COMPLETE SPECIFICATION.

" Improvements in Calculating Scales."

I, RUDOLPH CHARLES SMITH, of No. 214, Woodworth Avenue, in the City of
Yonkers, in the County of Westchester and State of New York, United States
of America, Engineer, do hereby declare the nature of this invention, and in
what manner the same is to be performed, to be particularly described and
5 ascertained in and by the following statement:-

" The object of my invention is to construct an instrument which will in every
case register mechanically the correct local value of the first left figure of
numbers used in the operation of a logarithmic scale for calculations. Such
an instrument, as is well known, is of the greatest utility, as it does away with
10 the many chances of error caused by the necessity of constant mental attention,
while using the ordinary slide.
   The large printed figures of the slide-rule are the first left figures of the
numbers used in the calculations and have the highest denomination, or the
highest local value; for instance, in 550, " 5 " is the first left figure and its
15 local value is 500.
   My present invention consists of a cursor which registers the ciphers which
must follow the first figure to give it its local value, in openings placed on the
cursor to line with the horizontal row of their printed figures, and show their
local value in ordinary notation.
20 As a further improvement, I have added means co-operating automatically
with the main slide which point visibly toward the direction of the particular
opening in which the ciphers of the figures of the main slide must be made to
appear and read, and at the same time show by the length of the pointer the
length of the section on which the figures must be read in the opening to which
25 this pointer points.
   My present invention is an improvement on the slide rules described in the
Specifications of my Patents 7579 of 1900 and 17,499 of 1904. In the former,
the columns in which the multiple of ten must be read to indicate the local
decimal value of the figures used on the main scale, are indicated by signs, but
30 these signs do not point visibly to the particular place where the multiple of
ten must be read. The multiple of ten is indicated by figures of reference 1
and 2, which figures of reference occur on the main slide and on the slide of
the auxiliary scale.
   In the slide rule according to the Specification of my Patent No. 17499 of 1904,
35 the place where the multiple of ten must be read to give the local decimal value
of a figure of the main scale, is indicated by the difference of the colour, without
pointing in the direction towards the particular place.
   My present improvement contemplates the use of pointers or lines on the
main stock and its slide and which are set by the move of the said main slide
40 to visibly point to the opening in the cursor in which the ciphers of the figures
of the main slide must be made to appear and be read.
   Figure 1 is a longitudinal side elevation of the calculating scale embodying
my invention.
   Figure 2 is a top plan view of the same with the slide moved to the left.
45 Figure 3 is a top plan view of the calculating scale with the slide moved to
the right.

[Price 8d.]

Figure 4 is a transverse section.

Figure 5 is a detached perspective view of the cursor.

The arrangement of the ordinary logarithmically-spaced slide-rule is well-known and needs no detailed description. It consists of a stationary part and of a slidable part which can be moved to the desired place on the stationary part 5 in proper guides.

The main slide 1 is preferably an elongated strip of hard wood on which are engraved the proper lines and characters as is usual on logarithmic slides.

The stationary part or stock 4 of the main slide-rule is also preferably formed of hard wood and on it are engraved the usual logarithmic scales which if used 10 with those on the slide will register equal ratios, as is well-known. The slide 1 slides, as usual, in grooves of the stock. The slide 1 as well as the stationary part 4 are provided with any of the well-known logarithmic Gunter scales; but in my improved instrument the slide 1 and the stock 4 are provided with directive pointers which for every section of the slide visibly point to the 15 particular openings of the cursor where the proper number of ciphers for a section must be made to appear.

