PAPER.

To convert weight per ream (in pounds) to grams per square meter, and vice versa.

Example: What is the weight in grams per square meter when a ream (500 sheets) Folio (17 × 22) weighs 16 pounds?

Referring to the equivalents on the back of the slide rule.

$$\text{Weight per sheet} = \frac{16 \times 1000}{500 \times 2.205} = \frac{32}{2.205} \text{ grams}$$

$$\text{No. of sheets per square meter} = \frac{39.37 \times 39.37}{17 \times 22}$$

$$\text{Hence } \frac{39.37 \times 39.37 \times 32}{17 \times 22 \times 2.205} = \text{weight in grams per square meter.}$$

DF					At 1 find 60. answer
CF				R to 32	2.205 to R
C	Set 17	R to 39.37	22 to R		
D	To 39.37				

From the foregoing it will be found that the use of the slide rule can be extended indefinitely. All that is necessary is to have a little patience and to use common sense in operating it.

K+E

MERCHANTS'

TRADE MARK

SLIDE RULE 4094

AND

DESK SLIDE RULES
N4096 & 4096M

KEUFFEL & ESSER CO.

NEW YORK · HOBOKEN, N. J.

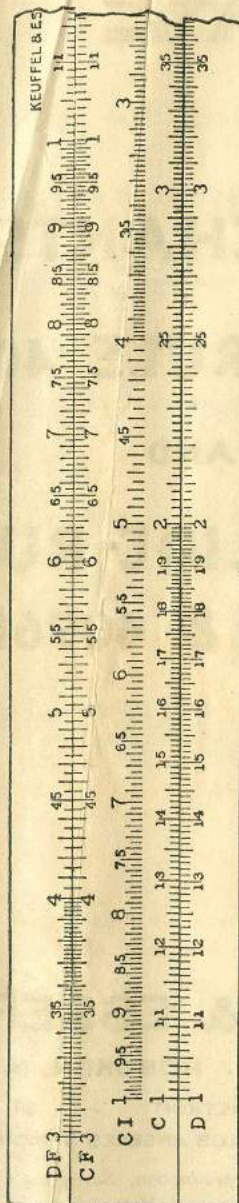CHICAGO · DETROIT · ST. LOUIS

SAN FRANCISCO · LOS ANGELES · MONTREAL

Drafting, Reproduction, Surveying
Equipment and Materials.
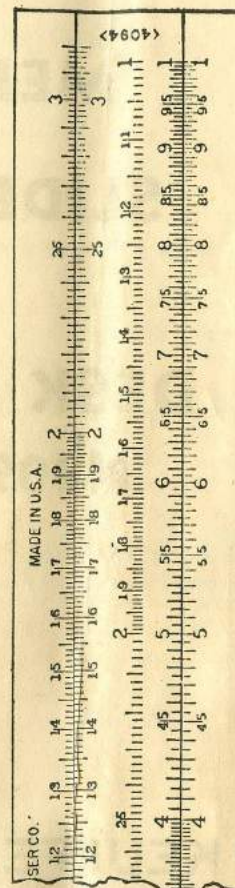*Slide Rules. Measuring Tapes.*

MERCHANTS' SLIDE RULE 4094

K+E

MERCHANTS' SLIDE RULE

4094

KEUFFEL & ES.

DF 3
CF 3
CI 1
C 1
D 1

Left half

(4094)

SER CO.'

MADE IN U.S.A.

Right half

K+E

MERCHANTS' SLIDE RULE 4094
AND
DESK SLIDE RULES N4096 & 4096M

INTRODUCTION.

The Slide Rule, a great saver of mental strain in working out calculations, has heretofore been largely confined to the use of the engineering professions. The merchant, importer, exporter, accountant, manager, mechanic, foreman, etc., to whom it is just as valuable, have hardly taken up its use, probably deterred by the many scales which make the regular Slide Rule appear rather complicated.

In the K&E Merchants' and Desk Slide Rules all scales used for the computation of square and cube roots, powers, sines, tangents, and other problems necessary for the engineer or technical man have been eliminated. In their stead we have retained only those scales which simplify the use of this valuable instrument for the merchant and others, whose problems are confined to multiplication, division and proportion.

DESCRIPTION.

