K+E

POCKET

SLIDE RULE

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(FORMERLY 9050-1)

INSTRUCTIONS

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K+E

MERCHANTS'™ POCKET SLIDE RULE

INSTRUCTIONS FOR OPERATING

This Slide Rule has application in the fields of estimating, cost accounting, statistics, merchandising, manufacturing, exporting, importing, etc.—wherever quick calculations are necessary.

It is used primarily for multiplication and division and the related operations of proportion, percentage, and combined multiplication and division.

The beginner is advised to confine his study to the simple operations of multiplication and division on the *C* and *D* scales.

Before attempting to perform the calculations, the user should practice the reading of the scale until he has acquired accuracy in locating numbers without hesitation.

The *C* and *D* scales are **identical** and are numbered from **1 to 10**, the spaces between the whole numbers **decreasing** steadily toward the right. The *CF* and *DF* scales are identical with the *C* and *D* scales, the only difference being in the arrangement, by which the index (1) of the *CF* and *DF* scales is placed near the middle. The *CI* scale is simply an inverted *C* scale, with the graduations and numbering running from right to left. These points are brought out in the following diagram.

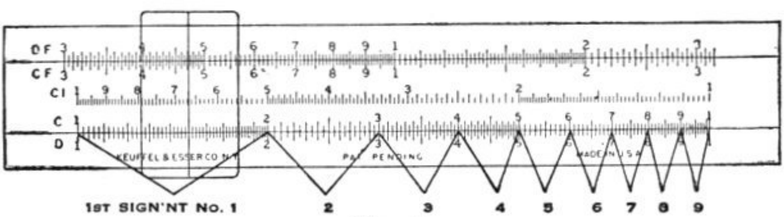

Fig. A

TO LOCATE THREE-FIGURE NUMBERS ON THE *C* AND *D* SCALES, there are *three* steps of procedure in the following sequence:

STEP I.—*Read the first significant figure.* (The first significant figure of a number is the first numeral that is *not* zero. Thus, 2 is the first significant figure of the numbers 0.0024, 24.0, 0.024, or 2.40.)

If the first significant figure is 1, the number will lie between the **main divisions** *1 and 2. If it is 2, the number will lie between 2 and 3. If 3, between 3 and 4, etc.* (*See Fig. A, page 1.*)

EXAMPLE: The number 246 lies between the main division 2 and 3 (as indicated by the bracket in Fig. I, a skeleton scale showing only the main divisions), since the first significant figure is 2.

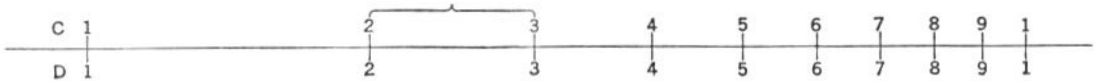

Fig. I. MAIN DIVISIONS.

STEP II.—*The second figure locates the number on the* **secondary divisions** *in a similar manner.*

EXAMPLE: In the number 246 the second figure 4 indicates that the location is between the 4th and 5th secondary divisions beyond the second main division, as indicated by the bracket in Fig. II, which is a skeleton scale with only the secondary divisions filled in. Note that there are ten of these secondary divisions to each main division.

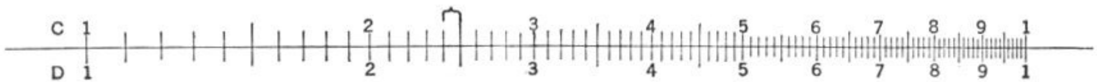

Fig. II. SECONDARY DIVISIONS.

STEP III.—*In a like manner the third figure locates the number on the* ***third set of divisions****, which appear in Fig. III—the Slide Rule Scale in its final form.*

EXAMPLE: Since the number 246 lies between the main divisions 2 and 3, where the subdivision is in halves, the third figure locates the number finally one fifth the distance beyond the half division between the 4th and 5th secondary divisions beyond the main division 2, as indicated by the arrow in Fig. III.

Fig. III. COMPLETE SCALE.

IMPORTANT NOTE—Were it practical to manufacture a rule with ten subdivisions to every secondary division, it would certainly be done, so that each space would have a **single** value, as have the secondary divisions. However, since the spaces grow smaller toward the right end of the scale, **it is practically impossible to subdivide the secondary divisions even into fifths throughout the scale. Therefore:—**

(*a*) The spaces between the secondary divisions lying between main divisions 1 and 2 are divided in fifths; so each of these subdivisions has a double value.

