569858 J. Ward

Form 27 (Small).

NAVIGATION

ROYAL AIR FORCE.

SKETCH BOOK.

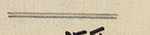
(FOR USE OF THE AIRCRAFT APPRENTICES' TRAINING ESTABLISHMENTS, THE ROYAL AIR FORCE COLLEGE, AND THE OFFICERS' ENGINEERING COURSE, HENLOW.)

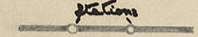
B 1

T. 9037. Wt. 2387. 8,000 Bks. 6/37. W. & S. Ltd. (218644)

CONVENTIONAL SIGNS (R.A.F 1" MAP)


Main Roads between Towns (Brown)


Other Metalled Roads (Brown)



Railways, Two or more Lines


Railways and Tramways, Single Lines


Windmill


Church or Chapel with Tower or Spire

Lighthouse


Aerodrome, Height in feet above M.S.L. (Red)


Landing Ground, " " " " " (Red)


Seaplane Station (Red)


Seaplane Mooring Area or Anchorage (Red)


Airship Station (Red)


Mooring Mast for Airships (Red)


Air Light (Red)


Lightship (Centre of Star) } Marine Lights (Red)


Aeronautical W/T Communication Stn (Red)


Aeronautical W/T Communication and D/F or Beacon Station (Red)

Air Port (i.e. With Customs Facilities (Red))


Aerodrome with Air Light (Red)


Aerodrome and Seaplane Station (Red)


Aeronautical W/T D/F or Beacon Station (Red)


Prohibited & Flying Area (Red)


Explosives Area (Red)


Danger Area (Red)


Unlighted } Airway Obstruction or
Lighted } Obstruction over 300' (100 metres) above Ground Level (Red)

Note. If the height of the obstruction above ground level exceeds 300 the maximum height in feet above mean sea level is indicated by figures.


H.T. Cables of particular danger to Navigation (Red)

