Sept. 14, 1937. S. E. BRAY 2,093,124

CALCULATING APPARATUS

Filed July 17, 1934 2 Sheets-Sheet 1

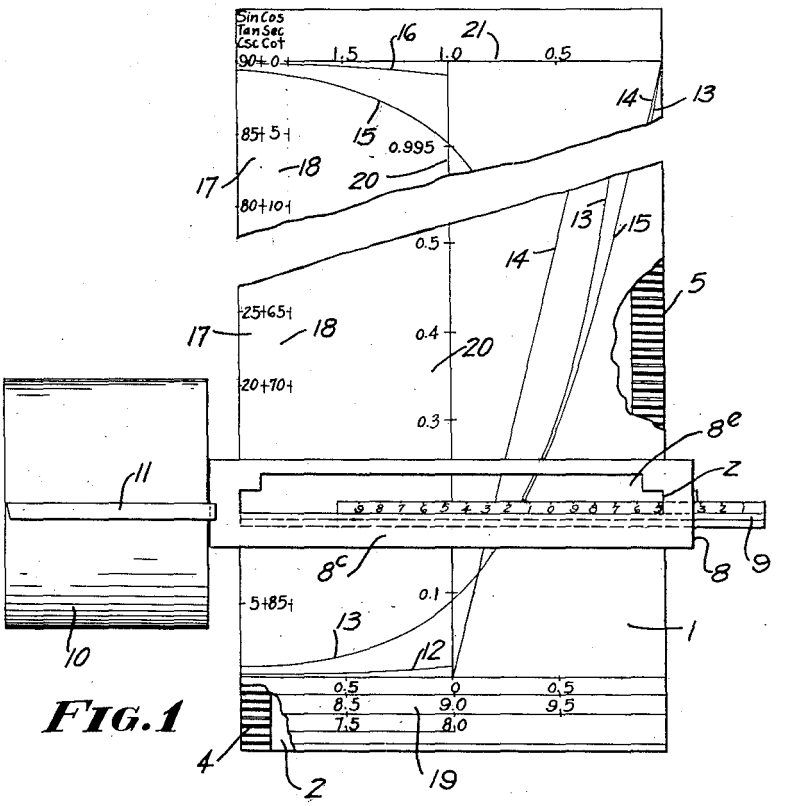

FIG. 1

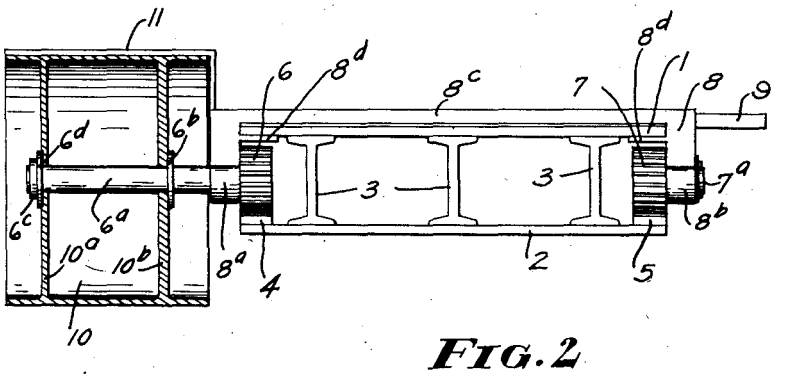

FIG. 2

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CALCULATING APPARATUS

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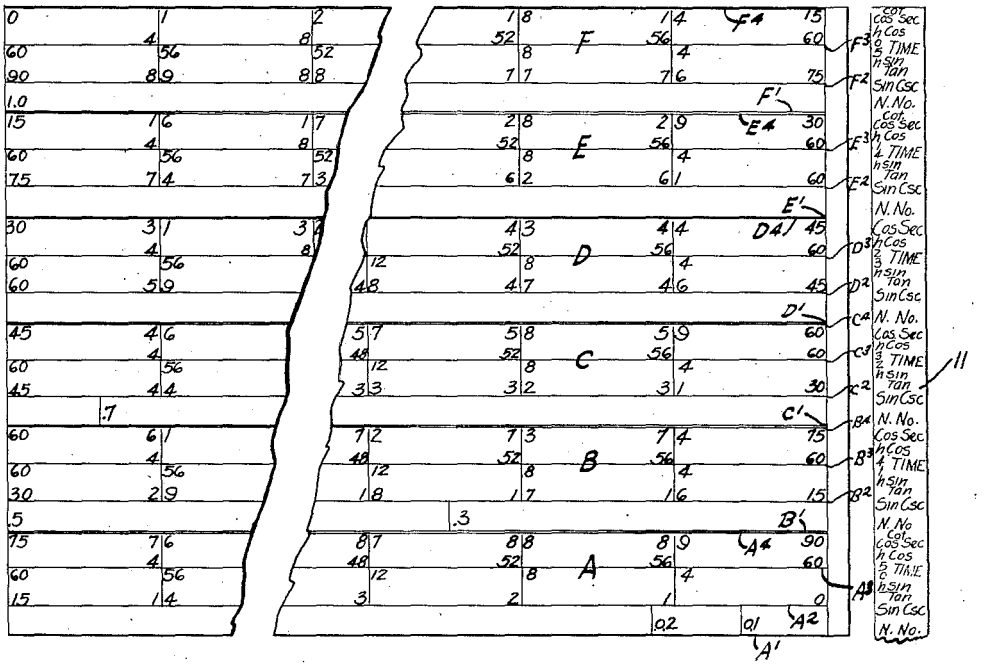

FIG. 4

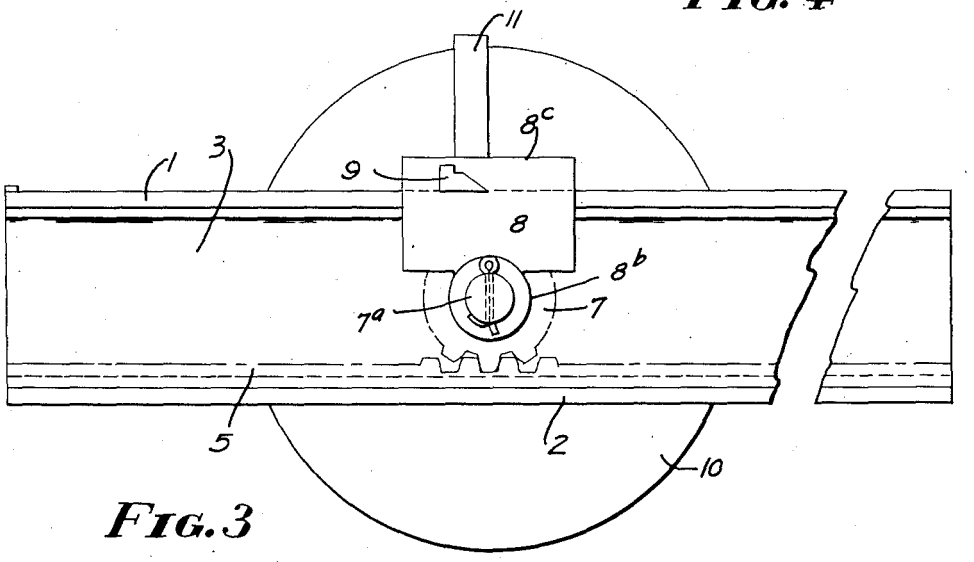

FIG. 3

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UNITED STATES PATENT OFFICE

2,093,124

CALCULATING APPARATUS

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Application July 17, 1934, Serial No. 735,557

8 Claims. (Cl. 235—61)

My invention relates to an apparatus to be used for making navigation computations and many kinds of logarithmic computations, and the objects of my invention are:

First, to provide a calculating apparatus that may be used for multiplication or division;

Second, to provide an apparatus of this class which may be used to compute the altitude, employing the sine and cosine method;

Third, to provide an apparatus of this class which is adapted to find the correction to be applied to an altitude of polaris;

Fourth, to provide an apparatus of this class which is adapted to find the latitude by the ϕ'—ϕ'' method, by adding a tangent, cotangent logarithmic curve;

Fifth, to provide an apparatus of this class which is adapted to find the azimuth and amplitude of a heavenly body;

Sixth, to provide an apparatus of this class which is adapted to find the logarithm of any number and also the number from any logarithm;

Seventh, to provide an apparatus of this class which is adapted to be used for working most any problem involving trigonometry;

Eighth, to provide an apparatus of this class in which the computations may be made very close and the scale used very fine;

Ninth, to provide an apparatus of this class which is very easy to operate; and

Tenth, to provide an apparatus of this class which is very simple and economical of construction, durable, efficient in its action, and which will not readily deteriorate or get out of order.

