PATENT SPECIFICATION

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557,895

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PROVISIONAL SPECIFICATION

Improvements relating to Computers of the Slide Rule Type

I, PAUL GOUDIME-LEVKOVITSCH, a British Subject, of Little Lyneham, Wentworth, Surrey, do hereby declare the nature of this invention to be as follows:—

This invention relates to computers of the slide rule type and more particularly but not exclusively to computers adapted for solving certain problems which occur in air navigation.

The conventional way of solving on a slide rule an equation of the form

$$1-\frac{C}{D}=\pm x \qquad \ldots\ldots (1)$$

is first to determine the value of $\frac{C}{D}$ and then to subtract the value found from 1 in order to find x.

In the improved computer according to the present invention there is combined with an ordinary logarithmic scale numbered in the usual manner (hereinafter referred to as the main scale) a relatively movable auxiliary scale whereby the value $1-\frac{C}{D}$ may be read off directly.

In one form, the auxiliary scale comprises a reversed logarithmic scale bearing, instead of the usual numbers, values obtained by subtracting those numbers from units, the point bearing the value 0 being the index of the scale. The negative signs may, if desired, be omitted from the scale and it will be understood that the numbers on the auxiliary scale may be multiplied by ten to any power as desired.

In use of a computer having such an auxiliary scale, the index of the auxiliary scale is set against the value of C on the main scale and against the value of D on the main scale the value of x is read off directly on the auxiliary scale.

The auxiliary scale may comprise, instead of a reversed logarithmic scale, a straightforward logarithmic scale numbered in the manner above set forth. In this case, the index of the auxiliary scale is set against the value of D on the main scale and the value of x is read off directly on the auxiliary scale against the value of C on the main scale.

The auxiliary scale may be embodied in a computer of the linear or circular type, and it will be seen that for a different value of D, say D^1, the value $1-\frac{C}{D^1}$ can also be directly read off on the auxiliary scale without altering the setting of the scales. This principle may be made use of to solve equations of the form

$$\frac{1-\frac{C}{D}}{1-\frac{C}{E}}=y \qquad \ldots\ldots (2)$$

For convenience, the factor $1-\frac{C}{D}$ will be called " A " and the factor $1-\frac{C}{E}$ will be called " B " Equation (2) then becomes $\frac{A}{B}=y$.

One convenient form of computer for solving equation (2) comprises two concentric, superposed, relatively rotatable discs, the lower disc having a greater diameter than the upper disc. On the lower disc and beneath the upper disc a circular main scale is engraved and a portion of this scale is visible through an arcuate window in the upper disc. The auxiliary scale, comprising a reversed logarithmic scale, is engraved around the inner edge of the window in the upper disc.

The first stage in solving the equation is to determine the values of A and B. The upper disc is rotated until the index of the auxiliary scale is set to the value of C on the main scale, and opposite the values of D and E on the main scale the values of A and B respectively are read

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off directly on the auxiliary scale. Dividing A by B will give y. For this purpose an additional logarithmic scale, hereinafter called the "Log A and B" scale, is engraved around the edge of the lower disc and a further logarithmic scale, called the "log y" scale, is engraved around the edge of the upper disc. Two radially-extending arms called "A" and "B" respectively are arranged to rotate about the axis of the discs and to be set against the "Log A and B" scale. The computer functions as follows:

The values of A and B having been determined, the movable arms "A" and "B" are set to the values which have been found. The upper disc is then rotated so that the index of the log y scale comes opposite the arm "B" and then the value of y may be read off directly on the log y scale against the arm "A".

In a modified form of computer, two pointers (called the "A" and "B" pointers) are arranged to move relatively to the auxiliary scale and are mechanically linked to the arms "A" and "B" respectively in such a manner that setting of the "A" or "B" pointer to any given value on the auxiliary scale causes the "A" or "B" arm respectively to move a proportional amount so that it indicates the same value on the "Log A and B" scale, and *vice versa*. To operate this type of computer the index of the auxiliary scale is set to the value of C on the main scale and the arm "A" is adjusted until the "A" pointer reads against the value of D on the main scale. The arm "B" is then adjusted until the "B" pointer reads against the value of E on the main scale. Finally the upper disc is rotated until the index of the log y scale comes opposite arm "B" and the value of y is read off directly on the log y scale against the arm "A". It will be seen that the operation of the computer is simplified and that it is only necessary to engrave the index of the auxiliary scale since the pointers "A" and "B" take the place of the rest of the scale.

According to an important feature of the present invention, a computer of the type above described is adapted to solve a problem which occurs in air navigation when finding the Wind Speed and Direction by what is known as the Four Point Bearing Method.

The procedure involved consists in timing the aircraft between certain intervals during which bearings are taken of a fixed object. The times are known as T_1, T_2 and T_3. From a knowledge of these times and of the Airspeed of the aircraft, the Wind Angle, i.e. the angle between the aircraft's course and the wind direction, the Wind Speed, the Drift and the Groundspeed may be found. Dealing first with the Wind Angle θ, I have derived this as follows:

$$\frac{1-\dfrac{T_2}{T_3}}{\dfrac{T_2}{T_1}-1} = \operatorname{Tan}\theta \qquad \ldots\ldots (3)$$

Calling $\dfrac{T_2}{T_1}-1$, A, and $1-\dfrac{T_2}{T_3}$, B, the equation becomes

$$\frac{B}{A} = \operatorname{Tan}\theta \qquad \ldots\ldots (4)$$

The computer comprises the "Log A and B" scale, the auxiliary scale, the movable arms "A" and "B" and the main scale already described. The main scale is called the Time scale and corresponds to the times T_1, T_2 and T_3. The log y scale around the edge of the upper disc is replaced by a scale of log Tan θ and is called the Wind Angle scale.

In order to find the Wind Angle the index of the auxiliary scale is set to the appropriate value of T_2 on the main scale. Opposite T_1 and T_3 on the main scale the values of A and B respectively are read off on the auxiliary scale. The arms "A" and "B" are set to their respective values on the "Log A and B" scale. The upper disc is then turned so that the index of the Wind Angle scale is set to arm "A", when the Wind Angle may be read off on its scale against arm "B".

A convenient way of finding the Wind Speed with this form of computer is to utilize the Angle of Drift ϕ. This may be read off directly since it can be shown that Tan $\phi = B$. Thus by marking off on the "Log A and B" scale, values of ϕ such that ϕ is equal to $\operatorname{Tan}^{-1}B$ the Drift Angle may be read off directly against the arm "B" at the same time that the Wind Angle θ is read off. A separate Drift Angle logarithmic scale derived as already described may however be engraved on the reverse side of the lower disc, if desired.

