PATENT SPECIFICATION

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COMPLETE SPECIFICATION

DRAWINGS ATTACHED

Improvements in or relating to Navigational Computers

I, ANTONIO LUIS CHAMICO HEITOR, of Rua das Amoreiras No. 161, 42, esq., Lisbon, Portugal, a Portugese subject, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to navigational computers.

According to the present invention there is provided a navigational computer having a frame, a slide with polar coordinate lines thereon, concentric circular arcs of the polar coordinates representing values of velocity with the numerical values thereof increasing with distance from the origin of the polar coordinate lines, said slide being slidably mounted in said frame for movement in a direction towards and away from said origin, a transparent compass rose rotatably mounted in said frame and overlying at least some of said polar coordinate lines, said rose having a linear scale of velocity extending radially from the centre thereof, there being a curved groove in said slide, the curvature being determined by a logarithmic function, means attached to said frame and defining a slide rule base having a logarithmic scale thereon, a member slidably mounted in said slide rule base and also having a logarithmic scale thereon, and means co-operating with said member and said groove whereby said member is positioned in said slide rule base in accordance with the position of said slide within said frame.

For a better understanding of the invention reference will now be made to the accompanying drawing in which the single figure is a plan view of a navigational computer.

The computer has a slide 1, preferably of thin sheet metal, plastic, or other rigid light weight material. A section of a system of polar coordinate lines are inscribed or imprinted upon the face of the slide. The concentric circular arcs of the polar coordinates represent values of air speed and ground speed with the numerical values thereof increasing with distance from the origin of the system. The radial lines are in terms of compass degrees or drift either right or left of a centre line 3. The centre line 3 is used for representing either course or heading.

The slide 1 is slidably mounted within a frame 2 for rectilinear movement with respect thereto parallel to the centre line 3. An annular compass rose ring 4 graduated from 0° to 360° is fixedly secured to the frame 2 and the graduation represents wind direction. An annular rotatable compass rose ring 5, also graduated from 0° to 360°, is concentrically mounted with respect to the fixed compass rose ring 4 and the bearing for the ring 5 is provided by the inner circumference of the stationary ring 4. The indicia markings of the two rings extend to the adjoining edges thereof. The outer periphery of the rotatable ring 5, which extends beyond the outer periphery of the ring 4, may be knurled to facilitate rotation by hand. The degree graduations on the rotatable ring may represent either true course or true heading, whichever is known in the problem to be solved.

The ring 5 is preferably provided with a transparent window upon which is inscribed or imprinted a graduated scale representing wind velocity in knots. The scale originates at the centre of the rotatable ring, known as the grommet, and extends radially outward in opposite directions to the periphery of the window. The scale from the centre to point N on the compass rose 5 may be printed in black and from the centre to the point S may be printed in red, for representing wind vectors heading either toward or away from the grommet.

A slide rule 11 is provided for calculating time-distance relationships. The slide rule consists of a base 8 fixedly secured to the frame 2 and an arcuate member 9 slidably movable within the base. The slidable member and slide rule base have slide rule scales thereon representing distance and time respectively.

The face of the slide 1 has a longitudinally extending curved groove 6 with a curvature determined by a logarithmic function. The purpose of this groove will appear hereinafter. The groove 6 is of sufficient size to receive in slidable relationship a pin 7 which is fixedly secured to the slide rule slidable member 9. The slide rule base 8 has an arcuate slot 10 cut therein. The pin 7 which is fixed to the slidable member 9, extends downwardly to engage the edge of the slot 10 as it slides in the groove 6.

As the slide 1 is moved linearly with respect to the frame 2, the slidable member 9 will be moved within the slide rule base 8. The relationship between movement of the slide 1 and movement of the slidable member 9 is such that when the grommet or centre of the rotatable compass rose is indexed over a speed circle on the slide 1, the slidable member 9 is automatically positioned in the slide rule base 8 so that the same value of distance as the speed will be positioned opposite a unit of time. As illustrated in Figure 1, a speed of 150 knots under the grommet corresponds to a setting of 150 nautical miles on the scale on the slidable member 9 opposite the time one hour, or sixty minutes, on the slide rule base 8.

In operation and in solving problems, the follow-general rules are applicable: Use the centre line 3 to represent either the course-ground speed or heading-air speed vector, whichever is given. If the centre line 3 is used for the course-ground speed vector, measure wind velocity on the black radial scale extending from the grommet to N on the compass rose 5. If the centre line 3 is used for the heading-air speed vector, measure wind velocity on the red radial scale extending from the grommet to S on the compass rose 5. Use the arcs of the polar coordinates to measure speed; read ground speed as the length of the course-ground speed vector and air speed as the length of the heading-air speed vector. Use the fixed compass ring 4 to represent wind direction, and set the rotatable compass ring 5 representing either direction of the course-ground speed vector or heading-air speed vector, whichever is given, opposite the wind direction. In all of the wind triangle problems the tail of the course-ground speed vector and the heading-air speed vector is always theoretically positioned at the origin of the polar coordinates.