The cursor 5 is arranged transversely and adjustably on the main slide-rule and comprises a main part or stock 7 of non-transparent material bearing the proper characters hereinafter referred to, a slide 8 of non-transparent material 20 thereon also bearing the proper characters, and a transparent celluloid sheet 80 folded around the main slide-rule upon the part 7 and slide 8 of the cursor, the ends of said sheet 80 where they come opposite to each other at the lower edge of the main slide rule being fastened by pieces of metal 81. The part 7 and slide 8 of the cursor are between the upper portion of the transparent 25 sheet 80 and the upper surface of the main slide-rule and the slide 8 is upon the part 7; and at the upper edge of the main slide-rule the upper adjacent ends of the part 7 and slide 8 project through a slit in the folded edge portion of the sheet 80, while at the lower edge of the main slide-rule the lower adjacent ends of the part 7 and slide 8 project between the facing surfaces of the ends of 30 the sheet 80 and also between the metal pieces or rivets 81, which serve as guides for said part 7. The upper portion of the sheet 80, which forms a part of the cursor 5, is provided with three index holes 17, 19, 20, coinciding with the equal spacing of the ciphers of the slide 8, by which the local value of the figures of the main slide is registered. The cursor 5 is also provided with index holes 21, 35 22, the hole 21 being preferably located in line with the printed figures on the main scale the ciphers of which it is intended to indicate, and the index hole 22 being preferably in line with the figures printed on the main scale the ciphers of which it is intended to indicate. The index hole 19 is preferably located in line with the printed figures on the main slide the ciphers of which it is intended 40 to indicate. This arrangement just described of the index holes 21, 22 and 19 in register with the respective lines of printed numerals with which they co-operate affords an effectual guide to the user of the scale in making accurate readings thereof and consequently prevents mistakes.

The upper left half of the stationary part 4 is provided with a bevel horizontal 45 material line 13 extending from the left end of the scale to the center dividing the spacing of the stationary scales in two halves. The right lower half is provided with a material bevel line 14 extending from the middle to the right end. The slide 1 has a material bevel line below the figures of the left half, a material line 15 or any other prominent visible means, as for instance, a 50 raised or grooved line extending to the middle, and a similar line 16 above the figures of the right half extending from the middle of the slide to the right end.

The Fig. 2 shows the slide moved to the left, a position which shows two lines 13 and 16 above the figures of the slide for the section between the end of the lines of the slide, and those of the stationary part. These two lines point 55 to the upper opening, and indicate that the figures of the section of the slide, where the edge of the cursor in fixing the position of the figure crosses two upper

lines, have the ciphers indicating their local value in the opening to which these upper lines point.

Fig. 3 shows the slide moved to the right and in this position there are two lower material lines 14 and 15 pointing to the lower opening of the slide 8, in
5 which the numbers of these figures on the section with the two lines must be read and taken. The figures of the outer sections of the slide have their ciphers in the middle opening to which the two horizontal lines above and below the figures point. If in using this arrangement of pointers on the slide of the figures and openings for the ciphers of the same, on cursor 5, each ratio of figures
10 set on the logarithmic slide is accompanied by a setting of the local value of the figures expressed, in the opening of the cursor, the correct result of calculations performed on the logarithmic slide-rule can be read.

The figures on the auxiliary slide 8, and its stationary part 7 of the scale for the local values, are in three rows which contain, respectively, the ciphers of
15 the rows of figures on the main scale with which they are horizontally in line, which rows of figures of the main scale are marked 3, 4, 1 and 2 (not as numerals of reference but as incorporated with the instrument), as shown on the left hand end of Figs. 2 and 3. It will be noticed that the upper row of the figures of the main stationary scale contains the square roots of the lower row of figures, while
20 the slides have the same row of figures as the lower row of figures on the stationary part.

The openings of the cursor 17, 19, 20, must be of the same spacing as the ciphers on the slide 8, and the stationary part; and the openings 21, 22 must be located properly, that when 19 in normal position of slide and stationary part
25 shows 00, the upper opening must show 0, and the lower one 00. With this vertical distance it follows that the lower opening will show the same number of ciphers as the middle one, and the upper one will show half the number of ciphers, and with the equal spacing of the ciphers the same ratio will be maintained.

30 I have discovered that this construction of the instrument is capable of registering the ciphers mechanically, following a very simple rule of operation, *viz*: Repeat every move of the cursor 5 and slide 1 of the main scale with the cursor 5 and slide 8 of the decimal-scale, using the numbers on the main scale and the ciphers of their first figures on the decimal-slide. Read all decimals in line
35 with the middle index 19 of the cursor 5; except for the figures on an inner section, if on such a section two lines point to the upper opening, the ciphers must be read in the upper opening, and if the two lines on the slide point to the lower opening, the ciphers must be read and taken in the lower opening.

