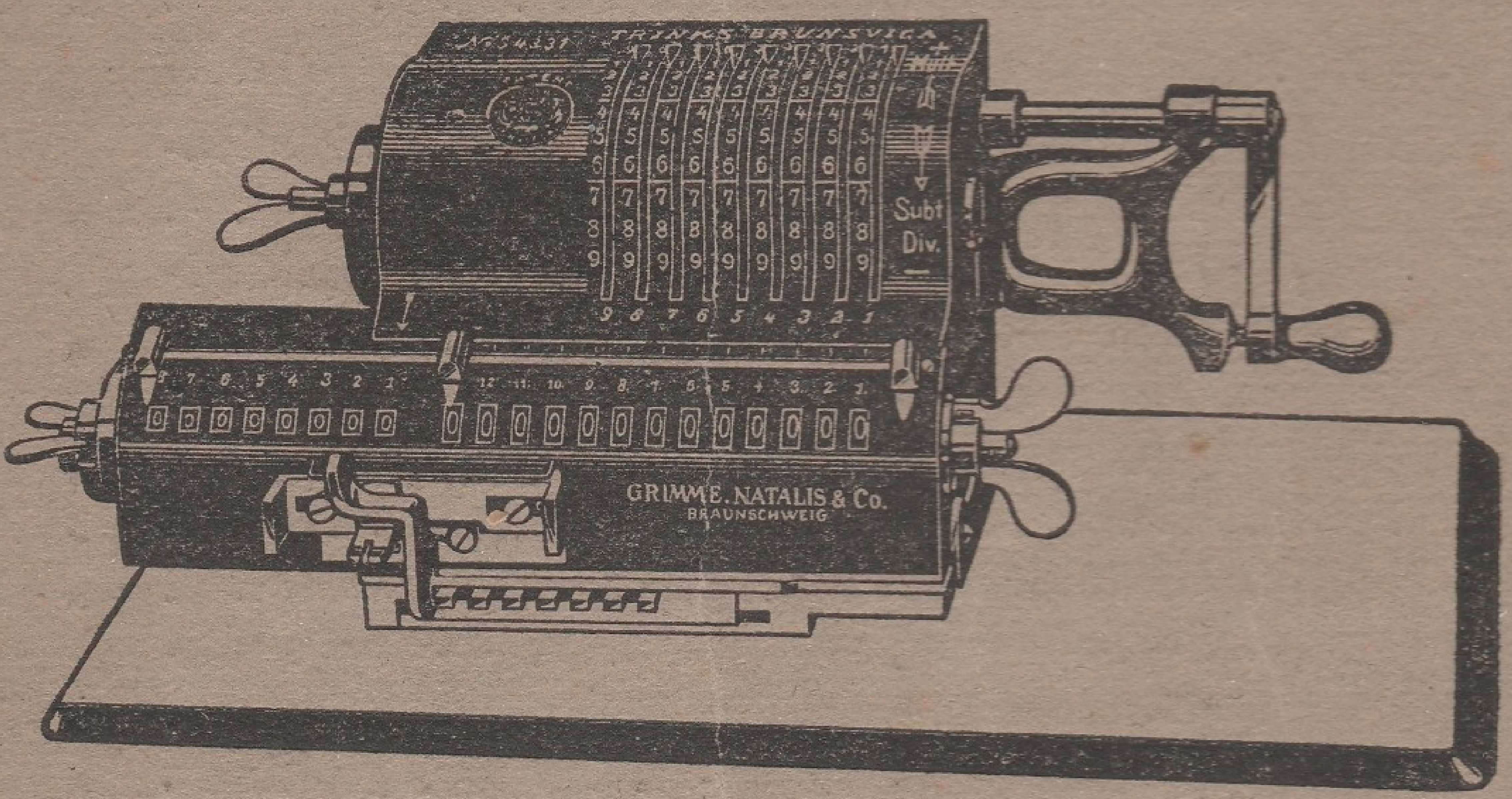
GENERAL INSTRUCTION BOOK

FOR THE

BRUNSVIGA

(SYSTEM TRINKS)



UNIVERSAL CALCULATING MACHINE

BRUNSVIGA CALCULATOR CO.,
4. ST. PAUL'S CHURCHYARD
LONDON E. C. 4.

Form. 1235. 1000. X. 22.

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Brains of Steel

BRUNSVIGA

(SYSTEM TRINKS)

THE STANDARD CALCULATING MACHINE.

Proves every Calculation

LEADING FOR 30 YEARS.

Simple to operate and reliable in use.
No brain effort or fatigue.
Rapid and accurate.
Perfect control, all figures being visible.
No checking required.

INTRODUCTION.

The use of the Calculating Machine in our days has become so common that there is hardly a single line of business, scientific or statistical work, to the figure-work of which it has not been adapted with the greatest advantage.

The operation of the „Brunsviga" is amazingly simple, in fact so easy that any person, familiar with the four rules of arithmetic, can add, subtract, multiply and divide on the machine after half-an-hour's practice. This, however, is not sufficient for the owner or user of the machine, who of course must get the greatest value from it by efficient and quick work.

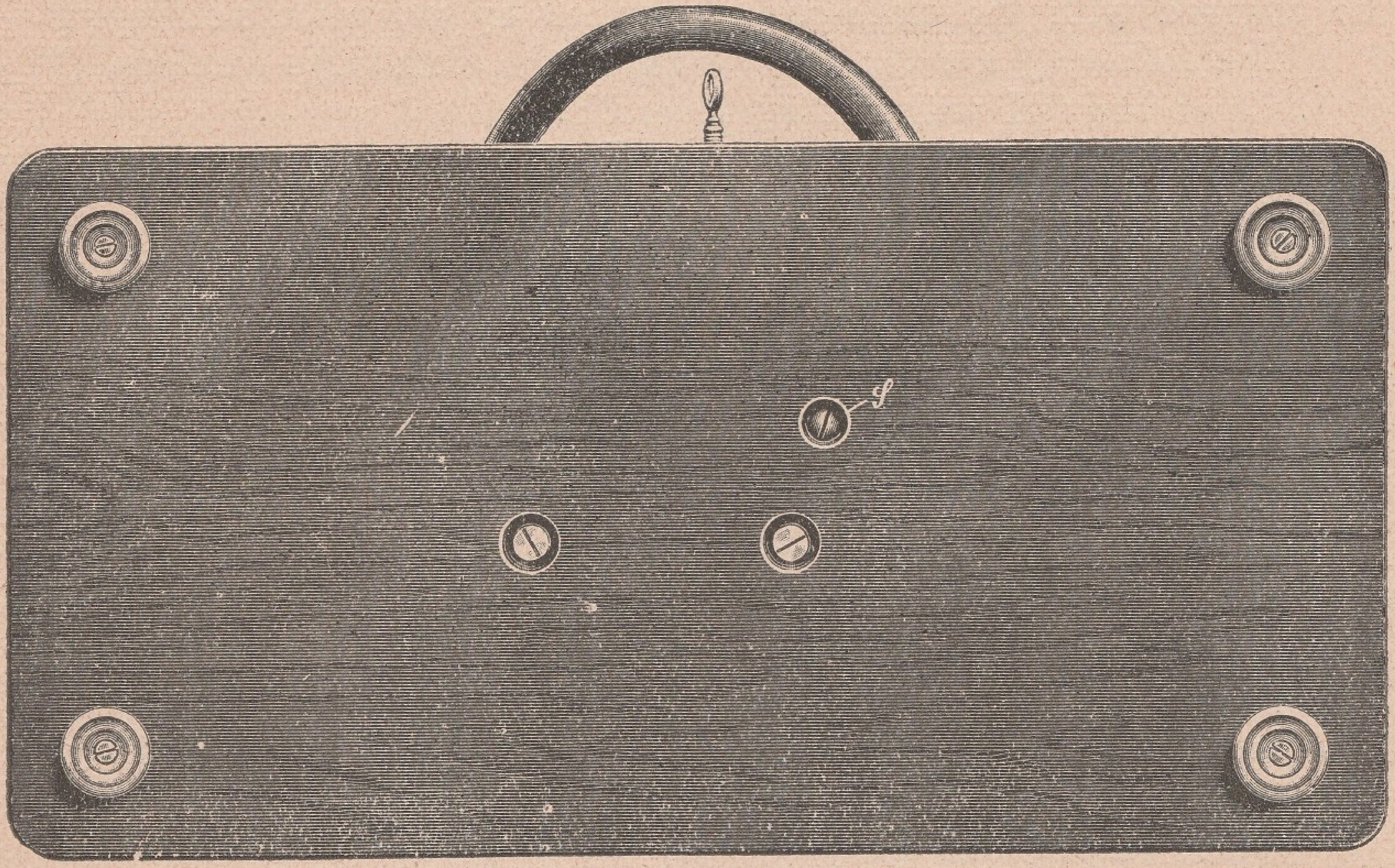
The „Brunsviga" does not require any trained specialist-operators to give the maximum of service. It is sufficient to carefully read the following pages, working out the given examples on the machine, to get a thorough knowledge of every important kind of figure work; this fundamental knowledge will then enable the operator to find the quickest and most practical methods of doing his own particular calculations. This little booklet, in spite of its small size, contains examples for all important classes of work, but, needless to say, we are always glad to give „Brunsviga"-users any additional information which they may require, like methods for figuring cube-roots, chain-discounts or any other special figure work.