(*b*) The spaces between the secondary divisions between main divisions 2 and 3, and 3 and 4, and 4 and 5, are divided in halves; so each subdivision has a value of five.

(*c*) The spaces between the secondary divisions for the remainder of the scale are not subdivided; so each subdivision has a value of ten.

5 spaces, each = 2

2 spaces, each = 5

1 space, each = 10

STEPS I, II and III are condensed in Fig. IV, below, showing the location of the number 246.

The reading of the *DF* and *CF* scales (called the folded scales) is accomplished in the same manner, the only difference being that the scales begin and end at the middle of the rule. Starting with main division 1 in the middle (called the middle index), main divisions 2 and 3 are to the right, while the remaining divisions run from the left and end in the middle at main division 1.

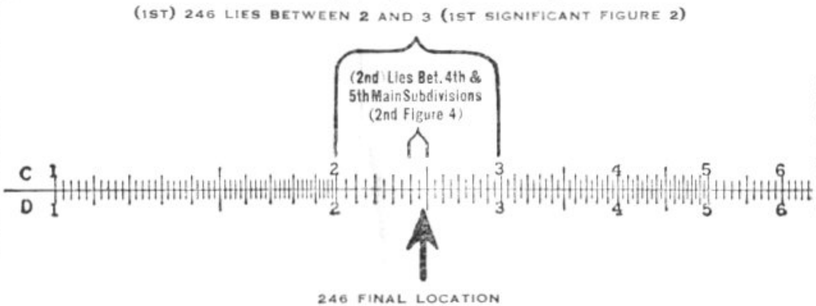

Fig. IV.

The *CI* scale is like the *C* scale inverted, i.e., the graduations and numbers run in the opposite direction; thus, to read 246 on this scale, find main division 2, then secondary 4 to the left, and subdivision 6 still further to the left.

It is advisable for the user to follow the same procedure on his Slide Rule, locating those numbers with the aid of the **hairline** on the **indicator** (runner).

Now locate 478 in the same manner, using the **indicator** (runner) to follow each step.

I. First significant figure 4 indicates that number lies between 4 and 5. **Set indicator at 4** (Fig. V.).

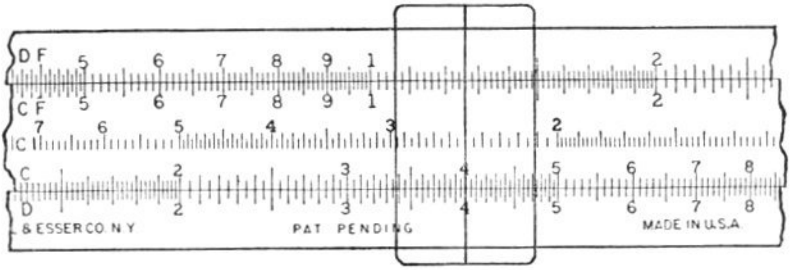

Fig. V

II. Second figure 7 indicates number lies between 7th and 8th secondary divisions. **Move indicator to 7th secondary division** (Fig. VI.).

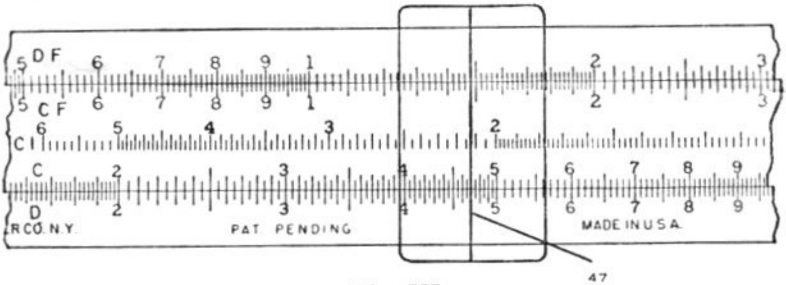

Fig. VI

III. Third figure 8 indicates the number lies 3/5ths of the distance between the **single subdivision** (**half**) and the next secondary division (Fig. VII.).

