THE SLIDE RULE SIMPLIFIED

BY

GEO. WASHINGTON RICHARDSON

Ex-Chief Electrician, U. S. Navy

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Revised and Enlarged

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GEORGE WASHINGTON RICHARDSON
Ex-Chief Electrician U. S. Navy
Machinery Hall, Washington Blvd. and Clinton St., CHICAGO, U. S. A.

PREFACE

Methods of solving mathematical problems by the use of logarithmic scales have been in use ever since shortly after the invention of logarithms, about 300 years ago. Originally, calculations were performed with the aid of a scale (or scales) and a pair of dividers, a notable example being the mathematical instrument known as the sector. Instruments manufactured at the present time, however, consist of a fixed part or body containing several scales, called the rule, and a sliding or rotating part, also containing several scales, called the slide, the entire instrument being called a slide rule.

Except when extreme accuracy is required, the slide rule can be used for all purposes of draftsmen, electricians, designers, and engineers, and it is also a useful instrument for merchants and business men. By its use, the most difficult and complicated formulas can be solved with ease and with a rapidity that cannot even be approached by any other method of calculation. It is invaluable for checking purposes; and when the very few principles governing its operation (and which are easily and quickly learned) have been mastered, it is practically impossible to make a mistake.

Many persons have been deterred from learning to use a slide rule owing to the erroneous idea that it is difficult to understand and that a knowledge of logarithms is a preliminary necessity. As a matter of fact, its operation is very quickly acquired and no knowledge whatever of logarithms is needed, except that a very slight understanding of the principles of logarithms may be necessary in order to get the full benefits of the special instrument known as the Logometric Slide Rule. In the case of all the other rules and interchangeable slides here described, no knowledge of logarithms is required.

The instructions in this book are clear and explicit, and they are so worded that they can be readily understood by anyone having a fair knowledge of arithmetic. The many illustrations show the beginner how to set the slide for practically every calculation he is likely to make, and the text matter explains in detail the reasons for every setting. The latter part of the book, which describes the use of the special rules and interchangeable slides, was written by Mr. J. J. Clark, M.E., who is the author of many books and pamphlets on engineering and mathematical subjects, and who has also written a book entitled "The Slide Rule," which has been very successful. Special attention is called to the diagrams illustrating the settings; these show at a glance the various settings and the order in which they are to be performed. Nothing similar to these has heretofore been printed.

GEO. W. RICHARDSON.

The Slide Rule Simplified

NOTE.—Pages 3 to 63, inclusive, relate to our engineer's Slide Rule No. 812 non add or subtracting.

All slide rule divisions are to be read decimally, for all spaces are, or should be, divided and subdivided into tenths, the visible marks being fifths, or halves, or even multiples of tenths.

Where spaces do not admit of subdivision, the fractions must be estimated, and after a little practice the eye grows so accustomed to the scale that tenths of a division may be read with sufficient accuracy for all practical purposes.

The divisions on the rule are marked simply with the numbers 1, 2, 3, and etc., **but these numbers are arbitrary** and any value required by the problem in hand may be assigned to them thus, the 3 may be called 3, or 30, or even 300, provided it is borne in mind that the figures on the whole line are affected in the same ratio during the calculation.

The slide rule consists of four scales marked A, B, C, and D, the A and B scales being generally spoken of as the upper set, and the C and D as the lower set. The A and B scales are exactly alike, and the C and D scales are also alike, except that they are divided off twice the length of the former.

The slide has the B and C scales mounted thereon and is free to slide adjacent to the A and D scales.

The **frameless** runner consists of a piece of transparent material, formed to fit the stock of the rule, with a hair line engraved parallel with the lines of the scales, and used for making extensions, and transferring readings from one scale to another. Different users of slide rules require different degrees of tension on their runner. Our frameless runner can be adjusted for any desired tension by the application of a little heat, such as from an electric bulb.

Reference will frequently be made to the **left** or **right** index 1, and it must be borne in mind that the latter, whether on the A, B, C, or D scale, is an arbitrary figure; for example, if a value of 1 is assigned to the left index of the A or B scales, the middle 1 will denote 10, and the right-hand index will be 100, while, on the other hand, if a value of 10 is assigned to the **left-hand** figure 1 on the A and B scales, the center (or middle index 1) will be 100, and the extreme **right** index will denote 1,000.

Likewise, we may call the left index 1 of the A scale 1, while we call the left index 1 of the B scale 10, or "vice versa," but it must be remembered that the figures on that whole line are affected in the same ratio during the calculation in hand.

GRADUATIONS

All numbers and divisions on the rule are to be read in decimals, for all the spaces are, or should be, divided and subdivided into tenths, the visible marks may describe fifths, or halves, which are even multiples of tenths, where the spaces do not admit of subdivision, the proportions ¼, ½ and ¾ must be estimated, and when the eye grows accustomed to the scale, tenths of a division may be judged with sufficient accuracy for all practical purposes.

The divisions on the rule are marked simply with the numbers 1, 2, 3, etc., but these numbers are **arbitrary,** and any required value by the problem in hand may be assigned.

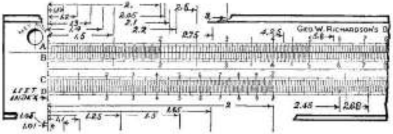

FIG. 1.

The illustration Fig. 1 has been drawn and dimensioned to aid the uninitiated in reading the divisions more readily. The **left** index is shown to be the extreme left of either the A, B, C, or D scales, and in this case it is set for value of 1. But as this 1 is an arbitrary figure, it may, where needed, be called .001, .01, or .1, or any tenth multiple of 1, such as 10, 100, 1,000, 10,000, etc., depending upon the requirements of the problem in hand.

