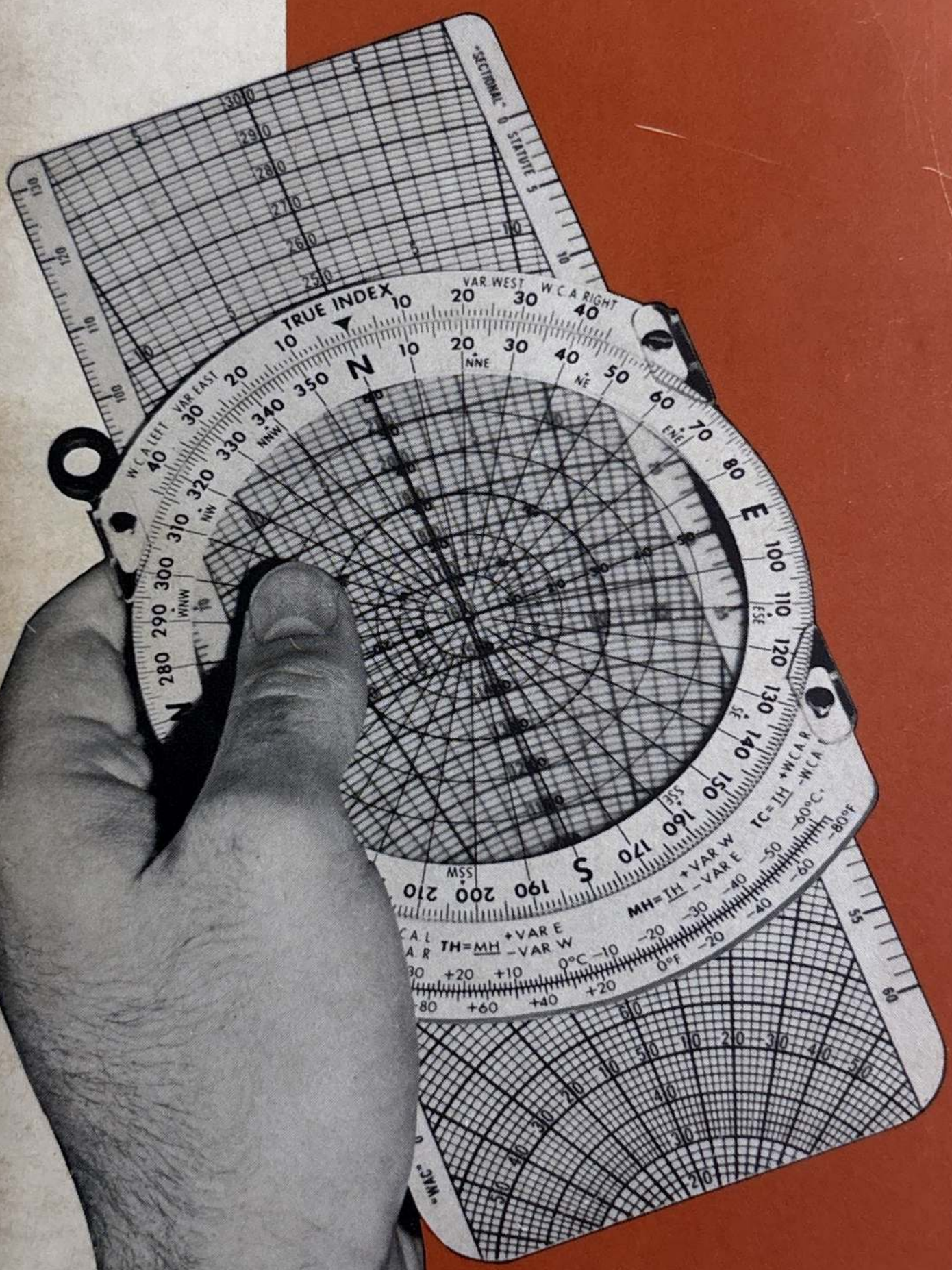
How to use your NEW....

Jeppesen®

E6B

Wind-Easy

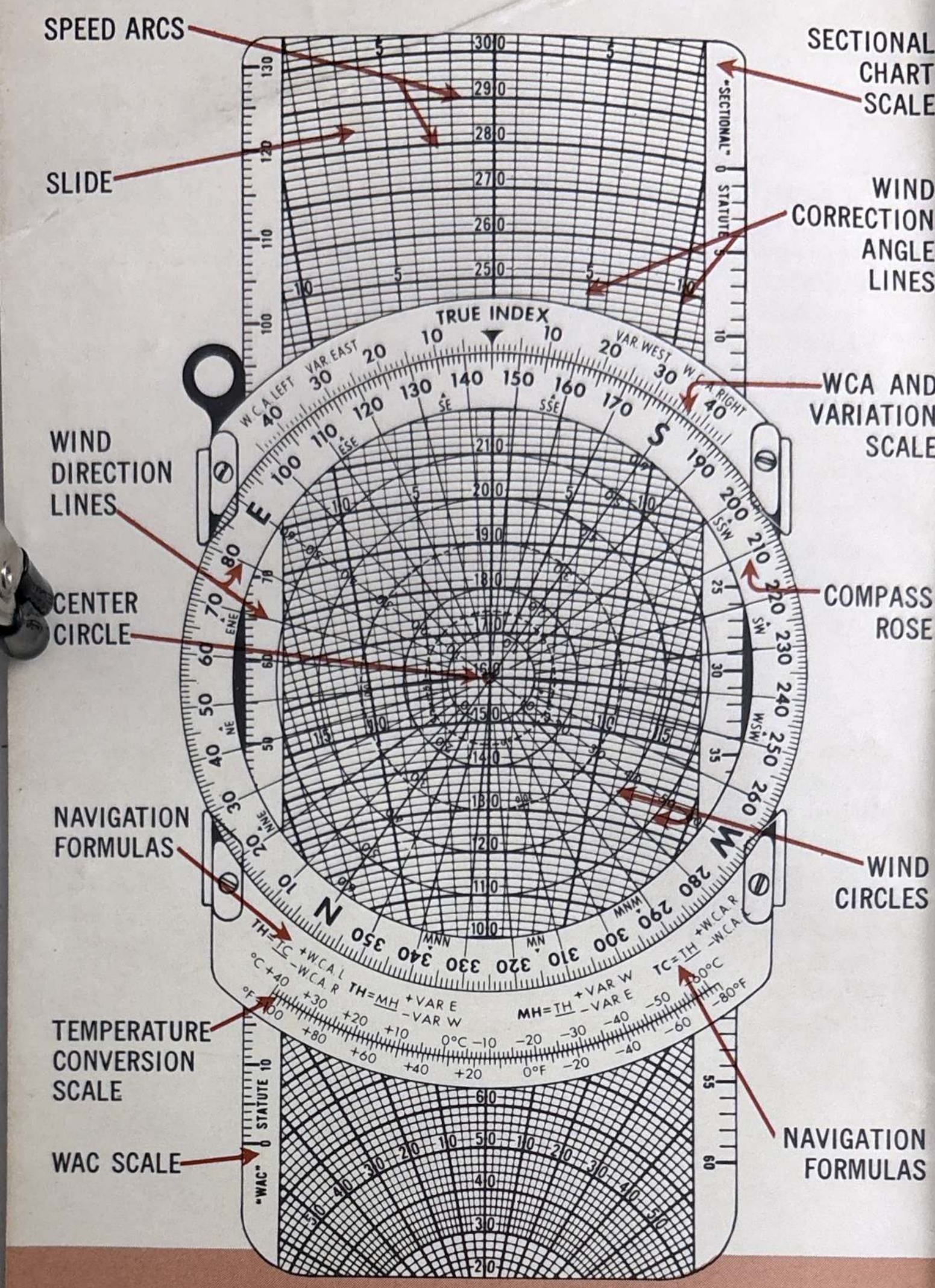
COMPUTER



BE-1

another top quality product

from Jeppesen & co.



The best features of all previous SLIDE COMPUTERS Combined into one

1. You set the compass rose only once
2. Your wind "dot" is pre-plotted—accurately
3. No protruding parts to break
4. Slide "doubles" as a plotter
5. Available in plastic or all aluminum

©1966 Jeppesen & Co.
All Rights Reserved
Published Simultaneously in Germany

TABLE OF CONTENTS

PART A--CALCULATOR SIDE

Time – Speed – Distance. 2
  Simple Proportion 3
  Fuel Consumption. 6
Conversions 7
Altitude. 10
  Density Altitude 11
  True Altitude 12
True Air Speed 13
  Mach Number. 15
  True Air Speed Computation at Higher Speeds 18
Slide Rule Use 20
Time and Distance to Station 22
Drift and Off – Course Correction 24

PART B--WIND SIDE

Wind Solution on the E6B 27
Flight Planning with Forecast Winds 35
True Heading & Ground Speed 36
True Heading and True Air Speed 38
True Course (Track) & Ground Speed 41
Finding Winds in Flight. 45
Hints on the use of the Wind Side 48
Additional Uses of the Jeppesen E6B 3 – Way Slide . . . 50

PART C--ANSWERS, DEFINITIONS AND TIPS

Answers to Practice Problems 51
Definitions 53
Tips on Care & Use of the E6B 56

Jeppesen & Co.
8025 East 40th Avenue
Denver, Colorado 80207

Jeppesen & Co., G.m.b.H.
Frankfurt Am Main
Kaiserstrasse 77
Germany

Part A

CALCULATOR SIDE



TIME | SPEED | DISTANCE

Time, speed and distance problems are solved with the E6B Computer in the conventional manner. . .using the outside scales on the calculator side. For the benefit of those 'knot so inclined,' the E6B is 'knot knecessarily knautical' and you can get perfectly good answers in MPH and statute.

First a word about reading the scales on the E6B. Each figure on the outer scales of the computer can stand for any number containing the given digits. The point marked '40' can stand for .4, 4, 40, 400, etc. You must determine, from the given problem, which value is correct.

SIMPLE PROPORTION

The slide rule face of the E6B computer is so constructed that any relationship between two numbers, one on the stationary scale and one on the movable scale, will hold true for all other numbers on the two scales. If the two *10's* are placed opposite each other, all other numbers will be identical around the whole circle. If 20 on the inner scale is placed opposite *10* on the outer scale, all numbers on the inner scale will be double those on the outer scale. If 12 on the outer scale is placed opposite 16 on the inner scale, all numbers will be in a three-to-four relationship. (See Fig. 1, below.) This feature of the slide rule permits you to supply the fourth term of any mathematical problem in proportion. The simplest and most useful application of the feature of the computer is in the solution of time-speed-distance problems.

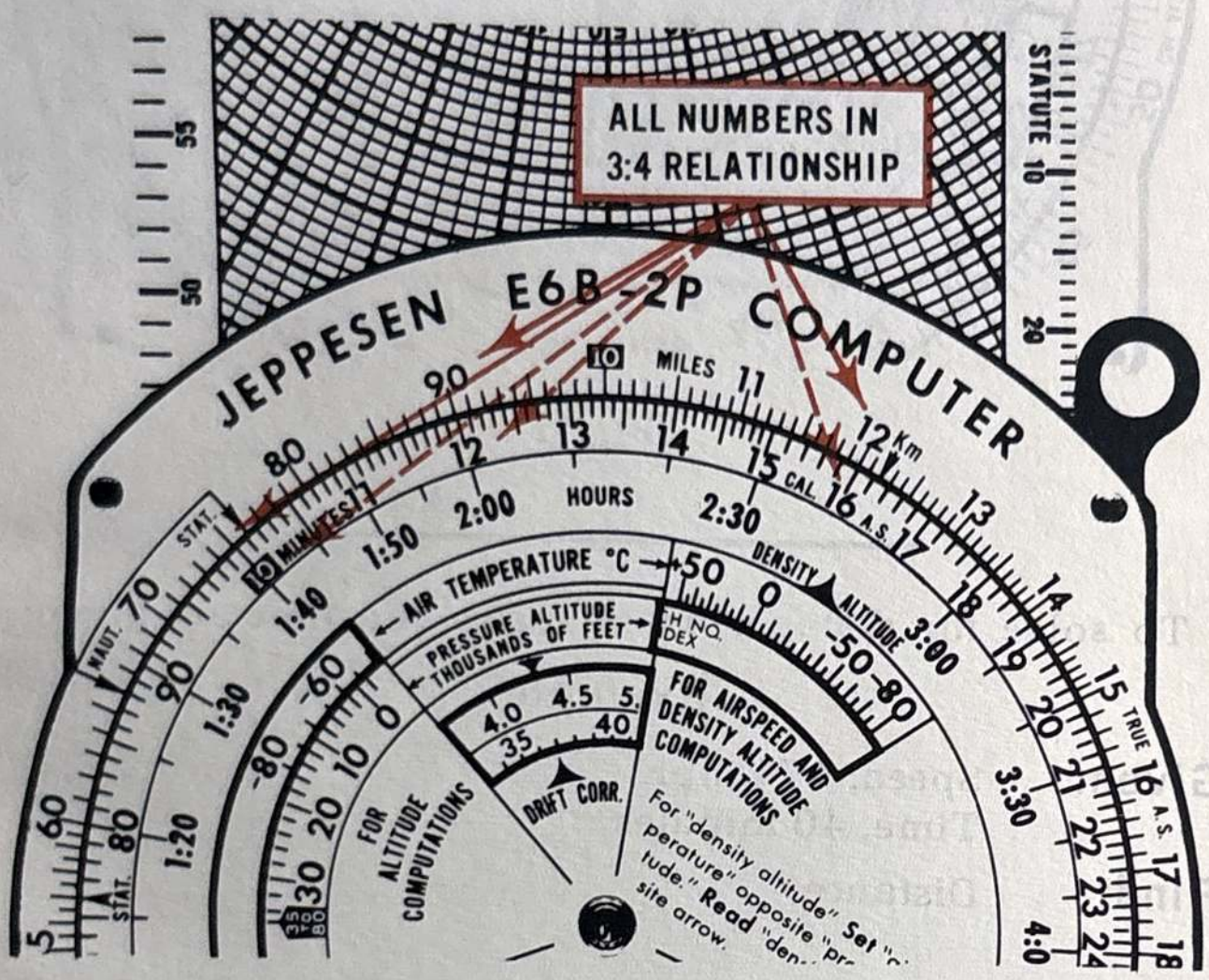


Fig. 1

TIME, SPEED, AND DISTANCE

A plane has traveled 24 miles in 8 minutes. How many minutes will be required to travel 150 miles? The answer is the missing number in a simple proportion:

$$24:8::150:\ ?\ \text{or}\ \frac{24}{8} = \frac{150}{?}$$

In the latter form, the proportion may be set on the computer exactly as it appears in Fig. 2, with 24 on the outer MILES scale opposite 8 on the inner MINUTES scale;

one then reads the number opposite 150 miles, and finds it to be 50 minutes. This is the basis of all time-speed-distance computations on the computer. In most of these problems the arrowhead "speed index" is used for setting or reading the rate. In addition to the minutes scale, an inner HOURS scale is used for reading times in excess of one hour.

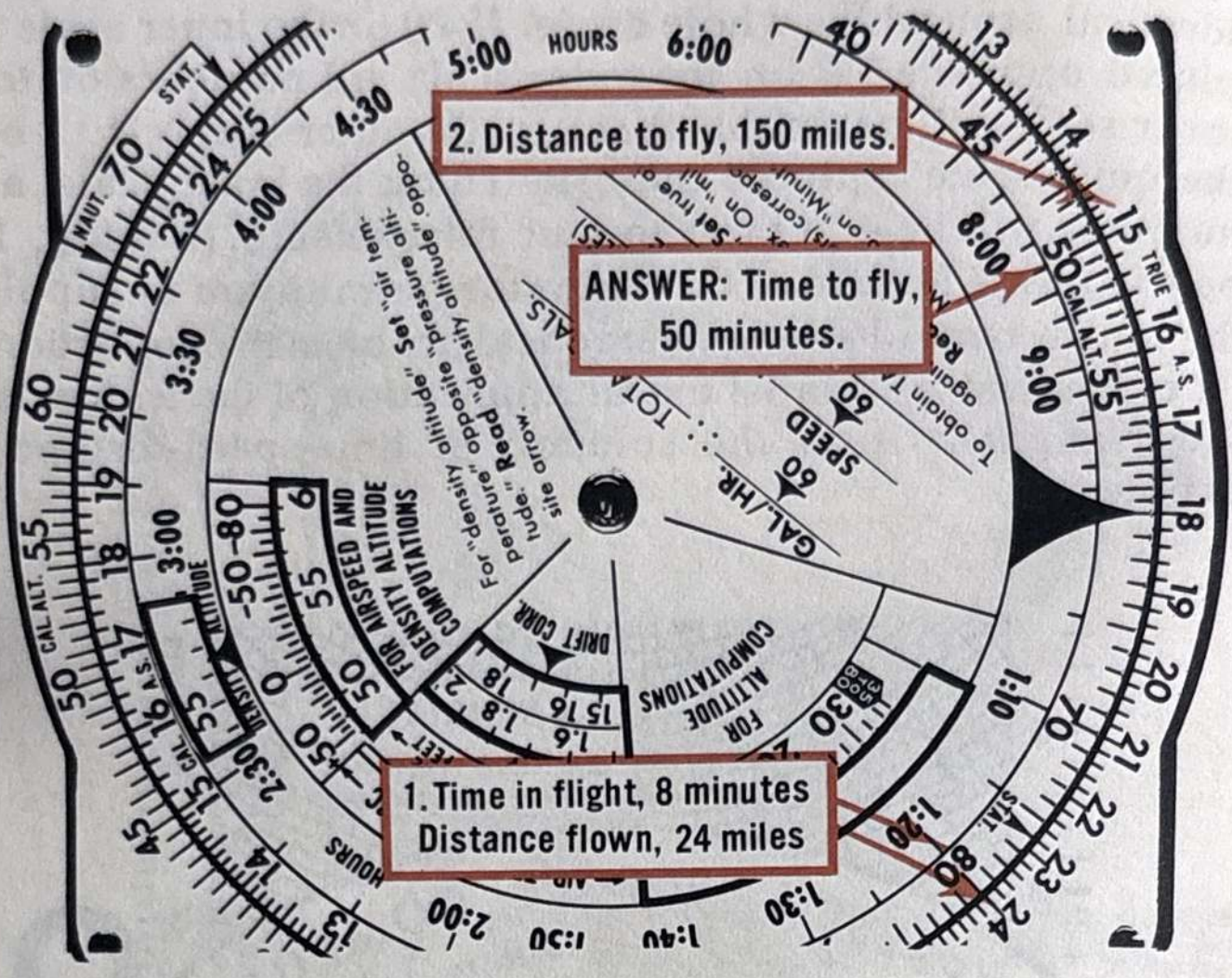


Fig. 2

To solve for distance when speed and time are given:

Example

Given: Speed, 174 mph
Time, 40 minutes

Find: Distance

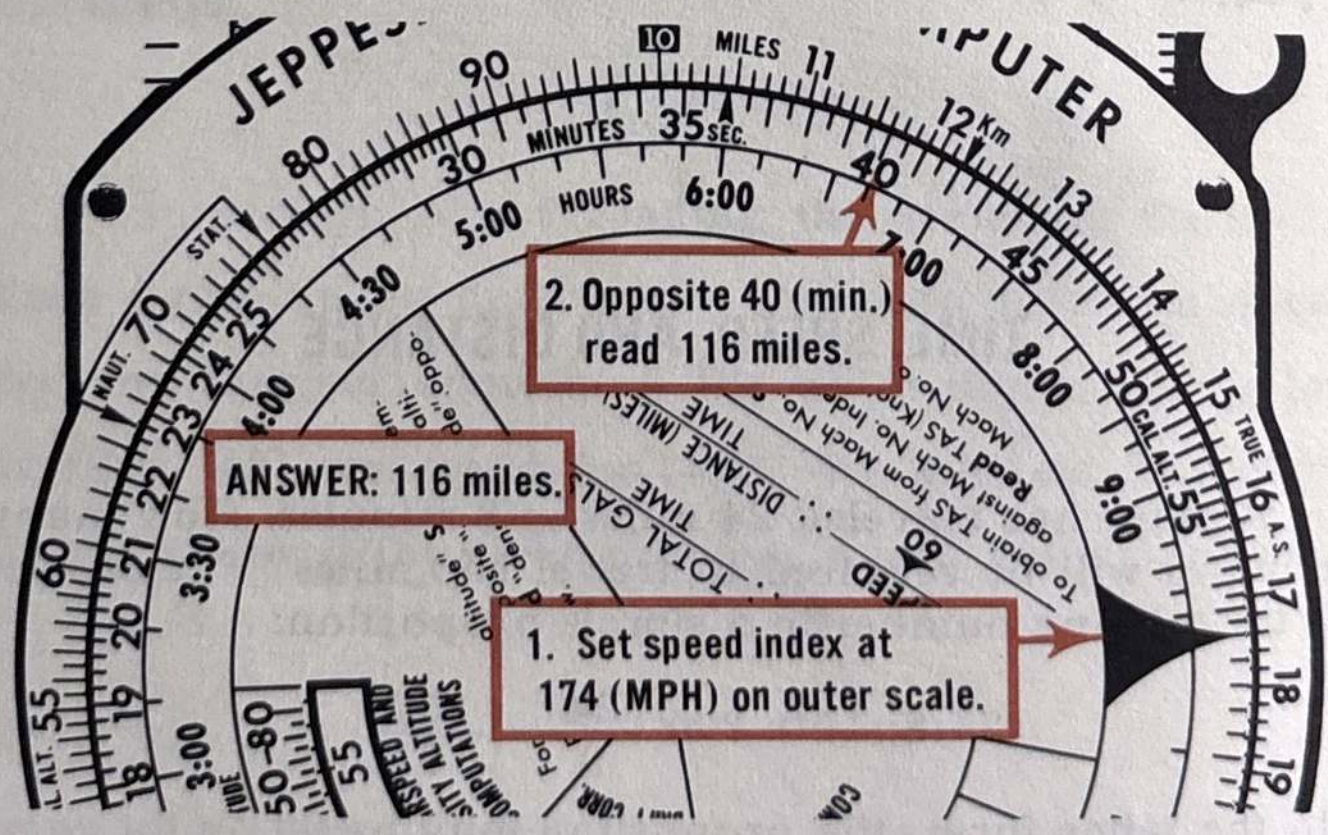


Fig. 3

To solve for time when speed and distance are known:

Example

Given: Speed, 113 knots
Distance, 180 nm (nautical miles)

