

**AERIAL NAVIGATION** 

AERIAL NAVIGATION. Compass: He compass has 4 cardinal points N.S.E. W+ 32 prints which are marked on the Maxines Company. N. The compass is divided into 360 equal parts called degrees, 1°= 60' + 1'= 60°. Bearings a courses are always measured clockwise 0° to 360. Lubber Line: - a white line marked on bowl of company + co-incides with the fore + aft axis of machine. 1 mile = 5280' 1 sea mile = 6080' The miles = & land wile (approx) ! Knot is speed of I sea mile per hour

Compass:

The compass has 4 cardinal points N.S.E.W & 32 points which are marked on the Mariners Compass. *Illustration of compass]* The compass is divided into 360 equal parts called degrees. 1°= 60' & 1' = 60°. Bearings & courses are always measured clockwise 0°to 360°. <u>Lubber line</u>: A white line marked on bowl of compass & coincides with the fore & aft axis of machine. 1 mile = 5280' 1 sea mile = 6080' 7 sea miles = 8 land miles (approx) 1 knot is speed of 1 sea mile per hour.

AERIAL MAYIGATION. PORT SIDE Storboard fide TRANSVERSE REDLIGHT. GREEN LIGHT 40 M.N. - CON 417 + Fore R.A. (radius of action) = 400 miles. S.S.O. (grown spad out) = 100 M.PH. G.S.I. ( - - in) = 120 M.P.H.  $R.A. = \frac{P(qso \times qsi)}{qso + qsi} \quad 400 = \frac{P(100 \times 120)}{100 + 120}$ 12000 P = 200 × 400 P = 220× 400 = 7033 hours. 12000  $P = \frac{R.A}{g.s.o.} + \frac{R.A}{q.s.i.} = \frac{400}{100} + \frac{400}{120}.$ = 4+3.33. = 7.32 hours.

[Illustration of aircraft seen from above, indicating fore, aft & transverse lines]	R.A.= $P(GSO \times GSI)$ $400 = P(100 \times 120)$ GSO & GSI100 & 120
R.A. (radius of action)       = 400 miles         G.S.O. (ground speed out)       = 100 M.P.H.         G.S.I. (""" in)       = 120 M.P.H.	$12000 P = 220 \times 400$ $P = \frac{220 \times 400}{12000} = 7.33 \text{ hours}$
	$P = \frac{R.A}{G.S.O.} + \frac{R.A}{G.S.I.} = \frac{400}{100} + \frac{400}{120}$

= 4 + 3.33 = 7.33 hours

Aerial Navigation (1)

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# Meteorology:

Temperature measured by a <u>thermometer.</u> Wind speed by a <u>anemometer.</u> Wind direction by a <u>weather cock.</u> Degree of saturation by an <u>Hydrometer.</u> Pressure by a <u>barometer.</u> Pressure can be measured in lbs/sq " of mercury

<u>Isobars</u> are lines drawn through all places having the same barometric pressure at the same time.

# **GENERAL SCHEME OF CYCLONE**

[Illustration of the same]

love: a cyclone is a system of closed bohars with low pressure in the centre. It widecites duty weather, name reloveds. uti- Cyclone: Is a sychen Actored Lobars with high pressure in the centre ... Wanter: 709 Mist. Cold ain Hotai Friend. Dew. peo of beards ! inus :- Maris Tails (fine weather) 27000' 5 50000' Curren :- Heeper up aloud } 4,000 to 6,000' Cauliflower lope } 4,000 to 6,000' Shatus :- Clouds in layers 0 to 3600'. Nimbus : Rein clouds 3000 to 6400 Windo above the last's surface: Success in speed at 5000' twee that on the ground weers clock-wing, at 5000' about 20 . How more steading Bunps - Is an upsetting of the equilibrium of the machine (1) Local heating acoobing of Cartle surface .

# Cyclone:

A cyclone is a system of closed Isobars with low pressure in the centre. It indicates dirty weather, rain clouds.

<u>Anti-cyclone</u>:

Is a system of closed isobars with high pressure in the centre.

