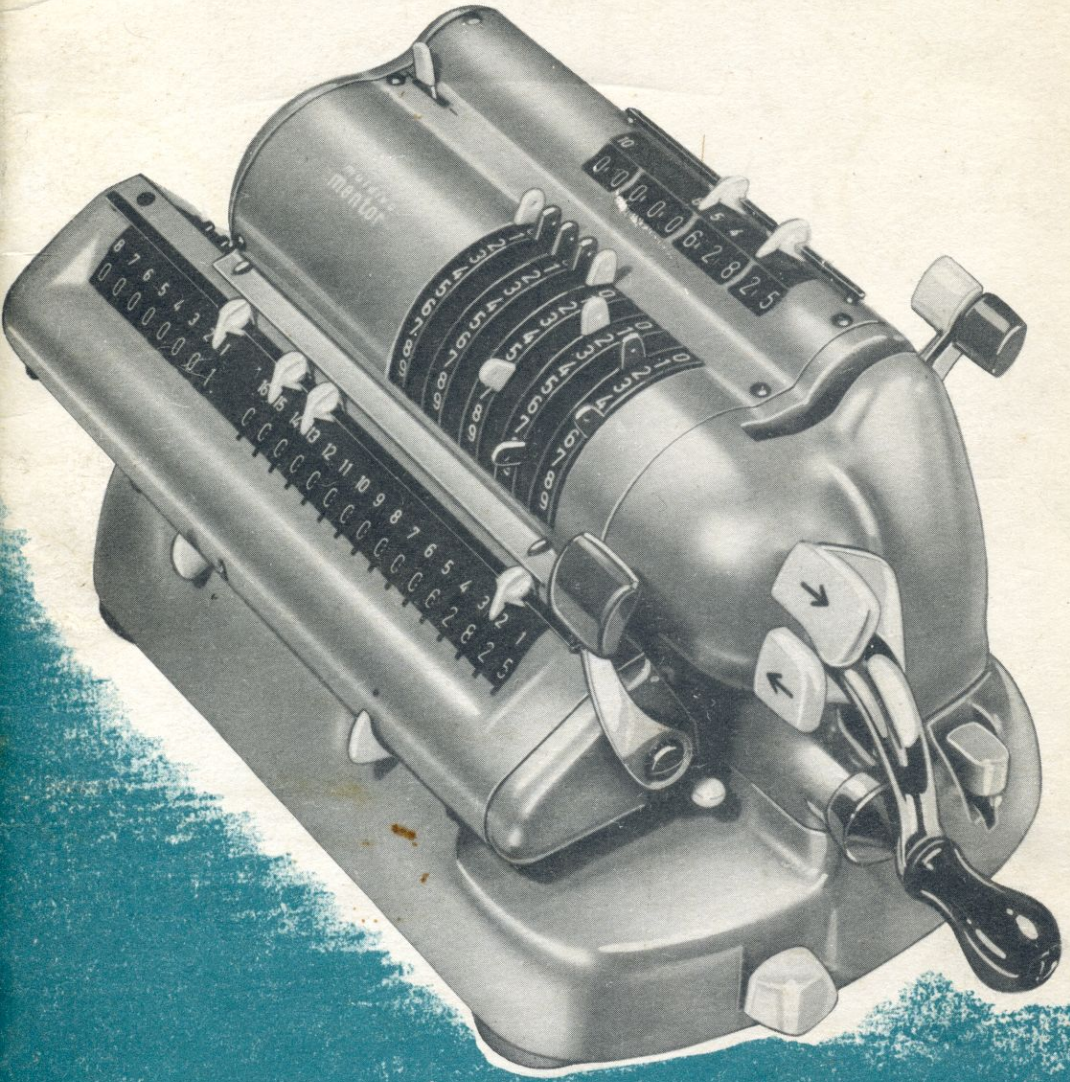
MULDIVO LTD.

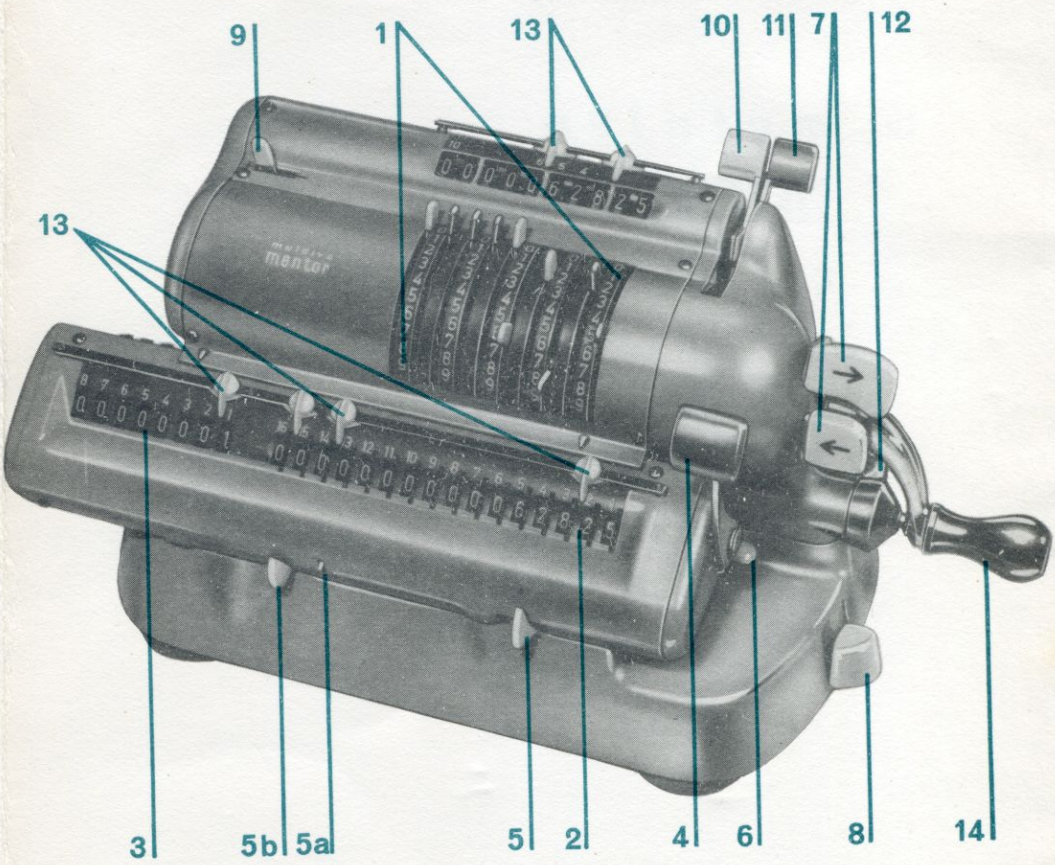


*muldivo*

# mentor

# instruction manual

INDEX:


9
1
13
10
11
7
12
13
3
5b
5a
5
2
4
6
8
14

# instruction manual

**MULDIVO MENTOR CALCULATOR**

## PRELIMINARY REMARKS

No special training is required for operating the MULDIVO MENTOR Calculating Machine. Just read carefully the following explanations, and once you have mastered the examples given, you will experience no difficulty in solving the particular calculating problems with which you may be faced in your own work.

All operating levers are so arranged as to enable the operator to handle them with the right hand only.

Automatic locks prevent false handling and consequent damage to the machine. Please bear in mind that your MULDIVO calculating machine is a precision instrument and that force should never be used if it should lock. When it occurs, it is most likely caused by one of the levers not being in its correct position, so first check up on this. If the machine cannot be freed, a mechanic had better be called in.

A turn of the crank handle once begun must always be completed in the same direction. If begun in error, it must be completed and the mistake corrected afterwards by a complete turn in the opposite direction.

## DESCRIPTION OF THE MACHINE

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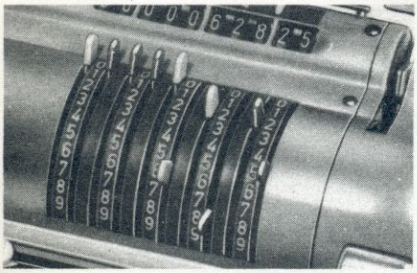


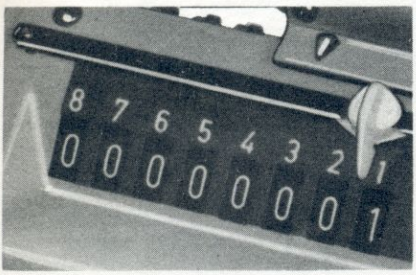
1 Setting levers with setting register

The setting levers are used for setting up the number with which a calculation is to be performed. To set the number 123, pull down lever No.3 to 1, lever No.2 to 2 and lever No.1 to 3.

The number set shows in the setting register, where it remains visible during the operation.

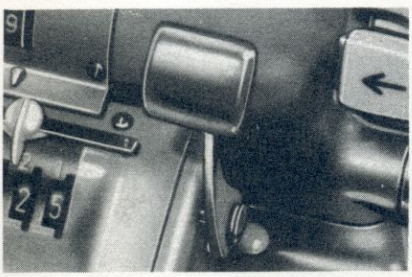
2 Product or result register

Takes up the right hand portion of the carriage. So called because it is here that the results of additions, subtractions and multiplications appear.




3 Counting or Quotient Register

Forms left hand part of carriage. It counts the revolutions of the crank handle and registers the results of divisions.



4 Clearing lever for product and counting registers

By pulling this lever down both registers are cleared simultaneously. At the same time, the carriage can be made to return to its initial position, i.e. over to the extreme left.

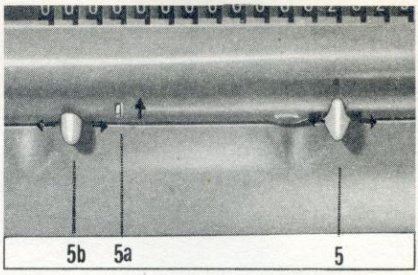
5 Lever for selectively clearing the result register or revolution register

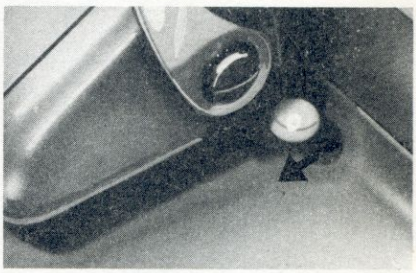
If only the result register is to be cleared, shift selector lever to right before actuating the clearing lever. If wishing to clear only the revolution register, shift lever to left before clearing. On clearing, the selector lever returns to neutral.

5a Correction of selector lever

If the selector lever has been shifted in error, move the little correction pin upwards; this causes the lever to return to neutral.

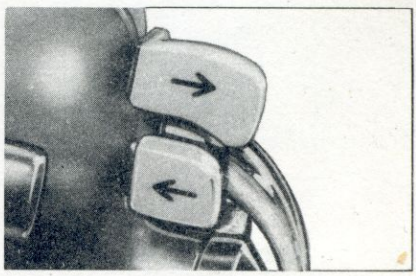
5b Locking lever for locking selector lever in either of its two positions



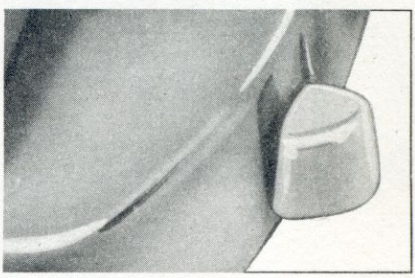
6 Lever for disconnecting carriage return mechanism

When this lever is moved forwards, the automatic carriage tabulating mechanism is disconnected. The carriage therefore remains stationary when the clearing lever 4 is operated.



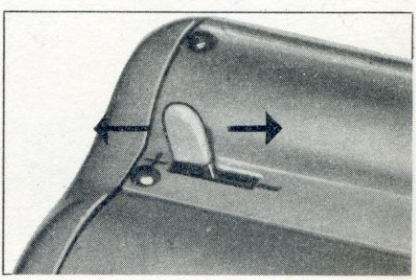
7 Carriage movement keys

For tabulating the carriage to right or left, one space at a time.



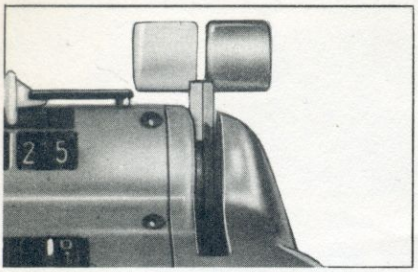
8 Carriage release key

Pressing this key allows the carriage to move over to the extreme left.



9 Plus-Minus control lever

It functions automatically. Needs shifting to Plus or Minus by hand only for some special operations.



10 Clearing lever for setting levers

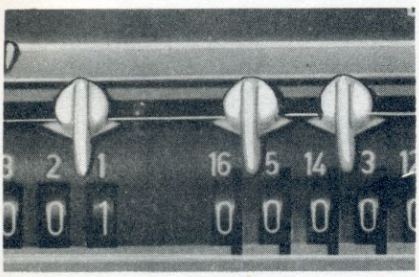
To cancel a number set in the setting register pull the clearing lever towards you.

11 Back-transfer lever

Connected with the clearing lever (10). To transfer a number from the result register back into the setting register, pull the combined clearing/back-transfer levers towards you, the back-transfer lever (11) with middle finger past the clearing lever stop until it becomes engaged. Pull down carriage clearing lever (4), thereby causing the number standing in the result register to be transferred back up into the setting register. The transfer effected, both levers revert to their initial position.

12 Back-transfer release button

If the back-transfer lever has been operated in error, release it by pressing the release button.




13 Decimal indicators

Used for marking off decimals in all registers; this greatly facilitates correct reading of figures.

14 Operating crank handle

To turn the crank handle pull the handle to the right and make quick even revolutions. Before completion of the last revolution, release the handle, allowing it to fall back toward the machine. The handle-pin thus enters its catch, preventing further movement.

## Initial position

The machine is in its initial position with the carriage shifted all the way to the left. Make sure all registers are cleared, showing zeros in all dials.

In working with the machine, place it on the table before you in such a way that you can rest the right elbow comfortably on the table. It does not matter if the machine stands before you at an angle. In turning the crank handle, move the hand lightly from the wrist to avoid fatigue.

# THE FOUR ARITHMETICAL PROCESSES ON THE MULDIVO CALCULATING MACHINE

## Addition

Shift carriage completely to left. Set 43, pulling down lever 2 to 4 and lever 1 to 3. Turn crank handle once clockwise. Change 43 to 376 without clearing setting register. Another clockwise turn of crank handle. The result shows in the right-hand register (result or product register). The 2 which has appeared in the left-hand register indicates that two numbers have been added.

Example 1:

43
376
419

## Addition of decimal fractions

Here the decimal indicators come in handy. They should be set at the beginning of an addition both in the setting and the result registers. Take care that the units, tens etc. are always set in the same column. The number 24, for example, must be set accordingly with levers 5 and 4.

Example 2:

13.500
89.350
24.000
357.365
484.215

## Subtraction

Shift carriage completely to left. Set 2376.35 with levers 6 to 1, setting decimal indicator in setting check register between dials 2 and 3. One clockwise turn of the crank handle. Change 2376.35 to 1953.03. Turn crank handle once anti-clockwise. The result appears in the product register.

Example 3:

2376.35
- 1953.03
423.32

## Multiplication

Shift carriage completely to left. Set 6 with lever 1. Three clockwise turns. The answer appears in the product register, in dials 1 and 2. The revolution register indicates the multiplier 3.

Example 4:

6 x 3 = 18

When multiplying 6 by 33, it is not necessary to turn the crank handle 33 times. After three turns with the carriage in position 1, space carriage to second or tens position by pressing carriage return key, then making three more clockwise turns.

Example 5:

6 x 33 = 198

When doing multiplications with figures of several digits, as in example 6, always be sure to set the larger number of the two and multiply by the smaller, or more exactly the one requiring the lesser number of rotations. Thus, in example given in the margin, you set 37 846 and multiply by 345, making 5 rotations first in the units position, then 4 in the tens position and finally 3 in the hundreds position.

Example 6:

37 846 x 345 = 13 056 870

## Short-cut multiplication

The short-cut method is used whenever any one digit of the multiplier is over 5. In example 7, set 674 in the usual way. Space carriage to tens position, then turn twice clockwise. Now shift carriage back to units position, making two anti-clockwise turns. You now have produced the multiplier 18 by subtracting 2 from 20, thus eliminating five turns.

Example 7:

674 x 18 = 12 132

Example 8:

5 674 x 876 = 4 970 424

Using the same method to solve example 8, you would have to find the complement of 876 on 1000. To save yourself this trouble, you begin this time with the carriage in position 1. Move Plus-Minus lever to PLUS and turn once anti-clockwise. This causes all the dials of the revolution register to show nines. All you have to do now is to transform these nines into the numbers required by continuing to make anti-clockwise turns. In the present example, this means three more anti-clockwise turns in the units position, two in the tens position and one in the hundreds position. To remove the remaining nines from the counting register, shift carriage one notch further to right and turn once clockwise.

Example 9:

158 824 x 193 = 30 653 032

In example 9, you start using the short-cut method only after multiplying by 3 in the conventional way, i.e. by making three clockwise turns with the carriage in the units position. This done, space carriage to tens position and turn once anti-clockwise, which makes the remaining dials of the counting register indicate nines. Since the second digit of the multiplier is 9, no further rotation is required in the tens position. The 1 in the hundreds position is obtained by two clockwise rotations.

This time it is not necessary to move the Plus-Minus lever, because you do not start right away with short-cut multiplication.

Example 10:

26.98 x 98.324 = 2652.78152

The placing of the decimal points in multiplication

According to the well-known rule, the product must have as many decimals as the two factors have together.

The two factors in example 10 having together five decimals, the decimal indicator in the result register must be placed between the dials 5 and 6.

Continuous multiplications (Chain multiplications)

The MULDIVO MENTOR is equipped with a back-transfer feature enabling problems of the type a x b x c ... to be solved without resetting of intermediate products.

Example 11:

125 x 13 x 45 = 73 125

Example 11: Set 125 and multiply by 13. Tabulate carriage back to initial position. Pull setting register clearing lever back towards you and engage back-transfer lever by pulling it with the middle-finger past the clearing lever stop. Pull down carriage clearing lever 4, thereby transferring the intermediate product 1625 back into the setting register and, at the same time, clearing the counting register. Now multiply by 45.

Example 12:

0.85 x 3.14 x 17.5 = 46. 70750

When doing chain multiplications with decimals (example 12), remember to place the decimal indicator in the result register following the rule given above, i.e. marking off as many decimals in the final answer as all the factors have together.

DIVISION

a) Division by subtraction

Shift carriage completely to right. Set dividend 144 in highest columns of result register using the little discs located beside the figure wheels (the setting discs must be moved upwards). You may also begin by setting the dividend in the setting register and then transferring it into the result register by one clockwise turn of the crank handle. In this instance, do not forget to clear the 1 which appears in column 8 of the revolution register. Place decimal indicator in result register behind 144.000 .. Now set divisor on setting register with levers 9 and 8. To avoid confusion, a blue spot has been marked at the head of the column in which the highest digit of dividends and divisors may be set.

Example 13:
144 ÷ 12 = 12

Place decimal indicator in setting check register behind 12.00.

The machine now counts how many times 12 can be subtracted from 144. The result, the quotient, will appear in the quotient register. Before beginning to divide, set the decimal indicator in the quotient register in accordance with the following rule:

Number of columns to the right of the decimal point in results register less number of columns to the right of decimal point in setting register = number of columns to be marked off by decimal point in quotient register.

The difference is 13 - 7 = 6. You thus place the decimal indicator in the quotient register between the dials 6 and 7.

You now start dividing by turning anti-clockwise until the bell rings. The bell signal means that you have made one anti-clockwise rotation too many, which must be corrected by turning the crank handle once the opposite way. In our example, the bell rings at the second turn. After correcting the over-turn by one clockwise turn, space carriage one place to left with the appropriate carriage movement key, and continue subtracting until the bell rings again, when you again compensate for over-turn by one in the opposite direction.

Example 14:
5345.73 ÷ 351 = 15.23

Example 14a:
331.21 ÷ 75 = 4.416133

The problem is solved after two rotations in column 7 of the quotient register, the dividend having disappeared completely from the result register and the quotient register showing the result of the division = 12.

Practise division with the examples indicated in the margin.

b) Division by addition

In division by addition the divisor is set in the setting register and the dividend formed in the product register below it by the corresponding plus or minus rotations.

Example 15:
5616 ÷ 36 = 156

In order to solve example 15, set 36 with levers 1 and 2, pushing carriage completely to right. Now we try to produce the dividend 5616 in the product register by multiplication and shifting the carriage to left as necessary.

The first clockwise rotation, with carriage shifted completely to right, brings 3 in column 9 of the product register. The next turn brings 3 up to 7, but since the first digit of the dividend is 5, this turn is clearly in excess and must therefore be corrected by an anti-clockwise turn of the crank handle. Space carriage one place to left, turn five times, space carriage again one place further and turn six times.

While turning the crank handle, keep comparing the figures that appear in the product register with the respective digits of the dividend, correcting as necessary by turns in the appropriate directions.

This method of division has the twofold advantage of requiring only one number to be set and of retaining the dividend, divisor and quotient in the machine, whilst in division by subtraction the dividend disappears as the division proceeds.

We recommend you to practise this method of division with other examples. Set decimal indicators following the rule indicated above.

## SPECIAL AND COMBINED CALCULATIONS

The possibilities offered by machine calculation are by no means confined to the solution of simple problems such as described in the foregoing paragraphs. With your MULDIVO calculator you can do more than this: it enables you, for instance, to carry out simultaneously different operations which otherwise must be performed one after the other. In the following paragraphs some of these special methods and short-cuts are described.

### Multiplication with addition of products

Example 16:

491 x 65
612 x 19
96 x 81
51 319

Calculate the first product 491 x 65. Clear revolution register, but allow product to remain in product register. Tabulate carriage back to initial position. Calculate second product (using short-cut method), again clear revolution register, shift carriage back to initial position and calculate third product. The products add up in the product register, which at the end shows the grand total of 51319.

Example 17:

4.25 x 0.75
\+ 23.30 x 3.18
\- 8.25 x 7.13
18.4590

In the same way it is possible to subtract one product from another, the only difference being that you have to multiply by making anti-clockwise rotations, (Example 17). In multiplying and simultaneously adding or subtracting decimals, take care that the units, tens etc. are in the same columns in the product register. This means that if one product has, for example, 5 decimals, the other products which are to be added or subtracted must be made to have the same number of decimals.

### Multiplication by a constant

Example 18:

412
516
527 x 13.25
693

Set constant as multiplicand with levers 4 - 1. Multiply by the first factor, 412. Do not clear revolution register but transform 412 into 516, which requires five more turns. Proceed in the same manner with the other multipliers.

### Division by a common divisor

Example 19:

315
1345 ÷ 45
75
693

The quickest way of doing several divisions by a common divisor is to multiply by the reciprocal of the divisor. The reciprocal is obtained by dividing 1 by the number. In our example, the division of 1 by 45 is 0.022222 ... Set up this constant and proceed as described in the paragraph "Multiplication by a constant".

### Multiplication with addition of multipliers and products

Example 20:

23.50 x 13
17.75 x 114
117.00 x 89
39.13 x 7
13 015.91

In example 20 it is required not only to calculate the sum of the different product , but also to obtain the sum of the multipliers, all in one operation. A very simple trick will help you to do this. If you set the figure 1 in column 10 of the setting register, it is obvious that while the right-hand portion of the result register shows the product 23.5 x 13, the left-hand portion simultaneously registers the product 1 x 13 = 13, that is, the multiplier itself. Take care not to clear the

Sum of multipliers: 223

1 from the setting register, but clear the revolution register after each multiplication, thus using it to check individual multipliers, while their sum is being accumulated at the left of the product register.

Multiplication followed by division

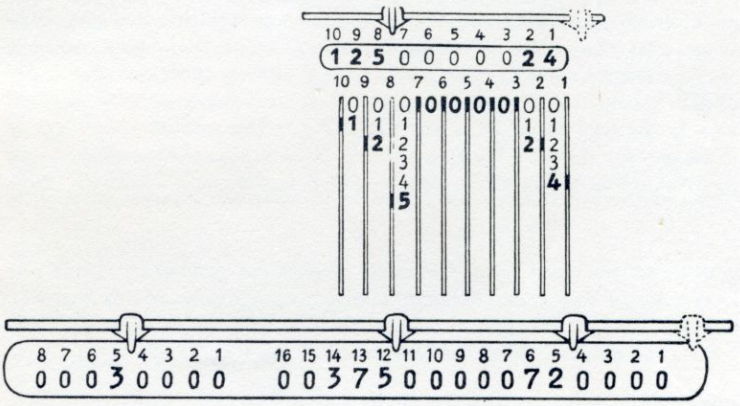
Example 21:

375 x 24
125

Begin by multiplying 375 x 24, setting multiplicand in the left-hand portion of the setting register with levers 9 - 7. Shift carriage completely to right and multiply by 24. Clear revolution register and setting register, set divisor 125 above product using levers 9 and 8, and divide by subtraction.

It is even possible to do this combined calculation in one operation. To this end, you set 125 at the left-hand side and 24 at the right-hand side of the setting register. Push carriage to right so that the red mark on the ledge above the counting register indicates the column 5. Now form the dividend 375 in the product register using the method of division by addition. It is not difficult to see that simultaneously with the division going on, the 24 set on the right is multiplied by the quotient (i.e. the result of the division 375 ÷ 125) forming in the counting register. (See illustration below).

Placing of the decimal indicators: in the quotient register 11 - 7 = 4. In the product register: 4 + 0 = 4 (four decimals in the quotient register).




Extraction of square roots

Example 22:

$\sqrt{\phantom{x}}$ 31' 45.00

One method of extracting square roots on the calculating machine is based on the fact that one always gets a square by a continuous addition of odd numbers (1 + 3 + 5...). It is obvious that, conversely, one must obtain a root by continuous subtraction of the odd numbers.

Example 22: Set 3145 in the columns 16 - 13 of the result register. Remember that before extracting the square root of a number, this has to be divided into groups of two figures each, beginning from the decimal point. As the number in the present example consists of two groups, the root is going to have two digits to the left of the decimal point. Therefore, place decimal indicator between columns 7 and 6 in the counting register.

Now set the first odd number, 1, with lever 8, that is, above the first group of the number. One anti-clockwise turn. Pull lever 8 to 3. Another anti-clockwise turn. Pull lever 8 successively to 5,7,9, each time making one anti-clockwise turn. As the bell has not yet rung, we must go on to the next odd number, 11. This you set with levers 8 and 9. On turning the crank handle backwards, you are warned by the bell that this subtraction exceeds the number above it. Correct it by one clockwise turn, reduce 11 to 10 by moving lever 8 back to zero. Space

carriage one notch to left and set 1 with lever 7. Leave lever 10 set on 1. In this position, subtract successively 1,3,5,7,9,11 (setting the latter with levers 7 and 8). As the bell still does not ring, increase 11 to 13. On turning the crank handle anti-clockwise, the bell rings. Correct the over-turn by one clockwise turn, reduce 13 to 12 by moving 7 back to 2, space carriage one notch to left, and set lever 6 on 1. Since the bell rings at the first anti-clockwise turn, correct it immediately, by pushing lever 6 back to zero, spacing carriage one notch to left and setting lever 5 on 1. Carrying on in the same manner to the limit of the machine's capacity you obtain in the quotient register the root 56.080295.

To check the result, multiply the root by itself, obtaining 3144.999487287025. The difference is insignificant and is due to the fact that we did not calculate the root to a greater number of digits behind the decimal point. For practical purposes, however, the result obtained is sufficiently accurate. This method, although somewhat tedious, is self-checking as the number finally set on the keyboard should always be twice the root extracted.

Example 23:

$\sqrt{\overline{6'76'25.00}}$

A quicker way of extracting square roots consists of using a table such as is contained in most technical handbooks or manuals, and where the square root of any number between 1 and 1000 can be found. Look up the square root of 676, the figure coming nearest to the number. Set 67625 in result register (columns 16 - 21), and above it, with levers 9 and 8, the root taken from the table (26). The number consisting of three groups, the root is going to have three digits. Accordingly, set decimal indicator between dials 6 and 5 in the result register. Now divide.

A value of the root, correct to about double the number of significant figures in the first approximation, is given by the mean of this approximation (26) and the answer to our division (26.0096), i.e. 26.005. Repeat the process, using the new value, if desired.

## CALCULATIONS IN BRITISH CURRENCY

### Conversion of decimal currencies into £ and vice-versa

Example 24: Convert £ 23.15.9. into U.S. $. Rate of exchange £ 1 = $ 2.80. Look up your decimal table for decimal equivalent of 15/9 = 0.7875. Set 23.7875 and multiply by 2.80. Result: £ 23.15.9. = $ 66.60(5).

Example 25: Convert US $ 375.50 into £. Rate of exchange: US $ 1.00 = £0.3571.

Set 375.50 and multiply by 0.3571. The product is 134.091050. Look for .091050 in the decimal table or, if not contained in it, for the figure nearest to it, which is .09167. The result, expressed in terms of pounds, shillings and pence is £ 134.1.10.

### Computation of percentages

Example 26: Some practical examples.

The retail price of an article is $ 49.75, the discount 35%. What is the amount of the discount and the net price ?

Set 49.75 with levers 4 - 1 and multiply by 35, after marking off four decimals in the product register. Record result. Do not clear any of the registers but transform 35 in counting register into 65, (the net price being 65 % of the gross price).

Another way of solving this problem is the following: Set 65 with levers 2 and 1, and 35 with levers 10 and 9 and multiply both by 49.75, thus obtaining in the right-hand side of the result register the net price = 32.337, and in the left-hand side the discount = 17.412.

Example 27:

A price is to be fixed so that on deducting 35 % there remains a net price of $ 12.60.

12.60 is 65 % of the price wanted (x). This can be expressed by the formula:

$$12.60 = \frac{x \cdot 65}{100} \quad \text{or} \quad x = \frac{12.60 \times 100}{65}$$

The problem is thus reduced to a simple division.

Calculate £ 63.15.6 less 35 % rebate, less 2 % cash discount.

Example 28:

| | |
|---|---|
| | £ 63.15.6 |
| less 35 % = | £ 22. 6.5 |
| | £ 41. 9.1 |
| less 2 % = | £ 16.7 |
| | £ 40.12.6 |

Look up decimal table for decimal equivalent of 15/6 = 0.775. Set 63.775 and multiply by 35. The amount of the rebate is shown to be 22.32125 = £ 22.6.5. Change 35 in revolution register to 65 = net price. This is shown to be 41.45375 = £ 41.9.1. Transfer 41.45375 back into setting register and multiply by 2, after marking off seven decimals in the product register. The result is 0.8290750 = 16/7. Now change 2 in counting register to 98 by first making four anti-clockwise turns in the units position, shifting carriage to hundreds position and finishing up with one clockwise turn. The final result showing in the product register is 40.624675 = £ 40.12.6. The problem requires the setting of only one number in the setting register.

Computation of interest

What is the amount of interest payable on £ 145.15.6 at $3\frac{1}{2}$ % in 30 days?

The interest formula is:

$$\frac{\text{Capital} \times \text{interest} \times \text{days}}{365 \times 100}$$

This can be simplified into:

$$\frac{\text{Capital} \times \text{days}}{\text{Fixed divisor}} = \frac{145.775 \times 30}{10285.714}, \text{ or alternatively,}$$

Capital x days x fixed multiplier =
145.775 x 30 x 0.0000972222

Additions in British currency

| | |
|---|---|
| £ | 3.12. 3 |
| £ | 59.15. 6 |
| £ | 7. 1. 4 |
| £ | 126.19. 9 |
| £ | 197. 8.10 |

Mark off by decimal indicator three groups of columns both in the setting register and the product register. The first two groups (of three columns each) from the right are for the pence and shillings. The remaining columns are for the pounds.

Set first amount like this; 3012003 (using levers 7 - 1). One clockwise turn. Add to this the second amount, which has to be set as follows; 59015006. In the same way set third and fourth amounts, making one clockwise turn each time. The total obtained is 195047022.

To get the pounds, shillings and pence correct, continue as follows:

Set complement of 12 = 88 plus one 9 in front, above pence columns in product register (using levers 3 - 1), and start clockwise turns. Each turn makes the amount of pence in the product register diminish by 12. On the first turn, the number of pence is reduced to 10.

Clear setting board. Set complement of 20 = 80 plus one 9 in front = 980 exactly above the shillings columns in the product register (using levers 6 - 5), and turn clockwise. On the second turn the amount of shillings has been reduced to 8. The result can now be read correctly as £ 197. 8.10.

Note: In this particular case the figures in the pence and shilling columns each become "normal" after only one turn. This is exceptional and usually several turns of the two complement figures are required.

Subtractions in British currency

A similar method is used for subtraction of Sterling amounts.

Example

| | |
|---|---|
| | £ 26.13.6 |
| - | £ 14.15.9 |
| | £ 11.17.9 |

Set £ 26.13.6 in the same way as described for addition, namely as 26013006, and add. Now set up £ 14.15.9 in the same manner and subtract. The product register shows 11997997. Set complements of 12 and 20 plus one nine before each, like this: 980988. One anti-clockwise turn allows the correct result to appear in the product register.

This method is based on a calculating trick called the "bridge of nines". You will understand it by visualizing that, in the first example, by adding the complement of 12 (= 88) to the 22 in the product register this number is brought up to 110. Owing to the 9 set in front, the 1 in the hundreds position, by the action of the tens transmission, is made to pass, as across a bridge, on to the 47 in the shillings column, leaving 10 in the pence columns, and so on.

**MULDIVO MENTOR CALCULATOR**
**INSTRUCTION MANUAL**

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