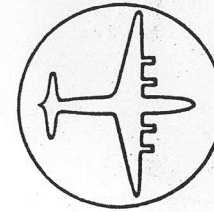


Swissair Navigator

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Manufacturer:

Hans Meierhofer Fabrique de plaques métalliques MELLINGEN/Argovie Switzerland

INSTRUCTIONS FOR USE.

The "Swissair Navigator" solves the most important navigational problems. By its special design it unites in the minimum of space and in one single instrument all the most usual navigational tables and instruments. (Pocket size computer).

Uses.

✓ Measuring distances by means of the inch and centimetre scale on the instruction plate.

Plotting track with directional disc and cord.

Position-finding with directional disc and cord.

Determining quadrantal altitude.

Distance-time-speed-problems.

Calculation of vertical speed.

Calculating time for ascent and descent.

✓ Solution of wind-triangle problems.

Airspeed- and altitude computations.

✓ Conversion between statute or nautical miles and kilometres.

✓ Conversion between feet or yards and metres.

Conversion between millibars and inches.

✓ Conversion between centigrade and fahrenheit.

✓ Conversion between pounds and kilograms.

✓ Conversion between U.S. gallons or imperial gallons and litres.

Calculation of fuel consumption and range, or weight of fuel.

Reading off sines and cosines.

Pressure pattern flight.

Calculating right-angled triangles.

The inner surface of the directional disc can be written upon; any notes recorded on it being readily erased.

Glossary of the navigational terms used in the value of "Compass Heading".

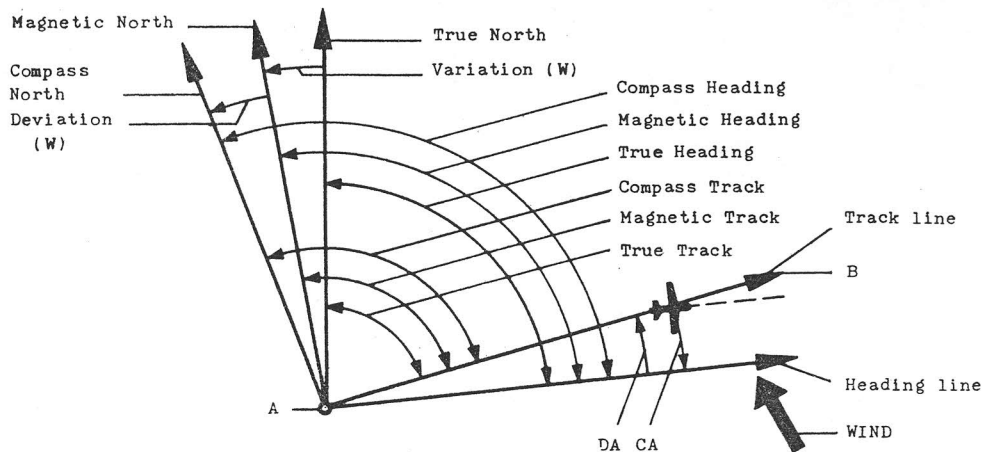


Fig. 1 DA = Drift Angle
CA = Correction Angle

Variation: Horizontal angle between the direction of True North and Magnetic North at a place. It is named E or W according to whether the direction of Magnetic North is to the East or West of True North.

Deviation: Angle measured in the horizontal plane between Magnetic North and the direction of a particular compass needle influenced by magnetic fields in the aircraft in addition to that of the Earth. It is named E or W according to whether the North-seeking Pole of the aircraft's compass lies to the East or West of the Magnetic North.

Wind angle: Angle between the Wind direction and True Track of aircraft, measured from 0° to 180° to the right or left of True Track.

Drift angle: Angle between the Heading and Track of an aircraft, measured from the Heading to the Track.

Correction angle: Angle between the Heading and the Track, measured from the Track to the Heading.

True Track: Actual line made good on the Earth's surface, measured clockwise from True North, from 0° to 360°.

Magnetic Track: True Track plus or minus Variation. Subtract for Variation East, add for Variation West.

Compass Track: Magnetic Track plus or minus Deviation. Subtract for Deviation East, add for Deviation West.