<u>Winter</u>	<u>Summer</u>	
Fog	Mist	
Cold air	Hot air	
Frost	Dew	

#### Types of cloud:

<u>Cirrus</u>: Mares' tails (fine weather) 27000' to 50000' <u>Cumulus</u>: Heaped up cloud) Cauliflower tops } 4,500' to 6,000' <u>Stratus</u>: Clouds in layers 0' to 3500' <u>Nimbus</u>: Rain clouds 3000' to 6400'

<u>Winds above the earth's surface</u>: Increase in speed at 5000' twice that on the ground & veers clockwise, at 5000' above 20°. Flows move steadily. Bumps: Is an upsetting of the equilibrium of the machine

(i) Local heating & cooling of the earth's surface.

Aerial Navigation (4)

aerial Masigalia WATER. 1 (ii) Inequalities of earth's unface ( woods , hills + valleys) (11) Hying under cloude. (1) War Flying . (cheles in flight - A.A.). Right - Pole Char is T.N. iding Way & By Day - Point low hand towards here list the augle between that - 12. This gives you South. [Illustration of surface to air flows caused by water]

(ii) Inequalities of earth's surface (woods, hills & valleys)

(Illustration of air flows over hills)

(iii) Flying under clouds

(iv) War Flying (shells in flight & A.A.)

<u>Finding Way by Night</u>: Pole Star is T.N. (Illustration of position of Pole Star] <u>By Day</u>: Point hour hand towards sun. Bisect the angle between that – 12. This gives you South.

(Illustration of how to calculate South)

the sente of the earth cuts the sin flash is a great cicle. cuich : any place not passing through centre fearth can surper The shaket route der the surface of the earth between repto is along the great well pring the The leigh of a great encle are who by the angle it subtends at the earthe of cucle . 3600 at cuelo = 60' = 60" = = 1 sea mile = 6080 a great encle lying mid way between 9) are series - preat cucho louving the poles

# Great circle:

Any place passing through the centre of the earth cuts the surface of earth in a great circle. Small circle:

Any place not passing through centre of earth cuts surface of earth in a small circle. The shortest route over the surface of the earth between 2 pts is along the great circle joining them. The length of a great circle ace is measured by the angle it subtends a the centre of circle. A great circle = 360°

1' = 1 sea mile = 6080'

Equator:

Is a great circle lying midway between the poles. <u>Meridian (of Long)</u>: Are semi-great circles joining the poles.

#### AERIAL NAV (5)

RERIAL NAV. (5). Paraelels of are surall cuicle baracle the equator. prime maridian (1000) The paring though Greenwich. aufular die nator meraned o along its mande ditude le equator wich to the mende · U map is a representation Maps + 6 hach : 1/a part I the earth with special reference to the O. S. Map: - Is obtained & a at the foot of usap nuasured an land tion I part of the ear apa al refere to a chait is at the us

## Parallels of Lat:

Are small circles running parallel to the equator. The prime maridian [sic] (No 0°) is the maridian [sic] passing through Greenwich. Latitude:

Is the angular distance N or S of the equator measured 0° to 90° along its maridian [sic]. Longitude:

Is the ace of the equator from the maridian [sic] of Greenwich to the meridian of the place. It is measured E or W of the Prime meridian.

### Maps & charts:

A map is a representation of the earth with special reference to the land.

# <u>O.S. Map:</u>

Is obtained by <u>Triangulation</u>. The scale is found at the foot of map & is used all over it measured in land miles.

#### Chart:

Is a representation of part of the earth with special reference to the sea. Scale for a chart is at the side & is used . . .

sea wills. seal. section of one place how another is measured in degrees a poles nelse ike poles attrac Methods & Magneting: (i) By melbing or Contacts. (ii) By induction or hamming (iii) Elechicity.

... opposite the place to be measured, in sea miles.

(Illustration of chart)

<u>Bearings:</u> Direction of one place from another is measured in degrees from N (T.M.C.)

(lillustration of bearings)

<u>Like poles repel</u> <u>Opposite poles attract</u>

#### Methods of magnifying:

- (i) By rubbing or contacts
- (ii) By induction or hammering
- (iii) Electricity

# AERIAL NAV (6)

HE RIAL NAV. 6. Hood will for Geographical NPole. Variation - to the longental angle between the maquetic mendean + the true meridian, meaning Eory of the here needidian.