Find: Time

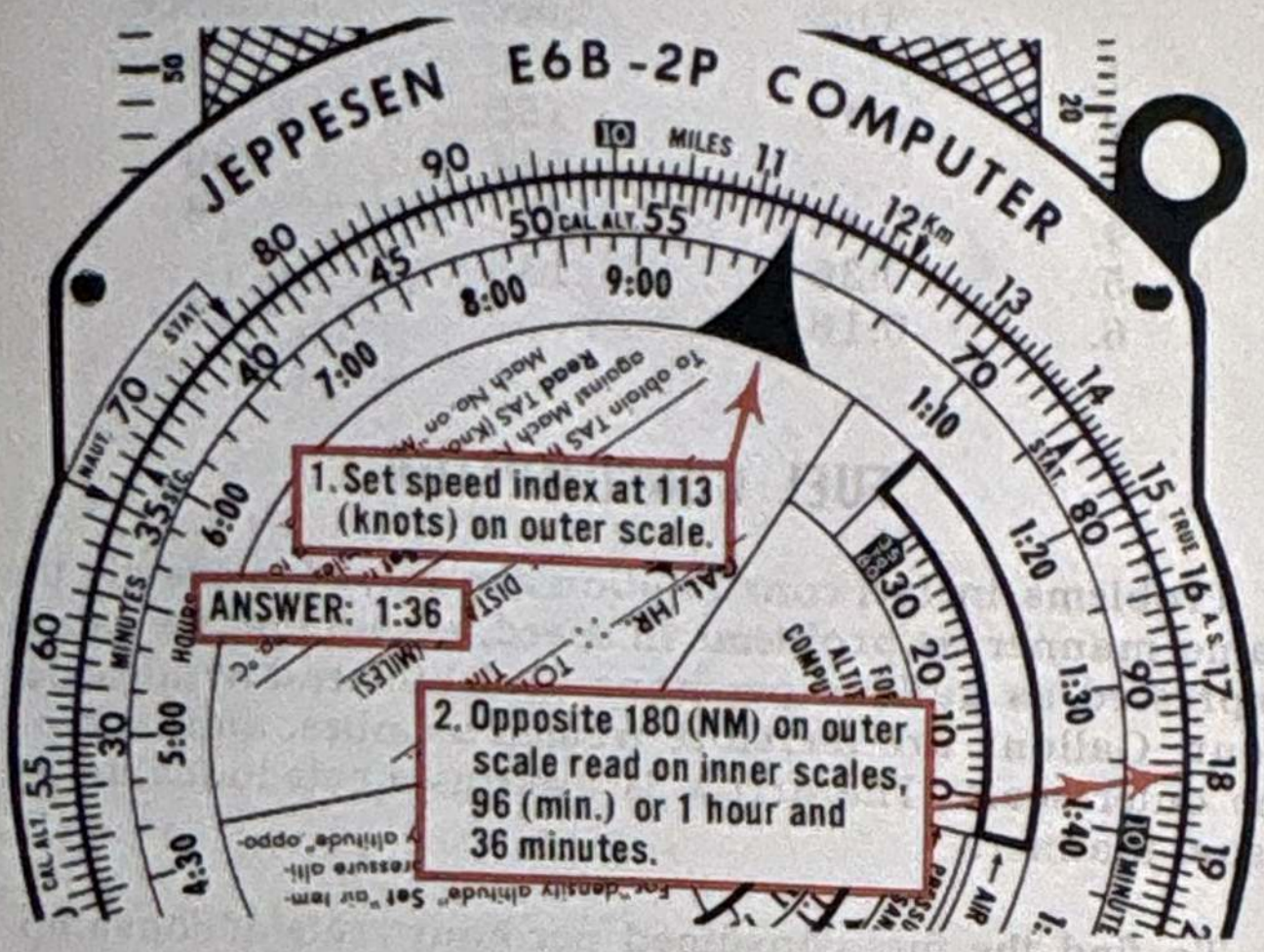


Fig. 4

To solve for speed when time and distance are known:

Example

Given: Distance, 266 miles
Time, 1:25

Find: Speed

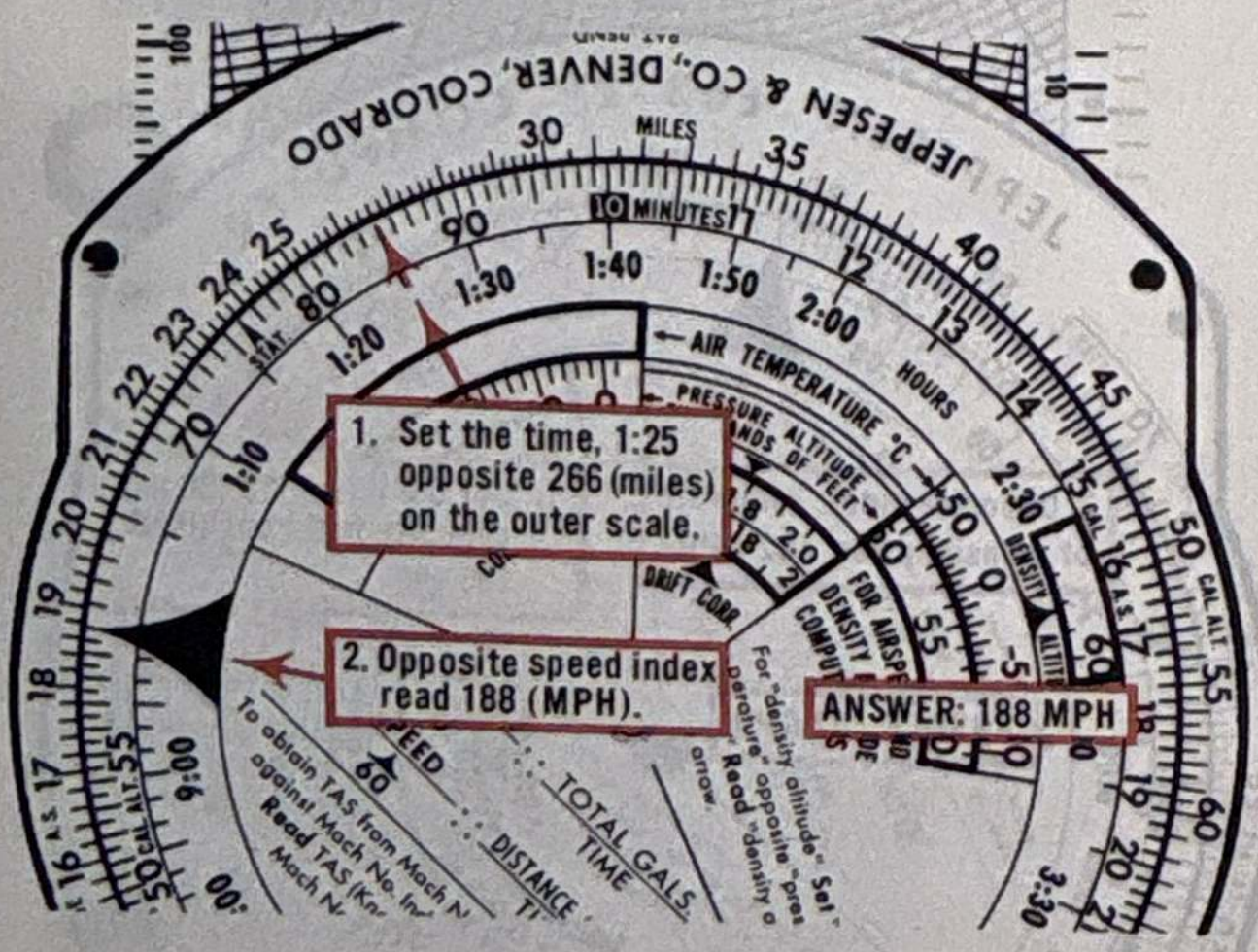


Fig. 5

PROBLEMS 1

Find the missing quantities; check your answers against the answers in Part C.

	Time	Ground Speed	Distance
1.	....	145	128
2.	1:17	150	....
3.	....	164	196
4.	0:33	....	78
5.	0:36	139	....
6.	0:18	....	47

FUEL CONSUMPTION

Problems in fuel consumption are solved in exactly the same manner as problems in speed, except that the rate is expressed as gallons per hour (gph) instead of miles per hour. Gallons are therefore treated as miles, and read on the outer scale. The arrow is used as a rate index, in the usual manner.

To find the fuel consumed per hour (rate of consumption) when the total fuel consumed and the flying time are known:

Example

Given: Fuel consumed, 135 gals.
Time in flight, 1:28

Find: Rate of fuel consumption

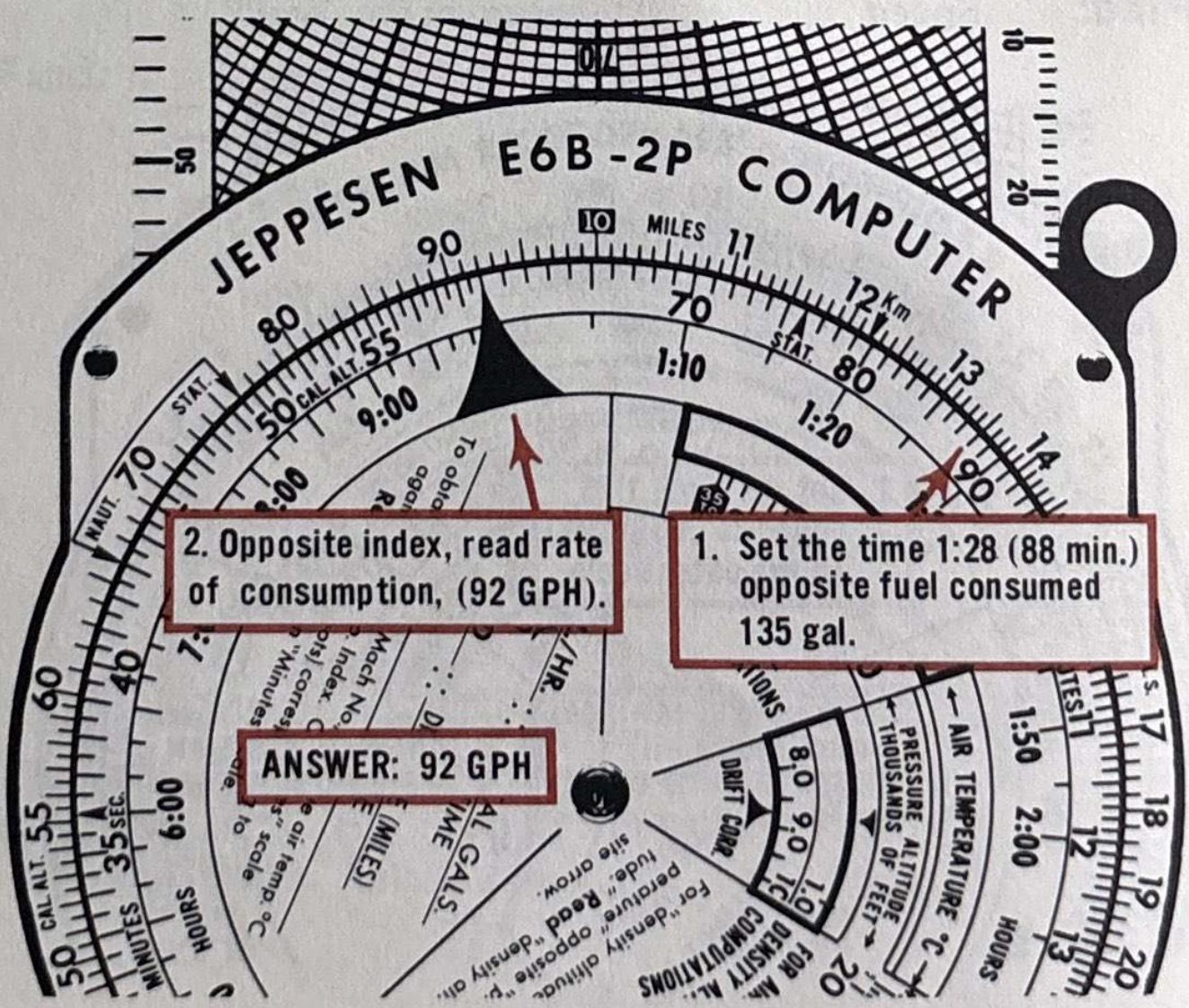


Fig. 6



CONVERSIONS

"Things aren't always what you want them to be –
But the E6B will help change them."
For instance, if you want to change:

Statute miles to nautical miles
Statute miles to kilometers
Minutes to seconds
Fahrenheit to centigrade

Or vice versa –

Here's how:

Note the following labeled arrows on the inside and outside scales of the calculator side of the computer: (Refer to Fig. 7)

NAUTICAL miles	near 66 on outer scale
STATUTE miles	near 76 on outer scale
KM. (kilometers)	near 12 on outer scale
SECONDS	at 36 on inside scale

STATUTE TO NAUTICAL TO KILOMETERS

The arithmetical factor for converting nautical miles to statute miles is 1.15; for converting statute miles to nautical miles, .87. It will be found that 76 (the STAT. mark) divided by 66 (the NAUT. mark) gives 1.15, and that 66 divided by 76 gives .87. In the same way, the conversion factor for statute miles to kilometers is .62, and 76 (the STAT. mark) divided by 122 (the Km. mark) gives the same conversion factor. The conversion on the computer is thus the familiar simple proportion:

$$\frac{66}{\text{Nautical miles}} = \frac{76}{\text{Statute miles}}$$

To convert statute miles to nautical miles:

Example

Given: 136 miles

Find: Number of nautical miles
Number of kilometers

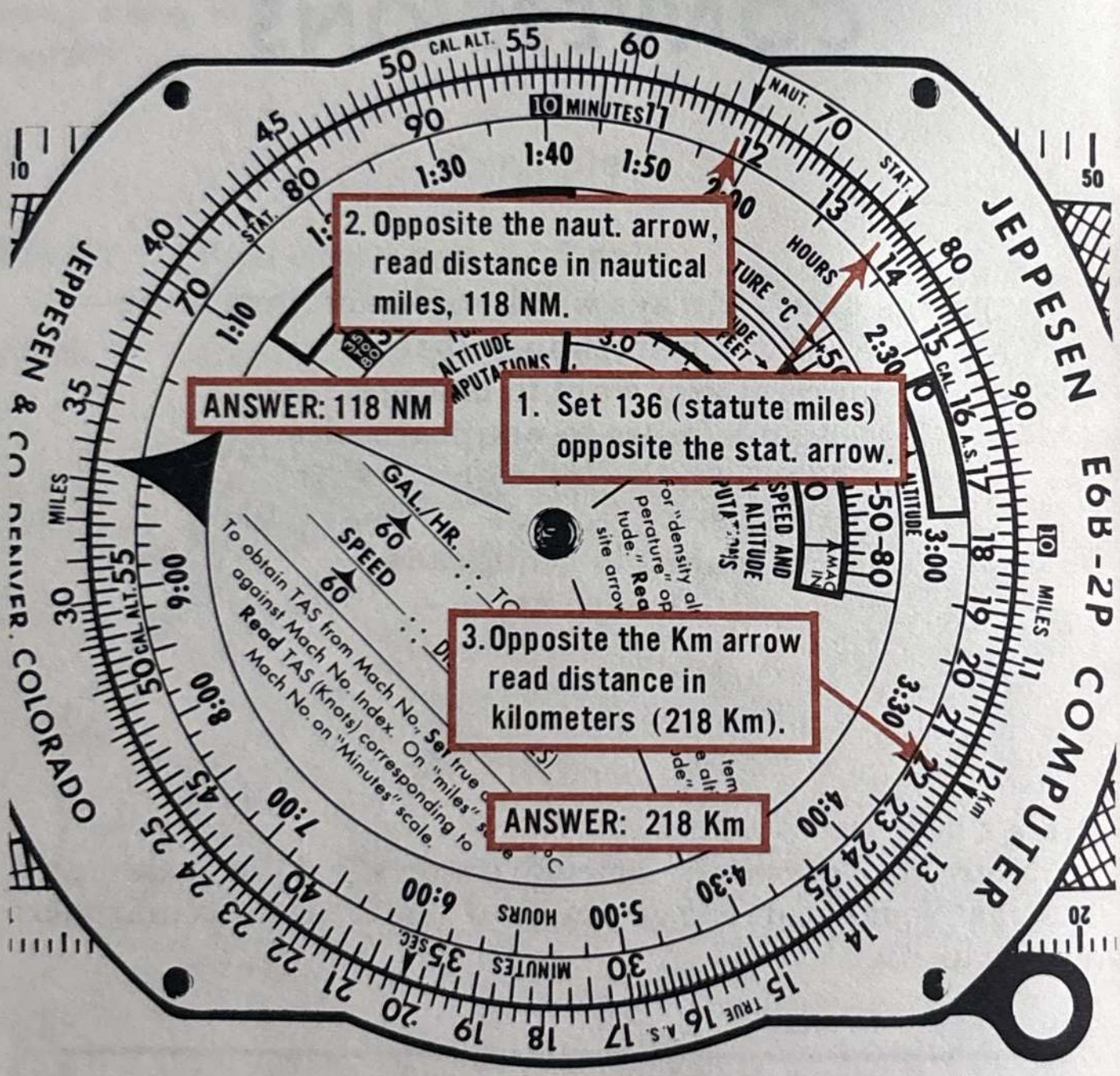


Fig. 7

Conversions of any of the other units are made in the same way. The known figure is placed under the arrow for the unit in which that figure was expressed and the unknown quantity is read under the appropriate arrow.

PROBLEMS 2

Find missing quantities; check your answers against the answers in Part C.

	Statute Miles	Nautical Miles	Kilometers
1.	240	....	....
2.	....	....	35
3.	15	....	....
4.	....	160	....
5.	....	....	47
6.	....	8	....

MINUTES TO SECONDS

At 36 on the inside scale is an arrow marked SEC. To convert minutes to seconds, place the time index ▲ opposite the number of minutes and read seconds opposite SEC arrow.

Example

Find number of seconds in 13 ½ minutes. Place time index ▲ opposite 13½ . Opposite SEC arrow (near 36 on inside scale) read 81.

Answer: 13 ½ minutes = 810 seconds.

FAHRENHEIT - CENTIGRADE

A temperature conversion scale is located on the wind face side of the E6B computer (see Fig. 8). Read temperature conversions directly from this scale.

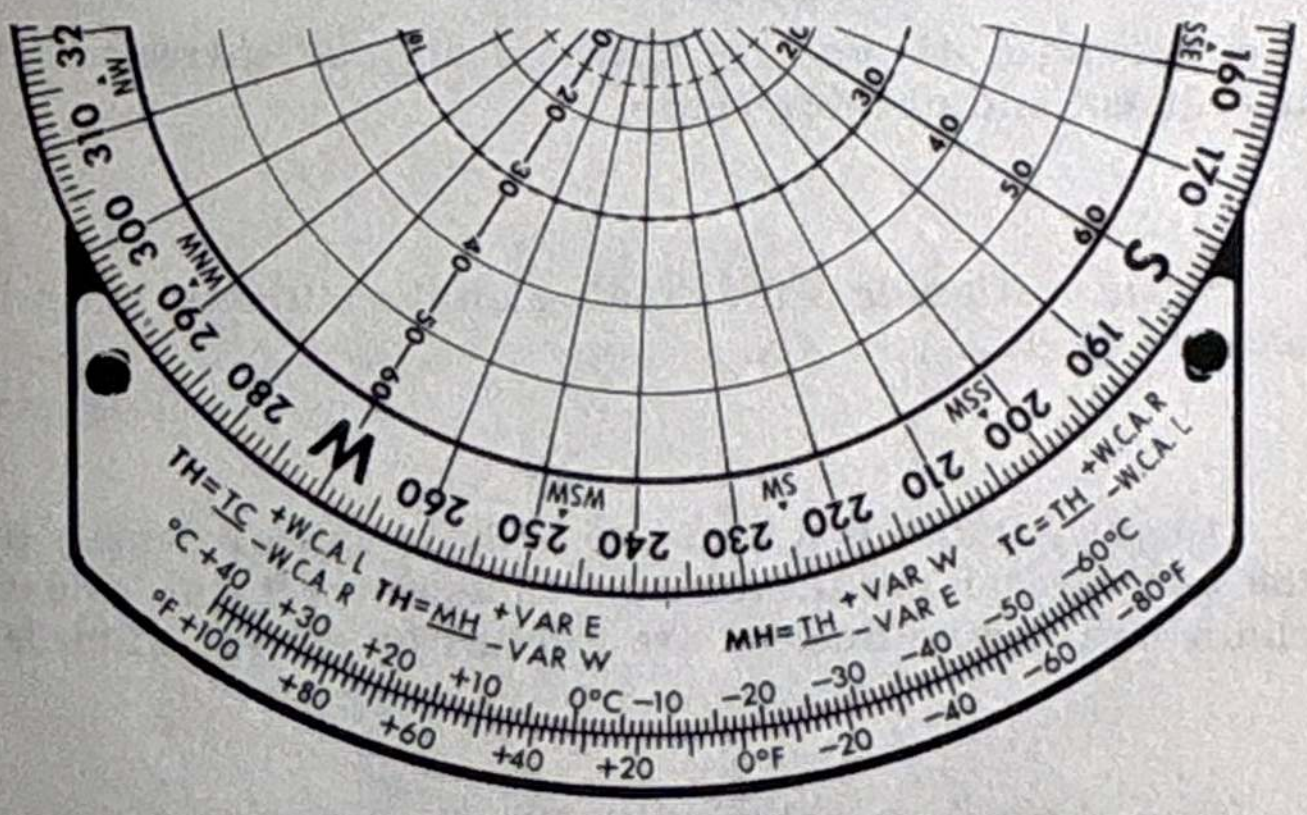


Fig. 8



ALTITUDE

"Altitude comes in assorted varieties. Ever wonder how high is 'up'?" No need for confusion if you remember the following points:

Indicated Altitude is the altitude reading on the altimeter when it is set to nearest station altimeter setting.

Calibrated Altitude is indicated altitude corrected for instrument and position error.

Pressure Altitude is the reading on the altimeter when it is set at 29.92.

Density Altitude is a measure of the weight or density of the air. Aircraft performance, such as take-off run, rate of climb and engine output, are affected by density altitude.

True Altitude is calibrated altitude corrected for temperature and pressure.

DENSITY ALTITUDE

Near the center of the computer is the density altitude window, entitled "For Air Speed and Density Altitude Computations".

Example

Given: Pressure altitude.....3000'
Air temperature.....25°C

Find: Density altitude

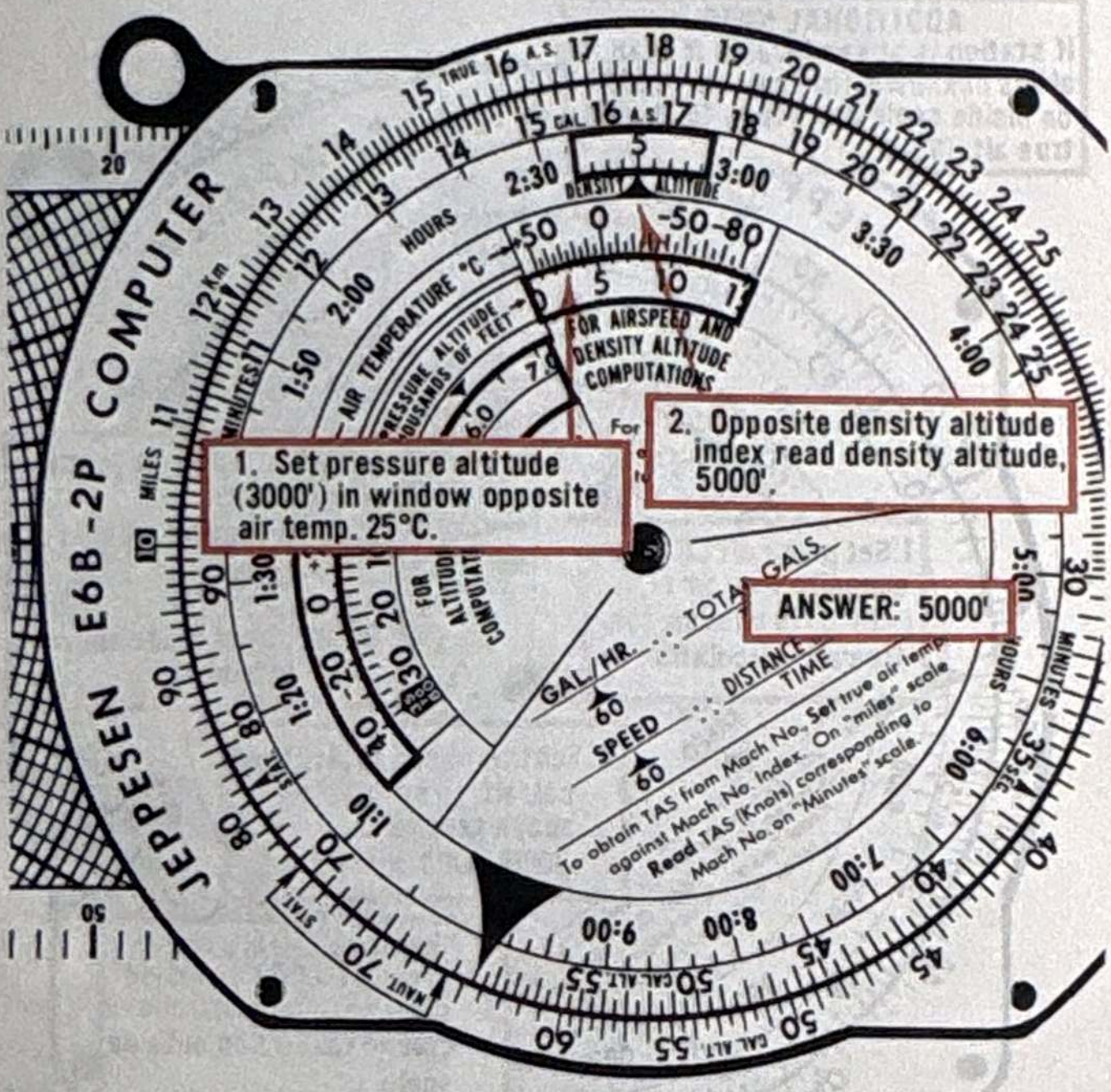


Fig. 9

PROBLEMS 3

Find density altitudes; check your answers against the answers in Part C.