The solution of various specific navigational problems with the improved computer is best shown by the following examples:

Example I

Given: true course 205°; true air speed 172 knots; wind vector 250°/30 knots.

Find: true heading, ground speed, and time required to fly 300 nautical miles.

(a) Set true course 205°, on the inside scale 5 against wind direction 250° on the outside scale 4.

(b) Move the slide to set wind force 30 knots on black wind velocity scale over the true air speed circle of 172 knots.

(c) Read: (1) ground speed 150 knots under the grommet; (2) drift correction + 7° under wind force on radial drift lines. Course 205° plus 7° drift correction gives true heading at 212°; (3) time v. distance is automatically set on the slide rule, opposite 300 on the scale 9, read two hours or 120 minutes on the scale 8.

In Example I the direction of the course-ground speed vector, and length of the heading-air speed vector are known, as well as the length and direction of the wind vector. In the solution of the problem the course-ground speed vector is theoretically laid out along the centre line 3 with the tail of the vector at the origin of the polar co-ordinate system. The wind vector, which is carried by the scale on the window, is positioned angularly by setting the true course on the compass rose 5 opposite the wind direction on the compass rose 4. The tail of the wind vector will complete the triangle by connecting with the true heading vector at the air speed of 222 knots. Therefore, when the length of the wind vector, 30 knots, on the black wind velocity scale intersects the air speed circle of 222 knots, the wind triangle is completed. The grommet represents the head of the true course vector where it intersects the wind vector. Therefore, the speed circle under the grommet will represent the length of the course-ground speed vector or the value of ground speed. The drift angle is the angle between the true course and true heading vectors and this may be read directly on the radial lines. The time and distance measurements may be read directly because of the automatic positioning of the time and distance slide rule with respect to the speed under the grommet which in this example is the ground speed.

Example II

Given: true course 220°; ground speed 155 knots; wind vector 275°/14 knots.

Find: true heading and true air speed.

(a) Set true course 220° on the inside scale 5 against wind direction 275° on the outside scale 4.

(b) Set grommet to ground speed circle, 155 knots.

(c) Read: true air speed, 164 knots, and drift correction +4° under black wind force scale at 14 on scale. Course 220° plus 4° correction gives true heading or 224°.

In this problem the direction and length of the course-ground speed vector are known, as are the direction and length of the wind vector. The course-ground speed side of the wind triangle is theoretically positioned along the centre line 3 again with its tail at the origin of the polar co-ordinates. The wind vector is angularly positioned by setting the true course on the compass rose 5 opposite wind direction on the compass rose 4. The head of the wind vector or grommet is positioned at the head of the course-ground speed vector over the ground speed circle of 155 knots. The length of the wind vector is known. Therefore, the speed circle lying under the wind force scale of 14 knots represents the length of the heading-air speed vector or true air speed. The drift correction is read directly from the radial lines and may be added to the true course to obtain the true heading.

Example III

Given: true course 032°; ground speed 156 knots; true heading 020°; true air speed 143 knots.

Find: wind vector.

(a) Set the grommet over ground speed, 156 knots.

(b) Place the black graduated wind force scale on the intersection of the true air speed line 143 knots, and the radiating line showing −12° drift correction.

(032° − 020° = 12°)

(c) Read: (1) wind force 34 knots directly on the black scale at the intersection (2) wind direction, 273° on the outer scale 4 against true course 032° shown on the inner scale 5.

(d) Read time v. distance on the slide rule below.

In Example III the length and direction of both the course-ground speed and heading-air speed vectors are known. The tail of both vectors will be theoretically positioned at the origin of the polar coordinates. The course-ground speed vector is again theoretically positioned along the centre line 3. Its length will intersect the speed circle of 156 knots. Since the angle between the course-ground speed and heading-air speed vectors is also known, the heading-air speed vector is positioned 12° to the left of the true course vector, or −12°, and the length of the heading-air speed vector is represented by the air speed circle of 143 knots. By rotating the wind vector scale with its head at the grommet (black scale) until the scale intersects the head of the true heading vector, thereby solving the wind side of the triangle, the wind force and wind direction can be directly from the scales.

Example IV

Given: true heading 126°; true air speed 156 knots; wind vector 070°/30 knots.

Find: true course and ground speed.

(a) Set true heading 126° on the inside scale 5 against wind direction 070° on the outside scale 4.

(b) Set the grommet on the true air speed circle 156 knots.