With the value 1 given to the **left** index on the A and B scales the next longest division towards the right is marked 1.5, the longest next following 2, etc. As the distance between the figure 1 and 2 is divided in 10 parts, each one of these divisions are tenths, and are marked in the above illustration as such, thus: 1.1, 1.2, 1.3, 1.4, etc.

These tenths are further subdivided into five parts, which are therefore read as 1.02, 1.04, 1.06, 1.08, that is, of course, when a value of 1 is given the **left**-hand index. Had a value of 10 been given this index, the point 1.5 would be read 15; the 2, as 20, and so forth, while similarly all divisions should be read off at a value increased in the same ratio; the decimal point must in this case be shifted one place to the right, while, on the other hand, if the left index had been given a value of 100, the 1.5 would be read 150; the 2, 200, etc., or the decimal point moved two places to the right. **Always remember that the figures are arbitrary,** and that when a value is once assigned, all the figures on that line are affected in the same ratio during the calculation.

When the left index value is 1, the right index is 100, and the middle index of the rule is 10. But if the left index is assigned a value of 10, then the right-hand one is 1,000, and the middle is 100.

This applies only to the A and B scales. As the C and D, or lower, scales, have no middle index, the right of the latter is read as 100, when the left has a value of 10, and correspondingly for other values adopted for the convenient solution of any particular problem.

MULTIPLICATION

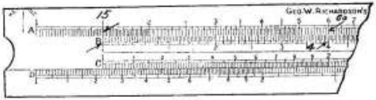

FIG. 2

Multiply 15 by 4 ($15 \times 4 = 60$). Set the **left** index of the B scale at 15 on the A scale, as illustrated in Fig. 2, and note over 4 on the B scale 60 on the A scale as the answer.

In this example the A scale has a value of 10, while B scale is only given a value of 1. The lower set of scales C and D could also have been employed in the example, and the answer read on same by simply placing the **left** index of C at 15 on D, then opposite 4 on C read the answer 60 on D. As the lower set of scales, C and D, have been laid out to a larger scale, they are to be recommended, as more accurate results can be obtained than on the upper set, A and B.

It may be well to mention here that in the example if the value of 1 instead of 10 was assigned to the A scale, the answer would be $1.5 \times 4 = 6$. On the other hand, if the value of 10 was assigned to both the A and B scales, or their left indexes, the problem would be $15 \times 40 = 600$. Hence the importance of assigning a value to the indexes of sufficient magnitude to cover the problem under consideration.

To multiply 18 by 2—set the left index B or C to 18 on A or D and at 2 on B or C read the answer 36 on A or D. The illustration Fig. 3 shows the solution of this problem on the A and B scales only. Thus, left index B set at 18 A, over 2 on B read 36 on A. Also with the slide in this position 18 may be multiplied by any other number if so desired, such as $18 \times 3 = 54$, $18 \times 4 = 72$, and $5 \times 18 = 90$, etc.

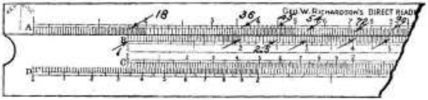

FIG. 2.

CONTINUOUS MULTIPLICATION

Suppose the problem is $18 \times 2 \times 2.5 = 90$. Multiply $18 \times 2 = 36$ as explained in the last example, but leave the hair line of the runner at 36 on A, then pull out the slide to the **right** until the **left** index of B comes under the hair line. This makes the setting to multiply 36 by any given number, and as 2.5 is the one required in this case, simply move the hair line of the runner to 2.5 B and read the answer 90 on A, as shown in Fig. 4.

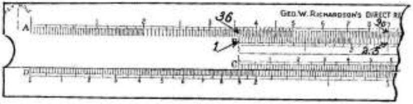

FIG. 4.

If it is desired to multiply $36 \times 63 = 2{,}268$, note that the slide rule will give the answer to only the third figure, and as the fourth is required it may be ascertained mentally thus: as in the above example the rule gives the answer only to the third figure, viz: 226, in order to ascertain the fourth figure simply multiply mentally the units of the two figures, that is $3 \times 6 = 18$, and the required fourth figure in the answer is found to be 8, so that the correct answer is 2,268.

It is very important to know how to proceed when, by reason of the continuous multiplications, it would be necessary to pull the slide from the stock of the rule, or move the runner off the end of the stock to reach the figures required. This difficulty may be overcome as shown in Fig. 5.

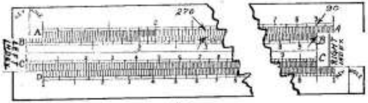

FIG. 5.

In Fig. 4 it was shown how to multiply 2.5×36. Now it is evident that if another extension had to be made, the above obstacles would present themselves. Therefore suppose another extension was to be made, or, in other words, that the last product 90 should be multiplied by 3, set the **right** index of B against 90 on A as shown in Fig. 5, then starting over again (apparently) on the **left** index B, setting the hair line of the runner to 3 on B, and read the answer 270 on A scale.

In this kind of a problem it was shown that the **right** index A (before the slide was shifted to left) equals 100. But as it becomes necessary to frequently change from **right** to **left** index, it should not be forgotten that the **left** index also becomes 100 instead of 1, hence the answer is read as 270 on A.

COMBINED MULTIPLICATION AND DIVISION

Multiply 36×2.5 and divide by 4.5. Proceed to multiply the same as described, setting the left index of B to 36 on A, and place the hair line of the runner to 2.5 on B (without looking at the 90 on A) as shown in Fig. 6. Next as per Fig. 7.

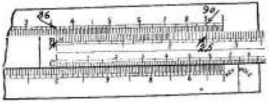

FIG. 6.

Move the slide towards the **left** until 4.5 on B shows under the runner as illustrated in Fig. 7, and read the answer 20 on A over the **left** index of B.

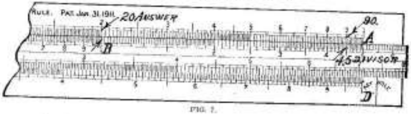

FIG. 7.

