Fig. 1

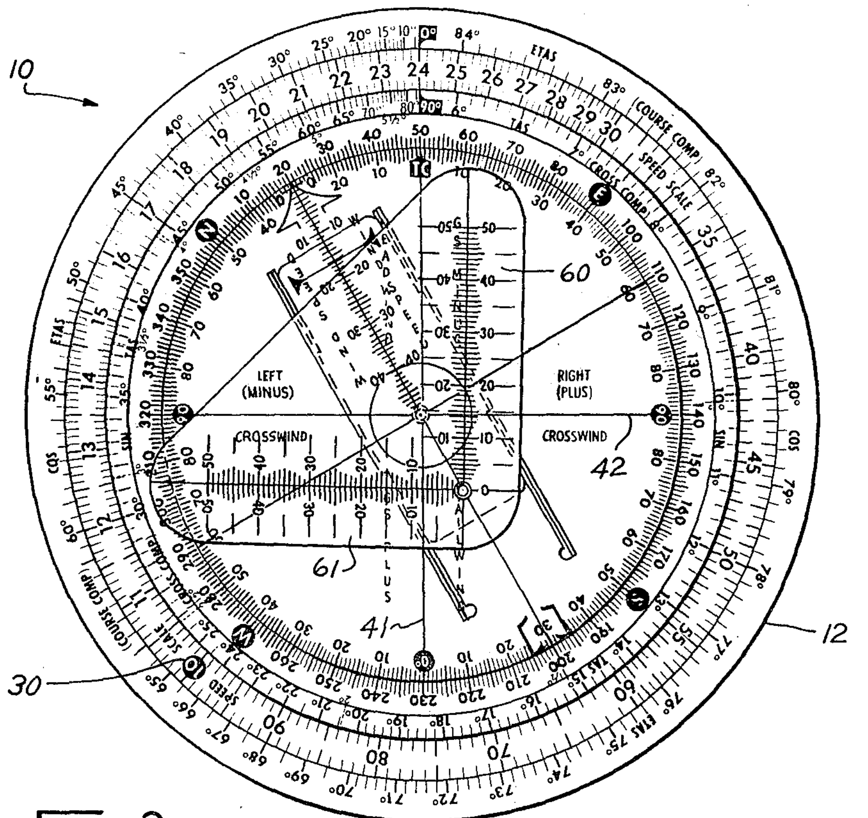

Fig. 2

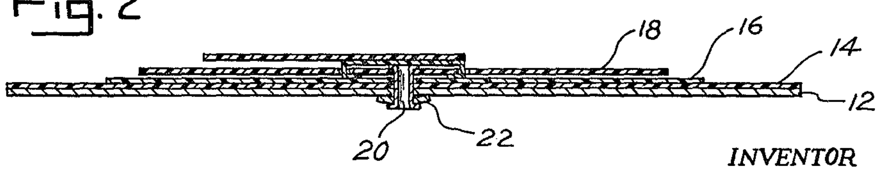

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Fig. 3

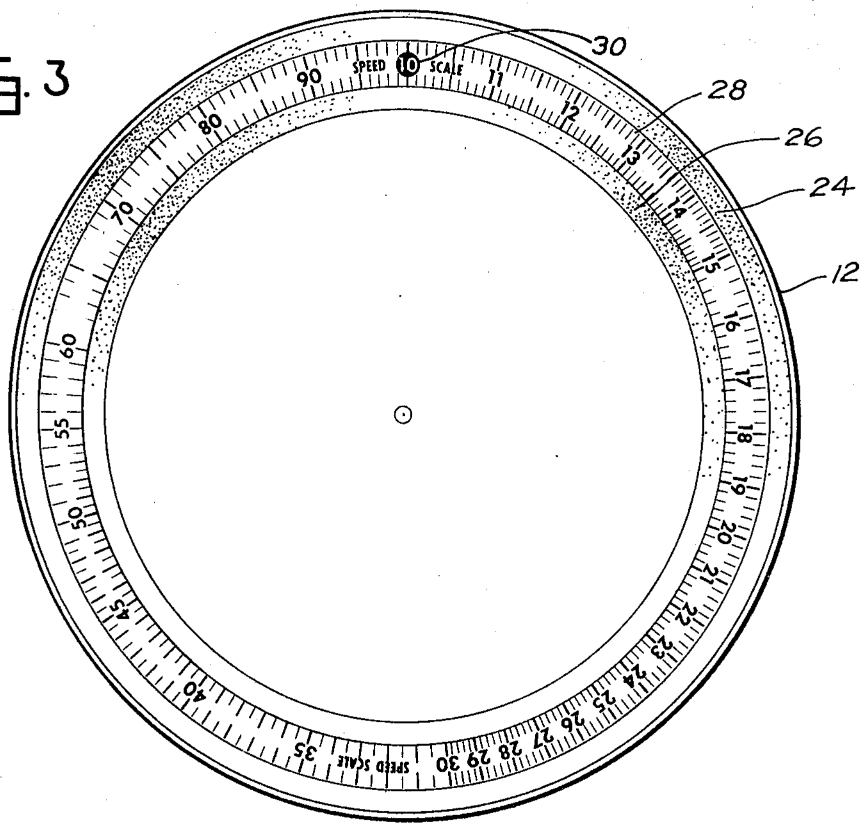

Fig. 5

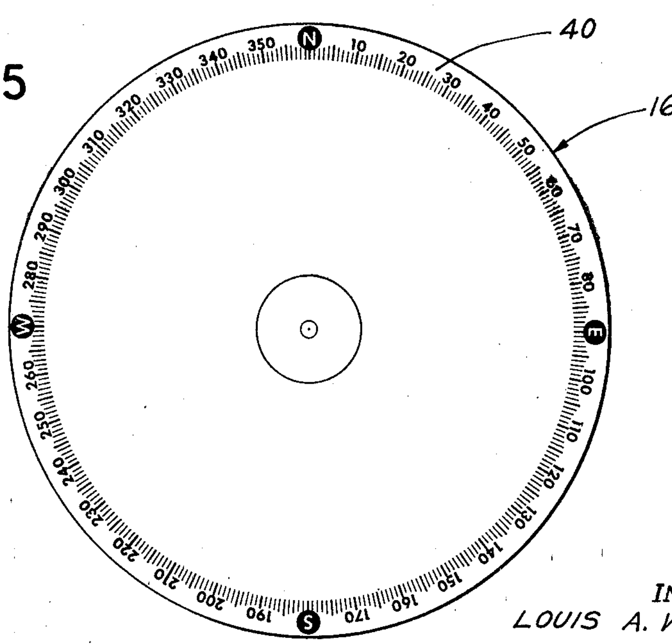

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Fig. 4