(c) Read: drift + 10°, true course 136°

(126 +10° = 136°)

and ground speed 142 knots under wind force of 30 on the red scale.

(d) Move the grommet to ground speed circle of 142 knots to read time v. distance on the slide rule below.

In this problem the length and direction of the true heading and wind speed vectors are known. The heading-air speed vector is laid out on the vertical line 3 with the grommet or head of the vector set at the speed circle of 156 knots. The wind vector is positioned by setting the true heading on the compass rose 5 against the wind direction on the compass rose 4. Since the wind vector is heading away from the heading-air speed vector, the wind force is read on the red scale. At the wind force of 30 knots or the head of the wind vector, the ground speed may be read and the drift is determined from direct readings: To make the time and distance computations, the grommet must be then positioned over the ground speed circle.

WHAT I CLAIM IS:—

1. A navigational computer having a frame, a slide with polar coordinate lines thereon, concentric circular arcs of the polar coordinates representing values of velocity with the numerical values thereof increasing with distance from the origin of the polar coordinate lines, said slide being slidably mounted in said frame for movement in a direction towards and away from said origin, a transparent compass rose rotatably mounted in said frame and overlying at least some of said polar coordinate lines, said rose having a linear scale of velocity extending radially from the centre thereof, there being a curved groove in said slide, the curvature being determined by a logarithmic function, means attached to said frame and defining a slide rule base having a logarithmic scale thereon, a member slidably mounted in said slide rule base and also having a logarithmic scale thereon, and means co-operating with

said member and said groove whereby said member is positioned in said slide rule base in accordance with the position of said slide within said frame:

2. A computer as claimed in claim 1, wherein a pin is secured to the member slidably mounted in said slide rule base, the pin engaging with said groove to be slidable therein.

3. A computer as claimed in claim 1 or 2, wherein said slide rule base and the member slidably mounted in said base are arcuate and are adjacent the outer periphery of the compass rose.

4. A computer as claimed in any one of the preceding claims and further comprising a fixed compass rose on said frame and arranged concentrically around the rotatable compass rose.

5. A computer as claimed in any one of the preceding claims, wherein the various scales and the groove are so arranged that movement of said slide to a scale setting where a certain velocity on the scale is aligned with the centre of the rotatable compass rose moves the member slidably mounted in the slide rule base to a scale setting representing the same velocity per unit of time.

6. A navigational computer comprising: a pair of superposed members; the lower one of said members having polar coordinate lines thereon and a groove therein, said groove having a curvature determined by a logarithmic function; the top one of said members having a fixed compass rose and a rotatable compass rose concentric with said fixed compass rose; a transparent window in said rotatable compass rose and overlying at least part of the polar coordinate lines on the lower member; said window having a velocity scale extending from the centre radially in opposite directions toward the periphery of said window; an arcuate scale representing time integral with said fixed compass rose; an arcuate member having a scale representing distance slidable within said arcuate scale; a pin secured to said arcuate member and depending into the logarithmic groove in said lower member to be slidable therein; and means for mounting said top and lower members for relative translatory movement with respect to each other thereby permitting the distance between the centre of said transparent window and the origin of said polar coordinate lines to be varied, whereby relationships between speed, direction, wind velocity, drift, time and distance may be computed as the upper and lower members are translated with respect to each other, and said compass roses are rotated with respect to each other.

7. A navigational computer for solving navigational problems of speed, drift, time, wind velocity, course, heading and the like comprising: a frame having a fixed compass rose ring representing wind direction integral therewith; a slide having polar coordinate lines representing speed and drift thereon, said slide being slidably mounted in said frame for movement in a direction toward and away from the origin of said polar coordinate lines; an annular member having a compass rose representing course or heading thereon, said member being rotatably journalled in said ring concentric with said fixed compass rose; a transparent window in the centre of said annular member having a diametral scale representing wind velocity, the window overlying at least part of said polar coordinate lines; there being a groove in said slide, the groove having a curvature determined by a logarithmic function, an arcuate slide rule base having a logarithmic scale representing time thereon and attached to said frame adjacent the outer periphery of said fixed compass rose, there being in said base an arcuate way having an arcuate slot in the bottom thereof; an arcuate member having a logarithmic scale representing distance thereon slidably mounted in said way; and a pin secured to the bottom of said member and depending through said arcuate slot into engagement with said groove to be slidable therien, whereby movement of said slide to a speed setting in the centre of said compass roses will move said member to the scale setting representing the same speed for a unit of time.

8. A navigational computer substantially as hereinbefore described with reference to the accompanying drawing.

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828,841 COMPLETE SPECIFICATION

1 SHEET

This drawing is a reproduction of the Original on a reduced scale.