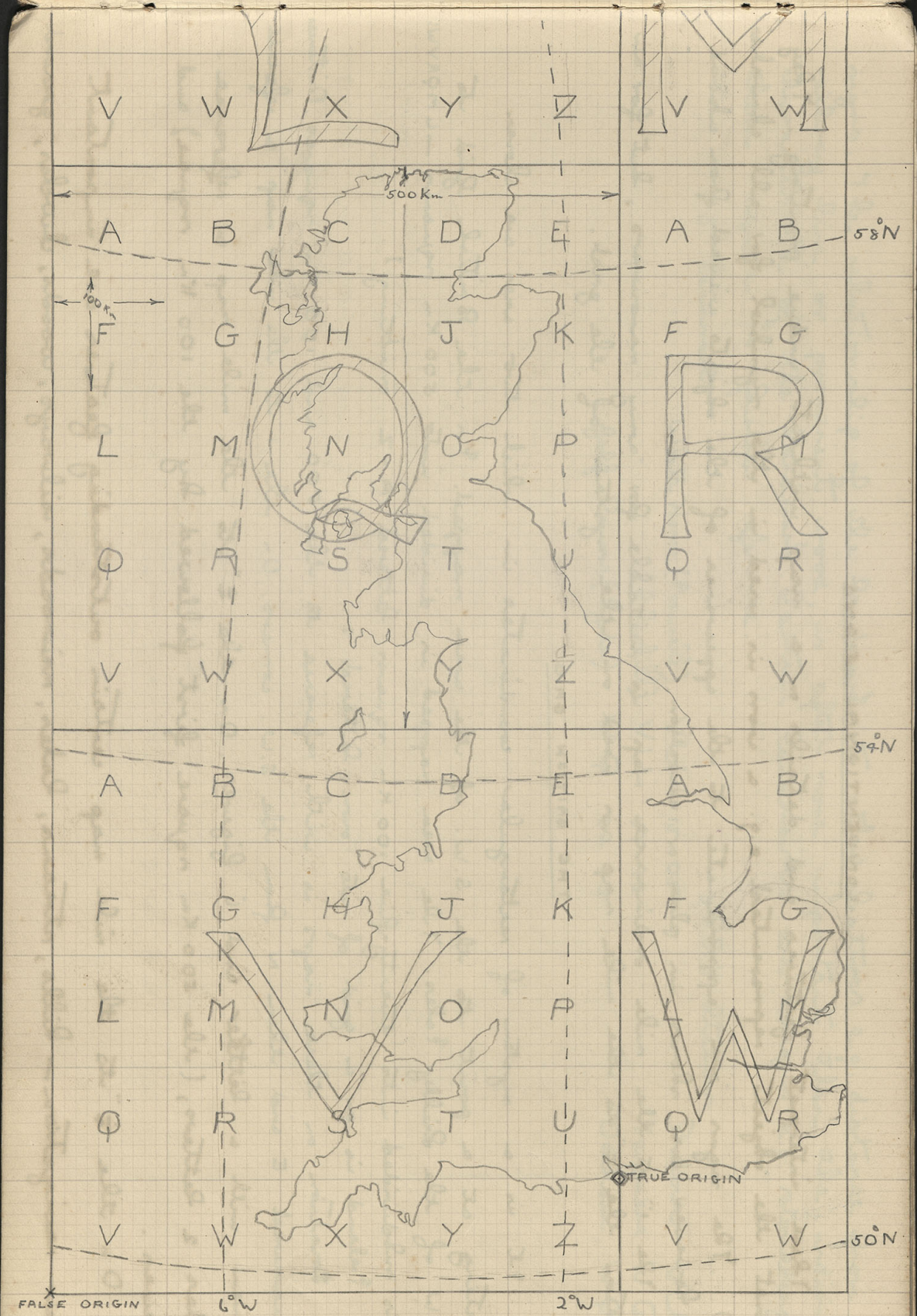

Aeronautical Landmark (Red)

Race Course (Red)


Golf Course (Red)


Ground Sign (Red)


Controlled Area (Red)



BRITISH GRID OF RECTANGULAR CO-ORDINATES.

CONVENTIONAL SIGNS

These interpret features and details on a map without undue printing. They interpret the object represented, e.g. a cross is used in the symbol for all churches (+ ⛪ ⛪). The signs are approximate to the appearance of the objects viewed from above; trees however are shown in plan or elevation.

The 1" to the mile ordinance map is suitable for army manoeuvres, but for air navigation the ½" to the mile map is used on the system of the grid.

THE BRITISH GRID

It is a system of rectangular coordinates in which two axes are drawn intersecting at a point to the S.W. of the area mapped. On the British grid to the S.W of the Scilly Isles. The area mapped is divided into 500 Km squares — L M Q R V W: each is subdivided into twenty-five 100 Km squares lettered A-Z omitting I.

Ireland is on a grid of its own lettered J.

Location on these maps is with reference to the 500 and 100 Km squares. Distances are measured E and then N from the S.W. corners. On the 1" to the mile map a reference is given with a letter and 6 figures. On the ½" to the mile map a reference includes 2 letters, (the 500 Km square first followed by the 100 Km square) and 4 figures.

On the ½" to the mile map certain outstanding features are important to air navigation — hills, streams, lakes, mainroads, railways, woods, churches, ground

signs. The relationship of the landmark to other features e.g. distance from main railway line or prominent wood, is often more important than the individual characteristics of the landmark. Certain landmarks are unique e.g. stonehenge, and these require no further reference.

3 Landmarks

White Horse (Pocwell)	VU	15	05
" (Eastill)	VU	49	90
Golf Course (Ryde)	WQ	02	13

3 R.D.F. Stations

Andover	VU	77	66
Yangmere	WQ	35	26
Odiham	WQ	18	68

GEOGRAPHICAL COORDINATES

Position on a map may be stated by giving Latitude and Longitude.

Lines of Latitude are circles drawn parallel to the Equator. The circles become smaller as they approach the poles. Latitude is stated as so many degrees, minutes, seconds, N or S of the Equator.

Meridians of Longitude are great circles that pass through the Poles. As they approach the Poles they get closer and closer. Longitude is stated in degrees, minutes, seconds, E or W of Meridian passing through Greenwich.