It makes no difference if the division is made first or last, and quite frequently it is more convenient to make the division first.

Take the last example given to divide first, place 4.5 on B adjacent to 36 on A and over 2.5 on B read the answer 20 on A.

As stated before, either the upper set of scales A and B or the lower set C and D may be used, and as we have just explained the setting of the former, it may not be out of place to explain the solution on the lower set. Therefore 36 on C against 4.5 on D and read 20 on C against 2.5 on D.

DIVISION

As division is the inverse operation of multiplication, Figs. 6 and 7 will suffice for an explanation.

To divide 90 by 2.5, set 2.5 on B adjacent to 90 on A, as per Fig. 6, and over the left index of B scale read on A scale 36 as the answer.

Likewise in Fig. 7 it is shown that with 90 on A against 4.5 on B, directly over the middle index B, the answer 20 is found on A.

In solving problems where both multiplication and division are required, it is best to multiply a few and then divide them, as by following this routine the slide or runner will not be moved in one direction constantly, and changing ends of the slide is avoided, which in itself is very confusing until one becomes more accustomed to operating the rule.

TO SQUARE A NUMBER

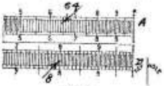

FIG. 8.

Use the A and D scales, and the square of any number on D will be found directly opposite on the scale A. The hair line of the runner is used in reading

from one scale to the other. Thus, set the runner to 8 on D and read on **A** the answer 64, as shown in Fig. 8.

TO FIND THE SQUARE ROOT OF A NUMBER

The finding of the square root of any number, being the inverse operation of squaring a number, the square root of 64 on A is, therefore, with aid of the runner, found to be 8 on D, as shown in Fig. 8.

TO CUBE A NUMBER

The four scales A, B, C, and D must be used. For example, find the cube of 3.

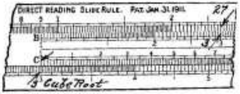

FIG. 9.

With the left index set at 3 on D, read the answer 27 on A adjacent to 3 on B, Fig. 9.

TO FIND THE CUBE ROOT OF A NUMBER

The finding of the cube root of a number is the inverse operation of cubing a number. Example: Find the cube root of 64. This also requires the use of the four scales.

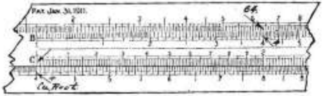

FIG. 10.

Set the hair line of the runner to 64 on A, as in Fig. 10, move the slide back and forth until a setting is found where the unit or figure is the same on the B scale under the hair line as it is on D at the left index C. In Fig. 10, 4 on B is opposite to 64 on A, and 4 on D is also opposite the left index of C therefore 4 is the cube root of 64.

The cube root in the previous problems was found under the **left index**, This does not hold good in all cases. Therefore, if it cannot be found on the left, try the **right** index. How to find the cube root of 729 is shown in Fig. 11.

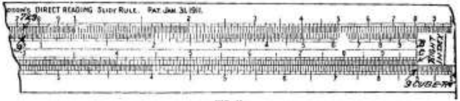

FIG. 11.

When the number opposite to 729 on A is the same as the number opposite to the **right** index C the cube root is found. In this case 9 on D.

TO REDUCE VULGAR FRACTIONS TO A DECIMAL OR "VICE VERSA"

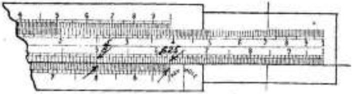

FIG. 12.

Fig. 12 illustrates the simplicity of changing the vulgar fraction $\frac{5}{8}$ to a decimal: Set 5 on C to 8 on D and over the right index of D read the decimal equivalent .625. Likewise the fraction may be found when the decimal is known.

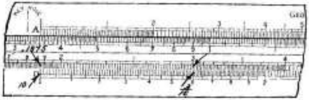

FIG. 13.

Fig. 13 illustrates the manner of ascertaining the decimal equivalent of $\frac{3}{16}$. Set 3 on C opposite to 16 on D and opposite the **left** index of D read the answer decimally, .1875, on C.

TO EXTRACT CUBE ROOT ON RICHARDSON'S 10" SLIDE RULE No. 812

Notation—Call left end-mark on all scales 1; denote any number on left half of scales A and B by giving its figures and the letter of the scale (thus, 27B means 27 on left half of scale B); Similarly, 27D means 27 on scale D; denote the numbers 2.1544 and 4.6416 on scale C by c^1 and c^2, respectively.

Cube Root.—To cube a number, as 2, bring 1C to 2D, and opposite 2B read 8 on A. To find the cube root of a number, as 8, move the slide until the number opposite 8 on B is the same as the number on D opposite 1C; this is evidently 2. Now retaining this setting, bring the runner to c^1, and the number on D under the hair line will be the cube root of 80, since $\sqrt[3]{80}=\sqrt[3]{8\times10}=\sqrt[3]{8}\times\sqrt[3]{10}=\sqrt[3]{8}\times2.1544$. Bringing the runner to c^2, the number on D under the hair line will be the cube root of 800, since $\sqrt[3]{800}=\sqrt[3]{8}\times\sqrt[3]{100}=\sqrt[3]{8}\times4.6416$.

Example.—Find the cube root of 78.5.

Solution.—$78.5=7.85\times10$. Bring runner to 785A; move slide until number on B under hair line equals number on D opposite 1C; this is apparently 199, but the reading on B is 198; hence, the true value is more nearly $\frac{2\times199+198}{3}=$ 1987, and $\sqrt[3]{7.85}=1.987$. Now bring 1C to 1987 D and move runner to c^1; under the hair line on D read 428; hence, $\sqrt[3]{78.5}=4.28$. Bringing the runner to c^2, read on D 923; whence, $\sqrt[3]{785}=9.23$.