True Heading: Direction in which the aircraft is pointing, measured clockwise from True North, from 0° to 360°.

Magnetic Heading: True Heading plus or minus Variation. Subtract for Variation East, add for Variation West.

Compass Heading: This is finally the reading on the aircraft's compass which the pilot steers from A to B. It is the magnetic Heading plus or minus the Deviation. Subtract for Deviation East, add for Deviation West.

1. TIME - DISTANCE - SPEED PROBLEMS.

a. **Time:** An aircraft flying at 378 kts. travels from A to B, a distance 217 n.m. How long will the journey take?

Answer: Set the black arrow-head (1 h) over 378. Read off over 217 (on middle ring) 34 minutes (approx.) on the outermost ring.

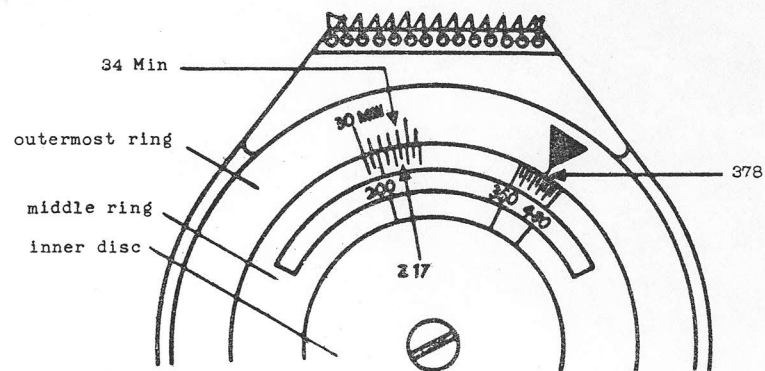


Fig. 2

b. **Distance:** An Aircraft travelling at a ground speed of 163 kts. continues at this speed for 4 hours 15 minutes. How far will the aircraft have travelled?

Answer: Set the black arrow-head over ground speed of 163 kts. Read off flown Distance 693 n.m. on the fixed middle ring under the flying time.

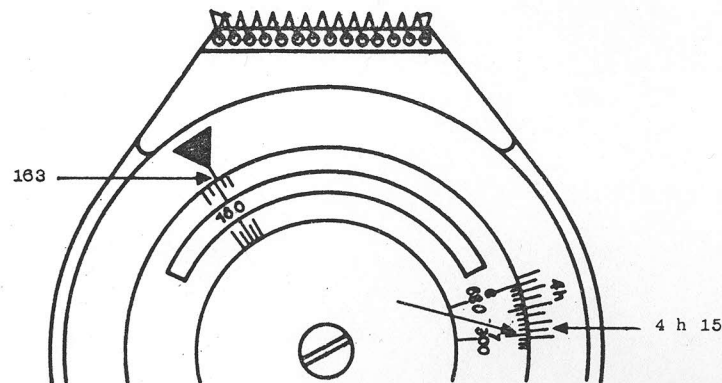


Fig. 3

- b 1. Distance: An aircraft is flying at 280 km/h. How far will it travel in 1 minute?

Answer: Set black arrow-head (1h) opposite 280 on middle ring.
Read off under "1 min" 4,65 km (on middle ring).

- b 2. Distance: An aircraft travelling at a ground speed of 187 mph. continues at this speed for 7 hours 30 minutes. How far will the aircraft have travelled?

Answer: Set (1h) over 187 (on middle ring). Read off 1400 miles on middle ring under the time 7h 30m.

- c. Ground speed: An aircraft is flying from A to B, a distance of 75 n.m. The flying time is 12 minutes. What is the Ground Speed?

Answer: Set the flying time 12 minutes (on outermost ring) opposite 75 (on middle ring). Read off the answer under the black arrow-head on middle ring, namely 375 kts.

- d. Calculation of vertical speed: In 11 minutes a difference in altitude of 2300 m was overcome (ascent or descent).

Required: Vertical Speed in m/sec. or feet/min.

Answer: Set 11 minutes (on rotating outer ring) over 2300 (2300 on fixed middle ring) and read off figure 350, 3,5 m/sec. under the mark "M/SEK" or 690 feet/min. under the mark "FT/MIN".