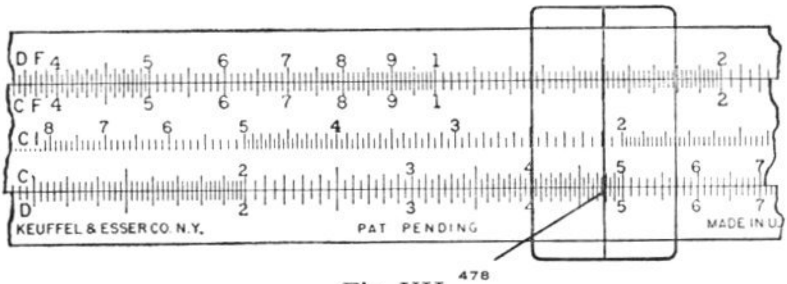

Fig. VII

Numbers containing a single digit are located at the main divisions, as —

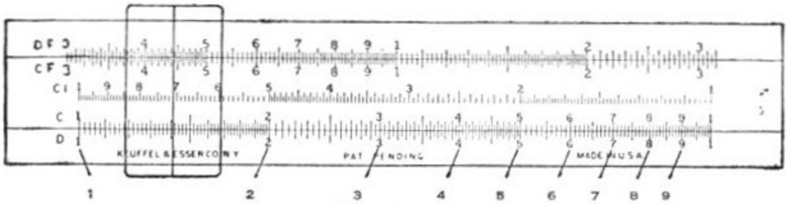

Fig. VIII

Two digit numbers are located like the three digit numbers, but are finally located on the secondary divisions instead of the final subdivisions, as —

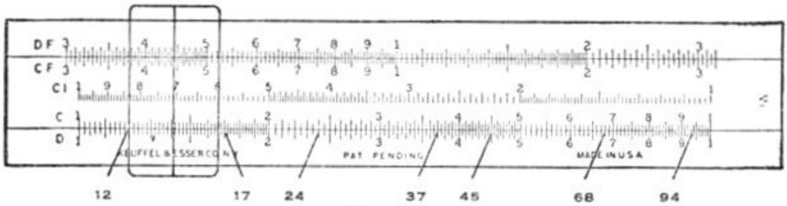

Fig. IX

Numbers containing a large number of digits need only be set to the third place, since the percentage of error introduced in the result is so minute as to be insignificant in the majority of problems,—especially ratio and percentage calculations, combined multiplication and division, and multiplications involved in estimating and appraising.

Thus, 187,475 would have to be called 187+ and set as follows:

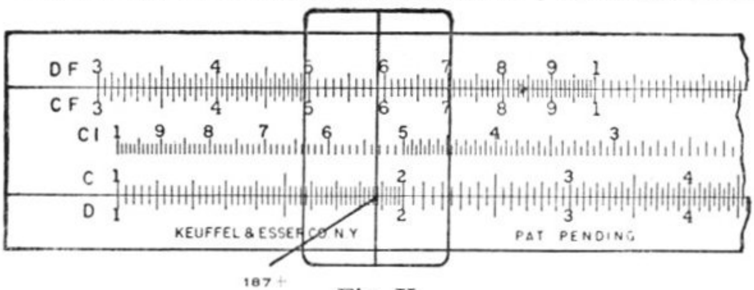

Fig. X

The learner should practice setting and reading until he feels confident that he can do so accurately and without hesitation. Then he is ready to give his attention to the solution of simple multiplication problems.

MULTIPLICATION

Rule: *To multiply two factors together, set the index of the C Scale (either the right or left end figure one) adjacent to one of the factors on the D scale and read the answer on D under the other factor on C; or set the index of the CF scale (middle figure one) adjacent to one of the factors on the DF scale, and read the answer on DF under the other factor on CF.*

$2 \times 3 = x.$

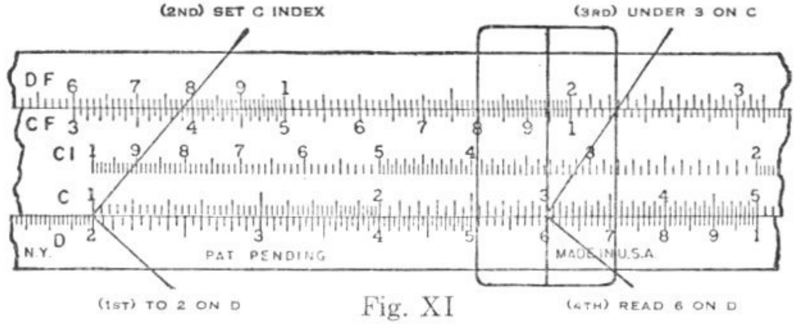

Fig. XI

This problem can also be solved on the *CF* and *DF* scales as follows:

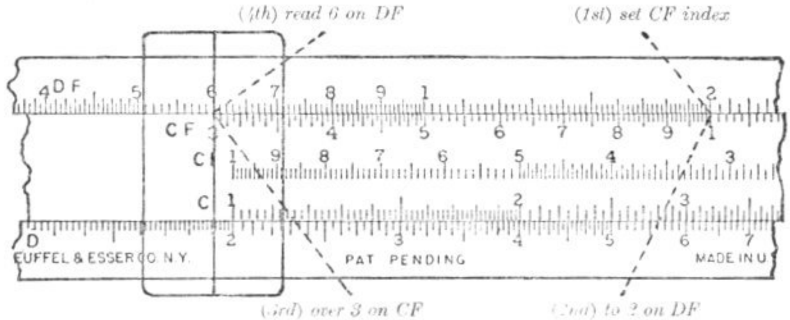

Fig. XIa

Note that the settings on the *C* and *D* and *CF* and *DF* scales occur simultaneously. When 1 on *C* is at 2 on *D*, the 1 on *CF* is at the 2 on *DF*; and when 3 on *C* is at 6 on *D*, 3 on *CF* is at 6 on *DF*. Consequently these scales may be used interchangeably. For instance, the settings may be made on the *C* and *D* scales, and the answer read on the *CF* and *DF* scales; or the settings may be made on the *CF* and *DF* scales, and the answer read on the *C* and *D* scales.

In the majority of the illustrations of examples which follow, the solution is shown both on the *C* and *D* and *CF* and *DF* scales. The solution involving the *C* and *D* scales is indicated by vertical bold face capitals and solid lines, and that involving the *CF* and *DF* scales by slanting light-face capitals and dotted lines.

$18 \times 26 = x.$

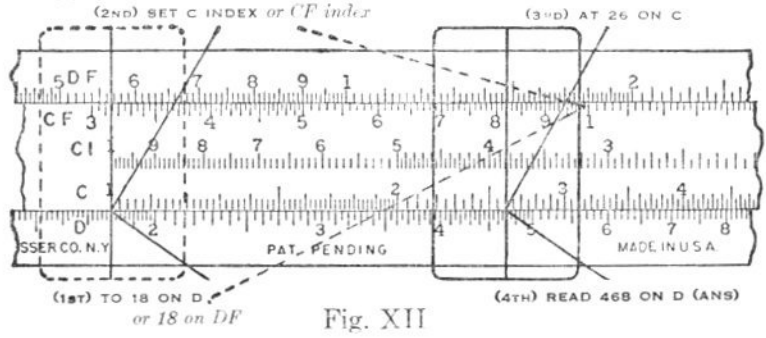

Fig. XII

72 × 51 = x.

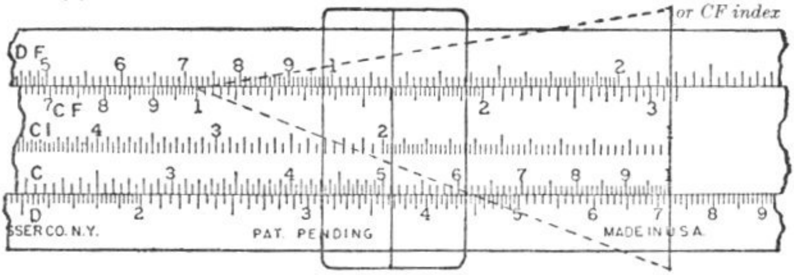

Fig. XIII

The slide rule gives 3670, but the 4th digit is obviously 2, since the last digits of 72 and 51 are 2 and 1 respectively.

Note that in making settings on the C and D scales to solve the last problem the right index must be used instead of the left, which was used in the first two problems. *If the slide projects too far to the right when the left index is used, use the right index; or make the settingon the CF and DF scales and read the answer either on the D or DF scale.*

THE DECIMAL POINT

Important: No mention has been made as to the method of determining the position of the decimal point in the last problems, since it has been apparent at a glance. In most cases, however, the operator should substitute round numbers for those appearing in the problem and determine the correct position of the decimal point by approximation.

