B. T. STEBER.

SLIDE RULE.

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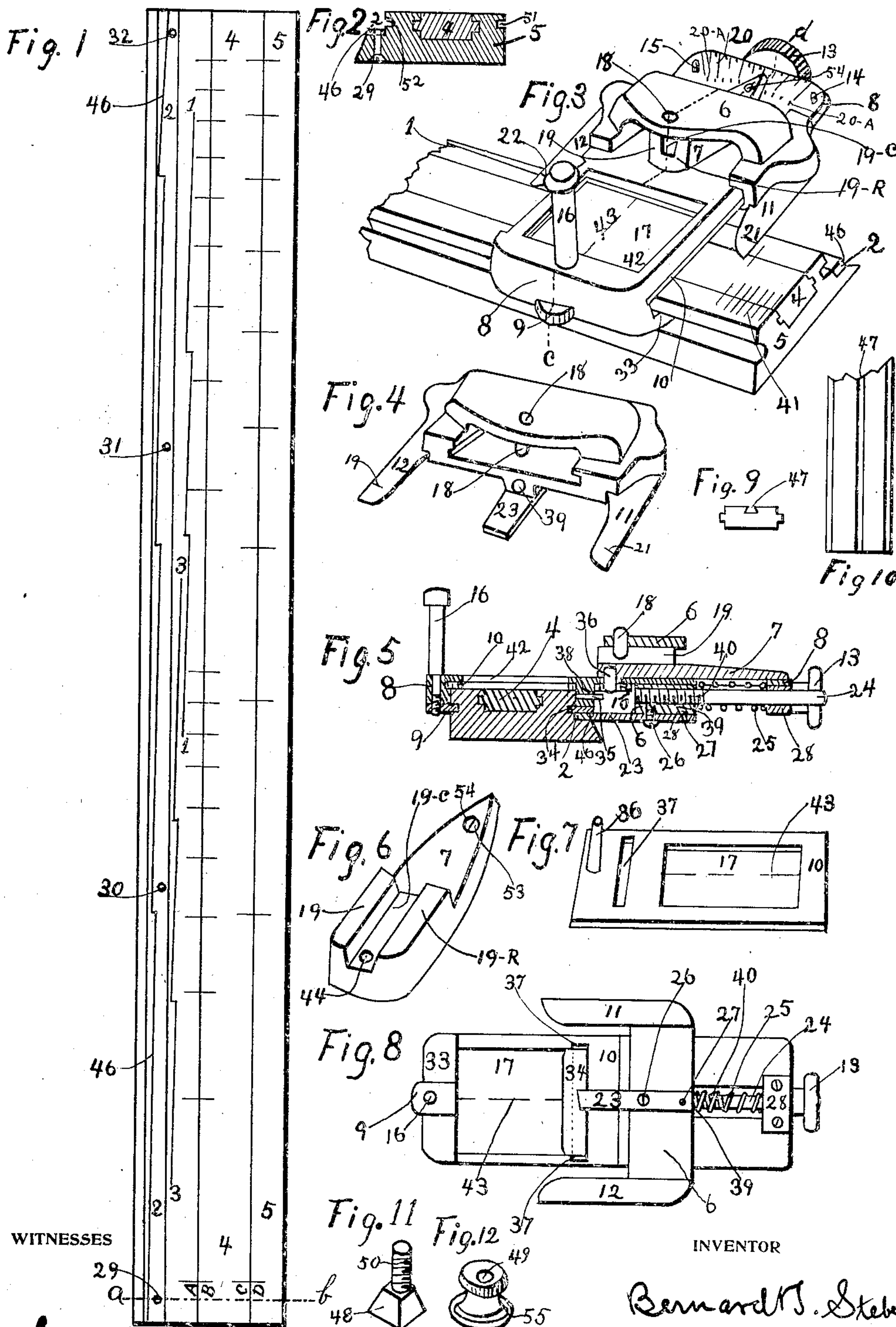
1,000,562. Patented Aug. 15, 1911.



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SLIDE-RULE.

1,000,562. Specification of Letters Patent. Patented Aug. 15, 1911.