The instrument registers factors of ratios or proper and improper fractions,
40 like:

$$\frac{1500}{600} \times \frac{80}{400} = 0.5 \text{ or } 5/10$$

by the following sequence of moves.

At the commencement of the operation, the slides may be regarded as set in their respective zero positions, in which the figures on the slides coincide with those on their co-operating stationary parts. Then move the cursor 5 to align
45 with the figure " 6 " (this being the significant figure of the divisor " 600 " in our example) on the main slide 1; then move the stock 7 and slide 8 of the cursor 5 together until the two ciphers " 00 " on the slide 8 appear at the middle opening 19, and then move the slide 1 to the left until the fifteen
50 division mark thereon (this being the first term of the ratio 1500) becomes in line with the left hand edge of the cursor. Then ordinarily or in the general use of the scale we would move the slide 8 but in this example we do not have to do so since the three ciphers " 000 " (which express the local decimal value of the first significant figure of 1500) on the slide 8 appear in the upper open-
55 ing 20 to which the two upper lines 16 of the section where 15 is taken point,

said three ciphers having, in this special example, attained their position in said opening 20 by the operation of placing the two ciphers in the middle opening 19 while fixing the value for " 6 ".

Now set the left hand edge of the cursor 5 to align with " 4 " on the right-half of slide 1, and at this time we would ordinarily again move the slide 8 but 5 it is not necessary in our example to do so since the two ciphers " 00 " already appear at the middle opening 19. Then move slide 1 to the right to replace the " 4 " by " 8 " at the left hand edge of the cursor, and at this time we would ordinarily or under the general rule move slide 8 but in our example it is not necessary to do so because the one cipher " 0 " already appears in the lower 10 opening 17, having attained that position (with the lower lines 15 of the section containing the " 8 " pointing thereto) from the former operation; said one cipher representing the local value of the " 8 " in " 80 " or " 0 ".

To read the result of the multiplication in the example given:

Move the parts 7 and 8 of the cursor together to show in the lower open- 15 ing 22 the blank space on the part 7 which is between the " 0 " and " /10 ", which movement will also cause the "/10" on slide 8 to appear in the lower opening 17, since the two lower lines 15 of the slide 1 point to said lower open-ing 17. Over the figure " 1 " at the middle of the stationary part 4, we may then read the figure " 5 ", which with the " /10 " shown in the lower opening 17, 20 stands for 5/10 or .5, and we thus read the result of the multiplication.

The general rule for the operation of the scale is to repeat every move of the cursor 5 and slide 1 with the cursor 5 and slide 8 of the decimal scale, using the numbers on the main scale and the ciphers of their first figures on the decimal scale, but in the example above given some of the repeat moves become 25 unnecessary for the reasons explained.

I do not limit myself to the precise construction and arrangement shown. It is evident that the same operation and result may be obtained on a disk or cylindrical surface, as on a plane.

Having now particularly described and ascertained the nature of my said 30 invention, and in what manner the same is to be performed, I declare that what I claim is:—

A logarithmic slide rule which carries an auxiliary slide rule having suit-ably spaced ciphers for continuous powers of 10, whereby when the setting of each first significant figure, used with the logarithmic slide, is repeated with 35 the proper number of ciphers on the auxiliary cipher slide, the correct local value of the respective first significant figures, is mechanically shown by the number of ciphers in the proper opening of the cipher slide cursor, to which the pointers are set by the move of the main slide.
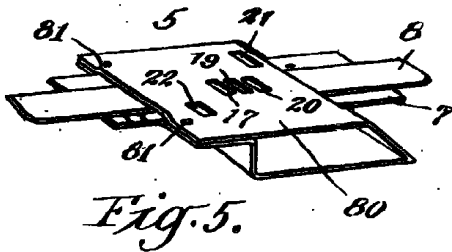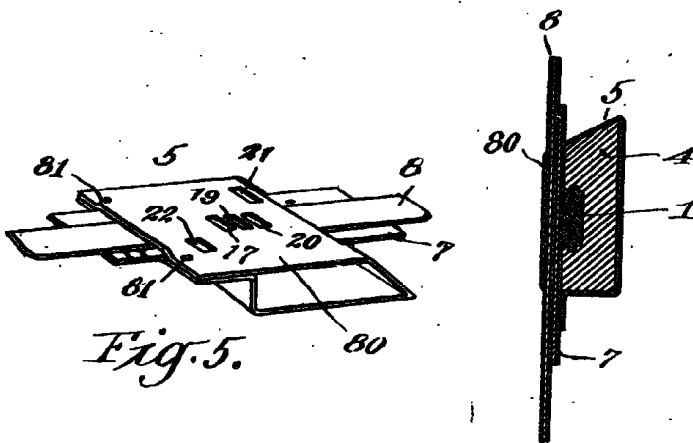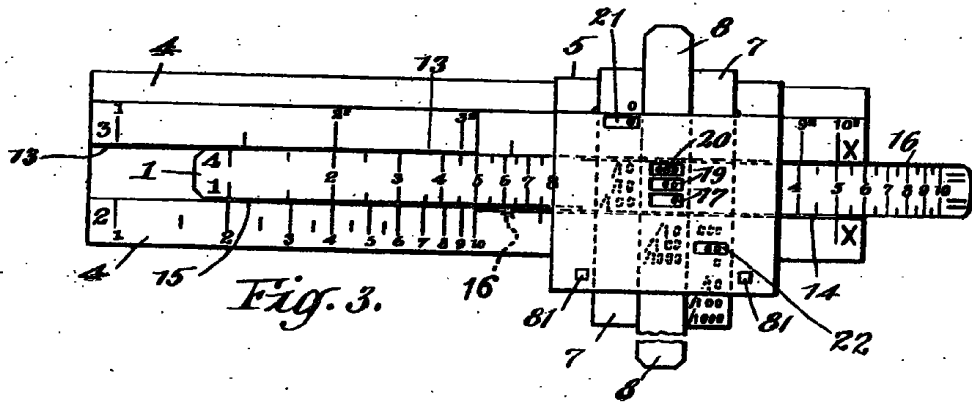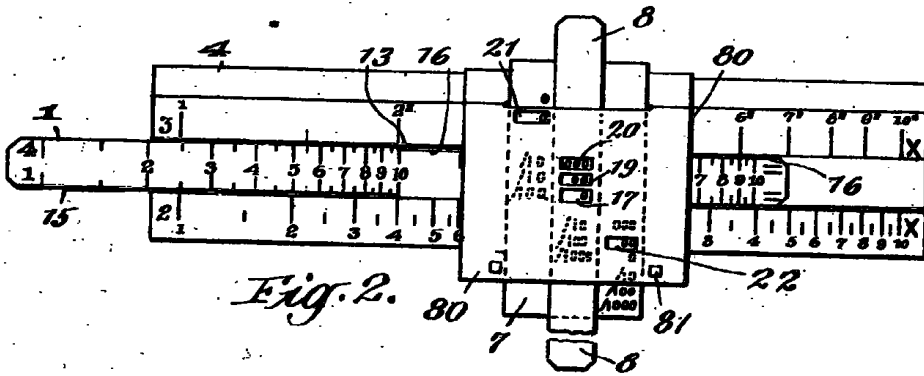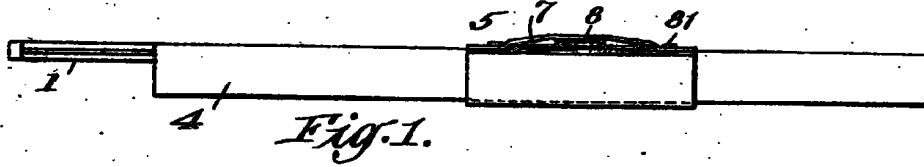
Dated this 19th day of March, 1909.   40

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SMITH'S COMPLETE SPECIFICATION.

(1 SHEET)

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 5.

Fig. 4.