3-18. Mach Number and True Airspeed Determination.

Given:	Calibrated Pressure Altitude	30,000
	CAS	300 knots
	C_T	0.8
	Indicated Temperature	-20°C
Find:	Mach No. and TAS	

Procedure:

(Figure 10), set altitude (30) opposite CAS (300) (a), set line on cursor to intersection of spiral and -20°C temperature (b). Under the line of the cursor read TAS (467) Mach No. 0.79. Additional information, temperature rise 23°C.

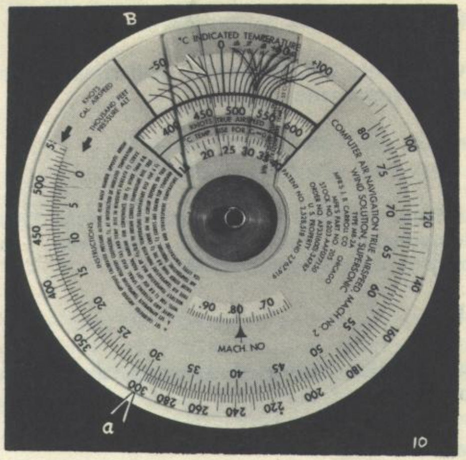

Figure 10

HANDBOOK OF

OPERATING INSTRUCTIONS

FOR

COMPUTER — AIR NAVIGATION
TRUE AIR SPEED, MACH. NO.
WIND COMPONENTS, SUPERSONIC

AIR FORCE TYPE MB-2A

PART NO. 205

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319 N. ALBANY AVENUE
CHICAGO 12, ILLINOIS

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SECTION I

INTRODUCTION

1-1. This handbook contains a description and instructions, with examples, to illustrate the method of using the Computer-Air Navigation, True Airspeed, Supersonic, Type MB-2A.

SECTION II

DESCRIPTION

2-1. GENERAL.

2-2. The Dead Reckoning Computer, Type MB-2A is a 4-1/4" circular device for obtaining the solution of the following type problems: True airspeed, mach number, temperature rise, time and distance, ground speed, fuel consumption, density altitude, relative wind, drift angle, true altitude, pressure pattern, drift and cross wind, standard atmosphere, velocity of sound, interception, radius of action and critical point.

2-3. The computer is designed for use by pilots, navigators, and flight engineers without the need of pencil or straight edge. All data and answers are read directly on the scales of the instrument.

2-4. The computer consists of 3 concentric discs which operate on a circular slide rule principle. It is fabricated from a plastic material with over-all size of 4-1/4". Both sides of the computer are used in the computations. Cursor lines are also provided on both sides for convenience and accuracy of results.

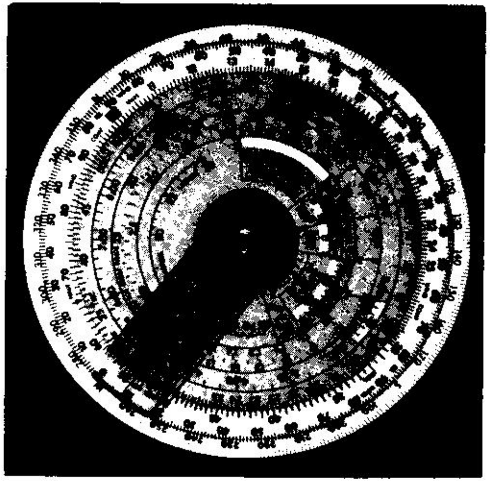


Figure 1

2-5. DETAILED.

2-6. The front face (figure 10) of the instrument is provided with the computer nomenclature, indicated temperature, calibrated airspeed, pressure altitude, true airspeed, mach number, temperature rise, temperature coefficient lines (C_T). Mach number, temperature rise and true airspeed are given by window presentations. The cursor lines on the front side of the computer are drawn for thermometer recovery coefficients of 0.6, 0.7, 0.8, 0.9, and 1.0. The back side (figure 1) of the computer is used for all the other computations referenced in paragraph 2-2 above. The computer is assembled with an eyelet in the center, surrounded by a 5/8" transparent disc, for use with the outer compass rose in course plotting. This side of the computer incorporates several features in addition to those of the Type D-4, E-11, E-6B, AN-5834-1, -1A, -1B, and MB-4. These additional features include:

a. An index mark, "SEC", has been provided at the 36 graduation of the minutes scale for the solution of problems in which the time factor is less than a minute.

b. The "NAUT" and "STAT" index marks have been moved to the minute scale, at 66 and 76 respectively, for a more ready reference in conversion use.

c. An index mark, "NAUT" has been provided at 66 on the miles scale, whereby, with one setting, it is possible to convert a series of statute miles to equivalent nautical miles, and vice versa.

c. A relative rose or "relative wind" scale has been added for use in determining wind relative to the aircraft track.

e. A drift correction scale, accurate to 18 degrees, has been incorporated.

f. Scales for determination of ground speed and drift have been added for used in conjunction with relative wind.

g. Standard Atmospheric Altitude scales and a Mach No. index have been provided for determination of true airspeed.

Examples to illustrate the method of using this computer are given in Section III, OPERATION.

SECTION III

THE BACK SIDE OF THE COMPUTER

3-1. Ground Speed, Time-Distance.

EXAMPLE #1

Given: Distance traveled = 240 nautical miles
Elapsed = 1 hr 20 min

Find: Ground speed

Procedure:

Set 1 hr 20 min (1:20) on "hours" scale opposite 240 nautical miles (24) on the "miles" scale. Opposite the large speed index at 60 on the "minutes" scale, read the ground speed on the "miles" scale.

