Solution of the same problem by ARISTO AVIAT 618: Set the wind 350° on the black azimuth graduation to TRUE INDEX. Plot the wind vector from center bore upwind, therefore upward along the center axis. Count off 30 knots on the speed arcs of the slide and pencil-mark the point so determined (fig. 46). Now rotate the true track 48° under the TRUE INDEX and shift the true air speed 210 kt of the slide to coincide with the plotted end point of the wind vector. Then read the result as explained above.

11.1.4 To find Wind Direction and Velocity from Drift Angle and Ground Speed

Given: True heading
True air speed
Ground speed
Drift angle

Required: Wind direction and velocity

Drafted Solution:

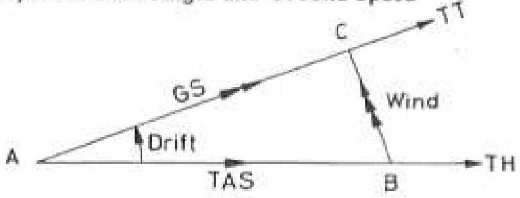

Fig. 47

(1) Along a line drawn from A to represent the true heading lay off the true air speed (line AB).
(2) From A lay off the drift angle, to the right of AB if the drift is +, to the left if −.
Along this side of the angle scale off the ground speed to obtain point C.
(3) The line drawn from B to C defines the wind direction and velocity.

Computer Solution:
(a) Set true heading to TRUE INDEX.
(b) Draw the true air speed under center bore.
(c) Pencil-mark intersection of drift ray with speed arc for the ground speed.
(d) Set the indicator to the marked point using the wind scale corresponding to the diagram slide.
(e) Read the wind velocity on the indicator scale over the pencilled mark and the wind direction on the azimuth graduation (red!).

Example:

Given: True heading 310°
True air speed 200 kt
Ground speed 176 kt
Drift + 7°

Required: Wind direction and velocity

Setting: 310° to TRUE INDEX (fig. 49)
200 kt to center bore
Pencil-mark the intersection of the black drift ray + 7° (on the right) with the speed arc 176.

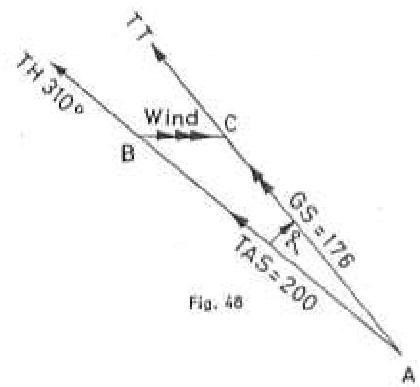

Fig. 48

Reading: Read the wind direction 270° and velocity 33 kt from the indicator.

Note: In the case of the 618 model, turn the plotted point downward to coincide with the Zero axis of the slide and read the wind direction opposite the TRUE INDEX. Count off the wind velocity on the numerated black speed arcs and their subdivisions.

Counting along the Zero axis is made easier when some round value, 200 for instance, is adjusted to the pencil mark. (fig. 50).

