ARC-5-5046N

REC
118.7 BURT
121.9 GRDC
122.2 RANGE
126.7 !

TRANS
121.9 GRNC
122.1 RNG
122.5 TOWR
126.7 RNG

AMAIR
E349-7-43-10M-Ⓔ

B-11139

INSTRUCTIONS
FOR USE OF

NAVIGATIONAL COMPUTER TYPE "B"

Charles Eaton

COMPILED BY
ENGINEERING DEPARTMENT
AMERICAN AIRLINES Inc.
MARCH 4, 1943

AMERICAN AIRLINES, INC.

INSTRUCTIONS FOR USE OF NAVIGATIONAL COMPUTER (TYPE B)

The following instructions apply specifically to the revised (Type B) computer, which may be identified by the letter 'B' preceding the serial number on the computer. However, these instructions also apply to all earlier computers, with the exception that earlier computers have no 'Minute Adding' and 'Temperature Conversion' disc, and 'Altitude Correction Window'.

Paragraph

1. The American Airlines Navigational Computer has been developed to aid the pilot in controlling his flight under all conditions of wind and weather. Practically all problems encountered in air navigation except those involving Celestial Navigation may be solved accurately and rapidly by the use of this computer. Proficiency in its use demands persistent practice, and it is suggested that before attempting to use it in the air the pilot work a number of practice examples on the ground.

2. The computer consists of four plastic discs which are free to revolve about a common center. One side of the computer is called SECTION I and the other side is called SECTION II.

SECTION I consists of three discs of different sizes:

A. Largest Disc - Miles or miles per hour, Feet, or feet per minute, Gallons, or gallons per hour - any quantity which varies with time.

B. Second Largest - Minutes, or Hours in all problems involving time. In problems involving Air Speed being corrected for Temperature Altitude. This scale is Indicated Air Speed, and Altitude Correction and Air Speed Correction.

C. Smallest - Minute adding scale and Temperature Conversion.

The second largest disc contains two windows through which may be observed the altitude scale for density correction of airspeed and temperature scale for correction of altitude.

At 60 minutes on the second largest disc, there is an arrow which is marked on some computers 'Ground Speed Index'. On some computers, this is 'Hour Index'. This index is used in problems involving any quantity per hour. When 'Hour Index' is referred to below, it is to mean 'Ground Speed' Index on the computers which are so marked.

SECTION II consists of two discs of equal size:

a. The transparent 'Degree-Wind Angle', marked 'D'.
b. The opaque 'Navigation' disc (beneath transparent disc) marked 'E'.

SECTION I

3. SECTION I of the computer is used for solving problems involving:

- True Airspeed
- Indicated Airspeed
- Ground Speed
- Distance
- Altitude
- Gasoline Consumption
- Climb
- Minute Adding
- Miscellaneous Calculations

4. OPERATION AS AN ORDINARY SLIDE RULE: For those who are accustomed to using an ordinary slide rule, it should be noted that the two outer scales of Section 'I' may be used as the 'C' and 'D' scales of the ordinary slide rule. Using the computer in this manner, all problems in multiplication, division, and proportion may be solved readily. For those not accustomed to the use of the slide rule, the decimal point is determined by inspection. The figure 10 may be 1.0, 10., 100, or 1. The problem will usually be such that the decimal point is easily determined. For instance in a problem concerning Airspeed, if the answer is 15 on the computer, it would be obvious that the Airspeed would be 150 miles per hour rather than 15 miles per hour.

5. TRUE AIRSPEED: (See GLOSSARY OF TERMS, at end of these instructions, for definition).

TRUE AIRSPEED: is calculated using the two scales on the outside of the two largest discs and also the small Temperature-Altitude scale in the window of the second disc.

6. The observed Outside Air Temperature is set opposite the observed Pressure Altitude using the small scales in the window. The True Airspeed may then be read on the outer disc opposite the Indicated Airspeed on the periphery of the second disc.

7. Note on Indicated Airspeed: To obtain this quantity, the reading of the Airspeed Indicator (Instrument Airspeed) must be corrected for Installation Error. This error varies with the type of installation but is approximately constant for each type of plane. The Installation Error is greatest on DC-3's and DST's at low airspeed and decreases as the airspeed increases until there is no appreciable error at high airspeeds. This is true because the installations are designed to give the least error at normal cruising speeds.

8. The average Installation Error for the airplanes in use on American Airlines is given in the following table. The plus sign before the correction indicates that it is to be added to the reading of the instrument (Instrument Airspeed) in order to obtain Indicated Airspeed.

DC-3 and DST Airspeed Installation Correction

Between 120 m.p.h. and 140 m.p.h.	(on instrument)	...+2 m.p.h.
Between 140 m.p.h. and 160 m.p.h.	(' ')	...+1 m.p.h.
Above 160 m.p.h..................	(' ')	....No Correction

Stinson Reliant Airspeed Installation Correction

At all speeds................................+ 5 miles per hour

9. Note on Pressure Altitude: Theoretically, the Kollsman pressure scale of an altimeter should be set to a pressure of 29.92 inches in determining the Pressure Altitude in order to obtain standard conditions. Practically, this is not absolutely necessary, as a variation from standard pressure of one inch (a rather large variation) will produce an error in the True Airspeed of only 2½ miles per hour.

10. Example I - Given: Altitude, Temperature, Instrument Airspeed

Required: True Airspeed

Flying at a Pressure Altitude of 10,000 feet with an Outside Air Temperature of -18 degrees centigrade, the pilot of a DC-3 observes that his airspeed instrument indicates a speed of 150 miles per hour. What is his True Airspeed?

(a) Obtain the Indicated Airspeed by adding the Installation Correction of 1 mile per hour for that speed range to the Instrument Airspeed, obtaining 151 miles per hour Indicated Airspeed.

(b) Set the Outside Air Temperature of -18 degrees centigrade opposite the Pressure Altitude of 10,000 feet in the window of the second disc, 'B'. (Fig. I).

(c) Opposite the Indicated Airspeed of 151 miles per hour on the outside of the second disc 'B', read the True Airspeed of 171.5 miles per hour on the outer disc, 'A'

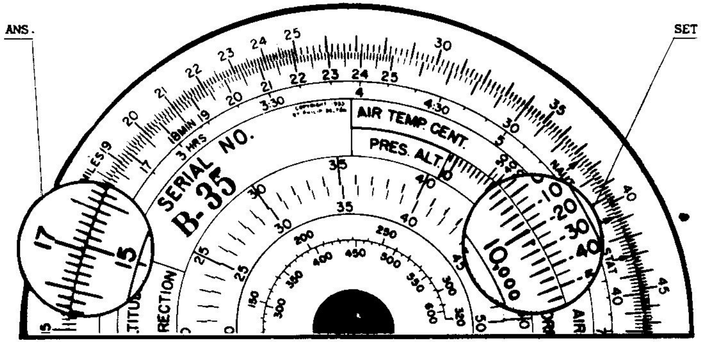

FIGURE I

11. GROUND SPEED: The two outer scales of Section I are also used for this problem. Two of the following quantities are available for its solution: Time, Distance, Ground Speed.

12. **Example 2.** Given: Distance and Time

Required: Ground Speed

A pilot finds by the use of check points that he has traveled 104 miles in 35 minutes. What is his Ground Speed?

(a) Set 35 minutes on the periphery of the second disc 'B' opposite 104 on the outer disc 'A' - (Fig. II).

(b) Opposite the Hour Index read 178 miles per hour on the outer disc 'A'.