It has been our aim to make our instructions as clear and precise as possible. Part I. gives the description of the different parts of the machine and their use. Part II. explains the fundamental calculations and also contains a set of most valuable short-cut methods. In Part III. we show how £ s. d. can be added and subtracted on the „Brunsviga" with great convenience without any conversions. Part IV. contains a set of the most important pratical examples.

The whole long range of „Brunsviga" models is covered by our Instruction Book; the special features of each of them are separately discussed under each heading.

Concluding, we should like to remind „Brunsviga"-users of the valuable „Decimal Cards and Tables" which we supply free of charge with every machine and should be glad to receive any new samples of interesting calculations or set up new tables for special work, required by our customers.

Read this <u>before</u> manipulating the machine.



In order to protect the mechanism of the machine against damages during transport a special screw is fastened to the base-board on the bottom side at S. This screw must be removed immediately upon arrival of the machine (in all events before any turn of the handle), then the carriage (which was held tight by this screw) should be moved slightly to the left until the key T snaps into right position.

I. Description of the various parts of the "Brunsviga-Calculator".

Read and observe carefully before operating the machine.

To protect the machine against dust and dirt it should always be covered with the cloth-cover supplied by us, when not in use.

The following are the main parts of the Brunsviga machine:

1. Chief body H with setting levers E.
2. Carriage Sh with result register R.
3. Revolution-Register U (or U and U1).
4. Crank D.
5. Winged nut F1 for replacing the setting levers to zero.
6. Winged nut F2 for clearing result register.
7. Winged nut F3 for clearing revolution register.
8. Lever or key T for moving the carriage to either side.
9. Decimal pointers K, sliding on a rod, for marking the decimal point, when decimals are required.
10. One or two bells, which ring and caution the operator, as soon as the capacity of the machine cannot hold the number of figures in the result register.

The left hand should be used to work:

the carriage Sh by lever T,
the winged nut F1,
the winged nut F3.

The right hand should be used to work:

the setting levers E,
the crank D,
the winged nut F2.

Crank (D).

To turn the crank pull the handle slightly out (to the right), make an even, quick revolution and allow the handle to return to its resting place (with the handle-pin B resting in the groove of the handle-shaft). If a number of turns are required, keep the handle pulled to the right and complete the revolutions without letting the handle-pin touch the shaft.

The crank can be turned in both directions: forward (for addition and multiplication), or backward (for subtraction and division). However, once started, the handle *cannot be moved the other way*; if by an error the handle has been turned too far or in the wrong direction, the revolution must be completed first and then, to correct the mistake, a revolution made in the opposite direction.

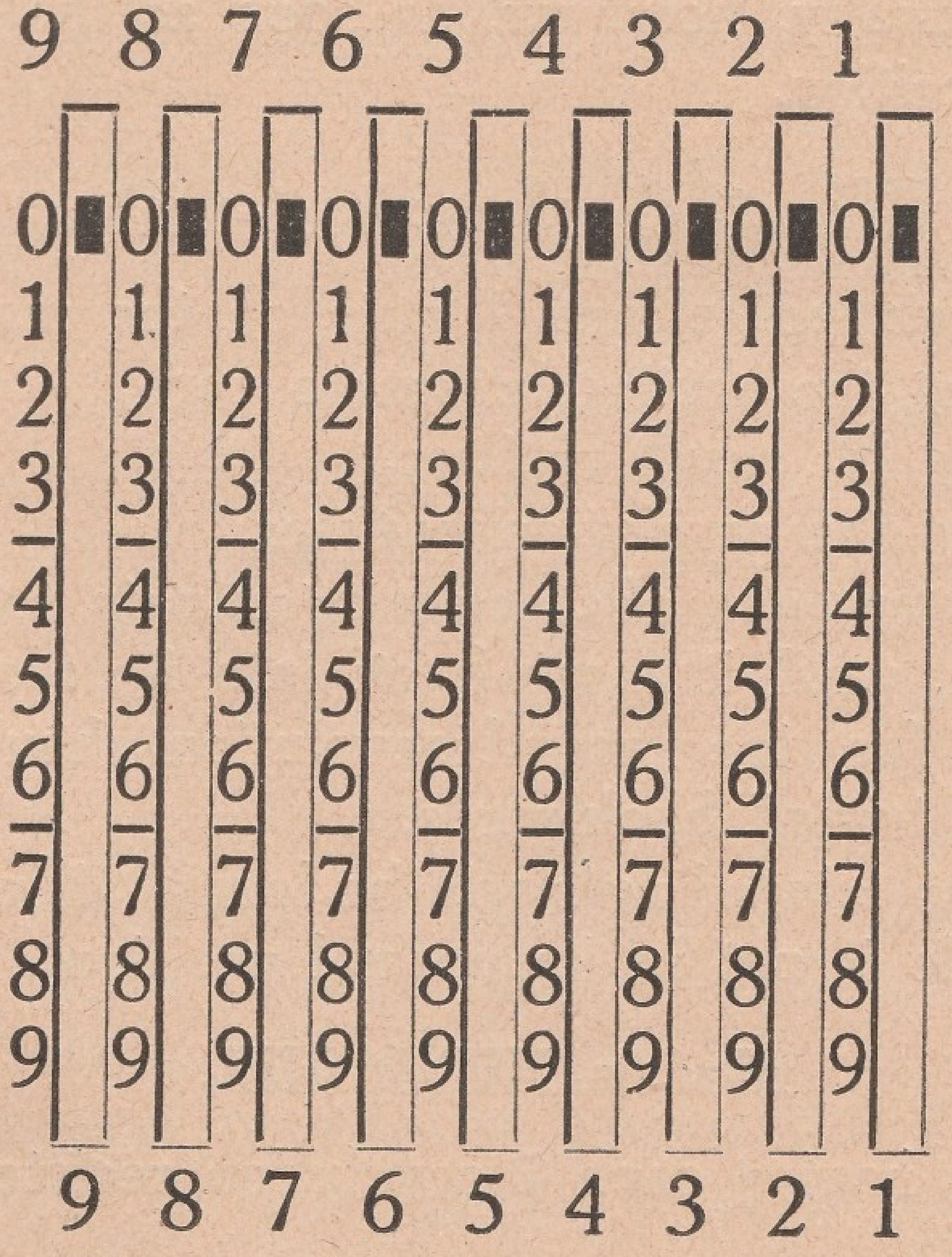
The crank can only be turned, when the carriage as well as all three winged nuts are in their correct, normal position. Should this not be the case with one of these parts, the crank will be *locked* and can be turned only after correcting the position of the part in question.