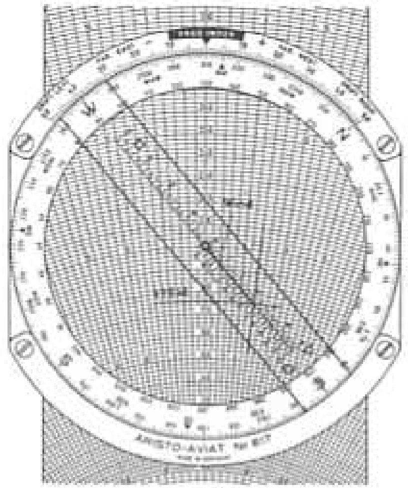

Fig. 49

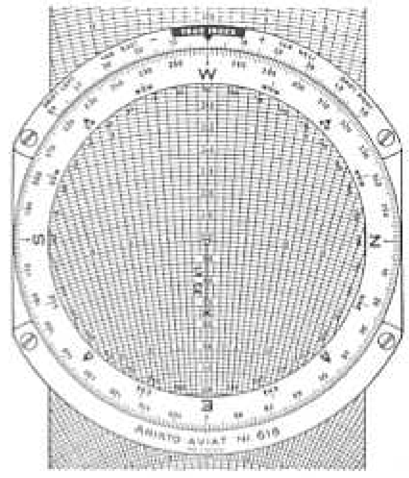

Fig. 50

11.1.5 Drift Problems

When two true headings are flown and the drift angles are measured, the wind can be determined from the drifts and the true air speed. The two courses flown should make an angle of at least 45° in order to produce satisfactory results.

Computer Solution:
(a) Set the true air speed on the slide scale under the center bore.
(b) Set the first true heading against the TRUE INDEX.
(c) With a pencil trace on the plotting surface the drift line along the slide ray corresponding to the observed first drift angle.
(d) Set the second true heading against the TRUE INDEX.
(e) Pencil-mark the place where the black drift ray for the second heading meets the previously drawn pencil line.
(f) Turn the indicator to the pencil-marked point to find the wind direction and velocity.

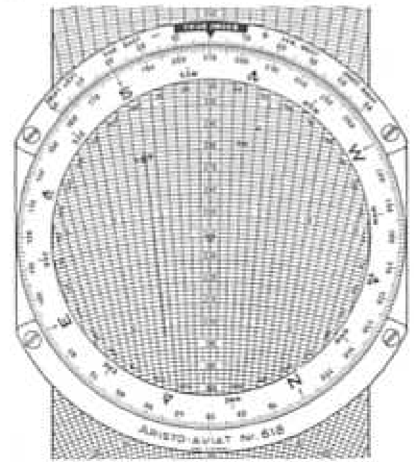

Fig. 51

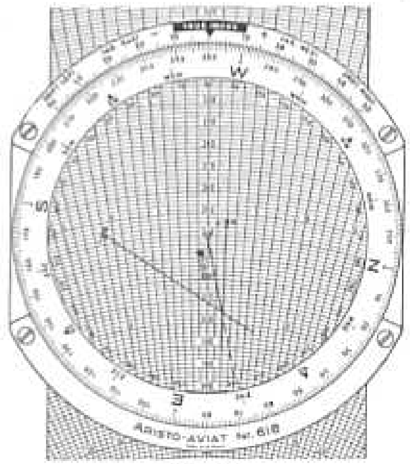

Fig. 52

Example: True air speed 240 kt
First true heading 210°, drift angle − 6°
Second true heading 260°, drift angle + 2°

Setting:
(1) 240 kt under center bore,
(2) 210° to TRUE INDEX (fig. 51),
(3) Trace the − 6° drift ray with a pencil.
(4) Turn 260° under TRUE INDEX (fig. 52).
(5) Mark the place where the + 2° drift ray cuts the pencilled line.
(6) Set the indicator to this mark.
(7) Read the wind direction and velocity.

Users of the ARISTO-AVIAT 618: Turn the intersection of the drift lines downward to the Zero axis and read the wind direction under the TRUE INDEX.

Result: Wind 248°/36 kt

11.1.6 Keeping an Air Plot

To keep an airplane on a plotted route use the rectangular grid net on side B, G or H of the slide.

Given: True headings flown, time on each lap, true air speed and wind data.

Required: Direction and distance of dead reckoning position from starting point or last known position.

Setting:
(1) First true heading to TRUE INDEX.
(2) Upper border of rectangular grid under center bore and, in a convenient scale ratio vertically down-grid plot the distance made good in the first lap flown with the first heading, ignoring the wind effect.
(3) For the second true heading proceed as before and plot the distance made good from the end point of the first line downward.
(4) Proceed accordingly for further headings, if any.
(5) Wind direction to TRUE INDEX.
(6) Plot the total wind effect for the times flown on the several headings from end point of the drafted true headings upward on the grid
(7) Turn the end point of the wind vector so plotted downward so as to lie on the center axis of the slide.

