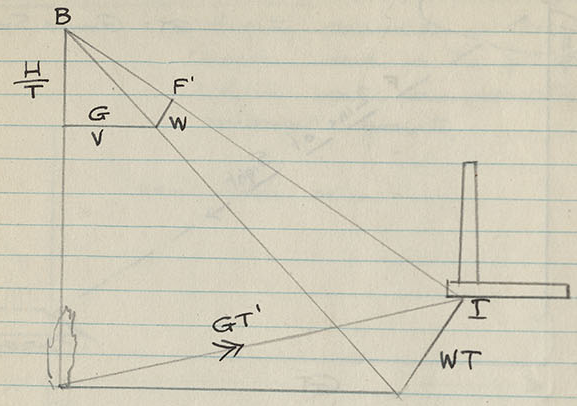
$T = \frac{\sqrt{H}}{4} = 4\sqrt{H}.$

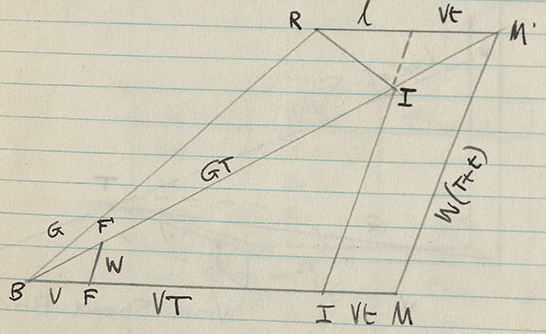




Hr + W/S bar (introducing the W/S bar on to the Hr bar

Dropping an IDEAL BOMB in a wind





Examples of calculating TIME LAG, Dist. and Length of h^r bar. Given, Trail angle air lag and Scale used

Scale = 1" = 50 f.p.s.

H^r = 19600', A/S = 150 m.p.h., Trail angle = 2°

l (Air Lag) = 220'

(15 m.p.h = 22 f.p.s.)

$$TD = \frac{2H}{60} = \frac{2 \times 19600}{66} = 653.3'$$

$$TD = l + Vt$$

$$653 = 220 + 220t \quad (V = 220 \text{ f.p.s})$$

$$433 = 220t$$

Time lag

or t = Approx 2 secs.

$$T = \frac{\sqrt{H}}{4} = \frac{\sqrt{19600}}{4} = \frac{140}{4} = 35 \text{ secs}$$

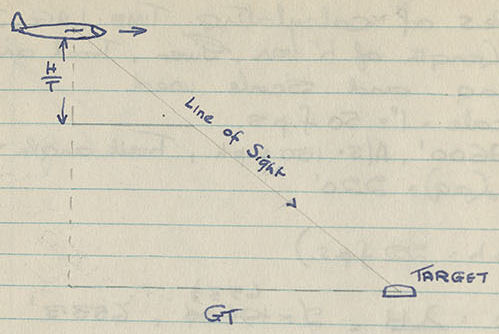
Then Total time = T + t = 35 + 2 = 37 secs

$$\frac{19600}{37} = 530, \text{ and since } 1" = 50 \text{ f.p.s.}$$

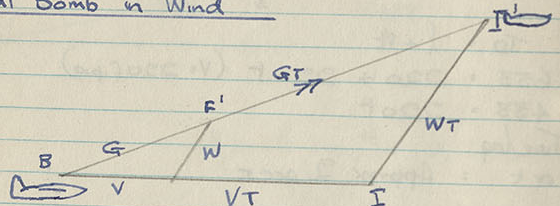
$$\frac{530}{50} = 10\tfrac{3}{5}" \text{ OR } 10.6"$$

Approx Ans

◇



Ideal Bomb in Wind



{ GT = Ground Speed VT = Airspeed.
WT = Wind Speed }

Given h^t 10,000 ft. A/S 150 m.p.h.

Find length of h^t. bar in inches
50 f.p.p = 50' per sec.

$T_D = l + Vt$

$440 = 220 + 220t$

$220t = 220$

$t = 1$

$T = \sqrt{\frac{10000}{H}} = 25$

$T + t = 26$

$\frac{H}{T+t} = \frac{10,000}{26} = 385$ ft per sec

Scale 50 f.p.p. = 1'

Length of h^t bar = 7.7"

$\frac{\lambda H}{60} = \frac{T_D}{1}$

$10,000\ \lambda = 440 \times 60$

$\lambda = \frac{44 \times 6}{100} = \frac{264}{100} = 2.64°$

Altimeter

ISOTHERMAL

i. G.P. 1013.2 mbs
ii Temp. of +10°C everywhere

ICAN

i G.P. of 1013.2 mbs.
ii Temp. of +15° on ground falling 1.98°C every 1000 ft. up to 36000'