The M.N. is situated in N. Canada about 1400 miles from Geographical N Pole.

<u>Variation:</u> is the horizontal angle between the magnetic meridian & the true meridian, measured E or W of the true meridian.

(Drawing of Variation)

61.00 . Levietion :- Is the angle between M.N. 7 C.N. it is measured from M.N. remay be wither E or W. permanent magnetion in machine :-Lubba line. CN-MIN pass can pescilin n Compass should read 00 actually penels about 10° CN M.N. Seviation E

### **Deviation**:

Is the angle between M.N. & C.N. It is measured from MN & may be either E or W.

Effect of permanent magnetism in machine:

(First drawing of compass showing incorrect readings when flying north)

Compass should read 0° Actually reads about 10°

(Second drawing of compass showing incorrect readings when flying East)

# AERIAL NAV (7)

AERIEL NAV. (7) Transient Magnetici is not corrected in an accoplance company (present types). transient Magnetain is due to post non For converting bearing from Tto C + C to T. Rules :-@ Cadd last 6 T.m. c add plant. I working pour true to compass. or flow clasterly aniation releviation is suchacted " westerly is added for a to T lotogood. Vise Versa Westerling Deviation E Compans least. VV -----Preater T.C. M.C. des. C.C Var 0 0 -0-N. 45 NE 4ºw 49 90 1°w 91 E 135 5°W 1740 SE 178 2°E. 8 120. 218 SIM JOE 225 W 270 2000 2720 NIW 315 3ºE 312 N 360 D°-300 Transient Magnetism: Is not corrected in an aeroplane compass (present types). Transient magnetism is due to soft iron in plane. For converting bearings from T to C & C to T.

Rules:

(a) C add East

(b) T.M.C. add West

If working from true to compass. Easterly variation & deviation is subtracted & westerly is added from C to T.

Vice versa holds good.

Deviation E Compass least.

" W " greater.

T.C.	Var	M.E.	Dev	C.C.
Ν		0	0°	0°
NE		45	1°W	49°
E		90	1°W	91°
SE		135	5°W	140°
S		180	2°E	178°
SW		225	7°E	218°
W		270	2°W	272°
NW		315	3°E	312°
Ν		360	0°	360°

Northerly tuning error When pavelling N + a sharp turn & E or w is made the compass mininger the When havelling 5 + a shar tun to E a W is made the com erates the term. indicated. TOWE TOE Udial. E TONN TOE a exagurated Do ustread compass aft S.R. turn for about 30 seco. after flattening out. (12 seco with 5/12).

#### Northerly turning error:

When travelling N & a sharp turn to E or W is made the compass minimises the turn. When travelling S & a sharp turn to E or W is made the compass exaggerates the turn.

> (illustration – effect of northerly tuning errors on compass)

Do not read compass aft. S.R. turn for about 30 secs. after flattening out. (12 secs with 5/17).

### AERIAL NAV (8)

AERIAL NAV. () With the and of a for deveater ne directions N, NE, E, SE, S, SW, W, N within 100 yds The retism e by com search una calling out a deveal a for by a machine rut Whee alle is: () mail flying position (11) Compass O.R. (1) Ho machine within 30 yds Head machine for M.N. woke the reading, correct for descation in hausverse tubes. Ð

## Swinging for deviation:

With the aid of a land compass mark out the following magnetic directions N, NE, E, SE, S, SW, W, NW, N. seeing that no building is within 100 yards & no machine within 30 yards. The permanent magnetism is overcome by corrector magnets, 'temporary magnetism' is allowed for by marking out a deviation table. Wheel machine onto swinging base & pay attention to the following points: (i) Machine in flying position (ii) Full war load (iii) Compass OK (iv) No machine within 30 yards. Head machine for M.N., note the reading, correct for deviation in transverse tubes.