Scale of map shown in three ways: —

① In words — 1 inch to 1 mile, ½ inch to 1 mile.
② By use of scale printed in margin — scale in KM or miles.
③ By a representitive fraction — representitive fraction = distance between any two points of map divided by distance between points on ground.

R.F. $\frac{\text{Map}}{\text{Ground}}$ units in same unity.

R.F for 1" to 1 mile map $\frac{1}{63,360}$ $\left(\frac{1}{60,000}\right)$

R.F for ½" to 1 mile map $\frac{1}{253,440}$ $\left(\frac{1}{250,000}\right)$

R.F for 1" to 1 mile map $\frac{1}{1,000,000}$

HEIGHT OR RELIEF Methods of Indicating.

① Form Lines. A method illustrating position of hills, but not so accurate as ③

② Contours. Lines running along the same height or mean sea level throughout their length.

③ Hachuring. Thick lines close together indicate ~~steep~~ steep slope. The lines further apart show slope less steep.

④ Hill Shading. Method uses colours instead of lines.

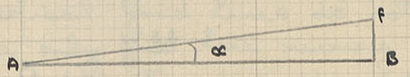
⑤ Layer Tinting. Adopted on ½" to the mile map series of tints indicate different heights, the deepest tints mark highest elevations.

⑥ Spot Heights. Indicate highest points usually in feet above Mean Sea Level.

On ½" to the mile map there is a combination of layer tinting and contours, also spot heights are shown.

On ½" map the difference in altitude between the successive contours (the Vertical Interval) is 200'. On 1" to the mile map the difference is 50'.

Gradient of slope



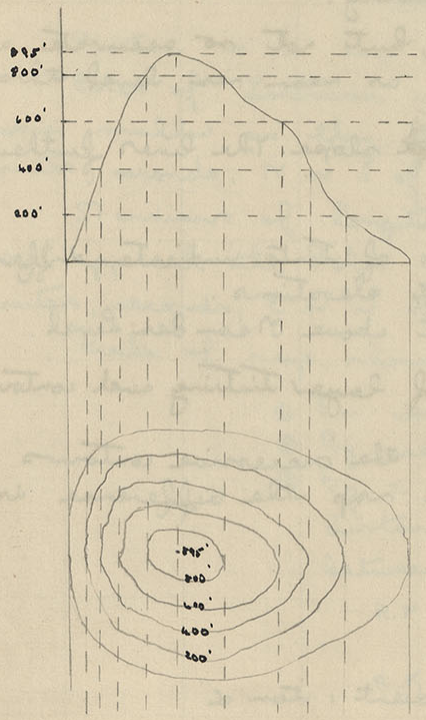
Horizontal Equivalent AB.
Vertical Interval BF

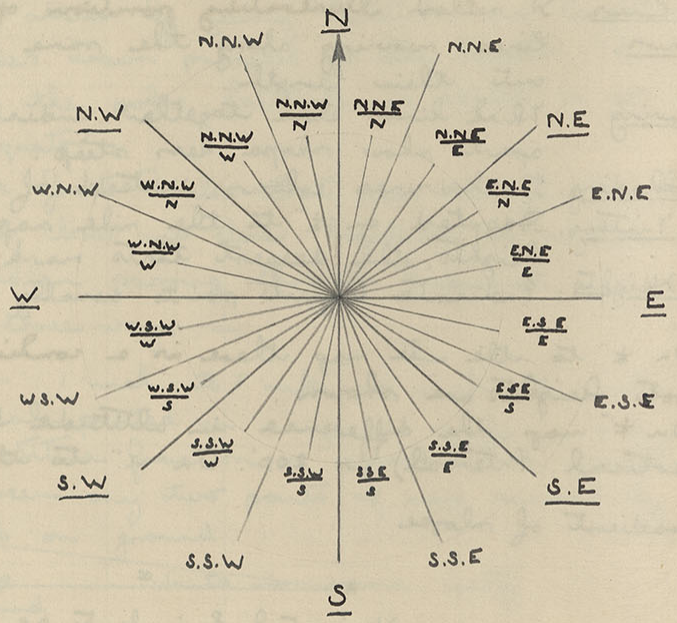
Gradient : tan α

: $\frac{BF}{AB}$

: $\frac{\text{Vertical Interval}}{\text{Horizontal Equivalent}}$.

