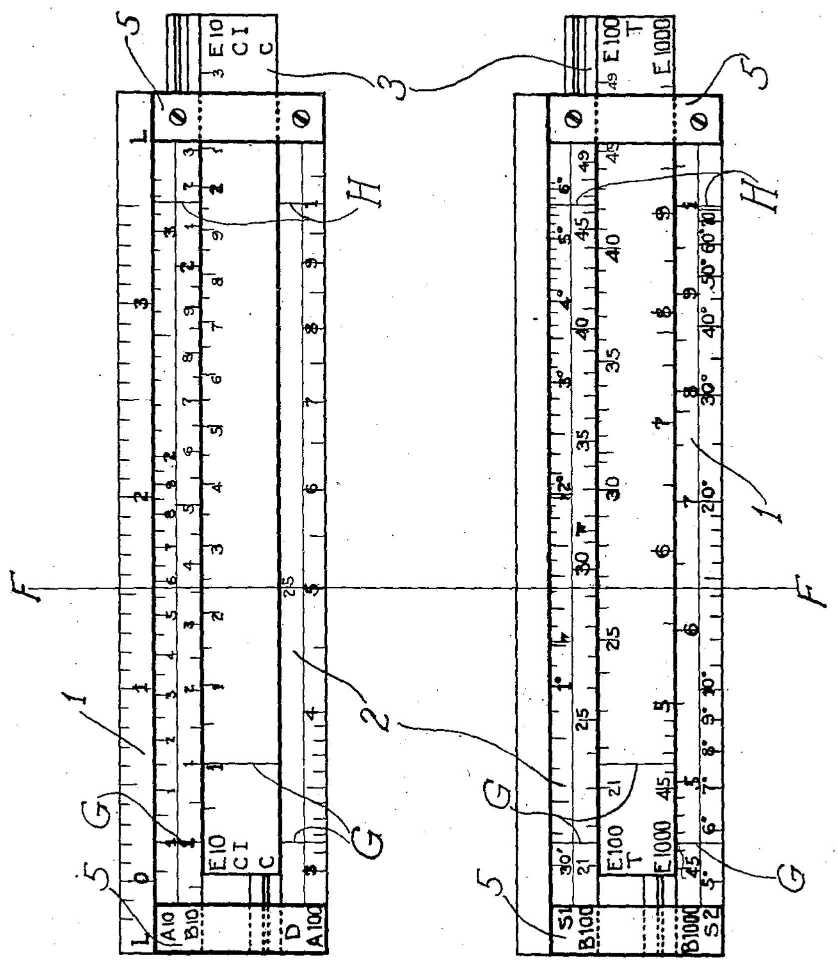
H. RITOW.

SLIDE RULE.

APPLICATION FILED MAR. 14, 1921.

1,405,333. **Patented Jan. 31, 1922.**

Fig. 1. Fig. 2.



Witnesses.
Bernard Bernardini
Melville F. Horine

Inventor
Herman Ritow.

UNITED STATES PATENT OFFICE.

HERMAN RITOW, OF CHICAGO, ILLINOIS.

SLIDE RULE.

1,405,333. Specification of Letters Patent. Patented Jan. 31, 1922.

Application filed March 14, 1921. Serial No. 451,949.

To all whom it may concern:

Be it known that I, HERMAN RITOW, a citizen of the United States, residing in the city of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Slide Rules, of which the following is a specification.

The present invention has relation to an improvement in that class of mathematical sliderules provided with logarithmic scales on both sides of the body and on both sides of the slide of said rules and known in the art as "Duplex" slide-rules.

The object of the present invention is to provide an improvement of the said "Duplex" sliderules whereby the convenience and scope of operation of the rule is increased and the accuracy of the rule greatly improved as hereinafter set forth.

I attain these objects by a novel arrangement of logarithmic scales on both faces of a "Duplex" sliderule as illustrated in the accompanying drawing, in which,—

Fig. 1 is a plan perspective view of one face and one edge of the sliderule, to be hereinafter referred to as the "upper" face and "upper" edge, and

Fig. 2 is a plan perspective view of the other face and of the remaining edge of the sliderule, to be hereinafter referred to as the "lower" face and "lower" edge of the said slidesule.

Similar numerals and letters refer to similar parts throughout the two views. Scales "C," "D," "CI," and "T," as these are identical with logarithmic scales of sliderules now on the market, have been omitted from the drawing. These scales are known by those skilled in the art as "C," "D," "CI" and "T" scales respectively.

