Instructions for using the Binary Slide Rule.

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GILSON SLIDE RULE CO., Stuart, Fla.
(*Slide Rule Makers since 1915.*)

John Gault

DESCRIPTION.

This circular slide rule is constructed to give at least ten years service. The Scales are protected by three coats of transparent lacquer, so that any ordinary wear will not erase the scales. However, if the user presses down on the Indicators when they are moved, the finish of the rule will become dull. To move the Short Indicator, catch the fingernail under the edge and raise the Indicator about 1/16th of an inch. The Long Indicator should be raised when it is moved.

Throughout these instructions the long indicator will be referred to as L and the short indicator will be termed S. It will be noted that whenever S is moved that L remains stationary, but that when L is moved S moves with it. Whenever L is moved in solving a problem, be sure that nothing interferes with the free movement of S. L always gives the answer to the problem.

The outer scale on the front side of the rule is called the C Scale. It is used for solving problems in multiplication, division and proportion. The beginner should master the C Scale before attempting to use any of the others. Therefore the problems given in the next paragraph should be solved on the C Scale and all others disregarded.

Figure 1 shows the scales.

TO MULTIPLY 5 x 7. Set L at 5 and S at 10. Turn L until S is at 7 and L will indicate the answer, 35.

TO DIVIDE 18 ÷ 3. Set L at 18 and S at 3. Turn L until S is at 10 and L will indicate the answer, 6.

To Solve 35 ÷ 15 x 3. Set L at 35 and S at 15. Turn L until S is at 3 and read the answer 7 under L.

TO SOLVE PROPORTION 7:35::5:x. Set L at 35 and S at 7. Turn L until S is at 5 and L will give the answer, 25.

READING THE SCALES.

These examples were made very simple, because when using larger numbers, the operator must be able to read the Scales. This can be learned by studying their construction. Taking the C Scale, it will be noted that beginning at the index and reading clockwise, the long lines are numbered 11, 12, 13, etc., to 2. Then each of these spaces if further divided into 10 subdivisions. Tenths of these subdivisions must be estimated if required by the problem. To locate any number beginning with 1, as 1365, move an Indicator to 13, then move it six more subdivisions to 136 and the center of the next subdivision gives 1365.

To locate a number beginning with 2, as 2247 (22.47. .022,470. 2,247,000, etc.) move the Indicator two large divisions from 2, which gives 22, then move it 4 divisions and estimate .7 of the next subdivision. Fig. 1 shows the location of these settings.

Problems involving multiplication, division and proportion can be solved on either the CI, A or Binary Scale in exactly the same manner as on the C Scale.

THE CI OR C INVERTED SCALE.

The second Scale is the CI or C Inverted Scale, which is graduated and read in a counter-clockwise direction. The two numbers on the C and CI Scales under an Indicator are reciprocals of each other and when multiplied (neglecting the decimal point) always equal 1. Using the C and CI Scales, three numbers can be handled at each setting of the rule.

To Multiply 77 x 842 x 128. Set L at 77 on C Scale and S at 842 on CI Scale.

Turn L until S is at 128 on C and L will give the answer as 83 or 8,300,000 on C.

To Solve 72.8 ÷ (31 x 42.5). Set L at 728 on C and S at 31 on C. Turn L until S is at 425 on CI and read the answer 552 or .0552 on C.

LOGARITHMS.

This scale gives the Logarithms of all numbers (Base 10). To find the Logarithm of any number set L at the number on the C Scale and read the Logarithm of the number under L on the Log. Scale. Thus Log. 2 is .301; Log. 7.5 is .875; Log 845 is 2.927. The Log. Scale can be used for addition and subtraction. To add set L at one number and S at 00. Turn L until S is at the second number and L will give the sum. To Subtract, set L at the minuend and S at the subtrahend. Turn L until S is at 00 and L will indicate the remainder.

ROOTS AND POWERS.

The A Scale can be used for multiplication, division and proportion in exactly the same manner as the C Scale. To square a number, set L or S at the number on the C Scale and read the square of the number on the A Scale.

To extract the Square Root of a number, first separate the number into groups of two figures each, beginning at decimal point and going either to the left or right as required as 2'34'27 or .00'64. If the left hand group contains one significant figure, use the first half of the A Scale, reading the square root on the C Scale. Use the second half of the A Scale if the left hand group contains two significant figures. Thus the Square Root of 2.5 is 1.58 and the Square Root of 25 is 5.

MULTIPLYING AND DIVIDING MIXED NUMBERS.