- e. Calculating time for ascent or descent: It is required to compute the time necessary to overcome a difference in altitude of 1900 m at a vertical speed of 3 metres per sec.

Answer: Set the dotted mark "M/SEK" (movable outer ring) over the figure 300 = 3 m/sec. on fixed middle ring and read off above 1900 (fixed ring) the time of 10 min. 40 sec. (i.e., second third after 10 min.) on outer ring.

Proceed similarly for feet/min.

II. SOLUTION OF WIND - TRIANGLE PROBLEMS.

a. Calculating Wind Angle and Wind Direction:

First Example: Given = True Track = 305°
Wind Direction (..from) = 085°

Required: Wind Angle

Set aeroplane nose (zero mark on wind angle disc) on True Track of 305°. Read off Wind Angle of 120° under Wind - Direction of 085°.

The wind strikes the aircraft from starboard rear. In order to keep the machine to its track, drift correction to starboard (i.e., into the wind) is necessary.

Second Example: Given = True Track = 265°
Wind Angle = 130° left

Required: Wind Direction.

Set aeroplane nose on True Track of 265°; above Wind Angle (inner disc) of 130° to the left, read off Wind Direction of 135° (on outermost scale).

Track and Wind Direction are always read from the outermost scale (fixed disc), Wind Angle from the outer scale of the rotating inner disc (from 0 - 180° left or right).

b. Calculation of Drift Angle and Ground Speed:

Example: Given = Wind Angle = 75°
Wind Speed = 45 km/h
True Air Speed (T.A.S.) = 250 km/h

Required: Drift Angle and Ground Speed.

Set Wind Angle (75°), on innermost disc (graduated in degrees) of the 4-part plate, under 250 km/h. (T.A.S.) on the fixed "speed disc" and read off Drift Angle (angle disc) 10° under Wind Speed of 45 km/h.

Leave these settings!

Subtract Drift Angle from Wind Angle (75° - 10° = 65°) and read off, above 65°, Ground Speed 235 km/h.

At a constant Wind Angle and True Air Speed, the corresponding Drift Angle (with corresponding Ground Speed) can be read off above any desired Wind Speed without rotating the degree disc.

Taking the Example in which the Wind Angle is 75° and the Airspeed is 250 km/h, we get the following readings:

	Drift Angle.	Ground Speed.
Wind Speed 50 km/h.	11°	234 km/h.
" " 60 km/h.	13°	229 km/h.
" " 70 km/h.	16°	223 km/h.
" " 80 km/h.	18°	217 km/h.

Note: If a Wind Angle is less than 15° or greater than 165°, the Ground Speed is ascertained by adding (tail wind) or subtracting (head wind) the Wind Speed.

Examples: True Track = 310°; True Airspeed = 250 km/h.
 Wind from 300° with speed = 35 "
 Ground Speed (head wind) = 215 km/h.

True Track = 310°; True Airspeed = 250 km/h.
 Wind from 140° with speed of = 35 "
 Ground Speed (tail wind) = 285 km/h.

c. Determination of Wind Direction and Wind Speed:

On the Basis of Ground Speed, True Air Speed and Drift Angle, all calculated in flight, the Wind can be computed.

Example: Given Ground Speed 250 km/h (or knots)
 True Air Speed 300 "
 Drift Angle 7° R

To find: Wind Direction and Speed.

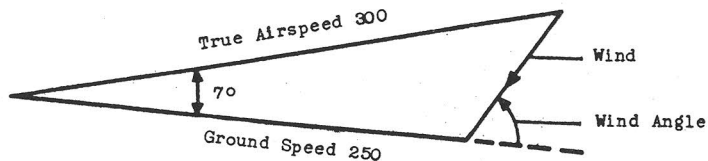


Fig. 4

As shown in the graphical representation of the Wind Triangle above, the Drift Angle lies between the two Speeds, Ground and True Air Speed. Therefore, the third side of the Triangle is the Wind.