	Pressure Altitude	Air Temperature	Density Altitude
1.	1500'	35°C	....
2.	0'	40°	....
3.	8000'	–10°	....

TRUE ALTITUDE

To find true altitude it is necessary to use calibrated altitude (or indicated if calibrated is not available), pressure altitude and true air temperature. *Greater accuracy can be obtained if you also know the altitude of the ground station giving your altimeter setting.*

Example

Given: Pressure altitude ..... 10,000'
Calibrated altitude ..... 9,000'
True air temperature ..... –20°C
Ground station altitude ..... 5,000'

Find: True altitude

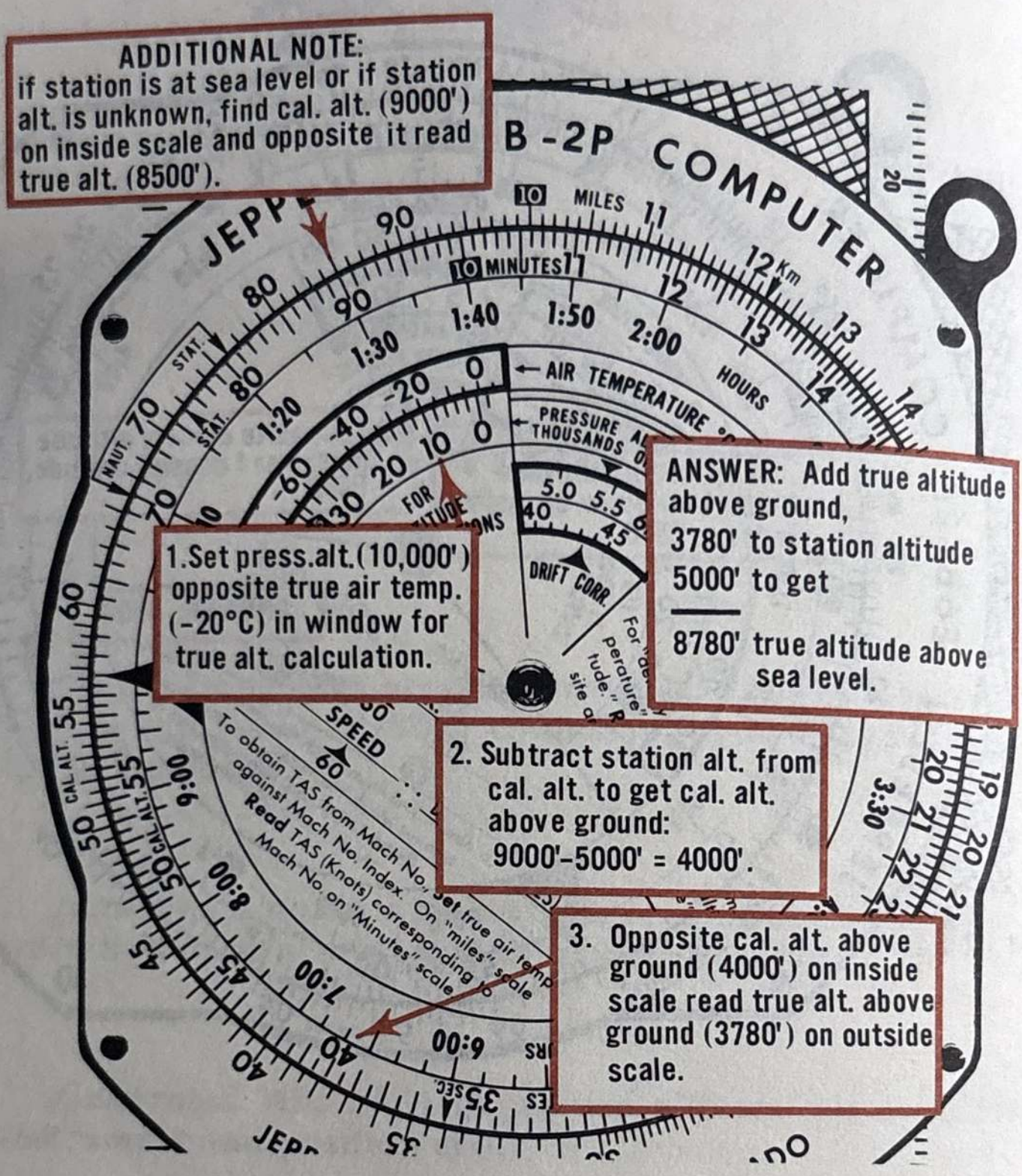
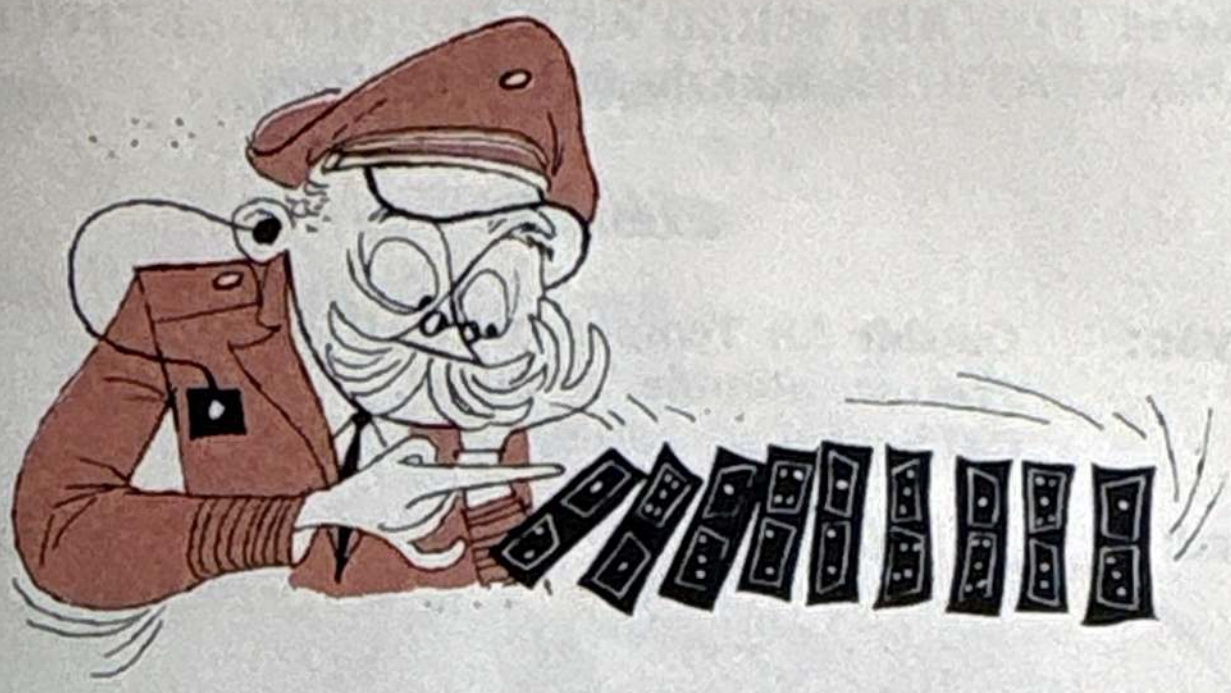


Fig. 10

PROBLEMS 4

Find true altitude; check your answers against the answers in Part C.

	Pressure Altitude	True Air Temp.	Calibrated Altitude	Station Altitude	True Altitude
1.	10,000'	25°C	11,400'	4,200'	....
2.	5,000'	0°	6,000'	Sea Level	....
3.	7,000'	10°	7,400'	1,900'	....
4.	20,000'	–15°	21,000'	Unknown	....



TRUE AIR SPEED

"Let's knock over this true air speed thing."

"In the old days pilots listened to the wind in the wires and were happy to be flying at any speed. Today we have the air speed indicator. It's a mighty fine gadget, but its reading is affected by various items such as temperature, pressure, compressibility and accidental misreading by the pilot who's thinking of the blonde in the tower."

The air speed indicator is constructed to operate correctly under standard atmospheric conditions, at a pressure of 29.92 inches of mercury and a temperature of 15°C. In flight, these conditions will rarely be found. The pilot will therefore have to correct the readings of his air speed indicator for pressure and temperature in order to discover his true air speed. The slide rule face of the E6B computer has a special scale which will enable him to make the necessary corrections; it is labeled FOR AIR SPEED AND DENSITY ALTITUDE COMPUTATIONS. The most accurate use of this scale requires the setting of pressure altitude (set 29.92 in. Hg. into the altimeter correction window—the hands of the altimeter will then read "pressure altitude").

Calibrated airspeed (the indicated airspeed corrected to compensate for error in the airspeed indicator or the pitot static system) will be used throughout this discussion. While calibrated airspeed is the technically correct airspeed to use for true airspeed computations, many light airplane pilots use indicated airspeed for solving true airspeed computations since the difference between calibrated indicated airspeed is relatively insignificant for light aircraft.

True air speed is obtained in one setting. Using the scale labeled FOR AIR SPEED AND DENSITY ALTITUDE COMPUTATIONS, take the following steps:

Example

Given: Outside Air Temperature, – 10°C
Pressure altitude, 20,000 ft.
Calibrated air speed, 200 mph

Find: True air speed

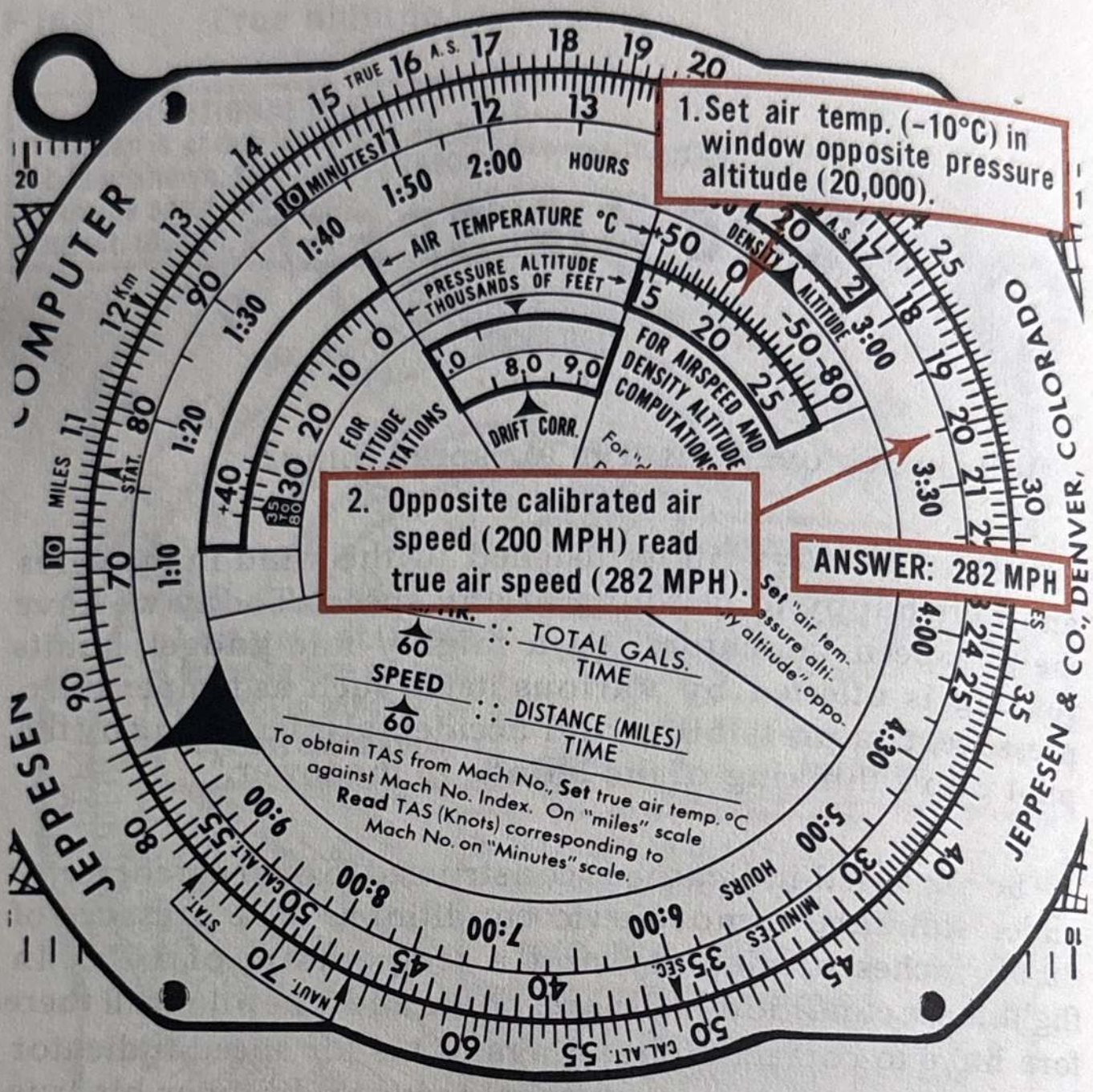


Fig. 11

(This solution disregards Compressibility, and Temperature rise. They are relatively insignificant at lower altitudes and air speeds.)

Two mistakes are frequently made: One is using the wrong "window" and the other is forgetting that the temperature scale is reversed. The plus temperatures are to the left.

At times, especially in case of controlled ground speed, the true air speed will be known and the pilot will want to know at what calibrated air speed to fly in order to make good the given true air speed. This solution on the E6B computer is the same as the preceding one, except that after outside air temperature and pressure altitude have been set in the proper relationship, the calibrated air speed is read on the minutes scale opposite the known true air speed on the miles scale.

Example

Given: Outside air temperature, 0°C
Pressure altitude, 5,000 ft.
True air speed, 200 mph

Find: Calibrated air speed

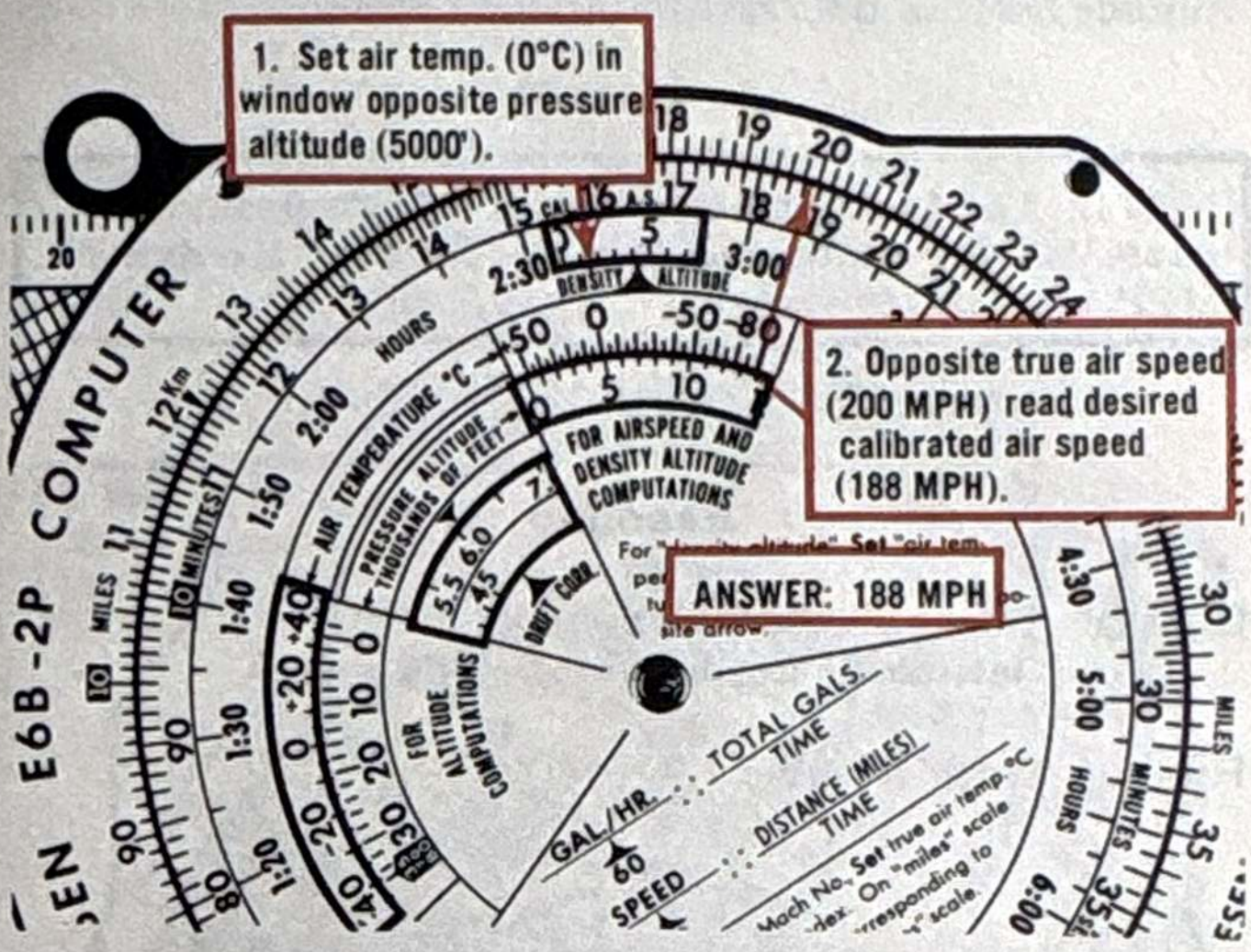


Fig. 12

PROBLEMS 5

Find true air speed; check your answers against the answers in Part C.

	Pressure Altitude	Outside Air Temp.	Calibrated Air Speed	True Air Speed
1.	3,000'	0°C	140 mph	....
2.	8,000'	–5°	160 knots	....
3.	12,000'	–10°	190 mph	....
4.	10,000'	0°	200 mph	....
5.	5,000'	3°	140 knots	....
6.	9,000'	–10°	150 knots	....

MACH NUMBER

Every airplane, even a 60 H.P. "cub" flies at a Mach Number. What's yours? OK here goes! Since Mach Number is dependent upon the speed of sound, which varies only with temperature, the same Mach Number represents different true air speeds at different temperatures.

MACH NUMBER FROM TRUE AIR SPEED AND TEMPERATURE

In PROBLEMS 5 problem 6 (Pg. 15), we found our true air speed to be 170 knots. The Mach Number index (↑) appears to the right of the Figure 80 on the Pressure Altitude Scale in the Pressure Altitude Window.

NOTE: The Mach Number Index (↑) is positioned to relate Mach Numbers to True Air Speed in Knots only. MPH must be converted.

Example

Given: True air speed, 170k
Outside air temperature, – 10°C

Find: Mach Number

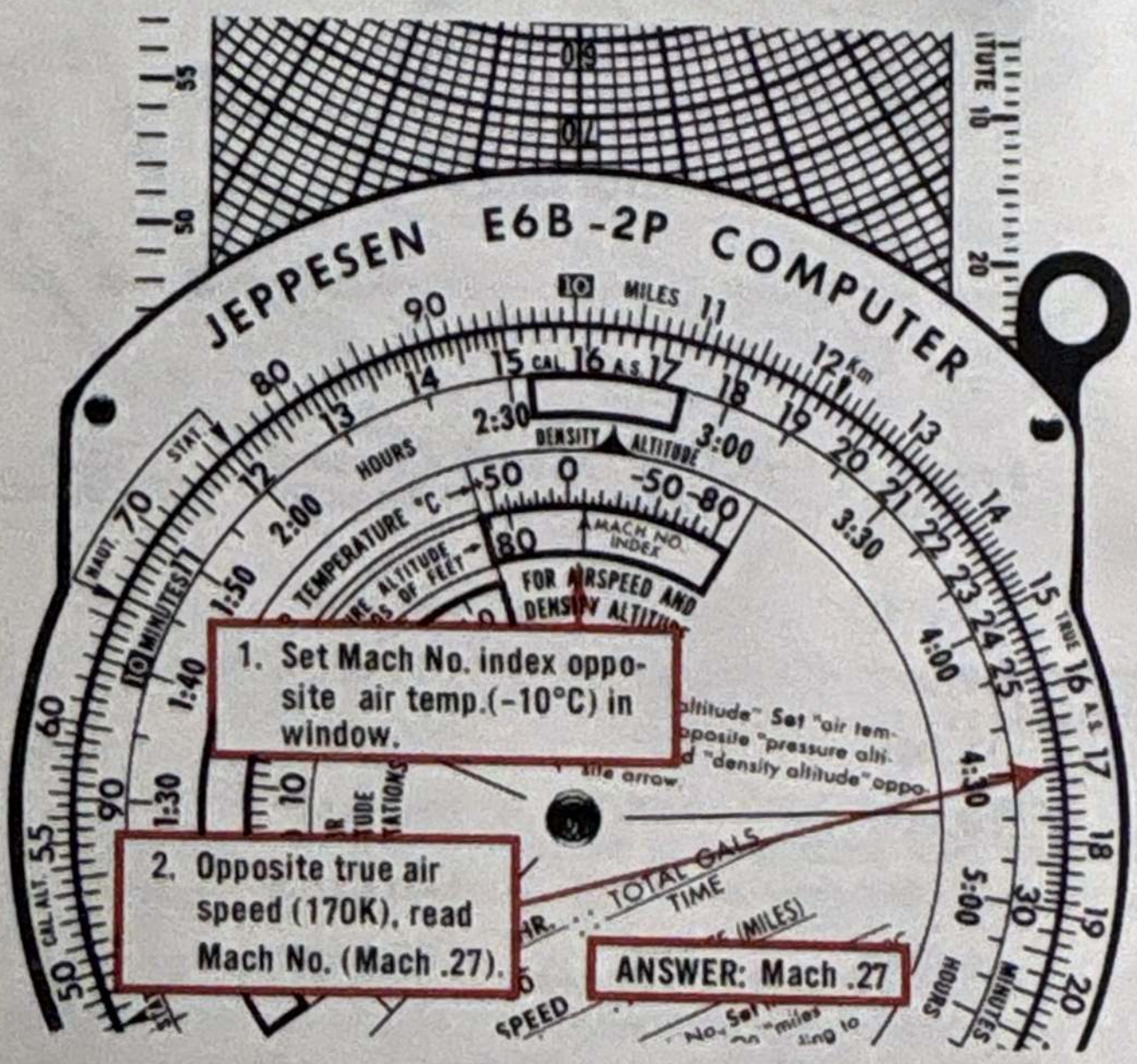


Fig. 13

Your Mach Number is somewhat less than the speed of sound, but there it is. . .Mach .27.

TRUE AIR SPEED FROM MACH NUMBER AND TEMPERATURE (TAS IN KNOTS ONLY)

In aircraft having a Mach indicator it is possible to get true air speed from Mach Number and temperature. At higher speeds, indicated air temperature must be "corrected" to true air temperature for "anywhere near" accuracy. See Page 18 for method of computing TAT (True Air Temperature).

Example.