With these and other objects in view as will appear hereinafter, my invention consists of certain novel features of construction, combination and arrangement of parts and portions as will be hereinafter described in detail and particularly set forth in the appended claims, reference being had to the accompanying drawings and to the characters of reference thereon, which form a part of this application, in which:

Figure 1 is a top or plan view of my computing apparatus shown fragmentarily and showing certain portions broken away to facilitate the illustration; Fig. 2 is an end view thereof showing certain portions broken away and in section to facilitate the illustration; Fig. 3 is a fragmentary side edge view thereof on an enlarged scale, and Fig. 4 is a flat development of the various scales positioned on the drum 10, while they have been omitted from the surface of the other figures because of the small scale of the drawings.

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

The table plate 1, base plate 2, plate separators 3, gear racks 4 and 5; gears 6 and 7, support 8, scale member 9, drum 10, liner member 11, logarithmic sine curves 12 and 13, natural sine curve 14, logarithmic tangent curves 15 and 16, sine tangent and cosecant degree scale 17, cosine cotangent and secant degree scale 18, logarithmic scale 19, natural sine scale 20, and tangent scale 21, constitute the principal parts and portions of my navigation and logarithmic computing apparatus.

The table plate 1 is preferably a metallic plate and is preferably about twelve inches wide by twenty-nine and two tenths inches long of any suitable thickness. The table plate is supported upon a base plate 2, which is preferably a similar plate of similar size, by means of a plurality of separator members 3, as shown best in Fig. 2, which separator members extend the full length of the plates 1 and 2. Secured on the upper side of one longitudinal edge of the plate 2 is a gear rack 4 and on the opposite side of the plate 2 is a similar gear rack 5. It is preferred to have ten teeth to the inch in these gear racks 4 and 5. Meshing with these gear racks 4 and 5 are gears 6 and 7, respectively. The gear 6 is provided with an extended axle member 6a which is journalled in a journal portion 8a of the support 8. This axle member 6a is secured to a drum member 10, said drum member being provided with transverse partitions 10a and 10b which are provided with holes therein adapted to receive the axle member 6a. The axle member 6a is provided with a flange 6b which rests against one side of the partition 10b and the extended end of the axle member 6a is threaded and provided with a nut 6c which sets up against a washer 6d, thereby securing the drum member rigidly to the axle 6a, so that said drum member revolves with the revolving of the gear 6. Thus providing synchronism between the table plate 1 and the drum 10 with the movement of the gear 6 on the rack 4.

The gear 7 is also provided with an axle 7a which is journalled in the journal portion 8b of the support 8. This support 8 is provided with an upper flat portion 8c which extends across the upper face of the table plate 1 and clears the same so that said member 8c will move above the upper surface of the plate 1 with the revolution of the gears 6 and 7 on the racks 4 and 5, and the support 8 is held in relation to the table plate 1 by means of lug portions 8d extending under the

under side of the plate 1, as shown best in Fig. 2 of the drawings. The support 8 is provided with a slotted portion 8e extending longitudinally with the upper face of said support leaving an open sight through said support 8 from the upper side. This support is provided with a groove in one end and along the side of the slot 8e in which is longitudinally shiftable the scale member 9, the scale member 9 having scale characters thereon which may be seen through the opening 8e with the movement of the scale longitudinally in the support 8. Secured to this support 8 and extending over the drum 10 is a liner member 11 which extends across the normally upper face of the drum at the middle portion thereof, as shown best in Figs. 1 and 3 of the drawings, which is for the purpose of lining the characters on the outer face of the drum, the characters being shown on Fig. 4 of the drawings on an enlarged scale.

The table plate 1 is provided on its upper surface by any suitable method, such as painting, stencilling, engraving, or the like, with logarithmic sine curves 12 and 13, natural sine curve 14, logarithmic tangent curves 15 and 16, sine, tangent and cosecant degree scale 17, cosine cotangent and secant degree scale 18, logarithmic scale 19, natural sine scale 20 and tangent scale 21. It will be here noted that the scales employed herein in connection with the plate 1 are arbitrary.