Solution: On the instrument, place the known Drift Angle exactly between the two Speeds (Ground Speed = 250, True Air Speed = 300) as follows: Turn the smallest Degree-Angle Disc on the front side of the instrument until (by trial and error) the Angle of "70" fits between the two Speeds, 250 and 300, on the encircling middle ring. This can be done at only one place on the Degree Scale. The disc setting then gives as a result: 30° or 150° under 250 and 37° or 143° under 300. With this setting, the Wind Speed can be read immediately over 70, or 61 km/h.

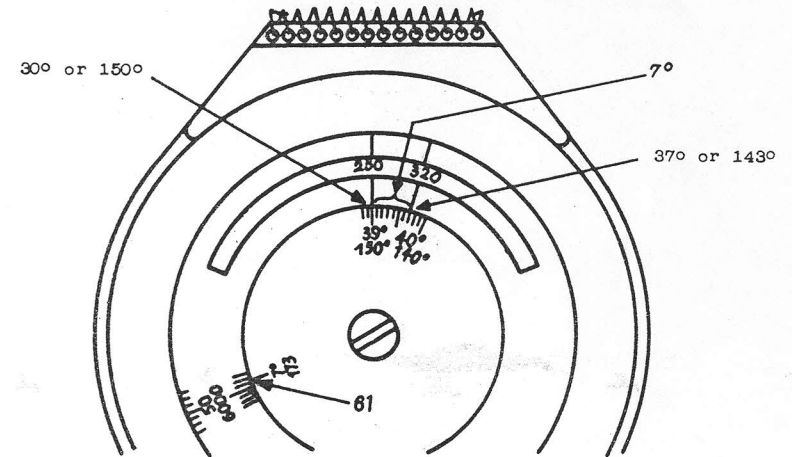


Fig. 5

Wind Angle. If the Ground Speed is less than the True Air Speed (Headwind), the bold-type number (90° or less) must be read off under the True Air Speed as the Wind Angle.

If the Ground Speed is more than the True Air Speed (Tailwind), the number (90° or greater) under the True Air Speed must be taken as the Wind Angle.

For our example: Read the Angle of 37° under 300. On the disc with the airplane, turn the disc so that the plane lies on the True Track for example 320°. Over the Angle of 37° to the left, read the Wind Direction of 283° (Wind from the left). With Wind from the right, read the Wind Direction of 357° over 37° to the right of the airplane.

Second Example: Given Ground Speed 205 m.p.h.
 True Air Speed 187 m.p.h.
 Drift Angle 6° (L or R)

To find: Wind Direction and Speed.

Solution: Place 6° between 205 and 187. Under the True Air Speed 187, read the Wind Angle of 135°. (The Ground Speed is greater, the Wind is a Tailwind, so we take the Angle between 90° and 180°).

Over the Drift Angle of 60, read the Wind Speed of 28 mph.

Turn the instrument. Place the Airplane-Disc on the True Track (3200).

Over "135" to the right, read the Wind Direction of 950, if the Wind is from the right. Wind = 0950/28 mph.

Over "135" to the left, read the Wind Direction of 1850, if the Wind is from the left. Wind = 1850/28 mph.

III. AIRSPEED AND ALTITUDE COMPUTATIONS .

a. Airspeed Computation:

Set the corrected Free Air Temp. in Centigrade, indicated by aircraft thermometer (on movable outermost ring), opposite Flight level Pressure Altitude on left altitude scale "FOR AIRSPEED COMPUT."

Read off True Airspeed (TRUE A.S.) under calibrated Airspeed (CAL.A.S.) on middle ring.

Example: Let the Free Air Temp. be -10°, the Flight level Pressure Altitude 15'000 feet and the Calibrated Airspeed 180 kts.

Required: True Airspeed (T.A.S.)

Set -10° on outermost ring opposite "15" (i.e., 15000 feet). Read off under CAL.A.S. (180 kts.) the True Airspeed 228 kts. on middle ring.

b. Altitude Computation:

Set the corrected Free Air Temperature in Centigrade, indicated by aircraft thermometer (Centigrade for Altitude Comput.) opposite Flight level Pressure Altitude on right Altitude scale "FOR ALTITUDE COMPUT."

Read off Corrected Altitude (COR.ALT.) under Calibrated Altitude (CAL.ALT.) on middle ring.