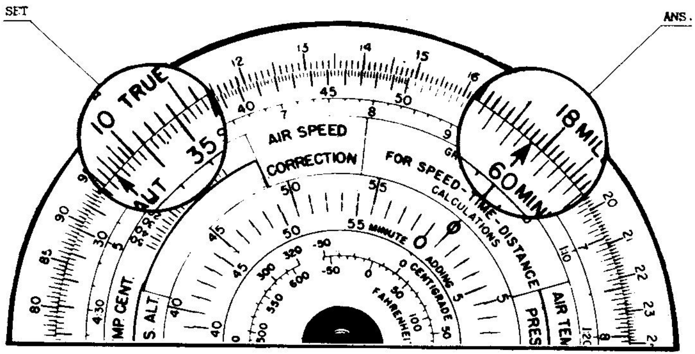

FIGURE II

13. **Example 3.** Given: Distance and Speed

Required: Time

A pilot wants to know how long it will take to go 486 miles at a Ground Speed of 156 miles per hour.

(a) Set the Hour Index opposite 156 on the outer scale 'A'-(Fig. III).

(b) Opposite 486 on the outer scale 'A' read 187 minutes (3 hours 7 minutes) on the inner scale 'B'.

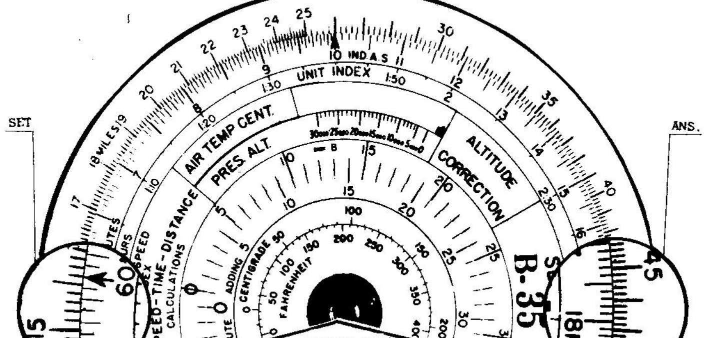

FIGURE III

Example 4. Given: Time and Speed

Required: Distance

14. A pilot wants to know what distance he will traverse in 28 minutes traveling at a Ground Speed of 148 miles per hour.

(a) Set Hour Index to 148 on the outer scale 'A' - (Fig. IV).

(b) Opposite 28 on the inner scale read 69 miles on the outer scale 'A'

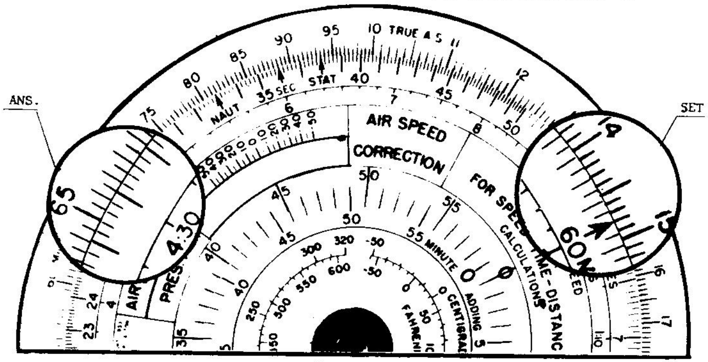

FIGURE IV

(Note: It is unnecessary to reset the computer after having once determined the speed. Thus, in the above example the pilot may determine the distance travelled in 46 minutes without changing the setting by merely looking opposite 46 on the inner 'B' scale for the Distance, 113½ miles on the outer scale, 'A')

15. MILES PER MINUTE: This may be read at once after the speed in Miles Per Hour has been obtained. The speed given in Miles Per Hour opposite the Hour Index is given in Miles Per Minute opposite the small arrow above the figure '10' on the second disc 'B'. (A large arrow marked 'Unit Index' appears on the revised computers at this point.)

16. Example 5. In example 3 the Ground Speed is 156 miles per hour. What is the speed in Miles Per Minute?

(a) With the Hour Index set at 156 miles per hour read the speed in miles per minute above the small arrow above the 10 on the second disc 'B'. 2.6 miles per minute. (See Fig. III).

17. There are times when a pilot may wish to know the time required to cover a short distance such as the distance from the cone of silence to the edge of a field, or between inner marker and range station. Since the distance is short, the time required may be less than a minute, in which case the time has more significance when expressed in seconds. In such cases, the 'Seconds Index' is used. This is found on second largest scale 'B' at 36. (There are 3600 Seconds in an hour.) The following example illustrates this problem.

18. Example 6. Given: Miles per Hour and Distance

Required: Number of seconds to cover the distance

A pilot is approaching a field at a ground speed of 120 miles per hour. The inner marker is 1½ miles from the edge of the field. The pilot wants to know how many seconds will elapse after crossing the marker before he is over the edge of the field.

(a) Set the 'Seconds Index' (or 36 if not marked) opposite 120 on the outer scale 'A'. - (Fig. V).

(b) Opposite 1.5 on the outer dial, read 45 seconds on the inner dial 'B'.

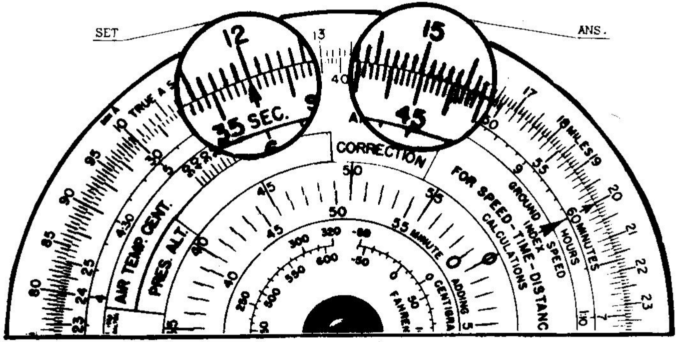

FIGURE V

19. MINUTE ADDING: The smallest disc on the Section I side of the computer is used for minute adding.

Example 7. A pilot is over a check point at 5:43 P.M. He estimates his arrival over the next check point in 26 minutes. What time will it be over the next check point?

(a) Set the 0 on the Minute Adding scale to 43 (the present time) on the scale just outside the smallest disc 'C' (Fig. VI).

(b) Opposite 26 on the small disc 'C' (the estimated elapsed time) read 09 on the outer scale. The time over the next check point will be 6:09 P.M.

Subtraction may be accomplished by reversing the procedure just described; that is, by placing the figure to be subtracted on the smallest scale opposite the figure to be subtracted from the outer scale. The difference will appear on the outer scale opposite 0 on the smallest scale 'C'.

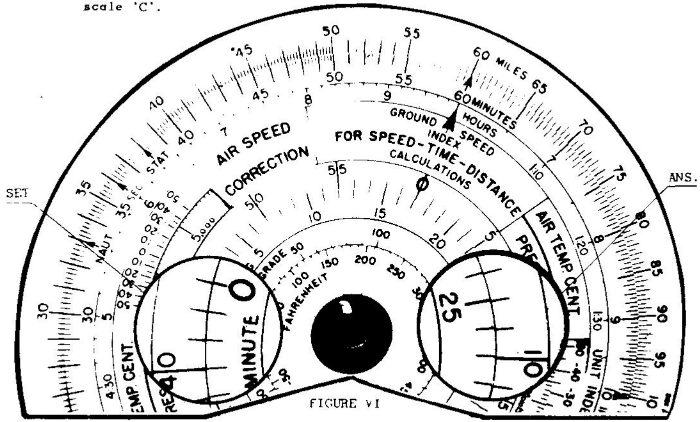

FIGURE VI

20. GASOLINE CONSUMPTION: The two outer scales of Section I may be used for this problem. Two of the following quantities are available for its solution: Total Gallons Used, Time, Rate of Consumption.

21. Example 8: Given: Time and Rate of Consumption

Required: Total Gallons Used

A pilot wishes to know how many gallons are necessary to fly 3½ hours at an average rate of consumption of 95 gallons per hour.

