INSTRUCTIONS FOR USING THE FULLER CALCULATOR

MODEL No. 1

The foregoing details of construction show that in operating the Calculator there can only be two different movements, viz., the moving of the Scale or the moving of the Indexes *A* and *B*. The former is a **multiplying movement** and the latter a **dividing movement.**

Therefore taking any factor of any calculation, if it is a Numerator it must be brought to the Index by **moving the Scale,** but if it is a Denominator it must be set by **moving the Index** *A* or *B* to the Scale.

Obviously, the same form of movement cannot be made twice in succession, that is, if the last movement was multiplying (moving the Scale), the next must be a dividing movement (moving the Index) to complete the sequence and give a result.

When no factor exists, the sequence of movement is completed by taking 1 as the factor. For instance, in simple or continuous multiplication the dividing movement is carried out using 1 as the factor, and moving the Index accordingly.

The Sequence of Movement is therefore the same whether for Multiplication, Division, or both combined.

The only other points to remember in this connection are that the **first** and **last** movements must **always be multiplying** (moving the Scale), and the **Fixed Index** *F* **is used on these occasions only.** That is, a multiplying factor is first of all set to the Fixed Index and no further attention is paid to this Index until the answer is read under it.

Note Carefully.

When the Indexes *A* and *B* are to be moved, the term **set** is used. When the Cylinder is to be moved, the term **bring** is used.

EXAMPLE OF MULTIPLICATION

$$\frac{173 \times 24}{1} = 4152.$$

Factor 173 is multiplying, therefore **bring** 173 to the Fixed Index *F*. The next movement must be **dividing** and the denominator factor is 1 understood, therefore **set** the movable Index *A* or *B* to 1 on the Scale.

The next movement must be multiplying, therefore bring 24 (240) to the *movable* Index *A* or *B*. The answer, 4152, is now under the Fixed Index *F*.

$$\frac{173 \times 24 \times 12}{1 \times 1} = 49824.$$

Having obtained the above answer, suppose we find it necessary to multiply further, say by 12 to bring feet to inches.

Simply continue the sequence of movements. The last movement was multiplying, therefore divide by 1 by setting the Index *A* or *B* to 1 on the Scale, and then multiply by bringing 12 to the movable Index, *A* or *B*. The answer, 49824, is now under the Fixed Index *F*. It should be noticed that the accuracy of the last figure 4, can be checked at once mentally.

EXAMPLE OF DIVISION

$$\frac{286 \times 1}{24} = 11{\cdot}916. \qquad \frac{286 \times 1 \times 1}{24 \quad\quad 11} = 1{\cdot}0833.$$

Being the multiplying factor 286 to the **Fixed Index F.**

Set the Index *A* or *B* to the dividing factor 24. To complete the sequence of movements, multiply by 1 understood by bringing 1 on the Scale to the Index *A* or *B*. The answer, 11·916, is under *F* Index.

To divide further by, say, 11 set the Index *A* or *B* to 11 on the Scale, complete the operation by multiplying by 1 understood, bringing 1 on the Scale to the Index. The answer, 1·0833, is under *F* index.

COMBINED MULTIPLICATION AND DIVISION

$$\frac{25 \times 22 \times 16}{11 \times 29 \times 14} = 1{\cdot}9704.$$

Bring 25 to *F*. Divide by setting *A* to 11. Multiply by bringing 22 to *A* or *B*. Divide by setting A or *B* to 29. Multiply by bringing 16 to *A* or *B*. Divide by setting *A* or *B* to 14. Complete sequence by bringing 1 to *A* or *B*. The answer 1·9704 (correct to four places) is under *F*.

It will be observed that these are operations of merely adding and subtracting lengths on the Scale, adding for multiplication and subtracting for division.

The following Tables cover all types of multiplication and division and set out the sequence of operations very clearly.

When the indexes are to be moved the term Set is used. When the cylinder is to be moved the term Bring is used.

MULTIPLICATION

$(a \times b)$
- Bring (*a*) to *F*
- Set *A* to 100
- Bring (*b*) to *A* or *B*
- Product read at *F*

$(a \times b \times c)$
- Bring (*a*) to *F*
- Set *A* to 100
- Bring (*b*) to *A* or *B*
- Set *A* to 100
- Bring (*c*) to *A* or *B*
- Product read at *F*.

$(a \times b \times c \times d)$
- Bring (*a*) to *F*
- Set *A* to 100
- Bring (*b*) to *A* or *B*
- Set *A* to 100
- Bring (*c*) to *A* or *B*
- Set *A* to 100
- Bring (*d*) to *A* or *B*
- Product read at *F*

It will be seen that a similar sequence of operations applies to finding the product of any number of factors.