The operating portion of the plate 1 is laid out as follows:

The operating portion of the plate is twenty-seven inches in length by ten inches in width. Within this area all curves plotted thereon are contained. To provide for scales 17 and 18 the width is increased two inches making the total width of the plate 1, twelve inches. To provide for scales 19 and 20 and proper traction for the gears 6 and 7, the length of the plate 1 is increased one and one tenth inches at each end, making the total length of the plate 1 twenty-nine and two tenths inches. In the plotting of all the curves, degrees are used for ordinates and their various logarithms as obscissae. With an operating length of twenty-seven inches this will permit each degree to cover a length of three tenths of an inch. The operating width of the plate 1 is divided into two equal parts each five inches wide. Each part represents a different index of a logarithm. It can best be explained by illustrating the plotting of the logarithmic sine curves 12 and 13. The logarithm of the sine of 0° is infinitely negative and it is not possible to plot it. The logarithm of the sine of 1 minute is 6.46373 but no logarithm of the sine which has an index less than 7 has been plotted as they are so infrequently used. Starting at 4 minutes we find the logarithm of the sine to be 7.06579. From the left working edge lay off .06579 x 5 inches to the right opposite 4 minutes as indicated on the scale 17. Opposite 5 minutes on the scale 17 lay off .16270 x 5 inches to the right. Opposite 6 minutes on the scale 17 lay off .24188 x 5 inches to the right. Continue in this manner until opposite 34 minutes 22 seconds, then lay off 1.0000 x 5 inches to the right. Since the angles with logarithmic sines having an index less than 8 are seldom used, curve 12 is constructed separately from the curve 13 in order to keep the operating width of the plate 1 within convenient limits as to size. Curve 13 is plotted similarly to the curve 12 starting at the left working edge of the plate 1 opposite 34 minutes 22 plus seconds and continuing to 90°. The vertical dividing line on plate 1 indicates where the index of the logarithm changes from 8 to 9. The natural sine curve 14 is plotted similarly to the curves 12 and 13 except that the natural sines are used as obscissae. The initial point is taken on the vertical dividing line of the plate 1 opposite 0°. The curve 15 which is a tangent curve is plotted similarly to curves 12 and 13 using logarithms of the tangent obscissae. Until about 5° it is practically integral with curves 12 and 13. From that point it separates to the right and reaches the right working edge of the plate 1 opposite 45° where it is equal to unity. In order to obviate greatly widening the working area of the plate 1 the curve is plotted from the 45° point to the left instead of to the right. To compensate for this the method of computing problems involving tangents or cotangents is varied.

It will be here noted that the logarithmic tangent curves and logarithmic sine curves are practically the same during the small degrees and follow the same lines 12 and 13 during this portion. These curves 12 and 13 serve also for the cosecant. In counting from the top of the board to the bottom, the curve serves as a cosine and secant curve. The scale 17 is marked in degrees according to the sines, tangents and cosecants, and the scale 18 has markings corresponding to the cosines, cotangents and secants.

It will be here noted that the relation of the gears 6 and 7 and the racks 4 and 5 is such that when the drum 10 makes a complete revolution the support 8 will advance from no degrees to fifteen degrees, as shown on the scale 17. The drum being eighteen inches in circumference, this permits each degree to be assigned an arc one and two-tenths inches in length. This distance can readily be divided into sixty parts each corresponding to a minute of arc. Also, one complete rotation of the drum 10 corresponds to one hour in time which is subdivided into measurements of four seconds in time. It will be noted that by using a small reading glass these indications may be further subdivided; it being noted that all divisional markings of time and arc on the drum are of equal length which is not usually found in apparatus for calculating by means of logarithms.

In Fig. 4 is illustrated the development of the markings on the drum 10. The lower side of this development in the assembled instrument is nearest to the plate 1. Since by the ratio and construction of the gears and gear racks the drum will make six revolutions in covering ninety degrees, the markings for the degrees and lines are read off in six groups of fifteen degrees and one hour. The liner 11 is not integral with the development shown in Fig. 4, but is mounted as shown in Fig. 3. The right hand edge of the liner 11 is the indicating edge. The top edge of the liner 11 as shown in the figure is farthest from the plate 1. There are six similar groups of indices on the liner 11 corresponding group for group with the six groups of the development of the drum 10, as shown in Fig. 4.