(a) Set Hour Index (1 hour) opposite 95 on outer scale 'A' - (Fig. VII).

(b) Opposite 3½ hours (210 minutes) on inner scale 'B' read 332 gallons on outer scale 'A'.

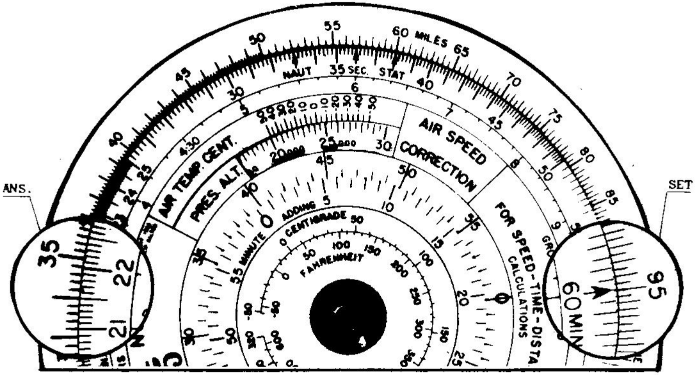

FIGURE VII

22. Example 9: Given: Total Gallons and Rate of Consumption

Required: Time

A pilot has 230 gallons aboard. How long will it last at an average rate of consumption of 80 gallons per hour?

(a) Set Hour Index (1 hour) opposite 80 on outer scale 'A' - (Fig. VIII).

(b) Opposite 230 on outer scale 'A' read 173 minutes (2 hours, 53 minutes) on inner scale 'B'.

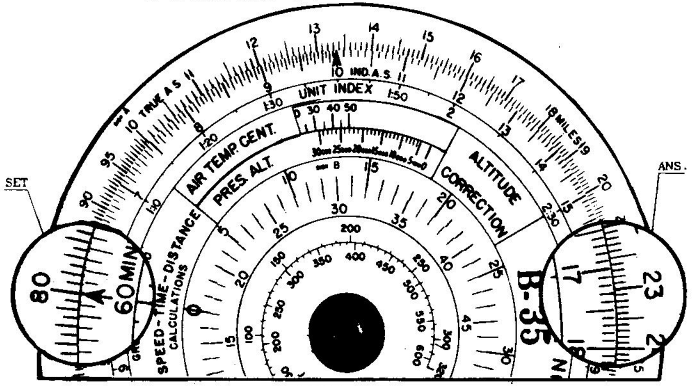

FIGURE VIII

Example 10: Given: Total Gallons Used and Time

Required: Rate of Consumption

23. After flying for 145 minutes (2 hours, 25 minutes) a pilot notes that he has used 228 gallons of gasoline. What is the Rate of Consumption?

(a) Set 145 minutes on the inner scale 'B' opposite 228 gallons on the outer scale 'A' (Fig. IX).

(b) Opposite the Hour Index (1 Hour) read the Rate of Consumption 94 gallons per hour.

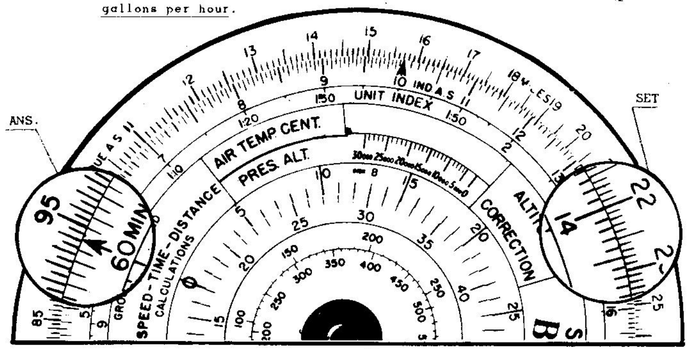

FIGURE IX

(Notes: In planes equipped with flowmeters the rate of fuel consumption may be found by noting the flow to both engines in pounds per hour and dividing the total flow by 6, (because 1 gallon weighs about 6 pounds). This can be done on the computer by putting the Hour Index opposite pounds per hour on the outer scale, the gallons per hour is then read on the outer scale opposite the Unit Index.

24. RATE OF ASCENT (or DESCENT). The two outer scales of Section I may also be used to solve this problem. Two of the following quantities are available for its solution: Total Elevation in Ascent (or Descent), Time, Rate of Ascent (or Descent).

25. Example 11: Given: Time and Rate of Descent

Required: Total Elevation in Descent

A pilot is descending at the rate of 300 feet per minute. What will be his loss of altitude after descending for 34 minutes?

(a) Set Unit Index (10 on the second disc 'B') opposite 30 (=300) on the larger disc 'A' (Fig. X).

(b) Opposite 34 on the second disc 'B' read 10,200 feet on the larger disc 'A'

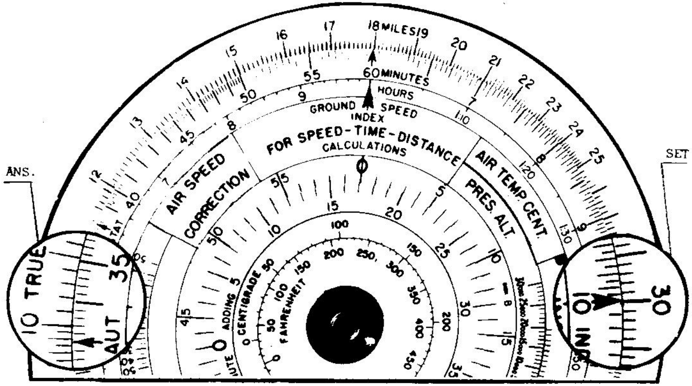

FIGURE X

26. Example 12: Given: Time and Total Elevation in Ascent

Required: Rate of Ascent

A pilot climbs 6900 feet in 15 minutes. What is his rate of ascent?

(a) Set 15 on 'B' disc opposite 6900 on 'A' disc. (Fig. XI).

(b) Opposite Unit Index above 10 on 'B' disc read Rate of Ascent, 460 feet per minute on disc 'A'.

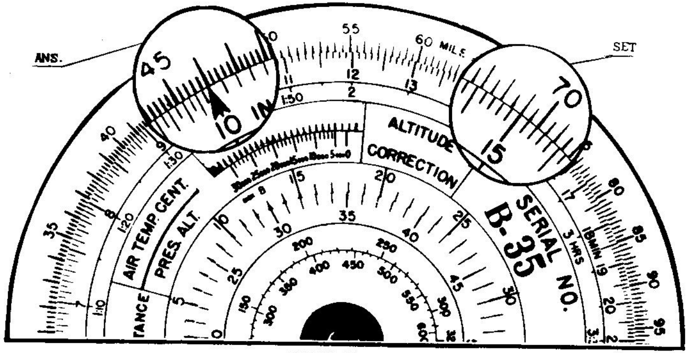

FIGURE XI

27. Example 13: Given: Rate of Ascent and Total Elevation in Ascent

Required: Time

A pilot climbs to 7400 feet above his starting point at the average rate of 500 feet per minute. How long will this require?

(a) Set the Unit Index (10 on 'B' disc) opposite 500 on the outer disc 'A' opposite 7400 on the outer disc, read the Time, 14.8 minutes on the 'B' disc. (Fig. XII).

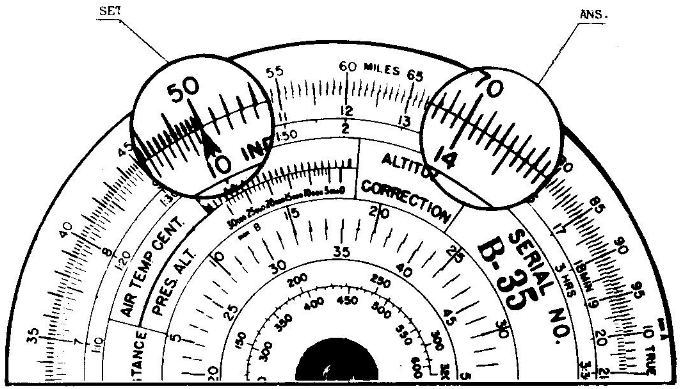

FIGURE XII

28. DISTANCE IN ASCENT (or DESCENT). The two outer scales of Section I may also be used to solve this problem. Two of the following quantities are available for its solution: Distance, Time, Speed. The method used in Examples 2, 3 and 4 should be used.