The K&E Merchants' and Desk Slide Rules carry five scales. The two adjacent scales on the upper edges of the rule and slide, called DF and CF, are alike, and those on the lower edges, called C and D, are also alike. The fifth scale lies between the CF and C scales on the slide, and is an inverted or reversed C scale, with the divisions and numbering running from right to left.

A runner or indicator is fitted to the rule.

HOW TO READ THE SCALES.

The graduations on the slide rule are not measures of length, but represent figures. The first thing for the beginner to do is to learn to read the graduations or scales accurately in terms of numbers.

Scales C and D consist of nine prime spaces of unequal length; the first line of each space is numbered, respectively, 1 (called left index), 2, 3, 4, 5, 6, 7, 8, 9; the last line is numbered 1, and is called the right index. The spaces 1-2, 2-3, 3-4, etc., decrease in length, the space from 1 to 2 being the longest and every succeeding space being shorter than the one preceding it.

Each of these prime spaces is divided into ten (secondary) spaces, also decreasing in length, the nine lines between prime 1 and prime 2 being numbered 11, 12, 13, 14, 15, 16, 17, 18, 19, in smaller figures than those of the prime graduations. Due to lack of space, the only other secondary lines on the Merchant's which are numbered are those midway between the primary graduations, as 25, 35, 45, 55, 65, 75, 85 and 95.

On the Desk Slide Rule, following the same system the secondary spaces between prime 2 and prime 3 are numbered from 21 to 29; and those between prime 3 and prime 4 from 31 to 39. If space permitted, all of the other secondary lines might also be numbered in the same way.

Each of the spaces between these secondary lines is again subdivided.

Thus, each secondary space between prime 1 and prime 2 on both the Desk and Merchants', is divided into ten (unequal) parts. The secondary spaces between prime 2 and prime 3, and prime 3 and prime 4 are divided into five unequal parts on the Merchants' and into ten unequal parts on the Desk Slide Rule. The secondary spaces between prime 4 and the end of the rule are, subdivided into two (unequal) parts on the Merchants' and into five (unequal) parts on the Desk, there being one line between the two secondary lines on the Desk, and four lines between the two secondary lines on the Merchants'. In reading the scale each of the two subdivisions of the Desk, counts five points in the third place and each of the five subdivisions on the Desk Slide rule counts two points in the third place.

To find a number, always read the first figure on the left on the prime line, the second figure of the number on the right thereof and the third figure on the secondary line to the right thereof and the third figure on the subdivision; thus, to read 336 (say three, three six, not three hundred and thirty-six) find prime 3, second 3 and sub. 6, which is the third division to the right of secondary 3 on the Merchants' Rule. See Fig. I.

In like manner, every other number is found by reading the significant number, then prefixing or affixing the necessary ciphers and assigning the decimal point.

Find in Fig. I the following numbers: 175, 322, 490, 1501, 405, and then find these same numbers on your Slide Rule.
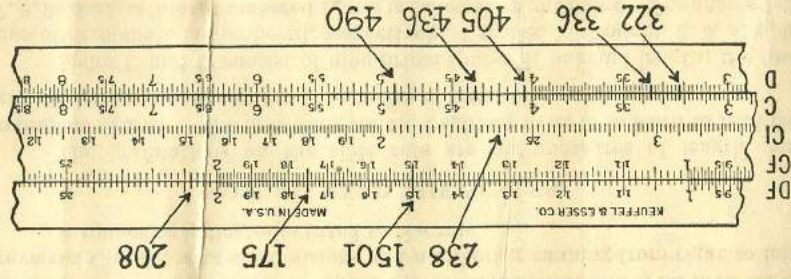
Fig. I.

238   1501   175   208
322 336   405 436   490

KEUFFEL & ESSER CO.   MADE IN U.S.A.

You may now place the decimal point where required; thus, this position may read 336 or any multiple thereof as: 336.00, 3.36, 33.60, 0.336, 0.0336, etc.

Fig. I.

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 about the middle of the rule. Starting with prime 1 in the middle, (called middle index), prime 2 and 3 are to the right, while the remaining scales run from the left and end in the middle at prime I.

Find 208: (two, naught, eight) prime 2, secondary 0, then sub. 8. (Note that if 0 appears after the prime number, it lies in the space between the prime division and the first secondary division next following.