Procedure.—Point off the number into periods of three figures each, in the usual way, in order to determine the position of the decimal point in the root. Shift the decimal point until it occupies the same relative position in the left-hand period that contains one or more digits; there will then be 1, 2, or 3 digits to the left of the decimal point; if 1, proceed as for $\sqrt[3]{8}$; if 2, proceed as for $\sqrt[3]{80}$; if 3, proceed as for $\sqrt[3]{800}$. Thus, 0.7854 will be regarded as 785.4; 0.007854, as 7.854; and 78540, as 78.54.

The reason for proceeding as above in obtaining the number 1987 is that two of the factors are 199, the third is 198, and the arithmetical mean is $(199+199+198)\div3=(2\times199+198)\div3=1987$, neglecting decimal points.

QUESTION.

Multiply 27 by 20?

Set runner to 27 on the "D" scale, bring left hand 1 of "C" scale to the hair line and under 2 of "C" scale, read on the "D" scale, 54. As in this case you have used the left hand 1 of the "C" scale, the slide projects to the right, and the number of figures in the product will be ONE LESS than the sum of the figures in the multiplier and multiplicand. The answer is therefor, 540.

QUESTION.

Multiply 3000 by 1800?

You read 54 on the "D" scale; as slide projects to the right, you mark off 8 less 1, or 7 figures, adding cyphers if necessary, and the answer becomes 5,400,000.

QUESTION.

Multiply 4150 by 825?

On the "D" scale read 342, and as the slide projects to the left you place 7 figures in the answer adding 4 cyphers, and the answer becomes 3,420,000 correct to three significant figures.

RULE.

If there is a decimal point in either multiplier or multiplicand, or in both, first treat them as if they were whole numbers, i. e., had no decimal points, and then move the decimal point of the product to the left a number of places equal to the sum of the decimal places in both the multiplier and the multiplicand.

EXAMPLE.

Multiply 41.5 by 8.25?

Slide projects to the left, therefore their product as whole numbers would have 6 figures, and this less the number of decimal places in both numbers, or 3, gives three figures in the product. The answer is therefore, 342.

QUESTION.

Multiply 1.85 by 3.45.

On the "D" scale read 6375, and as the slide projects to the right, there would be five places in the product, if the numbers had no decimal points. As there are 4 decimal places in both of the numbers, the correct number of places in the product will be 5 less 4, or 1 place, and the answer becomes 6.37.

QUESTION.

Multiply 2850 by 925? Answer 2,635,000.
Multiply 28.50 by 925? Answer 26,350.
Multiply 265 by 270? Answer 71,500.

MULTIPLICATION OF A CHAIN OF FIGURES.

RULE.

NOTE HOW MANY TIMES THE SLIDE PROJECTS TO THE LEFT IN GETTING THE PRODUCT, TO THIS NUMBER ADD THE SUM OF ALL THE FIGURES IN ALL THE FACTORS AND THEN SUBTRACT THE NUMBER OF FACTORS **LESS ONE.**

EXAMPLE.

Multiply 275, 85, 125 and 7 together?

Read 223 on the "D" scale, and as the slide projected to the left 2 times in getting the product, the number of figures in the answer will equal the number of figures in all the factors or 9, plus the number of slides to the left or 2, minus the number of factors less one or 3. The answer will therefore contain 9 plus 2 minus 3 places or 8 figures. Your answer is therefore, 22,-300,000.

EXAMPLE.

Multiply 450 by 28 by 42?

You will get 528 on the "D" scale, and as the slide projected once to the left, you will have 1 plus 7 minus 2, or 6 figures in the answer. Your answer will therefore be 528,000.

EXAMPLE.

Multiply 69 by 50 by 91?

Read 313 on the "D" scale, and as the slide projected twice to the left, the number of figures will equal 2 plus 6 minus 2, or 6, and the answer becomes 313,000.

Where any or all of the factors contain decimals, first treat them as if they were integers and then after getting the number of places or figures in the answer, as integers, subtract the sum of the decimal places in all the factors, or after getting the number of places as integers, move the decimal point of the product to the left a number of places equal to sum of decimal places in all the factors.

EXAMPLE.

Multiply 48 by .165 by 7.8?

Read on the "D" scale 617, as slide has projected to the left once, the number of figures in the answer if all the factors had been whole numbers, would have been 1 plus 7 minus 2, or 6, and the answer would have been 617,-000, you then move the decimal point to the left, a number of places equal to the number of decimal places in all the factors, or 4, and you get the answer, 61.7.

EXAMPLE.

Multiply .87 by 42 by .0029?

On the "D" scale read 817, and as the slide projected once to the left, regarding the factors as integers, the answer would have 5 figures in it, or 81,700. The sum of the number of decimal places in the factors is 6, you therefore move the decimal point 6 places to the left, adding one cypher to do this, and your answer becomes .0817.

EXAMPLE.

Multiply .047 by .0068 by .0088 by 2.7?

Read on the "D" scale 76, and regarding the factors as integers, the answer would have 8 plus 2 minus 3, or 7 figures, it would be therefore, 7,600,-000. Making off to the left the sum of the number of decimal places in all the factors, adding the necessary cyphers, you get as the answer, .0000076.

DIVISION.

In division the important thing to remember and note is the number of times the slide projects **to the right**.

RULE FOR DIVIDING ONE NUMBER BY ANOTHER.

WHEN SLIDE PROJECTS TO THE RIGHT NUMBER OF FIGURES IN ANSWER TO LEFT OF DECIMAL POINT WILL EQUAL NUMBER OF FIGURES IN DIVIDEND **PLUS ONE** MINUS THE NUMBER OF FIGURES IN THE DIVIDEND. IF SLIDE PROJECTS TO THE LEFT THE NUMBER OF FIGURES WILL BE EQUAL TO NUMBER OF FIGURES IN THE DIVIDEND LESS NUMBER OF FIGURES IN THE DIVISOR.

QUESTION.