Thus—2.47 × 34.2

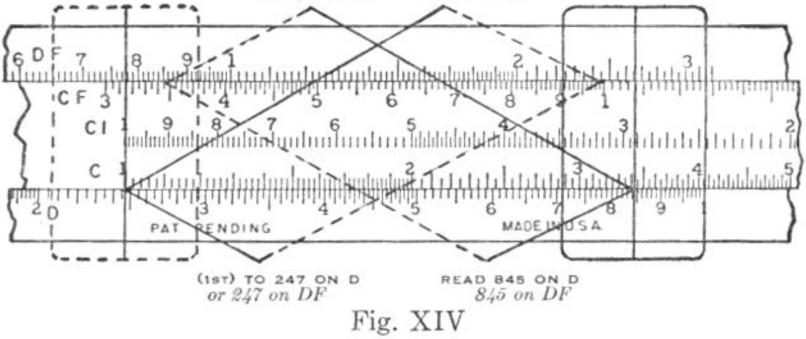

Fig. XIV

Make the setting in the regular way, and read the answer 845. Substitute 2 for 2.47 and 30 for 34.2 and note that the answer would be approximately 60. Therefore the answer must be 84.5, which is nearer to the approximation than 845 or 8.45.

When the student has operated the slide rule for some time, he will learn to make these approximations mentally and almost instantaneously.

DIVISION

Division is the reverse of multiplication. Refer to Fig. XI, showing $2 \times 3 = 6$. The same setting shows $6/3 = 2$.

Rule: *To divide one number by another, set the divisor on the C scale to the dividend on the D scale and read the quotient on the D scale, under the C index.*

Example $875 \div 35$

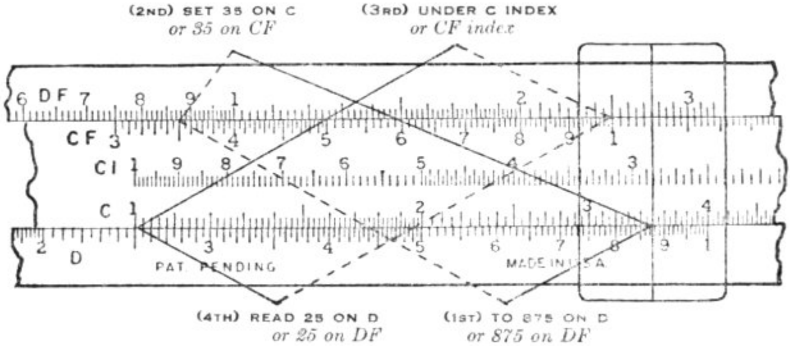

Fig. XV

As in multiplication, the decimal point should be set by approximation. Substituting round numbers, in the last problem, we see that 900 divided by 30 equals 30. Therefore the answer must be 25, as this is closer to 30 than 250 or 2.5.

THE INVERTED SCALE

By using the *CI* scale the operations of multiplication and division are reversed.

Rule: *To multiply two factors together, set the hairline of the indicator to one factor on D, bring the other factor on CI to the hairline of the indicator, and read the answer on D under whichever index of C is on the scale.*

$24 \times 35 = x.$

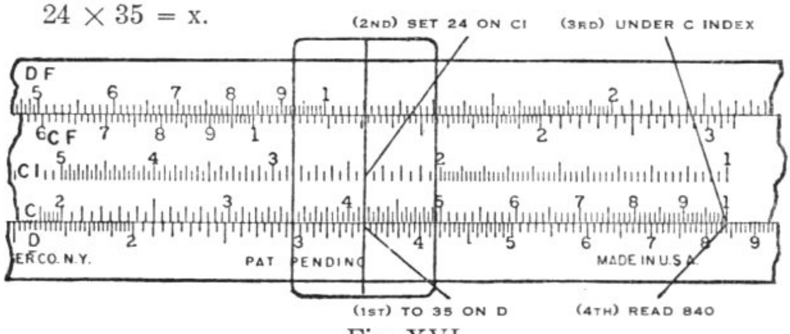

Fig. XVI

Rule: *To divide two factors, set the index of C adjacent to the dividend on D. Move the indicator to the divisor on CI, and read the answer under the hairline of the indicator on D.*