The Binary Scale is used for handling fractions and mixed numbers between the limits of 7/64th and 10. When desired, the answer to any problem solved on the Binary Scale can be read, as a decimal, on the A Scale. Also decimals on the A Scale can be used with fractions and mixed numbers on the Binary Scale and the result read on either scale.

THE LOG-LOG SCALE.

Referring to Fig. 1, the C, CI, A, and Binary Scales were constructed by laying off distances proportional to the Common Logarithms (Base 10) of the numbers on the Scales. Therefore multiplication on these Scales consists of adding the distances of the two factors. Subtraction consists of subtracting the distance of divisor from the distance of the dividend. All distances being measured from the Index. The Log-Log Scale was constructed by first getting the Natural Logarithm (base e, 2.71828) of the number and then getting the Common Logarithm (base 10) of the Natural Logarithm and laying off the distance proportional to this quantity. Thus the Natural Log. of 20 is 2.99573 and the Common Log. of 2.99573 is .476503. Therefore 20 on the Log-Log Scale would be located under an indicator set 2.99573 or 3.00 on the C Scale and .476503 or 477 on the Log Scale.

The Log-Log Scale gives the position of the decimal point and extends from slightly above 1 to 1,000,000. If a number or its desired root falls below the limit of the Scale, multiply the number by some convenient factor. Then, the root of the product, divided by the root of the factor, gives the root of the number. If the number or its desired power is greater than 1,000,000, resolve the number into two or more convenient factors that can be handled by the scale. Then the product of the powers of the factors gives the power of the number.

To Find the Power of a Number, Set L at the exponent and S at 10 on C Scale. Turn L until S is at the number on the Log-Log Scale. Read power at L on Log-

Log Scale. Find the value of 4.65 raised to the 3.7 power. Set L at 37 and S at 10 on C. Turn L until S is at 4.65 on Log-Log and L will give the answer as 290 on the Log-Log Scale.

To Extract the Root of a Number, Set L at 10 and S at the Index of the Root, on C, turn L until S is at the number on the Log-Log and L will give the root on the Log-Log Scale. Find the value of $\sqrt[7.3]{5,000}$. Set L at 10 and S at 7.3 on C Scale. Turn L until S is at 5.000 on Log-Log Scale and read 3.2 at L. For numbers which fall off the end of the scale, use same method as for "Powers."

To Find Natural Logarithms. (Base e) Set L at the number on the Log-Log Scale and read Logarithm on C Scale. Thus the Natural Log. of 1.68 is .518; of 675 is 6.52; of 32000 is 10.37

The Log-Log scale has four turns and may be extended any number of turns below **1.000,15** using the C scale, because this number is under an indicator set at 15 on the C scale. Therefore, to raise 1.000,034,45 to the 4.2ths power, set **L** at 42; **S** at **1**, turn **L** until **S** is at 3445, read **1447**, which makes the answer **1.000,144,7** (all solved on C scale). **If** the exponent, 4.2 or base had been slightly larger, the answer would be greater than 1.000,15 and could be read on the **Log-Log Scale.**

ADDING AND SUBTRACTING FRACTIONS.

The Fraction Scale is used for adding and subtracting fractions and is divided from 1/64 to 1 inch. The complete Log Scale may be considered as equal to 1 inch. Therefore, combinations of fractions and decimals may be added and subtracted on these two scales.

To add 7/64+19/32 set L at 7/64 and S at 1. Turn L until S is at 19/32 and L will give 45/64

31/64 − To subtract: 3/8. Set L at 31/64 and S at 3/8. Turn L until S is at 1 and read 7/64 under L.

Solve 9/64 13/32 27/64. Set L at 9/64 and S at 27/64. Turn L until S is at 13/32 and L will give 1/8.

If desired, decimals on the Log Scale may be substituted for any of the fractions in the above three types of problems. Then the answer can be read exactly, as a decimal or to the nearest 64th.

THE DRILL AND THREAD SCALE.

The Drill Scale uses the first half of the circle and the Thread Scale uses the second half. To find the size of a numbered or lettered drill place L at the number or letter on the Drill Scale and read the size as a decimal on the Log. Scale or as a fraction on the fraction scale. Thus, an I drill is .273″. I is the third division clockwise from F.

To find the size of drill to use for tapping a perfectly full thread use the Thread Scale. Set L at 5 on the Log. Scale and S at the number of threads on the Thread Scale (either U. S. S. or V form). Turn L until S is at the bolt size on the Fraction Scale and L will give the drill size on the Log., Fraction, or Drill Scale, as desired.