29. Example 14: Given: Speed and Time

Required: Distance

The pilot in Example 13 wishes to know how far he will have traveled when his climb is finished. His average True Airspeed is 120 miles per hour, and he is aided by a tail wind of 20 miles per hour.

(a) Set Hour Index to 140 miles per hour (120 + 20). (Fig. XIII).

(b) Opposite 14.8 minutes on the 'B' disc, read 34.5 miles on the 'A' disc.

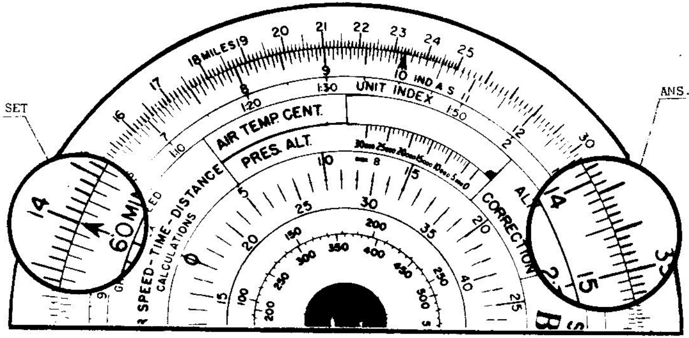

FIGURE XIII

SECTION II

30. This side of the computer is used for solving problems involving:

Wind Angle
Ground Speed
Wind Correction Angle
True Airspeed
Heading (Compass Heading)
Course Corrections
Wind Direction and Velocity
Triangles (both right and oblique)

31. On the underlying opaque disc 'E' there are a series of spiral curves, which represent graphically various values of wind angle and wind correction angle. These spiral curves are intersected by lines which run approximately at right angles to the wind angle lines. These intersecting lines represent values of wind velocity, airspeed, ground speed and distance. In brief, the spiral curves represent angles, the intersecting lines represent distances. A compass rose appears around the periphery of the disc.

32. On the transparent disc 'D' a circle at the periphery is graduated in degrees from 0 to 180 increasing both ways from the 0 point, which lies at the head of an arrow labeled 'G. S.' This arrow extends radially into the center of the disc and is graduated from 0 to 70.

33. Section II should always be held with the 'Zero' or 'N' position away from the user. This will facilitate locating directions on the disc.

34. <u>WIND ANGLE</u>: This is defined as the angle between the Wind Direction and the track or desired course. It is never more than 180 degrees.

(a) <u>Head Winds</u> involve Wind Angles from 0 to approximately 95 degrees.
(b) <u>Tail Winds</u> involve Wind Angles from approximately 95 to 180 degrees.

(Continued on Pa...

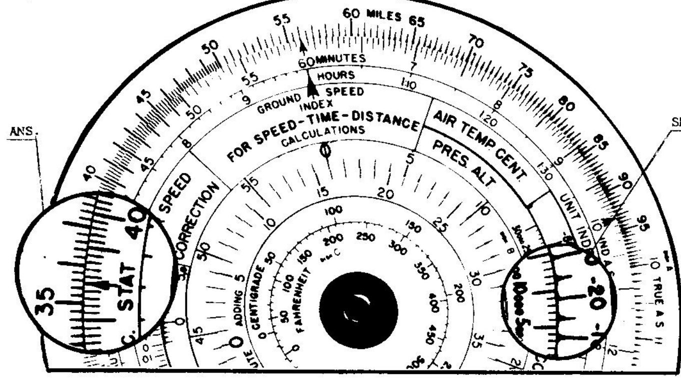

FIGURE XIV

35. <u>ALTITUDE CORRECTION</u>: At an airport whose altitude is 5000 feet above sea level, a pilot sets his altimeter to read 5000 feet. The airplane then climbs to an indicated altitude of 9000 feet; the outside air temperature being -20° Centigrade. What is the actual altitude above the airport and above sea level?

<u>Example 15</u>: <u>Given</u>: Indicated altitude 9000 feet over an airport, whose altitude is 5000 feet above sea level. The outside temperature is -20 degrees centigrade at 9000 feet.

<u>Required</u>: Actual Altitude above airport and above sea level.

(a) Set 9000 feet opposite -20 degrees centigrade in the window of the disc 'B', (Fig. XIV). Without changing the setting, opposite 4000 feet (difference between indicated altitude and ground altitude at which altimeter is set) on disc 'B', read 3740 feet on disc 'A'. This is the actual altitude above airport.

(b) The airplane is therefore 5000 plus 3740 or 8740 feet above sea level.

<u>Note</u>: This correction applies only to the difference between indicated altitude and the altitude of the airport for which the Kollsman pressure is set.

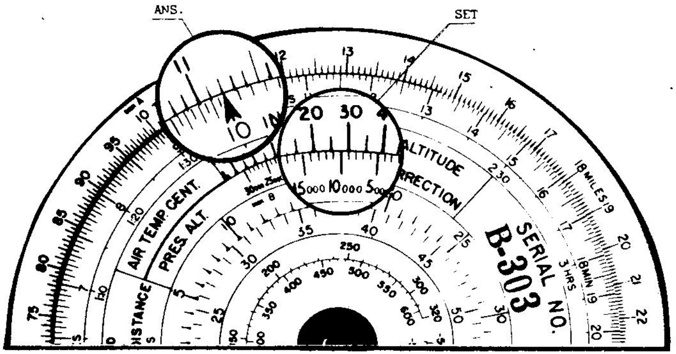

FIGURE XV

36. ALTITUDE CORRECTION: Flying at an indicated altitude of 10,000 feet, the pilot observes that the Outside Air Temperature indicates 28 degrees Centigrade. What is his True Altitude above sea level?

Example 16: Given: Indicated Altitude 10,000 feet, and Outside Air Temperature 28 degrees Centigrade.

Required: Actual altitude above sea level.

(a) Set the Outside Air Temperature of 28 degrees Centigrade opposite the 10,000 feet in the window for Altitude Correction of disc 'B'. (Fig. XV).

(b) Opposite the 10,000 feet mark on disc 'B' read 11,200 feet Actual Altitude on disc 'A'.

Note 1: The correction of altitude for temperatures other than standard is approximate at best. Temperature inversions and lapse rates other than standard detract from the accuracy of the altitude correction.
For most accurate use of the computer the average temperature and average altitude between the ground and the plane should set opposite each other in the window for altitude correction. The correct altitude will be read on disc 'A' opposite the indicated altitude on disc 'B'. For most conditions, however, it is accurate enough to set the observed temperature at altitude opposite the indicated altitude and the correct altitude read as above.
Because of the uncertainties of the correction, it is recommended that the airplane never be flown at a lower

indicated altitude than that intended for flight. Only increased altitude corrections should be made as a result of temperature corrections.

Note 2: Navigators in using this correction to find their true altitude for making ground speed checks, etc., thru the drift sight should bear in mind that atmospheric pressure variation enroute will cause appreciable errors in indicated altitude, a difference of 0.1 inches of mercury atmospheric pressure is approximately equivalent to 100 feet of altitude; an error which can be as much or more than the temperature correction.