(Illustration of compass deviated W)

If deviation is w, red and of corrector maquet prices it in the hansverse tube. If deviation is E, red end of corrector magnet points E in hausvere tube. Head machine M.E. note the reading, correct for devication in tore raft tubes. Der 1 If beviation is we red end of corrector maquet points in in fore raft bubes, i deveation is E red and of corrector maquet points E in 4 raft tubes. next head waching to m.s. H. deviation is under 4° E or ~ leave alone, if over 4° split the deviation N+S. Cohect in hausverse Tabes. Then lead machine MW. your 40 deviation, split it Error, correct in fore + aft tabes. Company has now been

If deviation is W, red end of corrector magnet points W in the transverse tube. If deviation is E, red end of corrector magnet points E in transverse tube. Head machine M.E. note the reading, correct for deviation in fore & aft tubes.

(Illustration of compass deviated E)

If deviation is W red end of corrector magnet points W in fore & aft tubes, if deviation is E red end of corrector magnet points E in 4 [sic] & aft tubes. Next head machine to M.S. If deviation is under 4° E or W leave alone, if over 4° split the deviation N & S. Correct in transverse tubes. Then head machine M.W., if over 4° deviation, split it E &W, correct in fore & aft tubes. Compass has

now been . . .

corrected for permanent maquetion Head machine topts of compass jug make out a deveation table. bourse of anoplanes:estered in the longentul angle Cour from the mendecin (T. Mac) tothe fore live of machine, it is measured the decidion doctorise auffeed: - is the speed with which an acceptance cuts its way through the aw. C.B. This equelo pround speed when there is no wind. Ground speed: - is the speed of an accoplance over the poured (or in relation to poured). It is found by noting the interval oftence between passing over 2 ground objects of distance apart. onl indicator. actual hack :- is the line on pround over which aeroplane actually fles Track augle :- is the augle from the mendian Amore to Heactural Wack.

, , , corrected for permanent magnetism. Head machine to 8 points on compass respectively & make out a deviation table.

Course of Aeroplanes:

<u>Course steered:</u> is the horizontal angle from the meridian (T.M. or C) to the fore & aft line of machine, it is measured from the meridian clockwise.

<u>Air speed:</u> is the speed with which an aeroplane cuts its way through the air. N.B. this equals ground speed when there is no wind.

<u>Ground speed:</u> is the speed of an aeroplane over the ground (or in relation to ground). It is found by noting the interval of time between passing over 2 ground objects of known distances apart. Or by ground speed indicator.

<u>Actual track:</u> is the line on ground over which aeroplane actually flies.

<u>Track angle</u>: is the angle from the meridian (T.M. or C) to the actual track.

itis meaner doctivise. mift - is the angle between fre + aft line a starboard. I hackangle is peake then T.C. drift stuboard three-decoa - Ground aloe to Starboard There is no drift when there is !-(1) Flat Calm (1) following wind . (iii) advice wind . Before an allowence for wind problem can be worked out the wind speed redirection for the beight at which you intend by must be found.

... it is measured clockwise. <u>Drift:</u> is the angle between fore & aft line of machine & actual track. It may be to port or to starboard. If track angle is greater than T.C., drift is to starboard & vice versa.

(Illustration of track angles & drift)

There is no drift when there is: (i) Flat calm (ii) Following wind (iii) Adverse wind

Before an allowance for wind problem can be worked out the wind speed & direction for the height at which you intend to fly must be found.

Your things to be found :- Air speed, Course Ground Speed actual hack an exceed is always measured allong 4 1 T.C. Ground speed is always wea along actual hack. Wind blows por T.C. to Inack an speed V.S+D Machine starts from A heading towards B T.C. 90°. With no wind machine would arrive over low 13 a lestance from A equal tits air speed. after I four you find youself over town c, then Achas been your actual back. Bis where you wich table, C is where you are, Reefore BC. is speed & direction of wind.

Four things to be found: Air speed. Steered course. Ground speed. Actual track.

Air speed is always measured along T.C. Ground speed is always measured along actual track. Wind blows from T.C. to track.

(Drawing - measuring air and ground speed)

Machine starts from A heading towards B T.C. 90°. With no wind machine would arrive over town B a distance from A equal to its airspeed. After 1 hour you find yourself over town C, then AC has been your actual track. B is where you wish to be, C is where you are, therefore B.C. is is [sic] speed & direction of wind.

allowener for Wind Parallelogram forces :- If hosporces act on a moving today in deferent directions the body moves along a path which Recuehant of the live forces. B AB + AC are two forces acting on A. Show BD. equal sparallel to AC. Fraw CD equal A will more value represe nce acting ou A. lelocity. Let CATAB be two delocities of a body at seen. Then CB will be ll's resultan

# Allowance for wind:

<u>Parallelogram of Forces</u>: If two forces act on a moving body in different directions the body moves along a path which is the resultant of the two forces.