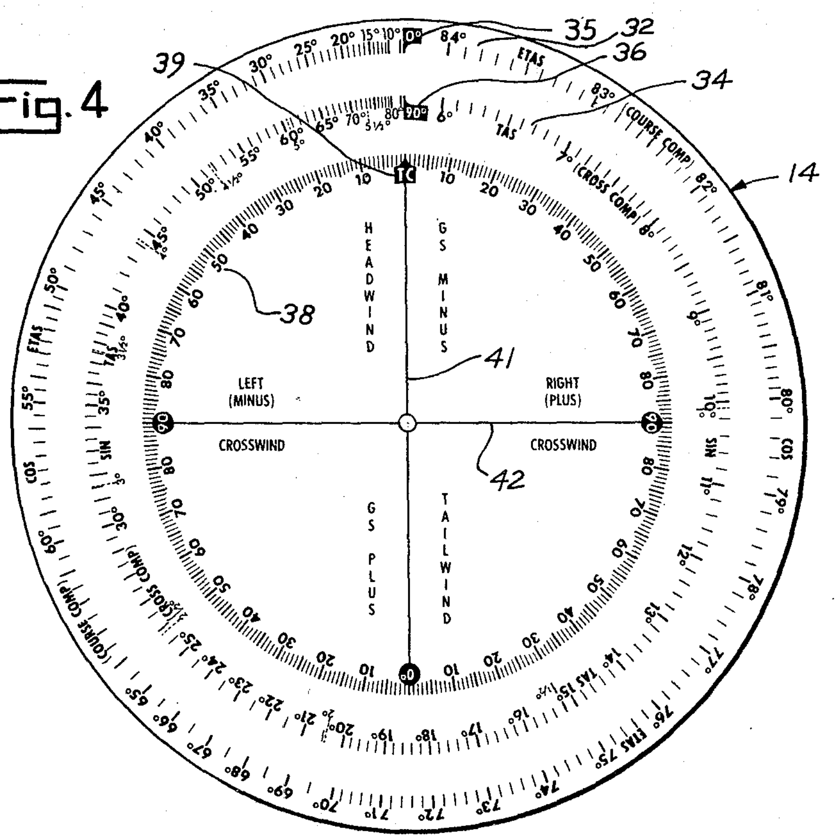

Fig. 6

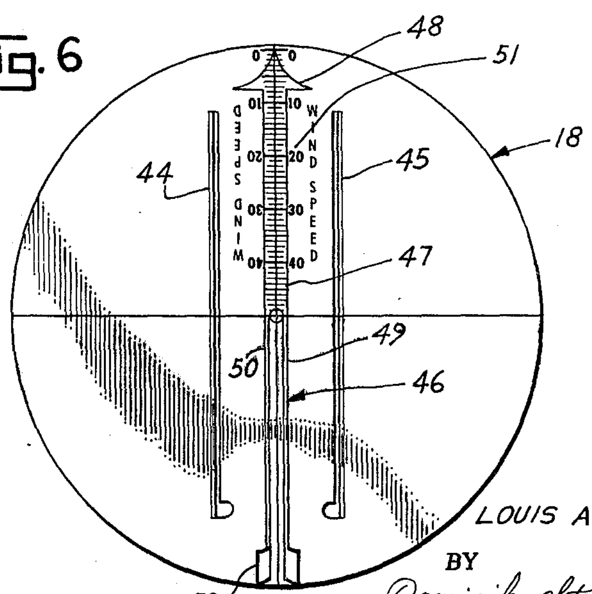

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Fig. 7

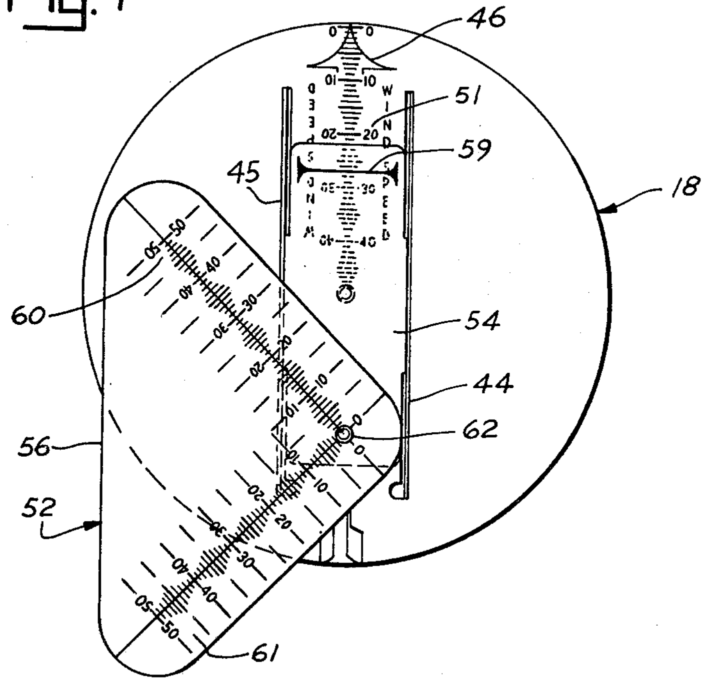

Fig. 8

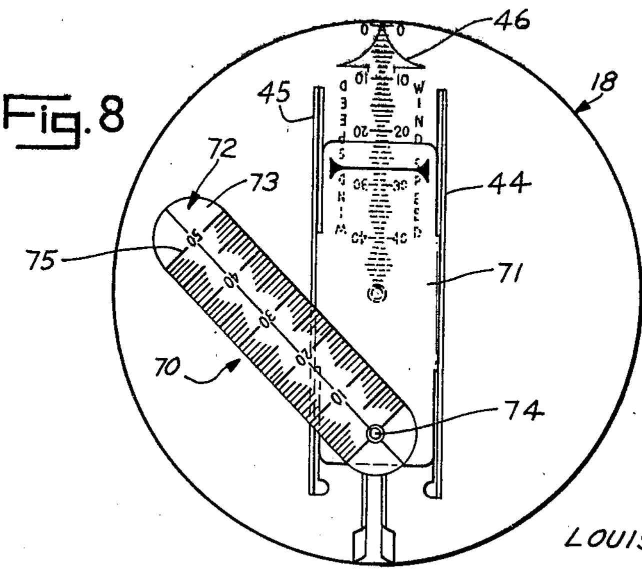