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To all whom it may concern:

Be it known that I, BERNARD T. STEBER, citizen of the United States, residing at Utica, in the county of Oneida and State of New York, have invented a new and useful Improvement in Slide-Rules, of which the following is a specification.

My invention relates to improvements in slide rules, especially such as employ logarithmic scales as a means of performing the various problems for which they are adapted, and the main object of my improvement is to supply means whereby the spaces between the inscribed graduations may be again subdivided and their subdivisions read without necessarily making the rule any longer. I attain these objects in the mechanism illustrated in the accompanying drawings, in which—

Figure 1 is a plan view of a 25 centimeter slide rule with the runner removed; Fig. 2 a sectional view of the same, taken at the line *a—b*. Fig. 3, a view in perspective of the rule with the runner attached thereto, the rule being shown in broken section, Fig. 4 a view in perspective of the runner carriage, the same being removed from the runner, Fig. 5 a sectional view of the runner and rule, taken at line *c—d*, of Fig. 3, Fig. 6, a view in perspective of the pointer lever the same being removed from the runner, Fig. 7 a view of the transverse movable hair line plate which carries the hair line, shown in perspective, the same being removed from the runner, Fig. 8 a view of the runner taken from the bottom side after the same has been removed from the rule, Fig. 9 an end view of a modified rule slide, Fig. 10 a plan view of the same, Fig. 11, a clamping bolt which is movable in the dovetailed slot 47 shown in Figs. 9, and 10, Fig. 12 a nut for the same.

Similar numerals refer to similar parts throughout the several views.

The guide plate 2 is secured to one edge of the rule by means of the screws 29, 30, 31, and 32 in such a manner as to enable its inclined edges 46 to act as a cam against the end of the projection 23 of the runner carriage 6, and to guide said carriage either inwardly or outwardly accordingly as the runner is moved in one direction or the other upon the rule. The carriage 6 carries the pointer lever fulcrum, 18, which slides within the slot 19^c of the pointer lever 7, this pointer lever has a hole 44 at its rear end which is engaged by means of the pin 36 with the hair line plate 10, and the carriage is so located that this is the short end of the lever. The graduation marks 20, and 20^A are located at the long end of the lever 7 which is arrested at each end by the pins 14, and 15, in order to limit its stroke. The pins 18, and 36, are preferably made tapering in order that the slightest play may be taken out by driving them inward, the hole 44, and channel 19, each being tapered to correspond with said pins. The top faces of the walls 19, and 19^R form together the top face of the pointer-lever, and the distance between these faces and the opposite face which rests on the top surface of the runner bed 8 must be such as to allow the pointer to play between the opening of the carriage 6, and the runner bed 8, without any lost motion, and yet to be an easy sliding fit between the two surfaces. It will be observed that when the pointer is moved from 14, to 15, the hair line plate 10, is also moved through the medium of the pin 36, and that the amount of space covered by such motion of the hair line plate 10, depends on the location of the fulcrum 18 which is preferably located to limit the moving of the hair line to the exact distance occupied by the one subdivision of the logarithmic scale which is crossed by the hair line; and that when this fulcrum is moved toward scale 20, in a direction away from the rule, the motion of the pin 36, and plate 10, is increased, and when the fulcrum is moved in a direction away from scale 20 and toward the rule, then the motion of the plate 10, is diminished and that the inclined or cam surface 46, of the plate 2, is of such a distance from the fulcrum and its connections, and of such a slope to cause the hair line to move the exact distance of any one space of the logarithmic scale, at any position of the runner, when the pointer lever is moved from pin 14 to pin 15, and thus the fractional value of any position occupied by the hair line between division marks of the logarithmic scale is indicated clearly by the pointer in either the enlarged scale 20, or 20^A the position being of like value with reference to the fractional parts of the respective spaces as hereinafter more fully described. In order that the plate 10, will keep the hair line 43, at right angles with the edges of the rule 5, I have provided the slot 37 in said plate, this slot is nicely fitted to the downwardly projecting portion 38, of the runner bed 8, the plate 10, being kept in place by means of the pin 35, shown in Fig. 5; the projecting portion 38, extends lengthwise of the slot 37, and fastened thereto is the gib 34, the slot 37, being a little longer as seen in Fig. 8, in order to allow the plate 10, enough play to subdivide the longest inscribed subdivisions on the rule. The dotted line across 34, Fig. 8, represents the inner edge of the projection 38, which is covered by the gib 34, which with 33, and 9, slide in the channels 51, and 52, of the rule shown in Figs. 2, and 5, and hold the runner in its place. At the rear end of the runner bed 8, on the bottom side is the bearing 28, which supports one end of the shaft 24, the other end of the shaft 40, being threaded and screwed into the screw hole 39, at the lower portion of the carriage 6, shown in Fig. 5. Between the bearing 28, and the lower portion of the carriage 6, and coiled around the spindle 24, is the spring 25, shown in Figs. 5, and 8, this spring is always pressing against the carriage 6.