It will be noted that in Fig. 4 the degrees marked on the drum 10 development correspond to the degree markings 17 and 18 in Fig. 1. The drum 10 markings magnify the markings 17 and 18 making it possible to obtain very favorable readings. Since the drum makes six revolutions in going from one end of the rack 5 to the other it is necessary to have six main divisions on the drum which I have designated A, B, C, D, E and F in Fig. 4. The markings A magnify the markings 1 degree to 15 degrees of the scale 17 and the

markings seventy-five degrees to ninety degrees of the scale 18, etc. Looking at Fig. 4 the lower line of the development is designated A1, the next line above A2, and so on until the lower one of the first double line is designated A4. The upper line of the first double line would then be B1 and so on. On A1 is plotted the natural sine scale which is obtained from the natural sine curve 14 and continued as the drum revolves on B1, C1, D1, etc.

On the line A2 angular distances corresponding to the angular distances on scale 17 are laid off. On the lower side of A3 minutes of time corresponding to the sine of the angle are laid off. On the upper side of line A3 minutes corresponding to the cosine of the angle are laid off. On A4 angular distances corresponding to the angular distances of scale 18 are laid off. This same procedure is followed on the other five main divisions.

Now assume that support 8, with drum 10, is at the lower end of the plate 1 and scale 9 is slid all the way to the left; move carrier 8 until the lower edge of the scale 9 is over one degree on scale 17. At this point it is also over eighty-nine degrees on scale 18. On the line A2 under liner 11 place a numeral 1 measuring one degree. On the lower side of line A3 place a numeral 4 meaning four minutes. On the upper side of line A3 place a numeral fifty-six, meaning fifty-six minutes. On line A4 place a numeral eighty-nine, meaning eighty-nine degrees. Continue in this way until the degrees from one degree to fifteen degrees have been plotted on line A2 and the degrees from ninety degrees to seventy-five degrees on A4, with the corresponding minute markings on line A3. When the upper edge of scale 9 is between five degrees, forty-four minutes and five degrees, forty-five minutes on scale 17, place .1 on line A1 since the natural sine of five degrees and forty-four minutes plus is .1. When the upper edge of scale 9 is between eleven degrees, thirty-two minutes and eleven degrees, thirty-three minutes on scale 17, place .2 on line A1 since the natural sine of eleven degrees, thirty-two minutes plus is .2. This procedure is followed until all the markings on A1 are laid off. Since the degree and time increments are all of equal length the divisions on B, C, D, E and F can be taken from the divisions on A.

Referring to the natural sine scale on A1, B1, C1, etc., it will be noticed that whereas in the ordinary slide rule the increments decrease progressively from zero to ten, in this instrument the increments increase from zero to ten. The divisions laid out on the development as shown in Fig. 4 can be further subdivided but for the sake of clearness it has not been attempted on these drawings. In fact, on the scale used, the degree markings can be divided into sixty parts giving readings of one minute of arc. The minutes of time markings can be divided to give readings of four seconds of time. The markings on A1, B1, C1, etc., can be greatly subdivided but owing to their nature not all to the same degree.

As laid off on the drum, as shown best in Fig. 4 it is possible to get accurate readings to four decimal places over the whole length and for a large part of it readings to five decimal places. The scale 9 being ten inches long is divided into two equal scale parts and each part divided into ten equal parts reading from left to right and resubdivided into equal parts; it being noted that the graduations on the scale 9 are of equal length.

Since the divisions on the drum 10 of which Fig. 4 is the development, excepting those of the natural sine numbers, are of equal length, a vernier arrangement could be used to get very precise readings.

The operation of my apparatus is as follows:

To multiply five by six, move the support until 5 found on C1 Fig. 4 opposite the thirty degree mark on C2. The upper edge of scale 9 will be over 5 on the scale 20 Fig. 1 at the same time if it is pushed to the left. Slide the scale 9 to left until its left end touches the curve 13 and mark reading on the scale 9 at Z. Move the support 8 until the number 6 on C1 is under the liner 11. The number 6 will also show through the slot 8e at the same time. Slide the scale 9 to the left until the reading at Z touches the curve 13. Move the support 8 until the left end of the scale 9 touches the curve 13. At this time 3 will show in the slot 8e on scale 20 and will also show under the liner 11 on line B1 Fig. 4.

To divide six by five, slide the scale 9 to the left until its left end touches the center line on plate 1. Move the support 8 until 5 on C1 is under the liner 11 with 5 also in the slot 8e. Mark where the scale 9 crosses the curve 13. Move the support 8 until 6 on C1 is under the liner 11 with 6 also in slot 8e. Slide the scale 9 until the point where it crossed the curve 13 when 5 was under the liner 11 touches the curve 13 in its present position. Move the support 8 until the left end of the scale 9 touches the curve 13. Under the liner 11 will be found on A1 the number 1.2. At this time the upper edge of the scale 9 will be between 1 and 2 on the scale 20.

To find the altitude of a heavenly body by the sine cosine method. See pages 157 and 158 American Practical Navigator, 1914 Edition. The formula is sine H (altitude) equals sine L (latitude) sine D (declination) plus cosine T (hour angle) cosine L cosine D. Let L equal 41 degrees 30′ N, D equal 19 degrees 21′ 11″, and T equal 4 hours 28 minutes three seconds. Move the support until 41 degrees 30′ found on C2 Fig. 4 is under the liner. At this time the upper edge of the scale 9 will be on 41 degrees 30′ on the scale 17 if pushed to the left. Slide the scale 9 to the left until the left end touches the curve 13. Note the reading at Z on the scale 9. Move the support 8 until 19 degrees 21′ 11″ is under the liner 11. This number will be found on B2 Fig. 4 and also the upper edge of the scale 9 will be between 19 degrees and 20 degrees of the scale 17. Slide the scale 9 to the left until reading at Z touches the curve 13. Move the support 8 until the left end of the scale 9 touches the curve 13 and read off under the liner 11 on line A1 Fig. 4 the natural sine .21960 and note it. Now move the support 8 until 4 hours 28 minutes 3 seconds, in upper side of line B3 Fig. 4, is under the liner 11. At this point the upper edge of the scale 9, if pushed to the left, will be approximately over 67 degrees on the scale 18 Fig. 1. Move the scale 9 to the left until it touches the curve 13 and note reading at Z on the scale 9. Move the support 8 until 41 degrees 30′, found on line D4 Fig. 4, is under the liner 11. The corresponding reading will be found in the slot 8e on the scale 18. Move the scale 9 until mark at Z touches the curve 13 and note new mark at Z. Move the support 8 until 19 degrees 21′ 11″, found on the line C4 Fig. 4, is under the liner 11. The same number will also be in slot 8e on the scale 18. Move the scale 9 until mark at Z touches the curve 13. Move

the support 8 until the left end of the scale 9 touches the scale 13 and read on line A1, under the liner 11, the natural sine .27596. Add the two natural sines and we obtain .49556. This figure is found on line B1 Fig. 4 and just above it on line B2 will be found 29 degrees 42' 20'' the altitude required.

To find the azimuth: The formula is: Sine azimuth equals sine T (hour angle) cosine D (declination) secant H (altitude). Move the support 8 until 4 hours 28m 3s, found on lower side of C3, is under the liner 11. At this point the upper edge of the scale 9, if pushed to the left far enough, will be approximately over 67 degrees on the scale 17. Slide the scale 9 to the left until it touches the curve 13. Note the reading at Z. Move the support 8 until 19 degrees 21' 11'' (declination), found on line E4 Fig. 4, is under the liner 11. Slide the scale 9 to the left until the reading at Z touches the curve 13. Move the support 8 until 29 degrees 22' 20'' (Altitude) found on line E4 Fig. 4, is under the liner 11. This figure also appears in the slot 8e on the scale 18. Note point on the scale 9 where it crosses the curve 13. Slide the scale 9 to the right until this point is at Z. Move the support 8 until the left end of the scale 9 touches the curve 13. Read off under the liner 11 on line F2 89 degrees 52'. This number will also appear in slot 8e on scale 17.

To find the amplitude from the formula sine amplitude equals sine declination secant latitude. Let declination equal 22 degrees 32' N. and latitude equal 11 degrees 29' N. Move the support 8 until 22 degrees 30', found on line A2 Fig. 4, is under the liner 11. Slide the scale 9 until its left end touches the curve 13. Move the support 8 until 11 degrees 29', found on line F4 Fig. 4, is under the liner 11. Note where the scale 9 crosses the curve 13 and slide the scale 9 to right until this point is at Z. Move the support 8 until the left end of the scale 9 touches the curve 13. Under the liner 11, on line B2 read 23 degrees 1'. This figure will also appear in slot 8e on the scale 17.

To find phi second from the formula tan D (declination) secant T (hour angle) equals tan phi second. Page 135 American Practical Navigator. Taking the first problem where T equals 14 degrees 00' 45'' and D equals 22 degrees 42' 22''. Move the support 8 until 22 degrees 42' 22'', found on B2 Fig. 4, is under the liner 11. Move the scale 9 until the left end touches the curve 15. Move the support 8 until 14 degrees 00' 45'', found on F4 Fig. 4, is under liner 11. Observe where on the scale 9 it crosses the curve 13. Move the scale 9 to the right until this point is at Z. Move the support 8 until the left end of the scale 9 touches the curve 15. Read under the liner 11, on line B2, 23 degrees 19' 45''.