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Fig. 9

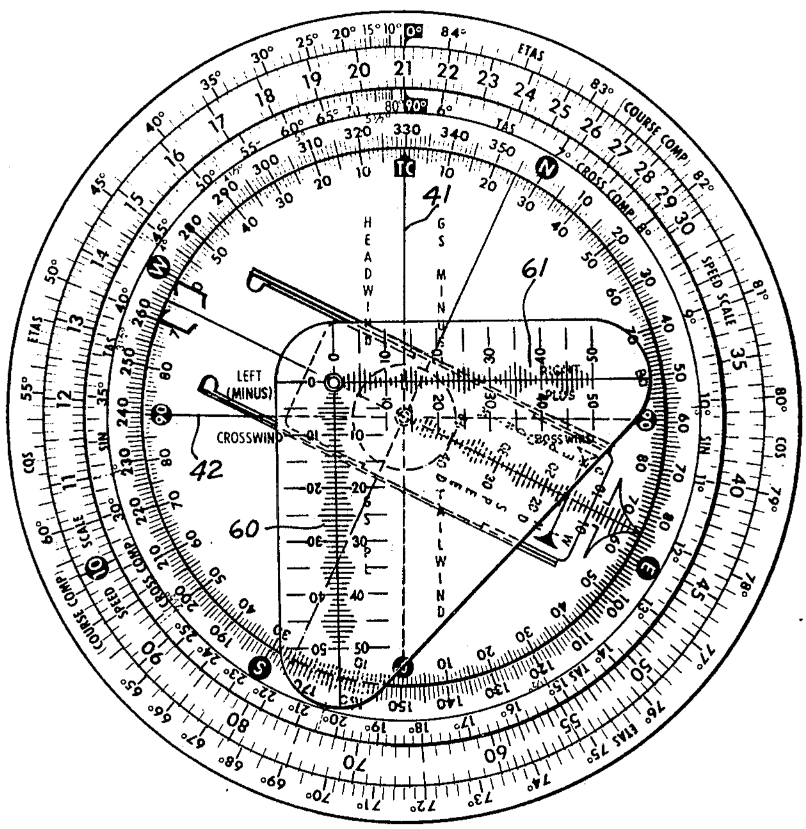

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Fig. 10

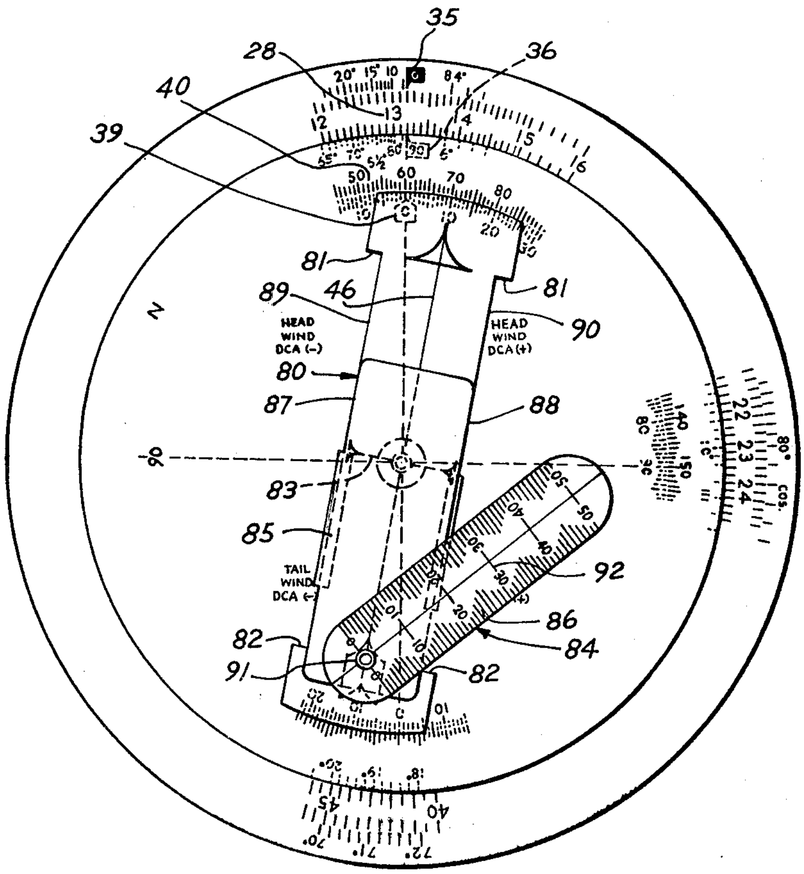

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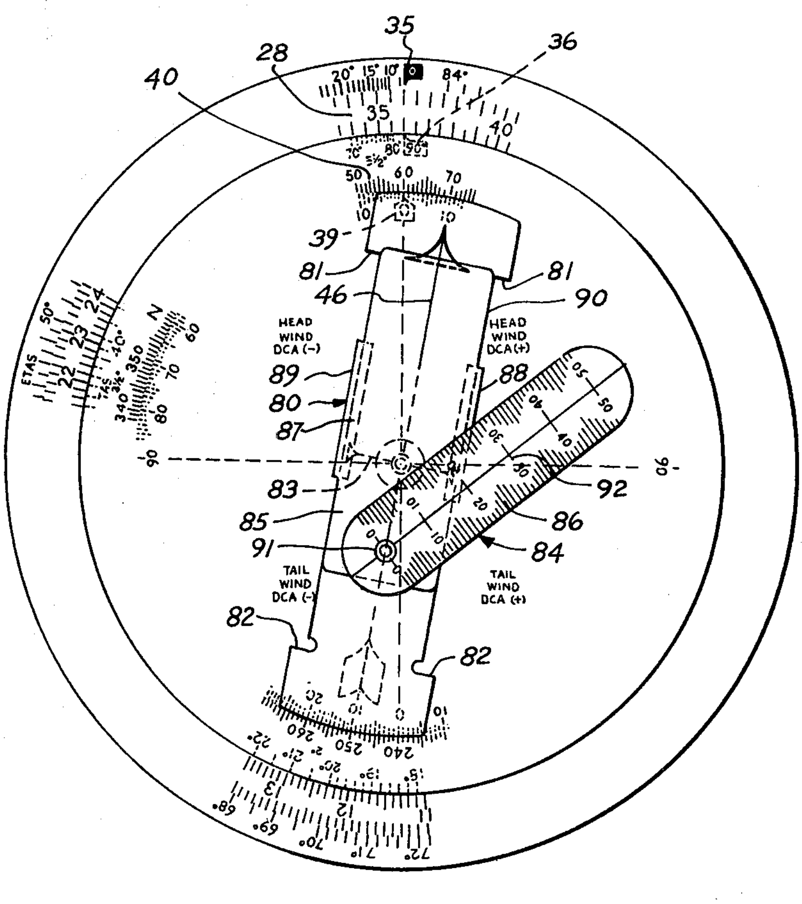
Fig. 11