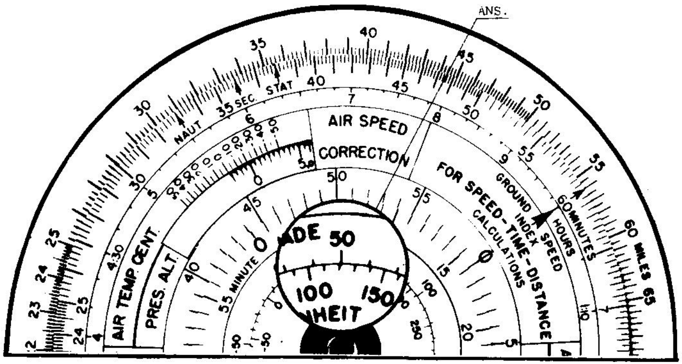

FIGURE XVI

37. TEMPERATURE CONVERSION: The smallest disc 'C' of Section I is used to convert the temperature scales. On disc 'C' either Centigrade or Fahrenheit temperature grading can be read directly.

Example 17: Given: 50 Degrees Centigrade

Required: Degrees Fahrenheit

(a) On disc 'C' (Figure XVI) find 50 degrees Centigrade. Opposite 50 degrees Centigrade read 122 degrees Fahrenheit.

38. NAUTICAL AND STATUTE MILE CONVERSION: On disc 'B' both Nautical and Statute miles are shown. The conversion from Statute to Nautical or Nautical to Statute miles is read directly on the outer disc 'A'.

Example 18: Given: 60 Statute Miles

Required: Nautical Miles

(a) Set Statute index arrow on disc 'B' opposite 60 on disc 'A' (Fig. XVII).

(b) Opposite Nautical index arrow on disc 'B' read 52 Nautical miles on disc 'A'.

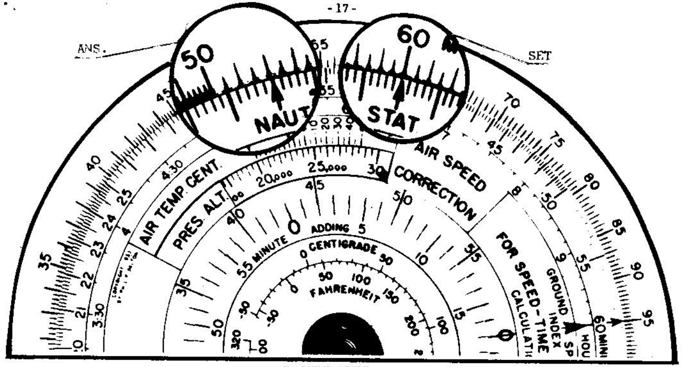

FIGURE XVII

39. TRACK AND GROUND SPEED: In this problem no attempt is made to solve Correction Angle, but merely to show the relation between Airspeed and Ground speed.

Example 19: Given: A Heading North (Zero degrees)
Airspeed 180 miles per hour,
Wind 40 miles per hour, West.

Required: Track and Ground Speed.

(a) Set the G. S. Index to 180 on course scale on the periphery of the opaque disc 'E'. (Figure XVIII).

(b) Under 40 on the G. S. arrow read 12 degrees, which is the Track.

(c) 12 degrees intersects the 185 miles per hour radial line which is the ground speed.

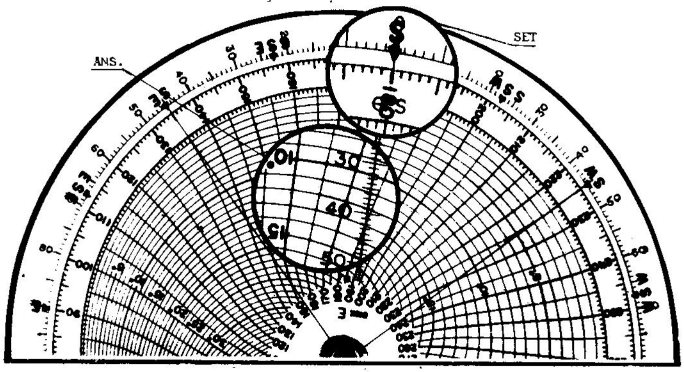

FIGURE XVIII

40. Wind angles are represented on the opaque disc by spiral lines. The value of the Wind Angle in degrees is given at several points along these spiral lines. The 0 to 180 Wind Angles are represented by the circle which surrounds the spiral lines, the 0 angle being on the right and the 180 angle on the left.

41. The head of the arrow on the transparent disc 'D' (this will be called the G. S. Index in the future) is rotated to the Course on the underlying disc 'E'. The Wind Angle is then read on the transparent disc 'D' over the wind direction.

42. Example 20: Given: Course and Wind Direction

Required: Wind Angle

A pilot desires to fly a Course of 236 degrees with a NNE wind. What is the Wind Angle?

(a) Set the G.S. Index to 236 on the underlying disc 'E' (Fig. XIX).

(b) Over NNE on the underlying scale 'E' read the Wind Angle of 146 degrees. This is a quartering tail wind.

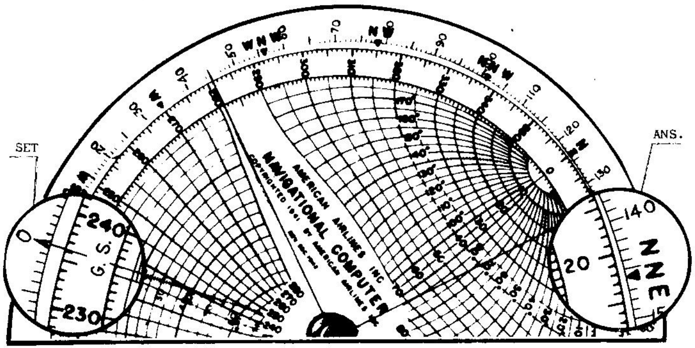

FIGURE XIX

43. In problems concerning wind and drift, the solution of a right angle triangle is a common problem. The solution of this type of triangle is illustrated by the following example.

44. Example 21: Given: Two Sides of Right Triangle

Required: Hypotenuse and Angles

One side of a right triangle is 30 miles, the other is 40 miles. What is the hypotenuse and what are the angles?

(a) Set the G. S. Index to 30 on the course scale on the periphery of the opaque disc 'E' (Fig. XX).

45. (continued)

(b) Under 40 on the G. S. Arrow read the hypotenuse, 50 miles and the angle opposite the 40 mile side, 53 degrees. The other angle then is 37 degrees (90 - 53).

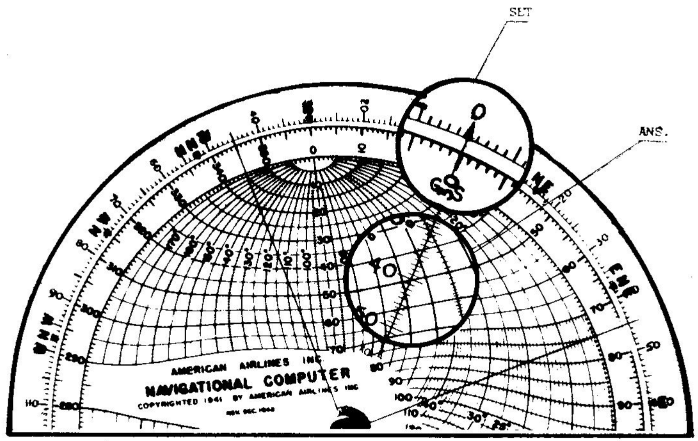

FIGURE XX

46. When the values of the sides are such that they are not readily applicable to the values on the Computer, they may all be divided or multiplied by the same factor, usually 2 or 3, and then the problem solved as above. The Angles ARE NOT effected when the sides are all changed by the same factor.

47. Example 22: Given: One Side and One Angle of Right Triangle

Required: Hypotenuse, Other Side, Other Angle

One side of a right triangle is 50. The angle opposite it is 29 degrees. What is the hypotenuse, other side and other angle?