Example: Let the Free Air Temp. be +10°, the Flight level Pressure Altitude 6000 feet and the CAL.ALT. 5400 ft. Required: Corrected Altitude (COR.ALT.).

Set +10° on outermost ring opposite 6000 feet on right Altitude scale.

Read off under CAL.ALT. 5400 feet the Corrected Altitude (COR.ALT.) of 5500 feet on middle ring.

IV. CONVERSIONS .

a. Conversion between U.S. gallons or imperial gallons and litres:

What are 33 U.S. gallons expressed in litres?

Answer: Set outermost ring with the mark "US.GAL." over 33 (fixed ring) and read off number of litres 125 (on the fixed disc) under the black arrow head.

At the same time read off under the mark "IMP.GAL." 27.5 Imperial gallons, under the mark "KGS" the weight of petrol of 91 kilograms and under the mark "LBS" the weight of petrol of 200 Pounds.

What are 320 litres expressed in imperial gallons and US gallons?

Answer: Set black arrow head "lh" over 320 on fixed ring and read off 70 imperial gallons under the mark "IMP.GAL."

At the same time we get the following readings:

Under the mark "US.GAL." read off 84.5 US. gallons, under the mark "KGS." read off the weight of petrol of 233 kgs.; and under the mark "LBS." read off the weight of petrol of 512 pounds.

b. Conversion between feet or yards and metres:

Proceed as when converting between gallons and litres, using the "FEET" and "YARD" marks.

c. Conversion between statute or nautical miles and kilometres:

Proceed as under IV. a., using the appropriate marks.

Note: The arrow head (lh) always indicates litres, metres, kilometres, whilst US. gallons, imperial gallons, feet, yards, nautical miles, statute miles or knots are read off under the appropriate marks (which are dotted to facilitate reference).

d. Conversion between millibars and inches:

Use the millibar and inch table of the directional disc.

e. Conversion between centigrade and fahrenheit:

Use the centigrade and fahrenheit scale of the directional disc.

V. CALCULATION OF FUEL CONSUMPTION AND RANGE .

After a flight of 80 minutes a fuel consumption of 370 litres is recorded. Total fuel is 2800 litres.

Required: Hourly fuel consumption, maximum duration of flight with remaining fuel supply.

Set 1 hour 20 minutes (80 min.) over figure 370 on fixed middle disc and read off hourly fuel consumption of approximately 277 litres under the black arrow head (1h).

Leave this setting!

Assuming that the fuel tanks holds 2800 litres in all, there remain 2430 litres after 370 litres have been consumed; Above this figure 2430 (on fixed middle ring) read off time of approximately 8 hours 45 minutes on outermost ring, i.e., the remaining fuel supply is sufficient, without allowing for landing operations, which must be regarded as an uncertain factor, for a further flight of 8 h 45 min. (approx.)

VI. READING OFF SINES AND COSINES .

Set "90°" on inner angle disc to "100" on fixed middle ring. The appropriate sine can be read off over the corresponding number of degrees.

Example: Over "1°" we read off the succession of digits
174 = 0.0174, i.e., the sine of 1°.

For	2°	we find	0.0347
	3°	" "	0.052
	11°	" "	0.190
	30°	" "	0.500

For the cosine take the sine of the complimentary angle of 90°.

Example: Cosine 65° corresponds to sine 25°, (90 - 65 = 25)
Set "90°" under "100" and over 25° read off cosine 65° = 0.42.

Cosine 60° corresponds to sine 30°. (90 - 60 = 30)
Set "90°" under "100" and over 30° read off cosine 60° = 0.500.

VII. PRESSURE PATTERN FLIGHT .

Pressure Pattern Flight is used on flights over large stretches of water and at latitudes greater than 15°. By measuring of pressure difference between two points (D₁ and D₂) the wind component perpendicular to the heading and the drift angle DA can be computed. (Fig. 6).