Submarine Contours in Blue
Vertical Interval = 5 fathoms (30')





NORTH - True - Grid - Magnetic.

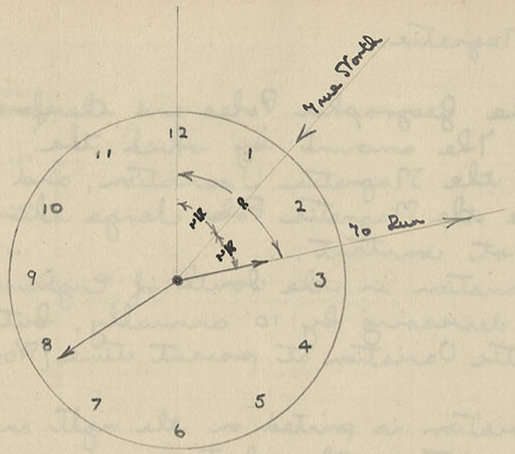
The Magnetic Poles do not coincide with the Geographic Poles and therefore a compass needle very rarely points True North. The amount by which the magnetic needle points from True North is called the Magnetic Variation, and is measured in degrees, minutes, and seconds. Since the Magnetic Poles change their positions the amount of Magnetic Variation is not constant.

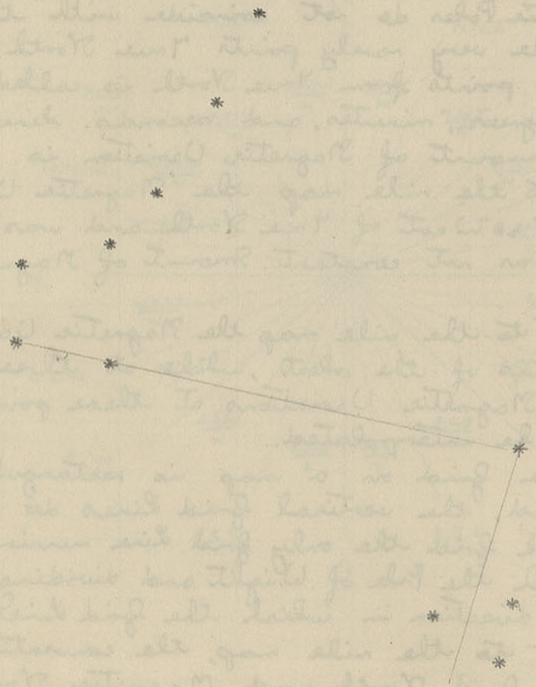
On the 1" to the mile map the Magnetic Variation in the South of England Jan 1925 was 13° 48' West of True North and was decreasing by 10' annually. But that decrease was not constant. Amount of Magnetic Variation at present time (Nov 1938) is 11° 38' West.

On the ½" to the mile map the Magnetic Variation is printed on the right and left-hand margins of the sheet, while at three points on the sheet a compass rose indicates the Magnetic Variations at these points. For the intermediate points the variations can be interpolated.

Since the Grid on a map is rectangular, and since the surface of the earth is curved, the vertical Grid Lines do not all run True North and South. On the British Grid the only Grid Line running True North and South is that passing through the Isle of Wight and dividing 500 K.m squares V and W. Grid North is the direction in which the Grid Lines point.

On the 1" to the mile map, the conventional sign in violet shows the angle between Grid North and Magnetic North on a given date, and the amount of annual increase or decrease, and also indicates the angle between Grid North and True North at the centre of the sheet. Also the amount of





deviation of the Grid Line from the Sheet North Line or the edge of the sheet.

On the 4" to the mile map a note below the scales indicates the amount of deviation of the Grid from True North on the East and West Margins of the sheet.

Setting a Map.