Answer: 180 knots

EXAMPLE #2

Given: Ground Speed = 180 knots
Distance to Travel = 210 nautical miles

Find: Time required to fly this distance

Procedure:

Set "speed index" to 180 knots (18) on the "miles" scale. Opposite 210 (21) on the "miles" scale, read 70 (7) on the "minutes" scale, or 1 hr 10 min (1:10) on the "hours" scale.

Answer: 1 hour 10 minutes

EXAMPLE #3

Given: Ground Speed = 180 knots
Time of Flight = 45 min

Find: Distance Traveled

Procedure:

Set the "speed index" to 180 knots (18) on the "miles" scale. Opposite the "minutes" scale read the distance traveled on the "miles" scale.

Answer: 135 nautical miles

3-2. Conversion of minutes to hours and vice versa.

This conversion is read directly from the computer without setting.

EXAMPLE:

Opposite 70 minutes read 1:10
" 150 " (15) " 2:30
" 300 " (30) " 5:00
" 550 " (55) " 9:10

3-3. Conversion of nautical miles to statute miles. This conversion uses the "NAUT", "STAT"indices on the minutes scale.

EXAMPLE:

Given: Distance, 220 nautical miles.

Find: Equivalent statute miles

Procedure:

(Figure 2) Set 220 (22) (a) nautical miles opposite the "NAUT" index. Opposite the "STAT" indices read statute miles.

Answer: 253. 5 statute miles.

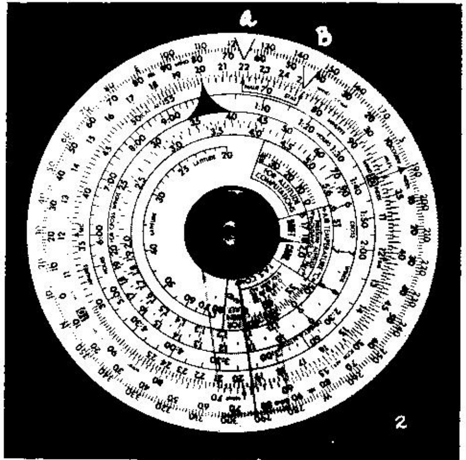


Figure 2

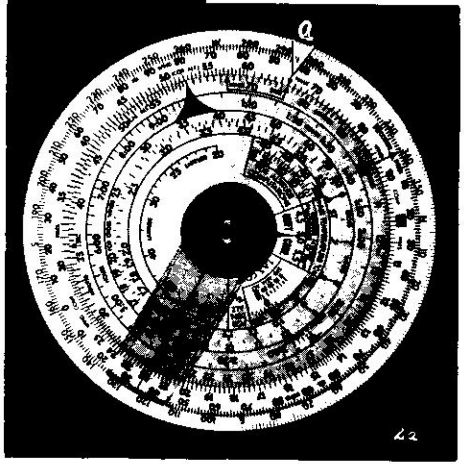


Figure 2A

A convenience is incorporated in the computer whereby any series of nautical miles may be converted to statute miles and vice versa, with one setting of the computer.

Procedure:

(Figure 2a) Set the "NAUT" (a) index on the miles scale opposite the "STAT" index on the minutes scale. Any series of nautical miles, as read on the miles scale, is now opposite its appropriate statute miles equivalent on the minutes scale and vice versa.

3-4. Fuel Consumption Computation.

These problems use the miles and minutes scales together with the speed index on the minutes scale, referred to in these solutions as the rate index.

EXAMPLE #1

Given:	Fuel consumed	=	175 gal
	Elapsed time	=	2 hours 04 minutes
Find:	Rate of consumption		

Procedure:

(Figure 3) Opposite 175 gal (b) on the "miles" scale set 2 hours 04 minutes (124 minutes) on the "minutes" scale. Opposite the "rate index" (a) read the rate of fuel consumption on the "miles" scales.

Answer: 84.7 gallons per hour

NOTE

In the above, and other cases, in which the setting of time in excess of one hour is involved, the use of the divisions on both the hours and minutes scales facilitate the more accurate setting of the rotating disc.

EXAMPLE #2

Given: Fuel remaining = 220 gallons
Rate of consumption = 84.7 gal/hr

Find: Remaining flight time

Procedure:

(Figure 3) Set "rate index" (a) to fuel consumption rate 84.7 gal per hour on the "miles" scale. Opposite fuel remaining on "miles" scale (220) (c) read remaining flight time on "minutes" scale.

Answer: 156 minutes or 2 hours, 36 minutes

3-5. Determination of True Altitude.

If the data is available, the pressure altitude used in altitude computations should be corrected for instrument and installation errors before use.

EXAMPLE:

Given: Air temperature aloft = -10°C
Indicated altitude = 18,500 feet (altimeter reading with indices set for true sea level pressure)
Pressure altitude = 20,000 feet (reading of instrument with the barometric scale set to standard sea level conditions, 29.92)

Find: True Altitude (altitude above sea level)

Procedure:

(Figure 4) Set pressure altitude, 20,000 feet (20) (a) opposite true free air temperature aloft, -10°C, which appears in the Air Temperature window. Opposite indicated altitude (b) (altimeter reading) on "minutes" scale, read true altitude on "miles" scale.

Answer: 19,600 feet, true altitude.