$74 \div 4 = x.$

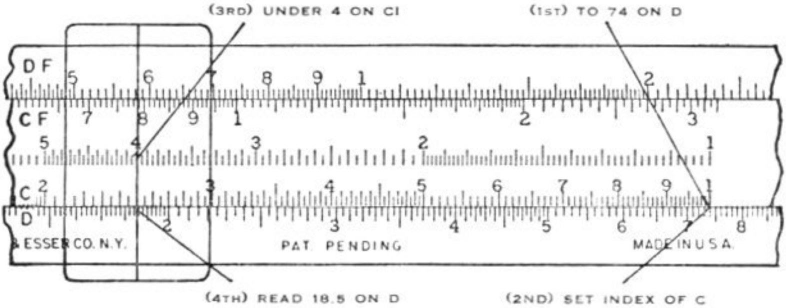

Fig. XVII

SOLUTION OF PROBLEMS INVOLVING BOTH MULTIPLICATION AND DIVISION

Problems involving both multiplication and division can be worked out on the slide rule with great rapidity, whereas considerable time would be required for solution by the arithmetic method. Note, in solving a problem of this type, that it is not necessary to read the answer for each step, since we are interested only in the final answer.

Example: $\dfrac{840 \times 648}{790} = x.$

The best method for solving problems of this type is to perform division first; then multiplication; and to continue in this order as far as possible.

Set 790 on *C* to 840 on *D* (division).

Move indicator to 648 on *C* (multiplication).

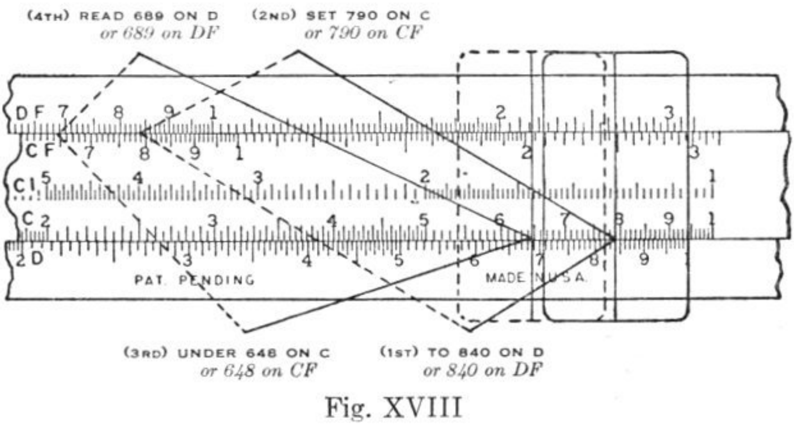

Fig. XVIII

MULTIPLICATION OF THREE OR MORE FACTORS

Three factors can be multiplied at one setting of the slide. This is accomplished by setting two of the factors on the regular scales and one on the *CI* scale.

Example. $642 \times 3.5 \times .0164$.

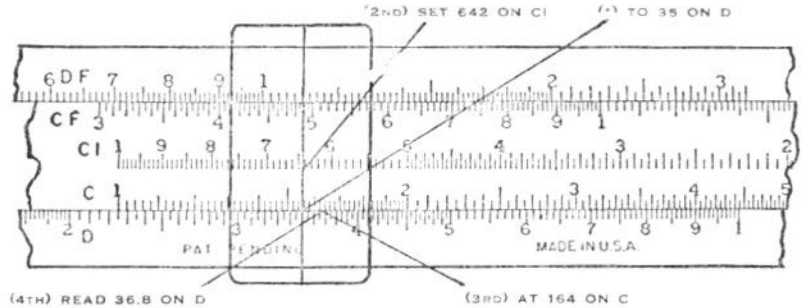

Fig. XIX

If your factors are to be multiplied, proceed as above for the first three, bringing the hairline of the indicator to the third factor, shifting the index of *C* or *CF* (depending upon whether the third factor was set on *C* or *CF*) to the hairline, and reading the answer on *D* or *DF* opposite the fourth factor on *C* or *CF*. Any number of factors can be handled through this procedure.

PROPORTION

Problems in proportion are encountered daily, and offer one of the most common uses for the slide rule. Among problems of this type are those which call for —

(1) The conversion of —

Yards to meters
Dollars to pounds
Knots to miles
Inches to centimeters, etc.

