tical. The dotted line marks the position of the runner for the square root of 20. This is diametrically opposite the position for the square root of 2.

For cube root, place the runner to the number on scale D, then move D with the runner until the same number is intercepted on scale E. The root required is on D under the right index, under the middle index or under the left index, according as the number lies between 1 and 10, 10 or 100 or 100 and 1000. The setting for the cube roots of 8, 80 and 800 is shown in fig. 6.

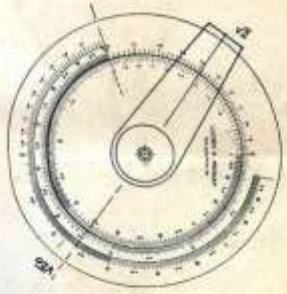

Fig. 5

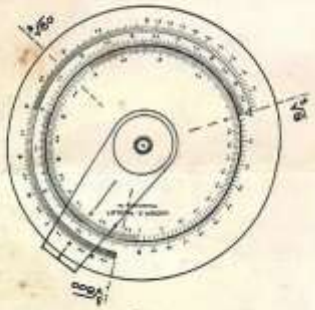

Fig. 6

To find under what index to read the root of a decimel, point off to the right in groups of three, the zeros from the decimal point until the first significant figure is passed. The figures to that point determine whether the root shall be read under the units, tens or hundreds index. Thus; the cube root of 0.000,000,000,080 is found under one of these points. Pointing off the zeros by threes, the first significant figure is passed at 80. Hence, the root will be found under the tens index corresponding to the root of 80.

The cube root of 80 is 4.31. To find the decimal point, prefix as many zeros to the root indicated by the reading as there are groups of three zeros in the number given. There are three such groups. Accordingly, the root is 0.000431.

Again, the root of 0.000,000,800 is found under the hundreds index corresponding to 800 and is 0.00929.

This rule for finding the decimal point applies equally to square roots, the zeros being pointed off in groups of two.

THE COMBINED RULE.

The direct and inverted rules secured back to back with their inner discs arranged to move in unison, constitutes a widely used type of rule with which three factors may be multiplied together at one setting. For example, to multiply 4 6 3, set the inverted scale as in fig. 1. The product of these two appears under the index of the direct rule and under 3 of the A scale the continued product 72 is given without further setting. For further multiplication the operations are as previously described.

The slide rule depicted herewith is designed to meet the need of an inexpensive and unusually portable instrument for performing the operations of multiplication, division and the extraction of square and cube roots with an accuracy comparable with that obtainable from a six-inch rule of the usual type.

The rule consists essentially of two discs of different diameters arranged to rotate relatively to each other about a common centre. Along the edge of the smaller disc are graduations numbered from 1 to 10. Adjacent to these on the larger disc are like graduations and numbering. To facilitate manipulation, on the reverse side of the rule there is a blank disc similar to the smaller graduated disc and securely attached to it.

A transparent radial arm with a hairline is provided, capable of rotating independently of either disc, by which any required point on the scale of the smaller disc may be marked.

In the direct rule the graduation on both discs are identical. In the inverted rule, the scale on the smaller disc is graduated to read in an opposite direction to the adjacent similar scale on the larger disc. In hereafter referring to these scales, they will be designated as follows:

Direct rule:—Inner scale, B.
Outer scale, A.
Inverted rule.—Inner scale, D.
Adjacent scale, C
Outer scale, E.

It will be noticed that the extreme points of the scales, with the exception of E, coincide. Herein lies a material advantage in point of rapidity over the straight form of slide rule. Frequently a reading with the latter can only be obtained by transferring the slide end for end. With the circular rule this time consuming operation is never necessary.

The rule is held at the centre by the thumb and middle finger, the forefinger resting on the end of the runner. To move the runner only, grasp the two smaller discs. To move the larger disc, the smaller discs and runner remining stationary, grasp the larger disc. The setting of the runner on the smaller disc is maintained by the friction between them.

OPERATION OF THE SIMPLE RULE.

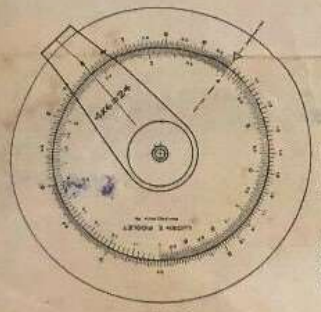

Fig. 1

To find the product of two numbers, as 4 and 6, set the index of scale A over 4 of scale B and under 6 of scale A read 24 on scale B. The position of the scales is shown in Fig. 1.

By reference to the figure it is seen that this setting for the product 24 is also the setting for all other factors of 24, as 3 and 8, 2 and 12, etc.

If a further multiplication is required, grasp the two discs and bring the runner to 24 on B. Then bring index of A to the runner and under 3 on A read 72 on B.

Division is obviously the reversal of the above process. Thus, to divide 72 by 3, set 3 over 72 on B and under the index of A read 24 on B. The position of the scales is, of course, the same as for the multiplication of 24 by 3.

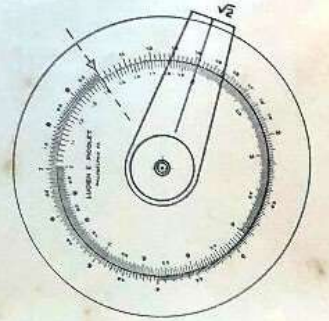

Fig. 2

To find the square root of a number, set the runner to the number on B, then move the outer disc until the reading on B under the index is the same as the reading on A over the runner; Fig. 2 illustrates the position of the discs and runner for finding the square root of two.

The slide rule does not discriminate between the multiples of ten of a given number and there are two, but only two positions in which the number over two on A and under the index on B are equal. Fig. 3 shows the setting for finding the square root of 20. Which setting to employ is generally easy to determine by inspection.

OPERATION OF THE INVERTED RULE.

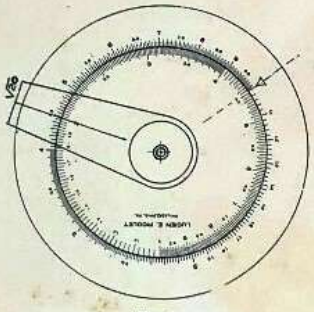

Fig. 3

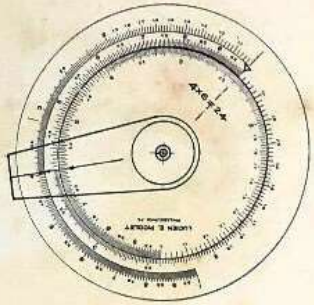

Fig. 4

The inverted arrangement is of no particular advantage for multiplication and division, but while as easily used for this purpose as the direct scale, the operation of extracting the square root is greatly facilitated.

The E scale for cube roots is precisely similar in character to the D scale. Its length is two-thirds that of the latter. By its use in conjunction with the D scale, cube roots are found with as little effort as a simple product.

To find the product of the two factors 4 and 6, set the runner over 4 of scale D, bring 6 of scale C over the 4, and under the index of C read 24 on D. The position of the scales is shown in fig. 4.

For further multiplication by 3, bring runner to 24 on D and 3 on C to the runner and again under the index read 72 on D.

To find a square root, place the index over the number on scale D, then move the runner until a point is found where the readings on D and C are alike, the position for the square root of 2 is illustrated in fig. 5. As before there are two positions of the runner where the readings on C and D are iden-