The integral parts of the improved sliderule are the sides 1 and 2, constituting the stock or body portion, the slide 3, which can be moved between the sides 1 and 2 and the runner (not shown in the drawing), which fits snugly around the body portion and has two transparent faces with a hairline marked on each transparent face and can be moved freely from one end to the other of the rule.

In Figs. 1 and 2 the slide 3 is shown moved toward the right between the sides 1 and 2 and the position of the slide is the same for both Fig. 1 and Fig. 2. The line F—F in the two figures shows the position of the hairlines of the runner.

The bars 5, 5, 5 and 5 fasten the sides 1 and 2 rigidly and parallel to each other at a distance such that the slide 3 can move freely but not loosely between the sides 1 and 2, and so that the runner (not shown in the drawing) can move freely but not loosely from one end to the other of the improved sliderule.

Upon the upper and lower faces, Figs. 1 and 2, of the sliderule logarithmic scales are marked. The lines, marked G and H in the drawing, are the index lines of the logarithmic scales and are placed at the mathematical beginning and at the mathematical end of each scale. The said scales extend beyond the lines "G" and "H" with the object of increasing the usefulness of the improved sliderule.

The scale "D" on the upper face of the side 2 is the usual logarithmic scale shown on the wellknown Mannheim sliderules and known by those skilled in the art as the "D" scale of the Mannheim rule. With the exception of the marking for the number 25 the scale "D' is not shown in detail on the drawing. The scale "C" on the upper face of the slide 3 indicated but not shown in detail on the drawing is identical with and contiguous to scale "D." Scale "CI" on the upper face of the slide 3, indicated but not shown in detail on the drawing is the reverse of scales "C" and "D" and its markings are the same distance from the right indexline "H" as the corresponding markings of scales "C" and "D" are from the left indexline "G." Scale "CI" is known by those skilled in the art as a "reciprocal" or "inverted" scale.

Scale "A—10" on the upper face of side 1 is the first half of a logarithmic scale of twice the length of scale "D," and scale "A—100" on the upper face of side 2 is the other half of the same logarithmic scale of double the length of scale "D," so that if the left indexline "G" of scale "A—100" is placed over and coinciding with the right indexline "H" of scale "A—10" we would obtain a logarithmic scale of twice the length of scale "D." By this arrangement I provide what may conveniently be termed a "folded" logarithmic scale.

Scale "B—10" on the upper face of side 1 is the first third of a folded logarithmic scale of three times the length of scale "D;" scale "B—100," on the lower face of side 2, is the second third of the said scale of three times the length of scale "D," and scale "B—1000", on the lower face of side 1, is the last third of said scale of thrice the length of scale "D". If scales "B—10", "B—100" and "B—1000" are placed one beside the other so that the "G" line of "B—100" coincides with the "H" line of "B—10" and the "G" line of "B—1000" coincides with the "H" line of "B—100", the three scales will make together one long logarithmic scale of three times the length of scale "D".

Scale "E—10" on the upper face of slide 3 is identical with and contiguous to scale "B—10", and scales "E—100" and "E—1000" on the lower face of slide 3 are identical with and contiguous to "B—100" and "B—1000", respectively. These E scales constitute a third folded scale arranged so that when the "G" and "H" lines of the slide 3 coincide with the "G" and "H" lines of the sides 1 and 2 all the markings on the "E" scales coincide with those on the "B" scales.

In the usual Mannheim and "Duplex" scales the scale of squares is composed of two small logarithmic scales each of half the length of scale "D" and the scale of cubes is made up of three short scales each of one third the length of scale "D." In my improved sliderule, as explained above, I use folded logarithmic scales of twice and three times the length of scale "D" cut into equal parts each of the length of scale "D." Therein lies both the improvement and the novelty of the sliderule as hereinafter set forth and explained.

The hairlines "F—F" on the transparent faces of the runner, (not shown in the drawing), are so marked that when one of the hairlines "F—F" coincides with one of the "G" lines or "H" lines of the sides 1 or 2 the two hairlines coincide with all the other "G" lines or "H" lines, respectively, of sides 1 and 2.