EXAMPLE: What drill should be used for a hole to tap a ½″ 13 U. S. S. Thread? Set L at 5 on the Log. Scale and S at 13 on U. S. S. Thread Scale. Turn L until S is at ½ on Fraction Scale and L reads .406″ on Log. Scale, 13/32 on Fraction Scale and Y on Drill Scale.

Tap breakage is often caused by using a drill too small for the tap. Therefore if the hole will give a thread that is longer than twice the diameter of the bolt, use a drill that is one or two sizes larger than given by the rule. A larger hole may be drilled in steel or wrought iron, as the metal flows into the thread while tapping.

THE CUBE SCALE

The K or Cube scale is used with the C scale for cubes and cube roots. Set either indicator to a number on C and read the cube on K. To extract the cube root, separate the number into groups of three figures, beginning at the decimal point, as 51'535.32 or 024'8. If the left group contains one, two or three significant figures, use the first, second or last one-third of the K scale. Set L at any quantity on the K Scale and read the cube root on the C Scale.

TYPE PROBLEMS AND SHORT CUTS.

Pi, or 3.1416 is given on the C and CI Scales, also ¼ Pi, or .7854 is given on these scales by the small mark near 8. The small mark at c on the Log. Scale is at .3937" which is equal to one centimeter. Further calculation gives 39.37" (1000 Cm) as the Meter.

The operator must be able to solve a problem by ordinary methods before attempting to use the Rule, which is an aid and a time-saver. The following type problems show how to handle the usual combination of factors which are met in practice. The operator should choose the type which is required by his problem and solve it accordingly. Only a few of the many possible combinations of the nine scale are given as others will suggest themselves to the operator as he becomes more familiar with the instrument. In the following problems, M. N, O, P and Q will represent known quantities and R the result. When any result is given by L, this result may be used as a factor in further calculations. It is not necessary to read the number under L until the final answer is obtained.

Solve M x N ÷ O = R. Use C. Scale. Set L at M and S at O. Turn L until B is at N and read R under L.

Solve M ÷ (N x O) = R. Set L at M and S at N on C Scale. Turn L until S is at O on CI Scale and read R at L on C Scale.

Solve M ÷ (N x O^2) = R. Set L at M and S at N on A Scale. Turn L until S is at O on CI Scale and L will give R on A Scale.

To Find Reciprocals, Set L at the number on the C or CI Scale and read the reciprocal on the other scale.

To solve any quadratic equation of the form $x^2 \pm bx \pm c = 0$, set L at 1 and S at C on CI Scale. Turn L until the (sum or difference as the case may be) of the values under L on C Scale and S on CI Scale equals b. These are the roots or values of x. The position of the decimal point may be located by inspection.

To find the value of $\sqrt{x^2 \pm y^2} = 0$, set L at y and S at x on CI Scale. Move L to 1 on A Scale. (This reduces y y y to 1 and reduces x in the same proportion). Now read the value under S on A Scale and reset S to this value at 1 as the case may be. Move L to y on C Scale and read the answer under S on CI Scale.

THE DECIMAL POINT.

If the C Scale of the Rule is used for multiplication and division and L turned clockwise to set S then the following rules will give the number of figures in the result. To simplify the rules the following terms are used. "Sum" is the number of figures in the multiplier plus the number of figures in the multiplicand. "Difference" is the number of figures in the dividend minus the number of figures in the divisor.

Rule 1. In multiplication, if I is moved to, or past, 10 to set S. the number of figures in the product equals the sum. Otherwise the number of figures in the product equals the sum minus 1. (Always turn L clockwise to set S).

In division, if S is set counterclockwise between L and 10 the number of figures in the quotient equals the difference plus 1. If S is set clockwise between L and 10 the number of figures in the quotient will be the difference.

COMMERCIAL PROBLEMS.

The C Scale is used for solving most commercial problems so if no scale is mentioned the C Scale should be used.

OVERHEAD. A merchant has $15,200 sales for a year with a $3,800 overhead. What is his percent of overhead? Set L at $15,200 (or 152) and S at $3,800. Turn L until S is at 10 and read 25 or 25% at L.

If an article costs the above merchant $2.50 and he wishes to make a 10% net profit, with a 25% overhead. What should be the selling price of the article? Add 10% and 25% and subtract them from 100% which gives 65%. Set L at 10 and S at 65. Turn L until S is at $2.50 (or 25) and L will give $3.85 as the correct selling price. If the selling price of other articles is desired (25% overhead and 10% profit) turn L until S is at the invoiced cost and L will give the selling price.