The projection 23, is secured to the carriage 6, by means of the screw 26, and is held in place by the detent 27, shown in Fig. 6, this projection 23, bears at its extreme end against the inclined surface or guide 46, of the plate 2, and thus regulates the position of the carriage 6, and fulcrum 18, thus regulating the distance traversed by the plate 10, when the pointer 7, is moved a given distance.

In order that the cam surface 46, of the plate 2, may freely regulate the motion of the carriage 6, the knob 13 must be moved so as to unscrew the spindle 24, far enough as to allow plenty of play between the bearing 28 and the hub of the knob 13, otherwise the spring would be prevented from pushing the projection 23, against the cam surface 46.

Before describing the operation of the rule with the C—D, scale I will describe how this rule is subdivided on said scale. Between 1, and 2, there are 200 subdivisions. Between 2, and 4, there are 200 subdivisions. Between 4, and 8, there are 200 subdivisions. Between 8, and 1, there are 40, subdivisions. Between 1, and 2, each subdivision represents 1/200. Between 2, and 4, each subdivision represents 1/100. Between 4, and 8, each subdivision represents 1/50. Between 8, and 1, each subdivision represents 1/20. It will be observed that each of the subdivisions in the group between 1, and 2, is of equal fractional value, and each in the group between 2, and 4, while of two times the fractional value of either one between 1 and 2, has the same fractional value as any of its neighbors which are between 2, and 4. Each in the group between 4, and 8, while having double the fractional value of either one between 2, and 4, has the same fractional value as any of its neighbors which are located between 4, and 8, and each in the group between 8, and 1, while having a value two and a half times greater than either one between 4, and 8, has the same value as any of its neighbors which are located between 8, and 1, and yet in each group each subdivision must be of a different length than its neighbor on account of the scale being a logarithmic scale. This is as fine as a 25 centimeter rule should be divided, and a good magnifying glass will be found a great advantage in performing operations with this rule. Because the divisions and subdivisions of a logarithmic scale must vary in length the inclined line 46, being the edge or cam surface of the plate 2, is of such a slope as to locate the carriage 6, where its fulcrum will cause the pointer 7, to exactly move the hair line plate 10 a distance equal to the length of whatever division may be located underneath the hair line 43, when said pointer is moved from pin 14 to pin 15. The fractional value, therefore of any position between any two graduation lines of the logarithmic scale used, will be clearly indicated by the pointer 7, upon the relatively enlarged auxiliary scale 20, or 20^{A}, and, on account of the increased length of said auxiliary scales they may be subdivided into fifty divisions upon the present rule and still be distinct, the number of possible subdivisions on the auxiliary scale depending upon the length of the pointer, and the corresponding length of said auxiliary scale; it becomes obvious from this explanation, and from reference to the drawings, and the problems herein described, that the pointer indicates positions upon the auxiliary relatively enlarged scale which positions are of "like fractional value" to the positions traversed by the hair line on the logarithmic scale of the rule, and that such values are clearly readable upon the auxiliary scale. It will be observed that in doing any problem whose answer lies between lines, as for instance "Find the square root of 50," where the result lies between the third and fourth division past 7, on the C. D. scale, each division having a value of 1/50, when the first index is unity, as stated above, the value of a 1/20th division on scale 20 of the runner would be 1/20x1/50, or 1/1000th. Placing the runner so the hair line will be on 7.06 and the pointer on 1, scale 20, then clamping the screw 16, to hold the runner in place we slowly turn the pointer away from 1 until the hair line is over the 5, of the A—B, scale, then counting up from 1, to the pointer, counting each of the 1/20th division of the scale No. 20, as .001, we find a little over 11 divisions, and 7.06, added to .011+ equals 7.071+.