The correct use of the crank is very essential for the efficient and long life of the machine, and therefore the following rules ought to be observed very carefully:

Turn the handle evenly, quickly, but without sudden jerks.
Never let the handle-pin hit against the handle-shaft.
Always complete one whole revolution of the handle.
Never try to force the crank, if it appears to be locked.
Always allow the handle to return to its normal position, otherwise the carriage and all other parts of the machine will be locked.

Setting levers.

The setting-levers project through slots in the top plate and are numbered at top and bottom. The figures on the top-plate are engraved in the following manner:



One below the other there are whole rows of 00000, 11111, 22222, and so on up to 99999.

These figures are used for setting up the number with which a calculation is to be performed. To set the number 6, bring the lever in row No. 1 to the position of the 66666. To set the number 789, bring the lever No. 3 to 7, lever No. 2 to 8, and lever No. 1 to 9. To set 346 425 987, bring

lever No. 9 to 3
„ „ 8 „ 4
„ „ 7 „ 6
„ „ 6 „ 4
„ „ 5 „ 2
„ „ 4 „ 5
„ „ 3 „ 9
„ „ 2 „ 8
„ „ 1 „ 7.

It is always best to insert a figure from left to right, as it is read off.

The levers cannot be moved if the crank-handle or any of the winged nuts are not at rest.

Model MJR.

This Model has special long setting levers with white handles. Before setting any lever the little plate L has to be pressed against the crank shaft, thereby releasing the levers.

A special check register is located below the setting levers which shows the figures set by means of the levers; the setting levers of this model do not revolve when the crank is turned, they lock automatically, however, as soon as the handle is moved from its normal position.

Winged clearing-nuts.

There are 3 winged (clearing) nuts on the machine:

F1 for bringing the setting levers to zero,

F2 for clearing the result-register,

F3 for clearing the revolution register.

When used, every one of these winged nuts must be turned one revolution forward, until it snaps back into its rest.

If turned too far, the second revolution should be completed; they must not be turned backwards.

Any one of the winged nuts will be locked, if either the carriage or the crank-handle is not in its normal position.

Models MH, MDIIR.

These models, having each 2 revolution registers naturally have 2 winged nuts F3.

Model MJR.

This model has a crank instead of the winged nut F1 for restoring the setting levers to zero. The operation of the crank is similar to the operation of the crank D.

Carriage.

Models B, MH, MJR.

There are two different movements of the carriage:

1. Moving automatically only to the next column either way.
2. Moving all the way (to any position) in either direction.

In the first instance one of the keys l and n is pressed in that direction, in which the carriage is to be moved, with a slight touch, causing the carriage to pass automatically into the next column. To move the carriage to the right press key l with the first finger of your left hand. To move the carriage to the left, press key n with the thumb of your left hand.

In the second instance, depress key m with first finger and thumb of your left hand and move carriage to the desired position. A rule should be made of pressing only one of the three keys without touching the other two. As long as the carriage has not snapped into its fixed position the machine cannot be operated, the crank and nuts being locked. In the same way the carriage can only be moved when the crank and winged nuts are at rest.

Model MDIIR.

This improved carriage is operated in the following manner. To space it automatically, just one column, simply press the knob T quickly to either side, and let go after each movement. To move the carriage all the way press the knob straight into the carriage and then move it as far as necessary either way.

Result Register (R).

The Result Register R is located below the setting levers on the right hand side of the carriage. On Models B, MB, MH, this register has 13 columns, on Model MJR 15, on Models MD and MDIIR 20. By turning the crank the figures set in the setting levers are transferred to the result register, and in this way the results are accumulated in additions, multiplications and subtractions.

Model MDIIR.

On this model the result register is fitted with a specil **split device.** By pushing out a little knob located at the right end of the carriage, below the winged nut F2, the result register is split between the 12th and 13th columns (or 10th and 11th columns), marked by a white dot, so that two separate totals can be accumulated. If it is desired to clear only one part of the result register, retaining the other, one of the two small levers located at the left of the 20th figure of the result register and behind the winged nut F2, are depressed when turning the clearing nut F2. Press the lever on that side on which you want to retain the result.

Revolution Register (U).

The Revolution Register is located on the left hand side of the carriage — it counts the revolutions of the crank. In turning the crank forward it counts the plus-revolutions from 0 to 8 in white figures. Turning it backwards it counts the minus-revolutions in red figures from 1 to 9; the 0 always appears in white, the 9 always in red. However, the counting will not carry over from one column to the next.

Model MH and MDIIR.

These two models are fitted with an additional revolution register U1 located above the setting levers. This **second register** really duplicates the work of the first revolution register, with the difference, however, that it is fitted with the **carry-over device.** It shows white figures for positive calculations and red figures for negative calculations, setting itself automatically to either in accordance with the first turn of the crank being plus or minus. Once started, however, it will remain positive or negative permanently until brought to 0 by the clearing nut F3.

Model MJR.

The one revolution-register of this model is located above the setting levers, and is fitted with a carry-over device.

Different signs on the machine.

(a) To the right of the setting levers two arrows are engraved on the cover, indicating that for additions and multiplications the crank must be turned forward (clock-wise), for subtractions and divisions backwards (anti-clockwise).

(b) The dials of the result register and revolution register are numbered consecutively to make the reading of the figures easier.

(c) On Models B, MB, MH and MDIIR the lower left-hand corner of the top plate bears an arrow, pointing to the revolution register. This arrow indicates in every position of the carriage in what decade the machine is working, whether in the units, tens, hundreds, thousands, etc.

(d) On Model MJR the indication of the decade is achieved in a different way. When moving the carriage numbers appear on the top of the carriage to the right of the main body, and the last of these Nos. always indicates the decade for operation. For instance if 5 is the highest number visible on the top of the carriage, it means that the machine will work in the 5-th decade, i. e. the 5th dial of the revolution register.

(e) To the left of the setting levers a small round opening shows a plus sign with every forward turn of the crank, a minus sign with every backward turn. Thus the operator always has a control whether his last revolution of the crank was plus or minus, which is a great advantage for quick and accurate work.

(f) Models MH, MJR and MDIIR in addition have two small round indicators to the left and right of the upper revolution register. If the left indicator shows up red, it means that this upper revolution register has been cleared by the winged nut F 3, is therefore in neutral position and consequently the first turn of the crank will set the register for positive, white figures (if turned forward), for negative, red figures (if turned backward). Once the setting of this register is determined by the first turn of the crank the left indicator shows up in black, and the register will remain at this setting irrespective of the crank being turned forward or backward until it is cleared by the winged nut F 3.

The right indicator shows a plus sign when the register is in a neutral position (after clearing same). If the first turn of the crank is forward, the positive plus sign remains. If the turn is backward, it changes to negative and remains plus or minus all the time until the next clearing of the register.

Safety locking devices.

Summarised, the following are the safety locking devices on the Brunsviga.

The crank, the carriage, and the three clearing nuts are all interlocked in unison. None of these can be operated if any other is not in its normal position. Owing to these devices it is impossible for the result not to show up entirely on the dials of the registers, or for a fresh operation to be started unless the result register has been positively cleared.

The setting levers are locked as soon as the revolution of the crank has begun so that they cannot, even accidentally, be dislocated.

Thus the Brunsviga has been brought up to a high standard of efficiency ensuring perfect safety of operation to the operator. Naturally the locking devices are not of such strength that they could not be overcome by force. If this occurs, serious damage to the mechanism must be the result and therefore the operator must make it a rule never to force anything in the machine, but always to find out the reason for locking and simply correct the part which had not been at rest.

The oiling of the Brunsviga should only be carried out at the places marked by arrows in our illustration. Every additional oiling only damages the mechanism and may cause serious and expensive repairs. Only the best machine oil ought to be used.

The Brunsviga Calculating Machine is a very finely constructed mechanical device which of course requires the necessary careful treatment. If the operator handles the machine with care he may expect the greatest efficiency from it and he will find that repairs are hardly ever required.

II. Examples.

A. Fundamental calculations*).

To learn the operation of the „Brunsviga", it is necessary to **go through** the following examples **on the machine.** It is not sufficient merely to read them.

At the beginning of every calculation the crank must be at rest with the handle-pin in the shaft, all setting levers must be at zero and all dials of result-register and revolution-register must show up zero.

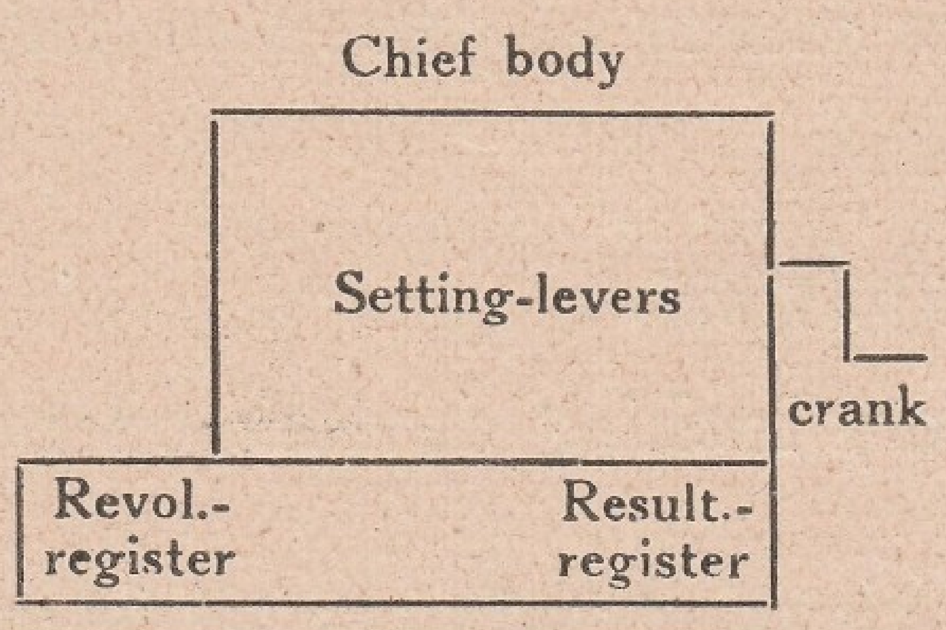


Fig. 1.

To illustrate the necessary settings and operations on the machine for the different calculations, we use the plan of the machine (fig. 1), and insert different signs with the following meanings:

Settings.

A circle or an oval with a number, letter or word means, that the said number has to be inserted into that part of the machine at which the circle or oval is shown (fig. 2). If two insertions or settings have to be made before the operation is started, then the number which has to be inserted first is marked by a double circle or double oval.

Turns of the Crank.

An oblong, containing a number, letter, or word, indicates that the said number has to be inserted into that part of the machine, at which the oblong is shown, by revolutions of the handle and, if necessary, movements of the carriage.

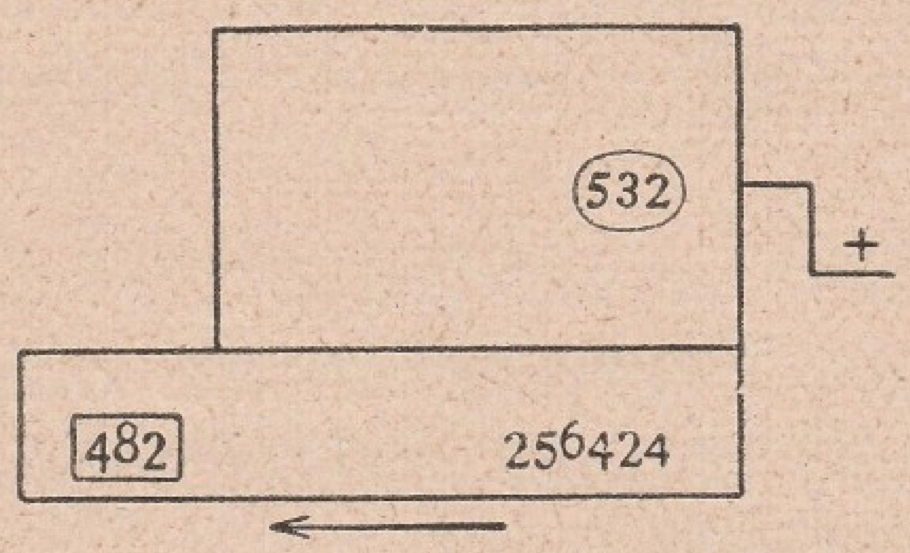


Fig. 2.

Furthermore, the direction in which the crank must be turned is indicated in the illustration by a + or — sign on the handle (fig. 2).

Results.

The result of a calculation is shown simply by a number, letter, or word, without any signs at all.

Position of Carriage.

The correct position of the carriage at the beginning of a calculation is indicated by an arrow: ←——— carriage moved to the left, ———→ carriage moved to the right. (fig. 2.)

*) The settings of the following examples are given for a machine of the capacity 9×8×13.

According to the above explanations the plan of the example shown in Fig. 2, would signify: ← carriage moved to the left; 532 must be set in the setting-levers, 482 must be inserted into the revolution-register by plus turns of the crank. The result, 256 424, appears in the result-register.

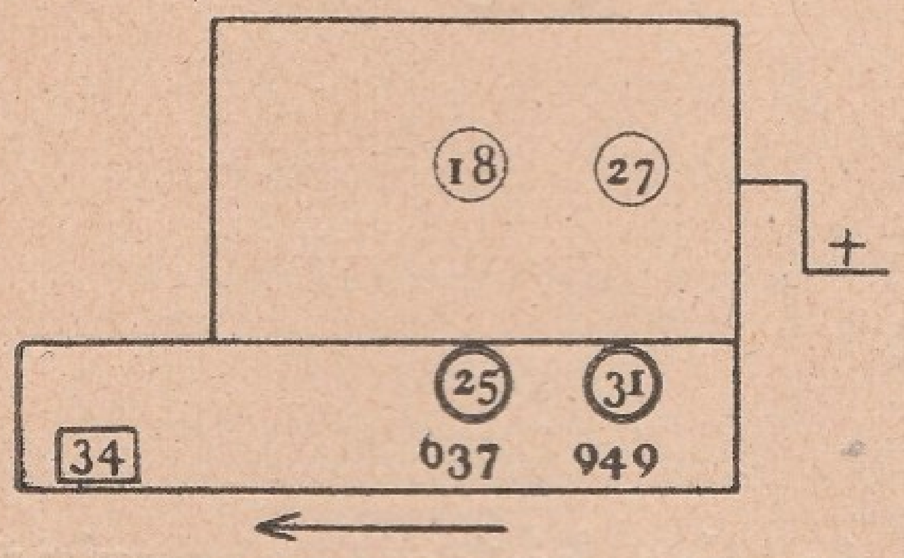


Fig. 3.

Fig. 3 would be explained thus: Carriage moved to the left. 25 and 31 must be inserted into the result-register. After this, the figures 18 and 27 must be set in the setting-levers, and 34 inserted into the revolution-register by + turns of the crank. The result-register will then show that the results are 637 and 949.

Addition of Whole Numbers.

Required the total of the following figures:

263	
60 451	
4 843	(Fig. 4)
2 624 152	

Take carriage to the extreme left, set levers to 263 (starting with lever No. 3), and transfer this figure to the result-register by one + turn of the crank. Proceed in the same manner with the remaining three figures; in doing so, either take the setting-levers to zero (clearing-nut F 1), when setting the following number or simply change the levers from the last figure to the next; practice shows which is the quicker way in every case.