Reading: Under TRUE INDEX: Direction of DR position from starting point.
The distance of the DR position from the starting point is measured between the end point of the wind vector and the center bore. This reading is taken by use of the numbers on the slide axis.

Example:

Given: True air speed 255 kt Wind 340°/50 kt
1st True heading 145°, time elapsed 6 min (air dist. 25.5 NM)
2nd True heading 90°, time elapsed 4 min (air dist. 17 NM)
3rd True heading 20°, time elapsed 7 min (air dist. 30 NM)
The air distances are calculated as given in para 6.2.3

Required: Direction and distance of DR position from starting point.

Drafted Solution:

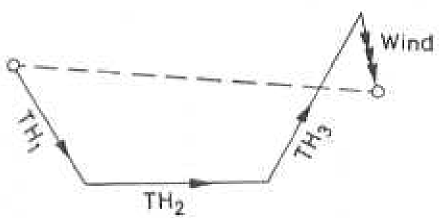

Fig. 53

Computer Solution:

Setting:
(1) 145° to TRUE INDEX and Zero line of rectangular grid on diagram B, G or H under center bore.
(2) Scale off 25.5 NM from center bore down.
(3) 90° to TRUE INDEX.
(4) Shift zero line of rectangular grid to the plotted point and scale off 17 NM from end of first plotted heading downward.
(5) 20° to TRUE INDEX.
(6) Shift Zero line of rectangular grid to the second point and scale off 30 NM, downward again.
(7) Wind direction 340° to TRUE INDEX.
(8) Shift the lower rim of rectangular grid to the third point and scale off drift 14 NM from last point up.

The drift for 17 min total flight time is determined from the equation:

$$\frac{50}{\triangle} = \frac{\text{Wind Drift in NM}}{\text{Total Flight Time}}$$

wherein 50 kt is the wind speed in nautical miles per hour.

(9) Turn end point of wind vector downward to match the center axis of the grid and shift its Zero line under the center bore.

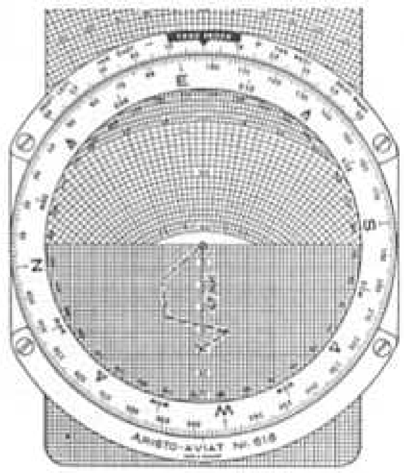

Fig. 54

Reading: Direction of DR position 97° opposite TRUE INDEX. Distance from starting point 47 NM along center axis (fig. 54).

11.1.7 Off-course Corrections

Given: The lateral departure in NM from the intended route. Distance of airplane from starting point.

Required: Angle of departure and course correction angle.

Procedure:
(1) Set one of the cardinal compass points under TRUE INDEX.
(2) From center bore, either up or down along the center axis, scale off the amount of lateral departure by use of its numeration or the red concentric circles. Place a pencil dot.

(3) Set another cardinal compass point differing by 90° from the original setting to TRUE INDEX.
(4) Set distance flown on center axis of slide under center bore.
(5) At the pencil dot read the angular value of the departure from the drift rays of the slide.
(6) Set the distance to go under the center bore and read the course correction angle for the distance to go, analogous to the procedure under (5).
(7) Add the two angular values and apply the total correction to the true heading: Subtract for right departure, add for left departure.