The Wind Speed W and Groundspeed G are found by a separate calculation. For example, on the back of the lower disc of the computer there may be engraved a circular logarithmic airspeed scale, numbered say 5—400 M.P.H., whilst on a third concentric, relatively rotatable disc arranged beneath the said lower disc there may be engraved a circular logarithmic sine scale which reads against the airspeed scale. By the Sine formula

$$\frac{W}{\text{Sin}\ \phi} = \frac{G}{\text{Sin}\ \theta} = \frac{V}{\text{Sin}\ (\theta + \phi)} \quad \ldots\ldots (5)$$

where V denotes the Airspeed. Hence it is only necessary to set the Airspeed V, against the sum of the Wind Angle and Drift Angle $(\theta + \phi)$ and read off directly the Wind Speed W against the Drift Angle ϕ and the Groundspeed G against the Wind Angle θ.

Dated this 29th day of July, 1942.

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Agent for the Applicant.

COMPLETE SPECIFICATION

Improvements relating to Computers of the Slide Rule Type

I, PAUL GOUDIME-LEVKOVITSCH, a British Subject, of Little Lyneham, Wentworth, Surrey, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to computers of the slide rule type and more particularly but not exclusively to computers adapted for solving certain problems which occur in air navigation.

The conventional way of solving on a slide rule an equation of the form

$$N \pm \frac{C}{D} = x \quad \ldots\ldots (1)$$

is first to determine the value of $\frac{C}{D}$ and then to add the value found to, or subtract it from N in order to find x.

My invention comprises a computer on which the value $N \pm \frac{C}{D}$ may be read off directly, the computer comprising a logarithmic scale of numbers (main scale) and a co-operating relatively movable reversed logarithmic scale (auxiliary scale) bearing, instead of the actual numbers, the values obtained by adding those numbers to or subtracting them from the value of N.

For solving an equation of the form $N - \frac{C}{D} = \pm x$, the auxiliary scale comprises a reversed logarithmic scale bearing, instead of the actual numbers, the values obtained by subtracting those numbers from the value of N, the point bearing the value $N - 1$ being the index of the scale. Negative signs may, if desired, be omitted from the scale and it will be understood that the numbers on the auxiliary scale may be multiplied by ten to any power as desired.

In use of a computer having such an auxiliary scale, the index of the auxiliary scale is set against the value of C on the main scale and against the value of D on the main scale the value of x is read off directly on the auxiliary scale.

The auxiliary scale may be embodied in a computer of the linear or circular type, and it will be seen that for a different value of D, say D^1, the value $N - \frac{C}{D^1}$ can also be directly read off on the auxiliary scale without altering the setting of the scales. This principle may be made use of to solve equations of the form

$$\frac{N - \frac{C}{D}}{N - \frac{C}{E}} = y \quad \ldots\ldots (2)$$

For convenience, the factor $N - \frac{C}{D}$ will be called " A " and the factor $N - \frac{C}{E}$ will be called " B ". Equation (2) then becomes $\frac{A}{B} = y$.

One convenient form of computer for solving equation (2) is illustrated in Figures 1 and 2 of the accompanying drawings, Figure 1 being a top plan view of the computer and Figure 2 a similar view of the computer with the upper disc removed.

The computer comprises two concentric, superposed, relatively rotatable discs, the lower disc 1 having a greater diameter than the upper disc 2. On the lower disc and beneath the upper disc a circular main scale 3 is engraved and a portion of this scale is visible through an arcuate window 5 in the upper disc. The auxiliary scale 4, comprising a reversed logarithmic scale, is engraved around the inner edge of the window in the upper disc, and this scale is numbered in the manner described above, the particular computer illustrated being adapted for the case when N is equal to unity.

The first stage in solving the equation is to determine the values of A and B. The upper disc 2 is rotated until the index of the auxiliary scale 4 is set to the value of C on the main scale, and opposite the values of D and E on the main scale the values of A and B respectively are read off directly on the auxiliary scale. Dividing A by B will give y. For this purpose an additional logarithmic scale of numbers, 6 hereinafter called the " Log A and B " scale, is engraved around the edge of the lower disc 1 and a further logarithmic scale of numbers, 7, called the " log y " scale, is engraved around the edge of the upper disc 2. Two radially-extending arms 8, 9, called " A " and " B " respectively, are arranged to rotate about the axis of the discs and to be set against the " Log A and B " scale. This form of computer functions as follows:

The values of A and B having been determined, the movable arms " A " and " B " are set to the values which have been found. The upper disc 2 is then rotated so that the index of the log y scale 7 comes opposite the arm " A " and then the value of y may be read off directly on the log y scale against the arm " B ".

Figure 1 shows the computer set for solving the equation

$$\frac{1-\frac{4}{5}}{1-\frac{4}{10}}=y,$$

The index of the auxiliary scale 4 is set against the numeral 4 on the main scale 3, the value of $1-\frac{4}{5}$ being given on the auxiliary scale opposite 5 on the main scale as 0.2, and the value of $1-\frac{4}{10}$ being given opposite 10 on the main scale as 0.6. From the values of A and B thus obtained, the value of y is readily determined in the manner given above.

In a modified form of computer (not shown), two pointers (called the " A " and " B " pointers) are arranged to move relatively to the auxiliary scale and are mechanically linked to the arms " A " and " B " respectively in such a manner that setting of the " A " or " B " pointer to any given value on the auxiliary scale causes the " A " or " B " arm respectively to move a proportional amount so that it indicates the same value on the " Log A and B " scale, and *vice versa*. To operate this type of computer the index of the auxiliary scale is set to the value of C on the main scale and the arm " A " is adjusted until the " A " pointer reads against the value of D on the main scale. The arm " B " is then adjusted until the " B " pointer reads against the value of E on the main scale. Finally the upper disc is rotated until the index of the log y scale comes opposite arm " B " and the value of y is read off directly on the log y scale against the arm " A ". It will be seen that the operation of the computer is simplified and that it is only necessary to engrave the index of the auxiliary scale since the pointers " A " and " B " take the place of the rest of the scale.

The auxiliary scale may be adapted to solve equations of the form

$$N+\frac{C}{D}=x$$

and thus equations of the form

$$\frac{N+\frac{C}{D}}{N+\frac{C}{E}}=y.$$

In this case the auxiliary scale comprises a reversed logarithmic scale bearing, instead of the actual numbers, the values obtained by adding those numbers to the value of N.