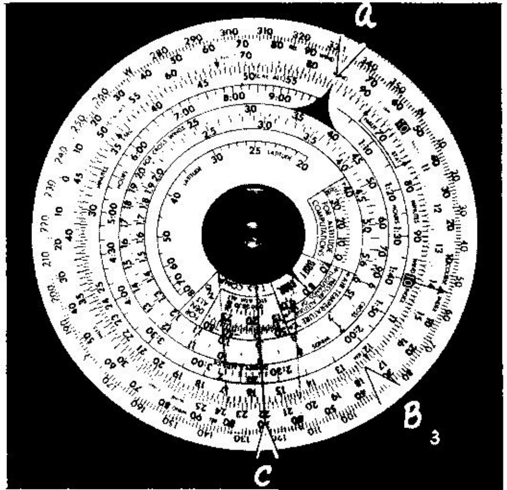


Figure 3

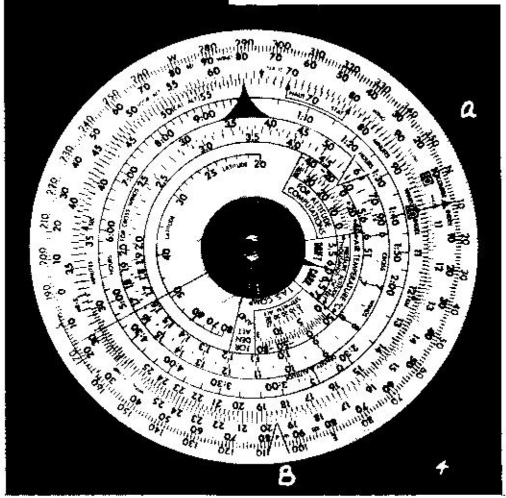


Figure 4

NOTE

For pressure altitudes above 35,000 feet, use the 35 to 80 pressure altitude graduation. If the true sea level pressure (altimeter setting) is not known, pressure altitude may be used throughout, but the altitude found will be different from the true altitude by the difference in feet between the altitudes corresponding to the correct altimeter setting and standard sea level conditions. If the ground level pressure altitude and temperature are also known, a more accurate method of correction is to set the mean pressure altitude opposite the mean temperature.

3-6. Determination of Density Altitude.

EXAMPLE:

Given: Air temperature aloft = -19°C
Pressure altitude = 5000 feet (reading of instrument with the barometric scale set to standard sea level conditions 29.92)

Find: Density altitude

Procedure:

Set true free air temperature aloft (-19°C) opposite pressure altitude (5000 ft), which appears in the pressure altitude window. Read the density altitude opposite the arrow in the density altitude window.

Answer: 2000 feet

Remarks: Note that two separate sets of scales are used to compute true altitude and density altitude.

3-7. True Airspeed Using Mach Number Index and True Free Air Temperature or Standard Atmospheric Altitude.

NOTE

The "mach number index" appears to the right of the pressure altitude scale in the pressure altitude window.

EXAMPLE #1

Given: True free air temperature = -50°C
Mach No. = 0.80

Find: True airspeed

Procedure:

(Figure 6) Set true free air temperature (-50°C) opposite the "mach number index" (a) in the pressure altitude window. Opposite mach number (b) on the "minutes" scale, read true airspeed in knots on the "miles" scale.

Answer: 465.3 knots true airspeed

EXAMPLE #2

Given: Standard Atmospheric Altitude = 40,000 feet
Mach number = 0.80

Find: True airspeed

Procedure:

Set the "mach number index" opposite standard atmospheric altitude (35 to 80 graduation). Read true airspeed in knots on the "miles" scale opposite mach number on the "minutes" scale.

Answer: 464 knots true airspeed

NOTE: This computation is used primarily in pre-flight planning work.

3-8. Special Instructions for Obtaining True Airspeed in Aircraft which have a Mach Meter but no Air Temperature Indicator.

For this computation it is necessary to use the scales in the altitude computation window to obtain free air temperature. The remainder of the TAS computation is similar to that explained above.

EXAMPLE:

Given: Mach number = 1.0
Pressure altitude = 30,000 feet
Ground temperature = +15°C
Pressure altitude at ground level = 500 feet

Find: True airspeed

Procedure:

(Figure 7) Set 500 feet pressure altitude opposite +15°C in the "altitude computation" temperature window (a). Read free air temperature at altitude opposite 30,000 feet pressure altitude (b).

Answer: -44°C

Procedure continued:

(Figure 7a) Set mach number index arrow opposite -44°C (a). Opposite mach number one (10) on the "minutes" scale read true airspeed (knots) on the "miles" scale (b).

Answer: 590 knots true airspeed

NOTE

The compressibility factor is automatically compensated in the mach meter. For any one setting of the mach number index opposite free air temperature, speed (in knots) may be determined and vice versa.