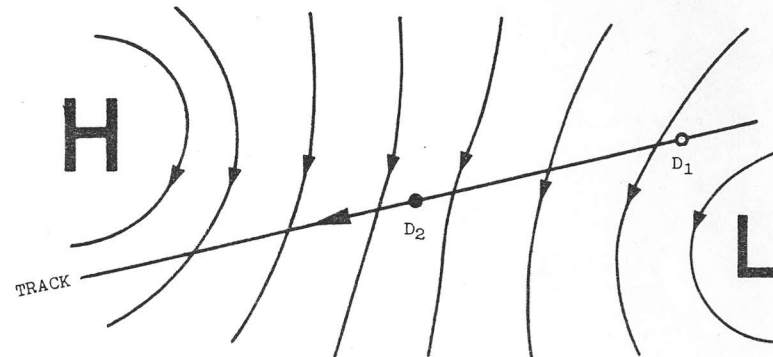


Fig. 6

The formula used for determining the component of the wind perpendicular to the heading of the airplane is:

$$V_n = K \frac{(D_2 - D_1)}{X}$$

V_n = Average wind component in knots perpendicular to the true heading.

D = Difference in feet between the readings of the radio and pressure altimeters, with the pressure altimeter always set at 29.92 inches.

D₂ = Difference at the end of the run.

D₁ = Difference at the beginning of the run.

K = Factor which depends on the latitude.

$$K = \frac{21.47}{\sin \phi} ; \quad \phi = \text{Average Latitude between readings.}$$

X = The air or no-wind distance in nautical miles travelled during the time between the first and second observations, or the true air speed multiplied by the time in hours between readings.

The following instruction must be applied: Fly at constant airspeed, heading and pressure altitude (29,92 inches on pressure altimeter). Read the radio altimeter and pressure altimeter simultaneously at points D_1 and D_2 . Take the difference D in feet. ($D = \text{radio altimeter} - \text{pressure altimeter}$, algebraically). Repeat two or three times. When you are certain of the value of D , record it with the time of observation. Be sure the + or - sign is correct.

Example: Let the air distance X be 120 nautical miles, the difference $(D_2 - D_1) = -180$ feet and the latitude 53° .

Required: V_n , Average wind component perpendicular to heading, and drift angle DA .

Set latitude (LAT.) 53° on inner angle disc opposite the sign V on middle ring. Set X (on movable outer ring) 120 nautical miles opposite K (90°).

Read on fixed middle ring V_n figure 40.5 = 40,5 knots under 180 ($D_2 - D_1$ on outer ring).

Drift Angle DA : Let the estimated ground speed (GS) be 200 knots.

Required: DA .

Set K (90°) on inner angle disc opposite 200 (on fixed middle ring).

Read on inner angle disc the drift angle of 12° under the value of 40 (knots).

Note: In northern Hemisphere:

"When D (radio altimeter minus pressure altimeter) increases algebraically, aircraft drifts to left, when D decreases algebraically, aircraft drifts to right."

In the southern Hemisphere, the above rule is reversed.

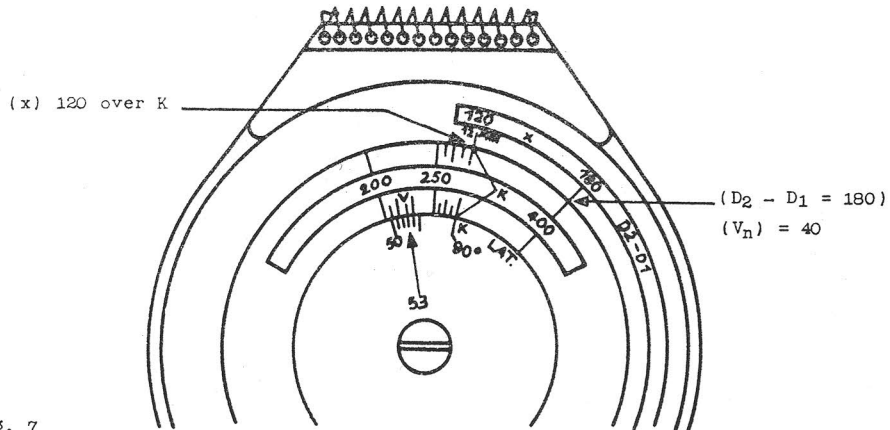


Fig. 7