Divide 480 by 24?

Read 2 on the "D" scale; slide projects to the right, so the number of figures will be 3 plus 1 minus 2, or 2, and answer is 20.

QUESTION.

Divide 5680 by 85?

Read 668 on the "D" scale; slide projects to the left and there will be 4 less 2, or 2 figures in the answer which is accordingly 66.8.

WHERE EITHER DIVISOR OR DIVIDEND CONTAIN A DECIMAL POINT.

A decimal point in the divisor makes the answer larger as you are dividing by a smaller number than if the figures of it were an integer. Likewise a decimal point in the dividend makes the answer smaller because you are dividing into a smaller number than if the figures represented an integer.

From this you derive the following rule:

IN THE DIVISION OF ONE NUMBER BY ANOTHER, IF THERE IS A DECIMAL PLACE IN EITHER OR BOTH NUMBERS, OBTAIN AN ANSWER AS THOUGH THEY WERE INTEGERS AND THEN MOVE THE DECIMAL POINT TO THE LEFT, THE NUMBER OF DECIMAL PLACES IN THE DIVIDEND, AND THEN MOVE IT BACK TO THE RIGHT, THE NUMBER OF DECIMAL PLACES IN THE DIVISOR.

EXAMPLE.

Divide 6850 by 26.5?

Read 259 on the "D" scale; slide projects to the right so that regarding both numbers as integers, the answer would contain 4 plus 1 minus 3, or 2 places, and would therefore be 25.9. Pointing off to the right the number of decimal places in the divisor, that is 1 place, your answer becomes 259.

EXAMPLE.

Divide 2.87 by 276?

Read 104 on the "D" scale; slide projects to the right so that regarding both numbers as integers, the answer would contain 3 plus 1 minus 3 or 1 figure to left of decimal point, and would therefore be 1.04. Marking off to the left the two decimal places in the dividend, you get as the final answer, .0104.

EXAMPLE.

Divide 28.75 by 30850?

Read 933 on "D" scale; slide projects to left, therefore number of figures will equal 4 minus 5 minus 2, or — 3; you will therefore add 3 cyphers to the left of first significant figure and answer becomes .000932.

COMBINED MULTIPLICATION AND DIVISION.

Examples of this sort involve a combination of the previous rules for division and multiplication, and can be solved by the following rule:

RULE.

NOTE EVERY TIME IN AN OPERATION OF MULTIPLYING THAT THE SLIDE PROJECTS TO THE LEFT AND ALSO EVERY TIME IN AN OPERATION OF DIVISION THAT THE SLIDE PROJECTS TO THE RIGHT AND KEEP ACCOUNT OF THE NUMBER OF THESE OPERATIONS; THEN TO THIS SUM ADD THE SUM OF ALL THE FIGURES IN ALL FACTORS ABOVE THE LINE AND SUBTRACT THE SUM OF ALL THE FIGURES IN ALL THE FACTORS BELOW THE LINE, AND THEN SUBTRACT THE NUMBER OF FACTORS ABOVE THE LINE **LESS ONE.** IN GETTING THE SUM OF THE FIGURES IN ALL FACTORS ABOVE OR BELOW THE LINE DON'T COUNT CYPHERS BETWEEN FIRST SIGNIFICANT FIGURE AND DECIMAL POINT.

EXAMPLE.

$$\text{Solve } \frac{27 \text{x} 75 \text{x} 150 \text{x} 42}{16 \text{x} 9 \text{x} 115} = 770$$

Read 77 on the "D" scale; in the multiplication the slide has projected to the left twice, and in the division the slide has projected once to the right, you therefore have for the number of slides, 3, and this plus 9, the number of figures in the factors above the line, minus 6, the number of figures in all the factors below the line, minus 3, one less than the number of factors above the line, gives 3. And your answer will therefore be 770.

EXAMPLE.

$$\text{Solve } \frac{22 \text{x} 22 \text{x} 650 \text{x} 75}{33000} = 716$$

Read 716 on the "D" scale, slide has projected twice to the left in the multiplication and no times to the right in division, you will therefore have in the answer 2 plus 9 minus 5 minus 3, or 3 figures, and the answer will be 716.

RULE.

Where any or all the factors, either above or below the line, contain decimal points, proceed as though all the factors were integers, and then point off to the right the sum of the decimal places below the line, and then point back to the left the sum of all the decimal places above the line, adding cyphers if necessary.

EXAMPLE.

$$\text{Solve } \frac{245 \text{x}.68 \text{x}.0075 \text{x} 14}{1.15 \text{x}.09 \text{x}.55} = 309$$

Read 309 on the "D" scale; slide projects twice to the left in multiplication and once to the right in division; you therefore add 3 to the number of figures above the line, or 9, minus 6 (the number of figures below the line) plus 6 (the number of decimal places below the line) minus 6 (the number of decimal places above the line), all minus one less than the number of factors above the line, or 3, which will all give you 3 figures in the answer which will therefore be 309.

This could be expressed in this way:

Add 3, Number of projections of slide.
Add 9, Number of figures in all factors above line.
Add 6, Number of decimal places below the line.
Subtract 6, Number of figures below line.
Subtract 6, Number of decimal places above the line.
Subtract 3, ONE less than number of factors above line.

The sum of the adds is 18 and the sum of the subtracts is 15; the difference between these two sums is 3, and this result is plus as the adds are larger. You will therefore have 3 figures to the left of the decimal point.

If the sum of the subtracts had been larger than the sum of the adds, then you would add cyphers to the left of the first significant figure, in number equal to this difference. If the sums of the adds and subtracts are equal, then the decimal point adjoins the first significant figure.

DECIMAL POINT IN USE OF A. & B. SCALE.

The operation of placing the decimal point in using the "A" and "B" scale is essentially the same as in using "C" and "D" scales but it is rendered somewhat more difficult by the fact that the scales are of half length and it is consequently more difficulty to lay down any rule for counting the slide projections. The following rule covers this point as well as any.