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3,497,678

NAVIGATIONAL COMPUTER

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Int. Cl. G06c *1/00, 27/00;* G06g *1/00*
U.S. Cl. 235—61 11 Claims

ABSTRACT OF THE DISCLOSURE

A navigational computer for solving wind vector problems including a plurality of rotatable discs having cooperatively arranged log cosine, log sine and log speed scales and a 360° compass rose thereon, for setting and reading effective true air speeds and ground speeds, true air speeds and true air speed components. A cursor slider having a cursor pivotally attached thereto is affixed to one of the discs and cooperates with a pair of wind speed component reference lines, to read and set wind speed components.

This invention relates, in general, to navigational computers and, in particular, to navigational computers for solving wind vector problems.

In U.S. Patent 2,775,404, there is disclosed a navigational computer for computing the speed and direction of the wind while in flight, based on certain given navigational data, and for computing the magnetic heading and ground speed for planning a flight when the speed and direction of the wind is forecast or known. Generally, the computer has a log cosine scale, a log sine scale and a logarithm speed scale on it which cooperate to perform computations and solutions of wind vector problems. The air speed and the wind are resolved into components by performing the necessary trigonometric computations, on these scales, by the relative positioning of the discs of the computer. The computer also has a graphical portion which is formed by a circular grid and a rectangular grid superimposed with one another. The mathematical relationship between these grids and the cooperating log speed scale and the log sine and cosine scales is such as to permit direct reading after an initial setting is made. The subject patent contains a detailed explanation of the theory and the operation of the computer to solve navigational wind vector problems.

The computer of the present invention is generally like the computer of the U.S. Patent 2,775,404, in that it also has a log cosine scale, a log sine scale and a logarithm speed scale for solving navigational wind vector problems. The circular and rectangular grids forming the graphical portion of the latter computer have been eliminated, however, and replaced with mechanical computer means. These mechanical computer means are used in cooperation with a pair of straight lines which perpendicularly intersect one another at the central axis of the computer, to permit direct readings to be made, after the computer is initially set up. Improved log cosine, log sine and numerical log speed scales also are provided so that the computer, while operating on the same theory as the computer of the subject patent, is far more accurate, is easier to read, and eliminates the need to interpret and/or interpolate the readings. Other improved features also are provided, as will be apparent from the description below.

Accordingly, it is an object of the present invention to provide improved navigational computers, particularly of the type adapted to solve navigational wind vector problems.

Another object is to provide improved navigational computers of the above type which have a design such

that the solutions can be more accurately computed and read.

Still another object is to provide improved navigational computers of the above type having mechanical cursor means which are operable to accurately determine the wind components.

A still further object is to provide improved navigational computers of the above type which are of a simple, inexpensive construction, yet sturdy, accurate and compact.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The above objectives are accomplished with a navigational computer which includes, generally, a base, a pair of intermediate discs, and a top disc, all affixed together in a concentric fashion and rotatable relative to one another. One of the intermediate discs has a log cosine scale and a log sine scale on it which are cooperatively arranged with a logarithm speed scale on the base disc to set or read crab angles, effective true air speeds and wind-speed components. The base disc also has a true course index on it which functions with a 360° compass rose on the other one of the intermediate discs, to set or read true courses and true headings. The top disc has a wind direction arrow for setting or reading wind speeds, and a mechanical wind component computing device including a cursor slider which is slidably affixed to the top disc and a cursor which is pivotally affixed to the cursor slider, for setting or reading wind components. The cursor slider is cooperatively arranged with the wind-speed scale on the top disc and has an index for setting or reading wind speeds on the wind-speed scale. The cursor pivotally affixed to the cursor slider has a wind-speed component scale on it and, when the wind direction arrow is set in the direction of the wind and the index on the cursor slider is set over the wind speed on the wind-speed scale on the top disc, the wind components can be read or set on the wind-speed component scale on the cursor, by pivotally moving the latter so that it extends perpendicular to and over respective ones of a pair of reference lines on the base disc, and reading or setting the wind components at the points where the reference lines intersect the wind-speed component scale on the cursor. In a preferred embodiment, the top disc is eliminated and only an arm having a wind direction arrow and a reference index is used. The cursor slider, in this case, is slidably affixed to and cooperatively arranged with the arm. With these arrangements of the computer, more accurate readings can be made, directly and without the need of interpreting or interpolating the indicated wind-speed component values.

The invention accordingly comprises an article of manufacture possessing the features, properties, and the relation of elements which will be exemplified in the article hereinafter described.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is a top plan view of a navigational computer exemplary of the invention;

FIG. 2 is a sectional view of the computer, taken along lines 2—2 of FIG. 1;

FIG. 3 is a top plan view of the base disc of the computer of FIG. 1;

FIG. 4 is a top plan view of the intermediate disc of the computer of FIG. 1 which is positioned atop the base disc;

FIG. 5 is a top plan view of the other one of the intermediate discs, illustrating the 360° compass rose thereon;

FIG. 6 is a top plan view of the top disc of the computer of FIG. 1, illustrating the wind-speed scale formed on it;

FIG. 7 is a top plan view of the top disc of the computer of FIG. 1, illustrating the mechanical wind component computing device affixed to it;

FIG. 8 is a similar top plan view of the top disc of the computer, illustrating a mechanical wind component computing device which is exemplary of a second embodiment of the invention affixed to it;

FIG. 9 is a top plan view of the computer, illustrating the manner in which the crosswind and tailwind (or headwind) components are determined, for an assumed navigational wind-speed problem;

FIG. 10 is a top plan view of the computer, illustrating a modified mechanical wind component computing device affixed to it, and further illustrating the manner in which the computer can be used to solve an assumed navigational wind-speed problem using the law of sines; and

FIG. 11 is a similar top plan view of the computer of FIG. 10, illustrating another setting thereof when solving the assumed navigational wind-speed problem.