1. Set G/P
2. . Temp.
3. . I.H.
4. Put I.H. at "I" read 'C'
. A.S. . . .

Procedure for finding W/V by 3 course Method :-

PILOT	B.A.	W.S + D. Procedure
Temp ..	Repeat	1. Set fig. on computer + compute
H^t ..	.	(a) Set W/S to max. T.A.S + H^t.
A/S ..	.	E/S to zero
	T.H.	
	T.A.S.	
	3 course method	
	1st Co. Ready	
1st Co. STEADY	REPEAT	2. Pick up drift, unlock, put r on r' – down rule and draw line.
	2nd Co. READY	3. Pilot a/c 60°
2nd Co. steady	REPEAT	4. As for '2'
	3rd Co. Steady	5. Pilot a/c 60°
3rd Co. steady	REPEAT	6. Repeat No. 4
	3rd Co. finish	7. Unlock, put intersection (i.e centre of cocked hat) over tail of wind arrow Lock
		8. Rotate bearing plate Knob until wind arrow lies athwart bomb sight with tail to right.
		9. Drop wind g. bar + turn W/S knob until whole in Cursor lies over centre of cocked hat.

PLOT	B.A.	W. S. & D. Procedure
		10. Read wind direction from Azimuth ring and W/S from W/S bar
	Wind found ... ... m.p.h.	

Bombing Corrections

1. When heading within 45° of the direction from which the wind is blowing, give LESS than the estimated correction

2. When heading within 45° of the direction to which the wind is blowing give MORE than the estimated correction.

3. When flying across wind give the apparent correction.

Lecture No 14. Bombing Procedure.

1. Bombing exercises

(a) One Direction Trooping - 1 Exercise at 4 - 6,000'
W/V to be found & 6 bombs dropped
Passing Standard --- 125 yds actual radius

(b) A.D.G at 4 - 6,000' {2 exercises
Find W/V and drop 6 bombs
Pass .... 125 yds. actual radius

(c) Application - 10 exercises at 4 - 6,000'
Find W/V & drop 6 bombs
Vectoring permitted - Pass ... 200yds average

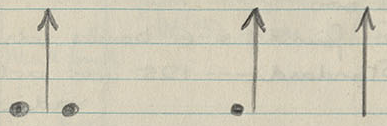
at 10,000'

(d) Application Night - 4 exercises at 4-6,000'
As for day application

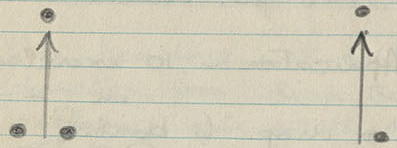
(e) Low Level - 3 exercises at 2 - 3,000'
Bombsight settings from graph
Runs into wind
Pass --- 100yds average, actual

2. Bombing Signals - (Day)

Consist of White arrow, Disc + Strip

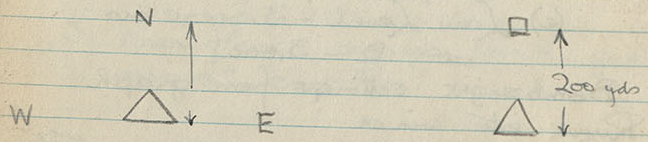


ALL CLEAR WAIT GO HOME



BOMBING WRONG TARGET RELEASE SMOKE

White smoke at Master quadrant



On land On water

3. Signals - Night

(a) N° 4 target only used
(b) Signal Arrow lit by RED lights
(c) Target lit by WHITE light
(d) Target only lit - Wait
(e) Both lit - Carry on
(f) Neither lit - Go home
(g) Details allowed shown on target

4. Targets

(a) Land
White △ 30' sides, with cardinal points marked 200 yds off

(b) Water (as above)
Orange △ 30' sides, white square (as above) of 10' sides - 200 yds NORTH

5. Action when:

(a) Landing after all bombs dropped
(b) " with bombs on carrier
(c) Bomb fails to drop

Lecture. No. 15. Low Level Bombing.

Most accurate type of bombing – and permits :–

(a) Evasion of heavy A.A. fire
(b) Confusion of ground observer system

Disadvantages :

(a) Penetration of armour unlikely
(b) Bombs must be delay fuzed

1. Method using C.S.B.S.

(a) The bombing angle is set, using the backsight set to a false height on the RED scale and one of the red beads on the drift wires as a foresight.

(b) Bombing angle depends on :–

i. Hᵀ of release
ii G/S
iii. Type of bomb & its T.V.

and these factors are given in a graph from which is obtained a false hᵀ. setting for the RED scale. Thus W/V+S is taken into account.

(c) Drift angle depends on wind direction. It is allowed for by making a rough drift setting by watching objects on the ground during the run up.