(Drawing - said parallelogram)

AB & AC are two forces acting on A. Draw BD equal & parallel to AC. Draw CD equal & parallel to AB. Then AD is the path along which A will move & also represents resultant force acting on A. Triangle of velocity:

(Drawing – said triangle)

Let CA & AB be two velocities of a body at sea. Then CB will be its resultant . . .

belocity in speed + direction. Let C = machine (A = air Speed. AB = Wenk, then CB is the pround speed ractual hack If us wind (flying pour Bristot to London) all that is necessary is to measure T.C. from map, convert it with C.C. Myon Hat course. always some wired: If durech Note :directly against a with you course would same, bet ground speed would be preake or less. If blowing from any other direction, neachine would be blocon sideways over He country. Marefore to get to London it would be necessary. to point nose of machine into wind at an angle to the Bustol - Loadon live in order that the combined effect of der speed move cral- wise over the pround directly over the Brisht - Lou doc liese. Given desired hack, wied speed a

... velocity in speed & direction. Let C = machine, CA = Air Speed. AB = Wind, then CB is the ground speed & actual track.

If no wind (flying from Bristol to London) all that is necessary is to measure T.C. from map, convert it into C.C. & fly on that course. Note:

Always some wind. If directly directly [sic] against or with you course would be same, but ground speed would be greater or less. If blowing from any other direction, machine would be blown sideways over the country. Therefore to get to London it would be necessary to point nose of machine into wind at an angle to the Bristol – London in order that the combined effect of Air Speed & wind would make your machine move crab-wise over the ground directly over the Bristol – London line. Given desired track, wind speed & . . .

direction - Aar speed, find TC to skee + ground speed. Course Steeres 1: TUAL TRACK SPEED Given Course skered, Aar speech, Wied speed + ducetion, find A.T + C.S 5 Course Steered Un deroplane sets out pour a to bouch a toon B which is 250 miles pour A on a T.B. 0/45.0 Wind is blowing pour 340° T. at 30 m. F.H. air speed of machine q 5 M. P.H. Variation 15° W: Deviation out 2°E Ded in 5° W. -

 $\ldots$  direction & air speed, find T.C. to steer & ground speed.

(Illustration of crabbed track)

Given course steered, Air speed, Wind speed & direction, find A.T. & G.S.

(Illustration of deviated actual track)

An aeroplane sets out from A to bomb a town B which is 250 miles from A on a T.B. of 45°.Wind is blowing from 340° T at 30 M.P.H. Air speeds of machine 95 M.P.H. Variation 15° W: Deviation <u>out</u> 2° E. Dev in 5° W.

Find ground speed out (600) & promed speed in (951) C.C. skered out tim Juice to complete journey. SD. = 80 m.P.H. IDS-M.P.H. + 11 11 11 1 5

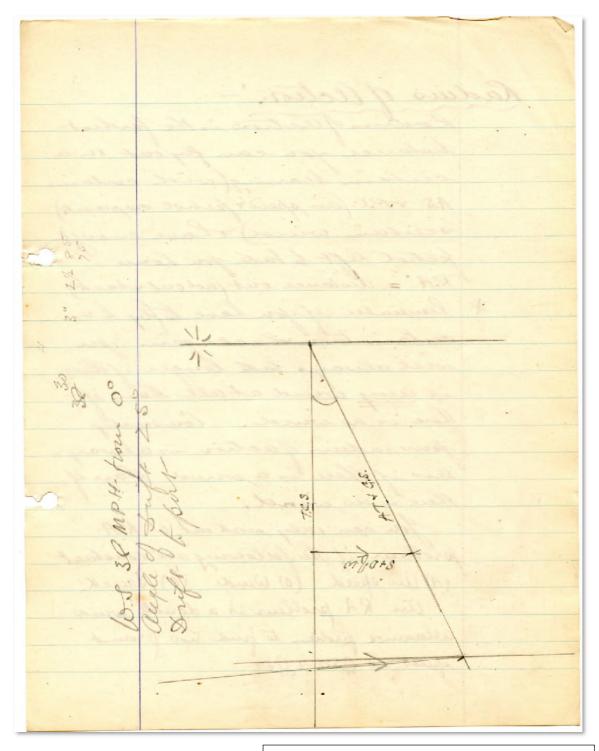
Find ground speed out (G.S.O.) & ground speed in<br/>(G.S.I.) C.C. steered out & in. Time to complete<br/>journey.(Illustration – calculation of speed and journey time)GSO= 80 M.P.H.GSI= 105 M.P.H.CCSO= 41°CCSI= 262°Total Time= 51/2 hours