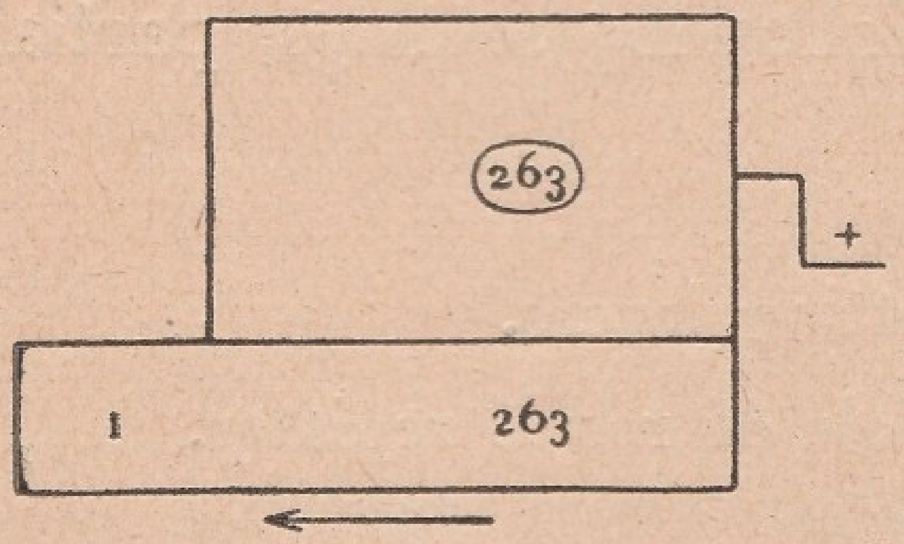


Fig. 4.

In our example the machine will successively show the following figures:

Revolution-register ↓		9|8|7|6|5|4|3|2|1	Setting-levers / Dials of result register
		0	in result register
	+	2 6 3	in setting levers
1 (1st. partial sum)		2 6 3	in result register
	+	6 0 4 5 1	in setting levers
2 (2nd. partial sum)		6 0 7 1 4	in result register
	+	4 8 4 3	in setting levers
3 (3rd. partial sum)		6 5 5 5 7	in result register
	+	2 6 2 4 1 5 2	in setting levers
4 (4th. final sum)		**2 6 8 9 7 0 9**	in result register

Addition of Decimal Fractions.

Required the total of the following decimal fractions:

```
  441·3
   21·763        (Fig. 5)
5 643·12
  542·0043
  125
```

Imagine all decimal fractions completed to the highest occuring number of decimals (by adding ciphers), in our example to 4 places; the same is also applied to whole numbers. In the result the number of decimals in question is then simply marked off.

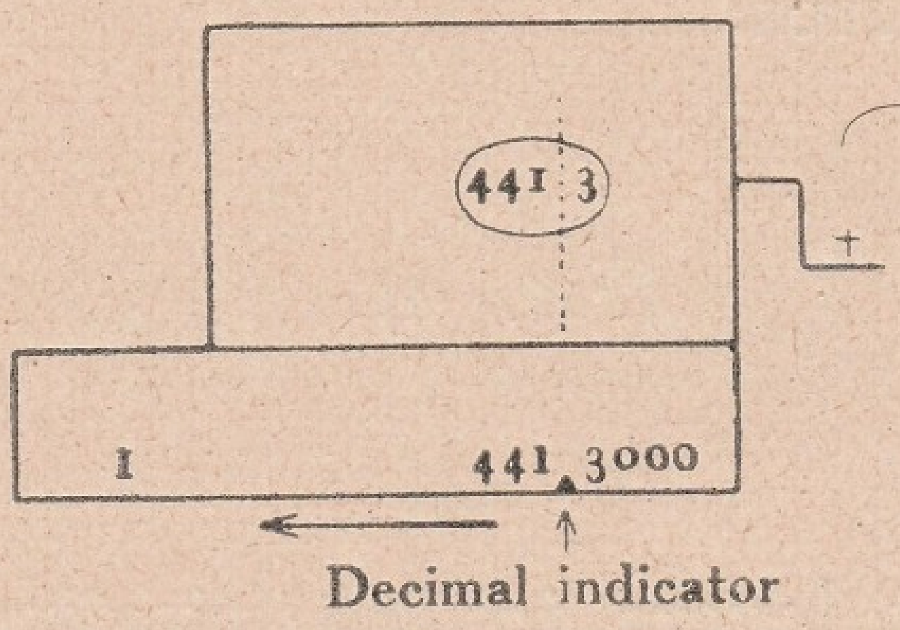


Fig. 5.

When figuring with decimal fractions it is best to use the decimal indicators for marking the decimal point. In our example, with the carriage moved to the extreme left the indicator must be set between the 4th and 5th dials of the result-register and between the 4th and 5th setting-levers (Fig. 5). The numbers are then inserted according to this decimal indicator.

The decimal-indicator in our illustrations is shown thus: ▲

In our example the machine shows the following settings, partial sums and totals:

Revolution-register ↓		9|8|7|6|5▲|4|3|2|1	Setting levers. Dials of result register.
		0 0 0 0 0▲ 0 0 0 0	in result register
	+	4 4 1▲ 3	in setting levers
1 (1st partial sum)		4 4 1▲ 3 0 0 0	in result register
	+	2 1▲ 7 6 3	in setting levers
2 (2nd partial sum)		4 6 3▲ 0 6 3 0	in result register
	+	5 6 4 3▲ 1 2	in setting levers
3 (3rd partial sum)		6 1 0 6▲ 1 8 3 0	in result register
	+	5 4 2▲ 0 0 4 3	in setting levers
4 (4th partial sum)		6 6 4 8▲ 1 8 7 3	in result register
	+	1 2 5	in setting levers
5 (5th final sum)		**6 7 7 3▲ 1 8 7 3**	in result register

Subtraction of whole Numbers.

681 (Minuend)
— 197 (Subtrahend)

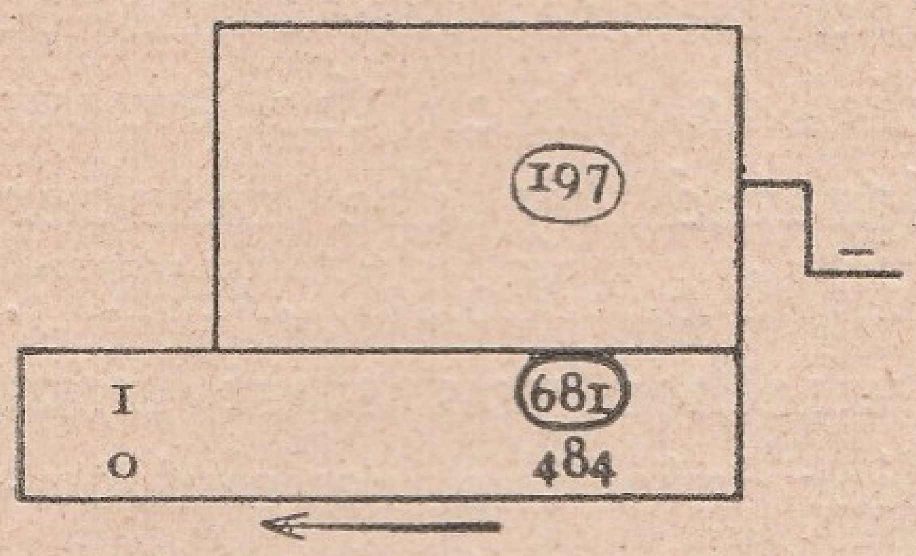


Fig. 6.

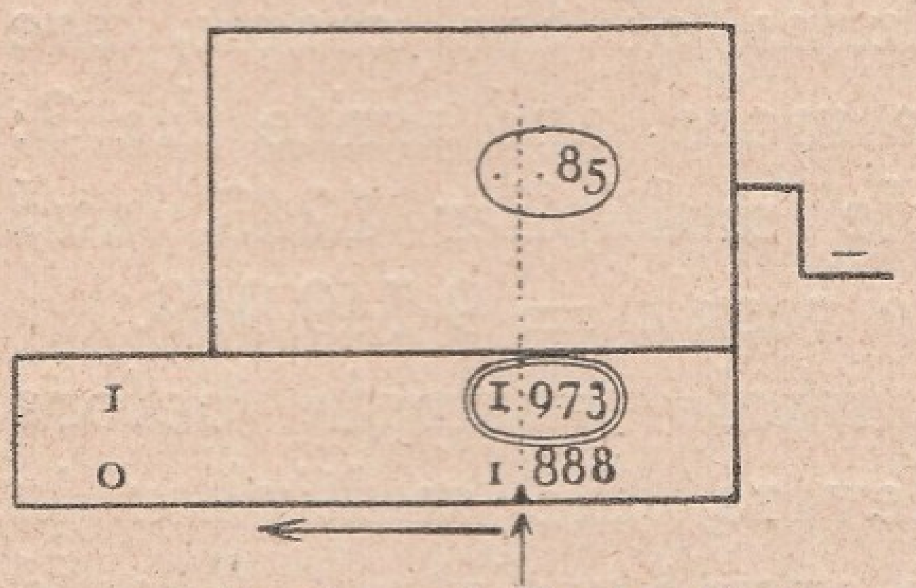
The process of any subtraction on the machine is the following:

Insert your Minuend (681), transferring same to the result-register by one + turn of the crank, then set up your Subtrahend (197) and make one — turn of the crank: the result (484) will then appear in the result-register.

Naturally the setting of the two figures must be performed in such a way that the units, tens, hundreds, etc., of the Subtrahend correspond in their position with those of the Minuend.

Subtraction of Decimal Fraction.

1·973
— ·085 (Fig. 7)



Setting of Decimalindicator

Fig. 7.

First transfer 1·973 to the result-register, point off the decimals by setting the decimal-pointers and insert 85 according to the latter. One — turn of the crank gives the result, 1·888.

It will be noticed that the method of subtraction is extremely simple, as it is done without the use of any complements or shifting of special levers.

Important.

For any addition or subtraction it is always best to **start** with the **carriage** at the **extreme left**.

Multiplication.

To perform any multiplication on the machine, you simply have to set one of the factors in the setting-levers and to insert the second one into the revolution-register by + turns of the crank. The result will then appear in the revolution-register.

4 × 3 = ?
(Multiplicand) (Multiplier) (Product)

Carriage to the extreme left. Set the multiplicand 4 with lever No. 1 and write the multiplier 3 into the revolution-register by 3 + turns of the crank. The dials of the result-register will then show the product 12.

Multiplication is really repeated addition, viz., 4 × 3 = 4 + 4 + 4. In our example we have actually added the multiplicand 4 three times.

7683 × 1243 = ?

Set the multiplicand 7683 in the setting-levers 4 — 1 and write the multiplier 1243 into the revolution-register. The movement of the carriage enables the operator to „write“ figures into any desired dials of the revolution-register. As explained before, the turns of the crank will always be recorded in that dial to which the arrow on the top plate points (or which is designated by the number appearing on the top of the carriage to the right on Model „MJR“).

As regards the result, it is immaterial whether you start from thr right or the left in „writing“ the multiplier into the revolution-register; however, it is more practical in most cases to insert the figure as you read it off, i. e., from left to right.

In our example you would therefore, having set up the multiplicand 7683, bring the carriage to the 4th position (because the multiplier has 4 figures), so that the arrow points to the 4th dial (or No. 4 appears on the top of the carriage). To do this, you press key „l“ three times. In this position the 1 is written, i. e., the crank is turned once forward, the revolution-register showing 1000. Now **space** the carriage to the left by pressing key „n“, write the 2 by turning the crank twice, the revolution-register showing 1200. Space again as above, write the 4 by 4 turns of the crank, the revolution-register showing 1240. Space once more, and write the 3: the revolution-register now shows the whole multiplier 1243, and consequently the result-register will show the result = 9 549 969.

Note that at the end you have the whole example before your eyes: the multiplicand in the setting-levers, the multiplier in the revolution-register and the product in the result-register. Should a mistake have been made in the number of turns on any of the dials the figure in question is simply corrected by + or — turns. The dials of the result-register will always show the correct result, corresponding to the figure in the revolution-register.

In verifying the multiplier with a glance you always have an absolute chek on the correct result and therefore no calculation need be performed twice.

Practise the following examples:

938 × 214 = 200 732
45 934 × 4231 = 194 346 754
8374 × 1524 = 12 761 976

Short-cut.

If the multiplier contains numbers between 6 and 9, the number of crank-revolutions can be reduced considerably by applying + **and — turns.** If for instance a figure is to be multiplied by 28, you first multiply by 30 and then subtract 2, having spaced the carriage. Thus there would only be 5 revolutions of the crank against 10 when using the ordinary method.

Using this short cut method the multiplier 9789 would require + 1 + 0 — 2 — 1 — 1 revolutions, starting in the 5th dial, (5 revolutions against 33), meaning:

$$\begin{array}{lr} + & 10\,000 \\ - & 200 \\ - & 10 \\ - & 1 \\ \hline = & 9\,789 \end{array}$$

A **mechanical rule for this short-cut,** easy to remember, is the following: If one number between 6 and 9 is to be handled, add 1 to the number to the left, and complete the number in question to 10. If there are 2 or more numbers between 6 and 9 to be considered, add 1 to the preceding figure, complete the following to 9 and only the last one to 10.

The following multipliers may serve as examples:

$$17282 = \underbrace{17}_{20-3}\quad \underbrace{28}_{30-2}\quad 2 = 20302 - 3020$$

$$97119 = \underbrace{97}_{100-3}\quad 1\quad \underbrace{19}_{20-1} = 100120 - 3001$$

$$172087 = \underbrace{17}_{20-3}\quad 2\quad \underbrace{087}_{100-13} = 202100 - 30013$$

On Models „B", „MB", „MD", the revolution-register records the minus turns of the crank in **red** figures.

On Models „MH", „MDIIR", the first revolution-register works in the same way, while the second one (also the only one on model „MJR"), shows the actual remaining figure.

Using the above-mentioned multipliers, the revolution-registers would therefore show:

	Revolution-registers	
	B., MB., MD.,	MJR.,
Multiplier	MH., MD II R-No. 1	MH., MD II R-No. 2
28	32	28
9789	10211	9789
17282	23 32 2	17282
97119	103 121	97119
172087	23 2113	172087

Should one want to obtain the **real** multiplier as well as the **converted** one on models „B", „MB", „MD", this can be done by setting the last lever (No. 9 or 12) to 1. Doing this in the following example:

531 × 279 = 148 149 (Fig. 8)

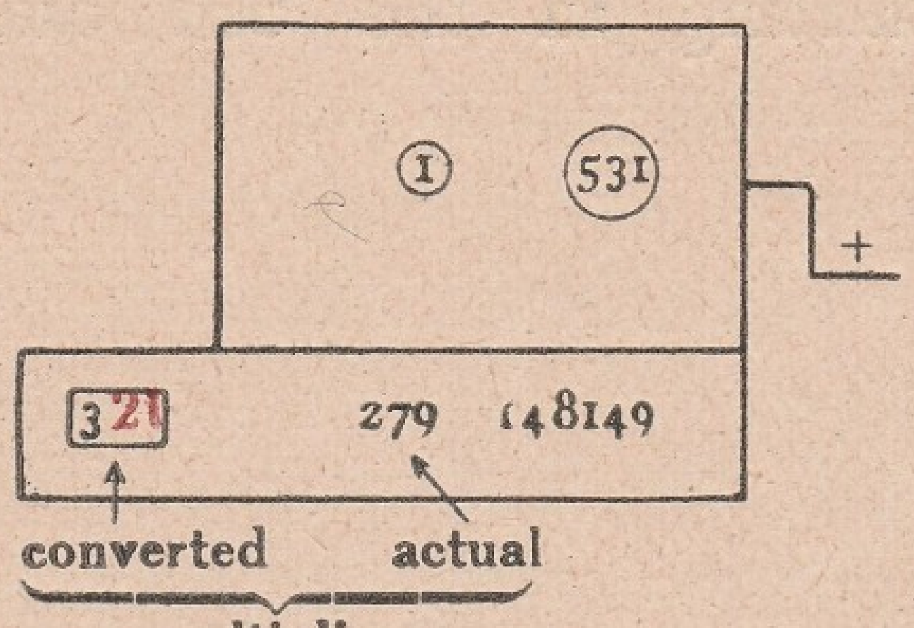


Fig. 8.

the 1 is automatically multiplied by 279, and you actually obtain the 279 on the left side of the result-register, while the revolution - register shows the short - cut 321. Of course, the figures used must not be too large, or the two numbers on the result-register would run into each other.

Division.

We have seen that multiplication really means repeated addition; correspondingly we can determine divison by calling it repeated subtraction, and this is the basis of the method used on the calculating machine. Dividing 60 by 12 you ascertain how many times the 12 can be subtracted from the 60 and find the answer 5, which is the result of the division.

Example: 165 : 37 = ?
(Dividend) (Divisor) (Quotient)

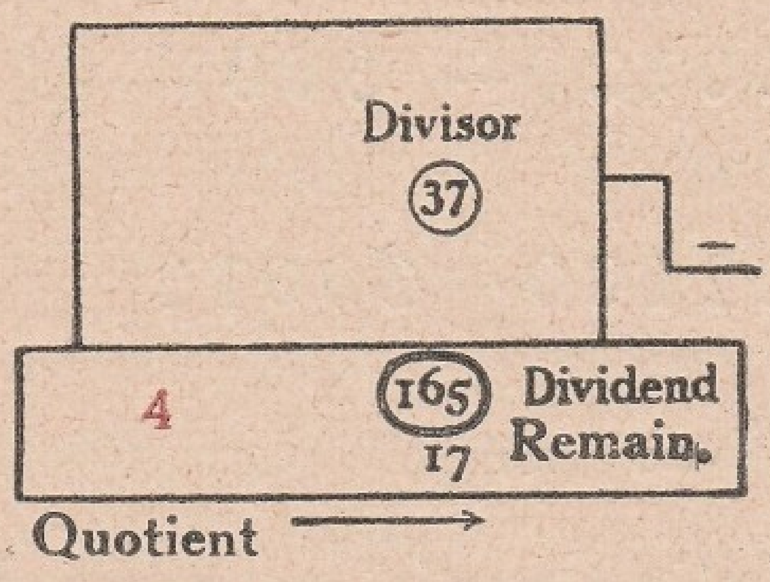


Fig. 9.

You insert and transfer the dividend 165 to the result-register and having done this clear the setting-levers and revolution-register (it is important not to forget the latter as otherwise the result will be wrong). Now set up the divisor 37 and subtract it from the dividend 165 five times; you will notice that with the fifth turn of the handle backwards the bell will ring, meaning that the divisor could not be subtracted from the last remainder. Therefore correct this last turn by one revolution forward, the bell will ring a second time, so that you are sure of the correction, and the result of the division consequently is 4 with a remainder of 17.

The quotient in the revolution-register will always appear in red figures, as — turns of the crank are registered. If the quotient consists of several figures, the carriage is spaced to the left after the completion of every column.

The machine shows the following figures:

Revolution-register		in setting-levers	in result-register
	165		„
1 = 1 st. subtraction	37	„	
	128		„
2 = 2 nd. subtraction	37	„	
	91		„
3 = 3 rd. subtraction	37	„	
	54		„
Result. 4 = 4 th. subtraction	37	„	
	17	as remainder	„
	37		
	999980		

With the 5th revolution the negative number 999 980 appears and the bell rings, meaning that you have to correct your last turn by turning once forward.

As a rule it is best to start a division with the carriage at the extreme right in order to have sufficient columns for the quotient and its decimals. (Instructions as to the fixing of decimal pointers will be found on page 16.)

Another detailed example follows:

465 184 112 : 38 762.

Carriage to the right, as far as possible; (arrow pointing to 5th dial, so that the 4 appears in the 13th dial of result register). Insert the dividend 465 184 112 and transfer it to the result-register; clear levers and revolution-register. Insert the divisor 38 762 exactly above the figures 46 518 of the dividend. In doing the subtractions the machine will show up the following figures:

Revolution-register	Result-register a. setting-levers	
	465184112	Result-register.
	— 38762	Setting-levers.
1	77564112	
	— 38762	
2	689944112	Bell has rung; turn the other way.
	+ 38762	
1	77564112	Space carriage to the left.
10	— 38762	
11	38802112	
	— 38762	
12	40112	
	— 38762	
13	961278112	Bell has rung; turn the other way.
	+ 38762	
12	40112	Space carriage to the left.
120	— 38762	
121	996163912	Bell has rung; turn the other way.
	+ 38762	
120	40112	Space carriage the the left.
1200	— 38762	
1201	999652492	Bell has rung; turn the other way.
	+ 38762	
1200	40112	Space carriage to the left.
12000	— 38762	
12001	1350	
	— 38762	
12002	999962588	Bell has rung; turn the other way.
	+ 38762	
12001 (Result)	1350	(Remainder)

Practise the following examples:

420495 ÷ 17 = 24735
280996694 5387 = 52162 *)
44114226 ÷ 736 = 59937 remainder 594.**)

Setting of decimal indicators.

One of the great advantages of the calculating machine is that in examples with decimals the decimal point is fixed at the start and remains there during the whole operation so that mistakes in this respect are out of the question.

(a) Multiplication.

The same rule applies as on paper. If the multiplicand has three decimals and the multiplier two, the product must have 3 + 2 = 5 decimals.

For instance:

$$\underbrace{57{\cdot}832}_{3} \times \underbrace{67{\cdot}35}_{2} = \underbrace{3894{\cdot}98520}_{5} \qquad 3 + 2 = 5$$

$$\underbrace{9853{\cdot}741}_{3} \times \underbrace{{\cdot}35718}_{5} = \underbrace{3519{\cdot}55921038}_{8} \qquad 3 + 5 = 8$$

$$\underbrace{{\cdot}00514}_{5} \times \underbrace{{\cdot}7841}_{4} = \underbrace{{\cdot}004030274}_{9} \qquad 5 + 4 = 9$$

If the example contains a series of multiplications with varying numbers of decimals, you have to pick the multiplicand with the largest number of decimals occuring and fix your indicators according to these. The factors are then set in accordance with the indicators and the correctly pointed result simply read off.

Example:

4·32 × 5·82 = ?
7·1 × 8·923 = ?
38· × 4·1 = ?
9·374 × 4·27 = ?

We find the largest number of decimals with the multiplicand 9·374 and the multiplier 8·923 with three decimals each. Therefore we have to mark off three places each in the setting-levers and revolution-register, and 3 + 3 = 6 in the result-register.

The units are now set just before the decimal point so that the machine will show:

4·320 × 5·820 = 25·142400
7·100 × 8·923 = 63·353300
38·000 × 4·100 = 155·800000
9·374 × 4·270 = 40·026980

---

*) Insert dividend with arrow pointing to 5-th position. Set divisor with levers 8 – 5.
**) Insert dividend with arrow pointing to 6-th position. Set divisor with levers 7, 6, 5.

(b) Division.

For division the following rule applies: If the dividend has 7 decimals and the divisor, as set in the machine, 2 decimals, then the quotient must have 7 — 5 = 2 decimals.

$$\underbrace{3894{\cdot}98520}_{5} \div \underbrace{57{\cdot}832}_{3} = \underbrace{67{\cdot}35}_{2}$$

If, in doing a division, it is desired to abtain a certain number of decimals to make the result more accurate the carriage is shifted to the extreme right at the start and the dividend then appears with a number of ciphers, which are marked off by the indicator as decimals.