The scale "T" on the lower face (Fig. 2) of the slide 3, which scale is indicated but not shown in detail in the drawing, is for the purpose of trigonometric calculations involving the tangents of angles and is used in conjunction with scales "C" and "D" of the upper face. It is well known by those skilled in the art as the "tangents" scale of the Mannheim rule. The scale "S1" on the lower face of side 2 and the scale "S2" on the lower face of side 1 are for the purpose of trigonometric calculations involving the sines of angles and are used in conjunction with the scales "C" and "D" of the upper face (Fig. 1). The scales "S1" and "S2" placed one beside the other with the "G" line of "S2" coinciding with the "H" line of "S1" make a folded sines scale similar to the well known "sines" scales of the sliderules now in use but of twice the length of scale "D." In the usual sliderules the "sines" scale is used in conjunction with the scale of squares whereas in my improved sliderule the sines scales "S1" and "S2" are used in conjunction with the "C" and "D" scales. With the improved sliderule, therefore, trigonometric calculations involving the sines and tangents of angles can be done with the same logarithmic scales as are used for most of the multiplications and divisions, hence with much greater convenience and twice the accuracy obtained with the sliderules now on the market. As the squares and cubes of numbers in my improved sliderule are all found on the same "C" and "D" scales all the usual computations can be done with the least loss of time on the one group of logarithmic scales "C," "D" and "CI," a much more convenient arrangement than that found on the sliderules on the market.

The scale "L" on the upper edge of side 1 is similar to the wellknown scale of logarithms on the sliderules now in use and is obtained by uniformly subdividing a distance of three times the length of scale "D" into tenths, hundredths and smaller subdivisions and using the first third part of said uniform scale. It is placed along the upper edge of side 1 so that its indexline "O" is exactly at the edge of the runner when the hairline of the runner covers the "G" lines of sides 1 and 2. It is used in conjunction with the scales "B—10," "B—100" and "B—1000" to determine the logarithms of the numbers on the "B" scales. The lefthand edge of the runner (not shown in the drawing) marks on the "L" scale the logarithm of the number under the F—F line on the "B—10" scale. For the logarithm of any number on the "B—100" or "B—1000" scales move the runner till the hairline (F—F) covers the number and add to the reading of the "L" scale 0.33333 for "B—100" numbers or 0.66667 for "B—1000" numbers. The logarithms so obtained are three times as accurate as those obtained with Mannheim sliderules on the market, of the same length as the improved sliderule.

On the remaining lower edge of side 2 an ordinary inch or centimeter scale can be printed or a table of engineering data made.

Multiplication and division can be done with the "C", "D" and "CI" scales in exactly the same way as with the scales on slide-rules now on the market. The use of the tangent or "T" scale in conjunction with the "C", "D" and "CI" scales is also the same as with the usual sliderules. But in calculations in which a power is raised or a root extracted, in computations requiring great accuracy or involving the sines of angles or the tangents of angles of 5° or less, the computations may be made with the sliderule I have invented not only far more conveniently but twice and even three times as accurately as corresponding computations may be made with the Mannheim sliderules now on the market, as will now be set forth and explained in detail.

For any position of the runner the reading under the hair-line F—F on the scale "D" is the cube of each of the three readings under the hairline F—F on the scales "B—10", "B—100" and "B—1000", and the square of each of the readings under the hairline F—F on the scales "A—10" and "A—100". This is readily seen if one imagines the three "B" scales placed one beside the other as previously explained to make one long logarithmic scale of three times the length of scale "D" and then the scale "D" placed under the three parts, and repeated three times with the "G" and "H" lines corresponding as before. This would obtain the same relation between the three scales "D" and the long combined "B" scale as between the cube scale and the "D" scale of the sliderules now on the market. A similar combining of the two "A" scales into one long scale opposite two "D" scales will show the same relation as between the "D" and "A" scales of the Mannheim rule.

Hence to obtain the root of a number set the runner so that the hair line F—F is over the number on the scale "D" and read off the cube roots and the square roots on the "B" and "A" scales, respectively, all under the hairline F—F. Use the "B—10" scale for cuberoots of numbers between 1 and 10, multiplied or divided by any power of 1000. Use "B—100" scale for the cube root of any number between 10. and 100., multiplied or divided by any power of 1000. Use the "B—1000" scale for the cube root of any number between 100 and 1000, multiplied or divided by any power of a 1000. Use the "A—10" scale for the square root of any number between 1 and 10, multiplied or divided by any power of 100. Use the "A—100" scale for the square root of any number between 10 and 100, multiplied or divided by any power of 100. The cube root or square root depends, therefore as usual, on the position of the decimal point in the power, but, though there are three possible cube roots and two possible square roots of every figure, all five of these roots can be obtained with one setting of the runner. In the sliderules on the market three settings of the runner are necessary for the three possible cube roots of a figure and two settings for the two square roots. As the cube root is obtained on my improved sliderule on a scale whose three parts combined are three times as long as the scale "D" the accuracy of the cube root so obtained is three times that obtained on the "D" scale of the sliderules now on the market of the same length as the improved sliderule. For a similar reason the accuracy of the square-roots obtained on my improved sliderule is twice as great as that obtained on the sliderules of the same length now on the market, with the exception of the Fabre or Nestler sliderules made in Europe and using the "A—10" and "A—100" scales.

To obtain the cube of a number set the runner with the hairline F—F over the number on one of the "B" scales and read the answer under the hairline F—F on the "D" scale.

As the "D" scale is three times as long as the cube scale of the sliderules on the market, my improved sliderule gives the cubes three times as accurately as the sliderules of the same length now sold.

To obtain the square of a number set the runner with the hairline F—F over the number on the "A—10" or "A—100" scale and read the answer under the hairline on the "D" scale. The same accuracy is obtained with the Nestler sliderules made in Europe, but my improved sliderule gives the squares on the very convenient "D" scale whereas the Nestler rules give the squares along the edges away from the slide, and has no C scale, and the Mannheim rules give the squares along the "Scale of Squares" which are half as accurate as the "D" scale.

Since the numbers on the "D" scale represent the squares of those on the "A" scales and the cubes of the numbers on the "B" scales, it follows that the "B" scale numbers are the two-thirds (2/3) powers of the "A" scale numbers and the latter are the three-halves (3/2) powers of the numbers on the "B" scales. One setting of the runner gives at once the three possible two-thirds powers and the two possible three-halves powers that correspond, the location of the decimal in the original figure determining the choice of the correct root.

In the drawing the hairline F—F covers the numbers given below on the scales indicated and these illustrate the manner in which the improved sliderule gives the roots and powers.

Scale "D"	$\sqrt{2.5}$	= 1.581	on scale	"A—10".
" "D"	$\sqrt{25.}$	= 5.000	" "	"A—100".
" "D"	$\sqrt[3]{2.5}$	= 1.357	" "	"B—10".
" "D"	$\sqrt[3]{25.}$	= 2.924	" "	"B—100".
" "D"	$\sqrt[3]{250.}$	= 6.300	" "	"B—1000".
Scale "A—10"	$(1.581)^{2/3}$	= 1.357	" "	"B—10".
" "A—10"	$(15.81)^{2/3}$	= 6.3000	" "	"B—1000".
" "A—10"	$(158.1)^{2/3}$	= 29.24	" "	"B—100".
" "A—100"	$(5.000)^{2/3}$	= 2.924	" "	"B—100".
" "A—100"	$(50.00)^{2/3}$	= 13.57	" "	"B—10".
" "A—100"	$(500.0)^{2/3}$	= 63.00	" "	"B—1000".
" "B—10"	$(1.357)^{3/2}$	= 1.581	" "	"A—10".
" "B—10"	$(13.57)^{3/2}$	= 50.00	" "	"A—100".
" "B—100"	$(2.924)^{3/2}$	= 5.000	" "	"A—100".
" "B—100"	$(29.24)^{3/2}$	= 158.1	" "	"A—10".
" "B—1000"	$(6.300)^{3/2}$	= 15.81	" "	"A—10".
" "B—1000"	$(63.00)^{3/2}$	= 500.0	" "	"A—100".

A very important novelty of the improved sliderule is the arrangement of the "B" scales and their counterparts the "E" scales. For with these scales multiplications and divisions can be carried out with the accuracy corresponding to a sliderule of three times the length of the sliderule. Multiplying and dividing with the "B" and "E" scales is identical with the same operation carried on with the "C" and "D" scales except that any one of the three "B" scales is used with any one of the three "E" scales without regard to the contiguity of the scales to each other. Thus with the help of the two hairlines on the transparent faces of the runner any number on the "B—10" scale can be divided by any number on the "E—100" scale although the latter scale is not even on the same side of the rule as the "B—10" scale. The hairline of the runner is set over the number on the "B—10" scale and the slide is moved till the divisor on the "E—100" scale is under the hairline F—F of the lower face of the runner. The answer must be picked out of three figures on the "B" scales found opposite the index-lines "G" or "H" of the slide. This choice is made either by a preliminary operation of the "C" and "D" scales or by a mental calculation.