According to an important feature of the present invention, a computer of the type above described is adapted to solve a problem which occurs in air navigation when finding the Wind Speed and Direction by what is known as the Four Point Bearing Method.

The procedure involved consists in timing the aircraft between certain intervals during which bearings are taken of a fixed object.

The aircraft flies on any desired course and when vertically over a selected object an artificial smoke cloud is released from the aircraft and a stop watch is started. The pilot then turns 180° and flies on a steady course. After about 90 seconds he makes another 180° turn and flies on a reciprocal course. If the turns have been correctly made the aircraft will now be heading straight for the smoke cloud, which will have drifted away from the object. The time of passing through the cloud is noted and is called T_1. The aircraft continues to fly on the same course and when the object is seen to bear 90° the time T_2 is taken; finally when the object bears 135° the time T_3 is taken.

Figure 3 illustrates the theory of the method when dealing with a headwind. When a tailwind is involved, the object comes abeam before the aircraft enters the smoke cloud and the time T_1 will be greater than T_2.

From a knowledge of the times, T_1, T_2, and T_3, and of the Airspeed of the aircraft, the Wind Angle, i.e. the angle between the aircraft's course and the wind direction the Wind Speed, the Drift and the Groundspeed may be found.

Dealing first with the Wind Angle θ, I have derived this as follows:

$$\frac{1-\dfrac{T_2}{T_3}}{\dfrac{T_2}{T_1}-1}=\operatorname{Tan}\theta \qquad \ldots\ldots (3)$$

Calling $\dfrac{T_2}{T_1}-1$, A, and $1-\dfrac{T_2}{T_3}$, B, the equation becomes

$$\frac{B}{A}=\operatorname{Tan}\theta \qquad \ldots\ldots (4)$$

My invention, accordingly, comprises broadly a computer for computing wind direction by the four point bearing method, said computer comprising a member having a logarithmic scale of numbers (Time scale), a second relatively movable member having a logarithmic scale bearing, instead of the actual numbers, the values obtained by subtracting those numbers from unity (auxiliary scale), a logarithmic scale of numbers (Log A and B scale), and a scale of logarithmic tangents (Wind Angle scale).

One form of computer for solving the above problem is shown in Figures 4 to 8 of the accompanying drawings, Figure 4 being a top plan view of the computer, Figure 5 a bottom plan view thereof, Figure 6 a top plan view of the computer with the uppermost disc removed, Figure 7 a bottom plan view of the computer with the two lowermost discs removed, and Figure 8 being a cross sectional view taken on line 8—8 of Figure 4.

The computer comprises two concentric relatively rotatable discs 10, 20, the lower disc 20 having a greater diameter than the upper disc 10. On disc 20 and beneath disc 10 the main scale 21 is engraved. This scale is called the time scale and corresponds to the times T_1, T_2, and T_3. A portion of the time scale 21 is visible through an arcuate window 11 in disc 10. The auxiliary scale 12, which is similar to scale 4 of the computer shown in Figures 1 and 2, is engraved around the inner edge of window 11 in disc 10. A "Log A and B" scale 22 (similar to scale 6 of Figures 1 and 2) is engraved around the periphery of disc 20.

A third concentric, relatively rotatable disc 30 is mounted immediately beneath disc 20 and this disc 30 bears a scale 31 of log Tan θ called the Wind Angle scale. An arm 32 (the "A" arm) is secured to disc 30 so as to rotate therewith and reads against the "Log A and B" scale 22, whilst a fourth concentric, relatively rotatable disc 40, mounted beneath disc 30, has an arm 41 (the "B" arm) which also reads against scale 22. The disc 40 has an arcuate window 42 through which a portion of scale 31 is visible.

In order to find the Wind Angle the index of the auxiliary scale 12 is set to the appropriate value of T_2 on the Time scale 21. Opposite T_1 and T_3 on the Time scale 21 the values of A and B respectively are read off on the auxiliary scale 12. The "A" and "B" arms 32, 41 are set to their respective values on the "Log A and B" scale 22, and, on turning over the computer, the Wind Angle may be read off on its scale 31 against the "B" arm 41.

A convenient way of finding the Wind Speed with this form of computer is to utilize the Angle of Drift ϕ. This may be read off directly since it can be shown that Tan ϕ = B. Thus by marking off on the "Log A and B" scale, values of ϕ such that ϕ is equal to Tan^{-1} B the Drift Angle may be read off directly against the arm "B" at the same time that the Wind Angle θ is read off. In the computer shown in the drawing, however, a separate Drift Angle logarithmic scale 23 derived as already described is engraved on the reverse side of the disc 20, and a portion of this scale is visible through window 43 in arm 41.

The computer shown in the drawings is set to show the values of the Wind Angle and Drift Angle in the case of a head-wind where:

Course through cloud -	=60° True
True Airspeed - - -	=150 knots
Bearing of object - -	To port
T_1 - - - - - -	=174 seconds
T_2 - - - - - -	=200 seconds
T_3 - - - - - -	=220 seconds

From the front of the computer it is seen that the values of "A" and "B" respectively are 15 and 9 and with the "A" and "B" arms set to these values on the "Log A and B" scale 22, the Wind Angle 30° is read off on its scale against the "B" arm 41 and the Drift Angle 5° against the said arm on the Drift Angle scale 23.

As the object bears to port, the Wind direction is 60° − 30° or 30° True, while the track is 60° + 5° or 65° True.

The Wind Speed W and Groundspeed G are found by a separate calculation. For example as shown in the drawings, there may be engraved on disc 40 a circular logarithmic Airspeed scale 44, numbered say 5—400 M.P.H., whilst on a fifth concentric, relatively rotatable disc 50 arranged beneath disc 40 there may be engraved a circular logarithmic sine scale 51 which reads against the Airspeed scale 44. By the Sine formula

$$\frac{W}{\sin\phi}=\frac{G}{\sin\theta}=\frac{V}{\sin(\theta+\phi)} \quad \ldots\ldots (5)$$

where V denotes the Airspeed. Hence it is only necessary to set the Airspeed V, against the sum of the Wind Angle and Drift Angle $(\theta+\phi)$ and read off directly the Wind Speed W against the Drift Angle ϕ and the Groundspeed G against the Wind Angle θ.