Given: Mach Number 1.16
True air temperature + 10°C

Find: True air speed

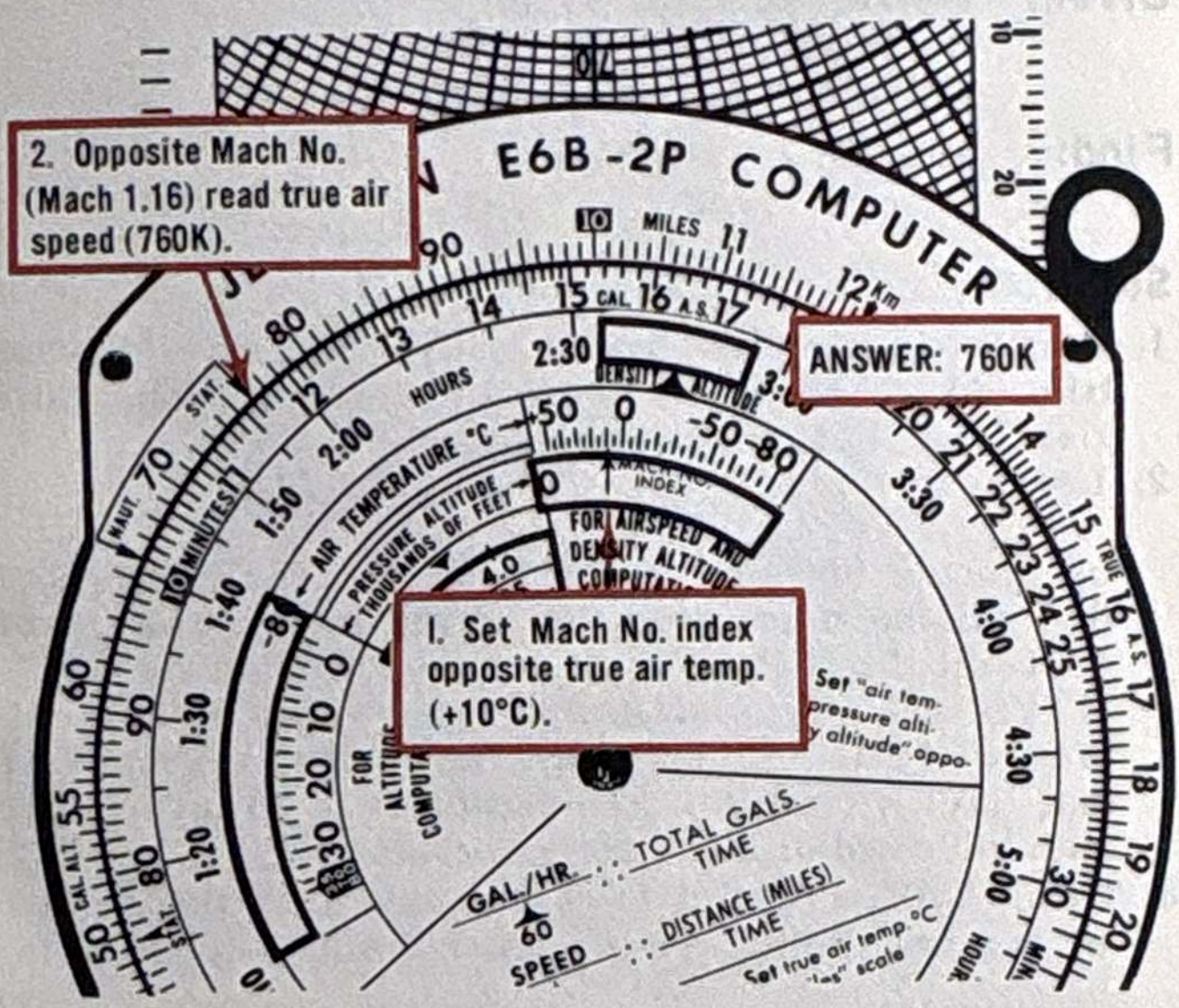


Fig. 14

PROBLEMS 6

Find Mach Number or true air speed; check your answers against the answers in Part C.

	True Air Temperature	Mach Number	True Air Speed
1.	–35°C	.70	. . . .
2.	0°	.67	. . . .
3.	–30°	. . . .	605

TRUE AIR SPEED COMPUTATION . . . AT HIGHER SPEEDS (TAS IN KNOTS ONLY)

Although the method of computing true air speed as described on Pages 13, 14 and 15 is satisfactory for lower speeds, significant errors are introduced at speeds above 200 knots. The "Huber System" for TAS determination (as used with Jeppesen Computer Models CR, CB, is the most direct and accurate method. However, satisfactory (high speed) TAS computations may be made with the E6B Computers using the following method. (Note: Basic Air Temperature – BAT – is Indicated Temperature corrected for scale error.)

Example

Given: Pressure altitude, 25,000 ft.
Basic air temperature, – 30°C
Calibrated air speed, 240 knots

Find: True air temperature
True air speed

Solution:

1. Compute a trial TAS by using BAT, PA, and CAS. This trial TAS (363 k) will be used to compute temperature rise (heat of compression error).
2. Use the formula $\frac{\text{TAS}}{950} = \frac{\text{Temperature Rise}}{\text{TAS}}$ by placing 950 on the minute scale under trial TAS of 363 on the miles scale. Read the temperature rise of 14°C on the MILES scale opposite 363 on the MINUTES scale. True air temperature would be approximately – 44°C (BAT – Temperature Rise). Remember that TAT (True Air Temperature) is always colder than indicated or basic air temperature.
3. Using TAT, PA, and CAS, compute TAS uncorrected for compressibility. Your answer should be 351 knots.

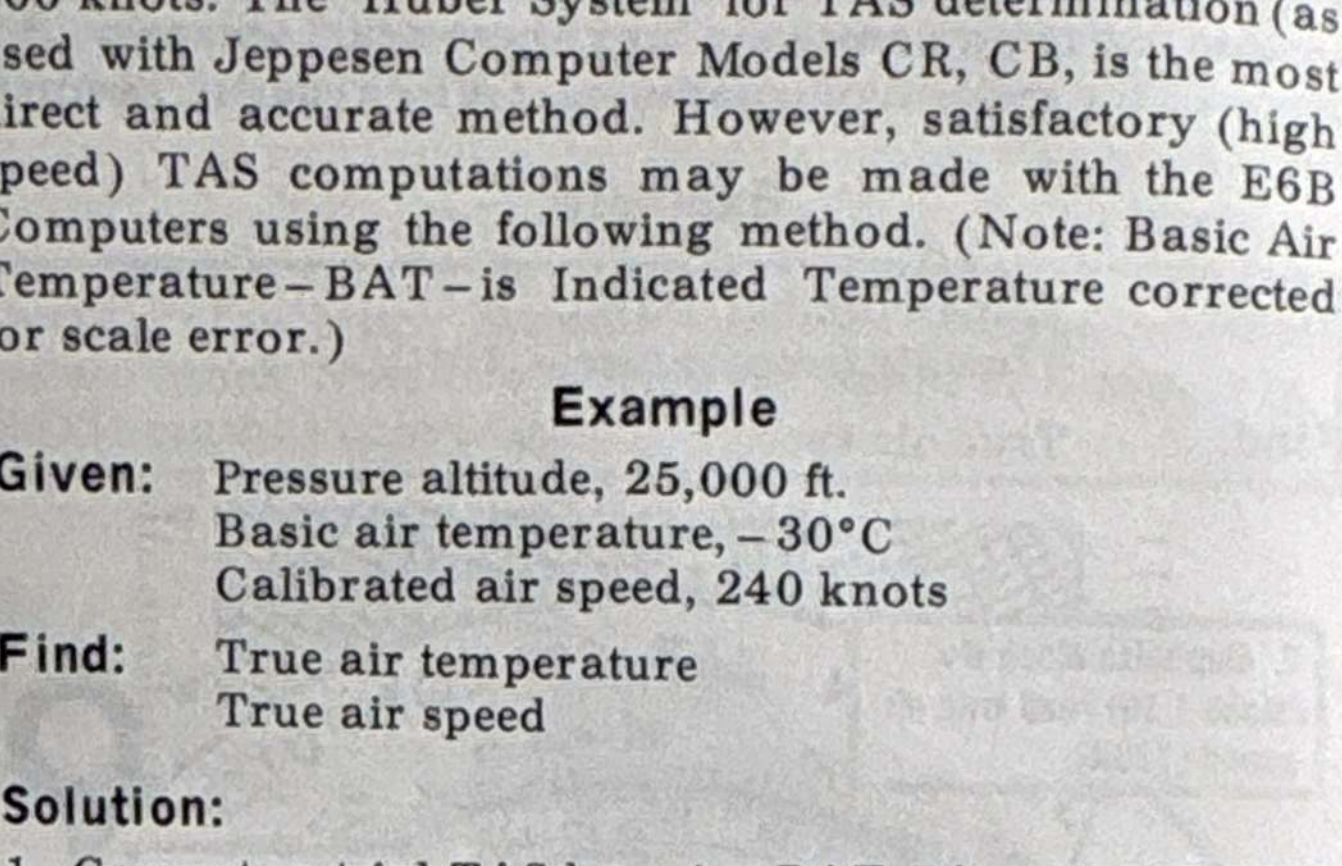


Fig. 15

4. Determine the F factor on the slide of your computer. Interpolating by inspection, you find it to be .97.

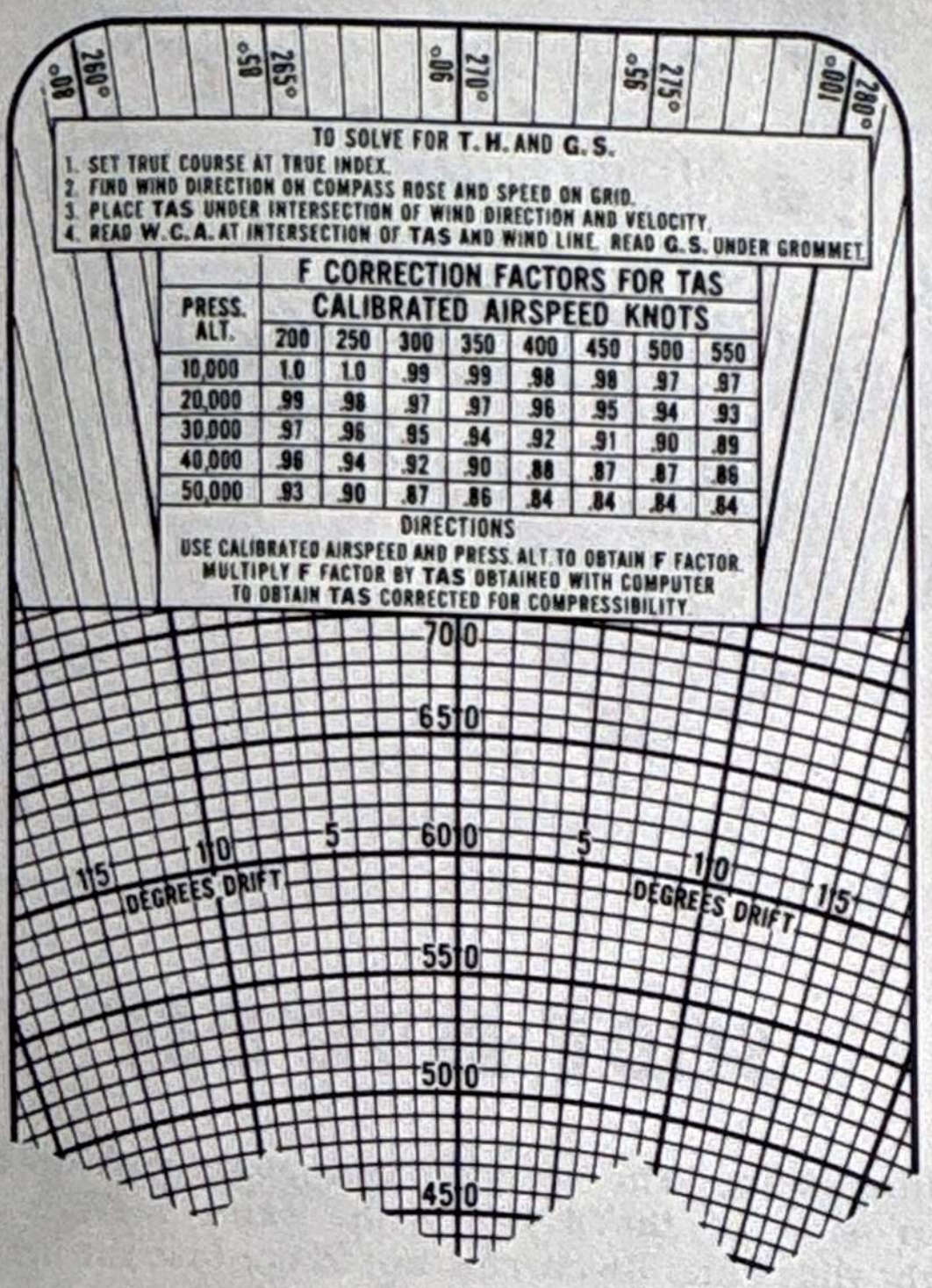


Fig. 16

5. Multiply TAS uncorrected for compressibility by the F factor. TAS is therefore 340 knots.

PROBLEMS 7

Find true air temperature and true air speed; check your answers against the answers in Part C.

	Pressure Altitude	Basic Air Temperature	Calibrated Air Speed	True Air Temperature	True Air Speed
1.	20,000'	–25°C	250k	....	....
2.	30,000'	–35°	300	....	....
3.	15,000'	–10°	280	....	....
4.	40,000'	–30°	210	....	....
5.	25,000'	–15°	325	....	....
6.	45,000'	–35°	200	....	....

You can convince yourself of the necessity of using this (or the Huber System) method of calculating high speed TAS by comparing the above answers with answers that you would have gotten with the method (low speed) described on Pages 13, 14 and 15.



SLIDE RULE USE

Multiplication and division are performed on the calculator side of the E6B in the same manner as on a straight slide rule. Be careful not to confuse the time index ▲, which stands for 60, with the unit index in these problems.

Example: 28 x 15

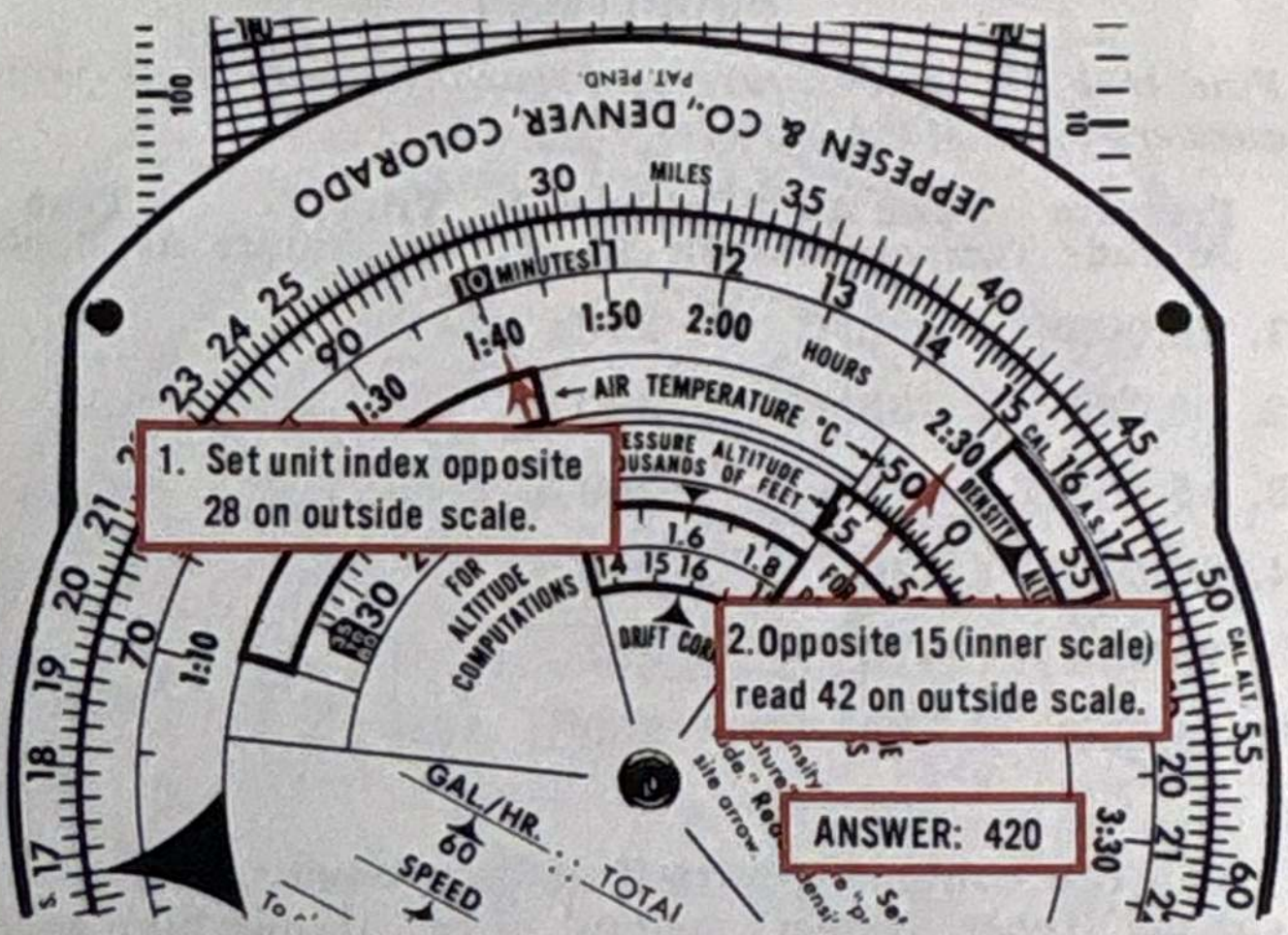


Fig. 17

Example: $182 \div 14$

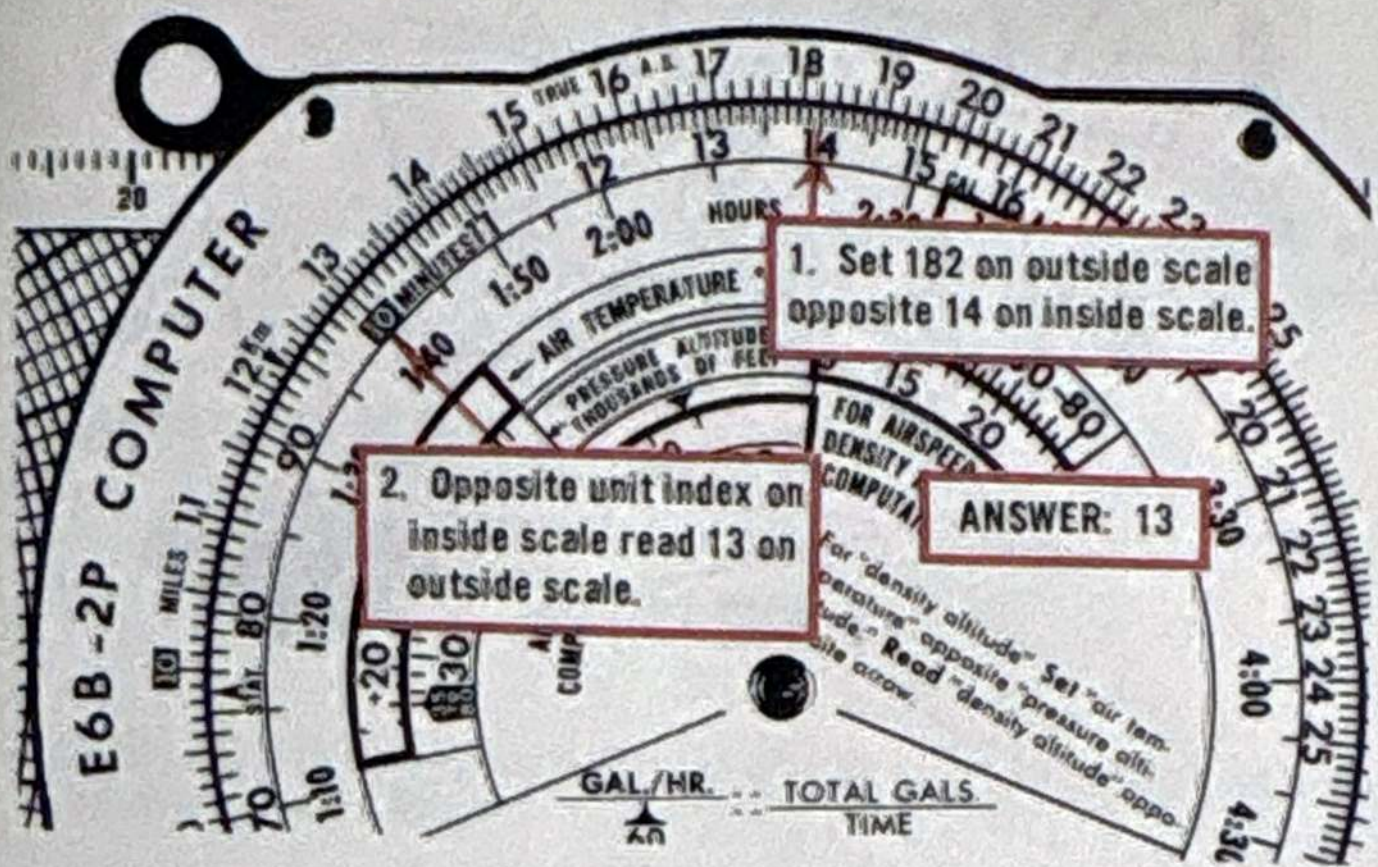


Fig. 18

Successive multiplication and division may be done on the E6B.

Example: $\frac{25 \times 12}{19}$

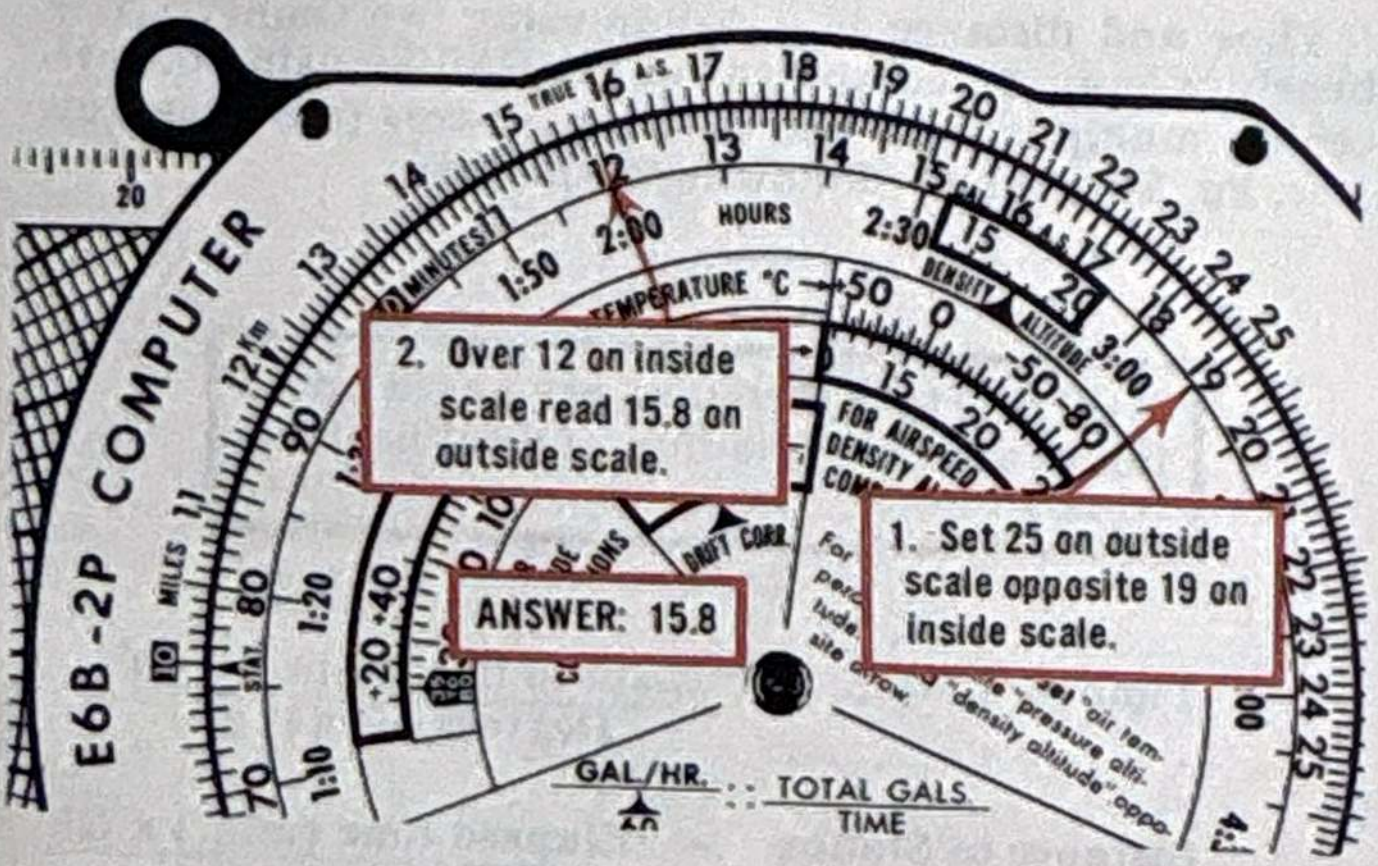
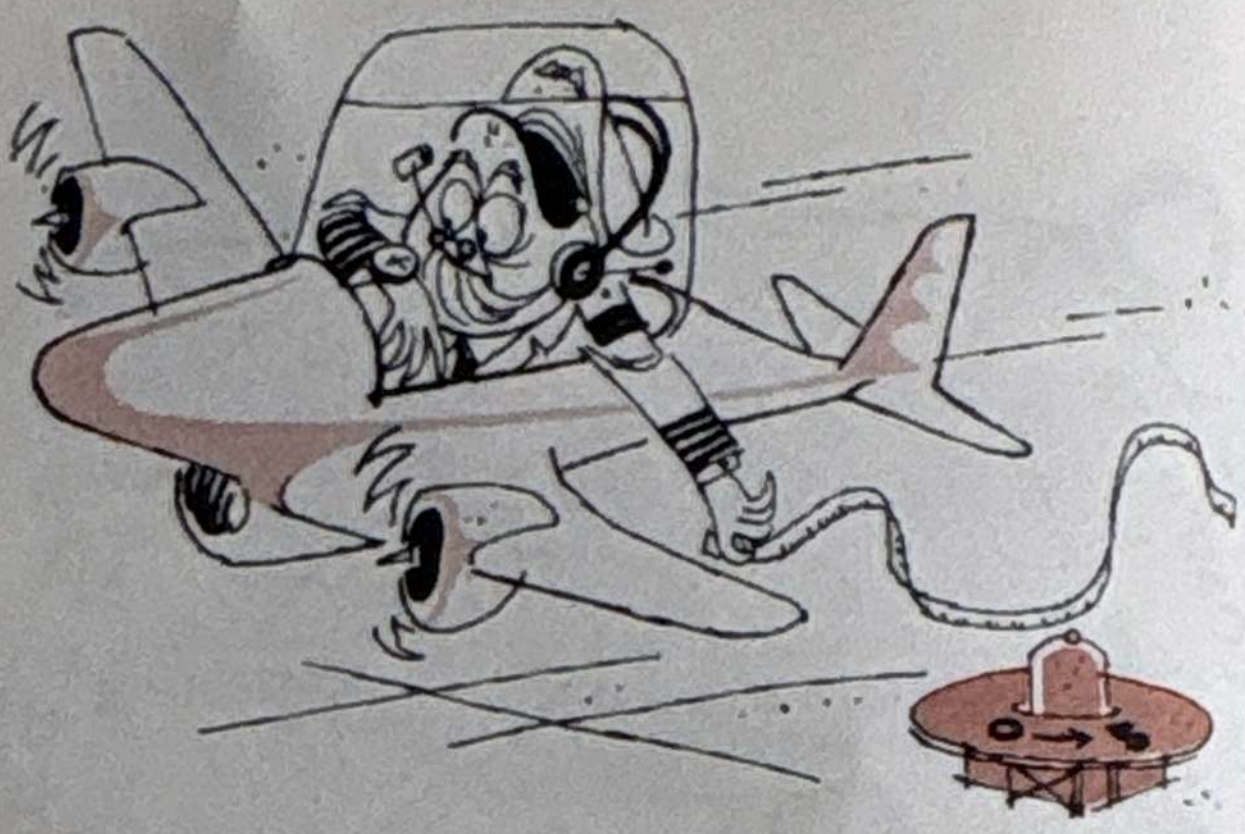


Fig. 19

PROBLEMS 8

Find answers; check your answers against the answers in Part C.