Similar reference characters refer to similar parts throughout the several views of the drawings.

Referring now to the drawings, in FIG. 1 there is illustrated a computer **10** having four circular discs **12, 14, 16** and **18** which are affixed together, concentrically, atop one another, as illustrated in FIG. 2, by means of a grommet **20** and a spring washer **22**. Each of the discs **12, 14, 16** and **18** is rotatable with respect to the others, as described more fully below. The circular disc **12**, is opaque and, as can be best seen in FIG. 3, has two spaced-apart annular rings **24** and **26** thereon, between which is a logarithmic speed scale **28**. The rings **24** and **26** each is colored so to both color-code and highlight a log cosine scale **32** and a log sine scale **34**, respectively, on the disc **14**. The speed scale **28** has an index **30** which, in the illustrated example, is a solid-colored circle having the numeral **10** therein.

The disc **14** is of a transparent material and is affixed atop the disc **12** (FIG. 2). As can be best seen in FIG. 4, the disc **14** has a diameter substantially the same as that of the disc **12**. The log cosine scale **32** and the log sine scale **34** are printed peripherally about the face of the disc **12**, in positions so as to overlay the annular rings **24** and **26**, respectively, and have indexes **35** and **36**, respectively, which are positioned directly opposite one another, on each of the opposite sides of the speed scale **28**. As indicated above, the rings **24** and **26** both color-code and highlight the log cosine and the log sine scales so that they can be easily observed and read.

While it will be appreciated that a logarithmic scale never reaches the zero value, for the purpose of this computer, the indexes **35** and **36** are labeled 0° and 90°, respectively, and are considered as the origin or starting point of the log cosine and sine scales **32** and **34**.

The log cosine scale **32** extends about the periphery of the disc **12** in a counter-clockwise manner, while the log sine scale **34** extends about the disc **12** in a clockwise fashion. Also, for all practical purposes, each of these scales extend from 0° to 90° so that any angle can be read directly on either of the two scales, without the need of converting it.

The disc **14** also has a true course index **39**, which is labeled TC, positioned such that it lies adjacent and is functionally associated with a 360° compass rose **40** formed on the disc **16** (described below). The index **39** and the indexes **35** and **36** all are aligned in a fashion such that each of them would lie along a radial line extended outwardly from the central axis (defined by the grommet **20**) of the computer **10**, to its outer edge, for reasons set forth below. A scale **38** which is graduated from 0° to 90° and then from 90° to 0°, in both a clockwise and a counter-clockwise direction from the true course index **39** also is provided on the disc **14**, for determining drift corrections and relative wind angles, in a manner described below.

Straight reference lines **41** and **42** are provided on the disc **14**, and function in conjunction with a wind-speed component scale **60** (described below) to set or read wind-speed components. These reference lines **41** and **42** are of equal length and perpendicularly intersect one another, at their midpoints, at the central axis of computer **10**. The refernce lines **41** and **42** also are positioned so that one of them, in the illustrated example, reference line **41**, is aligned with and extends inwardly from the index **39**.

Indicia is printed on the face on the disc **14** for indicating, for example, whether the computed wind components are right or left crosswinds, and head or tailwinds.

The disc **16** (FIG. 5) also is transparent and, as can be seen in FIG. 2, is affixed atop the disc **14**. The diameter of the disc **16** preferably substantially corresponds to the smaller diameter of the annular ring **26**, that is, its diameter at the inside edge thereof, and the 360° compass rose **40** is printed on the outer marginal edge thereof.

The disc **18** (FIG. 6) likewise is of a transparent material and, in FIG. 2, it can be seen that it is affixed atop the disc **16**. The disc **18** has a diameter such that its peripheral edge extends adjacent the compass rose **40** of the disc **16**. A pair of spaced-apart, parallel elongated slots **44** and **45** are formed in the disc **18**, at equal spaced distances on the opposite sides of the central axis of the computer **10**, respectively. A wind direction arrow **46** extends diametrically across the disc **18**, between the slots **44** and **45**. This wind direction arrow **46** advantageously is dfined by a solid shaft portion **47** extending from the central axis outward to the edge of the disc **18** where it terminates with an arrowhead **48** and a pair of parallel lines **49** and **50** extending in the opposite direction from the central axis to the edge of the disc **18** where it terminates with a tail **53**. A wind-speed scale **51** is provided on the disc **18**, and is cooperatively arranged with the wind direction arrow **46**. The wind-speed scale **51** has indicia in the form of straight lines which are extended transversely across the shaft portion **47** and which are numbered in tens, in increasing value from 0 knots at the tip of the arrowhead **48** to 50 knots at the central axis of the computer **10**.

As can be best seen in FIG. 7, a wind-speed component computing device **52** is affixed to the disc **16**, and includes a cursor slider **54**. The cursor slider **54** has a pair of outwardly extending flanges (not shown) which are reveresely folded so as to extend through respective ones of the slots **44** and **45** to slidably secure the cursor slider **54** and hence the computing device **52** to the disc **18**. The cursor slider **54** has an index **59** on it, which index is a line extending transversely across it and positioned so as to cooperate with the wind-speed scale **51**. The index **59** is aligned with the indicia of the wind-speed scale **51**, to apply a wind-speed value to the computer **10**, as described more fully below.

The cursor **56** is generally triangular-shaped and is pivotally affixed to the cursor slider **54**, by means of a grommet **62**. The wind-speed component scales **60** and **61** which are like the wind-speed scale **51** are provided on the cursor **56**, and extend perpendicular to one another. The wind-speed component scales **60, 61** increase from 0 knots at the grommet **62** to 50 knots at their outer ends. The cursor **56** is affixed to the cursor slider **54** in a fashion such that the indicia of the wind-speed scale **51** and the wind-speed component scales **60** and **61** increase in value in opposite directions.