(a) The other angle is simply 180 - (90 + 29) = 61 degrees.
(b) Rotate G. S. Index to the given side, 50.
(c) It will be found that the curve representing the angle ADJACENT to this side, 61 degrees, does not cross the G. S. Arrow.
(d) Divide the side by 2 obtaining 25 miles.
(e) Rotate the G. S. Index to 25. - (Fig. XXI).
(f) Read the other side along the G. S. Arrow above the 61 degree curve, 45.
(g) This must be multiplied by 2 to obtain its true value, 90 miles.
(h) Proceed as in Example 16 to obtain the hypotenuse.

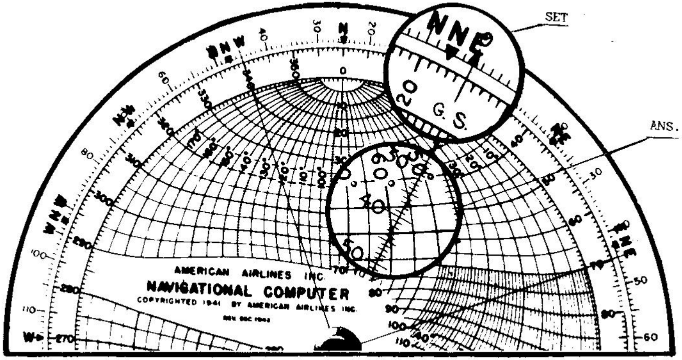

FIGURE XXI

48. Example 23: Given: Vertex Angle and Equal Side of Isoscales Triangle

Required: Base and Equal Angles

The course of a radio range has a spread of 4 degrees. How wide is the beam at a distance of 100 miles?

(a) Set G. S. Index to 100. (Fig. XXII).
(b) Over the 4 degrees curve read beam width, 6 miles.
(c) The equal angles are, of course (180 - 4) + 2 = 88 degrees.

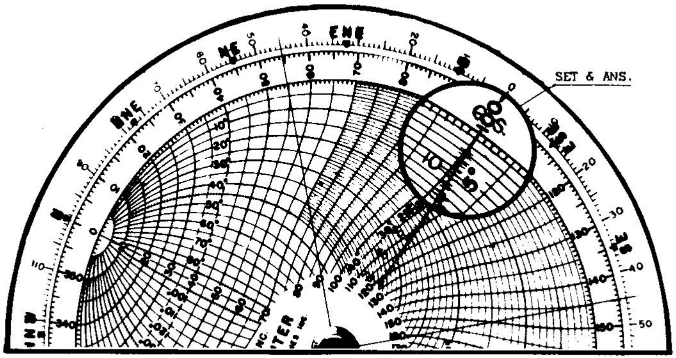

FIGURE XXII

49. HEADING CORRECTION TO PARALLEL OR RETURN TO GIVEN COURSE. This problem arises when the pilot after flying a given Heading or a certain distance finds that he is a certain distance off course. He wants to know what Heading Correction is necessary to parallel the original Course and what Correction is required to return to the original Course in a given distance. Methods in following problems are only approximate.

50. Example 24: Given: Distance Flown and Distance Off Course

Required: Heading Correction to Parallel Original Course.

After flying on instruments for 100 miles a pilot finds that he is 20 miles to the right of his course. What Heading Correction is necessary to bring his parallel to the intended course?

(a) Set 20 on the G. S. Arrow over the radial line running inward from 100 on the periphery of the opaque disc 'E' (Fig. XXIII).
(b) Under the 20 on the G. S. Arrow read the angle necessary to parallel the intended course, 12 degrees.

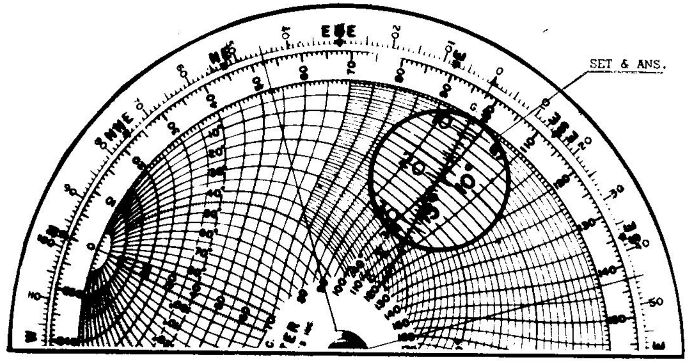

FIGURE XXIII

51. Example 25: Given: Distance Flown and Distance Off Course

Required: Heading Correction to return to Original Course in Given Distance

In Example 24 the pilot found that he would require a Heading Correction of 12 degrees to parallel original course. What Course Correction is necessary to return to Original Course in 150 miles?

(a) Set 20 on the G. S. Arrow over the radial line running inward from 150 on the periphery of the opaque disc 'E' (Fig. XXIV).
(b) Under the 20 on the G. S. Arrow read the ADDITIONAL correction necessary to return to the original course in 150 miles, 8 degrees. This is to be ADDED to the result obtained in Example 24 to obtain the TOTAL Heading Correction of 20 degrees to return to original course in 150 miles.

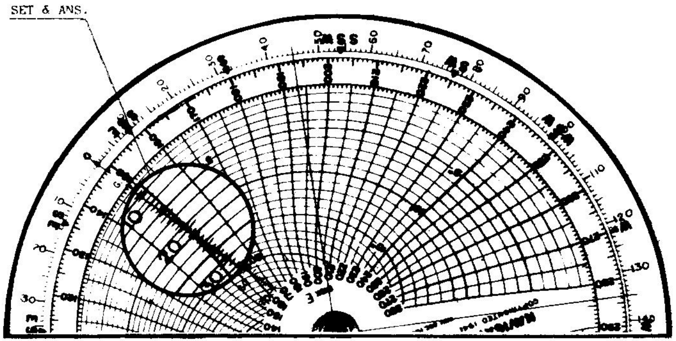

FIGURE XXIV

52. Thus, the pilot would change Heading left 12 degrees to parallel his original course, or change heading to the left 20 degrees to return to his original course in 150 miles. After flying 150 miles he would again change heading to the right 8 degrees, and then should be on the original course headed correctly.

53. GROUND SPEED AND WIND CORRECTION ANGLE: These two quantities may be solved in the same operation when the Wind Angle, Wind Velocity, and True Airspeed are known.

54. Example 26: Given: Wind Angle, Wind Velocity, True Airspeed

Required: Ground Speed and Wind Correction Angle

A pilot knows that the Wind Angle is 146 degrees (Par. 42), Wind Velocity 45 miles per hour, True Airspeed 180 miles per hour. He wishes to know his Ground Speed and Wind Correction Angle.

(a) Turn G. S. Index to 0.
(b) Make a pencil dot at intersection of 146 degree curve and 45 miles per hour line. (Fig. XXV).
(c) Rotate disc until dot lies over 180 miles per hour airspeed line (Fig. XXVI).
(d) Read Wind Correction Angle, 8 degrees on curve under dot.
(e) Read Ground Speed 216 miles per hour, at head of arrow.

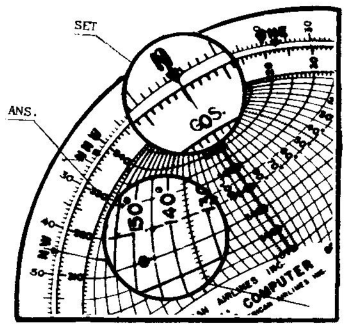

FIGURE XXV

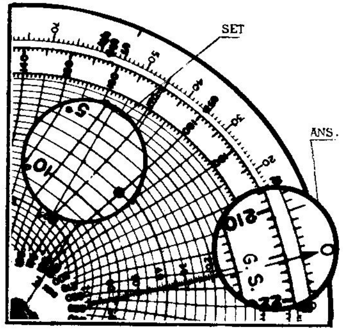

FIGURE XXVI

55. COURSE CORRECTION: In applying course corrections a single rule to remember in determining the Heading is:

RIGHT WIND ANGLES ARE PLUS AND WIND CORRECTION ANGLES ARE ADDED TO THE COURSE TO DETERMINE THE HEADING.