These course skered 120° Actual hack angle 95°. An open 100 M.P.H. Ground speed 95 M.P.H. Frid - Speed + derection from angle Aucetion gdrift: . WP+ D= 42 MPH for 190° prift & Port. 250. X S.B.S.

True course steered 120° Actual track angle 95° Air speed 100 M.P.H. Ground speed 95 M.P.H. Find: Speed & direction of wind, angle & direction of drift

(Illustration - calculation of drift)

WS & D = 42M.P.H. from 190° Drift to Port 25°



W.S 38 M.P.H. from 0° Angle of Drift 25° Drift to Port

(Full page illustration of drift to port)

Radius of action the beed y ke wie left- to ta Ke R.A. = distance out pustout + Remember if Lave lown the ale ul an we is ho elio les there is no wind can only work out a R.A. ing are constant the follow (C) Track (A) Un speed (B) We an R.A. problem is a double wind allowance problem to pud loo speeds i.e. G.S.O. + G.S.I

# Radius of Action:

Radius of action is the farthest distance you can fly out on a certain bearing (with certain A.S. & P.C. (air speed & petrol capacity) & certain wind) & have enough petrol left to take you home. R.A. = distance out (not out & back) Remember if you have to fly to a certain town & back again you will always take longer of there is <u>any</u> wind at all than if there is no wind. Conversely your radius of action is always less if there is a wind than if there is no wind.

You can only work out a R.A. problem if the following are constant: (A) Air speed (B) Wind (C) Track.

An R.A. problem is a double wind allowance problem to find two ground speeds i.e. G.S.O. & G.S.I.

you are tifly to place, soo kelowether pour me on a T.B. of 185° Wind it four acrodio blowing from 40°T at 25 Kust. AS. go Kusts Find. 480. + 981' in M.P.H. T.C. Skered out sie dive treach place. 250 miles away you fly out to a place on a T. B of 185° A.S. = 100 may Wind blowing from 300° T.B. at 25 MP.H. Fr returning from B. wind occus 12° renceases to som. P.H. Find & S.O., &SS: T.C. skered 0 + 1. live to complete freeney.

You are to fly to a place, 300 [note - added in pencil: 187.5 M] Kilometres from your aerodrome on a T.B. of 185°. Wind is blowing from 40° T at 25 [note – added in pencil: 28.6] Knots. A.S. 90 [note – added in pencil: 103] Knots.

Find. G.S.O. & G.S.I. in M.P.H.

- " T.C. Steered out & in.
- " Time to reach place.

You fly out to a place on a T.B. of 185° 250 miles away. A.S. = 100 MPH. Wind blowing from 300° T.B. at 25 M.P.H. On returning from B. wind veers 12° & increases to 30 M.P.H. Find G.S.O., G.S.I. T.C. steered 0 & 1 Time to complete journey.

You Hen work on following founded  $\mathcal{R}.\mathcal{A} = \frac{P \times G.S.O \times G.S.I}{G.S.O + G.S.I}$ piver P=4 Q20 = 80 Q.S.1 = 60 R.A. = 4 × 80 × 60 = 4800 = Homites. 80 + 60 120 = Homites. Live to turin = R.A. GSO EXAMPLE D. You have to scout along a hack 100°T A.S. go upl P.C. H hours, wind from 3400 at somph G.S.O. 112 mpl. Q.S.1 72 mph. C.S.I. Fraction A.S.0 R.A. 4×102×72 = 102+72 168 miles.