Lay it out in a position so that it can be read relative to the ground it represents, North to North, by objects recognizable on ground and map and by compass.

ADMIRALTY CHART.

Position is indicated by Geographical Co-ordinates. Latitude from the scales on the E & W margins, Longitude from the scales at the top and bottom.

On chart of Bristol Channel a compass rose is overprinted showing the direction of the True Meridian

Magnetic Variation is taken from lines of equal Magnetic Variation shown on the chart at intervals of 1° — Bearing 13° W. 1937 S.W England — 16° W 1937 S.W Ireland.

Most Admiralty charts are based on Mercator's projection. Longitude is kept a constant over the map and the Latitude scale is increased in proportion in the higher and lower regions of the map to keep the correct shape of territories. e.g. in the region of 60°-70° N. Lat. the Longitude measurement should be half what it is at the equator (since the lines of Longitude approach one another) ∴ the Latitude scale in that higher Latitude has been increased twice the measurement at the equator.

Measurement of Distance — Only the Latitude scale can be relied upon, on the basis of 1 minute of Latitude equal to 1 sea-mile (6080 ft).

Method of Measurement — Take a strip of paper and mark on it the points between which measurement is to be taken, bisect the distance between and drop a perpendicular to the nearer Latitude scale, place the strip against the Latitude Scale the mid point coinciding with the foot of the perpendicular, read off the Latitudes of the two points, subtract and

reduce to minutes. The result is nautical miles.

Examples

Lamorna Pt to St. Davids Head.
Hartland Pt to Bull Point.
Wolf Light to Lands End.

Conventional Signs of value to navigation refer mainly to the system of lights around the coast, other conventional signs are figures indicating fathoms and indications of the nature of the sea bed.

Lights

① Continuous steady light marked F — Youghal Harbour.
② A flashing light is marked Fl.
③ A Group flashing is marked Gp Fl with the series of flashes during the whole cycle.
④ Alternating light Alt show change of colour (W.R.W.) and may be combined with Group flashing.
⑤ Occulting Lights are marked Occ and give a period of brilliance greater than the period of eclipse.

The system of relief is by hachuring.

Bearings

Bearing is the angle measured clockwise from a fixed line to any line in question e.g. the bearing S.E from N: 135°, bearing of S.S.W from N: 202½°, bearing $\frac{\text{W.N.W}}{\text{N}}$ from N: 303½.

19/20

ELEMENTARY AIR NAVIGATION

Air Navigation is the art of conducting an aircraft from place to place by dead reckoning and fixing position by observations of terrestial objects and celestial bodies. It includes the ability to maintain a given direction in or above clouds and mist and by night.

Dead Reckoning is defined as the process of calculating the track and ground speed of an aircraft. The abbrev. D.R is always used. D.R. Track and D.R. Position as respectively the track and position arrived at by such calculation.

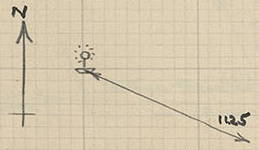
Both track and ground speed can be found by direct measurement. Since course and airspeed are always known, then if the wind velocity is given, the track and ground speed can be calculated by the triangle of velocities. Conversely if the track and ground speed are known the wind velocity can be calculated. Drift being the angle between the course and track is an important factor in the solution of the triangle of velocities.

Measurement and calculation of Drift, Track, Ground Speed, and Wind Velocity are the essence of D.R Navigation.

Fixing Position. The accurate fixing of position at frequent intervals is of greatest importance in air navigation. The simplest and most accurate way of obtaining a Fix (i.e. position) of an aircraft is to

observe some recognised object on the ground over which the aircraft passes.

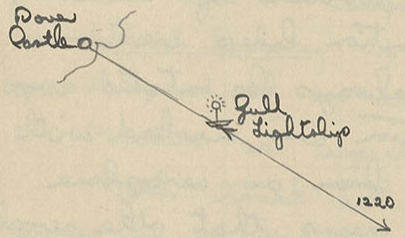
Position Lines. The bearing of an object taken from an aircraft then the position of the aircraft must be on a line drawn from the object in the reciprocal direction. Such a line on which the position of the aircraft is known to be is called a Position Line. When position lines are drawn on a map or chart the time of observation must always be stated over the line. Position lines obtained by direct observation are marked with single arrow heads near each end. e.g. if it is observed from an aeroplane that a lightship bears 300°T at 11.25 hrs. This means that the aeroplane bears 300° - 180° = 120°T from the lightship; a position line can therefore be drawn on the charts as shown.