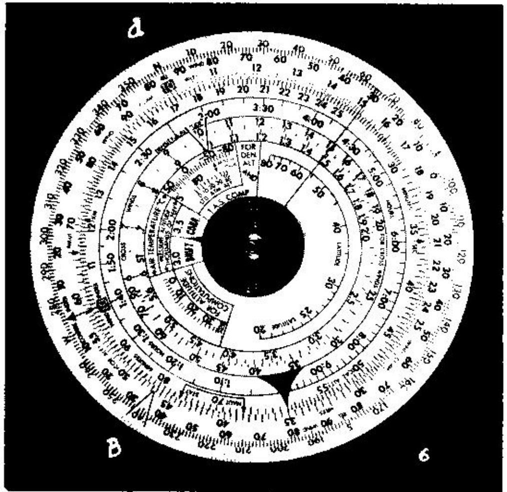


Figure 6

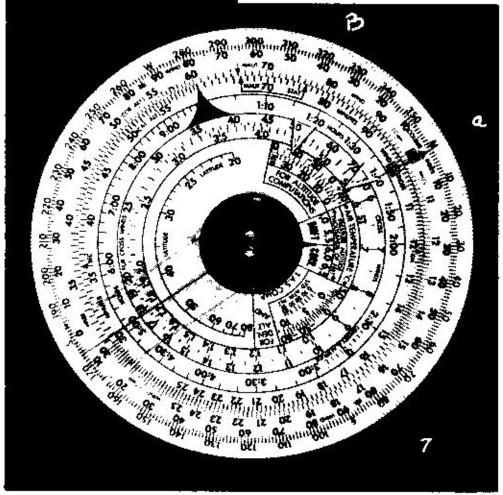


Figure 7

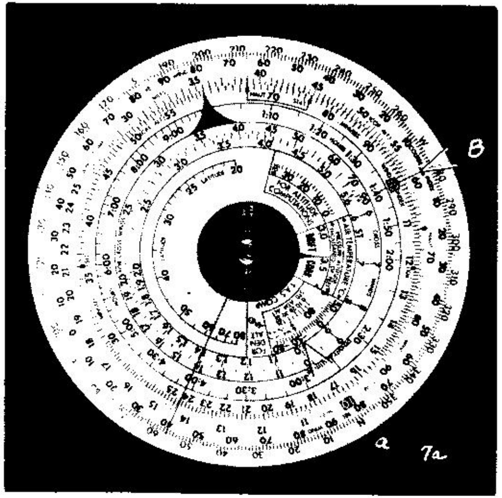


Figure 7A

3-9. Pressure Patterns by the D_2-D_1 Method

To determine the cross wind component, it is necessary to know the pressure altitudes and the absolute altitudes, obtained simultaneously from a pressure sensitive and a radio altimeter respectively, at two different times. Two separate sets of readings are required. The time interval between altitude readings should be at least 30 minutes, preferably longer. The approximate latitude of the aircraft must be known.

To obtain data, fly at a constant airspeed, heading, and pressure altitude (barometric scale set to 29.92).

a. Read the radio altimeter and pressure altimeter simultaneously, take the difference, "D".

D = radio altimeter minus pressure altimeter.

b. Repeat 2 or 3 times. When the correct D value is assured, record it with the time of observation. The correct + or - sign is essential.

c. Repeat the above operations at 1/2 hour interval, or greater.

D_1 is the D value in feet for the first set of data
D_2 is the D value in feet for the second set of data
V_n is the average wind component in knots, perpendicular to the heading
X is the air distance traveled between observations

EXAMPLE:

Given: (1) Time, 1620
Position, 47°30'N, 50°00'W
TAS, 190 knots
Absolute altitude, 8450 feet
Pressure altitude (29.92), 8400 feet

(2) Time, 1650
Position, 46°25'N, 48°35'W
TAS, 190 knots
Absolute altitude, 8510 feet
Pressure altitude (29.92), 8550 feet

Find: Crosswind component force, V_n.

Procedure: Using the first set of values, obtain D_1.

(Figure 8) D_1 = 8450 -8400 = +50 feet. Using second set of values, obtain D_2. D_2 = 8510 -8550 = -40 feet. Multiply TAS by time between two sets of readings to determine air distance traveled. X = 190 x 0:30 = 95 nautical miles. Determine the D_2-D_1 value as -40-(+50) = -90 feet. Set the D_2-D_1 value (90) on the "miles" scale opposite air distance traveled (95) on the "minutes" scale (a). Align the cursor with the aircraft's mid-latitude (47°N) (b) on the latitude scale and read the cross wind component force (c) under the cursor on the "miles" scale.

Answer: V_n = 28 knots (approximately)

(NOTE: To find an accurate drift angle, the ground speed must be known.)

EXAMPLE:

Given: Continuing previous problem, the ground speed between the two sets of data is 214 knots.

Find: Drift angle and direction

Solution:

(Figure 8a) Set the cross wind component (28 knots) on the "miles" scale opposite the ground speed (214 knots) on the "minutes" scale (a). Read the drift angle in the drift correction window (b).

Answer: 7-1/2 degrees

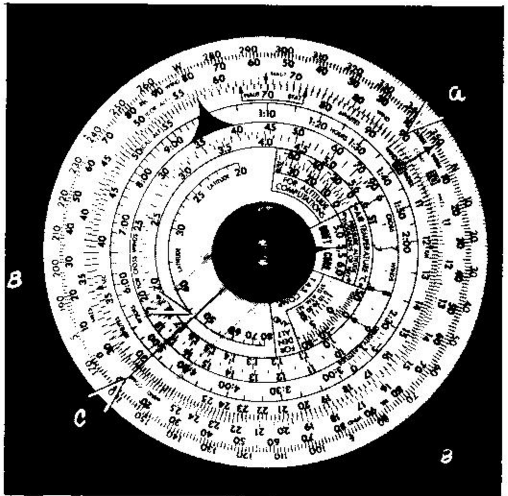


Figure 8

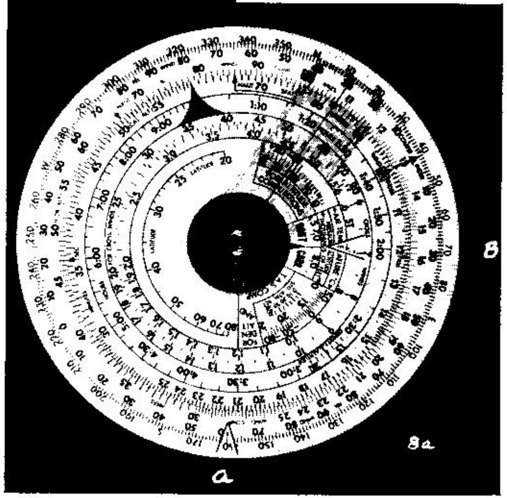


Figure 8A

NOTE

An approximation to the correct drift angle may be obtained by using TAS when GS is not available. Since $D_2 - D_1$ is negative (-), the drift is right in the northern hemisphere. The following rule need be remembered to determine left or right drift.

a. When $D_2 - D_1$ increases algebraically, aircraft drifts to the left. In the southern hemisphere the above rules are reversed.