RULE FOR MULTIPLICATION.

IF THE NEAREST LEFT HAND INDEX TO THE MULTIPLIER ON THE "B" SCALE, EXTENDS TO THE LEFT OF THE NEAREST LEFT HAND INDEX TO THE PRODUCT ON THE "A" SCALE COUNT IT, OTHERWISE DO NOT.

RULE FOR DIVISION.

IF THE NEAREST RIGHT INDEX TO THE DIVISOR ON THE "B" SCALE, EXTENDS TO THE RIGHT OF THE NEAREST RIGHT HAND INDEX TO THE QUOTIENT ON THE "A" SCALE, COUNT IT, OTHERWISE DO NOT.

PROPORTION

Either the upper or lower set of scales may be used for proportion, but the lower being drawn to a larger scale they are to be preferred. It will be noted that by moving the **slide** to the **right** until the **left** index of C is opposite to any number, say 2, on D, that any number on D coinciding with a number on C gives a proportion equal to 2 to 1.

To find the unknown quantity, or, in other words, the fourth term, of the proportion 180 : 25 :: 28.8 : X, set the slide as follows:

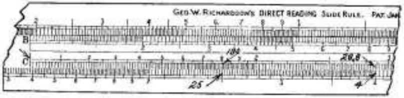

FIG. 14.

The illustration Fig 14 shows 180 on C opposite to 25 on D, and at 28.8 on C is the unknown quantity, or fourth term, 4 on D. This applies to all similar calculations. It is well to remember, however, that the first and third terms are always found on one scale, while the second and fourth terms are found on the other scale adjacent thereto.

MENSURATION OF SUPERFICIES

Tiling—A problem: Find the cubic contents in feet of a piece of tiling 2¼ feet (2.25 ft.) long, 17 inches wide, and 1¾ (1.75) feet thick.

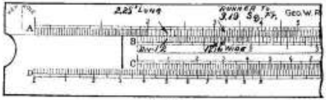

FIG. 15.

First calculate the sq. ft. as shown above by setting 12 on B at 2.25 (feet) on A and by placing the runner to 17 (inches in width) on B, read the sq. ft., 3.19, on A.

Second, the cubic contents may be ascertained by bringing the left index

of the slide under the runner to the 3.19 on A and at 1.75 on B read the cubic contents 5.6 on A. This is illustrated in Fig. 16.

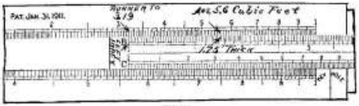

FIG. 16.

Find the area in square feet of a strip of tiling 65 ft. long and 14 in. wide

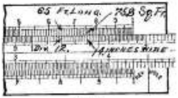

FIG. 17.

Set 12 on B to 65 on A and over 14 (inches) on B read the answer 75.8 sq. ft. on A, as shown in Fig. 17.

Tiling—How many squares contained in a piece of tiling 57 ft. long by 50 ft. wide?

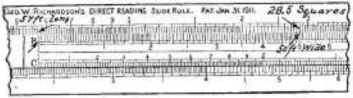

FIG. 18.

Set the left index B at 57 ft. on A and opposite to 50 ft. wide on B read 28.5 squares as the answer on A scale, as shown in Fig. 18.

Brick Work—Find the number of square rods in a brick wall 765 ft. long and 8 ft. high.

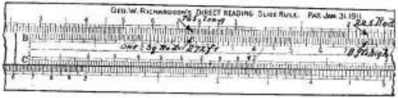

FIG. 19.

Set the number 272 on B adjacent to 765 on A and opposite 8 on B read the answer, 22.5 sq. rods, on A. See Fig. 19.

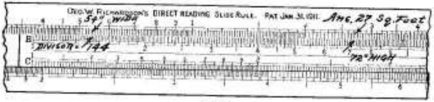

FIG. 20.

Glass, Sheet Material, Etc.—How many sq. ft. of glass in a door 72 in. high and 54 in. wide? In this example the length and width are both in inches, therefore the divisor is 144.

Set 54 on A opposite to 144 on B, and against 72 on B read the answer, 27 sq. ft., on A. (Fig. 20.)

Paviors, Plasterers, Painters, Walls—Measurements by the square yard or 9 sq. ft.

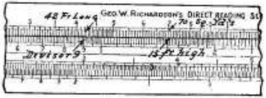

FIG. 21.

How many square yards in a wall 15 ft. high and 42 ft. long? Set 9 on **B** opposite to 42 on A, and over 15 on B read the answer, 70 sq. yd., on A.

Paviors' Sq. Yds.—A piece of paving 18¾ (18.75) ft. long and 15½ **(15.5)** ft. wide contains how many square yards?

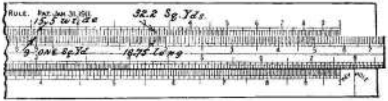

FIG. 22.

Set 15.5 on A adjacent to 9 (1 sq. yd.) on B. Then against 18.75 on B read 32.2 sq. yd. on A.

Lumber, Board Measure, Sq. Ft.—If the width is given in **inches** and the length in **feet**, set 12 on B to the length (in feet) on A and at the width in inches on B read the answer in square feet on A, as shown in Fig. 23.

How many sq. ft. in a board 14 in. wide and 18 ft. long? Place 12 on B against 18 on A, and over 14 on B read 21 sq. ft. on A.

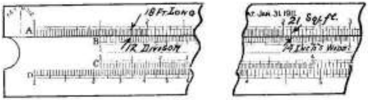

FIG. 23.

To find the square feet of, say, 39 boards of the size in the last example, simply set 1 on B against 21 on A, and opposite to 39 on B read the answer, 820 sq. ft., nearly, on A. This is shown in Fig. 24.