I have found in practice that the runner is apt to move out of place while working the pointer 7, unless held in some way, and as a very slight variation would change the result I have provided the clamp 9, and the clamping screw 16, for the purpose of holding the runner in place while doing problems. The clamp 9, holds the runner firmly in place by drawing upward in the groove 51, and forcing the front edge of the runner gib down against the lower edge of the groove the same coming in contact with the shelf 33 which prevents the runner from getting low enough to interfere with the working of the plate 10.

The subdividing of the A—B, scales must be indicated on scale 20^A, because its graduations decrease and increase more quickly than those of the C—D, scales. Their fulcrum could be located by providing another plate having inclined edges to match its short scales, and placing it either above or below plate 2, but I have on this rule provided the inscribed lines 1—1, and 3—3 and the two flat members 11, and 12, each of which has a line inscribed therein, these lines are used as guides to determine the location of the carriage 6, when subdividing divisions of the A—B, scales as follows: The runner is placed so the hair line will be at the desired position, and clamped there by the screw 16, and if the desired result lies upon the right hand scale then the line 19, on the flat finger 12, is made to aline with the portion of line 1, 1, which it crosses. This is done by first releasing the projection 23, which swings on the lower side of the carriage 18, the screw 23 being its fulcrum, and the detent 27, holding it into its place by clicking into a small recess 28, in the lower part of the carriage 6, shown in Fig. 5, the spring of the metal which constitutes the projection 23, being sufficient to hold the detent in place when so desired, and it is easily swung out of the way when not required. The carriage is then adjusted into its place by means of the knob 13, which turns the spindle 24, which is threaded at its end 40, and screws into the carriage at 39, which is a screw hole. A slight turn to the right will draw the carriage outward by means of the screw and the hub of the knob bearing against the bearing 28, and when the knob is turned to the left the spring 25, draws the knob against its bearing 28, where it is held firmly, in this manner by turning the knob either to the right or to the left as may be required the member 12, is drawn or pushed so its line will aline with line 1—1, when the left hand scale is used the operation is the same excepting that the member 11, is then made to aline. The reason why the right hand member 11, is used for the left hand scale, and the left hand member 12 is used for the right hand scale is because the members not being in the middle of the runner, they would run off from the scale unless so arranged.

It will be noticed that the pointer 7 has a hole 54, near its outer end, and this is supplied with an indicating line 53, shown in Figs. 3, and 6.

Figs. 9, 10, 11, and 12, are used on a modified kind of rule, it may be desirable at times when the result lies between the inscribed graduating lines of the rule to ascertain how much such undivided space represents by moving the slide 5, so the line which designates the result will aline with the one which it has just passed and then reading just how many divisions are represented by this back movement, which added to the number indicated by the last inscribed mark will give the answer sought, this would be advantageous if the subdivisions on either the B, scale or on the C, scale were desired while the slide was pushed out to one end of the rule, as for example when finding the area of a circle on B, from the diameter on D, scale. To do this the runner would be placed in a position on the, A scale, or on the D, scale which would correspond with the position on the B, or C, scale from which the problem should be worked, and the plate 2, put into commission if the C scale were to be read or the lines 1—1, or 3—3, put into commission if the B, scale were to be read. The stud Fig. 11 would now be slid into the groove 47, on the side toward which the slide is to be moved and the nut shown in Fig. 12, would be screwed to the screw portion 50, 49, being its screw hole, and, as the portion 48 of the stud fits the dovetailed groove 47, a slight turn of the nut will fasten it to the slide, care being taken that the portion of the nut 55, will touch the plate 10, and when the screw 16, is tightened any movement of the indicator pointer 7, in the proper direction will impart corresponding motion to the plate 10, which by its abutment against the nut flange 55, will move the slide. So soon as the proper lines are in alinement the desired result will be indicated upon the scale 20, or 20^A of the runner, and the subdivision can be accurately read, it would be advantageous when using the runner for the purpose of alining one graduation of a movable scale with a graduation mark of another scale to employ an additional runner in some cases to assist in marking certain locations before again moving either scale, for, it becomes apparent that when using my runner for the purpose, and in the manner just described it becomes a scale mover and an indicator of the values of the displacements caused by such movements.