Example:

Given: True heading 100°
Distance along intended track 380 NM
Departure 24 NM to the right after flying 210 NM

Required: Course correction angle

Drafted Solution:

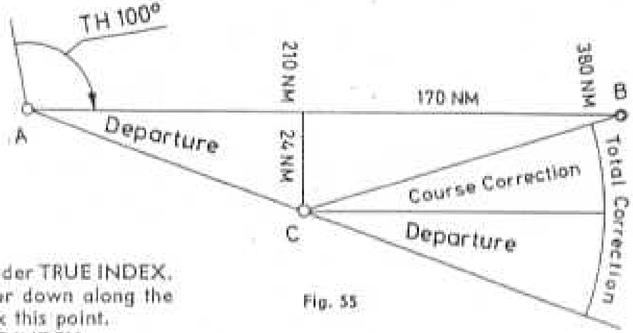

Fig. 55

Computer Solution:

(1) N of compass rose under TRUE INDEX.
(2) Scale off 24 NM up or down along the center axis and mark this point.
(3) Set E (or W) to TRUE INDEX.
(4) 210 on center axis of slide under center bore.
(5) Read angle of departure $6^1/_2°$ at the marked point (fig. 56).
(6) Set distance to go 170 under center bore and find the course correction angle 8° (fig. 57).
(7) To the true heading (100°) apply the total correction $6^1/_2° + 8° = 14^1/_2°$ leftward to obtain the new heading $85^1/_2°$ to be maintained to destination. This operation can also be performed with the arc wing DRIFT LEFT.

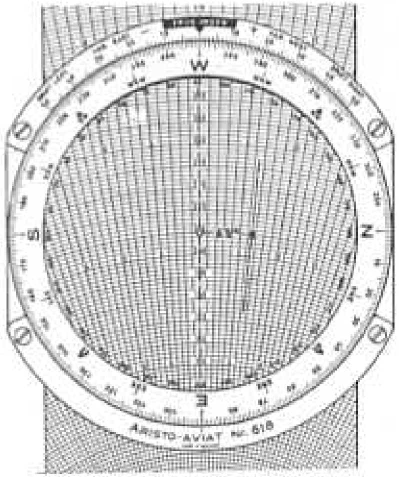

Fig. 56

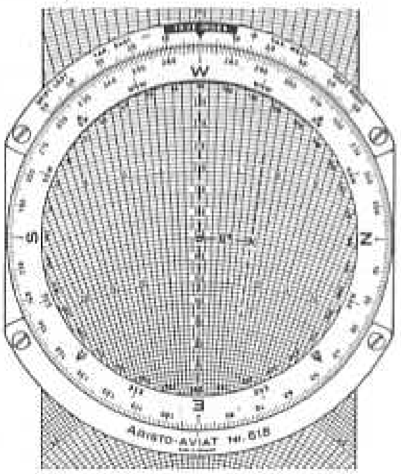

Fig. 57

11.1.8 Calculation of Cross Wind and Head or Tail Wind Components

When taking off or landing on a runway it is in many cases important to know the cross wind and/or head or tail wind components. These computations are made by use of the rectangular grid on slide B, G or H.

Setting: (1) Wind direction to TRUE INDEX.
(2) Shift Zero of grid net under center bore and plot the wind vector downward.
(3) Set direction of runway to TRUE INDEX.

Reading: (1) The distance from the labelled axis of the rectangular grid, counted along one of its horizontal lines to the end of the wind vector, gives the cross wind component.
(2) Counting from the Zero line vertically downward to the end of the wind vector gives the head or tail wind component.

Example 1: **Head Wind**

Direction of runway 265°, Wind 330°/30 kt

Procedure:

(1) 330° to TRUE INDEX
(2) Set Zero of rectangular grid to center bore.
(3) Plot wind vector 30 kt downward.
(4) Set direction of runway 265° to TRUE INDEX.
(5) Read the cross wind component 27 kt by following the respective horizontal grid lines from center axis to end of wind vector (fig. 59).
(6) Read the head wind component 13 kt by following one of the vertical grid lines from Zero line down to the end point of the wind vector (fig. 59).