1. $12.6 \times 31 =$
2. $267 \div 156 =$
3. $\frac{32 \times 18}{25} =$



TIME AND DISTANCE TO STATION

Time and distance to a station using two Omni or ADF bearings may be computed on the E6B by using the preceding multiplication and division process (see Slide Rule Use, Pg. 20) with the following formulas:

> NOTE: These formulas are based on an initial airplane heading of 090° bearing from station.

$$\text{Time to Station} = \frac{\text{Elapsed time (min.)} \times 60}{\text{Degrees of change}}$$

$$\text{Distance to Station} = \frac{\text{Elapsed time (min.)} \times \text{GS}}{\text{Degrees of change}}$$

Example

Given: First bearing taken at 10:15 = 090°
Second bearing taken at 10:18 = 099°
A constant heading is maintained between bearings

Find: Time to station

Solution:

$$\text{Time to Station} = \frac{\text{Elapsed time (min.)} \times 60}{\text{Degrees of change}} = \frac{3 \times 60}{9}$$

On calculator side, set 3 on outside scale opposite 9 on inside scale. Opposite 60 (1:00) on inside scale read answer on outside scale:

Answer: 20 minutes

PROBLEMS 9

Solve the following problems; check your answers against the answers in Part C.

Given: 1st bearing 280° at 8:26
2nd bearing 269° at 8:31
GS = 120 mph

Find: Find time to station
Find distance to station



DRIFT AND OFF-COURSE CORRECTION

"Unless you have the instinct of a homing pigeon, some day you'll find yourself off course. This need not be distressing if you continue on your original heading until you reach a recognizable check point. Measure your distance off course, miles flown and miles to destination. Then two easy computer adjustments will give you the number of degrees to correct your heading to take the shortest route to your destination."

One form of a simple proportion has been set up for quick usage in low level navigation where corrections must be immediate or in a case where the pilot is unable to determine his exact wind for precise corrections. This is the DRIFT CORR window.

The proportion is simply:

$$\frac{\text{distance off course}}{\text{distance flown}} = \frac{\text{correction to parallel}}{57.3}$$

and

$$\frac{\text{distance off course}}{\text{distance to fly}} = \frac{\text{correction to converge}}{57.3}$$

The window on the E6B was derived from prior usage of the old rule of thumb that one mile off course in sixty requires a one degree correction. The angular corrections given in the window are derived from the actual value of 57.3. The settings illustrated on Pages 25 and 26 are based on the above principle.

The illustrations show the procedure in using the DRIFT CORR window with a sample problem.

Example

Given: Course distance traveled, 400 miles
Distance off course, 30 miles

Find: (A) Correction angle to parallel desired course.
(B) Total correction angle to intercept desired course in 150 additional miles.

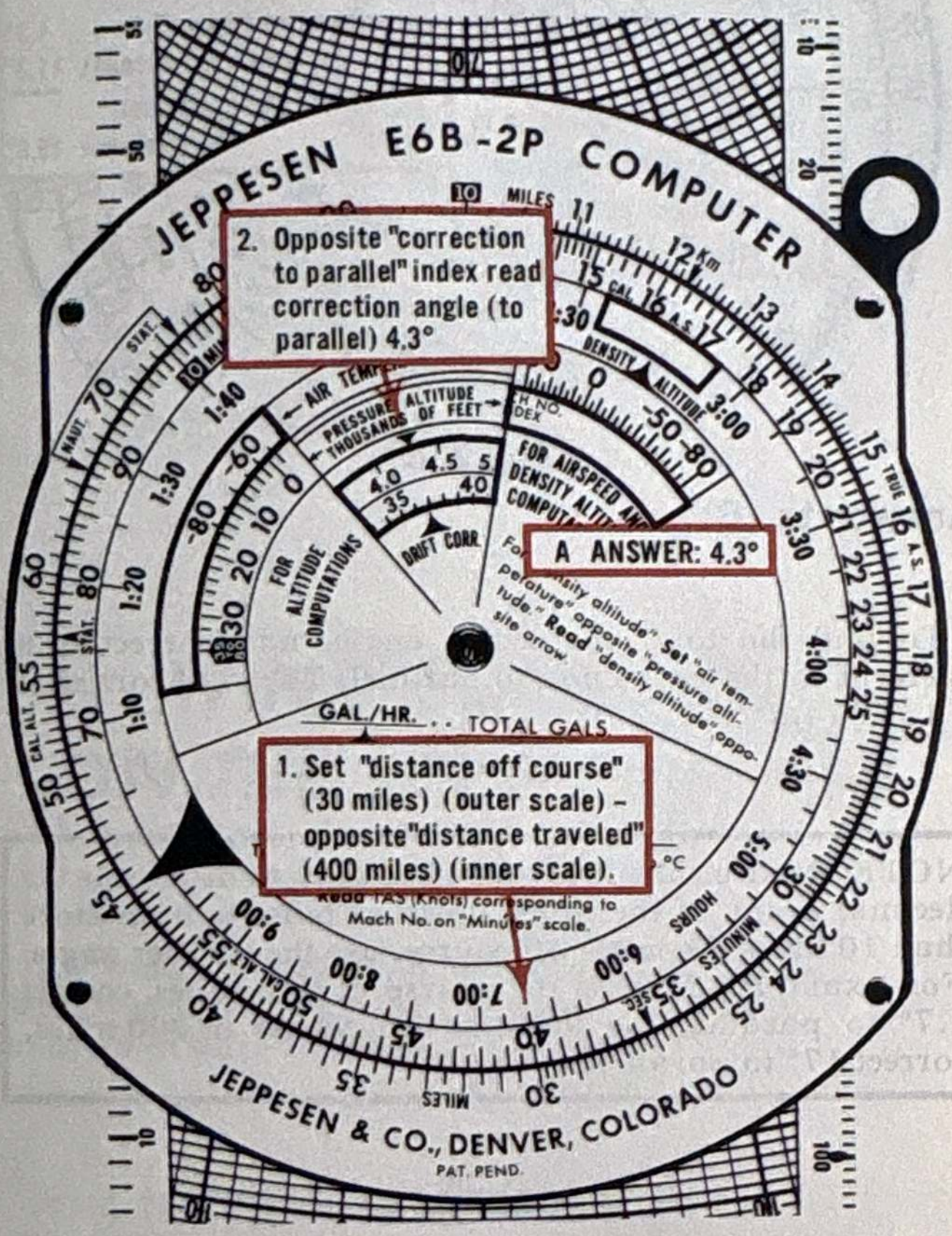


Fig. 20A

Answer to (A):

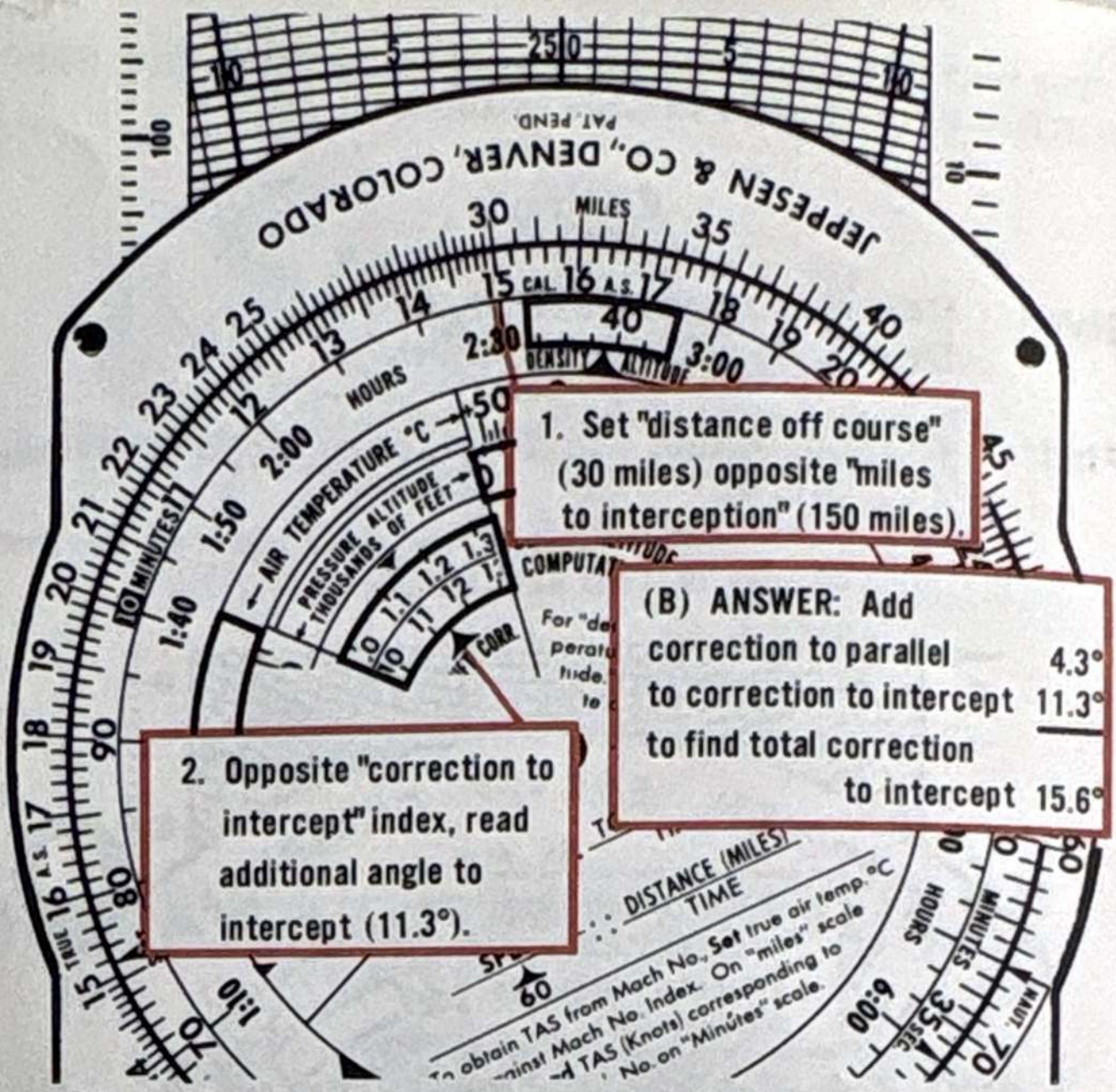


Fig. 20B

Answer to (B):

To find the total correction angle, add correction to intercept to the correction to parallel. The total correction is 15.6° (4.3° + 11.3°).

NOTE: Notice that it is still necessary to determine the decimal point. If the miles flown or miles to fly is more than 10 times the miles off course, use the smaller angle. For example: 9 miles off course in 300 miles, correct 1.7° to parallel; for 90 miles off course in 300 miles, correct 17° to parallel.

PROBLEMS 10

Find the correction angles; check your answers against the answers in Part C.

	Flown	Off Course	To Intercept	Correction to Parallel	Angle to Intercept	Total Correction
1.	200 mi.	15 mi.	75 mi.	....	....	....
2.	375	25	200	....	....	....
3.	260	10	145	....	....	....
4.	185	5	75	....	....	....
5.	250	13	90	....	....	....
6.	425	24	125	....	....	....

Part B

WIND SIDE



WIND SOLUTION ON THE JEPPESEN E6B

"All 'windy' problems depend upon the solution of the old eternal wind triangle. In its basic form, this triangle is made up of three simple vectors:

(1) A "wind" vector, made up of the direction and speed of the wind.

(2) A "ground" vector, representing the movement of the plane with respect to the ground, and made up of the true course (or track) and the ground speed.

(3) An "air" vector, representing the movement of the plane with respect to the air mass, and made up of the true heading and the true air speed.

There are, in all, six quantities involved: wind direction, wind speed, true course (track), ground speed, true heading, and true air speed.

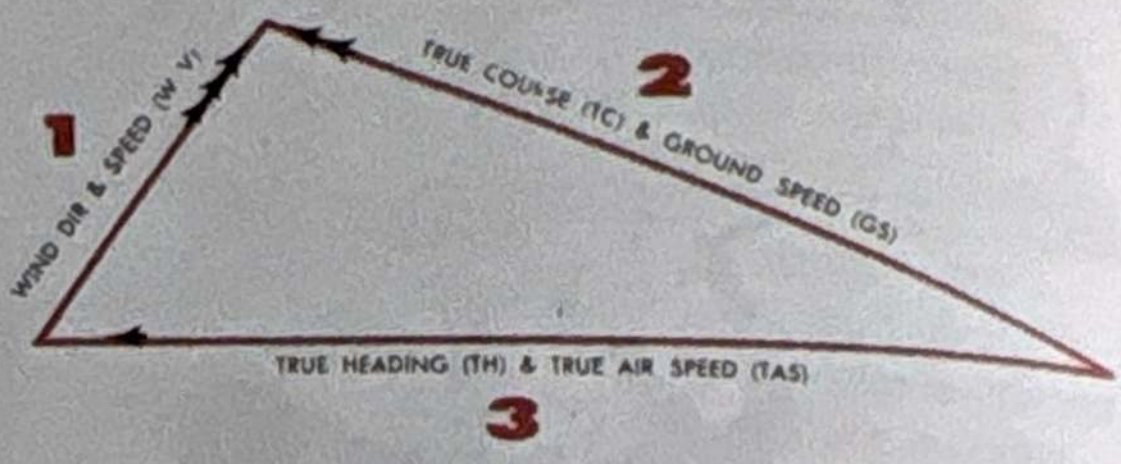


Fig. 21

Each of the vectors in the triangle has a direction and a length. The direction is measured as an angle from true north. The length is measured by some standard scale, the same for all three vectors. The triangle can be determined in one of three ways:

(1) By two sides and an included angle.

(2) By two angles and an included side.

(3) By three sides.

NOTE: The quantities representing direction are all true, i.e., measured from true north; in the same way, air speed is "true", i.e., corrected for temperature and altitude. *If any four of these quantities are known, the other two may be found very easily, either by a graphical or by a computer solution.* This solution is always in terms of one hour.

The wind face of the E6B computer is a simple arrangement for setting up wind vector triangles of the standard type. It consists of a movable disc graduated in degrees from 0° to 360° (see Fig. 22), making a complete azimuth scale, which can be used to set desired angular directions measured from true north. There is also a secondary scale giving the sixteen compass points in which wind directions

are stated; these may be used for plotting the wind when the wind value is stated in terms of these points rather than in degrees. The center of the disc is a transparent material on which a wind grid is printed to provide for ease in plotting the wind.

The solid line wind speed circles on the wind grid are always utilized with the low speed side of the moveable slide (Figure 24). The dashed wind speed circles labeled 50 and 100 are always utilized with the high speed side of the moveable slide (Figure 23).

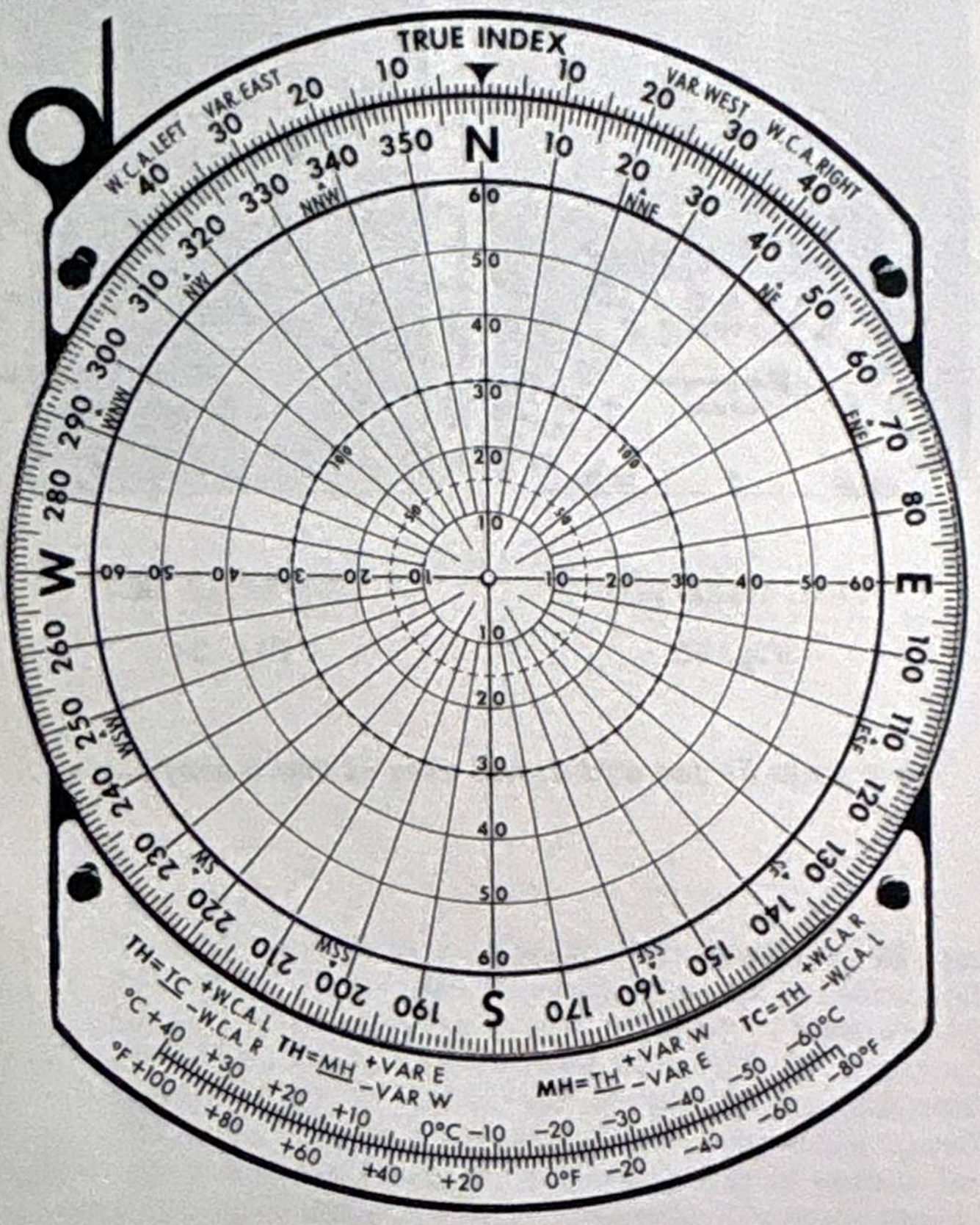
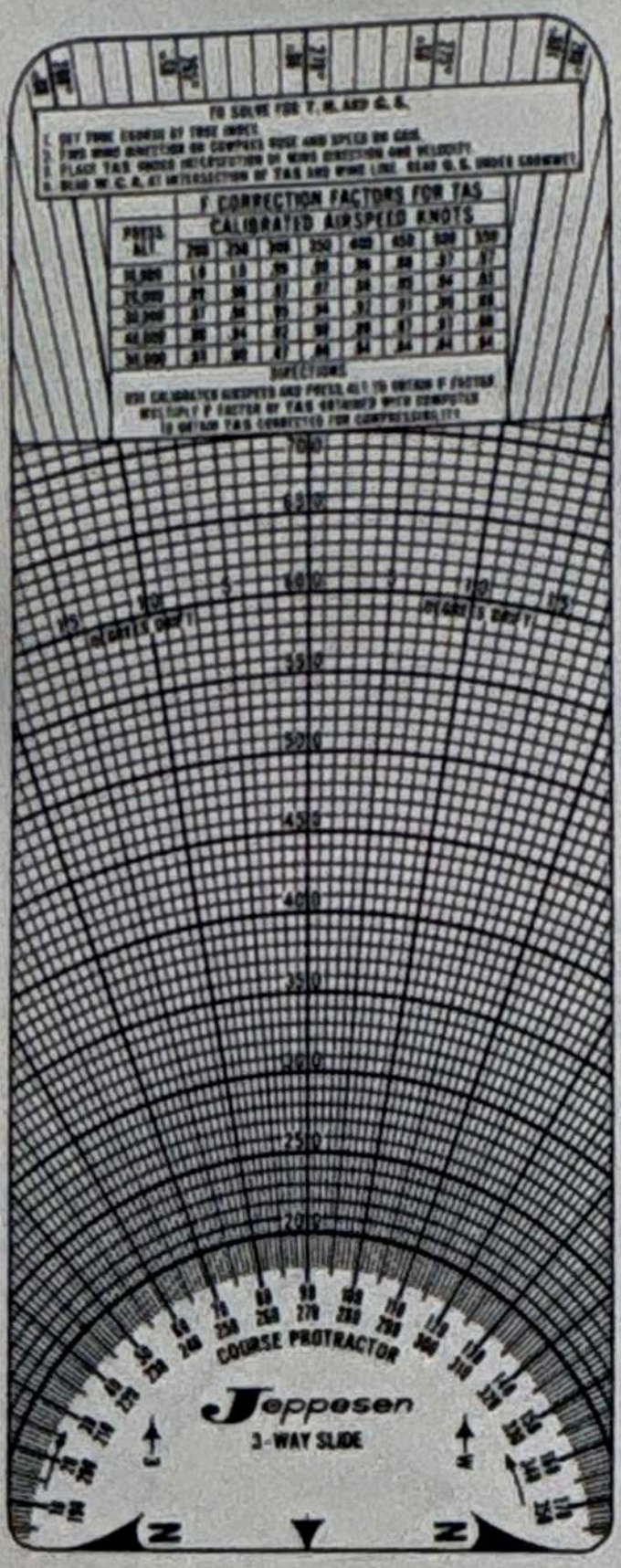
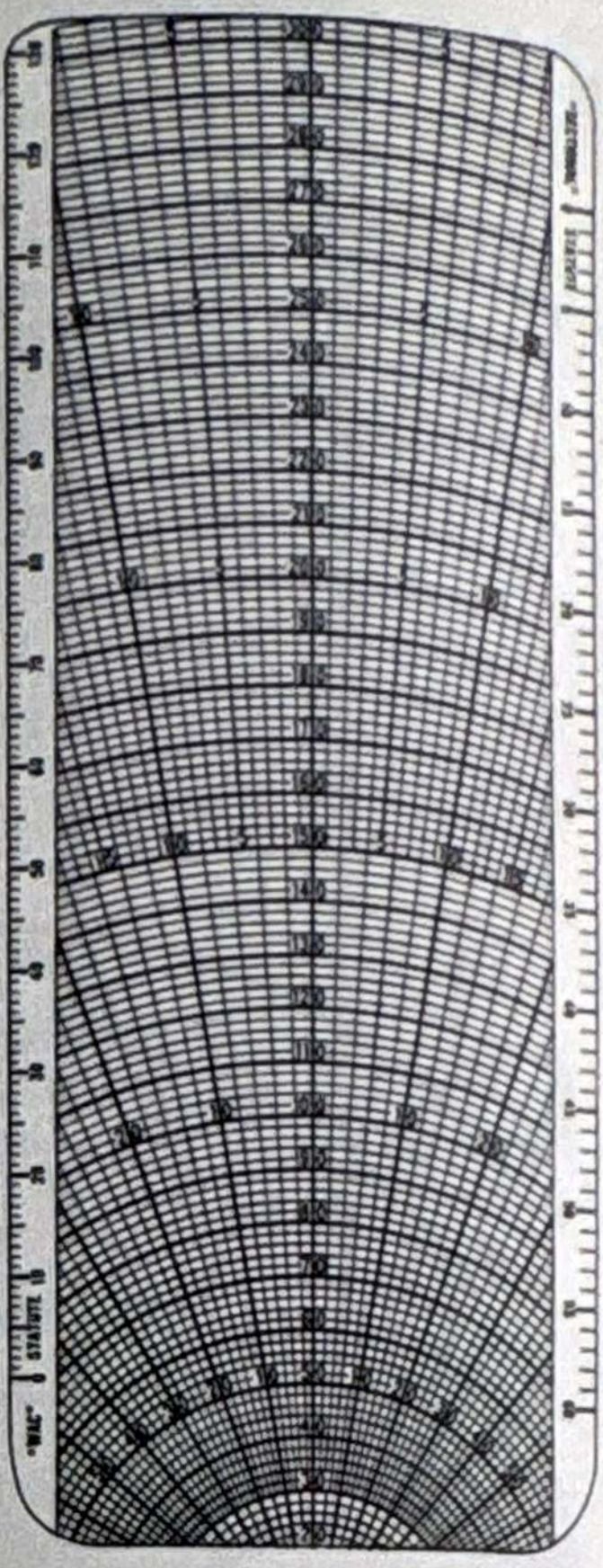


Fig. 22



HIGH SPEED SIDE

Fig. 23



LOW SPEED SIDE

Fig. 24

See page 50 for additional uses of this 3-way slide.