It becomes obvious that lines for the guidance and locating of the carriage 6, and its fulcrum 18, through the medium of members as 11, and 12, with their inscribed lines 19, and 21, may be inscribed in the slide in addition to and for the same purpose as are the lines 1—1, and 3—3, and that the members 11, and 12, may be made of any length required and may contain several such gage lines as 19, and 21, on each member.

At 41, Fig. 3, I have shown a vernier scale and it may be desirable to inscribe another one which increases in the opposite direction upon the opposite end of the rule, these are inscribed on the rule when the scale of equal parts, which is generally on the bottom side of the slide, is up and are used for subdividing the divisions of the scale of equal parts, which in the more modern rules is like the scale of sines, and the scale of tangents used in a stationary position by direct alining from the logarithmic scale, and can therefore be made to subdivide any of its divisions by moving it in one direction or another to the line which its desired recording line is nearest to, and reading the subdivisions caused by this displacement from the vernier. To illustrate its use, as well as to make the use of my runner more clear I submit the problem which follows.

Example: What is the amount of $150 at 5% at the end of 10 years? "The scale of equal parts upon this rule increases from left to right." The slide being placed in the rule with the scale of equal parts up, and the initials in alinement, we find above 105 D-scale (105 being the interest plus the rate) 21 and something past the mark on scale of equal parts. Next—move scale of equal parts to the right until 21, alines with 105. On vernier find the very close approximation .2, added to 21, is 21.2 x 10 equals 212. Move slide so initials will aline, and put runner to 212 on scale of equal parts, being sure that the hair line is exactly over the 212 mark. Remove the slide and return it with C, scale contiguous to D, scale, placing the first initial under the hair line of the runner, under 150 find 244 and something between lines on D, scale. Place the runner so the pointer will be touching the pin 14 on scale 20, and the hair line over 244 of D, scale. Move the pointer up until the hair line alines with 150 of C, scale and find on scale 20, of runner 3½ tenths or .35, thus giving the answer $244.35.

The scale of equal parts in this rule has 1000 divisions and is 25 centimeters long.

Describing the hair line 43, seen through the opening 42, of the runner 8, and again in Fig. 7, it will be observed that it is divided into three continuous parallel sections each section having a space between itself and the next section, this sectional line is scratched into a plate of mica, 17, with a fine needle point, and the scratches are filled with india ink, it is evident that any transparent substance can be used for this purpose in which a perfect and plain thin line can be made. I have left the openings in the hair line so as to be able to see the graduation marks at the place where the slide and the stationary part of the rule adjoin one another in order to be enabled to see the alinement of certain lines on the two contiguous scales in performing some problems, although it becomes apparent that any suitable kind of hair line can be used with my improvements whether continuous or not and scratched or etched upon a glass or other transparent or translucent plate, or scratched upon metal plates whose edges may be made to aline their inscribed hair lines with the divisional graduation lines.

Referring now more specifically to the indicator scales 20, and 20^A, of the runner it will be noted that the divisions thereon increase and diminish in length in approximately the same ratio as do the divisions of the respective logarithmic scales which they represent and whether the logarithmic divisions to be divided are at the end of the scale where they are longest, or at the other end where they are shortest, or at any intermediate point they are always subdivided into the same number of parts, each of equal fractional value with the other, the graduations on the auxiliary scale being a definite number. These runner scales 20, and 20^A, may be considered as subdividers for scales C—D, and A—B, respectively, and as greatly enlarged duplicates of the divisions to be subdivided, and supplied with means whereby like positions are indicated upon the enlarged scale, which is subdivided in the same logarithmic succession as is the logarithmic scale of the rule.

