Otis King's

Patent
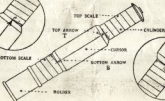
CALCULATOR.

Outline Drawings of Calculator, showing correct
setting of arrows to scales.

ALWAYS SET THE ARROWS
TO THE LINED-UP TO
THE FIGURES

TOP SCALE

BOTTOM SCALE

TOP ARROW

CYLINDER

CURSOR

BOTTOM ARROW

HOLDER

ALWAYS SET THE ARROWS
TO THE LINED-UP TO

GENERAL DESCRIPTION.

The Calculator consists of three parts :—

(1) THE HOLDER } on which are mounted spiral
(2) THE CYLINDER } logarithmic scales.
(3) THE CURSOR (or Indicator), carrying an arrow or an engraved arrow, or pointer, which can be set to any mark, or to which any mark can be set.

DETAILS OF SCALES.

Model K.

THE HOLDER carries a logarithmic scale 66 in. long, from 1 to 10, graduated as follows :—

By ·001 from 1 to 1·12   By ·005 from 2 to 4.
„ ·002 „ 1·12 „ 2   „ ·01 „ 4 „ 10.

In order that the range of the scale may be unlimited decimal points are not marked. Thus the reading 212, for instance, also serves for 2120, 21200, 21·2, 2·12, etc., etc. The position of the decimal point in the answer is found by inspection or by the application of the rules given on pages 7 and 8.

THE CYLINDER carries two scales in series which are identical in all respects with the above. The point at which these two scales meet half-way up the Cylinder is denoted by the word "ONE," and is referred to in the following pages as the "MIDDLE UNITY," or "UNITY."

METHOD OF OPERATION.

The following sequence of movements should always be adhered to in operating the Instrument :—

MOVEMENT 1.—Take the HOLDER in the left hand, and open Instrument gently to full extent. Move CURSOR to set bottom arrow.

MOVEMENT 2.—Move CYLINDER so that number on scale is set to top arrow (*not the arrow to the number*). Do not touch Cursor while moving Cylinder.

MOVEMENT 3.—Move CURSOR to set either arrow as required : the companion arrow will then point to the answer: (*see following examples*).

GENERAL RULES.

The following abbreviations are used to render the descriptions more precise :—

B = Bottom Arrow or Pointer on Cursor.

T = Top arrow or Pointer on Cursor.

Unity = { Middle Unity on Model K.
{ Available Unity on Model L. (*see previous page*).

To Multiply.
1. Set B to Multiplicand.
2. Set Unity to T.
3. Move T to Multiplier.

To Divide.
1. Set B to Dividend.
2. Set Divisor to T.
3. Move T to Unity.

4. Read Answer at B.

Problems of Proportion, Practice, Percentage, &c., involve either one, or a combination of both, of these operations.

EXAMPLES.

The following instructions apply to both Models K and L.

Multiplication.

Multiply 115 by 23.

Set B to 115. Set Unity to T. Move T to 23. Read answer at B : 115×23=2645.

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Division.

Divide 833 by 17.

Set B to 833. Set 17 to T. Move T to UNITY. Read answer at B : 833 ÷ 17 = 49.

Combined Multiplication and Division.

Solve $\dfrac{6 \times 4 \times 9}{7 \times 5 \times 2}$

Set B to 6. Set 7 to T. Move T to 4.

(B now indicates answer to $\dfrac{6 \times 4}{7}$)

Set 5 to T. Move T to 9.

(B now indicates answer to $\dfrac{6 \times 4 \times 9}{7 \times 5}$)

Set 2 to T. Move T to UNITY. Read answer at B :– 3·086.

Proportion.

I.   Solve 12 : 7 :: 16 : x ?

Set B to 12. Set 7 to T. Move T to 16. Read answer at T. 12 : 7 :: 16 : 9·333.

II. Solve 18 : 4 :: x : 53 ?

Set B to 18. Set 4 to T. Move T to 53. Read answer at B. 18 : 4 :: 238·5 : 53.

III. Divide 8975 in the proportions 83 : 79 : 33 : 19.

Set B to 8975. Set sum of required proportions, viz., 214, to T. Without altering the setting of the Instrument, move T in succession to 83, 79, 33, 19, and read the corresponding proportions at B, viz., 3481, 3313, 1384 and 797. (On Model I. this calculation necessitates "closing in" the Cylinder. See page 6.)

Percentages.