You then work on following formula

R.A. =  $\frac{P \times GSO \times GSI}{GSO + GSI}$ Given P = 4 GSO = 80 GSI = 60 R.A =  $\frac{4 \times 80 \times 60}{80 20 + 60}$ Time to timer =  $\frac{R.A.}{GSO}$ 

#### EXAMPLE

(1) You have to scout along a track 100° TA.S. 90 mph P.C. 4 hours, wind from 340° at 30 mph

G.S.O. 112 mph G.S.I. 72 mph

(Insert illustration of calculation and diagram)

EXAMPLE (2) You have to bound a town B on a T.B. of 78° +170 miles distant. Your a.S. in 80 mph + wind a form 200°T at 20 mph. How many lows person el you have to carry Petrol tune = R.A. + R.A. God うそ GEO shack G. ci aharke Eso. 90 mpt. G.S.1. 67 mph. P 170 + 170 407 \$.54 +

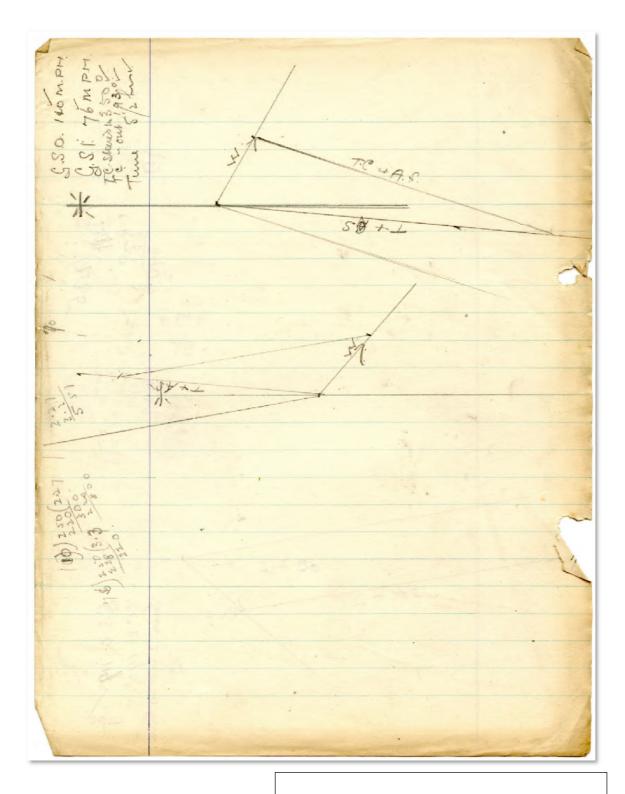
#### EXAMPLE (2)

You have to bomb a town B on a T.B. of 78° & 170 miles distant. Your A.S. is 80 mph & wind is from 200° T at 20mph. How many hours petrol will you have to carry.

(Insert illustration of calculations and diagram)

. . 080 0+1 . . 米 557I 5.4 + 2.1 2 453 1 2 6 Willow a

(Full page of calculations and diagram)