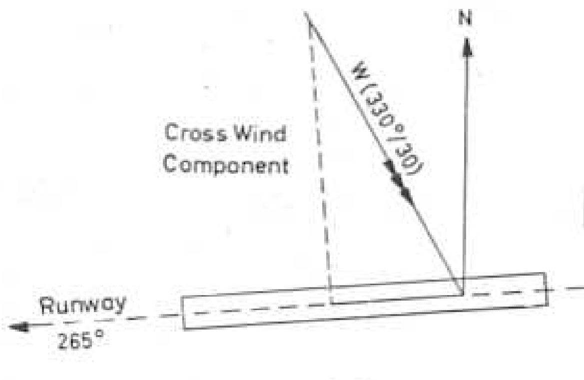

Fig. 58

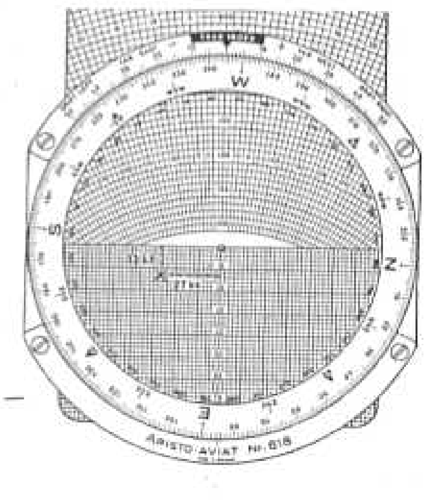

Fig. 59

Example 2: **Tail Wind**

Direction of runway 075° Wind 200°/40 kt

Procedure:

(1) Set 200° to TRUE INDEX.
(2) Set Zero of rectangular grid to center bore.
(3) Plot wind vector 40 kt down-grid.
(4) Set direction of runway 075° to TRUE INDEX.
(5) Shift the horizontal Zero line of the rectangular grid to coincide with the end point of the wind vector and read the cross wind component 33 kt counting leftward.
(6) Read the tail wind component 23 kt on the center axis under the center bore.

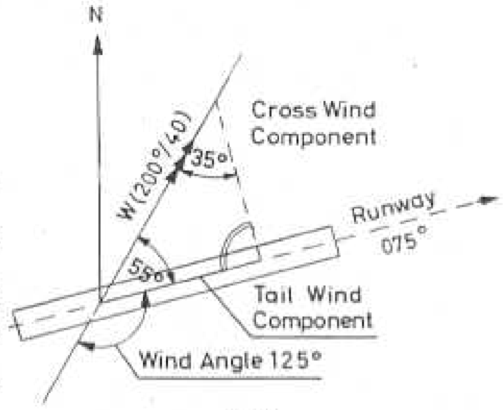

Fig. 60

11.1.9 Calculation of Drift from Cross Wind Component (V_n) or from Beam Displacement (Z_n)

(Pressure Pattern Navigation, see par. 8)

Given: True air speed, ground speed and V_n

Required: Drift

Drafted Solution:

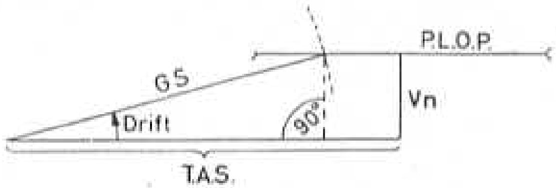

Fig. 61

Computer Solution:

(a) Set one of the cardinal points of the compass rose (N, for instance) against the TRUE INDEX and plot the V_n vector from center bore upward or downward.

(b) Set one of the compass points differing by 90° either way from the first adjustment (E for instance) against TRUE INDEX, and shift the slide to bring the black speed arc for the ground speed under the end point of the V_n vector.

(c) Read the drift under this location.