In the example given above the sum of the Wind Angle and the Drift is 35° and it will be seen from the drawings that, on setting the Airspeed 150 against the Angle 35°, the Groundspeed 130 knots is read off against the Wind Angle 30° and the Wind Speed 23 knots is read off against the Drift Angle 5°.

As previously mentioned, in the case of a Tailwind, T_1 will be greater than T_2. Thus T_1 will appear against the right hand portion of scale 12, i.e. that part of the scale marked "A and B" in the drawings. In the case of a Tailwind, the Wind Angle scale 31^1 on disc 30 and the Sine scale 51^1 on disc 50 are employed and means are preferably provided to remind the user that, for a Tailwind case, these scales are used. For example, the part of scale 12 marked "A" and "B", and scales 31^1 and 51^1 may be in red, as indicated in the drawings by these scales being double lined, the other scales being in black.

The Wind Direction, the Wind Speed and the Drift having been determined in the manner described above, the Computer may then be used for finding the Course to steer, the Drift and the Groundspeed for any new track. The angle which the Wind makes with the proposed new track is determined and is called the new "Wind Angle + Drift". Setting this value on the Sine scale 51 on disc 50 against the Airspeed on the Airspeed scale 44 on disc 40 enables the new Drift to be read off on scale 51 against the Wind Speed on scale 44 and the new Groundspeed to be read off on scale 44 against the Wind Angle on scale 51.

The following example will make this clear:

Airspeed: - - - - -	150 knots.
Wind Direction as found: -	10° True.
Wind Speed as found: - -	21 knots.
New Track to be made good:	340° True.

The angle between the new Track and the Wind Direction is 360° − 340° + 10°, or 30°, and this is called the new "Wind Angle + Drift".

1. Set new Wind Angle + Drift of 30° on scale 51 against the Airspeed of 150 knots on scale 44.

2. Against the Wind Speed of 21 knots on scale 44 read off on scale 51 the Drift on the new Course of 4°.

3. Against the Wind Angle 26° (30° − 4°) on scale 51 read off on scale 44 the Groundspeed on the new Course of 130 knots.

Hence the new Course is 340° + 4° = 344° True.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A computer of the slide rule type for computing wind direction by the four point bearing method, comprising a member having a logarithmic scale of numbers (Time scale), a second relatively movable member having a logarithmic scale bearing, instead of the actual numbers, the values obtained by subtracting those numbers from unity (auxiliary scale), a logarithmic scale of numbers (Log A and B scale), and a scale of logarithmic tangents (Wind Angle scale).

2. A computer of the circular slide rule type for computing wind direction by the four point bearing method, comprising a disc having a logarithmic scale of numbers (Time scale), a second concentric, relatively rotatable disc having a reversed logarithmic scale (auxiliary scale) adapted to co-operate with the Time scale and bearing, instead of the actual numbers, the values obtained by subtracting those numbers from unity, a second logarithmic scale of numbers ("Log A and B" scale), a scale of logarithmic tangents (Wind Angle scale) and two arms adapted to rotate about the axis of the discs and to be set against the "Log A and B" scale and to co-operate with the Wind Angle scale.

3. A computer as claimed in Claim 2, including a Drift angle scale whereby, when the Wind Angle is read off on its scale against one of the arms (the "B" arm), the Drift angle may be at the same time read off on its scale against the said arm.

4. A computer as claimed in Claim 3, wherein the Wind Angle scale is borne by a third concentric, relatively rotatable disc which is secured to the other of the arms (the "A") so as to rotate therewith.

5. A computer as claimed in Claim 3 or in Claim 4, including a logarithmic Sine scale and a logarithmic scale of numbers (Airspeed scale) whereby the Wind Speed and the Groundspeed may be determined from the value of the Airspeed and the sum of the Wind Angle and the Drift Angle.

6. A computer as claimed in Claim 5, wherein the "B" arm is secured to a fourth concentric, relatively rotatable disc so as to rotate therewith, the Airspeed scale is borne by the fourth disc, and the Sine scale is borne by a fifth relatively rotatable disc.

7. A computer of the slide rule type on which the value $N \pm \frac{C}{D}$ may be read off directly, said computer comprising a logarithmic scale of numbers (main scale) and a co-operating relatively movable reversed logarithmic scale (auxiliary scale) bearing, instead of the actual numbers, the values obtained by adding those numbers to or subtracting them from the value of N.

8. A computer of the slide rule type for solving an equation of the form $\frac{A}{B} = y$, where $A = N + \frac{C}{D}$ and $B = N + \frac{C}{E}$, or $A = N - \frac{C}{D}$ and $B = N - \frac{C}{E}$, said computer comprising a member bearing a logarithmic scale of numbers (main scale), a second relatively movable member bearing a reversed logarithmic scale (an auxiliary scale) which co-operates with the main scale and which bears, instead of the actual members, the values obtained by adding those numbers to or subtracting them from the value of N, and also comprising two further relatively movable co-operating logarithmic scales of numbers (a "Log A and B" scale and a "log y" scale).

9. A computer as claimed in Claim 8, wherein the first member bears the "Log A and B" scale and the second member bears the "log y" scale.

10. A computer as claimed in Claim 8 or in Claim 9, wherein the two members are concentric, superposed, relatively rotatable discs, and there are provided two radially extending arms adapted to rotate about the axis of the discs and to co-operate with the "log A and B" and the "log y" scales.

11. A modification of the computer claimed in Claim 10, wherein two pointers or like members are arranged to move relatively to the auxiliary scale and are each mechanically linked to one of the said arms in such a manner that setting of the pointers to any given values on the auxiliary scale causes the arms respectively to move a proportional amount so that they indicate the same values on the "log A and B" scale, and *vice versa*, the auxiliary scale, if desired, comprising only the index.

12. A computer according to Claim 7 substantially as hereinbefore described and as shown in Figures 1 and 2 of the accompanying drawings.

13. A computer according to Claim 2 substantially as hereinbefore described and as shown in Figures 4 to 8 of the accompanying drawings.

Dated this 17th day of June, 1943.

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2 & 3, Norfolk Street, Strand, London, W.C.2,
Agent for the Applicant.

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Fig.1.