— 4 —

The CI scale is like the C scale inverted, i, e., the graduations run in the opposite direction (from right to left) and must be read in that direction; thus, to read 238 on this scale, find prime 2, then secondary 3 to the left and sub. 8 to the left and prime 3 to the left (Fig. I). The numbers on the CI scale are in red.

The runner or indicator has a glass with a fine hairline engraved on it. It is used to facilitate reading and to permit of extended calculations being worked out without the necessity of reading off the intermediate results.

We recommend that the beginner familiarize himself with the reading of the numbers before attempting to make calculations. This can be done in spare moments and the matter will be quickly mastered, if the rules given above are followed.

MULTIPLICATION.

Multiplication is accomplished by setting either index (or 1) of C or CF (on slide) to the multiplicand on D or DF; then, opposite multiplier on C or CF, find answer on D or DF.

Example: 24 × 35 = 840.
To 24 on D, set Index of C. Opposite 35 on C or CF, find answer, 840 on D or DF.

Fig. II.

840   35   24
840   35

KEUFFEL & ESSER CO.   MADE IN U.S.A.

In this case the answer can be found both on D and DF, but if 24 were to be multiplied, without resetting the slide, by say 45, 62 or 97, etc., the answer could be found only on the DF scale, as the C scale containing these multipliers, extends beyond the D scale.

Example: 12 × 95 = 1140.
To 12 on DF, set middle index of CF. Opposite 95 on CF, find answer, 1140 on DF.

1140   12
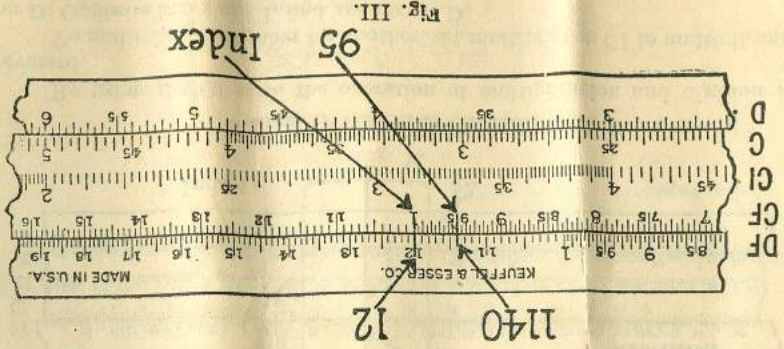95   Index

KEUFFEL & ESSER CO.   MADE IN U.S.A.

Fig. III.

— 5 —

Now without resetting the slide, the answer resulting from multiplying 12 by any number can be found on either D or DF or both.

Thus, find answer of 12 × 15 = 180 on D and DF.

$$12 \times 83 = 996 \text{ on D and DF.}$$
$$12 \times 94 = 1128 \text{ on DF only.}$$
$$12 \times 28 = 336 \text{ on D only.}$$

It will be noted that for 12 × 94 the first three digits of the answer are read directly as 112. But 94 on the slide lies between subdivisions 2 and 3 to the right of secondary 11 on the rule. The distance of 94 from subdivision 2 must be estimated by eye—this distance being estimated as .8 the distance between subdivisions 2 and 3. Hence, the answer is 1128.

DIVISION.

To divide one number by another, first find dividend, i.e., the number to be divided, on D or F, to this set divisor found on C or CF, and opposite either index find answer.

Example: 725 ÷ 25 = 29.

Set hairline of runner (to facilitate reading) to 725 on D, shift slide until 25 on C is under hairline (set at 725). Opposite index of C (and CF) find answer 29.

Fig. IV.

Example: 66 ÷ 12 = 5.5

Set runner to 66 on DF, then 12 on CF to runner. Opposite index CF find answer 5.5 on DF (also opposite index C find answer on D).
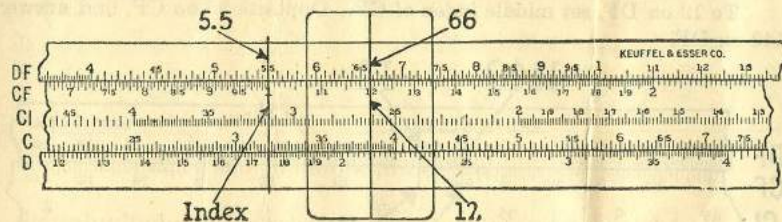

Fig. V.