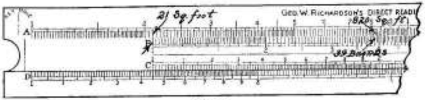

FIG. 24.

Note—This applies only to boards 1 in. To find the board measure for any other thickness, multiply according to the rules given for multiplication.

Board Measure—Wheel Strips, and Small Pieces—Find the number of sq. ft. board measure of 311 pieces of wheel strips 1½ in. × 1⅝ in. × 6½ ft. long. As explained before, the slide rule is scaled decimally, therefore it becomes necessary to change the above vulgar fraction into decimals, which may be done either mentally or upon the slide rule. Instructions for this operation are explained elsewhere under its heading.

Briefly, we may say when the above numbers are thus changed the problem would read 1.5 × 1.625 × 6.5 × 311.

First—Find the sq. ft. in one piece by placing 12 on the C scale opposite to 6.5 on the D scale, as shown in Fig. 25, and at 1.5 on C read .81 sq. ft. on the D scale.

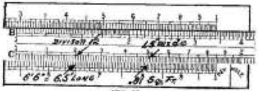

FIG. 25.

Second—To multiply .81 × 311, proceed as in Fig. 26, by setting the **right** index of C to .81 on D, then under 311 on C read the answer, 252 sq. ft., on D. (Fig. 26.)

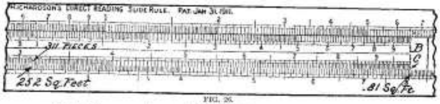

FIG. 26.

Third—The examples are for boards 1 in. thick. For material 1⅝ in. thick, which equals 1.625, leave the runner at 252 on D and bring the **left** index C opposite to it. Then at 1.625 on C read the answer on D as almost 410 sq. ft., the correct answer being 409½ sq. ft. (Fig. 27.)

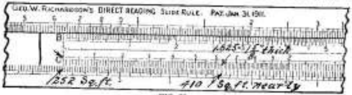

FIG. 27.

Paper Mills, Printers, Box Manufacturers—Find the number of sheets of cardboard to cut a given number of cards. Suppose the sheet measures 20 in. × 30 in. and the cards are to be cut 3 in. × 5 in.

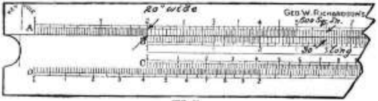

FIG. 28.

Set the slide as shown in Fig. 28, with left index B at 20 on A, then at 30 on B read 600 sq. in. on A.

A card 3 in. × 5 in. contains 3 × 5 = 15 in. Therefore, if the rule is set as shown in Fig. 29 with 15 on B opposite to 600 on A, the answer can be read off at random for the required sheets to cut any given amount of cards. Fifty sheets make 2,000 cards, 90 sheets make 3,600, or for any number of cards wanted, on the A scale, the required number of sheets is opposite thereto on the B scale.

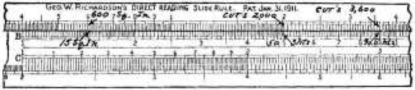

FIG. 29.

Land Measuring—Acreage—In measuring land the divisors are generally 10 sq. chains, 160 sq. perches, or 4,840 sq. yds. per acre.

How many acres in a piece of land 26 chains and 20 links in length, and 3 chains and 50 links in width?

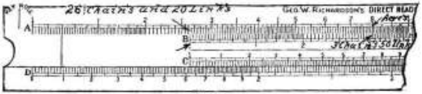

FIG. 30.

Set the rule as shown in Fig. 30 with left index of B at 26.2 and on A read 8 acres opposite to 3 chains and 50 links on B.

How many acres in a strip of land 28 perches wide and 40 perches long? Set 160 on B opposite to 28 on A and at 40 on B read the answer, 7 acres, on A, as shown in Fig. 31.

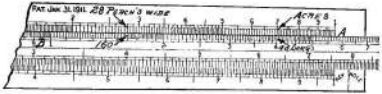

FIG. 31.

How many acres in a piece of land 420 yards long and 75 yards wide?

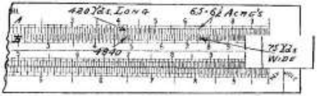

FIG. 32.

Set the rule as shown in Fig. 32 with 420 on A opposite to 4,840 on B, and read the answer, 6.5 = 6½ acres, on A opposite to 75 on B.

MISCELLANEOUS PROBLEMS

Timekeepers and Pay-Roll Accountants—A workman receives $22.50 per week of 50 hours, but he only works 7 hours; how much is due him; also what is the rate per hour?

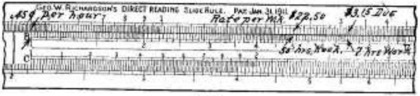

FIG. 33

The illustration here shown, Fig. 33, exemplifies the value of the slide rule, because, when the rate per week is set on the A scale opposite to the number of hours which constitute a week's work on the B scale, the amount due for any other number of hours worked set on the B scale will be found opposite thereto on the A scale, and in addition to this, the rate per hour is shown at either the left or right index on the A scale.

In the above example set $22.50 on the A scale oposite 50 (hours) on the B scale, and over 7 (hours worked) on the B scale read the amount due opposite thereto on the A scale, or $3.15.

If the rate per hour is required, it can be found on the A scale opposite to the **left** index B. Yet under certain conditions the rate per hour will be shown opposite to the **right** index B, depending upon the magnitude of the problem. Fig. 33 shows it at the **left**.

Bankers, Brokers—A customer receives an annual interest of $770 on a loan for $22,000; what is the rate of interest?

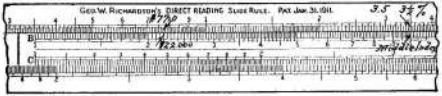

FIG. 34.

Place 22 on the B scale (which is the same as 22,000) at 77 on the A scale (which is the same thing as 770), and opposite the middle index 1 on B is shown 3.5 = 3½% on the A scale. Other problems are worked in a similar manner.