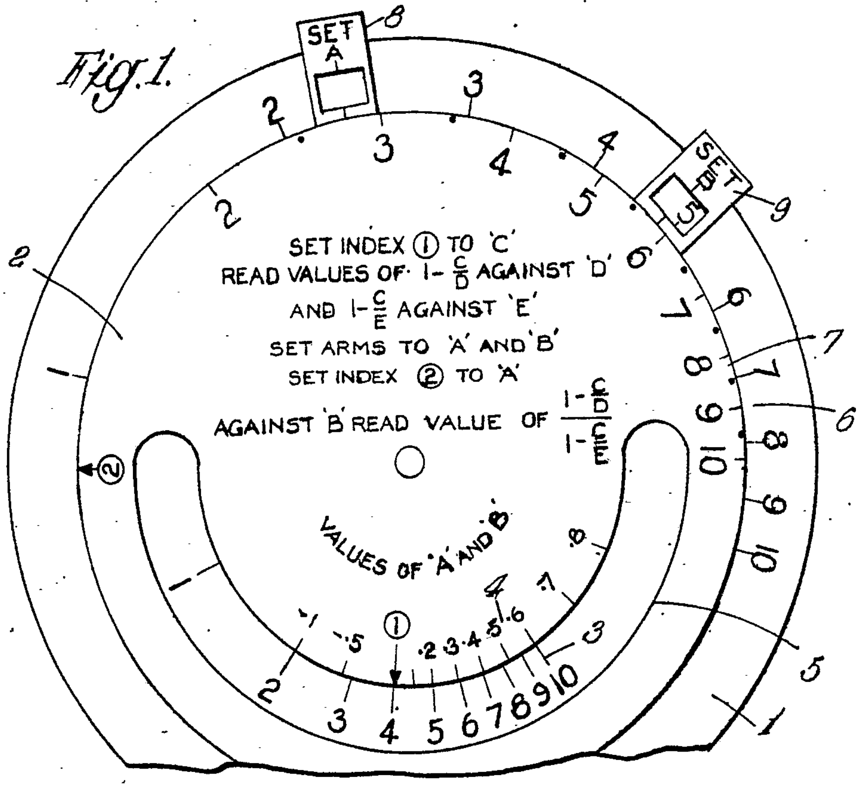
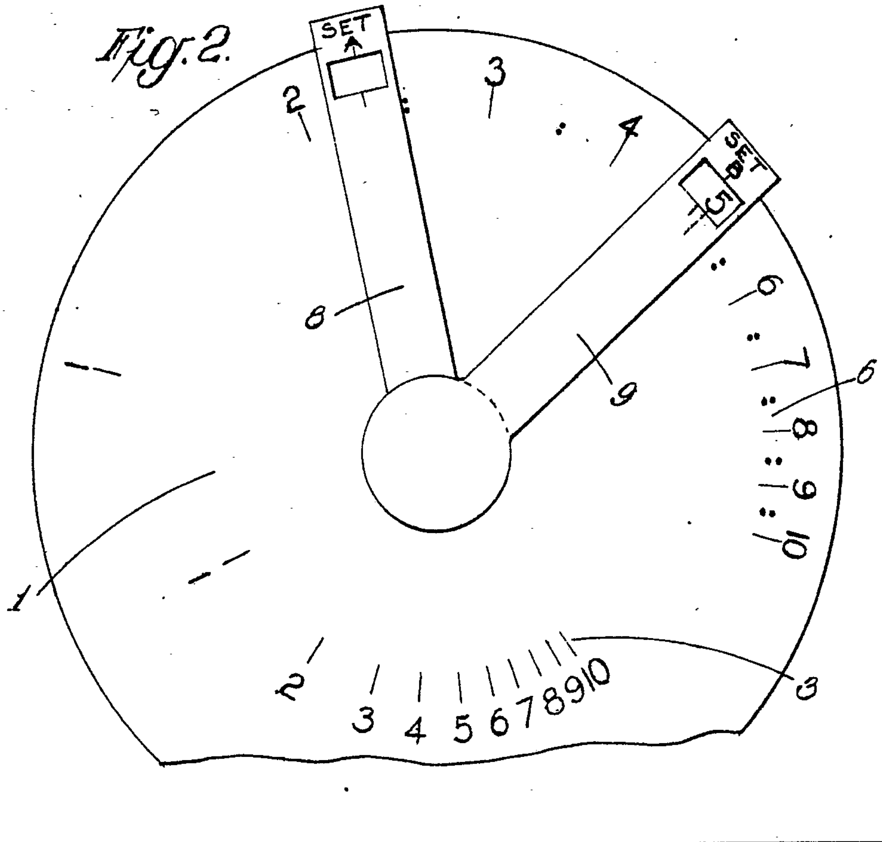

SET A
SET B
SET INDEX ① TO 'C'
READ VALUES OF 1 - C/D AGAINST 'D'
AND 1 - C/E AGAINST 'E'
SET ARMS TO 'A' AND 'B'
SET INDEX ② TO 'A'
AGAINST 'B' READ VALUE OF (1 - C/D)/(1 - C/E)
VALUES OF 'A' AND 'B'

Fig.2.


SET A
SET B

7

6

6

Fig. 5.

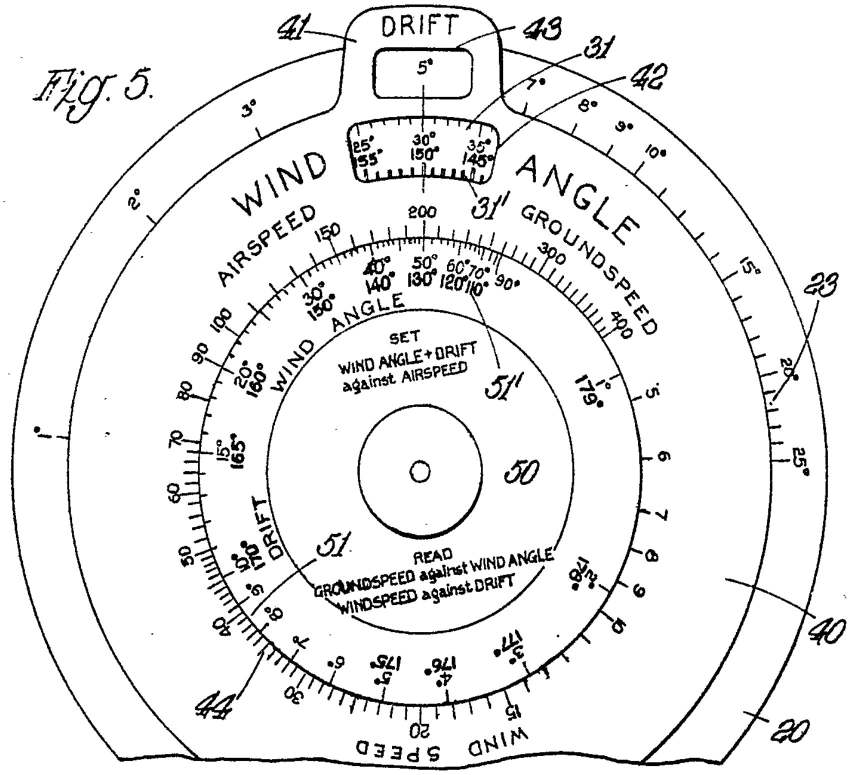
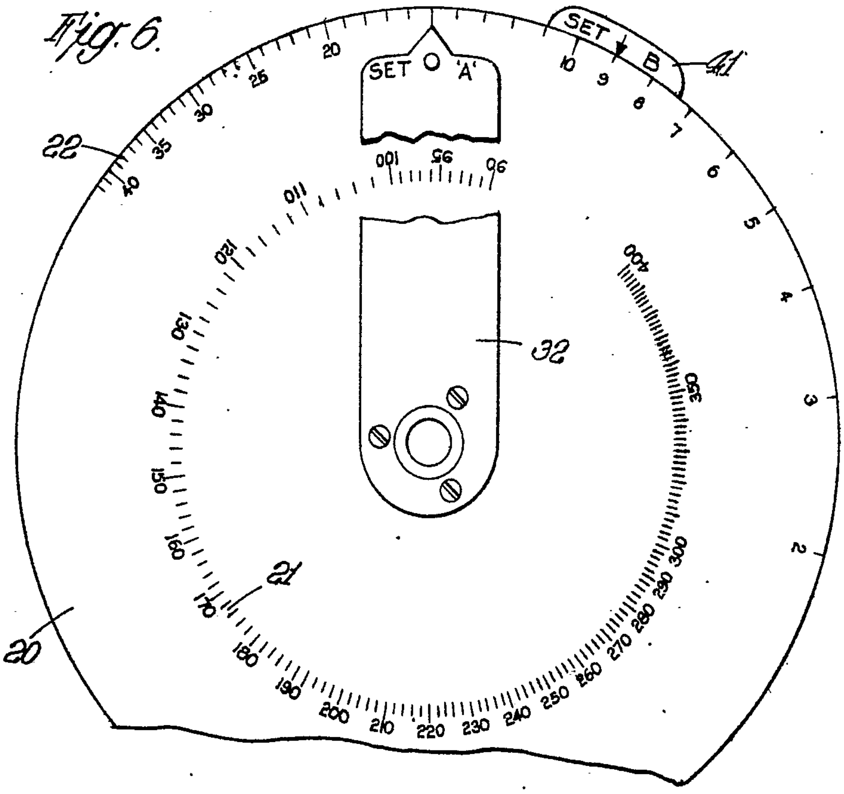


Fig. 6.



[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 1.

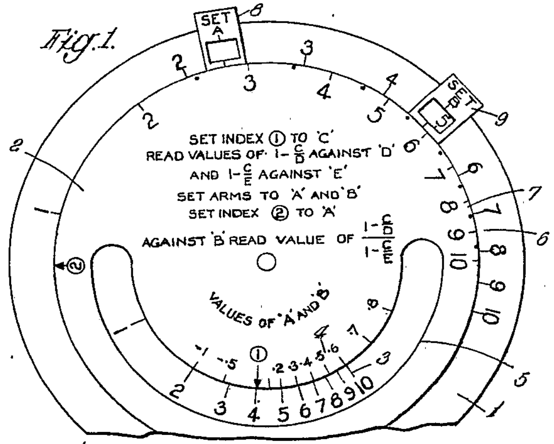


Fig. 2.

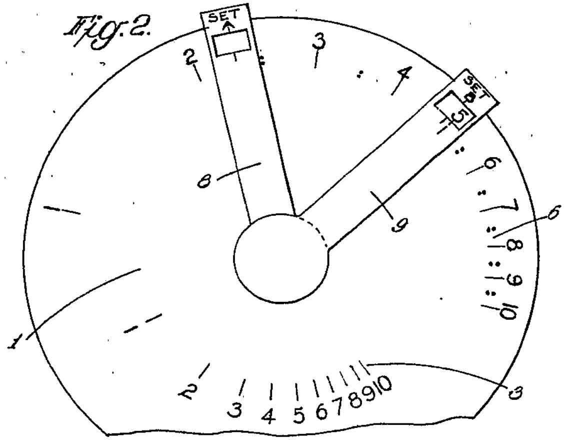


Fig. 5.

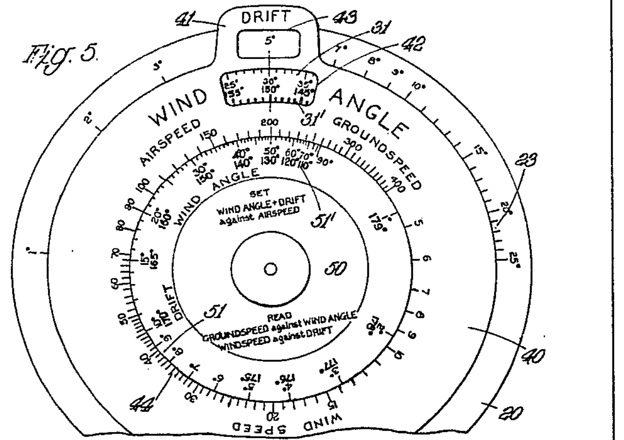


Fig. 6.

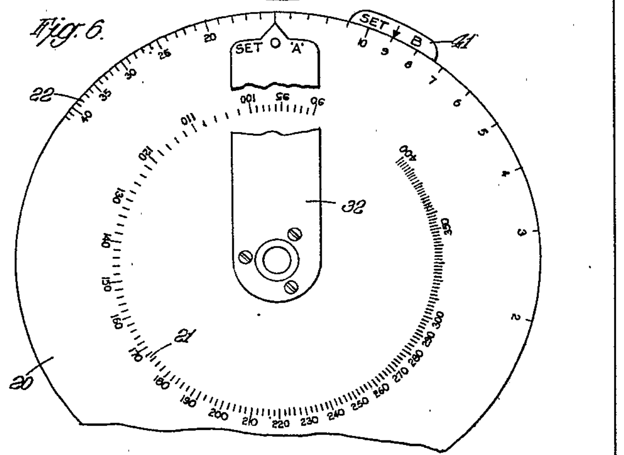


Fig. 3.