The arc described by the pointer lever 7, is approximately one tenth of a circle, and the necessary distance required to move the fulcrum is approximately .02 of an inch, the longest divisions to be divided are approximately 2½ one hundredths of an inch long, and the shortest ones are approximately 1/100th inch long. The longest is between 8, and 10 on the C, D, scale, and the shortest is at the end of the 1 to 2, 2 to 4 or 4 to 8 portion, the longest of each of these sections being approximately .02 of an inch. The variations produced by these differences which require the changing of the relative positions occupied by the fulcrum are hardly noticeable, but can be corrected on rules requiring a wider range of difference between the length of divisions by changing the shape of the channel 19^c, and by changing the marks on the indicator scales.

In using the word hair line in my claims I use it in its broadest meaning, and to signify any line used for a similar purpose.

When so desired the projection 38 may be cut away at the side which is contiguous with the rule sufficiently to allow the use of the well known runner spring, instead of being fitted snugly as shown in the drawings.

While I have shown in the drawings a holder 5, and a slide 4, it is obvious that my improvements can be used for some purposes when the holder is alone, as when doing problems in square root, which can be performed with the slide 4 removed from the holder if so desired.

I claim—

1. In a logarithmic calculating rule having inscribed thereon a scale of divisions of equal fractional value having long and short spaces and an auxiliary inscribed scale of enlarged relative dimensions; the combination of means for indicating positions between inscriptions on said scale, and means for indicating positions of like fractional value on the auxiliary inscribed scale of enlarged relative dimensions with means for adjusting the indicating means so they will indicate the value of the same number of divisions each of equal fractional value for either long or short spaces.

2. In a logarithmic calculating rule, the combination of a holder having inscribed thereon a logarithmic scale whose divisions vary in length, a slide having inscribed thereon a logarithmic scale whose divisions vary in length, and an auxiliary scale of enlarged relative dimensions, with means for moving the slide or holder, to change their relative positions to one another, and means for adjusting the indicating means to indicate the fractional value of displacements between given graduation marks on the slide and holder, upon the auxiliary scale of enlarged relative dimensions.

3. In a logarithmic calculating rule having inscribed thereon a scale of divisions of equal value having long and short spaces, the combination of a holder, a runner, a movable hair line, a pointer, and an auxiliary scale of enlarged relative dimensions, with a fulcrum and means for changing the relative position of said fulcrum and said pointer so the pointer will indicate upon the auxiliary scale the fractional value of the position of the hair line between graduation marks whether dividing long or short spaces.

4. In a logarithmic calculating rule, the combination of a holder having a logarithmic scale inscribed thereon, and a slide having a logarithmic scale inscribed thereon, with a runner, and a hair line plate movable in said runner in a direction longitudinal with the rule, and means for moving the same.

5. In a logarithmic calculating rule, the combination of a holder, a slide, a runner, and an independently movable hair line plate with a moving lever and fulcrum coöperating to change the stroke of one end of said lever.

6. In a logarithmic calculating rule, the combination of a holder a slide, a runner, and an independently movable hair line plate with a moving lever, a fulcrum coöperating to change the stroke of one end of said lever, and a movable fulcrum carrier.

7. In a logarithmic calculating rule, the combination of a holder a slide, a slidable member mounted upon the holder, an independently movable member mounted in said slidable member, and means for holding the slidable member rigidly to the holder with means for attaching the independently movable member to the slide.

8. In a logarithmic calculating rule, the combination of a holder having a logarithmic scale inscribed thereon, a slide having a logarithmic scale inscribed thereon, a slidable member mounted upon the holder, an independently movable member mounted in said slidable member, and means for holding the slidable member rigidly to the holder with means for attaching the independently movable member to the slide and means for indicating the fractional value of space between a line or its alinement on the slide, and a line or its alinement on the holder.

9. In a logarithmic calculating rule, the combination of a division of a given length having a determined fractional value, a division of a different length having the same fractional value as the first named division, and a relatively enlarged subdivided auxiliary scale, with means for subdividing either one of the said divisions into the same number of parts of equal fractional value, and means for indicating the fractional value of either of such subdivisions on the said relatively enlarged subdivided auxiliary scale said means comprising a lever having a fixed stroke at one end and a fulcrum movable therein coöperating to change the stroke of the other end of said lever.