Having now described the construction of the computer **10**, its operation in solving an air navigational problem can be described as follows. The problem or solution which is most often encountered is to determine the true heading, the crab angle, and the ground speed while planning a flight, when the true course, the true air speed, the forecast wind direction and wind speed are known. Assuming that:

(1) the true course is 050°,
(2) the true air speed is 240 knots,
(3) the wind direction is 200°, and
(4) the windspeed is 16 knots.

the computer **10** is manipulated in the manner described below to determine the true heading, the crab angle and the ground speed.

The disc **14** is first rotated with respect to the disc **12**, to align the indexes **35** and **36** with the indicia corresponding to 240 knots (the true air speed) on the air speed scale **28**, as illustrated in FIG. 1. Next, the disc **16** is rotated with respect to one another, to align the true course index **39** with the indicia corresponding to 050° (the true course) on the compass rose **40**. Holding the discs **12**, **14** and **16** fixed with respect to one another, the disc **18** is rotated to set the tail **53** of the wind direction arrow **46** to the direction from which the wind blows, that is, in this case, with the indicia corresponding to 200° (the assumed wind direction) on the compass rose **40**. With this arrangement, the wind direction arrow **46** presents an actual picture of "how the wind blows" with respect to the aircraft so that the problem can be more easily visualized and solved. The cursor slider **54** is slidably moved to align the index **59** thereon over the indicia corresponding to 15 knots (the wind speed) on the wind-speed scale **51**.

After these initial settings have been made, the crosswind components are easily, quickly and accurately determined as follows. The cursor **56** is pivotally moved so that the wind-speed component scales **60** and **61** thereon extend perpendicular to and over respective ones of the reference lines **41** and **42**, as illustrated in FIG. 1. A crosswind component of 8 knots is read on the wind-speed component scale **61**, where the reference line **41** intersects it. The crosswind is determined to be a right crosswind, by noting the position of the grommet **62**, that is, whether it is positioned to the right or to the left of the reference line **41**, and the legend of the disc **12**, which, in this case, reads "right crosswind." Accordingly, the crosswind component is determined to be a right crosswind of 8 knots.

The value 8 knots is now located on the logarithmic air-speed scale **28** (or, in this case, 80 knots since the indicia **80** can be interpreted as 8.0 or 80 or 800 etc., as in the case of any slide rule) and below it just to the left on the log sine scale **34** the value of approximately 8° is read. The 2° is the crab angle and, since it is a right crosswind, the crab angle is added to the true course of 050° and the true heading is therefore determined to be 052°.

The headwind or tailwind component, as the case may be, is determined by reading the value 14 knot on the wind-speed component scale **60**, over the reference line **42**, and it is further noted from the position of the grommet **62** and the legend on the disc **12** that this wind component is a tailwind.

Ground speed is determined by adding the tailwind to, or substracting a headwind from, the consine component of the true airspeed. The cosine component of the true airspeed, in this case, is determined by observing the air speed which is aligned with the angle 2° on the log cosine scale **32**. For all practical purposes, this value is read as 240 knots, although it is actually slightly less than this. The tailwind of 14 knots is added to this 240 knots, and the ground speed therefore is 254 knots.

From the above description, it is seen that the crosswind components are easily and quickly determined and, furthermore, that they can be read directly from the wind-speed component scales **60** and **61** without the need to interpret the indicated readings, by extending them to intersect another scale or to interpolate the reading on this other scale. It is further apparent that the indicated readings are far more accurate since the wind direction and wind speed both are precisely applied to the computer **10** and the wind-speed components are read directly from the wind-speed component scales **60** and **61** as described above. Furthermore, the computer **10** is extremely accurate at low wind speeds, whereas other similar computers, particularly the computer disclosed in the above-mentioned U.S. Patent 2,775,404 are not.

In FIG. 9 the computer **10** is illustrated in the manner in which it is initially set up to determine another navigational wind-speed problem. In this case, the known elements are:

True course	°	330
True air speed	knots	210
Wind direction	°	265
Wind speed	knots	15

and again it is desired to determine the true heading, the crab angle and the ground speed.

In FIG. 9 it can be seen that the indexes **35** and **36** of the log cosine scale **32** and log sine scale **34**, respectively, are aligned with the true air speed of 210 knots on the logarithmic speed scale **28**. The true course of 330° on the compass rose **40** is aligned with the true course index **39** on the disc **14**. The tail **53** of the wind direction arrow **46** is aligned with the wind direction of 265° on the compass rose **40**, and the cursor slider **54** is positioned to align its index **59** over the wind speed of 15 knots on the wind-speed scale **51**.

The cursor **56** is positioned so that the wind speed component scales **60** and **61** extend perpendicular to and over the reference lines **41** and **42**, as described above. A headwind component of 7 knots is read on the wind-speed component scale **60**, over the reference line **42**, and a left crosswind of 13 knots is read on the wind-speed component scale **61**, over the reference line **41**. By following the steps outlined above, the crab angle is determined to be approximately 3.5° and the true heading therefore is 326.5°. The ground speed is determined to be 203 knots.

Another navigational wind-speed problem sometimes encountered is to determine the wind direction and the wind speed, while in flight, when the true course, the true air speed, the true heading and crab angle, and the ground speed are known. To illustrate how the computer **10** is manipulated to determine the wind direction and speed, assume that the aircraft has the following:

True course	°	330
True air speed	knots	210
True head	°	326.5
Crab angle	do	3.5
Ground speed	knots	203

To solve this problem, the true air speed of 210 knots on the logarithmic air-speed scale **28** is aligned with the index **35** of the log cosine scale **32**, and the true course of 330° on the compass rose **40** is aligned with the true course **39**, as illustrated in FIG. 9.

The headwind component is first determined by multiplying the true air speed by the cosine of the crab angle, and then subtracting the ground speed from the determined value. Thus, under 3.5° on the log cosine scale **32**, the value of 210 knots is read on the speed scale **28**. This is the cosine ground speed component and since it is more than the ground speed, it is apparent that the wind is a headwind. Thus, by subtracting the ground speed of 203 knots from the cosine ground-speed component of 210 knots, the headwind component is found to be 7 knots.

Multiplying the true air speed of 210 knots by the sine of the crab angle of 3.5°, the crosswind component is found to be 13 knots. Since the crab angle is to the left, the wind is obviously a left crosswind.