Position Lines by Transit. When two objects on the earths surface appear to be in line with an observer they are said to be in transit, and two objects in transit give a position line. The objects should not be selected too near the aircraft; 3 miles may be taken as a suitable distance for the near object. The Greek letter ϕ is used to denote a transit in the air

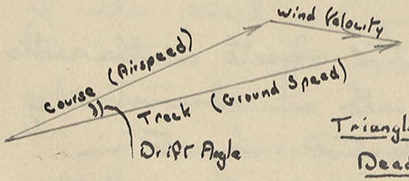
navigation log. e.g. suppose Dover Castle and the Gull Lightship be observed in transit at 12.20 hrs; then the entry in the log would be as follows

1220 hrs Gull Lightship ∅ Dover Castle and the a position line would be drawn on the chart as shown



Position Lines by Direction Finding Wireless (D.F. W/T.)

Bearings obtained by D.F. W/T. can be used as position lines.



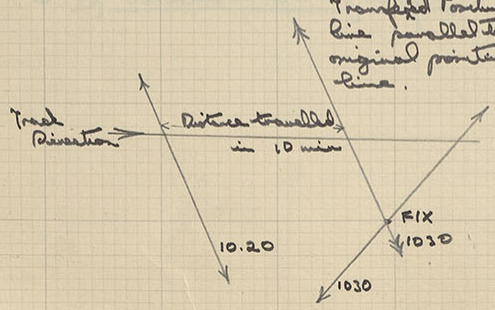
Triangle of Velocities

Dead Reckoning

Running Fixes

It frequently happens that only one position line can be obtained at a given moment, and although no fix can be obtained from this solitary observation, it may be used later when another observation of the same or another ~~thing~~ object can be obtained.

The diagram shows two position lines taken at different times (10.20 & 10.30). If the track bearing and the groundspeed are known approx. as is usual the distance travelled between the times of observation, 10" in the above case, can be marked out as shown to obtain a transfered position line for 10.30. this will appear to give a fix



This type of fix is called a running fix, & the distance is made good by the transfer position & the direct position lines is called the run. Transfered position lines are always marked with two arrow heads at each end. Since the track groundspeed are rarely known with dead accuracy position lines

17 should not be transfered unless this is unavoidable. No great reliance can be placed on a position line transfered after a considerable run.

Methods of measuring Track.

① By two fixes.

Two fixes have been plotted on a map or chart, the track can be laid down by a straight line joining them, and measured by means of a protractor. Since the time between fixes is known and the distance can be measured from the map or chart, the groundspeed can be found.

② By back-bearings.

If the aircraft flys on a steady course and passes directly over a fixed object a back-bearing taken of this object a little later will give the reciprocal of the track. The bearing should be taken when the object is well astern and the mean of several readings should be taken

③ By observation of drift.

Great Circles and Rhumblines

A Great Circle is a circle on the surface of a sphere whose plane passes through the centre of the sphere. The shortest distance along the surface of the sphere between two points is that measured along a Great Circle passing through the points. For navigational purposes, however, a Great Circle track is not a convenient one to follow since the Great Circle does not cut the meridians at equal angles. Therefore frequent changes of course are necessary if it is desired to keep a Great Circle track.

A Rhumbline is a curve on the earth's surface which cuts the meridians at equal angles, such a curve is a very convenient track to follow since a steady course can be steered. It is however not the shortest distance between two places.

The difference in distance between Great Circle and Rhumbline tracks is not important except over very large distances. Consider the following comparisons.

Calshot to:—	Great Circle	Rhumbline
New York	2976 naut miles.	3088 naut. mils.
Yokio	5219 " " .	6182 " " .