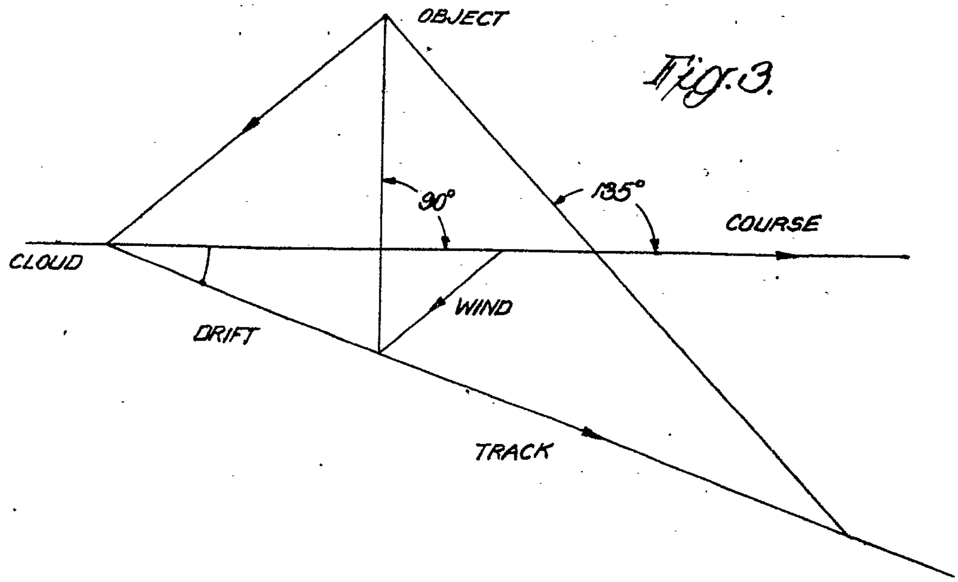
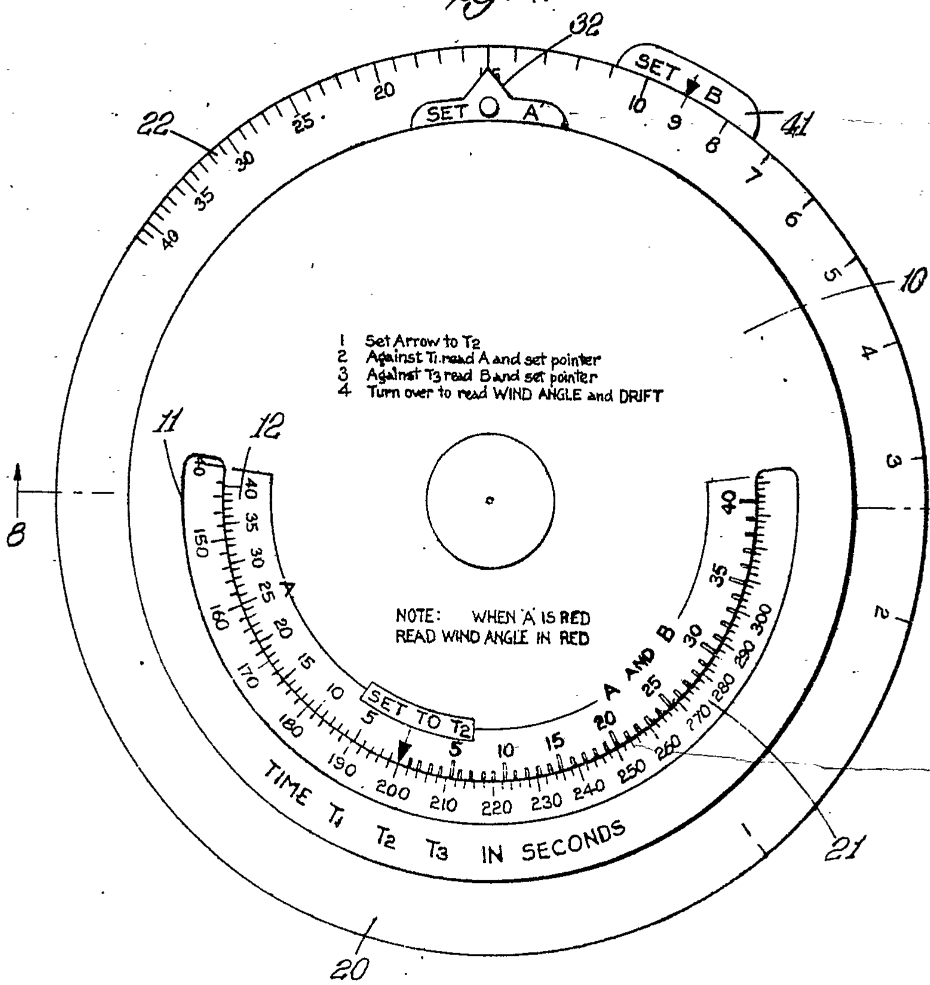

OBJECT
90°
135°
COURSE
CLOUD
WIND
DRIFT
TRACK

Fig. 4.


32
SET A
SET B
41
22
10
1 Set Arrow to T2
2 Against T1 read A and set pointer
3 Against T3 read B and set pointer
4 Turn over to read WIND ANGLE and DRIFT
11
12
8
8
NOTE: WHEN 'A' IS RED
READ WIND ANGLE IN RED
A
A AND B
SET TO T2
TIME T1 T2 T3 IN SECONDS
21
20

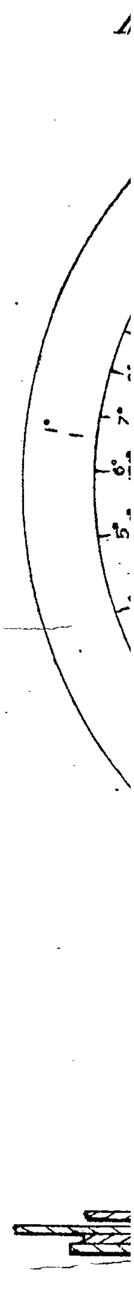


Fig. 7.