DIVISION

$\frac{a}{m}$
- Bring (*a*) to *F*
- Set *A* or *B* to (*m*)
- Bring 100 to *A*
- Quotient read at *F*

$\frac{a \times b}{m}$
- Bring (*a*) to *F*
- Set *A* or *B* to (*m*)
- Bring (*b*) to *A* or *B*
- Quotient read at *F*

$\frac{a \times b \times c}{m}$
- Bring (*a*) to *F*
- Set *A* or *B* to (*m*)
- Bring (*b*) to *A* or *B*
- Set *A* to 100
- Bring (*c*) to *A* or *B*
- Quotient read at F

$\frac{a}{m \times n}$
- Bring (*a*) to *F*
- Set *A* or *B* to (*m*)
- Bring 100 to *A*
- Set *A* or *B* to (*n*)
- Bring 100 to *A*
- Quotient read at F

$\frac{a \times b}{m \times n}$
- Bring (*a*) to *F*
- Set *A* or *B* to (*n*)
- Bring (*b*) to *A* to *B*
- Set *A* or *B* to (*n*)
- Bring 100 to *A*
- Quotient read at *F*

$\frac{a \times b \times c}{m \times n}$
- Bring (*a*) to *F*
- Set A or *B* to (*m*)
- Bring (*b*) to *A* or *B*
- Set *A* or *B* to (*n*)
- Bring (*c*) to *A* or *B*
- Quotient read at *F*

It will be seen that a similar sequence of operations applies to the division of the product of any number of factors by the product of any number of other factors.

TO FIX THE DECIMAL POINT

In fixing the decimal point, we make use of the **Characteristic** of the logarithm of the number. This **Characteristic** is simply the number of figures before the decimal point, minus one : thus, the **Characteristic** of 294·386 is 2, because there are three figures before the decimal point.

EXAMPLES

The Characteristic of 4360 is 3
" " " 4·36 is 0
" " " ·436 is —1

Similarly, if there is a nought immediately following the decimal point, the Characteristic will be —2 ; if two noughts, —3 ; and so on, thus :—

The Characteristic of ·0436 is—2
" " " ·00436 is—3

In Multiplication, the Characteristic of the Product is the sum of the Characteristics of the factors, plus 1 for every time a factor is brought to the lower movable index *B*, instead of the upper movable index *A*.

48·42 = ·06434 = 3·115. In this case, 6434 is brought to *B*, so that the Characteristic of the product = 1 —2 + 1 = 0 ∴ there is one figure before the decimal point in the product which is therefore 3·115.

13·28 × 142·7 = 1895. In this case, neither factor is brought to *B*, therefore the Characteristic of the product is 1 + 2 = + 3, so that there are four figures before the decimal point.

14 × 12 × 3 = 2 × ·277 = 279·2. In this case, 2 is brought to *B*, so that the Characteristic of the product is 1 + 1 + 0 + 0 —1 + 1 = + 2. There are therefore three figures before the decimal point.

In Division, the Characteristic of the Quotient is the algebraical difference between the sum of the Characteristics of the factors of the numerator and the sum of the Characteristics of the factors of the denominator. To this difference 1 is added every time a factor of the numerator is **brought** to B, and 1 is subtracted every time B is **set** to a factor of the denominator.

$$\frac{4{\cdot}75 \times 3{\cdot}5 \times 2{\cdot}75}{{\cdot}1604} = 285{\cdot}0$$

In this case, 2·75 is brought to B, so that the Characteristic of the quotient is $(0 + 0 + 0) - (-1) + 1 = +2$.
There are, therefore, three figures before the decimal point.

$$\frac{21{\cdot}75 \times 15{\cdot}25 \times 8{\cdot}333 \times 238 \times 2240}{268{\cdot}75 \times 1728} = 3173.$$

In this case 15.25, 8·333 and 238 of the numerator are brought to B, and B is set to 268·75 and 1728 of the denominator.

The Characteristic of the quotient is, therefore $(1 + 1 + 0 + 2 + 3) - (2 + 3) + 3 - 2 = +3$ and there are four figures before the decimal point.

LOGARITHMS, POWERS AND ROOTS

To obtain powers not higher than the seventh, the quickest way is by direct multiplication.

For higher powers and roots. Place the upper movable index (A) to the number, and read the scales (N and M). These added together give the *mantissa* of the logarithm of the number. To this the *characteristic* has to be added. The characteristic of the logarithm of a number greater than unity in *one less* than the number of figures in the integral part of that number. Thus the characteristic of 5432 is 3, of 543·2 is 2, of 54·32 is 1, and of 5·432 is 0.

