Feb. 10, 1925. **1,525,752**

C. S. LARKEY

SLIDE RULE

Filed Jan. 21, 1924

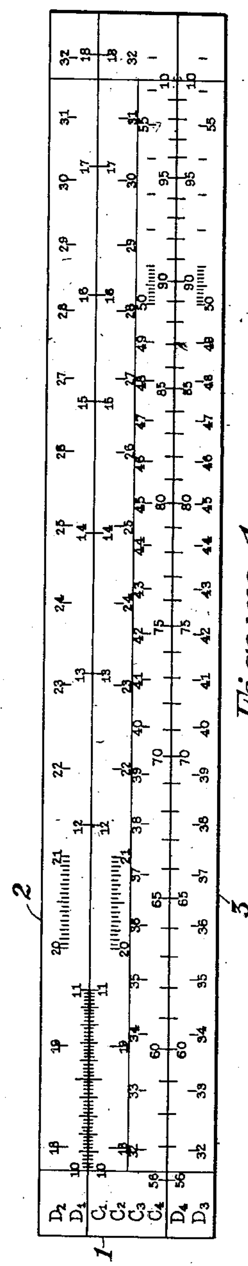

Figure 1

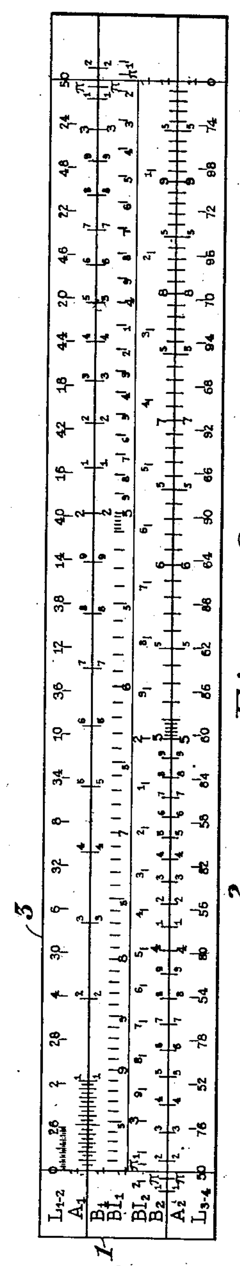

Figure 2

Chas. S. Larkey, INVENTOR

BY

ATTORNEY

Patented Feb. 10, 1925. 1,525,752

UNITED STATES PATENT OFFICE.

CHARLES S. LARKEY, OF TULSA, OKLAHOMA.

SLIDE RULE.

Application filed January 21, 1924. Serial No. 687,839.

To all whom it may concern:

Be it known that I, CHARLES S. LARKEY, a citizen of the United States, residing at Tulsa, in the county of Tulsa and State of Oklahoma, have invented a new and useful Slide Rule, of which the following is a specification.

My invention relates to improvements in slide rules in which the scales are subdivided into equal parts and arranged in a series across the length of each face of the rule; and the objects of my improvements are, first, to provide scales which can be read to a greater number of significant figures than can be read on rules of the same length now in use; second, to arrange and designate such scales so that a ready reference may be had from one to another.

I attain these objects by the arrangement illustrated in the accompanying drawing, in which—

Figure 1 represents one face and Figure 2 the opposite or reverse face of the rule.

Similar numerals refer to similar parts in each view.

The slide 1 is arranged to move along the sides or body 2 3, which parts 2 3 are connected together by some suitable mechanical arrangement not shown in the drawing so that they function as one rigid part.

In Figure 1 on the slide 1 are shown four scales designated respectively C_1, C_2, C_3 and C_4, which scales taken together in sequence as shown represent one continuous logarithmic scale or cycle, corresponding in its nature to the C-scale of the ordinary Mannheim slide rule, each one of which four scales being equal in length to one-fourth of the complete logarithmic cycle. On the side 2 the D_1 and D_2 scales are exactly similar to and correspond with the C_1 and C_2 scales of the slide 1; likewise, on the side 3 the D_3 and D_4 scales are exactly similar to and correspond with the C_3 and C_4 scales of the slide 1.

In Figure 2, on the slide 1, are shown four scales designated respectively B_1, BI_1, BI_2 and B_2, the B_1 and B_2 scales constituting one complete logarithmic scale or cycle divided into two parts of equal length, and the BI_1 and BI_2 scales also constituting one complete logarithmic scale or cycle divided into two parts of equal length, but arranged in a reverse order so that the numbers represented thereon are reciprocal to the numbers shown on the B_1 and B_2 scales. On the side 3, scale A_1 corresponds with and is exactly similar to scale B_1 of the slide 1; and likewise on side 2 scale A_2 corresponds with and is exactly similar to scale B_2 of the slide 1. On the side 3 is shown an evenly graduated scale L_{1-2}, which is designed to give the mantissas of logarithms of numbers shown on the D_1 and D_2 scales of Figure 1; likewise, on side 2 is shown a similar scale L_{3-4}, which is designed to give the mantissas of logarithms of numbers shown on the D_3 and D_4 scales of Figure 1.

The numbers and letters of scales BI_1 and BI_2 are to be of a contrasting color to the numbers and letters of other scales for convenience of reference.

The order of graduating or subdividing the scales shown in each view is indicated where each change occurs by the complete graduations being shown, it being intended that such order be followed in graduating each scale to the point where a different order is indicated.

It will be noted that subscript numbers are used to designate parts of each complete scale; thus A_2 designates the second part of the A scale, and C_4 designates the fourth part of the C scale, etc. The use of subscripts in this manner facilitates operations performed on this rule, by furnishing ready reference from one scale to another, while at the same time retaining the identity of each scale in its entirety.

In multiplication or division, simple operations of addition or subtraction respectively of subscripts determine the subscript of the scale on which the result of the operation may be read. In finding the squares or square roots of numbers, reference is made from the odd numbered subscripts of one scale to the odd numbered subscripts of another, or from the even numbered subscripts of one scale to the even numbered subscripts of another.

These and further uses are explained in detail by the following examples:

In multiplication, when the slide is moved to the right, readings from the C to the D scales are to be found on the D scale having a subscript equal to either 1 or 5 less than the sum of the subscripts of the scales on which the two numbers to be multiplied are found, 1 being subtracted when the sum is 5 or less and 5 being subtracted when the sum is 6 or more. When the slide is moved to the left, the same rule applies except that 0 or 4 is subtracted instead of 1 or 5, 0 being subtracted when the sum is 4 or less and 4 being subtracted when the sum is 5 or more.

For example, in multiplying 23 by 12, the slide must be moved to the right. 23 is found on the D_2 scale and 12 on the C_1 scale. The sum of subscripts is 3. Deducting 1 (the sum being less than 5), the product should be found on the D_2 scale. Thus moving the slide to the right and setting the left hand index of the C scale to 23 on the D_2 scale, 276 is read on the D_2 scale opposite 12 on the C_1 scale.

Or, on multiplying 87 by 55, the slide must be moved to the left. 87 is found on the D_4 scale and 55 on the C_3 scale. The sum of subscripts is 7. Deducting 4 (the sum being greater than 5), the product should be found on the D_3 scale. Thus moving the slide to the left and setting the right hand index of the C scale to 87 on the D_4 scale, 4785 is read on the D_3 scale opposite 55 on the C_3 scale.

In division, when readings are made with the slide moved to the right, either 1 or 5 is added to the subscript of the D scale on which the dividend is found, from which the value the subscript of the C scale on which the divisor is found is subtracted to obtain the subscript of the D scale on which the quotient is read; 1 being added if the subscript of the C scale is equal to or less than the subscript of the D scale, and 5 being added if the subscript of the C scale is greater than that of the D scale. When readings are made with the slide moved to the left, the same rule applies except that either 0 or 4 is added to the subscript of the D scale instead of 1 or 5, 0 being added when the subscript of the C scale is less than that of the D scale, and 4 being added when the subscript of the C scale is equal to or greater than that of the D scale.

For example, in dividing 288 by 12, the slide is moved to the right until the divisor 12 on the C_1 scale is opposite the dividend 288 on the D_2 scale. The quotient 24 is then read on the D_2 scale opposite the left hand index of the C scale, since by the rule of subscripts, 1 must be added before the difference is taken, giving 2 for the subscript of the D scale on which to find the quotient.

Or, in dividing 750 by 15, the slide is moved to the left until the divisor 15 on the C_1 scale is opposite the dividend 750 on the D_4 scale. The quotient 50 is then read on the D_3 scale opposite the right hand index of the C scale, since by the rule of subscripts 0 must be added before the difference is taken, giving 3 for the subscript of the D scale on which to find the quotient.

In examples involving the squares of numbers, reference is made from the C scale to the B scale or from the D scale to the A scale, as with the ordinary Mannheim rule, the subscripts used to designate parts of these scales facilitating such reference. Thus the squares of numbers shown on the D_1 and D_3 scales are to be found on the A_1 scale, and the squares of numbers shown on the D_2 and D_4 scales are to be found on the A_2 scale, such squares being exactly opposite the numbers themselves on the reverse face of the rule. The same rule also applies to the C and B scales.

For example, in finding the area of a circle of radius 5, by the formula $A=\pi R^2$, 5 is found on the D_3 scale. Its square 25 is then found by direct reference on the A_1 scale, to which either index of the B scale may be set and the area 78.54 be read on the A_2 scale, opposite π on the B_1 scale if the slide is moved to the left, or on the B_2 scale if the slide is moved to the right. In this example reference was made from an odd numbered subscript of the D scale to the odd numbered subscript of the A scale.

In examples involving the square roots of numbers, this process is reversed, the square roots of numbers shown on the A_1 scale being read on the D_1 and D_3 scales and the square roots of numbers shown on the A_2 scale being read on the D_2 and D_4 scales. The same relation also exists between the B and C scales. If the number whose root is sought be divided into periods of two digits each, beginning at the decimal point, the first period will contain either one or two digits. When it contains one digit, reference is from the A_1 scale to the D_1 scale or from the A_2 to the D_2 scale, depending upon which of the A scales the number is found; if it contains two digits, reference is from the A_1 to the D_3 scale or from the A_2 to the D_4 scale, depending upon which of the A scales the number is found; likewise with the B and C scales.

For example, in finding the square root of 25, since this number contains two digits, reference is from the A_1 scale, where the 25 is found, to the D_3 scale, where the root 5 is read exactly opposite the 25; while for the square root of 250, since the first period of this number contains one digit, reference is from the A_1 scale to the D_1 scale, where the root 15.81 is read exactly opposite the 250.

The subscripts used with the L scale are for reference from the D scale, when logarithms of numbers shown on the D scale are desired, or vice versa; thus the logarithms of numbers on the D_1 scale are to be found on the L_1 scale, those on the D_2 scale on the L_2 scale, et cetera. Since the L scale is an evenly divided scale, it is not necessary to repeat parts of this scale, hence the L_1 and L_2 scales are shown as one with a double set of scale numbers; likewise, the

L_3 and L_4 scales, the lesser set of scale numbers being read for the lesser subscript number and the greater set of scale numbers being read for the greater subscript number, in each instance.

Other slide rules have been made where scales are divided into parts or segments, but in order to know upon what segment of a scale to read the result of a calculation, it is necessary to resort to some table or mechanical device, while by this rule the desired segment is directly indicated by the subscript numbers used to designate each separate part or segment of a complete scale, as shown by the foregoing examples.

Parts or segments of scales on other slide rules have also been designated by numbers in addition to the letters used, but such designation has been for the purpose of identifying such parts or segments, only. On this rule, numbers used in the subscript form are for the purpose of direct reference between different scales.

Co-logarithmic scales or cycles have been used in registry with logarithmic scales or cycles, from which reciprocals of numbers may be read from the one scale to the other, but the principle has never been applied to a scale divided into parts or segments, such as is shown on my rule in the comparison of the BI_1 and BI_2 scales with the B_1 and B_2 scales.

I claim:

1. In a slide rule having two fixed bars and one sliding bar, a logarithmic scale or cycle divided into four equal parts or segments, two of which segments on one of the said fixed bars and the other two of which segments on the other of the said fixed bars, with a logarithmic scale or cycle divided into two equal parts or segments on the said sliding bar, so arranged that the squares of numbers on the fixed bars may be read directly on the sliding bar from the one scale to the other.

2. In a slide rule having two fixed bars and one sliding bar, a logarithmic scale or cycle divided into two equal parts or segments, one of which segments on one of the said fixed bars and the other of which segments on the other of the said fixed bars, with a logarithmic scale or cycle divided into four equal parts or segments on the said sliding bar, so arranged that the squares of numbers on the sliding bar may be read directly on the fixed bar from the one scale to the other.

3. In a slide rule having two fixed bars and one sliding bar, a logarithmic scale or cycle divided into two equal parts or segments, with a co-logarithmic scale or cycle divided into two equal parts or segments in fixed registry therewith, such that the reciprocals of numbers may be read directly from the one scale to the other.

4. In a slide rule having two fixed bars and one sliding bar, scales designated by letters with subscripts, such that the subscripts indicate parts or segments of a complete scale designated as a whole by the letter with which said subscripts are used, the numbers used for such subscripts being such that in comparing segments of scales for multiplication or division, the sum of subscripts of the scale segments compared will indicate the scale segment on which the result of multiplication may be read and the difference of subscripts of the scale segments compared will indicate the scale segment on which the result of division may be read.

5. In a slide rule having two fixed bars and one sliding bar, a logarithmic scale or cycle divided into four equal parts or segments, two of which segments on one of the said fixed bars, and the other two of which segments on the other of the said fixed bars, with a co-logarithmic scale or cycle divided into two equal parts or segments on the said sliding bar, so arranged that the squares of the reciprocals of numbers on the fixed bars may be read directly on the sliding bar when brought into registry therewith from the one scale to the other.

6. In a slide rule having two fixed bars and one sliding bar, a logarithmic scale or cycle divided into four equal parts or segments, with an evenly graduated scale which may be brought into registry therewith, such that the mantissas of logarithms of numbers may be read directly from the logarithmic scale to the evenly graduated scale.

7. In a slide rule having two fixed bars and one sliding bar, an evenly graduated arithmetic scale divided into equal parts or segments, such that portions of the scale may be repeated over the same graduations by the use of multiple sets of scale numbers, and such that each set of scale numbers represents mantissas of logarithms of numbers on a logarithmic scale or cycle divided into the same number of equal parts or segments and brought into registry therewith.

CHAS. S. LARKEY.