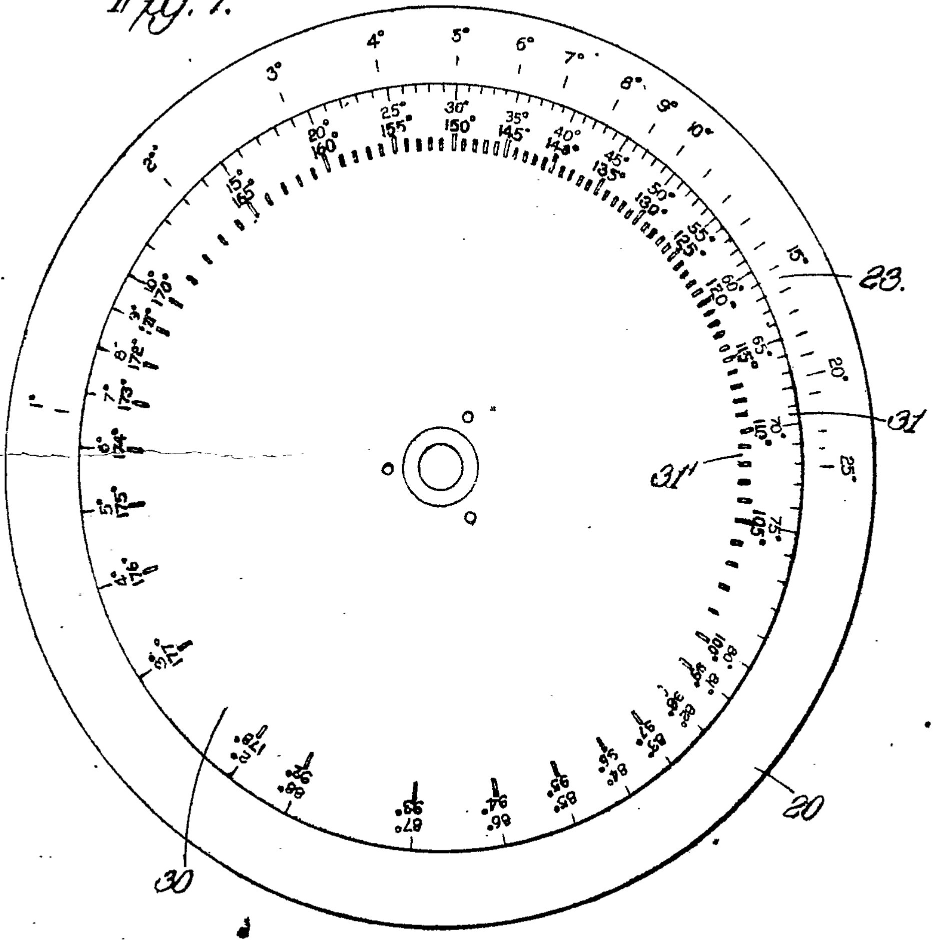
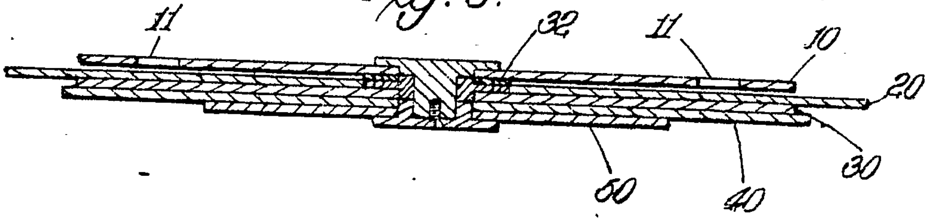


Fig. 8.



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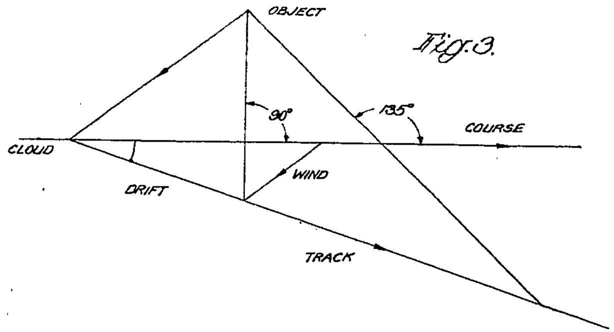

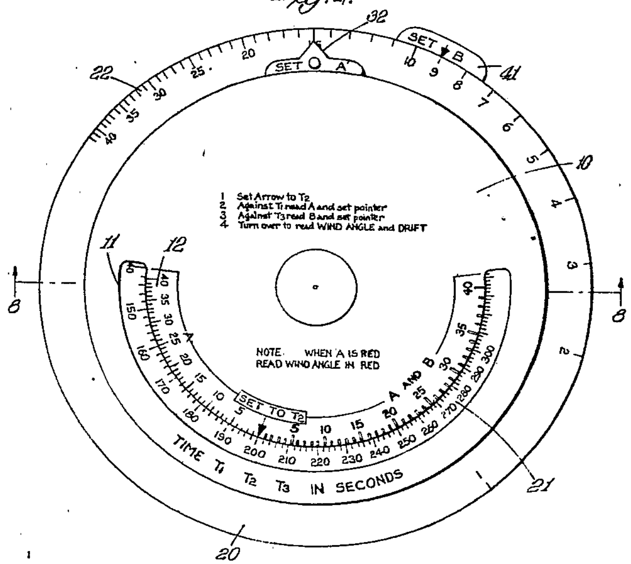

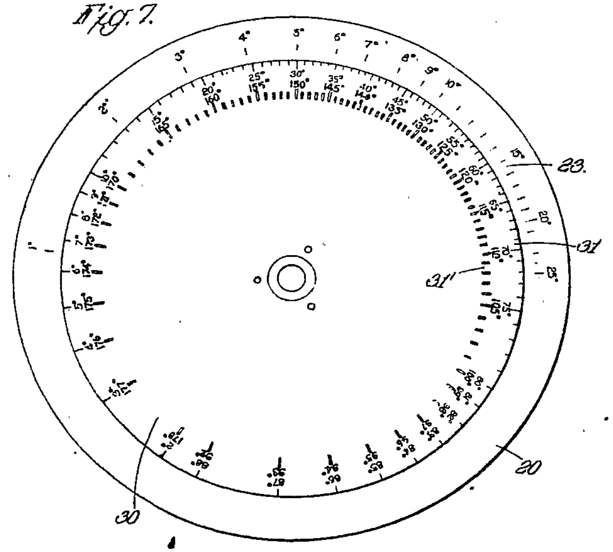

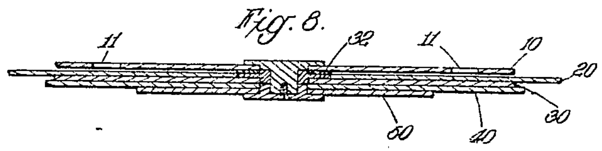

[This Drawing is a reproduction of the Original on a reduced scale.]

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