THE INVERTED SCALE.

By using the CI scale the operation of multiplication and division is reversed.

To multip'y one number by another, set multiplier on CI to multiplicand on D. Opposite index of CI, find answer on D.

Example: 24 × 35 = 840

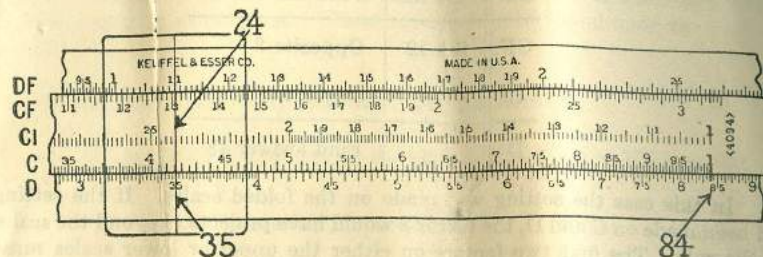To 35 on D set 21 on CI. Opposite index of CI find answer 840 on D.

Fig. VI.

To divide, set index of CI to dividend on D. Opposite divisor on CI find answer on D.

Example: 74 ÷ 4 = 18.5

To 74 on D set right index of CI. Opposite 4 on CI, find answer 18.5 on D.

Fig. VII.

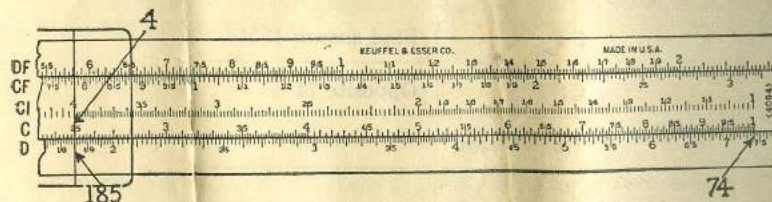For simple multiplication and division, however, we recommend the use of the regular C, D, CF, DF scales.

COMBINED MULTIPLICATION AND DIVISION.

We now come to examples involving more than two factors and will illustrate them diagrammatically.

Example: $\dfrac{24 \times 35}{6} = 140$

24 divided by 6 and multiplied by 35 equals 140.

C	Set 6	Opposite 35
D	To 24	Find answer, 140

Example: $\frac{72 \times 8}{12} = 48$

DF	To 72	Find answer 48
CF	Set 12	Opposite 8
C		Opposite 8
D		Find answer 48

In this case the setting was made on the folded scales. If the setting had been made on C and D, the factor 8 would have projected beyond the scales on the rule. The first two factors on either the upper or lower scales must be set in such manner that not more than one-half of the slide projects beyond the rule.

MULTIPLICATION OF THREE 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: $35 \times 6 \times 74 = 15540.$

DF		Find answer 15540
CF		Opposite 74
CI	Set 35	
C		
D	To 6	

CONTINUOUS MULTIPLICATION AND DIVISION.

A combination of multiplications and divisions can be performed, the final result only being noted. To illustrate this we will take the following simple problem:

Example: $\frac{4 \times 6 \times 8 \times 7}{2 \times 5 \times 3} = 44.8$ (R stands for Runner.)

DF						Find Answer 44.8
CF		Runner to 6	5 to R	R to 8	3 to R	Opposite 7
C	Set 2					
D	To 4					

EQUIVALENTS AND SETTINGS.

The slide rule furnishes a ready means of converting the units of one system into those of another. This is done by means of certain settings, which we have carefully worked out. These settings will be found upon the back of the rule.

Example: How many pounds in 152 kilograms?

In the Table of Settings on the back of the rule find 176 opp. 388

C	Set 176	Opposite 152	(kilos.)
D	To 388	Find answer 335.2	(lbs.)

Without resetting, any number of pounds on D or DF will be found opposite the equivalent number of kilograms on the C or CF scales. Vice versa, any number of kilograms on C or CF will be found opposite the equivalent number of pounds on the D or DF scales.

Example: What is the pressure produced by a head of 56 feet of water? From the table of settings note that feet head of water is to lbs. per sq. in. as 316 is to 137.

C	Set 316	Opposite 56	(feet)
D	To 137	Find answer 24.3	(lbs. per sq. in.)