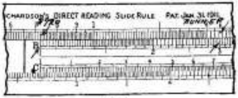

FIG. 35.

Example—Find the interest due on $600 at 6% for 2 years and 5 months.

Solution—2 years and 5 months equals 29 months. First, set left index of B scale to 6 on the A scale, and move the hair line of runner to 6 (6%) on the B scale. Second, move slide until 12 comes under the runer, moving the hair line again to 29 on the B scale, and under the hair line on the A scale read 87 or $87.

Example—A merchant purchases a bill of goods for $18.00 and sells same for $27.00. Find what percentage of profit he makes on the sale.

Solution—The difference equals 27 less 18 is 9, therefore set 9 of the C scale adjacent to 18 on the D scale, and against the (left) index D read 5 (which represents 50%) net profit.

Example—The list price of an article is $27.00. It is sold to dealers at $18.00. What discount in percentage does he receive?

This is liking to the last problem, except you set 27 (instead of 9) on C adjacent to 18 on D scale, and opposite the **right** index C read 66 2-3%, and this deducted from 100% leaves 100 — 66 2-3 — 33 1-3%.

You could however get the same answer without subtracting by counting 33 1-3 **backwards** from the **right D** scale index to the **right C** scale index, or in other words the spaces or remainder left between these two points.

How much interest will be due on $720 at 3% for 5 months?

Set the left index of B to 72 on A, also on the left half of A scale as shown in Fig. 35. Place runner 3 on B and leave it at this position. Move the slide B to the **left** until 12 comes under the hair line of the runner as shown in Fig. 36, and opposite to 5 on B read the answer, $9.00 interest, on the A scale.

To find the rate per day, use 365 days for divisor, instead of 12 months.

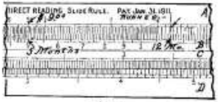

FIG. 36.

Merchants—If 850 articles cost $6.30, what will 270 articles cost? Or, if 850 pounds cost $6.30, what will 270 pounds cost?

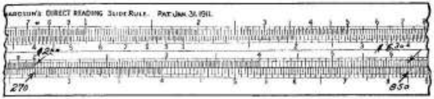

FIG. 37.

Set 850 on D opposite to 6.30 on C, as shown in Fig. 37, and at 270 on D read the answer, $2.00, on A.

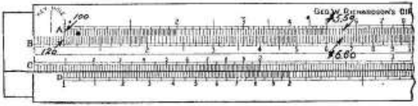

FIG. 38.

A bill of goods was bought for $5.50; what price must they be sold at to make a profit of 20%? The cost price is in proportion to the sale price, as 100 : 120. Therefore, place 120 on B under left index of A scale and at 5.5 ($5.50), also on the A scale read the answer $6.60 on the B scale. (See Fig. 38.) This applies to all similar problems.

A bill of goods was sold amounting to $745. It cost $26.60 to sell them; what is the cost of selling in per cent?

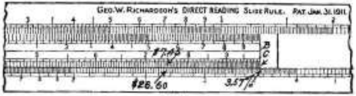

FIG. 39.

Set 745 on C opposite to 26.60 on D, and read 3.57% on D scale opposite to the **right** hand end, or **right** index, of the C scale. (Fig. 39.)

Trade Discounts—A bill of goods cost $6.35 with 37½% discount; what is the net cost? (A slight mental calculation is required in this problem, thus: 100 — 37.5 = 62.5.)

Setting rule as shown in Fig. 40 with **right** index of the C scale against 62.5 on D, the net amount, $3.96, on D can be read at $6.35 on the C scale.

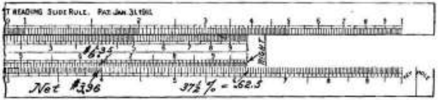

FIG. 40.

Note—If more than one discount is required, say, for instance, 5% off from $3.96, simply repeat the operation by setting the hair line of the runner to 396 on D, bringing the **right** index C to the hair line (and recall that 100 — 5 = 95), and move runner again to 95 on C, and read the net, $3.76, on D

FIG. 41.

as illustrated in Fig. 41. Additional discounts may be calculated in a similar manner.

ELECTRICAL

THE SLIDE RULE A COMPLETE WIRE TABLE.

Knowing any **one** of the following values, five others may be read off, viz: diameter in mils, area in circular mils, square mil area, pounds per 1,000 ft.; resistance in ohms per 1,000 ft., size wire B. and S. gauge.

An annealed copper wire, at 20° C. or 68° F., and 80.8 mils in diameter required the other equivalents as above.

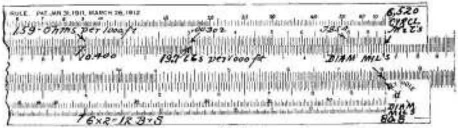

FIG. 42

Proceed to set 80.8 on the C scale directly over the right index of the D scale as shown in Fig. 42.

Note—Then directly under and in line with the **right** index of the A scale read on the B scale 6,520 circular mils area.

To find the square inch or square mil area, leave the slide as per first setting (Fig. 42) and place the hair line of the runner to the special graduation mark .7854 (if such a graduation mark is on the rule) on the A scale, and read opposite same 51, which means .0051 sq. in. area, on the B scale.

To find the weight per 1,000 ft., set the runner on the A scale to 302 (.00302) and adjacent to same read on the B scale 19.7 pounds per 1,000 ft., as shown in Fig. 42.

To find the resistance in ohms per 1,000 ft., place the hair line of the runner to 104 (10,400) on the B scale, as shown in Fig. 42, and read the answer, 1.59 ohms res., under the runner of the A scale.

To find size wire B. and S. gauge set runner as per resistance in ohms 1.59 per (1000 ft.) on A scale and under hair line on lower log scale read 6 (double this) equals No. 12 B. and S. gauge.