The angles for sines, cosecants, and tangents are read on lines A2, B2, C2, etc.; the angles for cosines, secants and cotangents are read on lines A4, B4, C4, etc. Sines of hour angles are read on the lower sides of A3, B3, C3, etc. Natural sines, natural numbers and logarithms are read on lines A1, B1, C1, etc.

To find the logarithm of 2: Move the support 8 until 2 found on line A1 Fig. 4 is under the liner 11. At this time 2 on scale 20 will be under the upper edge of the scale 9 Fig. 1. (Note:—the sole reason for scale 20 is to indicate roughly when the support 8 has been moved enough). Slide the scale 9 to the left until it touches the curve 13. Now move the support 8 until the left end of scale 9 touches the curve 14. It will be noted that at this time the upper edge of the scale 9 is slightly past 3 on scale 20. Now under the liner 11 Fig. 1 on line B1 will be found .30103.

The purposes of scales 19, 20 and 21 are as follows: Taking first scale 19. The lower line of the scale 19 shows the indexes of the logarithms used in plotting the curve 12. The line next above shows the indexes of the logarithms used in plotting the curve 13 and in plotting the curve 15 up to 45 degrees, while the top line of the scale 19 is merely a graduated line which has graduations corresponding to those on scale 9. Now taking scale 20, the natural sines indicated on scale 20 bear the same relation to the natural sines plotted on the drum 10 and shown on the development in Fig. 4, as do the sine, cosecants and tangents on the scale 17 bear to the sines, cosecants and tangents plotted on the drum 10. In other words, the natural sines on the drum 10 are an expansion of those on scale 20. Since the natural sines on drum 10 are plotted in six groups, it is necessary to have a method of knowing what circle to use or how many times the drum 10 must revolve before a number can be lined up. The scale 20 will accomplish this because its indexes are synchronous with the indices on the natural sine circles on the drum 10. Now taking scale 21. The scale 21 shows the indices of the logarithms of the tangents used in plotting the curves 15 and 16 for angles above 45 degrees.

As regards the scales 19 and 21 as hereinabove set forth, it will be noted that these scales 19 and 21 are not in any respect necessary to the full operation of the instrument and serve only as an aid to the operator who is not sure of his logarithms, while the scale 20 is necessary as previously explained above.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a calculating apparatus, a plate provided with a logarithmic sine curve thereon, a natural sine curve thereon in cooperative relation therewith, a scale along one side of said plate with degrees of angular measure markings conforming in position with the varying curve of said logarithmic sine curve for indicating the sine and cosecant degrees of said curve and a cooperative indicating scale shiftable longitudinally and transversely of said plate over said curves and markings.

2. In a calculating apparatus, a plate provided with a logarithmic sine curve thereon, a natural sine curve thereon in cooperative relation therewith, a scale along one side of said plate with degrees of angular measure markings conforming in position with the varying curve of said logarithmic sine curve for indicating the sine and cosecant degrees of said curve and a cooperative indicating scale shiftable longitudinally and transversely of said plate over said curves and markings, a scale with degrees of angular measure markings conforming with the angular markings of said cosine and secant on said plate, and a natural sine scale intermediate the sides of said plate.

3. In a calculating apparatus, a plate provided with a logarithmic sine curve thereon, a natural sine curve thereon in cooperative relation therewith, a scale along one side of said plate with degrees of angular measure markings conforming in position with the varying curve of said logarithmic sine curve for indicating the sine and cosecant degrees of said curve and a cooperative

indicating scale shiftable longitudinally and transversely of said plate over said curves and markings, a scale with degrees of angular measure markings conforming with the angular markings of said cosine and secant on said plate, and a natural sine scale intermediate the sides of said plate, and a logarithmic tangent curve in continuation of the logarithmic sine curve on said plate.