Example 1:

Given: V_n = 29 kt to the right
Ground speed 205 kt

Required: Drift

Result: Drift + 8°

Example 2:

Given: Beam displacement Z_n = 34 NM to the right
Ground speed 210 kt, time elapsed between measurements of D-values 90 min.

Required: Drift

From the ground speed and the time flown determine the distance 315 NM made good between the air positions of the two altitude measurements (cf. 6.2.3). Next calculate the drift as described above but substituting the distance 315 NM between the two air positions for the ground speed.

Result: Drift + 6°

11.2 Departure Problems

Departure (also known as Parallel Distance) is the distance expressed in nautical miles between two meridians along a parallel of latitude. For departure problems use the approximate formula:

Departure = difference of longitudes × cosine latitude

Computer Solution:

(a) Set N to TRUE INDEX.

(b) Set horizontal Zero line of rectangular grid under center bore.

(c) In a suitable scale plot the difference in longitude given in minutes of arc from center bore horizontally leftward.

(d) Rotate the given latitude under the TRUE INDEX.

(e) The horizontal distance of the end point of the line segment which represents the difference in longitude, measured from the center axis of the slide, gives the departure expressed in NM in the scale ratio adopted for step (c).

Example:

Find the departure between Long 5 °E and 6 °E at Lat 54 °N.

Difference in longitude 1° = 60'.

Result: 35 NM.

11.3 Finding the Conversion Angle (C.A.)

The approximate formula for the conversion angle is:

C.A. = 1/2 difference of longitude × sine of the mean latitude

Computer Solution:

(a) Set N to TRUE INDEX.

(b) Shift horizontal Zero line of rectangular grid to center bore.

(c) From center bore leftward, in a suitable scale ratio, (e. g. side of a square bounded by strong lines = 1° change in longitude) plot half the difference in the two given longitudes.

(d) Set the mean latitude to the TRUE INDEX.

(e) In the scale chosen under (c) read the conversion angle as the perpendicular distance of the plotted point from the horizontal Zero line.

Example:

Location of transmitter Lat 51 °N Long 8 °W

DR position of aircraft Lat 53 °N Long 4 °E

Difference in longitude 12° (hence 1/2 difference = 6°)

Mean latitude 52°

Setting: (1) N to TRUE INDEX.
(2) Horizontal Zero line of rectangular grid to center bore.
(3) Scale off 6 unit squares leftward along the horizontal line.
(4) Set 52° to TRUE INDEX.

Reading: Conversion angle 4.7° as explained under (e). The numerations of the center axis are helpful in taking the count.

12. Trigonometric Solution of Triangle Problems with the ARISTO AVIAT 610 - 615

Triangle problems are solved with the scale (r) labelled SPEED and the scale (s) labelled ∢ sin.

The law of sines states:

$$\frac{a}{\sin\alpha} = \frac{b}{\sin\beta} = \frac{c}{\sin\gamma}$$

Hence, when three parts are given, the remaining elements can be computed.

12.1 Solution of Triangle Problems in General

Setting: Set the given angle on the sine scale (s) under the given opposite side of the triangle on the speed scale (r).

Reading: Read the required side from the outer scale opposite the given angle of the triangle on the sine scale, or read the required angle from the sine scale opposite the given side of the triangle on the outer scale.

Examples: (1) $a = 30$ in
$\alpha = 25°$
$b = 52$ in
Required: angle β
Result: $\beta = 47°$

Fig. 62

(2) $b = 20$ in
$\beta = 16°$
$\gamma = 28°$
Required: side c
Result: $c = 34$ in