10. In a logarithmic calculating rule, the combination of a relatively enlarged subdivided auxiliary scale representing one division of the rule, a slide, a holder, and a graduated scale whose divisions vary in length, with mechanical means for moving said slide, and means for indicating the value of relative positions on the slide and holder between graduation marks on the relatively enlarged subdivided auxiliary scale.

11. In a logarithmic calculating rule, the combination of a slide, a holder, and a graduated scale on each whose divisions vary in length and a detached relatively enlarged subdivided auxiliary scale representing one division of the rule, with means for

indicating relative positions on said slide and holder, and means for indicating the fractional value between their graduation marks upon the detached relatively enlarged auxiliary scale.

12. In a logarithmic calculating rule, the combination of a relatively enlarged auxiliary scale, a holder having a logarithmic scale inscribed thereon, and a slide having a logarithmic scale inscribed thereon, with a runner and a hair line plate movable in said runner in a direction longitudinal with the rule, and means for moving the same.

13. In a logarithmic calculating rule the combination of a lever a relatively enlarged auxiliary scale, a holder having a logarithmic scale inscribed thereon, and a slide having a logarithmic scale inscribed thereon, with a runner and a hair line plate movable in said runner in a direction longitudinal with the rule.

14. In a logarithmic calculating rule, the combination of a lever, a relatively enlarged auxiliary scale, and a holder having a logarithmic scale inscribed thereon, with a hair line plate movable in a direction longitudinal with the rule.

15. In a logarithmic calculating rule, the combination of a lever, a movable fulcrum for said lever, a relatively enlarged auxiliary scale, a holder having a logarithmic scale inscribed thereon, and a slide having a logarithmic scale inscribed thereon with a hair line plate movable in a direction longitudinal with the rule.

16. In a logarithmic calculating rule, the combination of a lever, a movable fulcrum for said lever, a relatively enlarged auxiliary scale, a logarithmic scale, and a hair line plate movable longitudinal with the rule.

17. In a logarithmic calculating rule, the combination of a holder a slide, and a hair line plate, with a moving lever and a fulcrum coöperating to change the stroke of one end of said lever.

18. In a logarithmic calculating rule, the combination of a holder a slide, and a movable hair line plate, with a moving lever, a fulcrum, coöperating to change the stroke of one end of said lever, a movable fulcrum carrier, and a guide for locating the fulcrum carrier.

19. In a logarithmic calculating rule, the combination of a holder, a slide, and a movable hair line plate, with a moving lever, a fulcrum slidable therein, and means for changing the stroke of the short end of the lever.

20. In a logarithmic calculating rule, the combination of a holder having a logarithmic scale inscribed thereon, a lever, means for changing the stroke of said lever, a relatively enlarged auxiliary scale, and a slide having a logarithmic scale inscribed thereon, with a hair line plate movable in a direction longitudinal with the rule.

21. In a logarithmic calculating rule, the combination of a logarithmic scale, a lever, means for changing the stroke of said lever at one end, means for limiting its stroke at the other end, a relatively enlarged auxiliary scale, and a slide having a logarithmic scale inscribed thereon, with a hair line plate movable in a direction longitudinal with the rule.

22. In a logarithmic calculating rule, the combination of a logarithmic scale and a hair line or indicator movable between graduations of said scale, and a relatively enlarged auxiliary scale and an indicator movable over and between divisions of said auxiliary scale, with connected means whereby each indicator occupies the same relative fractional position on its respective scale.

23. In a logarithmic calculating rule, the combination of two logarithmic scales, each inscribed on a separate plate, a lever for moving one of said plates, and a movable fulcrum for said lever, with a relatively enlarged subdivided graduated auxiliary scale at some portion of the long end of said lever.

24. In a logarithmic calculating rule, the combination of two logarithmic scales, each inscribed on a separate plate, a hair line carrier, a lever for causing the hair line carrier to move, and a movable fulcrum for said lever, with a relatively enlarged subdivided graduated auxiliary scale at some portion of the long end of said lever.

25. In a logarithmic calculating rule, the combination of two logarithmic scales, each inscribed on the same plate, a hair line carrier, a lever for causing the hair line carrier to move, and a movable fulcrum for said lever, with a relatively enlarged subdivided graduated auxiliary scale at some portion of the long end of said lever.

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