(2) The determination of weight of one quantity when the weight of another quantity is known.

It will be found that when the slide is set so that 2 on *C* coincides with 4 on *D*, that all readings on *C* bear to the coinciding reading on *D* a ratio of 2:4 or 1:2.

Stating this in a general rule—*with any setting of the slide, all coinciding readings are in the same ratio to each other.*

Example:

If we know that 2.7 quarts of a liquid weigh 4 lbs. and we wish to determine the weight of 1.4 quarts, we set 2.7 on *C* scale adjacent to 4 on *D* scale and under 1.4 read the answer 2.07.

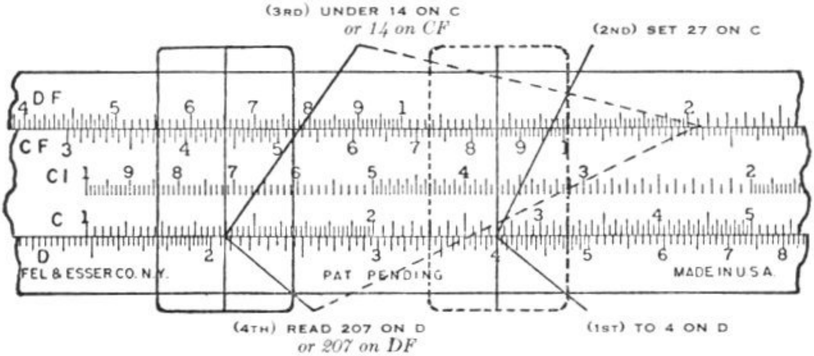

Fig. XX

Example:

If we desire to convert a number of different readings in square meters to square yards, we set 1 on *C* to 1.196 on *D* (1 square meter = 1.196 square yards) and under any reading in square meters on *C*, we find the corresponding reading in square yards on *D*.

DISCOUNTS

A very large variety of practical problems may be solved by means of the slide rule; and many of these are covered in the manuals of the Slide Rule, published by Keuffel & Esser Co. As an indication of what may be done, the following method of solving problems in simple discount is explained.

In solving discounts on the slide rule always use 100 less the discount. Thus, if the discount is 18%, use 100—18 = 82. Then set the right hand index of *C* to 82 on *D*, and opposite any amount on *C* or *CF*, the amount remaining after the discount is deducted will be found on *D* or *DF*.

For a combination of discounts, as 30—15—5% proceed as follows:

Set right hand index of *C* to 70 = (100—30) on *D*.
Move indicator to 85 = (100—15) on *C*.
Move right index of *C* to indicator.
Move indicator to 95 = (100—5) on *C*.
Move right index of *C* to indicator.
Opposite any amount on *C* find the amount remaining after the discounts are deducted.

THE *L* SCALE

The following statements indicate how the L scale is used to find the logarithms of numbers to the base 10.

(A) When the hairline is set to a number on the D scale it is at the same time set to the mantissa (fractional part) of the common logarithm of the number on the L scale, and conversely, when the hairline is set to a number on the L scale it is set on the D scale to the antilogarithm of that number.

(B) The characteristic (integral part) of the common logarithm of a number greater than 1 is positive and is one less than the number of digits to the left of the decimal point; the characteristic of a number less than 1 is negative and is numerically one greater than the number of zeros immediately following the decimal point.

Example. Find the logarithm of (a) 50; (b) 1.6; (c) 0.35; (d) 0.00905.

Solution. (a) To find the mantissa of log 50,

push hairline to 50 on D,
at hairline on L read 699.

Hence the mantissa is .699. Since 50 has two digits to the left of the decimal point, its characteristic is 1.

Therefore $\log 50 = \mathbf{1.699.}$

(b) Push hairline to 16 on D,
at hairline on L read 204.

Supplying the characteristic in accordance with (B), we have

$$\log 1.6 = \mathbf{0.204.}$$

(c) Push hairline to 35 on D,
at hairline on L read 544.

Hence, in accordance with (B), we have

$$\log 0.35 = \mathbf{9.544 - 10.}$$

(d) Push hairline to 905 on D,
at hairline on L read 956.

Hence, in accordance with (B), we have

$$\log 0.00905 = \mathbf{7.956 - 10.}$$