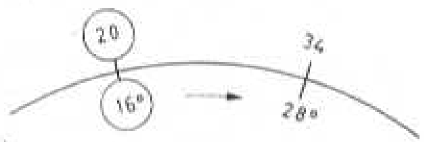

Fig. 63

12.2 Wind Triangle Problems

12.2.1 The Wind Triangle

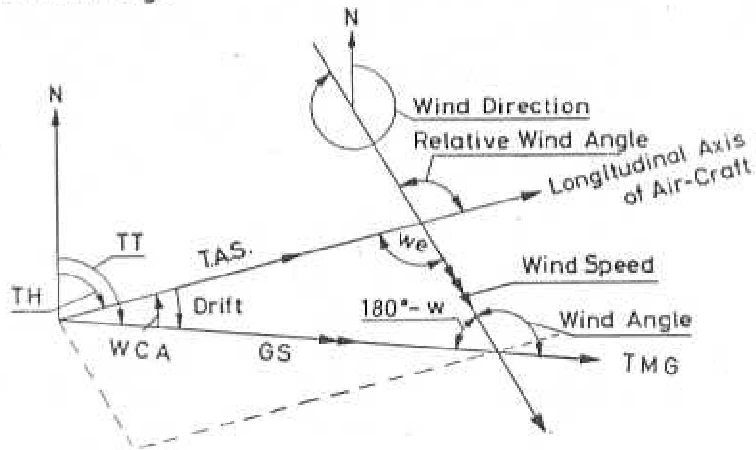

Fig. 64

The wind triangle results from the vectorial combination of velocities, namely the true air speed T.A.S. and heading as well as the wind speed and direction; the resultant of these two components is the ground speed GS along the track made good T.M.G.

If the aircraft drifts to the right, or starboard, the drift is plus; if to the left, or port, the sign is minus.

If the aircraft is headed to the right of the track, the W.C.A. (wind correction angle) is plus, if headed to the left, the sign is minus.

Relative wind angle = wind angle − wind correction angle (or drift)
Wind angle = relative wind angle + wind correction angle (or drift)
Wind correction angle (or drift) = difference between wind angle and relative wind angle.

The following relation may, therefore, be derived from the individual parts of the wind triangle:

$$\frac{\text{Wind Speed W.S.}}{\sin \text{Dr or W.C.A.}} = \frac{\text{True Air Speed T.A.S.}}{\sin w} = \frac{\text{Ground Speed GS}}{\sin we}$$

w = wind angle we = relative wind angle

12.2.2 Determination of the Wind Correction Angle and the Ground Speed

Given: Required track, air speed and wind

Required: Wind correction angle and ground speed

Setting: (a) Set the required track on the blue compass rose over the "aircraft index". Turn the hairline of the double indicator over the wind direction on the blue compass rose.

Reading: Read the wind angle under the hair line from the black inner scale (u) which is divided from 0° to 180° to the right and left of the aircraft index.

Setting: (b) Set the wind angle on the blue scale (s) labelled "∢ sin" under the air speed on the red scale (r) labelled SPEED.

Reading: Read the wind correction angle from the sine scale opposite the wind speed on the outer scale.

Sign convention: wind from **right** — wind correction angle **plus**
wind from **left** — wind correction angle **minus**

To obtain the relative wind angle subtract the wind correction angle from the wind angle. With the setting (b) unaltered read the ground speed from the speed scale opposite the relative wind angle on the ∢ sin scale.

Example:

Given: TT = 48°
Wind = 350°/30 kt
wind angle w = 58°
T.A.S. = 210 kt

Required: W.C.A. and GS

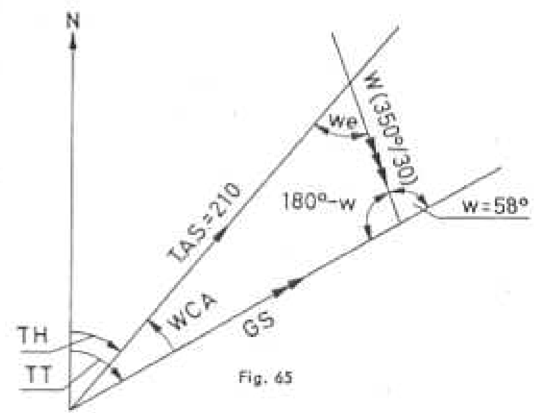

Fig. 65