With these two values determined, two legs of the wind component right triangle relative to the true course are now known. The wind direction and speed is determined by applying these two values to the wind-speed component computing device **52**, as follows: the cursor **56** is positioned so that the wind speed component scales **60** and **61** extend perpendicular to and over the reference lines **41** and **42**. The cursor slider **54** is simultaneously moved to align the left crosswind component of 13 knots on the wind-speed component scale **61** over the reference line **41**, then is extended perpendicular to and over the reference line **42**. The disc **18** is rotated and the position of the cursor **56** is adjusted while it is rotated to align the headwind of 7 knots on the wind-speed component scale **60** over the reference line **42**. In this position, the tail **53** of the wind direction arrow **46** is aligned with the wind direction which, in FIG. 9, can be seen to be 265°. The index **59** on the cursor slider **54** also is aligned over the wind speed on the wind-speed scale **51**, and the wind speed can be seen to be 15 knots.

In FIG. 8, the disc **16** is illustrated having a wind-speed component computing device **70** affixed to it, which includes a cursor slider **71** and a cursor **72**. The cursor slider **71** is identical to the cursor slider **54**, and is slidably affixed to the disc **16** in a like fashion. The cursor **71**, in this case, however, comprises an elongated, generally rectangular-shaped member **73** which is pivotally affixed to the cursor slider **71**, by means of a grommet **74**. The cursor slider **72** also only has one wind-speed component scale **75** provided on it, which increases from 0 knots at the grommet **74** to 50 knots at its outer end. The wind-speed component scale **75** provided on it, which increases from 0 knots at the grommet **74** to 50 knots at its outer end. The wind-speed component scale **75** and the wind-speed scale **51** on the disc **18**, therefore increase in value in opposite directions, in the same fashion as the wind-speed component scales **60** and **61**, when the cursor **72** is affixed to the cursor slider **71**.

In using the wind-speed component computing device **70** to solve an air navigational problem, for example, the navigational problem illustrated in FIG. 1, the discs **12**, **14**, **16** and **18** are initially set-up in the same manner as described above, when using a computer **10** having a wind-speed component computing device **52** affixed to it.

After these initial settings have been made, however, the cursor **72** is pivotally moved so that it extends perpendicular to and over the reference line **41**. A crosswind component of 8 knots is read on the wind-speed component scale **75**, where the reference line **41** intersects it. Next, the cursor **72** is pivotally moved so that it extends perpendicular to the other reference line **42**. A tailwind of 14 knots is read on the wind-speed component scale **75**, where the reference line **42** intersects it.

It can be seen from the above description that the only major difference in the operation of the computer **10** having a cursor **72** affixed to it instead of a cursor **56**, is that the cursor **72** must be manipulated so as to position it perpendicular to each of the two reference lines **41** and **42** in order to determine both crosswind components. In the case of the cursor **56**, both crosswind components can be determined with only one setting.

In FIGS. 10 and 11, the disc **18** and the wind-speed component computing device have been substantially modified so as to provide a still more simplified arrangement. It can be seen that the disc **18** is reduced to merely a generally rectangular-shaped arm **80** which is rotatably affixed to and extends diametrically across the disc **16**. The end portions at each of the opposite ends of the arm **80** are formed so as to provide stop shoulders **81** and **82**, and all of the indicia except for the wind direction arrow **46** has been removed. A single index in the form of a straight line **83** extends across the width of the arm **80** perpendicular to the wind direction arrow **46**, at the center of the computer.

The wind-speed component computing device **84**, in this case, includes a cursor slider **85** and a cursor **86**. The cursor slider **85** is generally rectangular-shaped and has a securing and alignment flange **87** and **88** integrally formed along each of its opposite sides which are folded over and about the parallel side edges **89** and **90** of the arm **80**, to slidably affix the cursor slider to the arm. These flanges also abut the stop shoulders **81** and **82** on the arm **80**, so that the cursor slider **85** cannot become disengaged from the arm.

The cursor **86** comprises an elongated, generally rectangular-shaped member which is pivotally affixed to the cursor slider **85**, by means of a grommet **91**. A single wind-speed scale **92** is provided on the cursor **86**, and this wind-speed scale increases from 0 knots at the grommet **91** to 50 knots at its opposite end. This wind-speed scale **92** functions both to set the wind speed and to determine wind-speed components, in a manner described more fully below.

In using this computer to solve an air navigational problem, such as the navigational problem illustrated in FIG. 1, the discs **12**, **14** and **16** are initially set-up in the same manner as described above. The arm **80** is rotatably adjusted to align the wind direction arrow **46** in the direction that the wind blows, as illustrated in FIG. 10. The wind speed is set by slidably adjustably positioning the cursor slider **85** and the cursor **86** to align the indicia on the wind-speed scale **92** corresponding to the wind speed, in this case, 15 knots, over the index **83** on the arm **80**.

The crosswind component is determined by pivotally moving the cursor **86** so that it extends perpendicular to and over the reference line **41**. In this position, the value 8 knots is read on the wind-speed scale **92**, where the reference line **41** intersects it. Next, the cursor is pivotally moved so that it extends perpendicular to and over the other reference line **42**. A tailwind of 14 knots is now read on the wind-speed scale **92**, where the reference line **42** intersects it.

It can be seen that the wind-speed components are determined in generally the same manner with the cursor **86** as they are with the cursor **72**. The major advantage and the most desirable features of the last described arrangement is the simplicity of the arrangement and the substantially uncluttered appearance of the computing device, due to the elimination of the wind-speed component scales. This arrangement, accordingly, is generally preferred.

The computer **10** has another feature which is not provided by other similar computers. It may be noted that the arrangement of the scales is such that the computer can be used to easily and quickly solve wind vector problems using the right triangle solution rather than graphically, as described above. This feature is particularly useful when high wind speeds are encountered as, for example, when following the jet streams. Such wind vector problems can be graphically solved, in the manner described above, however, the accuracy of the computers is not as great.

As an example, suppose that

(1) true course is 060°,
(2) true airspeed is 360 knots,
(3) the wind direction is 250°, and
(4) the wind speed is 132 knots.

In solving this wind vector problem, the 0° index **35** and the 90° index **36** first are aligned with the indicia on the speed scale **28** corresponding to the wind speed which, in this case, is 132 knots, as can be best seen in FIG. 10. The indicia 060° (which is the true course) of the compass rose **40** on the disc **16** is aligned with the true course index **39** (FIG. 10), and the tail of the wind direction arrow **46** is aligned with the indicia 250° of the compass rose **40**.