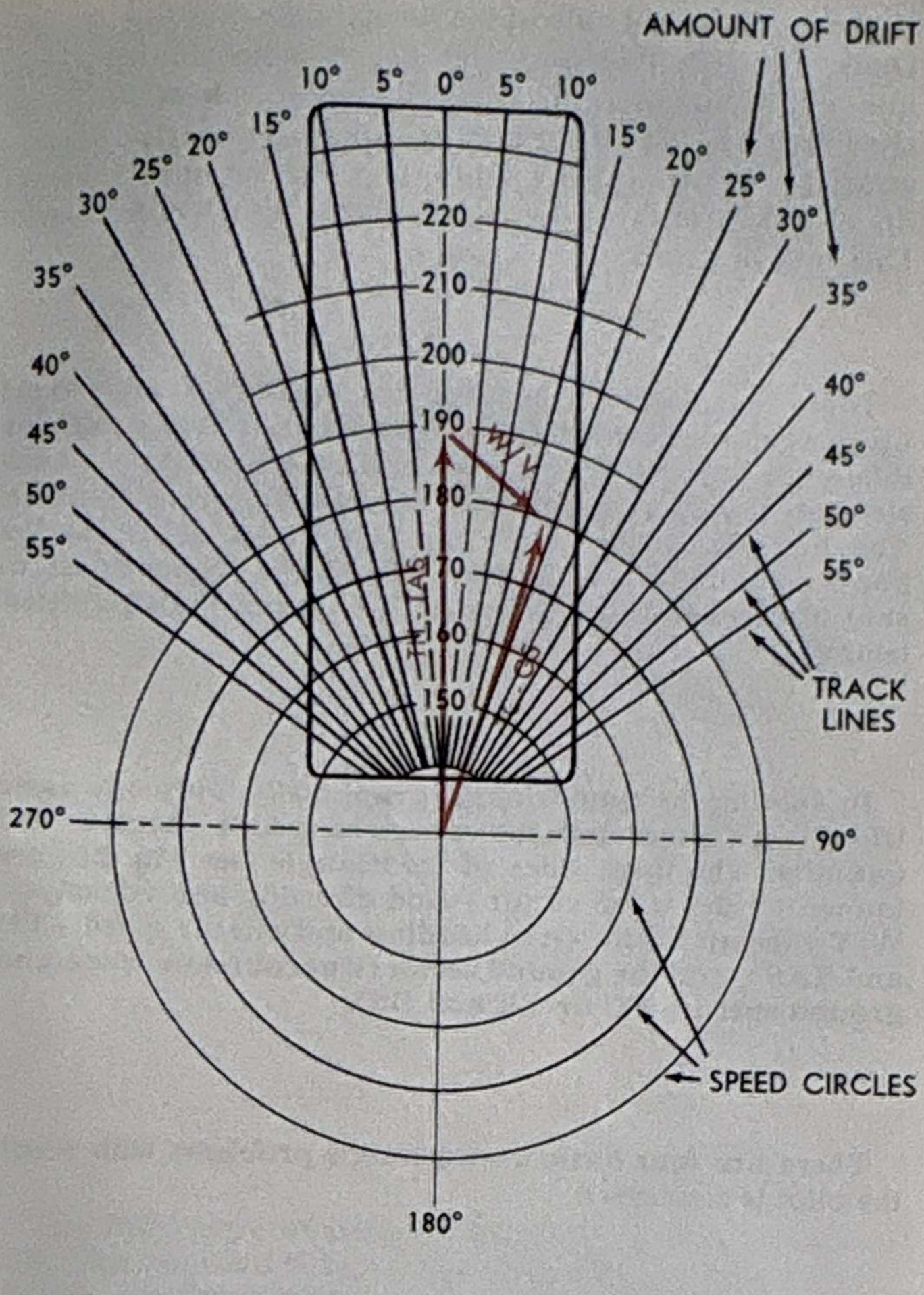


Fig. 25

The second part is a movable slide (see Fig. 23) on which are printed two sets of lines. One set is a series of concentric arcs, known as "speed circles". These are at equal distances, each representing two units of distance, and numbered from 20 to 300 on one side of the slide and from 200 to 700 on the other side. Since these are "speed circles", they are used for all measurements of speeds for the wind triangle: wind speed, ground speed, true air speed. The second set of lines is a series of converging straight lines, which do not actually meet on the slide itself but which converge toward a point outside the slide. These are called "track lines", since they show the number of degrees by which track (or true course) differs from true heading.

On the high speed side of the 3-way slide (see Fig. 23) the track, or drift lines, are one degree apart for all speeds above 200 mph or knots. On the low speed side of the 3-way slide (see Fig. 24) the track, or drift lines, are five degrees apart up to 30 mph or knots, two degrees apart between 30 and 150 mph or knots, and one degree apart above 150 mph or knots.

These two parts of the wind face make it possible to set up speeds, angular directions from true north, and angular difference between true course and true heading—all the elements necessary for the solution of wind vector triangles. The handling of the computer is a matter of placing the known quantities on the computer in the proper relationship and reading the unknown ones from the completed triangle.

In solving the wind triangle graphically, only one basic triangle is correct since the vectors have both direction and quantity. The three sides of the triangle (see Fig. 25) are known as the wind vector (wind direction and velocity—W/V), the air vector (true heading and true air speed –TH and TAS), and the ground vector (true course or track and ground speed—TC or TR and GS).

There are four basic wind triangle problems with which the pilot is concerned.

The first solution is for TH and GS. This problem is most common to pre-flight planning. To solve it graphically, the wind vector is plotted first, the TC plotted on a reciprocal bearing from the head of the wind vector, and the TAS swung in an arc across the TC vector. Point A is established.

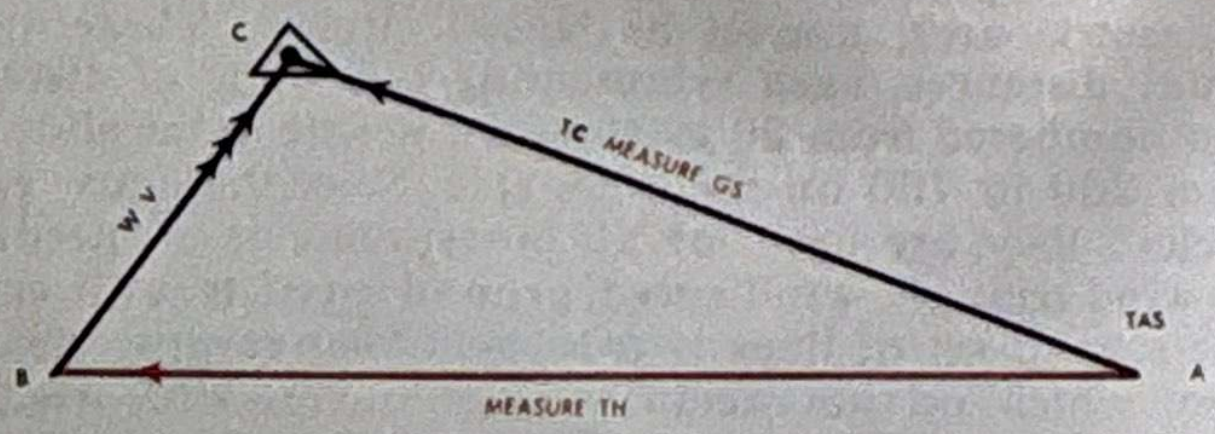


Fig. 26

The second problem may be encountered if the flight requires a certain GS. Again the wind vector is plotted first. The ground vector is established with its head to the head of the wind vector. The components of the air vector, TH and TAS, are then measured between points A and B.

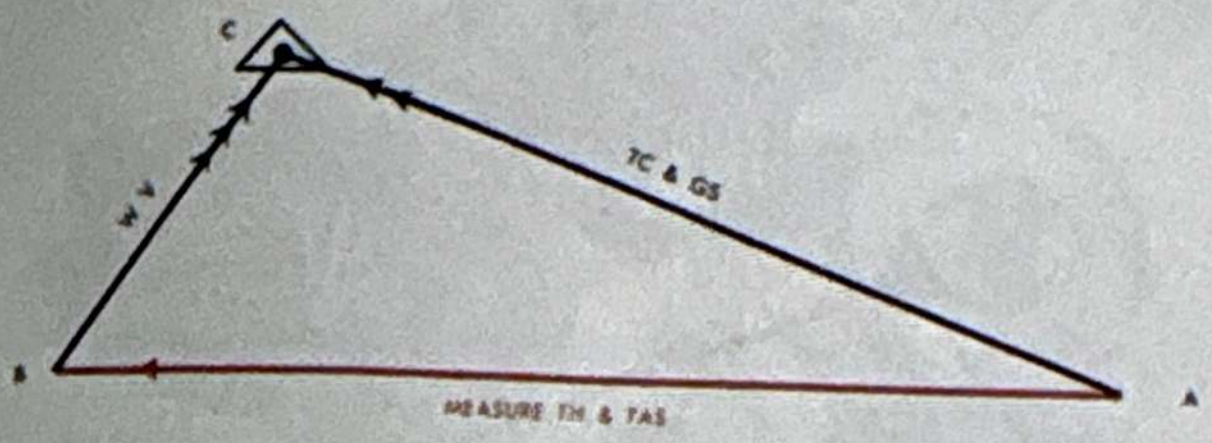


Fig. 27

The third type of problem involves solving for TC and GS. This solution is basic to pure dead reckoning when no fixing aids are available. The wind vector is plotted and the head of the air vector attached to the tail of the wind vector. Departure point A is established and TC and GS can be measured between points A and C.

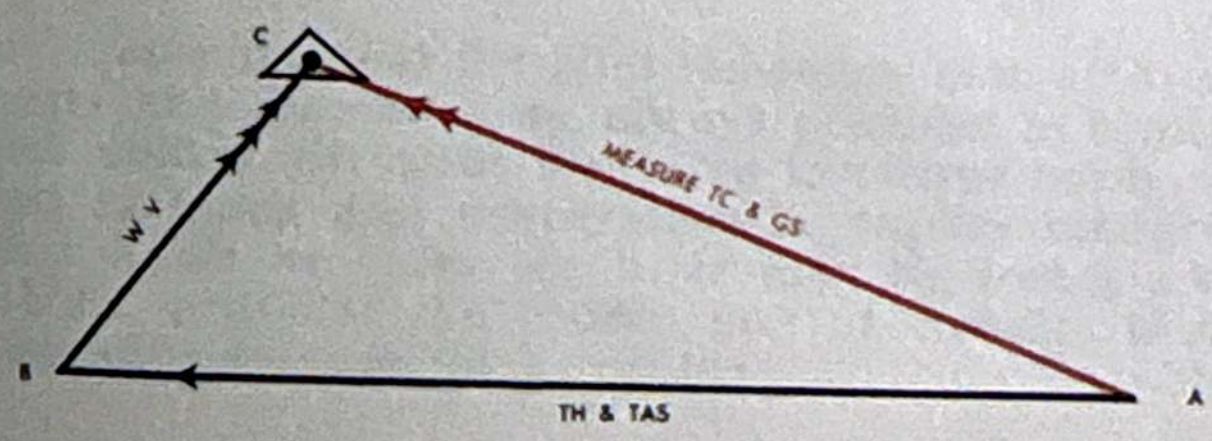


Fig. 28

The last problem involves solving for the actual wind. This problem is usually encountered while in flight. By establishing a departure point, A, and plotting the air and ground vectors from it, points B and C are located. The wind is measured from B to C since the aircraft will always be blown from heading to track.

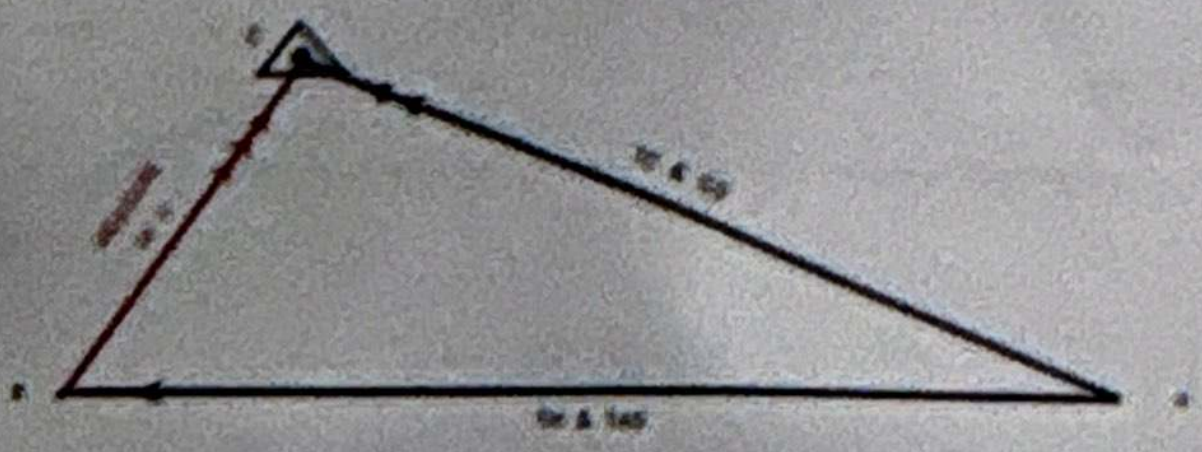


Fig. 29



FLIGHT PLANNING WITH FORECAST WINDS

The most common type wind problem usually encountered by the pilot is the one in which he is required to calculate true heading and ground speed. This problem is usually solved in the flight planning stages when true course, true airspeed and forecast or reported winds are known quantities.

It is essential that the pilot remember that winds aloft reports and forecasts are always provided in a format which utilizes directions measured from true north, wind speed in knots and temperature in degrees centigrade. Either knots or miles per hour may be used in a wind problem provided the chosen unit of measure is used consistently throughout the problem.

There are several ways of solving flight planning problems however, the one outlined here is the most consistent with the other solutions presented in the booklet.

Example

Given: True Course, 195°
Wind direction, 240°
Wind speed, 30 knots
True airspeed, 180 knots

Find: Groundspeed
True heading

Solution:

1. Set the true course (195°) under the TRUE INDEX.
2. Locate the wind point on the transparent disc. This is accomplished by finding the wind direction (240°) on the periphery of the computer disc, then proceeding toward the center of the disc on the 240° degree line until it intersects the appropriate wind circle (30). The wind point may either be mentally noted or marked with a pencil dot.
3. Adjust the moveable slide until the arc representing the true airspeed (180 knots) is read directly under the wind point as illustrated in Figure 30.

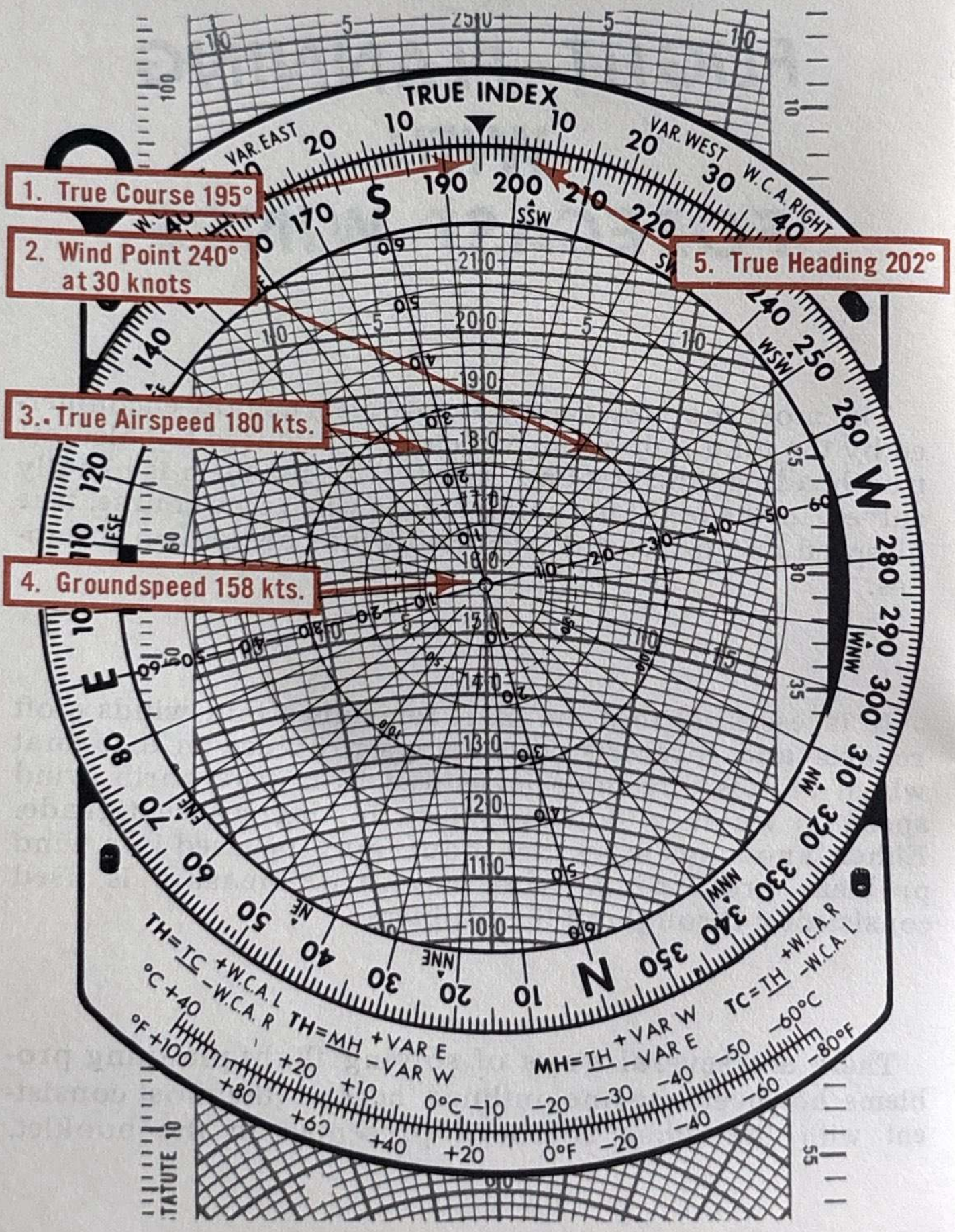


Fig. 30

4. Read the groundspeed (158 knots) on the speed arc directly under the small circle at the center of the disc.
5. Read the wind correction angle (7° right) directly under the wind point on the vertical lines printed on the moveable slide. Note that the wind point is approximately over the vertical line 7th from the right of the center line.
6. Since the wind correction angle is 7° right, the true heading is 7° to the right of the true course. Thus, read the true heading (202°) 7° right of the TRUE INDEX.

NOTE: All of the wind problems presented in this booklet will be solved with the true course (track) under the TRUE INDEX, the true airspeed under the wind point and the ground speed under the small circle in the center of the transparent disc.

PROBLEMS 11

Find groundspeed and true heading; check your answers against the answers in Part C.

	True Course	Wind Direction	Wind Speed	True Airspeed	Ground Speed	True Heading
1.	080°	148°	32k	170k	.....	.....
2.	010°	300°	18	130	.....	.....
3.	160°	015°	29	190	.....	.....
4.	275°	225°	15	140	.....	.....
5.	050°	180°	35	200	.....	.....
6.	190°	078°	30	175	.....	.....



TRUE HEADING AND TRUE AIR SPEED

"Have a date to meet someone? Whether it's a good looking gal, an airplane to intercept or a flight schedule to make good, there are times when you want to know the true air speed that will enable you to make good a given ground speed. Here's how:"

Your ground speed will be determined for you in advance. The problem of pre-flight calculations then becomes one of finding true heading and true air speed. This solution differs only very slightly from the one for true heading and ground speed.

Example

Given: True course, 240°
Wind direction, 090°
Wind speed, 20 knots
Ground speed, 140 knots

Find: True airspeed
True heading

Solution:

1. Set the true course (240°) under the TRUE INDEX.
2. Locate the wind point (090° at 20 knots) on the transparent disc.
3. Adjust the moveable slide until the arc representing the groundspeed (140 knots) is read directly under the small circle in the center of the transparent disc.

4. Read the true airspeed (123 knots) under the wind point.
5. Read the wind correction angle of 5° left on the vertical lines under the wind point. The true heading (235°) is found by reading 5° to the left of the TRUE INDEX as illustrated in Figure 31.