I.   What is 5% (a) of 162?
   (b) off 162?
   (c) on 162?

Set B to 162 (capital amount or quantity). Set UNITY to T. The Instrument is now set to solve percentage problems involving % OF, % OFF and % ON 162.

(a) Move T to 5 (rate %). Read answer at B :– 5% of 162 = 8·1.

(b) Move T to 95 (100 – rate %). Read answer at B : 5% off 162 = 153·9.

(c) Move T to 105 (100 + rate %). Read answer at B : 5% on 162 = 170·1.

II. What % of 3735 is 4·54 ?

Set B to 3735. Set UNITY to T. Move B to 4·54. Read answer at T : 121·55%.

III. What is the percentage of profit on cost where goods purchased for £5,760 are sold for £9,420 ?

Set B to 5760 (capital). Set UNITY to T. Move B to 9420 (selling price). Read answer at T :– 163·5. Percentage of profit = 63·5% (163·5 – 100).

Constant Factors.

I. In cases where one pair of factors is repeated throughout a series of problems, the Instrument may be set to the constant terms, and the answers found by subsequent movements of the Cursor only.

In Exercise Example 1, for instance, the Instrument being set to the constant terms 162 : 100%, any percentage of, off or on 162 will be shown at B when T is moved to the relative figure, e.g., Move T to 45. Read answer at B :– 45% of 162 = 72·9. Move T to 126. Read answer at B :– 26% on 162 = 204·1, and so on.

II. Decimalise $\frac{3}{8}$, $\frac{5}{16}$, $\frac{29}{32}$, $\frac{46}{51}$.

Set B to 32. Set UNITY to T (32 and 1 being the constants in this series). Move B in succession to 3, 7, 15, 29 and read corresponding answers at T, viz., ·09375, ·21875, ·46875, ·9062.

Sterling Calculations.

The Sterling items must be reckoned as decimals of pounds, shillings or pence as best suits the problem.

I. If 54 articles cost £39 4s. 6d., what is the price of 15 ?

(a) Set B to (£) 39·225. Set 54 to T. (The cost of any number of articles at this price can now be obtained by moving T to the number required.) Move T to 15. Read answer at B : 15 articles cost £10·895, i.e., £10 17s. 11d.

Alternatively—

(b) Set B to 784·5 (shillings). Set 54 to T. Move T to 15. Read answer at B :—15 articles cost 217·9 shillings, i.e., £10 17s. 11d.

II. Find Interest on £675 at 6½% p.a. for 29 days.

$$\left(£675 \times \frac{6 \cdot 5}{100} \times \frac{29}{365}.\right)$$

Set B to 675. Set Unity to T. Move T to 6·5. Set 365 to T. Move T to 29. Read answer at B: £3·486, i.e., £3 9s. 8¼d. (If preferred, multiply further by 240, and read answer at B: 836·75 pence i.e. £3 9s. 8¼d.)

In some calculations it may be found preferable to invert the setting of the Instrument and to work the Cunities on Holder Scale instead of to those on the Cylinder Scale. In this case, the answer is of course read at the Pointer opposite to the one indicated in the foregoing examples.

Model L

THE UPPER CYLINDER SCALE—When this Scale is used in conjunction with the Holder Scale to perform the types of Calculations described in the preceding pages, it will be noted that upon occasion the Cylinder becomes closed in or opened out too far for the Pointer on the Cursor to be moved to the required figure. In this case proceed as follows, without altering the setting of the Instrument :—

To Close Cylinder In.   Move T to bottom Unity.
        Set up Unity to T.

To Open Cylinder Out.—Move T to top Unity.
        Set bottom Unity to T.

The Pointer can then be set to the required figure and the calculation completed. This operation may be performed during any calculation and does not affect the process or answer in any way.

THE LOWER CYLINDER SCALE.—Where involved expressions occur above or below the line, the Otis King's Calculators offer valuable advantages over the ordinary slide rule, which, even if engraved with log-log scales, cannot solve the following, whereas Model L will give all powers and roots, fractional

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or otherwise, of all numbers without limit, and solve any expression, however extended. The following expression is given as an example :—

$$\frac{1 \cdot 008^{-2 \cdot 1} \times \sqrt[3]{63} \times 4000}{6 \times 260000 \times 42^{1 \cdot 12}} = \cdot 2495.$$

All involved expressions must be replaced by their numerical value before the problem can be dealt with, and this prior process is, of course, common to both the slide rule and the Otis King's Calculator. The intermediate stage in dealing with the above problem is to simplify it into the following :—

$$\frac{1 \cdot 025 \times 3 \cdot 98 \times 4000}{6 \times 12 \cdot 11 \times 900 \cdot 1}$$

The process for effecting this is as follows :—

To LOGARIZE—(i.e., find the logarithm representing a number).