If a case of 48 articles cost the above merchant $145, what should be the selling price of one article so that he will make a 10% net profit with an overhead of 25%? Set L at 48 on CI Scale and S at 65 on C Scale. Turn L until S is at 145 on C Scale and L will indicate 465 on C Scale. Therefore the correct selling price for each article would be $4.65. The above method may be used for finding selling price of articles bought by quantities, including dozen and gross lots. When finding the selling price of an article when the unit cost is known, set L at 10. If the cost of the lot is known, set L at the quantity, on the CI Scale and proceed in the same manner.

TRIGONOMETRIC FUNCTIONS.

The back side of the Rule has one indicator, which will be referred to as T. It has three separate Sets of scales. The outer scale of each Set is Degrees, the middle scale is Sines and the inner scale is Tangents. Each degree graduation has one or two figures on each side of the line, as 53|37. The figures at the left of each line give the degrees for Sines and Tangents and increase from 0 to 90 degrees in a clockwise direction, while the figures at the right of the line give the degrees for Cosines and Cotangents and increase from 0 to 90 degrees in a counter-clockwise direction. Each of the larger degree divisions is divided into .1 degree or six minute divisions.

To read the function of any angle, set the hair-line, T, to degrees and read the function on its scale. The co-functions are read on their corresponding scales but the degrees must be read counter-clockwise Thus:- Sine 65°42′ is .9114 Tangent 18°30′ is .3346 Cos. 51°54′ is .6170.

To read to one Minute.

It will be noticed that the divisions on the three Degree scales are not on radial lines but differ by 2 degrees. To increase 2 degrees, move the hair-line to the next outer degree scale, moving to the center if necessary. By going halfway between the degree divisions of any two adjacent (or the outer and inner) graduations, the hair-line can be set to one minute.

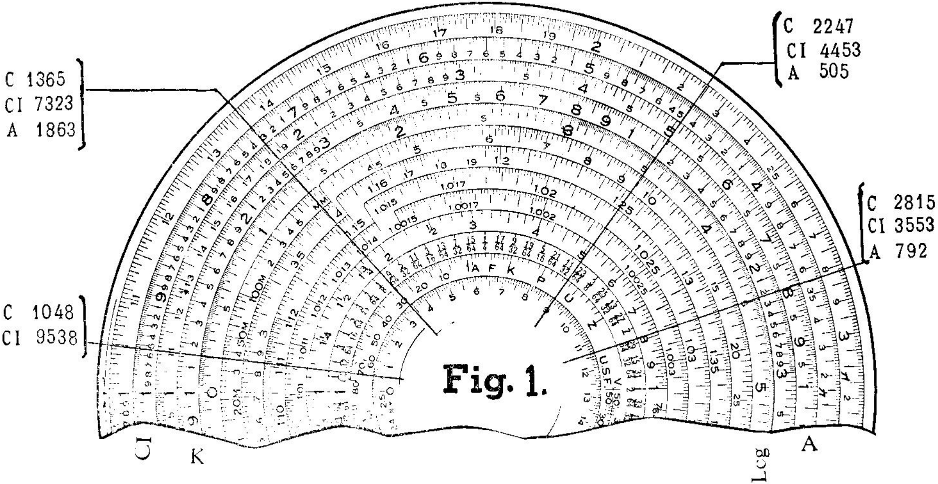
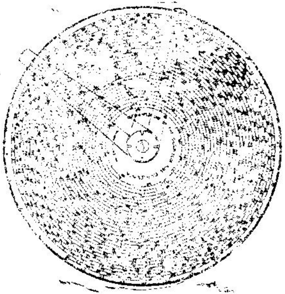

C 1365
CI 7323
A 1863
C 2247
CI 4453
A 505
C 2815
CI 3553
A 792
C 1048
CI 9538
CI
K
Log
A

Fig. 1.

THE ATLAS SLIDE RULE.



Will solve any problem in multiplication, division and proportion as quickly as the ordinary ten-inch straight slide rule and it will give the result with a maximum probable error of 1 in 30,000. This instrument has two Logarithmic Scales, one 25 inches long and the other, a spiral, 50 feet long. Two results to every problem can be read. The result given by the short scale can be read to three figures and the result on the 50 foot scale can be read to five figures as 98,687.

The "Atlas Slide Rule" will handle three factors at one setting and hold the result, two additional factors can be used with this result at each additional setting. The graduations on this rule are always in plain view of the operator so that any number can be quickly read. The rule is made of aluminum 1-16th of an inch thick; covered with white celluloid enamel. The graduations are engine divided and will remain accurate.

Diameter 8 5-16 In. Price, with Case and Instructions, $9.00, postpaid,

BE WISE.