After these settings have been made, reference is made to the sacle **38** and the wind direction arrow **46** to determine the relative wind angle. In this case, it can be seen to be 10°. The course component of the wind is now determined by reading 130 knots on the speed scale

28, below and aligned with the indicia 10° on the cosine scale **32**. By looking at the direction in which the wind direction arrow **46** points, it can be seen that this is a tailwind. The crosswind component is determined by reading 23 knots on the speed scale **28**, over and aligned with the indicia 10° on the sine scale **34**. Again, noting the direction of the wind direction arrow **46**, it can be seen that this is a left crosswind.

Now, the 0° and the 90° indexes **35** and **36** are aligned with the indicia on the speed scale **28** corresponding to the true airspeed which, in this case, is 360 knots, as illustrated in FIG. 11. Knowing the crosswind component is 23 knots, the crab angle is determined by reading the value 3½° on the sine scale **34**, below and substantially aligned with the 23 on the speed scale **28**. A rule of thumb to follow in determining the crab angle is to use the small angles if the crosswind component is less than ⅒ of the true airspeed. Applying this rule in the instant case, ⅒ of the true airspeed would be 36 knots and the cross wind component is only 23 knots, hence the small angle 3½° rather than 40° is used. The true heading is determined by subtracting the crab angle 3½° from the true course of 0.50°, since the wind is a left crosswind. The true heading therefore is 056.5°.

The ground speed is determined by, in this case, adding the course component to the product of the cosine of the crab angle times the true airspeed since it is a tailwind. The product of the cosine of the crab angle times the true airspeed is determined by reading the value indicated on the airspeed scale **28**, below and aligned with the angle 3½° on the cosine scale **32**. In this case, for all practical purposes, it can be seen that this value is just slightly less than 360 knots. Adding the tailwind of 130 knots to this, it is determined that the ground speed is 490 knots.

From the above description, it can be seen that the wind speed components, the crab angle, the true heading and the ground speed all can be easily, quickly and accurately determined, regardless of the wind speed.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above article without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Now that the invention has been described, what is claimed as new and desired to be secured by Letters Patent is:

1. A computer for the solution of navigation problems comprising a plurality of cooperating discs mounted on a common central axis and rotatable with respect to each other; a first one of said discs having a true course index and wind-speed component reference means thereon; a second one of said discs having a compass rose circumferentially formed on it; said true course index and said compass rose being cooperatively positioned with respect to one another to set and read true courses on said compass rose; and means rotatably affixed to said computer having thereon a wind direction arrow, a reference index, at least one wind-speed scale, and a mechanical wind-speed component computing device, said wind direction arrow being positioned to cooperate with said compass rose to set and read wind directions on said compass rose, said mechanical wind-speed component computing device being operable to set and to read wind speeds on said wind-speed scale and to set and read longitudinal and transverse wind-speed components on said wind-speed scale in cooperation with said windspeed component reference means.

2. The computer of claim **1**, wherein said means comprises a third disc having said wind direction arrow and said wind speed scale provided on it, said mechanical wind-speed component computing device being affixed to said third disc and having said reference index and a wind-speed component scale provided on it, said device being operable to set and to read wind speeds on said wind-speed scale and to set and read longitudinal and transverse wind-speed components on said wind-speed scale in cooperation with said wind-speed component reference means.

3. The computer of claim **2** wherein said wind-speed component reference means comprises a pair of straight lines which perpendicularly intersect one another at said common central axis, one of said lines being aligned with said true course index on said first disc.

4. The computer of claim **2**, wherein said mechanical wind-speed component computing device comprises a cursor slider having said reference index thereon slidably affixed to said disc with said reference index positioned to cooperate with said wind-speed scale to set and to read wind speeds thereon, and a cursor having one wind-speed component scale thereon pivotally affixed to said cursor slider, said cursor being pivotally adjusted to extend perpendicular to and over said pair of straight line wind-speed component reference means to set and read said longitudinal wind-speed component and said transverse wind-speed component, respectively.

5. The computer of claim **2**, wherein said mechanical wind-speed component computing device comprises a cursor slider having said reference index thereon slidably affixed to said disc with said reference index thereon positioned to cooperate with said wind-speed scale to set and to read wind speeds thereon, and a cursor having two wind-speed component scales thereon which have a common index and which are perpendicularly disposed with respect to one another, said cursor being pivotally affixed to said cursor slider and being pivotally positionally adjustable to position each of said two wind-speed component scales perpendicular to and extending over different ones of said pair of straight line wind-speed component reference means to simultaneously set and to read both said longitudinal and transverse wind-speed components.

6. The computer of claim **1**, wherein said means comprises a generally rectangular-shaped arm rotatably affixed atop the second one of said discs and having said wind direction arrow and said reference index provided on it, said mechanical wind-speed component computing device comprising a cursor slider slidably affixed to said arm and a cursor having said wind speed scale thereon pvotally affixed to said cursor slider.

7. The computer of claim **1**, further including a disc having a logarithmic numerical air-speed scale thereon; and a disc having logarithmic trigonometric function scales thereon; said logarithmic numerical air-speed scale and said trigonometric function scales being positioned to cooperate in slide rule fashion to resolve known navigational data into certain trigonometric components.

8. The computer of claim **7** wherein said logarithmic numerical air-speed scale is formed on a fourth disc which is mounted on said common central axis and is rotatable with respect to said plurality of cooperating discs; and wherein said logarithmic trigonometric function scales are formed on said first one of said discs.

9. The computer of claim **8** wherein said logarithmic numerical air-speed scale and said trigonometric function scales each have an index which are aligned.

10. The computer of claim **9** wherein said logarithmic trigonometric function scales comprises a cosine and a sine scale in spaced relation on opposite sides of said logarithmic numerical air-speed scale, respectively, said cosine scale including indicia having 0° represented at said index and increasing angles represented about the circumference of said disc in a counter-clockwise fashion, said sine scale including indicia having 90° represented at said index and decreasing angles represented about the circumference of said disc in a counter-clockwise fashion.

11. The computer of claim 5, wherein said wind-speed scale has indicia which increases in value from the outer periphery of said disc toward said common central axis, and wherein said wind-speed component scales on said cursor increase in value from said common index toward the outer extremity of said cursor.

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