NOTE

If the flight level pressure difference is not available and the flight level is less than 15,000 feet, the barometric pressure difference on the ground (in inches) may be multiplied by 1000 to get an equivalent pressure difference in feet. This value is generally accurate for all practical purposes.

3-10. Determination of the Relative Wind Angle

The outside compass rose (stationary) scale and the relative wind rose on the rotatable disc are used for this problem.

EXAMPLE #1

Given: Course to be made good, 40°
Wind direction, 160°

Find: Relative wind angle

Procedure:

Set the "course index" to the desired course (40°) on the "compass rose". Opposite the wind direction angle (160°) on the "compass rose", read the relative wind angle on the "relative wind" scale.

Answer: 60°

NOTE

A visual presentation of the wind is given on the computer by considering the course index to be the nose of the airplane. Thus the wind is from the rear and right.

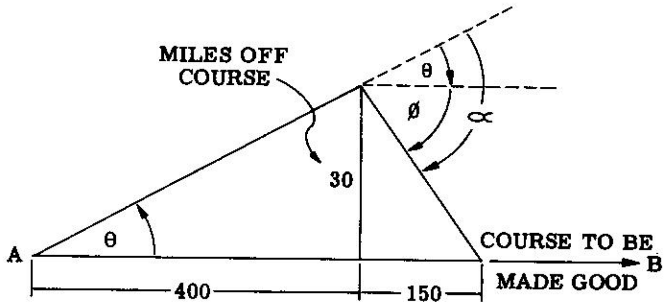
3-11. Off Course Corrections.

Given: On certain flights, the following information is determined:

Course distance traveled = 400 nautical miles
Distance off course = 30 miles

Find: Correction angle to parallel desired course and correction angle to intercept desired course in 150 additional course miles.

NOTE: In this solution the "course miles flown" and the "course miles to be flown" are used.



Procedure:

Set the miles off course (30) on the "miles" scale opposite the course miles flown (400) on the "minutes" scale. Read the angle to parallel (θ) in the drift correction window.

Answer: 4.3° approximately

Set the miles off course (30) on the "miles" scale opposite the course miles to be flown to reach intended course at the desired point (150) on the "minutes" scale. Read the additional angle (Ø) to correct the return to desired course in the drift window.

Answer: 11.3° approximately

The total angle (α) to correct to return to the desired course at the time the off-course leg is determined is the sum of the two correction angles found above.

$$\alpha = \theta + \emptyset = 4.3° + 11.3° = 15.6° \text{ approximately}$$

CROSS WINDS

This problem is essentially the previous type solutions performed in reverse order.

Given: Course to be made good = 80°
True Airspeed = 450 knots
Wind Correction Angle = 7° right

Find: Cross wind component

Procedure:

Set wind correction angle (7°) in the drift correction window. Opposite the true airspeed (450 knots) on the "minutes" scale, read cross wind component on "miles" scale.

Answer: 55.2 knots

WIND SOLUTION INSTRUCTIONS

1. Determine relative wind angle as defined in par #3-10.

2. Place cursor over TAS on "miles" scale.

3. Rotate center disc until relative wind angle is read under cursor on "wind" scale.

4. Opposite wind velocity on "miles" scale, read drift angle on "wind scale". It may be convenient to use cursor for this determination.

5. Re-align cursor with TAS on miles scale. If the relative wind angle indicates a tail wind component the drift angle is added to the pre-set relative wind angle to determine ground speed and vice versa for a head wind component. This is accomplished by holding the concentric disc in place and moving the cursor index so as to read the sum (for tail wind) or difference (for head wind) of the relative wind and drift angles.

6. Read ground speed on "miles" scale under cursor.

NOTE

If sum of relative wind and drift angles exceed 90°, subtract the total angle in excess of 90°, from 90° and read appropriate ground speed at final cursor setting. For example: If drift angle = 9° and relative wind angle = 85 degrees, total angle = 94°. Therefore ground speed is read with final cursor setting at 90°-4° = 86°,

WIND PROBLEM

Given: TAS = 500
Intended Track (TC) = 050°
Wind D/V = 070°/160 knots
Find - Relative Wind
Drift Correction
True Heading
Ground Speed