LEFT WIND ANGLES ARE MINUS AND WIND CORRECTION ANGLES ARE SUBTRACTED FROM COURSE TO DETERMINE HEADING.

56. Example 27: Given: Course and Wind Correction Angle

Required: Heading

A pilot desires to fly a Course of 236 degrees. The Wind Angle is + 146 degrees. The Wind Correction Angle is 8 degrees. What heading should he fly?

(a) Since the Wind Angle is PLUS, the Wind Correction Angle should be added to the Course, giving a Heading of 244 degrees (236 + 8).

57. WIND DIRECTION AND VELOCITY: This problem arises when the pilot flies a known Course at a known Wind Correction Angle, True Airspeed and Ground Speed, and wishes to know the Wind Velocity and Direction.

Example 28: Given: Course 94 degrees, Wind Correction Angle 10 degrees, True Airspeed 165 miles per hour, Ground Speed = 146 miles per hour.

Required: Wind Direction and Velocity

(a) Rotate the G. S. Index to 146 miles per hour.
(b) Make a pencil dot over the intersection of the 165 True Airspeed line and the 10 degree wind Correction angle curve. - (Fig. XXVII).
(c) Rotate the G. S. Index to 0. (Fig. XXVIII).
(d) Under the dot read Wind Velocity of 34 miles per hour and Wind Angle OF 60 DEGREES.
(e) Turn the G. S. Index to the Course, 94 degrees. - (Fig. XXIX).

58. (continued)
(f) Since the plane is crabbing to right, the Wind Angle is plus (Para. 55). Under Wind Angle of 60 degrees on the right of the arrow, find Wind Direction ESE (or more exactly 154 degrees).

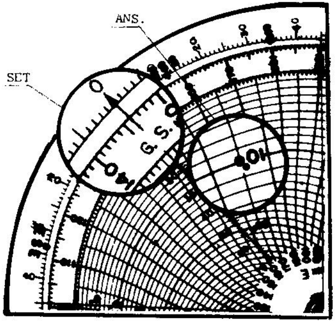

FIGURE XXVII

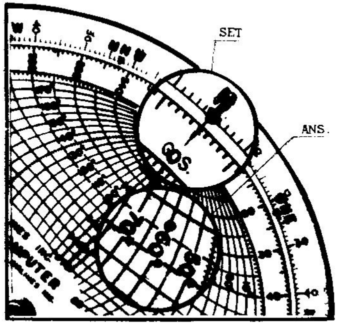

FIGURE XXVIII

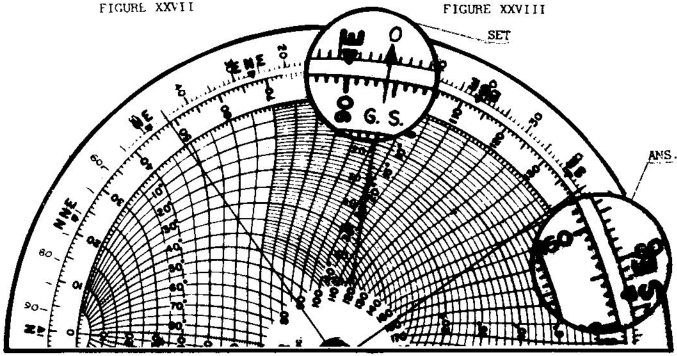

FIGURE XXIX

59. The Heading Correction determined in example 25 may also be used in calculating Wind Direction and Velocity. If the Wind Correction Angle is known, the Heading Correction may be added (algebraically) to it to obtain the Correct Wind Correction Angle. Thus, if a Wind Correction Angle of 10 degrees left has been held over a given distance and it is found on obtaining a check that the plane is several miles to the right of the course, the necessary correction to fly parallel to the intended course may be determined by the method illustrated in Example 24. The quantity obtained in this manner is then ADDED to the original Wind Correction Angle to obtain the correct Wind Correction Angle, which is used in solving the Wind Direction and Velocity problem as in Example 28.

60. Example 29: Given: Course, Wind Correction Angle, Airspeed, Ground Speed, Distance Off Course.

Required: Course Correction, Wind Direction, and Velocity

A pilot flies at a True Airspeed of 178 miles per hour, a Ground Speed of 219 miles per hour (as determined by check points), and is crabbing to the left 10 degrees. His Course is 157 degrees. After flying on instruments for 140 miles he finds that he is 40 miles to the LEFT of his course. What Heading Correction is necessary to bring his parallel to his original course? What is the Wind Direction and Velocity?

(a) Set 40 on the G. S. Arrow over the radial line running inward from 140 on the periphery of the opaque disc 'E' (Fig. XXX).
(b) Under the 40 on the G. S. Arrow read the angle necessary to parallel the intended course, 17 degrees.
(c) Rotate the G. S. Index to 219 miles per hour. (Fig. XXXI).
(d) Make a pencil dot over the intersection of the 178 True Airspeed line and the 7 degree Wind Correction Angle curve. (Algebraic sum of 17 degrees to right and 10 degrees to the left.)
(e) Rotate the G. S. Index to 0. (Fig. XXXII).
(f) Under the dot read the Wind Velocity of 48 miles per hour and Wind Angle of 152 degrees.
(g) Turn the G. S. Index to the course, 157 degrees. (Fig. XXXIII).
(h) Since the plane should be crabbing to the right, the Wind Angle is plus (Para. 55). Under Wind Angle of 152 degrees to the right of the arrow, find Wind Direction NW (or more exact 309 degrees).

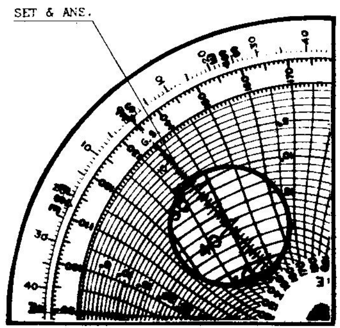

FIGURE XXX

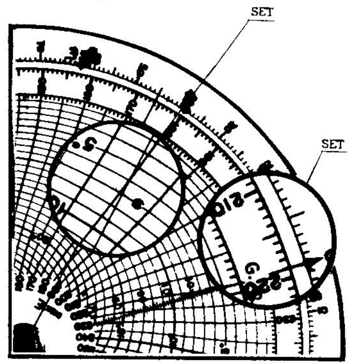

FIGURE XXXI

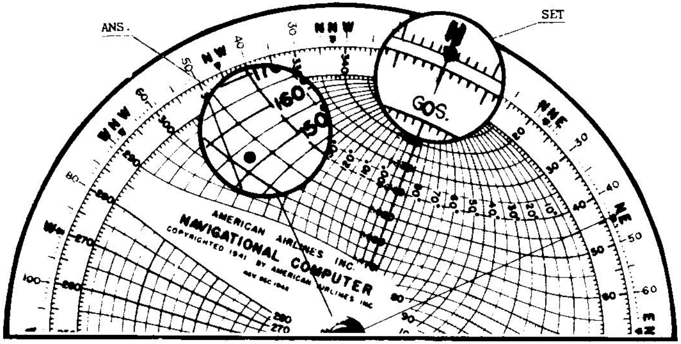

FIGURE XXXII

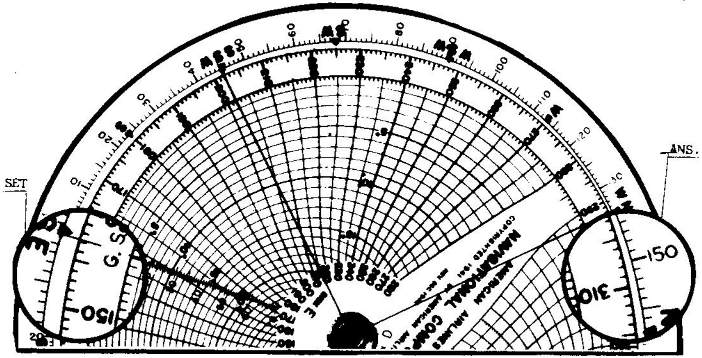

FIGURE XXXIII

61. Example 30: What effect will a direct cross wind have on the Ground Speed and Wind Correction Angle? Since the G. S. Index Arrow represents a Wind Angle of 90 degrees (direct cross wind), this problem may be investigated by setting the desired cross wind on the G. S. Arrow over the radial line extending inward from the True Airspeed. The G. S. Arrow will then point to the Ground Speed, and the Wind Correction Angle will appear at the intersection of the G. S. Arrow with the True Airspeed Line.