Thus the division 13.57 / 2.658=5.106 is done on the improved sliderule by moving the runner until the hairline F—F covers the number 13.57 on the "B——10" scale, turning the rule over to the lower face (Fig. 2.) and moving the slide 3 until the number 2.658 on the "E—100" scale is directly under the hairline F—F. The answer is read on the "B—1000" scale opposite the indexline "G" of the slide after the choice among the the three numbers on the "B" scales opposite the "G" lines of the slide has been decided by the mental computation that the answer must be somewhere between 5 and 6. Figures 1 and 2 of the drawing show the setting of the slide and of the hairlines F—F for the above division and for the following computations:—

$$2.370 \times 1.234 = 2.924.$$
$$63.00 / 5.727 = 11.00.$$

The combination of double-length and triple-length logarithmic scales with the "D" scale of the Mannheim rule gives my improved sliderule the greatest convenience in working with cubes and cuberoots, squares and squareroots, three-halves and two-thirds powers, increasing the accuracy of these operations two-fold and three-fold; makes it possible to do all the usual computations with the convenient "C," "D" and "CI" scales; and makes my improved slide rule a very handy instrument for calculations requiring normal accuracy and at the same time a rule with which computations can be made with the same degree of accuracy as with Mannheim sliderules of three times the length of my improved sliderule. These advantages should serve to recommend it to engineers and calculators.

I do not limit myself to the actual arrangement of scales shown in the drawing so long as the broad description heretofore given is complied with, as my invention includes such modifications as would occur to those skilled in the art. Furthermore, I do not limit myself to the use of folded scales made up of parts aggregating only two or three times the graduated length of the rule as they may comprise a sufficient number of parts to make up any desired aggregate length.

I claim as new and desire to secure as Letters Patent:—

1. A slide rule comprising a stock having guides and a slide, Mannheim D and C scales of the graduated length of the rule carried by the stock and slide respectively, and folded logarithmic scales carried by the stock and slide respectively, each of said folded scales consisting of a plurality of consecutively subdivided parts each of the graduated length of the rule and having index lines at their mathematical beginning and end coincident with the index lines of said D and C scales respectively.

2. A slide rule comprising a stock having guides and a slide adapted to be moved longitudinally between said guides, a Mannheim D scale on one face of the stock, a Mannheim C scale on the slide adjacent to the D scale, and folded logarithmic scales carried by the stock and slide respectively, each of said folded scales being composed of two parallel parts of equal length ruled consecutively to indicate the square roots of correlative numbers of the D scale, each of said parts having index lines coincident with the index lines of the D scale.

3. A slide rule comprising a stock having guides and a slide adapted to be moved longitudinally between said guides, a Mannheim D scale on one face of the stock, a Mannheim C scale on the slide adjacent to the D scale, and folded logarithmic scales carried by the stock and slide, each of said folded scales being composed of three parallel parts of equal length ruled consecutively to indicate the cube roots of correlative numbers of the D scale, each of said parts having index lines coincident with the index lines of the D scale.

4. A slide rule comprising a stock having guides and a slide adapted to be moved longitudinally between said guides, a Mannheim D scale on the upper face of the stock adjacent to the lower margin of the slide, a Mannheim C scale on the upper face of the slide adjacent to the D scale, a folded logarithmic scale carried by the stock parallel with the slide, the latter scale being composed of three parallel parts of equal length ruled consecutively to indicate the cube roots of correlative number of the D scale, one of said parts being arranged on the upper surface of the stock adjacent to the upper margin of the slide, and others of said parts

being arranged on the under surface of the stock adjacent to the upper and lower margins of the slide respectively, and a scale on the upper and under surface of the slide, the latter scale being composed of three parts placed adjacent respectively to the upper and lower margins of the slide, and identical respectively with adjacent parts of the folded logarithmic scale on the upper and under surface of the stock, each of said parts having index lines coincident with the index lines of the D scale.

5. A slide rule comprising a stock having guides and a slide adapted to be moved longitudinally between said guides, a Mannheim D scale on one face of the stock adjacent to the lower margin of the slide, a Mannheim C scale on the corresponding face of the slide adjacent to the D scale, folded logarithmic scales carried by the stock and slide, each of said folded scales being composed of two parallel parts of equal length ruled consecutively to indicate the square roots of correlative numbers of the D scale, and a sine scale carried by the stock, said sine scale being composed of a plurality of consecutively subdivided parts each having index lines coincident respectively with the index lines of the D scale.

In witness whereof I sign my name in the presence of two witnesses.

HERMAN RITOW.

Witnesses:
BERNARDINI BERNARD,
MELVILLE F. HORINE.