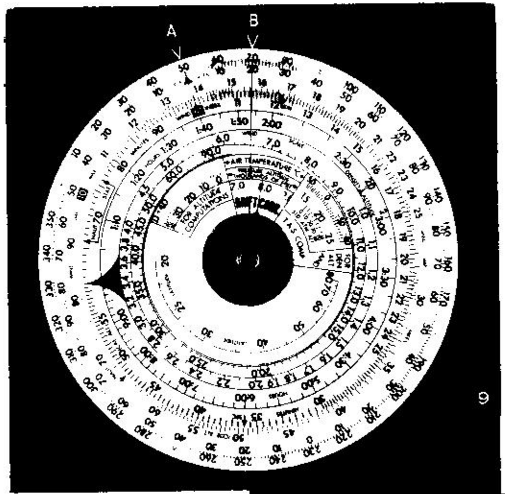
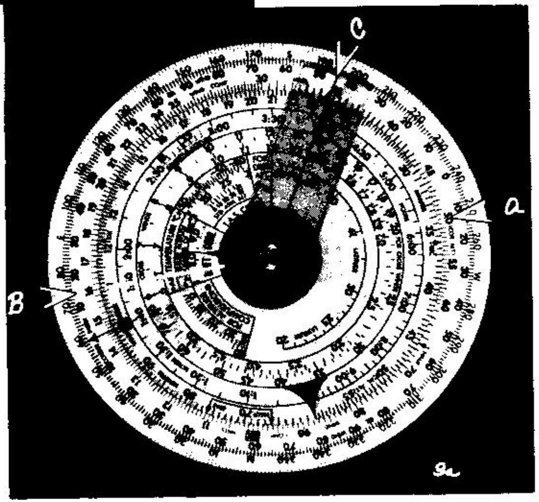


Figure 9

Figure 9A



Procedure:

a. Set "course index" of relative rose to TC(50°) on compass rose. (a) (fig 9).

b. Opposite wind direction (70°) on compass rose, read relative wind angle on compass rose (20°) (b) (fig 9). Note that the wind will provide a head wind component and left drift angle.

c. Pre-set cursor to TAS (500) on miles scale.

d. Rotate inner disc to align relative wind angle (20°) on "wind scale", with the pre-set cursor (a) (fig 9a).

e. Opposite wind velocity (160) on "miles" scale, read drift angle (6.3°) on "wind scale" (b) (fig 9a).

f. Because wind has head wind component, the 6.3° must be subtracted from relative wind angle for ground speed solution. 20°-6.3° = 13.7°. Holding center disc stationary, move cursor CCW by amount of drift angle (6.3°) or to 13.7° on wind scale. (c) (fig 9a).

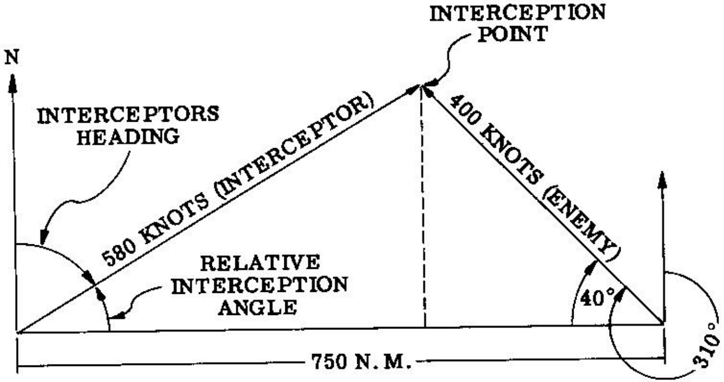
g. Read ground speed (347 knots) on miles scale. (c) (fig 9a).

h. Since drift is left, correction is right, or added to the true course of 50°. 50°+6.7° = 56.7° true heading.

3-12. The Interception Problem.

Given: An enemy is determined to be 750 nautical miles due east of an interceptor. Its heading is 310° and ground speed is 400 knots. The interceptor can make 580 knots.

Find: The course of the interceptor to make contact with enemy and elapsed time before interception.



Procedure:

The answers are obtained by solving the two simple triangles above. The angle of the enemy, relative to the interceptor, is determined to be 40° and the relative heading of the interceptor is somewhere in the north easterly direction. By determining the common leg of the two triangles, the interception angle is easily found. A ratio of the sum of the two base legs, to the original distance between the two aircraft, will give the time to intercept.

Set "wind index" to enemy's speed (400 knots) on "miles" scale. Align cursor with the enemy's relative angle (40°) on the "wind" scale. Read the common leg of the triangles (257 nautical miles approximately) under the cursor on the "miles" scale. Move cursor to 50° (90-40) on the "winds" scale and read the base leg of enemy's triangle as 307 miles under cursor on "miles" scale. Realign "wind index" to interceptor's speed (580 knots) on the "miles" scale. Set cursor to the value of the common leg of the triangles (257) on the "miles" scale and read interceptor's relative angle (26.4°) on the "winds" scale. Realign cursor to 63.5 (90-26.4) on the "winds" scale and read the base leg of the interception triangle as 520 nautical miles under the cursor on the "miles" scale. The interceptor's heading is now determined by subtracting 26.4° from north.

Answer: 63.6°

The time to intercept is determined by the relative closing speed of the two aircraft. Adding the two base legs 520 + 307 827 knots relative speed. Set the "time index" to 827 knots on the "miles" scale and read the elapsed time to intercept on the "minutes" scale opposite the initial separation distance (750 nautical miles) on the "miles" scale.

Answer: 54.5 minutes

NOTE: This problem is based on a no-wind assumption. Allowances for wind must be made to the interceptor's heading, assuming the ground speed and track of the enemy are known.

3-13. Pressure Pattern.

Single Heading Flight

Flight from Kelly AFB, Texas, to WPAFB, Ohio
Measure distance--958 NM
Note track desired (TC)--049.5°
Note mid latitude--approximately 34°
Obtain from wx forecaster the pressure difference at flight altitude forecasted for Kelly at TO and for WP at (ETA) (TO + 2 + 30)
Flight altitude--18000'

Kelly pressure difference-- +200'
WP pressure difference--- +800'
Since difference at destination is algebracially greater, aircraft will drift left. ((+800)-(+200)) = +600

Set the value 600 on "miles" scale opposite distance 958 on minutes scale. Align cursor with the mid latitude, 34 on latitude scale and read net crosswind displacement (24) under the cursor on the "miles" scale. If pilot was to fly "no wind" heading, he would be 24 miles NW of WP at end of ETA.)