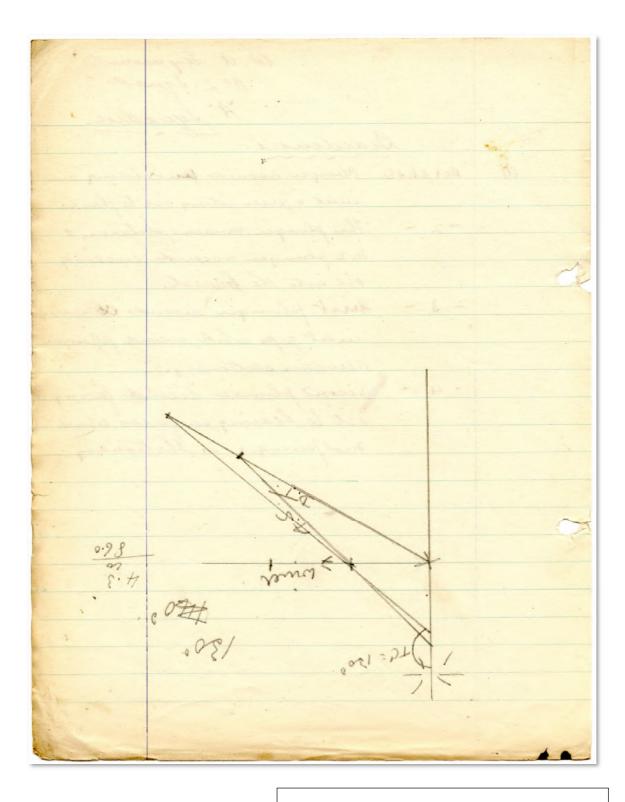


(Full page of calculations and diagram)

W. a. Segueon. Nº 2 Squad "A' Squedros. Beardinor No shoke Rlunger ascurds for covering oil (). what + permitting out to flow in This plunger remains stationar + -2 to 2 plunger ascends sucking oil into the panel. Thirst plunger decends covering - 3 in let pipe while second plunger remain stationary. Second plunder decends facing oil to bearing surfaces while First plunger is Stationary

W.A. Seymour No 1 Squad <u>"A" Squadron</u>

<u>Beardmore</u>	
(1) No 1 stroke	Plunger ascends uncovering oil inlet
	& permitting oil to flow in
"2"	This plunger remains stationary &
	No 2 plunger ascends sucking oil
	into the barrel
"3"	First plunger descends covering
	inlet pipe while second plunger
	remains stationary.
"4"	Second plunger descends forcing oil
	to bearing surfaces while first
	plunger is stationary



(Full page diagram of calculation of windspeed and drift)

2 6 200 5-38 348 4.0 200 198 198 200 198 200 198 200 4 60 21 4 hr 4 15.2 5 33 9 Geo - 8 1 4 G.S. 66 Ser. Geo gh 32 mm

(Full page diagram of calculation of time to get to target)

Abouching expedit to true 250 miles away The 3000 Twind blows 25 mph pon 1650 T. A.S. 100 mph 3 hrs petrol making allowance for clino ile. 84 - 12 3 - 12 36 Geo. 115 mpb Geo. 78 mpb 50/3.2 . 45 11 RA P = 115 + 250 2.2 5 hr 24 mm an advisance in made of , hoir 3 burn

A bombing expedition to town 250 miles away T.B. 300°

If wind blows 25 mph from 165° T A.S. 100 mph ? hrs petrol making allowance for climbs etc.

(Illustration of calculations and diagram)

An allowance is made of 1 hour 31 mins 7 hrs of petrol will be carried.

Anoplane sent out along a hack 340 " T wind pour 100 T @ 30 mph Al gomph. 6hr of pehol an canto ? R.A. making allowance 90 114 Geo 114 mpl when his pepel is a R.A := 4/2×114×63 114+ ·5-×114×63 3177 184 miles. 1

Aeroplane sent out along a track 340° T wind from 185° T 30 mph. A.S. 90mph. 6hrs of petrol is carried ? R.A. making allowance

(Illustration of calculations and diagram)

auchlan over A proces CC. 900 AS 85 mph after this over B. 70 mps F. J.A. ? direction webed your Var 15° W Der 5° E. 500 Not 230 With from + 50 - 20 mpl I.P.M 6.80. 90. 6.81: 57: 1.42 6.30. Gei TPT = RA = 4/2 × 90 × 57 90+ 57. = 4.5×90×57 147 . R.A. = 15-7. Tlot = 1.57 90

Aeroplane over A. Proceed C.C. 90° A.S. 85mph After 1 hrs over B. 70 m E of A. ? direction & velocity of wind Var 15° W Dev 5° E

(Illustration of calculations and diagram)

Roustling: From Naney to:-Cologne 160 miles Cobleng 120 -Farmstadt 140 -. Mayouer 120 -Shasburg 70 -Mansheim 120 -Frankfat 150 -Karlsruhe 104 -.

Bombing:		
From Nancy to:		
Cologne	160 miles	
Coblenz	120	u
Darmstadt	140	11
Mayence	130	"
Strasburg	70	и
Mannheim	120	и
Frankfurt	150	и
Karlsruhe	104	u