Given: True Airspeed and Cross Wind

Required: Ground Speed and Wind Correction Angle.

62. (continued)
A direct cross wind of 40 m.p.h. acts on an airplane with a True Airspeed of 200 m.p.h. What is the Ground Speed and Wind Correction Angle?

(a) Rotate G. S. Index until 40 along arrow falls directly over the radial line extending inward from 200. (Fig. XXXIV).
(b) Under the G. S. Index read the Ground Speed, 196 m.p.h.
(c) Under the 40 on the G. S. Arrow, along the 200 True Airspeed line, read the Wind Correction Angle, 12 degrees, (11.5 degrees)

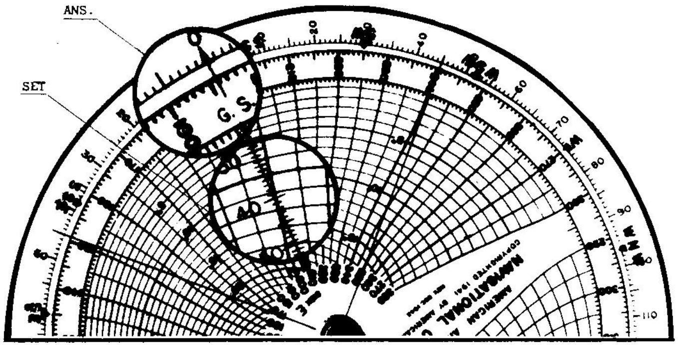

FIGURE XXXIV

63. Example 31: Oblique Triangles:

Given: Three Sides
Required: Three Angles

(a) Set G. S. Index to first side.
(b) Draw pencil line along radial line representing second side.
(c) Rotate G. S. Index to 0.
(d) At intersection of pencil line with third side place dot.
(e) Under dot read SUPPLEMENT of angle between first and third sides.
(f) Rotate G. S. Index to first side again.
(g) Under dot read angle between first and second sides.
(h) For angle between second and third side, subtract sum of other angles from 180 degrees.

64. Example 32: Given: Two Sides and Included Angle

Required: Third Side and Other Angles

(a) Set G. S. Index to first side.
(b) Place a pencil dot over intersection of radial line representing second side with curve representing included angle.
(c) Rotate G. S. Index to 0.
(d) Under dot read third side and also SUPPLEMENT of angle between first and third sides.
(e) Obtain third angle by subtracting sum of first two from 180 degrees.

65. Example 33: Given: Two Sides and Angle NOT Included between them, but angle adjacent to FIRST Side.

Required: Third Side and Other Angles

(a) Set G. S. Index to FIRST side.
(b) Draw pencil line along radial line representing second side.
(c) Rotate G. S. Index to 0.
(d) Place dot along the pencil line over SUPPLEMENT of given angle.
(e) Under dot read third side.
(f) Rotate G. S. Index to first side again.
(g) Under dot read angle between FIRST and SECOND sides.
(h) For third angle subtract sum of first two from 180 degrees.

66. Example 34: Given: Two Angles and Included Side

Required: Other Angle and Other Two Sides

(a) Set G. S. Index to given side.
(b) Draw pencil line along curve representing first angle.
(c) Rotate G. S. Index to 0.
(d) Place a dot on pencil line over intersection with curve representing SUPPLEMENT of second angle.
(e) Under dot read side adjacent to second angle.
(f) Rotate G. S. Index to first side again.
(g) Under dot read third side.
(h) Obtain third angle by subtracting sum of first two from 180 degrees.

67. Example 35: Given: Two Angles and Side NOT Included

Required: Other Angle and Other Two Sides

(a) Obtain third angle by subtracting sum of first two from 180 degrees.
(b) Proceed as in above example, using two angles and included side.

GLOSSARY OF TERMS

GROUND SPEED: Speed that the airplane actually makes good over the earth's surface. (See Par. 53 et seq.)

INSTRUMENT AIRSPEED: The actual reading of the airspeed instrument. (See Par. 7 & 8)

INDICATED AIRSPEED: Speed resulting after the Installation Error correction has been applied (+ or -) to the INSTRUMENT AIRSPEED. (See Par. 7 & 8)

TRUE AIRSPEED: Speed resulting after correcting INDICATED AIRSPEED for existing air temperature and pressure. The actual speed of the plane through the air. (See Par. 6 and 10)

VARIATION: The angular difference between TRUE GEOGRAPHIC NORTH and the MAGNETIC NORTH MERIDIANS.

DEVIATION: Error resulting from numerous magnetic fields of a local nature which effect a compass causing it to indicate MAGNETIC NORTH incorrectly.

*COURSE: The COURSE is the direction in which it is desired that the airplane should travel across the earth from one point to another. This may be expressed as TRUE COURSE, a MAGNETIC COURSE, or a COMPASS COURSE. (See Par. 34 et seq.)

TRUE COURSE: The direction expressed in degrees from 0 to 360 with reference to true geographic north.

MAGNETIC COURSE: The direction expressed in degrees from 0 to 360 with reference to the earth's magnetic north.

COMPASS COURSE: The direction expressed in degrees from 0 to 360 with reference to the airplane compass' north, or Compass Reading.

HEADING: The direction in which the airplane is actually pointed. Usually different from the COURSE due to compensation for wind effect in order to make good the COURSE. This may be given in reference to TRUE, MAGNETIC, and COMPASS in the same manner as COURSE.

TRACK: The actual path made good by the airplane across the earth's surface.

*DRIFT ANGLE: The angle between HEADING and the TRACK, and is termed right or left according to the way the airplane is drifted.

*WIND CORRECTION ANGLE: The angle which must be added to or subtracted from the COURSE to obtain the HEADING, expressed in degrees as either PLUS OR MINUS. (See Par. 53)

WIND DIRECTION: The TRUE DIRECTION FROM WHICH the wind is blowing, expressed in degrees from 0 to 360. (Measured in reference to true north)

WIND FORCE: (Velocity) Force of wind expressed in terms of its speed in miles per hour.

WIND ANGLE: Angular difference between airplane's track (or desired course line) and the wind direction. Measured from the track to the wind direction either right or left according to which side wind is blowing from. IT NEVER EXCEEDS 180 DEGREES. (See Par. 34)

SUPPLEMENT OF AN ANGLE: The difference between the angle and 180 degrees.

INSTALLATION ERROR: For airplanes it is the correction made to the airspeed indicator to obtain indicated airspeed. (See Par. 8)

CRABBING: This is a term applied to indicate that an airplane is being headed into a cross wind in order that it maintain its true course.

G. S. INDEX = Ground Speed Index.

*(Note: There is a very distinct difference between DRIFT ANGLE AND WIND CORRECTION ANGLE, and they are seldom equal.)

INDEX

Problems: