Nov. 13, 1928.

1,691,104

J. G. ZOLLMAN

CALCULATING DEVICE

Filed May 3, 1926

2 Sheets-Sheet 1

FIG. 1

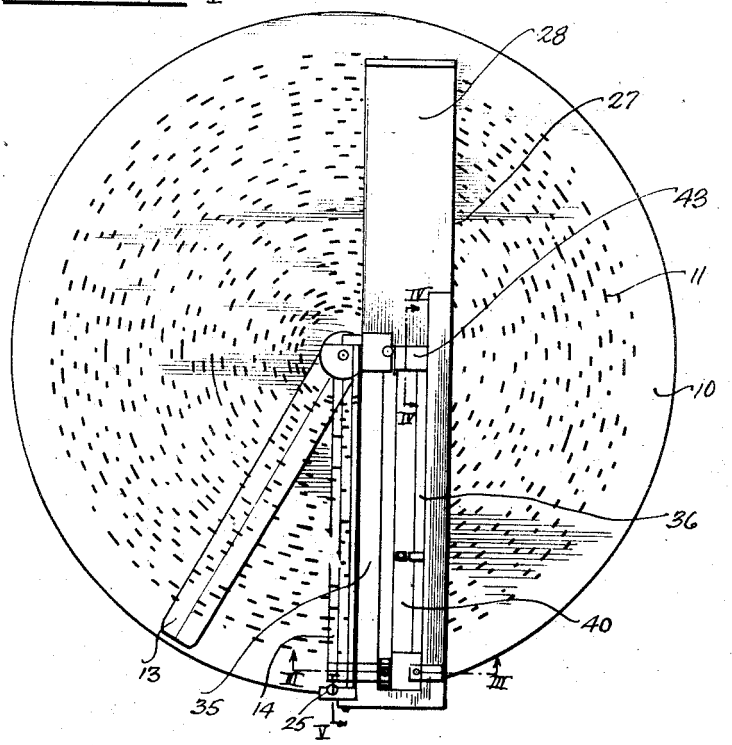


FIG. 3

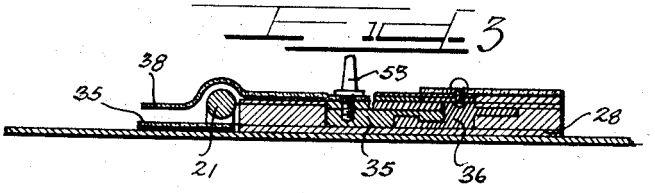


FIG. 4

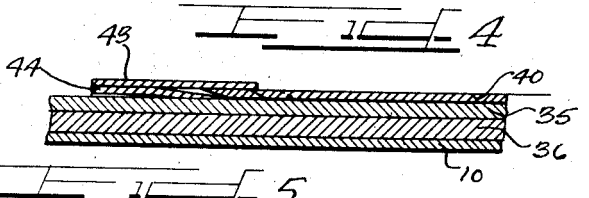
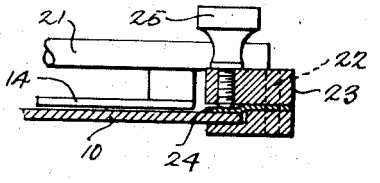


FIG. 5



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CALCULATING DEVICE

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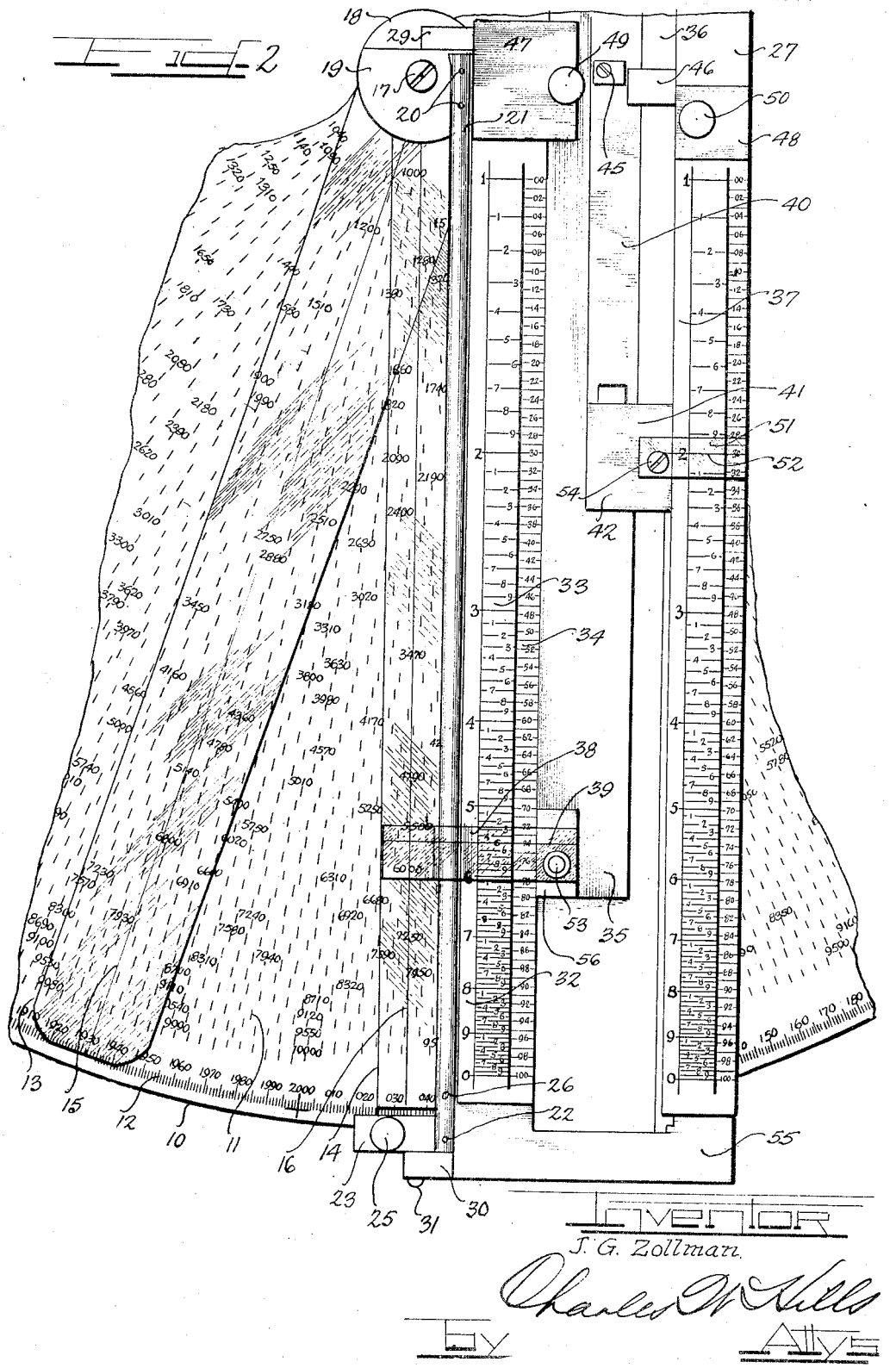
2 Sheets-Sheet 2

FIG. 2



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Patented Nov. 13, 1928. 1,691,104

UNITED STATES PATENT OFFICE.

JOHN GUSTAV ZOLLMAN, OF CHICAGO, ILLINOIS.

CALCULATING DEVICE.

Application filed May 3, 1926. Serial No. 106,204.

This invention relates to logarithmic calculating devices and has for its object improving such devices, not only as regards accuracy but also as respects simplicity and ease and speed of operation.

Other and further important objects of this invention will be apparent from the disclosures in the accompanying drawings and the following specification.

The invention (in a preferred form) is illustrated on the drawings and hereinafter more fully described.

On the drawings:

Figure 1 is a plan view of the device as a whole.

Figure 2 is a fragmentary plan view on an enlarged scale (actual size) of the more important parts of the device.

Figure 3 is a section on the line III—III of Figure 1.

Figure 4 is a section on the line IV—IV of Figure 1.

Figure 5 is a section on the line V—V of Fig. 1.

As shown on the drawings:

The device includes a disc 10, conveniently made of metal such as brass, on which are printed, or engraved, or otherwise marked, a series of numbered graduations 11, arranged spirally thereon and spaced proportionately to the logarithms of such numbered graduations.

The distances from the center of the disc to the beginning and end of the spiral is such that the graduations at these points are substantially equal, while the intermediate graduations increase until they are about twice the size of those at either end. This advantageous result is obtained by making the distance from the center of the disc to the beginning of the spiral about $\frac{1}{10}$ of the distance from the center to the end of the spiral.

Around the periphery of the disc are graduations 12, corresponding to the logarithms of the numbered graduations 11.

The result of the desired calculation is obtained by means of two radially arranged indicator arms, movable relatively to the disc having the spiral graduations thereon, and also relatively to each other.

According to the present invention, these indicator arms are conveniently formed of celluloid strips 13, 14, with radial lines marked thereon; the line 15 on the strip being 13 colored red while the line 16 on the other strip 14 is colored green.

The celluloid strips or arms 13 and 14 are pivotally mounted on a bolt 17 passing through a hole in the center of the disc 10 and secured by a nut, not shown, on the underside of the disc. On the upper side of the disc beneath the overlapping ends of the arms 13 and 14 is a washer 18 and above the arms is a segmental member 19. To this segmental member is riveted at 20 one end of the rod 21, the other end of which is riveted at 22 to a clamp 23 encircling the margin of the disc 10.

The construction of this clamp is shown more particularly in Figure 5 from which it will be seen that a tongue 24 is provided which may be forced into frictional engagement with the periphery of the disc 10 by a thumb screw 25.

The arm 14 is attached to the rod 21 and clamp 23 by means of a rivet 26 so that the arm 14 may be held in adjusted position by tightening the thumb screw 25 of the clamp. Ordinarily friction is sufficient to keep the arms 13 and 14 in adjusted angular relationship, but if desired a clamping screw may be provided for this purpose.

Suppose it is desired to multiply "X" by "Y". The red line 15 is placed over zero on the outer logarithmic scale 12 and the green 16 is placed over "X" on the spiral graduations 11. Then keeping the two lines in the same angular relationship the red line is moved on the spiral graduations over "Y" and the result is found under the green line.

The parts are shown in Figure 2 in the positions they assume in multiplying 2750 by 2. The red line 15 was placed over the zero on the logarithmic scale 12 and the green line 16 placed over the figure 2000 on the spiral then keeping the angular relationship of the two lines 15 and 16 constant the red line 15 was moved over the number 2750 and the result, 5500, is then under the green line 16 as shown in Figure 2.

In the device illustrated there are 50 turns of the spiral series of graduations all of which are intersected by the green line 16 and the problem is therefore to determine on which spiral to read the answer. In a general way the answer can be guessed at sufficiently to say that the answer to the above calculation,

for example, is neither 24006 nor 83241 but without supplemental calculations it is difficult if not impossible to state which of the following figures, representing intersections of the green line 16 with the spiral viz, 47903, 50161, 52525, 55000, 57592, 60306, 63148, is the correct result.

If there were only 10 turns to the spiral instead of 50 this difficulty would not be so great but in that event the instrument would not be so accurate.

The accuracy of a slide rule or other logarithmic calculating device depends in a large measure on the length of the scale.

In the device illustrated in the drawings, (Fig. 2 actual size) the total length of the spiral is around 120 feet. With a 10″ slide rule the accuracy is about 1 in 200. With a 120′ slide rule the accuracy is about 1 in 30,000.

Obviously the length of the scale varies directly with the number of turns on the spiral so that the greater the number the greater the accuracy possible with the device.

To use 100 turns would make the device difficult to read without increasing its size excessively; to use 10 turns would unduly lower its accuracy so that the superiority of the device over the usual 10″ slide rule would be greatly diminished. The selections of 50 turns in place of 48 or 53 is in part to facilitate obtaining the logarithms and anti-logarithms of numbers by means of the logarithmic scale 12. Using 50 spirals the logarithmic graduations will run from 0 to 2000 so that fifty turns of 2000 each will give 100,000 in all. If there were 48 turns to the spiral there would have to be 2080 divisions on the logarithmic scale, which would involve additional calculations every time the logarithm or anti-logarithm of a number was required, since the number given on the logarithm scale instead of being added to an even number of thousands would have to be added to some such number as 27,040 and this latter number would have to be obtained by multiplying 2080 by the number of turns of the spiral, say 13.

The means provided for indicating on which spiral the result is to be read includes a straight slide rule attachment 27. This straight slide rule comprises a base 28 provided with laterally extending arms 29 and 30. The arm 29 is pivotally connected to the segmental member 19 by a pin, not shown, which has sliding engagement with a hole in the member 19. The arm 30 carries a screw 31 adapted when screwed home to enter a hole in the clamp 23. By unscrewing the screw 31 the base 28 and parts carried thereby may be removed from the device.

Mounted on the base 28 is a scale 32 having thereon two sets of graduations 33 and 34 corresponding to the number and logarithmic scales respectively of an ordinary slide rule.

These graduations are so located and proportioned that the "1" on the number scale and the "0" on the logarithmic scale are opposite the point at which the spiral graduations commence; while the "10" on the number scale and the "100" on the logarithmic scale are opposite the point at which the spiral graduations end.

If now the ordinary slide rule operations are performed it will be found that opposite the approximate result on the scale 32 is that portion of the spiral on which the accurate result is to be read.

While this result may be obtained by means of a slide bar having thereon graduations exactly like those on the scale 32 I prefer to employ the improved form of slide rule shown in the drawings.

Two ungraduated sliding bars 35 and 36 are provided adapted to slide between the scale 32 and another exactly similar scale 37. The bar 35 carries a celluloid indicator 38, with a line 39 thereon, adapted to extend over the green line 16 on the arm 14 so that by the point of intersection of the lines 16 and 39 the particular spiral on which the accurate result may be read is determined.

The bars 35 and 36 are made to overlap and interlock with each other as shown more particularly in Figure 3. On top of the bars is a sliding locking strip 40 having a bevelled end adapted to slide beneath a plate 42 mounted on the bar 36. The lower end of the strip 40 is also bevelled. The other end of the strip 40 is bevelled, as shown in Figure 4, and is adapted to enter the space beneath a plate 43 and above a tongue 44 connected thereto.

When forced into such space the strip exerts a wedging action which locks the bars 35 and 36 against further relative movement, and a similar wedging action takes place simultaneously at the opposite end of the strip 40. A knob or projection 45 is provided for manipulating the sliding locking strip 40.

Plates 47 and 48 are arranged on either side of the base 27 for carrying set screws 49 and 50 respectively by means of which the bars 35 and 36 may be locked against movement relative to the base 28.

On the bar 36 is arranged a celluloid indicator 51 with a line 52 thereon, extending over the scale 37.

The bar 35 may be moved to and fro by the fingers, the screw 53 which holds the indicator 38 in position being conveniently provided with a projecting head adapted to be gripped by the fingers. Similarly the screw 54 which holds the indicator 51 in place might similarly be provided with a projecting head. However, as shown, a separate lug 46 is provided for enabling the bar 36 to be moved by the fingers.

The operation may be explained conveniently in connection with the multiplication of 2750 by 2 already referred to. The first step is to move bar 35 until its indicator is over 2750 on the graduations 33, then the bar 36 is moved until its indicator is over "1" on the logarithmic scale 37. The two bars 35 and 36 are then locked together by moving the locking strip 40 and finally both bars are moved together until the line 52 on the indicator carried by bar 36 is over the "2" on the logarithmic scale 37. The result of the multiplication is then to be read under the line 39 of the indicator attached to bar 35, viz, 5500.

When the product of the unit numbers is greater than 10, as, for example 7 and 8 or 721 by 8382 then the bar 36 instead of being set with its indicator opposite "1" will have to be set with its indicator opposite "10".

To divide "A" by "B" set line 39 over "A" and 52 over "B" lock the bars together and then bring line 52 over "1" or "10" according as "A" is greater than or less than "B".

On the disc set the green line 16 over "A" and the red line 15 over "B" and move both arms simultaneously until the red is over the zero on the logarithmic scale when the answer will be under the green line.

It will be noted that with the construction shown the sliding bars 35 and 36 never extend beyond the margin of the disc 10 as would be necessary if a straight slide rule of ordinary construction be used.

Further the parts are so proportioned that when either of the bars 35 and 36 are moved as far as they will go in either direction the lines 39 and 52 of their respective indicators will be on one of the marks "1" or "0" as the case may be on the scales 33 and 37. This greatly simplifies the operation of the device. This advantageous result may be obtained in various ways. As shown the ends of the bars 35 and 36 in their downward (Fig. 2) movement strike the cross piece 55 extending across the ends of the scales 33 and 37 and are thus limited in their movement in that direction. In the opposite direction the striking of the edge of the indicator 51 against the plate 48 limits the extent of movement of the bar 36. The movement of the other bar 35 is checked by contact between the plate 56 which carries the indicator 38 and the plate 47.

Another feature of advantage is the ability to lock the moving parts in adjusted position and so prevent misplacement leading to erroneous results.

It will also be observed that both number and logarithmic scales are arranged on the same side of the instrument thus avoiding turning the same over to read the logarithms of any number or to determine the antilogarithms of any logarithmic number.

In some cases it may be desirable to add sine and tangent scales and for scales adapted to give square and cube of a given number.

I am aware that many changes may be made, and numerous details of construction may be varied through a wide range without departing from the principles of this invention, and I therefore do not purpose limiting the patent granted hereon, otherwise than necessitated by the prior art.

I claim as my invention:

A slide rule comprising a single disc having a series of numbered graduations arranged spirally thereon spaced proportionately to the logarithms of such numbered graduations, two relatively movable indicators pivotally mounted to turn about the center of said disc, and a straight slide rule connected to one of said indicators with a scale thereon having the "1" and "10" marks at the same distances from the center of the disc as the "1" and "10" marks on the spirally arranged graduations, and an indicator on said straight slide rule adapted to give the approximate numerical result of the calculation with the straight slide rule and simultaneously indicate on which spiral to read the accurate result.

In testimony whereof I have hereunto subscribed my name.

JOHN GUSTAV ZOLLMAN.