Set net crosswind displacement (24NM) on "miles" scale opposite distance (958) on "minutes" scale. Read drift angle (1.5°) in drift correction window.

Single heading would be 051 degrees true.

3-14. Conversion of Minutes of Longitude to Miles at Various Latitudes.

At the equator, one minute of longitude is approximately equal to one nautical mile, which is equal to 1 minute of latitude. At any other latitude, one minute of longitude is somewhat less than 1 nautical mile. The conversion of longitude to nautical miles may be performed as follows:

EXAMPLE:

Find the length of 1 minute of longitude at 38° latitude.

Procedure:

Align the cursor with the Co latitude of 38° ((90° - 38°) = 52°) on the winds scale.

Read the nautical miles under the cursor on the minutes scale.

Answer: 0.787 nautical miles

The length of any flight can now be determined between any two given values of longitude at 38° latitude.

Given: 10°E longitude to 30°W longitude, at 38° latitude

Find: Distance in nautical miles

40° longitude x 60 = 2400' longitude
2400 x 0.787 = 1890 nautical miles
(approximately)

To multiply, set the "wind index" to 0.787 on the "miles" scale. Opposite 2400 on the "minutes" scale read the answer (1890) on the "miles" scale.

NOTE: Division is the reverse of this process. Set the numberator on the "miles" scale opposite the denominator on the "minutes" scale. Read the quotient opposite the wind index on the "miles" scale.

3-15. Determination of Standard Temperature at Various Altitudes.

EXAMPLE:

Determine the standard temperature at 30,000 feet pressure altitude.

Procedure:

Set 30,000 in the "density altitude" window. Opposite 30,000 feet pressure altitude in the "for density altitude computations" window read the standard temperature on the corresponding temperature scale.

Answer: -44.5° (approximately)

3-16. Radius of Action.

Solve for GS as noted in wind problem. This can be accomplished in two steps:

$$t = \frac{\text{GS in}}{\text{GS out} + \text{GS in}} \times \text{endurance}$$

where t is time to turn.

EXAMPLE: Track 50° w/v 70°/160

TAS 500 knots endurance 2 + 20 (2.33) hours

$$t = \frac{647}{347 + 647} \times 2.33$$

t = 1.51 hours (note: if endurance is in minutes, then t will be in minutes)

This side of the computer is applicable for airspeed indicators operated by the pitot-static pressure difference and indicating the true airspeed when flying in sea level standard atmosphere. Computations are based on 1 knot = 6080.20 ft/hr and pressure altitude is in accordance with the 1952 WADC model atmosphere.

The air is treated as a perfect gas, with $\propto$ 1.40 and R= 96.03 ft/°K, and for these values the computations are exact.

Notice that on the cursor, the thermometer recovery coefficients (C_T) are plotted for values of C_T = 0.6, 0.7, 0.8, 0.9, and 1.0, at the standard sea level temperature of +15°C and the standard stratosphere temperature of -55°C. Note, also, that the characteristic of the plot for C_T = 0.8 is a straight line. Since C_T = 0.8 is the most common recovery coefficient in use by the Air Force, the extra straight line was plotted on the cursor for convenience. Since only the two values mentioned above are plotted for C_T other than 0.8 an interpolation between the sea level and stratosphere coefficients is required when flying at altitudes below 35,000 feet and at other than sea level. A linear interpolation will suffice for this procedure. For example, when flying at 20,000 feet with a C_T of 0.9, the 0.9 C_T curves must be interpolated as $(\frac{20{,}000}{35{,}000})$ or 4/7 of the space between the sea level and stratosphere plots must be used for the correct C_T curve. Notice that the darker of the C_T curves is always the standard stratosphere curve (35,000 ft approximately).

3-17. Use of the TAS, Mach Number, and Temperature Rise Scales.

EXAMPLE:

Given: Calibrated airspeed = 300 knots
Calibrated pressure altitude = 60,000 feet
Indicated temperature = +30° Centigrade
Temperature recovery coefficient (C_T) = a. 0.8
b. 1.0

Find: Mach number for a and b
True airspeed for a and b
Temperature rise for a and b
True free air temperature for a and b

Procedure:

Align the calibrated pressure altitude (60,000 ft) on the movable scale with the calibrated air speed (300 knots) on the stationary scale. Read the mach number directly opposite the arrow in the mach number window.

Answer: 1.427 for both cases a and b

To determine true airspeed and temperature rise of a; without resetting computer, align temperature recovery coefficient, $C_T = 0.8$ with the reference spiral and indicated temperature (+30°C). Read the true airspeed under the cursor line in the "true airspeed" window.

Answer: a, 840.0 knots TAS

The temperature rise is now available directly beneath the cursor line in the "temperature rise window for $C_T = 0.8$".

Answer: a, 74.4° Centigrade

To determine the true airspeed and temperature rise of b; by setting the cursor only; align the temperature recovery coefficient ($C_T = 1.0$ of the standard stratosphere curve) with the indicated temperature and the reference spiral. Read the true airspeed in the "true airspeed" window beneath the cursor line.

Answer: b, 815.3 knots TAS

Without any resetting, read the temperature rise in the temperature rise window at 70.1°C. Since the scale visible in the "temperature" window is plotted for $C_T = 0.8$ only, the temperature rise, as read under the cursor line (70.1°C), must be corrected for the $C_T = 1.0$ thermometer. This is easily accomplished by the following simple formula, and the "miles" and "minutes" scales on the reverse side of the computer

$$\text{Correct temperature rise} = \text{observed temperature rise} \times \frac{C_T}{0.80}$$

Answer: $\text{Correct temperature rise} = 70.1 \times \frac{1.0}{0.8} = 87.6°C$

NOTE: Multiplication and division problems have been discussed previously.

To obtain the true free air temperature of a and b,

True free air temperature = indicated temperature - temperature rise.

Answer: a, +30-74.4 = -44.4°C
b, +30-87.6 = -57.6°C

This problem explains the general use of the TAS, mach number and temperature rise scales. However, reciprocal approaches may be used when desired.

EXAMPLE:

What must be the calibrated airspeed, at sea level, to fly the speed of sound.

Procedure:

Set the mach number index to 1.0 opposite 0 feet pressure altitude, read 661 knots CAS.

3-18. Mach Number and True Airspeed Determination.

Given:	Calibrated Pressure Altitude	30,000
	CAS	300 knots
	C_T	0.8
	Indicated Temperature	-20°C

Find: Mach No. and TAS

Procedure:

(Figure 10), set altitude (30) opposite CAS (300) (a), set line on cursor to intersection of spiral and -20°C temperature (b). Under the line of the cursor read TAS (467) Mach No. 0.79. Additional information, temperature rise 23°C.

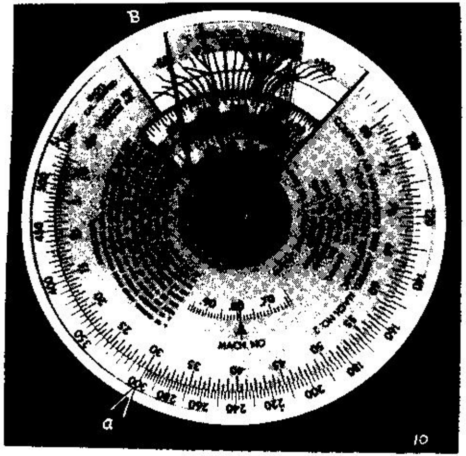


Figure 10

HANDBOOK OF

OPERATING INSTRUCTIONS

FOR

COMPUTER — AIR NAVIGATION
TRUE AIR SPEED, MACH. NO.
WIND COMPONENTS, SUPERSONIC

AIR FORCE TYPE MB-2A

PART NO. 205

J. B. CARROLL COMPANY
319 N. ALBANY AVENUE
CHICAGO 12, ILLINOIS

INDIVIDUAL ACTION

AIR BURST OF ATOMIC BOMB

Sioux City Air Base, Iowa

BEFORE BURST

If Red Alert is sounded, TAKE PRESCRIBED ACTION. The best defense against "A" bomb is the same as against HE bombs.

DURING AND AFTER BURST

	1. Take cover, unless under other attack, and stay for 10 seconds after explosion or until heavy debris has stopped falling.	Underground shelters, basements, and slit trenches give good protection. Lie close to wall out of line from possible flying debris. Keep head covered and avoid exposure of bare skin. Never stand in open. Fall flat if no protection is available.
IF AT DUTY STATION	2. RESUME DUTIES IF ABLE	The war won't be over. Get back to work and be ready for instruction (usually from your OIC or NCOIC). Do your part to help launch aircraft and recover them.
IF NOT AT DUTY STATION	3. HELP OTHERS	Thousands of lives can be saved by prompt first aid. Help save lives by helping others. By the time the debris has stopped falling, there is no radiation hazard.
	4. REPORT TO DUTY STATION	Organization is necessary to reduce the effects of the bomb. Report to receive treatment if necessary, and to work to help overall situation.
	5. DON'T PANIC AND DON'T SPREAD RUMORS	Rushing aimlessly about will hinder rescue and damage control. Keep your experience to yourself and don't enlarge on what you hear from others. Do your assigned duty.

REMEMBER — THE LARGE CASUALTIES IN JAPAN RESULTED FROM FAILURE TO PROVIDE AIR RAID WARNING AND FROM LACK OF ORGANIZATION. MOST OF THESE PEOPLE WOULD HAVE BEEN SAVED IF THEY HAD BEEN IN SHELTERS.

EFFECTS

AIR BURST* OF ATOMIC BOMB

BLAST	SUDDEN SHOCK	Shock pressure from burst not enough to kill. Flying debris causes almost all injuries.
HEAT	1. "FLASH" HEAT (first few seconds)	Burns on exposed skin occur out to 2 miles. Light-colored clothes or any shielding substance afford protection. Keep your shirt on.
	2. FIRES	Flash heat starts forest and brush fires. Many fires started by stoves, short-circuits, etc. Broken power lines start electrical fires. (Fight these fires in normal manner.) Your basement is an excellent shelter.
NUCLEAR RADIATION	1. "FLASH" RADIATION	50% of radiation occurs in the first second; 80% in first 10 seconds, all in first 90 seconds. Fall or dive fast, to place as much material as possible between you and blast. In most cases if you are not wounded or burned, you need not worry about radiation. Your basement is an excellent shelter.
	2. LINGERING RADIATION (From deposited bomb material)	So small it is not a hazard. Disregard it.

* BOMBS WILL PROBABLY BE EXPLODED HIGH IN THE AIR. SURFACE OR SUB-SURFACE BURSTS MAY REDUCE BLAST AND HEAT EFFECTS AND INCREASE LINGERING RADIATION. (THIS IS SERIOUS BUT CAN BE HANDLED BY PROPER CARE. AN AIR BURST WOULD MOST LIKELY BE THE TYPE OF NUCLEAR BURST YOU WOULD BE SUBJECTED TO.