With the above setting, opposite any head of water in feet on C (or CF), read the corresponding pressure on D (or DF). To find the head of water which will be supported by the atmospheric pressure at sea-level (14.7 lbs. per sq. in.), opposite 14.7 on scale D read 31.9 feet on C.

PERCENTAGE.

Discounts.

Simple discount is set by reading the scales backwards, deducting direct from 100, thus, for a discount of 18%, set right hand (and middle) index at 82 (100 — 18 = 82) and the rule is set, so that opposite any number on C, the answer will be found on D. This is equivalent to multiplying by 82%.

For a combination of discounts, set by the use of the runner, thus for 27½-15-5%, proceed as follows:

C	Right Ind.	R to 85 (100-15)	Ind. to R	R to 95 (100-5)	Ind. to R	Opp. any amount
D	To 72.5 (100-27½)					Find answer

Profits.

Profits based on cost price are added by setting left index of C to the amount of profit added to 100 on D, thus: To add a profit of 25%, set left index of C to 125 (100 + 25) on D. Opposite any number on C find answer on D. This is equivalent to multiplying by 125%.

Profits based on selling price are added by dividing cost price by 100 minus the percent, thus: To add a profit of 20%, set 100 — 20 = 80 on C or CF to cost on D or DF. At index of C or CF read selling price on D or DF.

Selling Price.

To get selling price of a line of goods by deducting the discount and adding the desired profit.

Example: What is the selling price of Plumbers Brass Safety Chain on reels of 500 ft. purchased at a discount of 60-10-5%, to yield a profit of 25% on selling price?

C	Set Index	R to 90	Index to R	R to 95	75 to R	Opp. List
D	To 40 (100—60)					Find selling price.

Size of Chain	List	Selling Price
000	3.30	1.51
00	3.60	1.64
0	4.30	1.96
1	5.20	2.37
2	6.40	2.92
3	9.00	4.11
4	10.30	4.70

SIMPLE INTEREST.

Set 360 (the number of days in the year) on C, to the given rate on D. Move the indicator to the principal on C. Bring the index of C to the indicator. Opposite the number of days for which the interest is required on C, find interest on D. Opposite time in days on D or DF find interest on C or CF.

Example: $475.00 for 225 days, at 4½ per cent.

C	Set 360	R to 475	Rt. Index to R	Opposite 225
D	To 4.5			Read 13.36 Ans.

COMPOUND INTEREST.

Space off on scale D (as shown below) the distance 100 plus rate per cent as many times as the required number of years, and multiply by principal.

Example: What will be the amount of $250.00 placed at compound interest for four years at 6 per cent?

C	Set 1	R to 106	1 to R	R to 106	1 to R	R to 106	1 to R	Opp. 250
D	To 106 (100 + 6%)							Find ans. 315.62

LUMBER MEASURE.

Example: Lumber required for 27 table tops 38″ × 56″ × 1¼″ and cost at $87.50 per 1000, plus 20% for cutting waste.

CI	Set 38				87.5 to R	
C		R to 56	144 to R	R to 125		Opposite 120
D	To 27			Find 498 ft. B. M.		Find Cost $52.37

$$\frac{27 \times 38 \times 56 \times 125 \times 875 \times 120}{144}$$

27 × 38 × 56 equals number of square inches, this divided by 144, the number of square feet, this multiplied by 1.25 the square feet in board measure. This multiplied by the cost per square foot, .0875 × 120 (100 + 20 per cent), equals the cost.

WEIGHT AND COST OF SHEET BRASS FOR STAMPING.

Example: Required 2 gross stampings of No. 16 sheet brass 8 in. wide at 14½ cents per pound, seven pieces to cut from a running foot.

Find number of running feet of brass, number of square feet, weight and cost of same.

These four answers are found with three settings of the slide.

$$\frac{288 \times 8 \times 2.25 \times 14.5}{7 \times 12}$$

C	Set 7	Opposite 1	R to 8	12 to R	Opposite 1	R to 2 25	1 to R	Opposite 14.5
D	To 288	Find number of running ft. × 41 2			Find number of sq. ft. 27.4	Find weight 61.7 lbs.		Find cost $8.95

Note: 2.25 is weight of one square foot of brass. These weights are found in any brass manufacturer's catalogue.