4. In a calculating apparatus, a plate provided with a logarithmic sine curve thereon, a natural sine curve thereon in cooperative relation therewith, a scale along one side of said plate with degrees of angular measure markings conforming in position with the varying curve of said logarithmic sine curve for indicating the sine and cosecant degrees of said curve and a cooperative indicating scale shiftable longitudinally and transversely of said plate over said curves and markings, a scale with degrees of angular measure markings conforming with the angular markings of said cosine and secant on said plate, and a natural sine scale intermediate the sides of said plate, and a logarithmic tangent curve in continuation of the logarithmic sine curve on said plate, and a supporting member mounted on said plate in which said longitudinally and transversely mounted scale is shiftably mounted.

5. In a calculating apparatus, a plate provided with a logarithmic sine curve thereon, a natural sine curve thereon in cooperative relation therewith, a scale along one side of said plate with degrees of angular measure markings conforming in position with the varying curve of said logarithmic sine curve for indicating the sine and cosecant degrees of said curve and a cooperative indicating scale shiftable longitudinally and transversely of said plate over said curves and markings, a scale with degrees of angular measure markings conforming with the angular markings of said cosine and secant on said plate, and a natural sine scale intermediate the sides of said plate, and a logarithmic tangent curve in continuation of the logarithmic sine curve on said plate, and a supporting member mounted on said plate in which said longitudinally and transversely mounted scale is shiftably mounted, and means synchronized with both angular measure scales on said plate and supported in connection with said support said means being provided with subdivisions of said sine, tangent, cosecant, cosine, cotangent, and secant degree markings on said plate.

6. In a calculating apparatus, a plate provided with a logarithmic sine curve thereon, a natural sine curve thereon in cooperative relation therewith, a scale along one side of said plate with degrees of angular measure markings conforming in position with the varying curve of said logarithmic sine curve for indicating the sine and cosecant degrees of said curve and a cooperative indicating scale shiftable longitudinally and transversely of said plate over said curves and markings, a scale with degrees of angular measure markings conforming with the angular markings of said cosine and secant on said plate, and a natural sine scale intermediate the sides of said plate, and a logarithmic tangent curve in continuation of the logarithmic sine curve on said plate, and a supporting member mounted on said plate in which said longitudinally and transversely mounted scale is shiftably mounted, and means synchronized with both angular measure scales on said plate and supported in connection with said support said means being provided with subdivisions of said sine, tangent, cosecant, cosine, cotangent, and secant degree markings on said plate, consisting of a revolubly mounted drum with said subdivisions mounted on the surface thereof.

7. In a calculating apparatus, a plate provided with a logarithmic sine curve thereon, a natural sine curve thereon in cooperative relation therewith, a scale along one side of said plate with degrees of angular measure markings conforming in position with the varying curve of said logarithmic sine curve for indicating the sine and cosecant degrees of said curve and a cooperative indicating scale shiftable longitudinally and transversely of said plate over said curves and markings, a scale with degrees of angular measure markings conforming with the angular markings of said cosine and secant on said plate, and a natural sine scale intermediate the sides of said plate, and a logarithmic tangent curve in continuation of the logarithmic sine curve on said plate, and a supporting member mounted on said plate in which said longitudinally and transversely mounted scale is shiftably mounted, and means synchronized with both angular measure scales on said plate and supported in connection with said support said means being provided with subdivisions of said sine, tangent, cosecant, cosine, cotangent, and secant degree markings on said plate, consisting of a revolubly mounted drum with said subdivisions mounted on the surface thereof, and a liner supported on said support and extending over said drum.

8. In a calculating apparatus, a plate provided with a logarithmic sine curve thereon, a natural sine curve thereon in cooperative relation therewith, a scale along one side of said plate with degrees of angular measure markings conforming in position with the varying curve of said logarithmic sine curve for indicating the sine and cosecant degrees of said curve and a cooperative indicating scale shiftable longitudinally and transversely of said plate over said curves and markings, a scale with degrees of angular measure markings conforming with the angular markings of said cosine and secant on said plate, and a natural sine scale intermediate the sides of said plate, and a logarithmic tangent curve in continuation of the logarithmic sine curve on said plate, and a supporting member mounted on said plate in which said longitudinally and transversely mounted scale is shiftably mounted, and means synchronized with both angular measure scales on said plate and supported in connection with said support, said means being provided with subdivisions of said sine, tangent, cosecant, cosine, cotangent, and secant degree markings on said plate, consisting of a revolubly mounted drum with said subdivisions mounted on the surface thereof, and a liner supported on said support and extending over said drum, said means consisting of gear racks mounted in connection with said plate longitudinally thereof, gears meshing with said gear racks, and a shaft for supporting said drum.

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