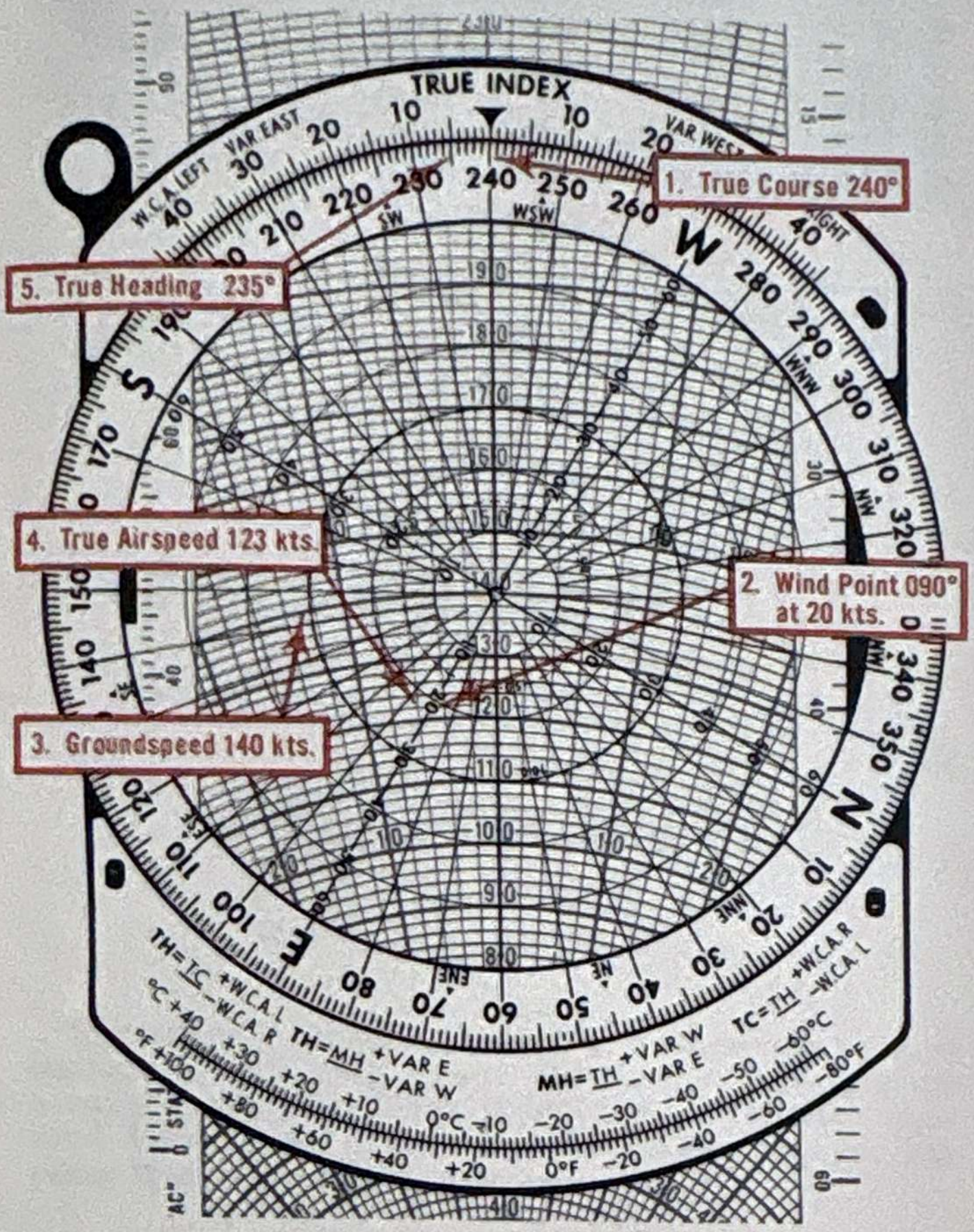


Fig. 31

NOTE: Remember that for any problem worked on the E6B computer, the true course is always set at the TRUE INDEX , the true airspeed is set at the wind point and the groundspeed is set at the small circle in the center of the transparent disc.

PROBLEMS 12

Find true airspeed and true heading; check your answers against the answers in Part C.

	True Course	Wind Direction	Wind Speed	Ground Speed	True Airspeed	True Heading
1.	340°	220°	20k	160k	151	333
2.	274°	050°	15	153	.....	.....
3.	183°	150°	25	135	.....	.....
4.	005°	230°	10	154	.....	.....
5.	112°	070°	20	126	.....	.....
6.	266°	320°	30	153	.....	.....



TRUE COURSE (TRACK) AND GROUND SPEED

"Sometimes it's mighty interesting to know where you're going and how fast. Your air speed and heading are usually available in flight. If, in addition, you have some wind information (either reported or forecast) you can easily find true course and ground speed."

In a practical sense, this solution is useful to the airborne pilot when he knows the wind, true heading and true airspeed but has no means by which he can determine the true course or groundspeed. A problem such as this can be solved as follows:

Example

Given: True heading, 175°
Wind direction, 320°
Wind speed, 30 knots
True airspeed, 180 knots

Find: True course (track)
Groundspeed

Solution:

1. Set the true heading (175°) at the TRUE INDEX as a temporary measure. (Since a correct solution cannot be read from the computer with the true heading at the TRUE INDEX, a further adjustment must be made as the problem progresses.)
2. Locate the wind point (320° at 30 knots) on the transparent disc.
3. Adjust the moveable slide until the true airspeed arc (180) is directly under the wind point as illustrated in Figure 32.

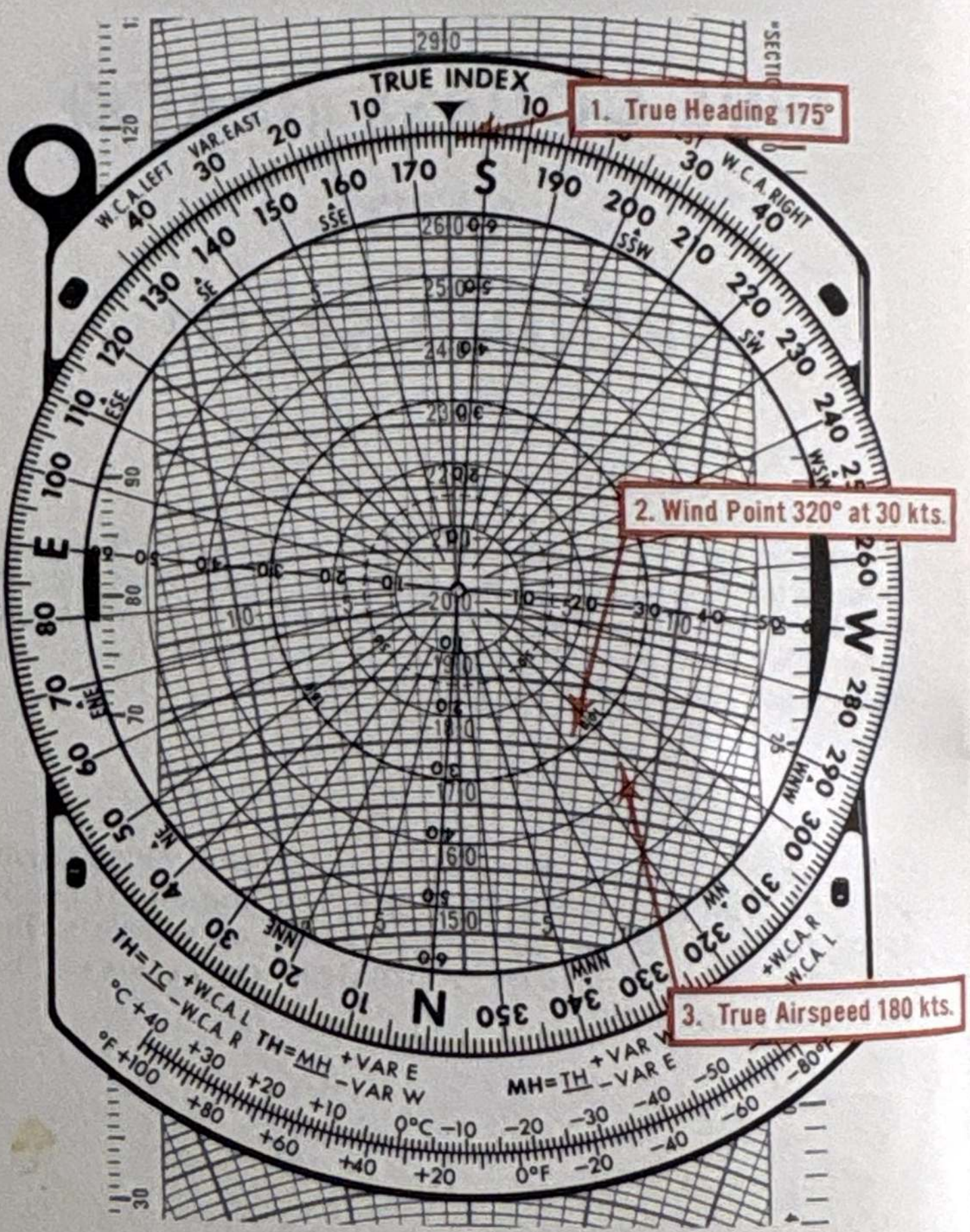


Fig. 32

4. By noting the position of the wind point in relation to the vertical wind correction angle lines, one may notice approximately a 5° right wind correction angle. Since this value is the difference between the true heading and the true course, adjust the transparent disc 5° to the right placing 170° under the TRUE INDEX which corresponds to the 5° right wind correction angle noted at the wind point. This angular relationship must be maintained in order to reach a correct solution.

5. Adjust the moveable slide to keep the true airspeed arc (180) under the wind point. (If this action appreciably affects the angular relationship referred to in step 4, a second adjustment of the transparent disc and the moveable slide may be necessary).

6. Read the groundspeed (206 knots) under the small circle in the middle of the transparent disc.

7. Read the true course (170°) at the TRUE INDEX as illustrated in Figure 33.

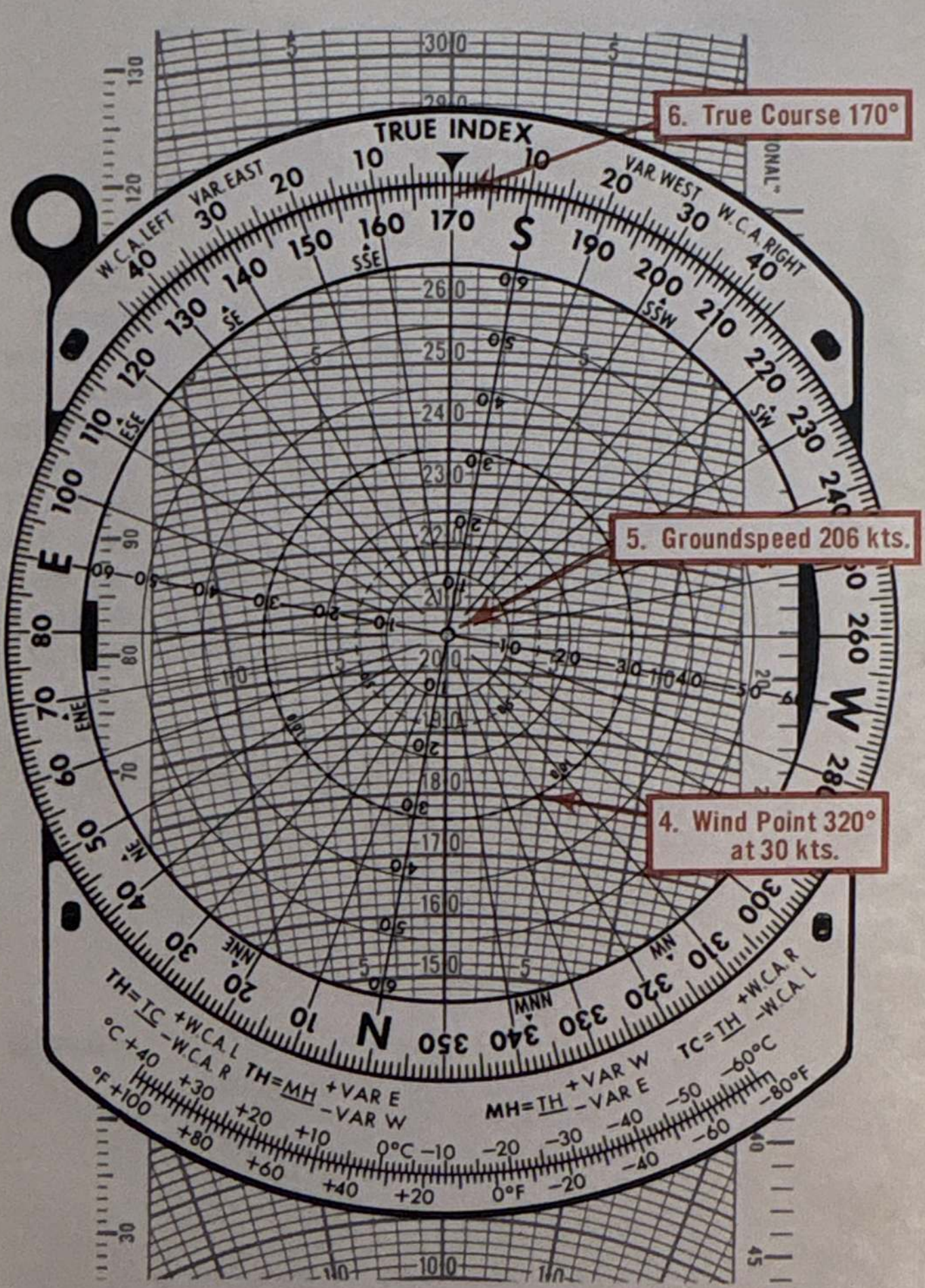
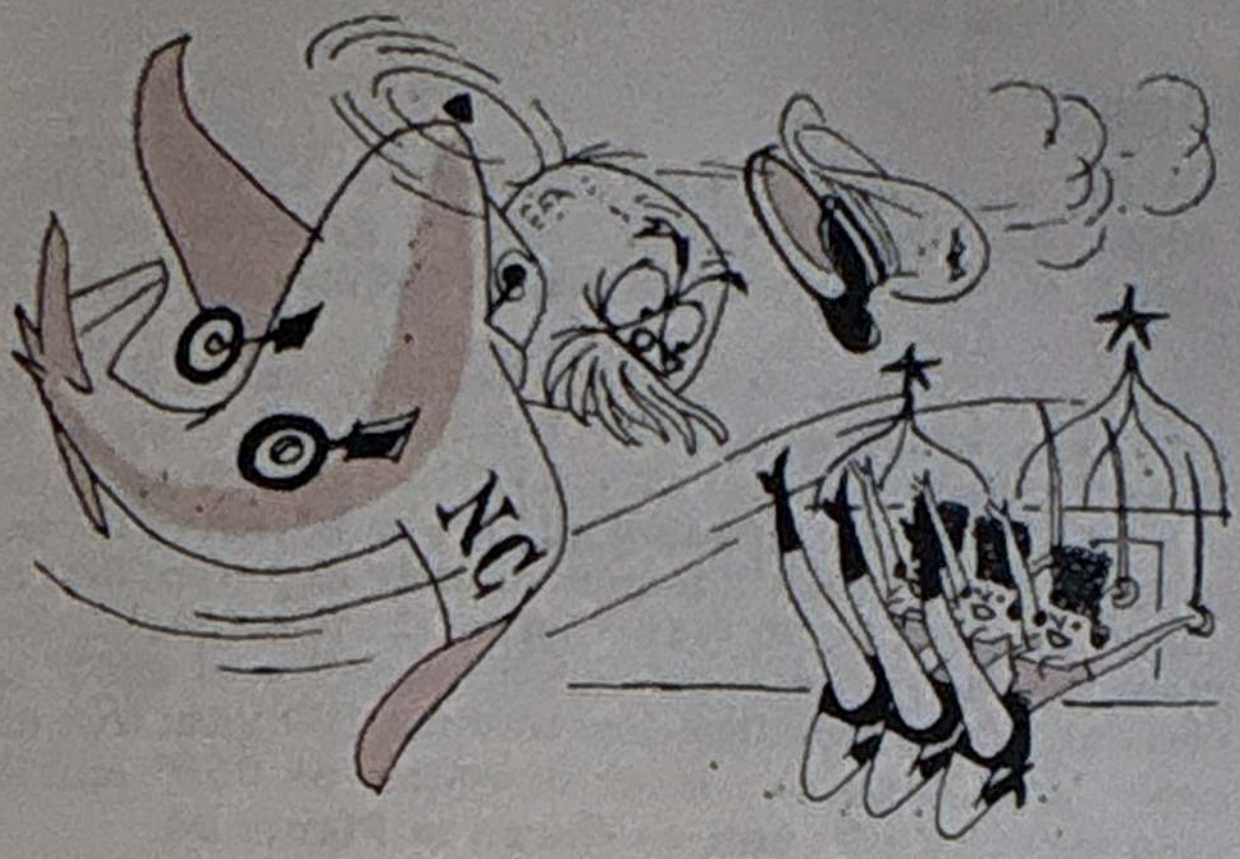


Fig. 33

PROBLEMS 13

Find groundspeed and true course (track); check your answers against the answers in Part C.

	True Heading	Wind Direction	Wind Speed	True Airspeed	Ground Speed	True Course
1.	075°	350°	30k	140k	141	82°
2.	240°	115°	28	155	172	248°
3.	352°	025°	36	145	114	360°
4.	115°	185°	40	170	.....	.....
5.	026°	230°	25	200	.....	.....
6.	173°	190°	30	160	.....	.....



FINDING WINDS IN FLIGHT

"Gentlemen, often after you get 'upstairs' you find the wind is not behaving as the 'weather-guesser' said it would. You must hold a different heading from that originally estimated, in order to make good your course, and your are crossing check points ahead of or behind planned times. You know how fast and where you're going (ground speed and true course). . . .also the heading that's getting you there (true heading). . . . . .but without accurate wind information you can't re-estimate the legs ahead. Hence you need to determine the actual wind direction and speed."

Let's assume the following:

Example

Given: True course (track), 122°
Groundspeed, 154 knots
True heading, 118°
True airspeed, 160 knots

Find: Wind direction
Wind speed

Solution:

1. Set the true course (122°) under the TRUE INDEX.
2. Adjust the moveable slide until the groundspeed (154 knots) is directly under the small circle in the middle of the transparent disc.
3. Compare the figures for true heading and track. The difference between the true heading and track is the wind correction angle (WCA). Note on the computer disc that the true heading (118°) is 4° left of the true course (122°), thus it is immediately apparent that the wind point will be on the left side of the transparent disc.
4. Place the wind point at the intersection of the 4° left vertical wind correction line and the 160 knot true airspeed arc. Read the wind direction as 059° and the wind speed as 13 knots as shown in Figure 34.

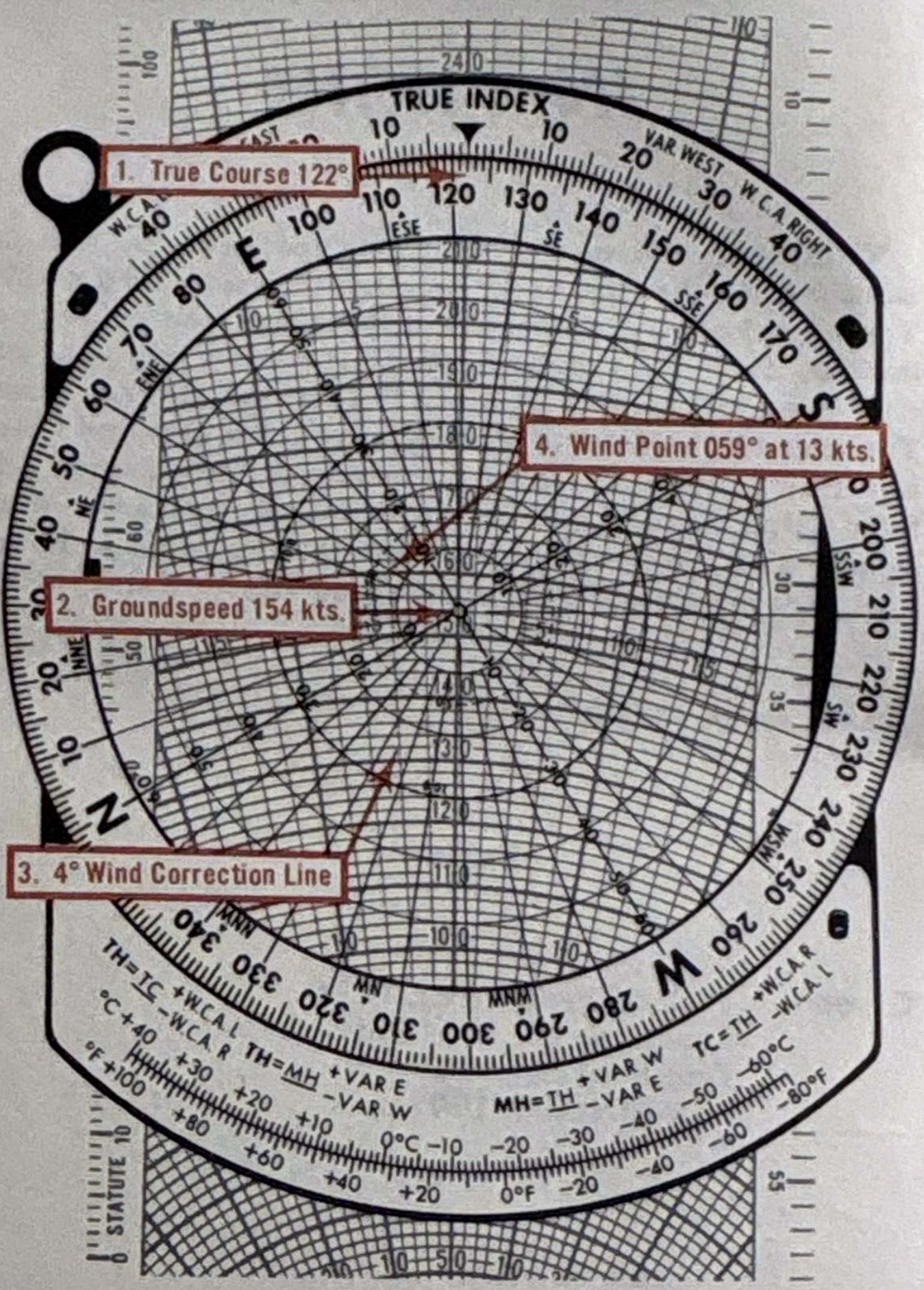
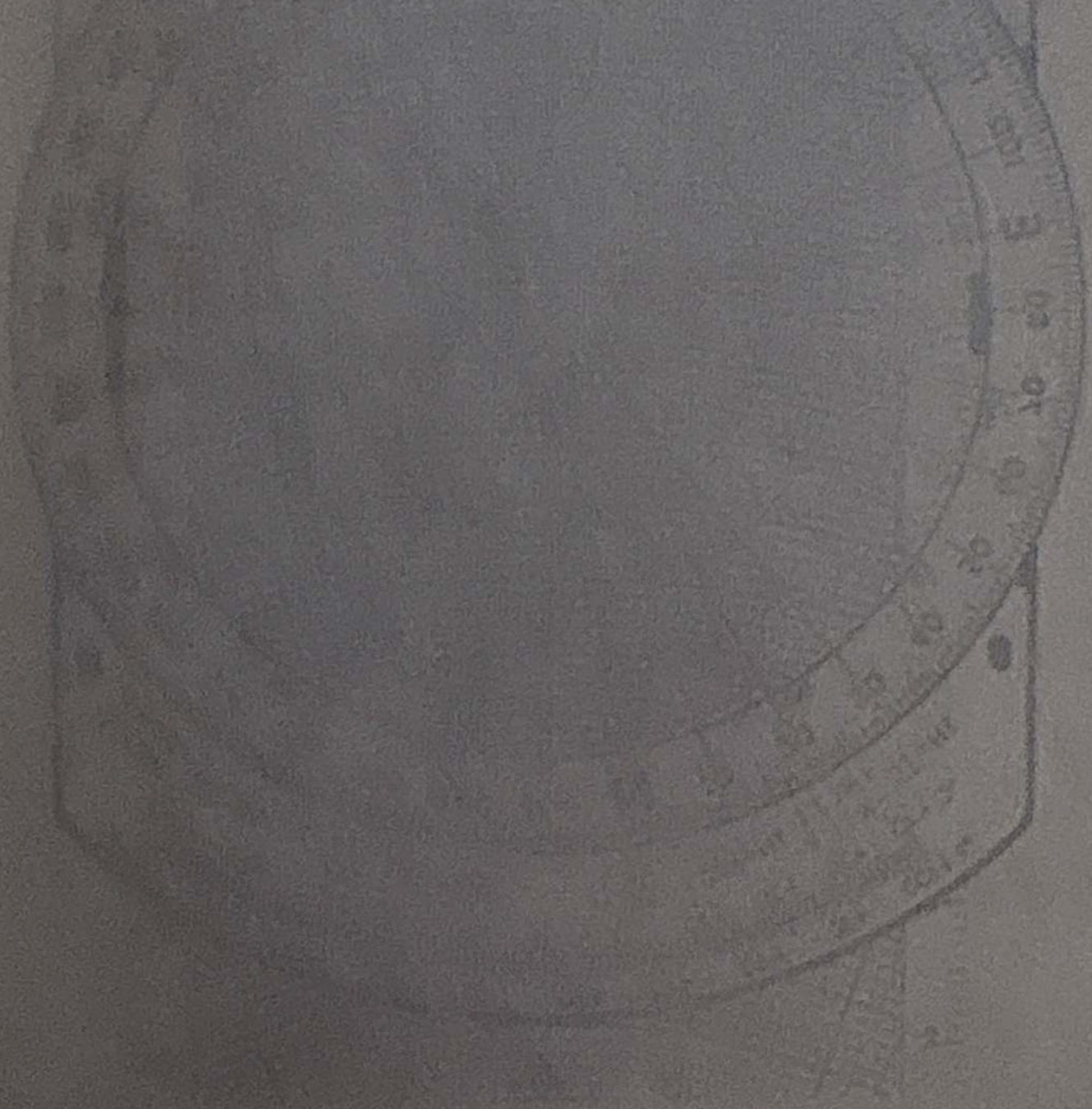


Fig. 34

PROBLEMS 14

Find wind direction and speed; check your answers against the answers in Part C.