Set B to bottom Unity of Holder Scale. Set "·000" of lower Cylinder Scale to T. Move B to number (antilogarithm), and read mantissa at T.

To DELOGARIZE—(i.e., to find the number represented by a logarithm).

Set B to bottom Unity of Holder Scale. Set "·000" of lower Cylinder Scale to T. Move T to mantissa. Read antilogarithm (number) at B.

To ascertain any Power or Root of any number.

POWERS.
Multiply the logarithm of the number by the index of the power and take the antilogarithm of the product.
Example :—What is $1 \cdot 008^{2 \cdot 1}$
Log. of 1·008—0·0035
0·0035 × 3·1—0·01085.
Antilog. of 0·01085—1·025.
Therefore $1 \cdot 008^{2 \cdot 1}$—1·025.

ROOTS.
Divide the logarithm of the number by the root and take the antilogarithm of the quotient.
Example :—What is $\sqrt[3]{63}$.
Log. of 63—1·7993.
1·7993÷3—0·5998.
Antilog. of 0·5998—3·98.
Therefore $\sqrt[3]{63}$—3·98.

TO DETERMINE POSITION OF DECIMAL POINT.

The following rules apply to both Models K and L.—

A number having n figures to the left of the decimal point shall be designated as having n places. A decimal number having n cyphers to the right of the decimal point, between the decimal point and any number other than 0, shall be designated as having $-n$ places.

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Thus the numbers—

    5430000, 674, 81·2, 7·82, 0·45, 0·0421, 0·00675;
    have +7, +3, +2, +1, +0, −1, −2 places

Multiplication.

To find the number of places (p) in the product (P=X×Y).

RULE I.   (a) When the result is *below* the original setting p=m+n.

Example : 5×4 (m=1 ; n=1).
    Set B to 5. Set T to 4. Move T to 1. (This is below setting.)
     ∴ p=m+n=2.   Answer=12.

   (b) When the result is *above* the setting, the product has m+n+1 places

Example : 5×4 (m=1 ; n=1).
    Set B to 5. Set T to 4. Move T to 3. (This is above setting.)
     ∴ p=m+n+1.   Answer=9.

Division.

To find the number of places (q) in the quotient (Q= $\frac{X}{Y}$).

RULE II.   q=m or q=m+1 as follows :—
   (a) When the result is *above* the setting, the quotient has m−n places.

Example : 5÷4 (m=1 ; n=1).
    Set B to 5. Set 4 to T. Move V to Unity. (This is above setting.)
     ∴ q=m−n=0.   Answer=1·25.

   (b) When the result is *below* the setting, the quotient has m−n+1 places.

Example : 5÷4 (m=1 ; n=1).
    Set B to 5. Set 4 to T. Move T to Unity. Read answer at B. (This
    is below setting.) ∴ q=1·1+1=0·1. Answer=1·25.

Calculations involving Multiplication and Division.

RULE III.   Two methods may be used in working out complex problems
involving both multiplication and division. These are :—

   (1) Taking numerator and denominator alternately.
   (2) Taking all the numerators first and then dividing consecutively by the
      denominators.

Of these two methods, only the latter can be used if the position of the
decimal point is required. If the other is used, the decimal point must be
found by inspection.

First multiply consecutively the series of factors in the numerator and then
divide consecutively by the factors of the denominator.

Take the algebraic sum of the places in the factors of the denominator
from the algebraic sum of the places in the factors of the numerator, and to
this result add the algebraic sum of the results obtained from the application
of Rules I and II to the several steps of the calculation.

$$\frac{43·2 \times 3·2 \times 4 \cdot 0·0217 \times 0·98}{0·0000621 \times 41200 \cdot 0·125 \times 671} = 141·14 \ .$$

No. of places in factors of denominator   −5+2+(−1)+0+4 . .
           numerator   −5+4+(+4)+−2 . .

                Difference   +2 .

Results of various steps in calculation   −1 +1 +1 . .   +1 .

         Number of places in answer   +3 .

               Answer=141·14.