Multiply or divide the resulting number by the power or root, as shown above. Then place the cylinder so that it reads on the scales (N and M) the decimal part of the quotient. The power or root is then at the index (A). In the result the number of figures before the decimal point is *one more* than the number in the integral part of the above quotient.

The scale (N) is read from the top divided spiral line and (M) from the vertical edge of the scale (N).

Examples. 5^{13}, on placing (A) to 500, scale (N) reads ·68 and scale (M) ·01897, which gives the logarithm of 5 = ·69897, the characteristic being 0. Then ·69897 × 13 = 9·08661. Now placing the cylinder so that it reads ·08661 on scales (N and M) the index (A) reads 12207, and the required power is 1220700000, having 10 figures, as the integral part of the above quotient is 9.

$\sqrt[5]{741}$, on placing (A) to 741, scale (N) reads ·86 and scale (M) ·00982, which gives the logarithm of 741=2·86982, the characteristic being 2. Then 2·86982 ÷ 5 = ·57396. Now placing the cylinder so that it reads ·57396 on scales (N and M) the index (A) reads 37495, and the required root is 3·7495, having one figure before the decimal point, as the integral part of the above quotient is 0.

ROOTS OF DECIMAL FRACTIONS

Write them as vulgar fractions, and multiply numerator and denominator by ten or a power of ten, so that the denominator may have a complete root. Then take the required root of the numerator by the method given above, and of the denominator by inspection.

Thus

$$\sqrt{\cdot 4} = \sqrt{\frac{4}{10}} = \sqrt{\frac{40}{10^2}} = \frac{\sqrt{40}}{10}$$

$$\sqrt[3]{\cdot 04} = \sqrt[3]{\frac{4}{10^2}} = \sqrt[3]{\frac{40}{10^3}} = \frac{\sqrt[3]{40}}{10}$$

$$\sqrt[5]{\cdot 586} = \sqrt[5]{\frac{586}{10^3}} = \sqrt[5]{\frac{58600}{10^5}} = \frac{\sqrt[5]{58600}}{10}$$

$$\sqrt[3]{\cdot 00065} = \sqrt[3]{\frac{65}{10^5}} = \sqrt[3]{\frac{650}{10^6}} = \frac{\sqrt[3]{650}}{10^2}$$

$$(\cdot 0434)^{\frac{5}{6}} = \left(\frac{434}{10^4}\right)^{\frac{5}{6}} = \left(\frac{43400}{10^6}\right)^{\frac{5}{6}} = \frac{(43400^5)}{10^5}$$

The facility of obtaining and working with logarithms of numbers gives the rule a great additional value.

NOTE.—The Scales *N* and *M* have been replaced in Model 2 by a very long open scale on the inner cylinder. This model is specially recommended for calculations involving the extended use of logs.

TABLES

The tables printed on pages 27-32 have been made and selected as those considered most useful. Owing to our want of a decimal system, it has been deemed most important to have a series of tables which give for our measures of weight, length, time, etc., the equivalent decimal fraction of the larger for successive numbers of the smaller unit. This enables results to be obtained without the necessity of reduction. Thus to find the area of a rectangle whose sides are 24′ 6¼″ and 43′ 5½″. The table gives by inspection ·5208 and ·4583 opposite 6¼″ and 5½″ respectively, so that the area is obtained by multiplying 24·521 by 43·458. The result, as shown by the calculator, is 1065·6. If the parts of a square foot are required in twelfths, the table show that ·6 of a foot is equivalent to 7¼ twelfths, and the result reads 1065—7¼.

DIRECTIONS FOR PERFORMING CALCULATIONS INVOLVING PERCENTAGES AND RATIO

For rapidity combined with accuracy, the **Fuller Calculator** is probably the most efficient instrument in existence for calculating **Percentage Costs** and all **Proportional Values.**

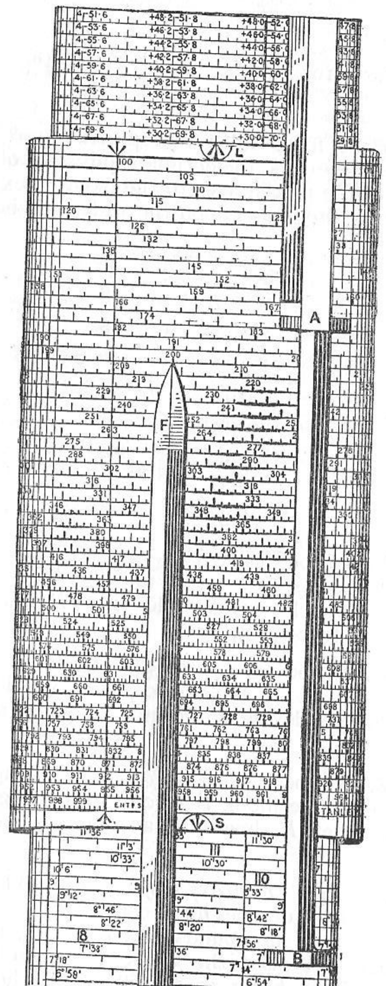
When either of the movable indexes is at one number and the fixed index at another, and the cylinder is turned into any other position, though the numbers at the indexes will be different **their ratio will remain constant.**

Example.—To convert francs and centimes into sterling money, supposing exchange 25f. 25c. for £1. The ratio between centimes and pence is 2525 to 240. Place the cylinder so that the fixed index is at 2525, and make one of the movable indexes point to 240. Then on moving the cylinder to read off different numbers of centimes at the fixed index, the corresponding value in pence will be read at the movable index.

Wages Table.—To find the wages for different times at 35s. per week of 57 hours. Place the cylinder so that the fixed index is at 57, and make one of the movable indexes point to 420, the number of pence in 35s. Then on moving the cylinder to read off different numbers of hours at the fixed index, the corresponding wages in pence will be read at the movable index.

To determine Percentages.—Set the fixed index *F* to the total number or quantity and the movable indexes to the 100 and 1000 marks which are at the top and bottom of the scale. Then bring each of the component numbers in turn to the fixed index *F*, when the percentage will be shown by whichever of the movable indexes is upon the scale.

FULLER CALCULATOR MODEL No. 2



Two-thirds full size LOG. 2 = ·3010

Fig. 3

MODEL No. 2

This is a Fuller Calculator with two extra Scales on the inner Cylinder in place of the Table of Data.

(1) A Scale of Logarithms to four decimal places.

(2) A Scale of Sines from 5° 45′ up to 88°.

INSTRUCTIONS FOR USING THE LOGARITHM SCALE

A logarithm consists of two portions; a whole number portion, or characteristic, and a decimal fraction or mantissa.

For numbers less than unity the characteristic is minus, for example:

The log. of $0{\cdot}4821 = \bar{1}{\cdot}6831$, or $-1 + {\cdot}6831$.

This may also be expressed as a quantity which is all negative thus: $-{\cdot}3169$.

Quantities in this form are much more easily handled when calculating with a slide rule, than quantities which are partly positive and partly negative. This fact has been made use of in graduating the logarithm scale of the Fuller Calculator.

The scale has been figured to read both ways, from right to left and from left to right. One set of readings (right to left) is marked + and deals with numbers of unity or more. The other reading is marked — and deals with numbers of less than unity.

To find the logarithm of a number:

If any number on the main scale be brought to the fixed index *F*, the logarithm of that number automatically appears on the inner cylinder under the index *L*, at the top of the movable cylinder. If the number dealt with is greater than unity, the plus reading is taken, but if it is less than unity, the minus reading is the correct one.

EXAMPLES

Find the log. of 4·4480. Bring 4448 to F and under L read: + ·6481, or — ·3519. As the number dealt with is greater than unity, obviously the plus reading is correct.

To find the log. of ·2590. Being less than unity, the log. will be minus. Bring 2590 to F, and under L read: —·5868.

Suppose the log. of a still smaller number is required, say ·02590, obviously the reading will be the same, prefixed by the characteristic " 1," *i.e.*, —1·5867.

To find the antilog. of any number, the procedure is, of course, the reverse of the foregoing.

To find the value of $(24·2)^{2·3}$. Bring 24·2 to F, and under the index L, read: ·3837, the mantissa of the log.

The characteristic is 1, and the complete log. is 1·3837. Multiply this by 2·3 by usual method, and the result will be 3·1827; set the mantissa ·1827 to the index L, and under the index F, read: 15233, the antilog.

The answer is therefore + 1523·3.

To find the value of $(·3642)^{4·2}$. Set ·3642 to F and the log. = — ·4387. (Being less than unity, the negative value is taken.)

Multiply this by 4·2 by usual method, and the result will be — 1·8425.

Bring — ·8425 to L, and read 1437 at F, which makes the answer ·01437.

THE SINE SCALE

This scale occupies the lower half of the inner cylinder. Like the other scales it is a spiral, having a total length of approximately 32 ft. resulting in a very open reading.

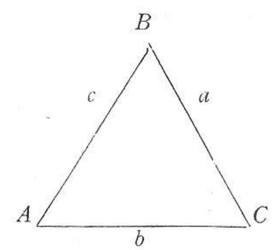
Each division on the scale from 5° 45′ to 48° represents one minute, but from 48° onwards each division represents 5 minutes. This scale is recommended to **Engineers and Surveyors** for solving any expressions involving the use of Sines or Cosines. Calculations in **latitude** and **departure** can be solved in a fraction of the time spent in working with tables, and triangles can be solved with great rapidity and accuracy.

INSTRUCTIONS FOR USE

If any angle on the Sine Scale is brought to the index S, *Fig.* 3, the Sine of the angle will be found on the movable cylinder against the fixed index F.

∴ Bringing any angle on the Sine Scale to the index S is equivalent to setting F to the actual value of the Sine of the angle concerned.

Solution of Triangles.



From the general formula :—

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a = \frac{b \sin A}{\sin B} = \frac{c \sin A}{\sin C}$$

$$b = \frac{a \sin B}{\sin A} = \frac{c \sin B}{\sin C}$$

$$c = \frac{a \sin C}{\sin A} = \frac{b \sin C}{\sin B}$$

hence: **Given two angles and one side** or **two sides and the angle opposite one of them** we can solve the triangle by using one of the above formulæ.

Example 1. Let $A = 75^\circ$, $C = 24^\circ$, $b = 126$ yards.

Then $B = 180^\circ - (75^\circ + 24^\circ) = 81^\circ$

To find *a.*

$$a = \frac{b \sin A}{\sin B} = \frac{126 \times \sin 75^\circ}{\sin 81^\circ}$$

Thus the calculation is performed as in ordinary combined multiplication and division, except that the index *S* is used for setting the sine values.

Move the cylinder until its index *S* marks 81° on the scale of sines: set the movable index to 126: move the cylinder until its index *S* marks 75° on the scale of sines: read a (12323) on the movable index.

i.e., $a = 123{\cdot}23$

To find *c.*

$$c = \frac{b \sin C}{\sin B} = \frac{126 \times \sin 24^\circ}{\sin 81^\circ}$$

Move the cylinder until its index *S* marks 81° on the scale of sines: set the movable index to 126; move the cylinder until its index *S* marks 24° on the scale of sines; read *c* (51888) on the movable index.

i.e., $c = 51{\cdot}888$ yards.

Where the sine of an angle greater than 90° is involved, we can make use of the following:—

$$\sin A = + \sin (180^\circ - A).$$

Example II.

Let $A = 42^\circ$, $C = 41^\circ$, $b = 120$ yards

$\therefore B = 97^\circ$

To find *a.*

$$c = \frac{b \sin C}{\sin B} = \frac{120 \times \sin 41^\circ}{\sin 97^\circ}$$

$$\sin 97^\circ = \sin (180^\circ - 97^\circ) = \sin 83^\circ.$$

Move the cylinder until its index *S* marks 83° on the scale of sines: set the movable index to 120: move the cylinder until its index *S* marks 41° on the scale of sines: read *c* (79318) on the movable index.

i.e., $c = 79{\cdot}318$ yards.

To find *a.*

$$a = \frac{b \sin A}{\sin B} = \frac{120 \times \sin 42^\circ}{\sin 97^\circ} = \frac{120 \times \sin 42^\circ}{\sin 83^\circ}$$

Move the cylinder until its index *S* marks 83° on the scale of sines: set the movable index to 120: move the cylinder until its index *S* marks 42° on the scale of sines; read *a* (8091) on the movable index.

i.e., $a = 80{\cdot}91$ yards.

Example III. Two sides and one angle given.

Let $a = 71{\cdot}3$ yards, $b = 109{\cdot}0$ yards, $B = 54^\circ\ 15'$

To find A.

Since

$$\frac{a}{\sin A} = \frac{b}{\sin B}$$

$$\therefore\ b \sin A = a \sin B$$

$$\therefore\ \sin A = \frac{a \sin B}{b} = \frac{71{\cdot}3 \times \sin 54^\circ\ 15'}{109}$$

Move the cylinder until its index *S* marks 54° 15′ on the scale of sines: set the movable index to 109: move the cylinder to **bring** 71·3 to the movable index: read *A* (32° 3′ 40″) against the index *S* on the scale of sines.

$$A = 32^\circ\ 3'\ 40''$$

To find C.

$$C = 180^\circ - (A + B) = 180^\circ - (32^\circ\ 3'\ 40'' + 54^\circ\ 15^\circ\ 0'') = 93^\circ\ 41'\ 20''$$

To find c.

$$c = \frac{b \sin C}{\sin B} = \frac{109 \times \sin 93^\circ\ 41'\ 20''}{\sin 54^\circ\ 15'\ 0''}$$

(*Note*: $\sin 93^\circ\ 41'\ 20'' = \sin 86^\circ\ 18'\ 40''$.)

Move the cylinder until its index *S* marks 54° 15′ 0″ on the scale of sines: set the movable index to 109: move the cylinder until its index *S* marks 86° 18′ 40″ on the scale of sines: read *c* (13402) on the movable index.

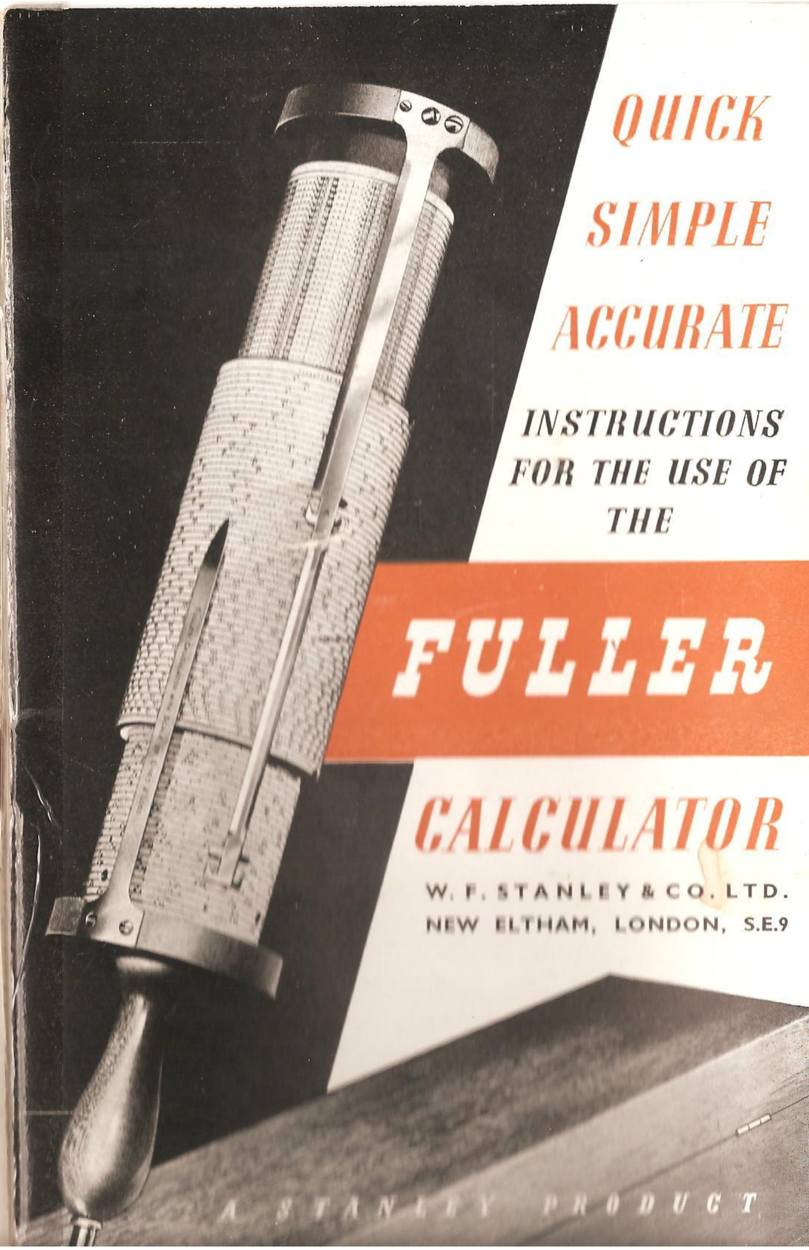
i.e., $C = 134{\cdot}02$ yards.

QUICK
SIMPLE
ACCURATE

INSTRUCTIONS FOR THE USE OF THE

FULLER CALCULATOR

W. F. STANLEY & CO. LTD.
NEW ELTHAM, LONDON, S.E.9



PROFESSOR FULLER'S

CALCULATORS

HAVING A

LOGARITHMIC SCALE OF NUMBERS

41 Feet 8 Inches in Length

GEORGE FULLER, M.Inst.C.E.

FORMERLY PROFESSOR OF ENGINEERING
IN THE QUEEN'S COLLEGE, BELFAST

INSTRUCTIONS
FOR THE USE OF THE
CALCULATOR

STANLEY

TRADE MARK

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MODEL No. 1

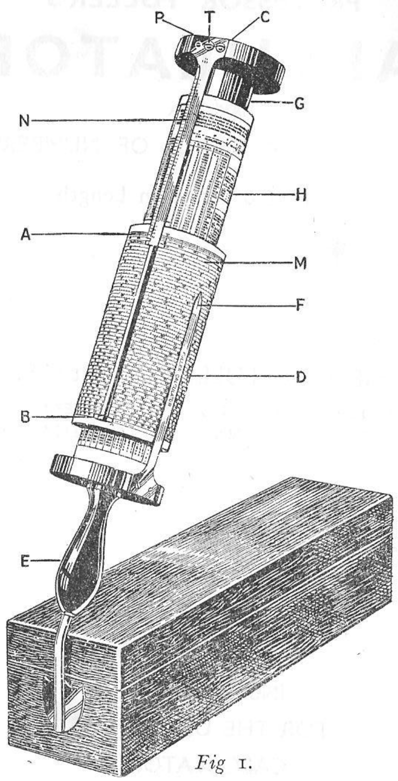

Fig 1.

The **Fuller Calculator** as used on its support, which is attached to the end of the box. When not in use the support is kept in a fitting inside the box.

THE FULLER CALCULATOR

is a logarithmic calculator. Its fundamental principle is precisely the same as the ordinary Slide Rule, but it differs radically in mechanical construction.

The principles of logarithmic calculators are too well-known to those likely to be interested for it to be necessary to enlarge upon the subject here, especially as it is absolutely unnecessary to have any knowledge of the subject to use the calculator.

The **FULLER CALCULATOR** will perform all calculations involving:

MULTIPLICATION	PERCENTAGES and
DIVISION	COMBINED MULTIPLICATION
PROPORTION	and DIVISION,

giving an accuracy of 1 in 10,000.

It costs only a fraction of the cost of an Arithmometer, and it is far less complicated to use. Its construction is so simple that there is nothing to get out of order, consequently maintenance charges are practically nil.

Anyone can calculate with the Fuller after a brief study of the following instructions **without any mathematical knowledge whatever.**

For **Percentage** and **Proportional Calculations** it is the most efficient calculator of its type in existence.

DESCRIPTION

The Calculator consists principally of a cylinder *D* about 6 inches high by 3 inches diameter, on which is mounted the spiral logarithmic calculating scale, which is **500 inches in length.**

This revolves and slides on an inner cylinder *H*, which is held by a handle *E*. The settings are made and the calculations effected by use of the metal pointers or indexes *A* & *B* & *F* shown in the illustration.

As the accuracy of a Logarithmic Calculator, other things being equal, is directly proportional to its length, the vast superiority of this calculator over all others working on the same principle is obvious.

The instrument is contained in a mahogany Box, which is also adapted for use as a stand to save the fatigue of holding the instrument in the hand. *See Fig.* 1.

Three different models are available. All are similar in construction but two of them bear additional scales on the inner cylinder *H*, a description of which will be found in the followin pages.

MODEL No. 1

For calculations involving :

MULTIPLICATION	PERCENTAGES and
DIVISION	COMBINED MULTIPLICATION
PROPORTION	and DIVISION.

This model has no scale on the inner cylinder *H* which is occupied by a table of useful data.

The Spiral Scale is divided as follows :

Each of the primary divisions as far as 650, is divided into ten parts, and from thence to 1000 into five parts ; so that all numbers of four figures have either a mark upon the scale, or are midway between two marks. Thus 4786 is shown by a mark ; also 8432 ; but 8431 is not shown by a mark, but is midway between 8430 and 8432. In a large part of the scale the space between these secondary divisions is large enough to be easily divided into parts by the eye. Thus many numbers of five figures are easily shown ; for example, 26854. There are the first three figures at 268, then 5 is at the fifth secondary division, and the 4 must be estimated by the eye as $\frac{4}{10}$ of the space between 2685 and 2686. As the decimal point is arbitrary the same figures do not always mean the same amount. Thus to represent 26854, 2685·4, 268·54, 26·854, 2·6854, ·26854, ·026854, etc., the same point on the scale is used.

To fix the decimal point in the result obtained (**though this may** ***most frequently*** **be determined merely by inspection**), rules will be given founded on the characteristics of the logarithms of numbers.

The index of the logarithms of numbers

between	1000	and	9999	is	3,
,,	100	,,	999·9	,,	2,
,,	10	,,	99·99	,,	1,
,,	1	,,	9·999	,,	0.
,,	·1	,,	·9999	,,	$\bar{1}$,
,,	·01	,,	·09999	,,	$\bar{2}$,
,,	·001	,,	·00999	,,	$\bar{3}$.

INDEXES OR READERS. (Common to all three Models.)

These are three in number. *See figure* 1.

(1). *F* the fixed index.

(2). *A* the top movable index.

(3). *B* the lower movable index.

The *A* and *B* movable indexes actually consist of two pairs of indexes, namely, one pair on the left, and one on the right. Those on the left should be used whenever possible, as it is easier to read the scale when the previous graduations are visible. It sometimes happens, however, that when using the left index a calculation terminates with the fixed index *F* disposed immediately over the bar of the *A* and *B* indexes, making it impossible to read the answer. In such cases, which will be rare, the calculation must be repeated, using the right index.

The bar carrying the movable indexes lies closely against the cylindrical scale, but the fixed index stands well away from the scale to allow the movable bar to pass freely under it and is pressed down by the thumb of the left hand when taking a reading.

Either *A* or *B* may be used and usually it is only possible to use one of them as the other will be off the scale. **Whenever possible** ***A*** **should be used in preference to** ***B*****.**

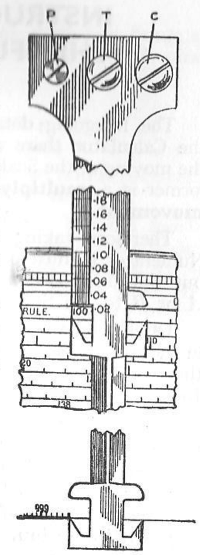

Fig. 2.—Showing Position of Indexes *A* and *B* when correctly adjusted

TO ADJUST THE INDEXES

Before attempting to calculate it is as well to see that the Indexes *A* and *B* are in correct adjustment.

Referring to the illustration, it will be seen that they are fixed exactly the length of the spiral scale apart.

When the index *A* is set to the beginning of the scale, the index *B* should coincide with the last division on the scale. Should it not so coincide owing to the bar being out of adjustment, viz., not parallel to the axis of the cylinder, it can be adjusted by means of the screws fixing the bar to the inner cylinder at the top. *See figure* 2.

P is a pivoting screw. *T* is the tightening screw and *C* is not really a screw at all, but a **Cam.** If *T* is released and *C* turned, the bar will be seen to move from side to side, with respect to the Axis of the instrument. When it is in correct alignment, tighten *T* and the rule is ready for use.

Example.—What percentage of 840 are the following numbers ?

336	231	73·5	and	47·25
40%	27·5%	8·75%		5·625%

Bring 840 to the fixed index and set the movable indexes to the ends of the scale, that is, the 100 and 1,000 marks respectively; now shift the scale to bring 336 to the fixed index. The movable index then shows the percentage to be 40. Then bring the following numbers in turn to the fixed index, when the percentage will be simultaneously found at the movable index.

To Add or Subtract a Percentage.—Bring 100 to the fixed pointer and set the movable index to 100 plus or minus the required percentage. The percentage ratio is now set and any amount brought to the fixed index will reveal the corresponding amount under the movable index *A* or *B*.

Example.—Add 2½% to £40; £120; £60. Bring 100 to the fixed index *F* and set movable index *A* to 102½ or 102·5. Bring £40; £120; and £60 in succession to the fixed index *F* and the respective answers will be found under the movable index *A*, namely £41; £123; and £61·5.

To subtract 2½% the procedure is exactly the same, but the movable index *B* would be set to 100—2½ or 97·5.

INSURANCE BROKERAGE CALCULATIONS BY THE FULLER CALCULATOR

How much are 10%, 15%, 25%, ½%, 4½% and 45% of £586 18*s*. 3*d*.

Bring 100 to the fixed index to represent 100% and set the movable index to £586·9125, the decimal equivalent of £586 18*s*. 3*d*.; then bring each of the percentages to the fixed index, when whichever of the movable indexes is upon the scale will show the answer as follows:—

				£	*s*.	*d*.
10%	—	58·69125	or	58	13	10
15%	—	88·035	or	88	0	9
25%	—	146·73	or	146	14	7
½%	—	2·9345	or	2	18	8
4½%	—	26·411	or	26	8	3
45%	—	264·11	or	264	2	2
		£586·9090		£586	18	3

Example 1.—£60,000 @ 5/6%—£165. Bring 600 (for 60,000) to the fixed index and set the upper movable index *A* to 20; then bring ·5 (5/6) to the lower movable index *B* when the index *F* shows the answer to be 165.

Example 2.—£5,000 @ 7/5%—£18 10*s*. 10*d*. Bring 500 (for 5,000) to index *F* and set the index *A* to 20; then bring 7·417 shillings to the lower index, when the index *F* reads £18·541.

Example 3.—£12,000 @ 10/6%—£63. Bring 120 (12,000) to index *F* and set the index *B* to 20; then bring 10·5 (10/6) to index *A*, when index *F* shows the answer as £63.

Example 4.—£400 @ 10/6%—£2 2*s*. 0*d*. When dealing with small amounts it is sometimes more convenient to read the answer in shillings instead of in pounds and decimals, so bring 400 to index *F*, as usual, but place the index *A* at 100 (1) instead of at the division 20. Then bring 10·5 (shillings) to the index *A*, when the index *F* gives the answer as 42/-.