	True Course	Ground Speed	True Heading	True Airspeed	Wind Direction	Wind Speed
1.	087°	141k	075°	140k	....	....
2.	247°	173	240°	155	....	....
3.	340°	116	352°	145	....	....
4.	101°	161	115°	170	....	....
5.	028°	224	026°	200	....	....
6.	169°	132	173°	160	....	....



HINTS ON THE USE OF THE WIND SIDE

1. The wind side of the E6B Computer incorporates a handy method for converting true course to magnetic course or vice versa. Notice that VAR. EAST (variation east) and VAR. WEST (variation west) are printed respectively on the left and right sides of the TRUE INDEX.

For example, if the pilot desires to determine the magnetic course when the true course is 170° in an area where the variation is 12° east, he need simply set 170° under the TRUE INDEX and then read the magnetic course (158°) 12° to the left of the TRUE INDEX. Of course, the problem may be reversed to determine the true course when magnetic course and variation are known factors. (See Figure 35)

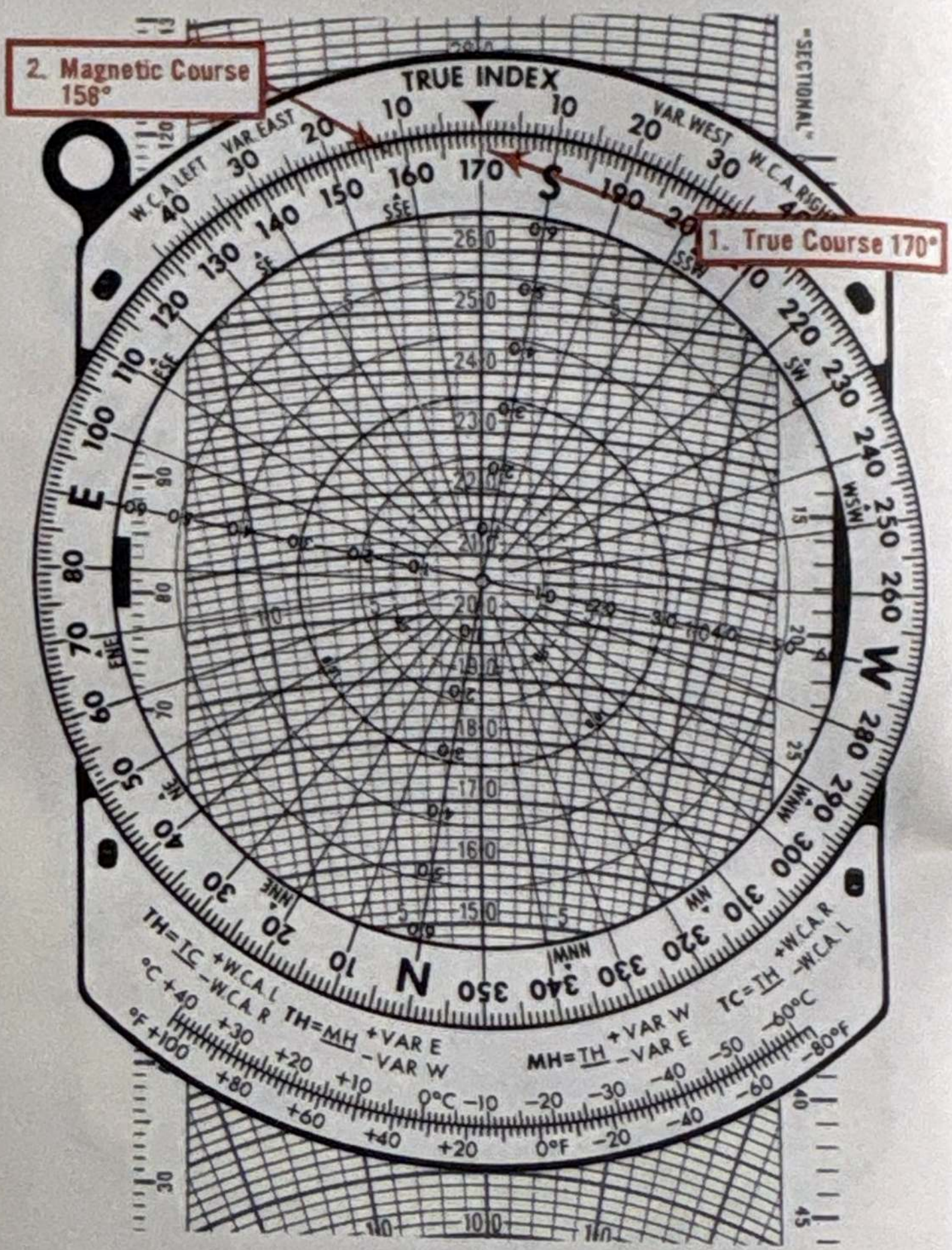


Fig. 35

2. If, in any wind problem, the wind point is plotted on the left side of the computer the wind correction angle will be to the left. That is, the true heading will be left of the true course. This is designated on the computer by the "W.C.A. LEFT" and "W.C.A. RIGHT" printed on either side of the TRUE INDEX.

ADDITIONAL USES OF THE JEPPESEN E6B 3-WAY SLIDE

The E6B 3-way slide is a mighty fine piece of equipment. It not only enables you to figure wind and speed problems, but it also gives you a protractor and mileage scale on the same unit to figure course and distance without having to carry or handle another separate accessory item.

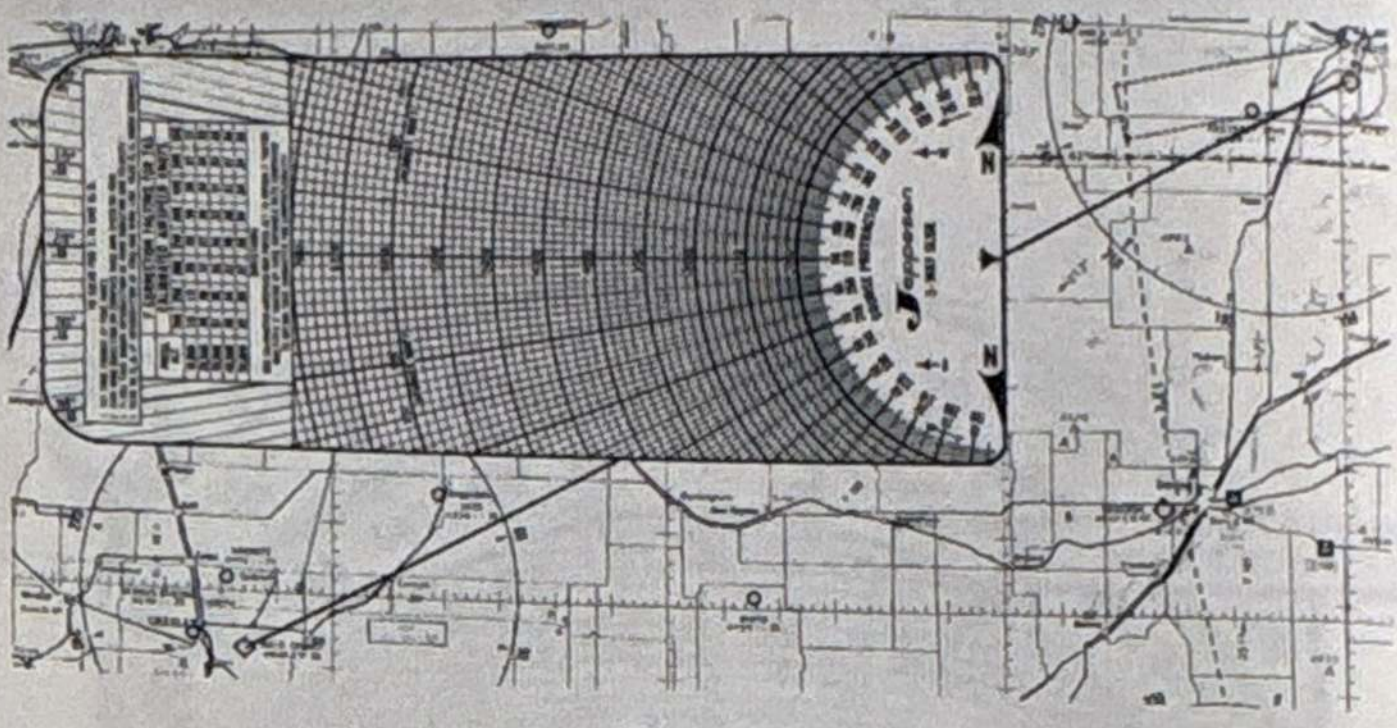


Fig. 36

COURSE PROTRACTOR

This handy feature enables you to determine true course (TC) on WAC or Sectional Charts quickly and easily. These charts have many lines running north-south and east-west (longitude, latitude, section lines, highways, etc.) for quick orientation to true north. For practical purposes, such orientation is entirely adequate for flights using these charts. Remember, however, to correct for variation to obtain magnetic course. Fig. 36, for example, shows the Course Protractor in position for a course line with a TC of 243°. Note that each set of figures on the Course Protractor gives the reciprocal figure so that whichever direction you're headed you can read the number directly. There are also course figures (with reciprocals) located on the other end of the slide for additional convenience within their range. Remember, these lines are all spaced only one degree apart.

MILEAGE SCALES

A set of mileage scales for both WAC and Sectional Charts is another fine feature to be found on the E6B 3-way slide. Now you can use this same slide to measure distance on either of these charts conveniently without carrying a separate plotter.

Part C

ANSWERS, DEFINITIONS AND HINTS

ANSWERS TO PRACTICE PROBLEMS

PROBLEMS 1

1. 53 min.
2. 192 mi.
3. 1:12
4. 142
5. 83 mi.
6. 157

PROBLEMS 2

1. 208.5 naut. mi.
   385 kilometers
2. 21.8 stat. mi.
   18.9 naut. mi.
3. 13 naut. mi.
   24 kilometers
4. 184 stat. mi.
   295 kilometers
5. 29.3 stat. mi.
   25.4 naut. mi.
6. 9.2 stat. mi.
   14.8 kilometers

PROBLEMS 3

1. 4,000'
2. 3,000'
3. 7,000'

PROBLEMS 4

1. 12,200'
2. 5,900'
3. 7,600' (7,590')
4. 21,800'

PROBLEMS 5

1. 144 mph
2. 179 kts.
3. 228 mph
4. 235 mph
5. 150 kts.
6. 170 kts.

PROBLEMS 6

1. 421 kts.
2. 432 kts.
3. Mach 1.0

PROBLEMS 7

1. –37°C 326 kts.
2. –58°C 452 kts.
3. –23°C 341 kts.
4. –49°C 414 kts.
5. –39°C 462 kts.
6. –56°C 428 kts.

PROBLEMS 8

1. 391
2. 1.71
3. 23.0

PROBLEMS 9

1. 27 min.
2. 54 mi. (stat.)

PROBLEMS 10

1. 4.3°, 11.3°, 15.6°
2. 3.8°, 7.1°, 10.9°
3. 2.2°, 3.9°, 6.1°
4. 1.5°, 3.8°, 5.3°
5. 3.0°, 8.2°, 11.2°
6. 3.2°, 11.0°, 14.2°

PROBLEMS 11

1. 156 kts., 090°
2. 122 kts., 002°
3. 211 kts., 156°
4. 130 kts., 270°
5. 221 kts., 058°
6. 184 kts., 181°

PROBLEMS 12

1. 151 kts., 334°
2. 143 kts., 279°
3. 157 kts., 178°
4. 147 kts., 002°
5. 141 kts., 107°
6. 173 kts., 274°

PROBLEMS 13

1. 141 kts., 087°
2. 173 kts., 247°
3. 116 kts., 342°
4. 161 kts., 101°
5. 224 kts., 028°
6. 132 kts., 169°

PROBLEMS 14

1. 350°, 30 kts.
2. 112°, 27 kts.
3. 030°, 40 kts.
4. 185°, 40 kts.
5. 225°, 25 kts.
6. 190°, 30 kts.

DEFINITIONS

Heading (H) – direction in which the longitudinal axis of the aircraft is pointed with respect to north. True heading is related to true north, magnetic heading to magnetic north, and compass heading to compass north.

Course (C) – intended direction or path of travel over the surface of the earth with respect to north.

Track (T) – actual direction or path of travel made good over the surface of the earth with respect to true north.

Wind Correction Angle (WCA) – The angular difference between the heading of the aircraft and the course, necessary to counteract wind effects to keep the aircraft on course.

Drift Angle (DA) – The angular difference between the course and the track as the result of wind effects, when the aircraft heading is the same as the course. Note: For a given course, wind and air speed the crab angle is not exactly equal to the drift angle because heading of the aircraft relative to the direction of the wind is different in the two cases.

Indicated Air Speed (IAS) – Indicated air speed is equal to the pitot static airspeed indicator reading as installed in the airplane without correction for airspeed indicator system errors but including the sea level standard adiabatic compressible flow correction. (This latter correction is included in the calibration of the air-speed instrument dials.)

Calibrated Air Speed (CAS) – Calibrated air speed is equal to the air-speed indicator reading corrected for position and instrument error. (As a result of the sea level adibatic compressible flow correction to the air-speed instrument dial, CAS is equal to the true air speed TAS in standard atmosphere at sea level.)

Equivalent Air Speed (EAS) – Equivalent air speed is equal to the air-speed indicator reading corrected for position error, instrument error, and for adiabatic compressible flow for the particular altitude. (EAS is equal to CAS at sea level in standard atmosphere.)

True Air Speed (TAS) – True air speed of the airplane relative to undisturbed air. (TAS = EAS $(p°/p)1/2$).

Effective True Air Speed (Eff. TAS) – The amount of true air speed along the course. As a given wind has cross wind and course (head or tail) wind components, so true air speed has two components, effective true air speed along the course and crab component equal to the cross wind component.

Ground Speed– The rate of motion over the ground, the result of interaction between true air speed and wind speed in their relative directions of motion.

Component– The amount of a force effective at an angle to the direction of the force.

True Direction (T)– Direction with respect to true north. Heading, course and track may be measured from true north (TH, TC, and TT). Wind is measured from true north, except wind reported by towers for local traffic, which is reported magnetic.

Magnetic Direction (M)– Direction with respect to magnetic north. Heading, course and track may be measured from magnetic north (MH, MC, MT). Magnetic direction has a fixed variation from true direction at any locality (except for minute annual change) no matter what angle is measured.

Compass Direction (C)– Direction with respect to compass north. Heading, course and track are rarely measured from compass north (CH, CC, CT). Compass direction deviates from magnetic direction in varying amounts for each angle measured and the deviation for any angle will vary from time to time.

Pressure Altitude (PA)– Altitude recorded with altimeter set at 29.92 inches of mercury or 1013.2 millibars.

Density Altitude (DA)– Basically, air density, as applied to flight, is the measure of the number of molecules of air per cubic inch which can act upon the aircraft surface with the resulting forces of lift, drag, etc. Density of a gas is determined by pressure and temperature. Density altitude is the theoretical density of a standard atmosphere at that altitude. Aircraft performance is directly related to air density; therefore, performance is determined by density altitude regardless of indicated or actual altitude.

True Altitude (TA)– The altitude as close to absolute altitude above sea level as it is possible to obtain from instruments within the aircraft. Usually this altitude is quite accurate, but there is no guarantee that it will be so. Unknown variations in pressure may produce dramatic errors.

Indicated Altitude (IA)– Altitude recorded with altimeter set for pressure reading at a ground station.

Calibrated Altitude (CA)– Indicated altitude corrected for mechanical errors resulting from complexity of installation.

Mach– Related to the speed of sound. Mach 1.0 is the speed of sound in the atmosphere. All factors other than temperature have practically no effect on the speed of sound, but temperature has a large effect. Mach 1 is

669.6 MPH at –50°C and 806.9 MPH at +50°C. Therefore, a specific mach number does not determine speed in MPH or knots directly, but a specific mach number has a specific MPH or knots equivalent which is different for each different temperature.

Temperature Rise – Increase in temperature indication over true outside air temperature resulting from the heat of friction and the heat of compressibility of the air.

Standard Atmosphere – Pressure and temperature values for any given altitude, arbitrarily established as a standard basis to which all problems related to altitude may be compared.

The standard atmosphere is defined as follows:

(i) The air is a dry, perfect gas,
(ii) The temperature at sea level is 59°F.,
(iii) The pressure at sea level is 29.92 inches Hg,
(iv) The temperature gradient from sea level to the altitude at which the temperature equals –67°F. is –0.003566°F./ft. and zero thereabove,
(v) The density p° at sea level under the above conditions is 0.002378 lb. sec. 2/ft.4.

TIPS ON CARE AND USE OF THE JEPPESEN E6B COMPUTER

Caution – The vinyl plastic model of the E6B computer should not be exposed to temperatures at or above 140°F or 60°C. Temperatures at or above 140°F or 60°C will cause warping to occur. The computer should not be left exposed to direct sunlight inside a cockpit, especially during warm weather.

To avoid losing or mislaying the computer in the cockpit, tie a string, or place a bead chain, through the loop on the side of the computer. The computer can then be worn around the neck or attached in the cockpit. A bead chain, with a fastening device, can be purchased at any hardware store. A bead chain is quite practical since it will not twist.

The E6B can be adjusted for "accuracy" and "tightness" through the following procedure.

1. **Adjust for "Tightness"**
   - A. Loosen the bottom two (2) retaining screws. It is not necessary to loosen screws more than one (1) full turn – this will prevent their loss while adjusting.
   - B. Pull the bottom plate "away from assembly" ever so slightly. Test rotating disc for "desirable looseness".
   - C. Tighten bottom two (2) screws "by degrees", testing rotating disc as you tighten to maintain "desirable looseness".
2. **Adjust for "Accuracy"** – The Jeppesen E6B Computers are the most accurate computers of this type available. . . but as in other things, factory assembly sometimes requires further adjustment for the very best performance.
   - A. Test your computer slide for "alignment accuracy" . . . check alignment of the center slide line with the small circle on the transparent disc, at both ends of the slide. Remove slide from computer, turn slide over, insert into computer and repeat test.
   - B. If alignment of center lines at both extremes and on both sides is good. . .you're all set to work problems.
   - C. If alignment of the slide is OK on one side, but not on the other. . .the trouble is in the printing on the slide itself. Your Dealer or Jeppesen & Co. will gladly replace it at no charge. (Send in all parts of the computer.)
   - D. If the slide center line does not align with the small circle, proceed as follows:
     - (1) Loosen all four (4) retaining screws (do not loosen more than one (1) full turn so as not to lose screws).
     - (2) Grasp the computer firmly in one hand (with slide installed in computer), press the rotating disc and retaining bar assembly in the direction required to align the small circle with the slide center line.
     - (3) When aligned, tighten the four (4) screws so they "just barely hold" and check the alignment with the slide in different positions.
     - (4) When you have it into satisfactory alignment, tighten all four (4) screws securely to retain this setting.

NOTES

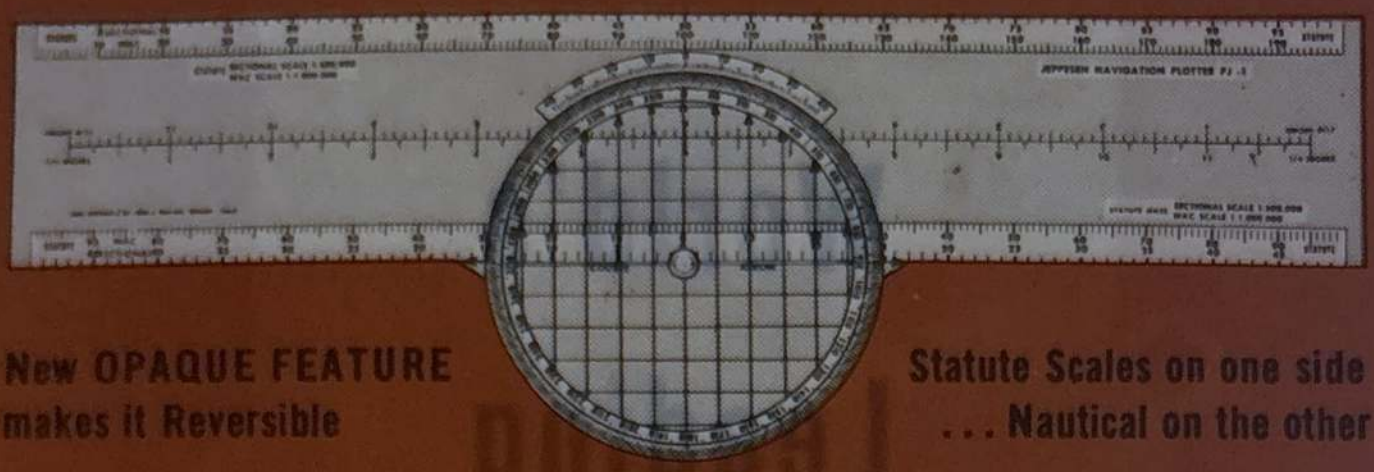
NOTES

NOTES

NOTES

New PJ-1 Plotter

earns the *Jeppesen* name



New OPAQUE FEATURE makes it Reversible

Statute Scales on one side ... Nautical on the other

Azimuth rotates for complete simplicity. Jeppesen Quality, Accuracy and Durability make this one far superior to anything on the market **$3.50**



IN-FLIGHT RECORDINGS

Easy to understand—easy to remember—entertaining to listen to! Full 12″ records, microgroove, hi-fidelity, 33⅓ speed, can be played on any standard or stereo equipment.

- Los Angeles to New York—VFR, an actual cross-country VFR flight (big double album)
  CAT. NO. RLA **$14.98**
- Tower Communications
  CAT. NO. RTC . . . . . **$ 5.98**
- On Course, On the Glide Path
  CAT. NO. ROC . . . . . **$ 5.98**
- ATC Clears (learn to copy ATC Clearances)*
  CAT. NO. RAC-2 . . . . . **$ 8.98**
- Instrument Flight
  CAT. NO. RIF . . . . . **$ 8.98**
- Weather for Pilots (big double album)
  CAT. NO. RWP **$12.98**
- In Radar Contact
  CAT. NO. RRC . . . . . **$ 5.98**
- Theory of Flight
  CAT. NO. RTF . . . . . **$ 5.98**
- Morse Code for Pilots*
  CAT. NO. RMC-2 . . . . . **$ 8.98**

*Include "Programmed" study booklets.

ALL THESE QUALITY JEPPESEN PRODUCTS AVAILABLE FROM YOUR AVIATION DEALER

World's Leading Producer of Quality Pilot Supplies

"Service for Safety"

Jeppesen & CO.

A SUBSIDIARY OF THE TIMES MIRROR COMPANY

8025 E. 40th Avenue, Denver, Colorado 80207

Please address all inquiries from Europe, Africa, and Middle East to Jeppesen & Co., GmbH, P.O. Box 16-447, Frankfurt/Main, Germany.

Printed in U.S.A.

Prices subject to change without notice.