Example:

$$43 \div 12{\cdot}8 = ?$$

Carriage to the extreme right. Set dividend 43 with levers Nos. 2 and 1 and transfer to result-register which will show 430000000; set indicator thus 43▲0000000. Clear setting-levers and revolution-register. Set divisor 12·8 with levers Nos. 3—1. The dividend, in the result-register, has 7 decimals, the divisor 1, consequently the quotient will have 7 — 1 = 6 decimals. Set indicator on revolution-register between dials 6 and 7 and proceed with your subtraction in the usual way, obtaining as result, 3·359375.

Practise these examples:

158394·73 ÷ 924·76 = 171·281; rem.: = ·91244
5·3785 ÷ 12·713 = ·42307087; rem.: = ·00000002967

Remember these rules:

Multiplication: Number of decimals in result (product) equals the number of decimals in multiplicand **plus** number of decimals in multiplier.

Division: Number of decimals in result (quotient) equals the number of decimals in dividend **minus** number of decimals in divisor.

Always count the number of decimals in the figures as they are **set on the machine,** not as they appear on paper in the example; very often this difference causes mistakes with the beginner if no attention is paid to this rule.

B. Special methods and short cuts.

1. Simultaneous solving of two multiplications with the same multiplier.

Example:

412 × 215 = ?
518 × 215 = ?

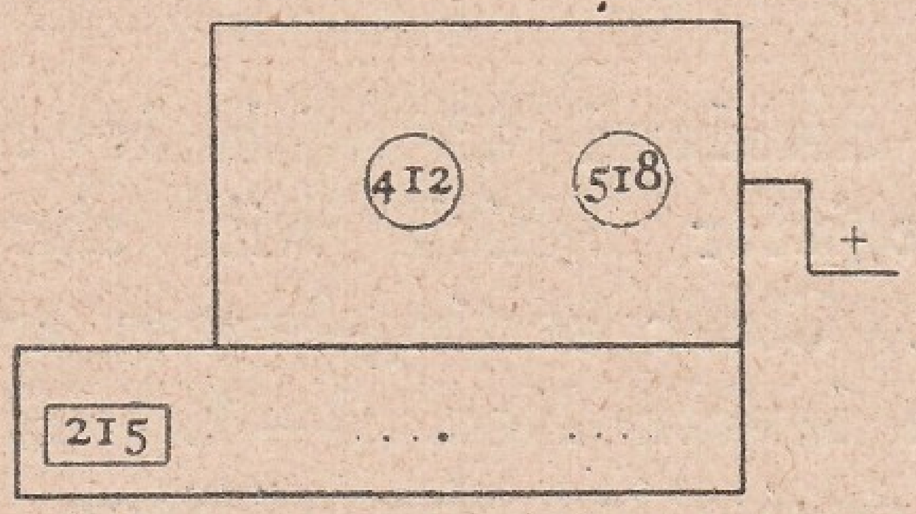


Fig. 10.

Insert both multiplicands into machine (with levers 9, 8, 7 and 3, 2, 1, separated by 3 ciphers), and write the multiplier 215 into the revolution-register in the usual manner. With one operation both results are obtained:

412 × 215 = 88580 (set indicator after 0)
518 × 215 = 111370

(Of course the size of the figures for this method is limited; for larger figures models with larger capacity must be used.)

2. Multiplications with a constant multiplicand.

Example:

518 × 463 = ?
518 × 527 = ?
518 × 632 = ?
518 × 853 = ?
518 × 1012 = ?

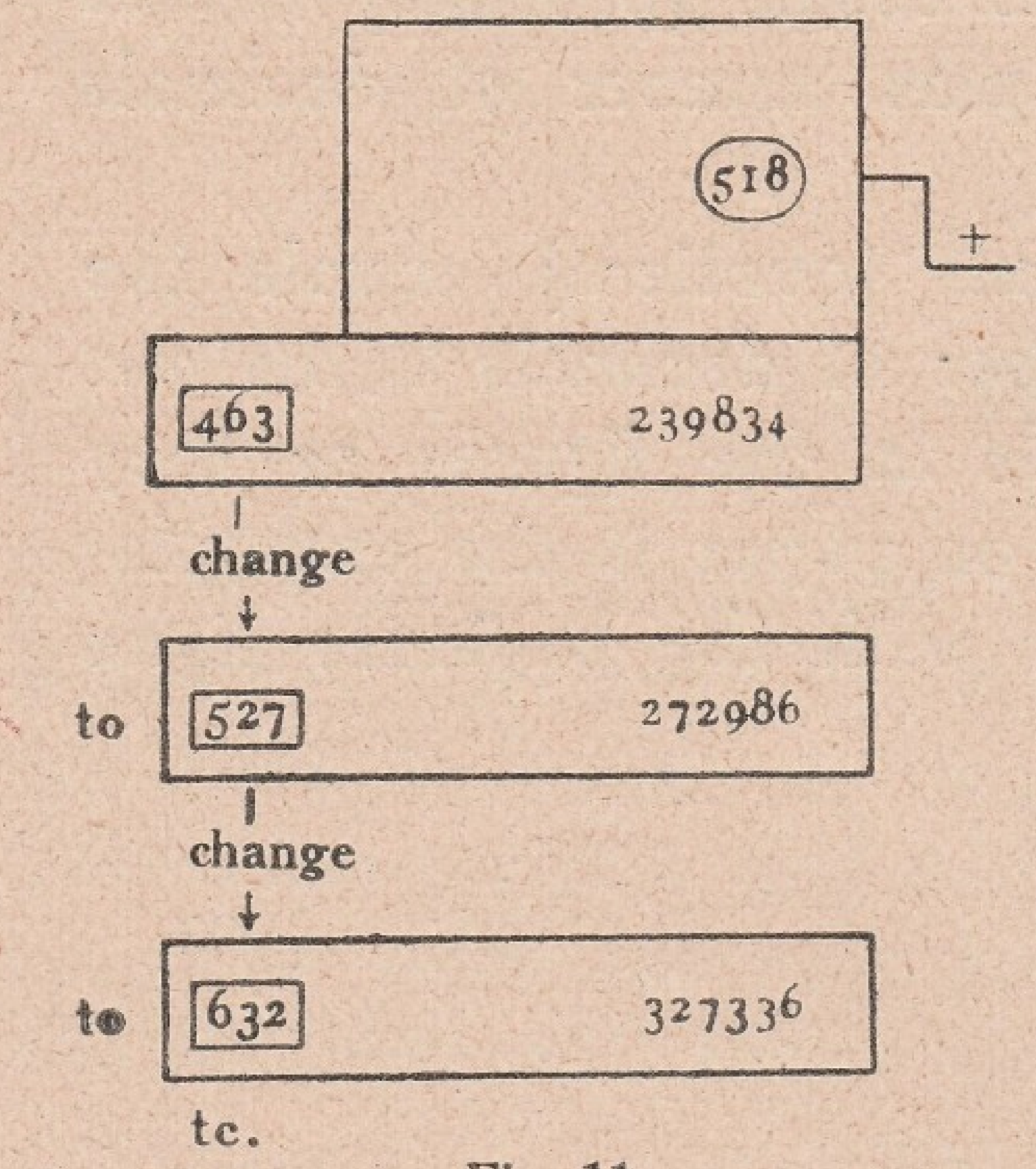


Fig. 11.

Set the constant factor 518 with setting-levers Nos. 3 to 1 and write 463 into the revoultion-register; this gives you the first result 239834. **Do not clear** anything but simply **change** the 463 to the next multiplier 527 (using plus and minus turns), obtaining the second result 272986, and so on.

463	×	518	=	239834
527	×	518	=	272986
632	×	518	=	327376
853	×	518	=	441854
1012	×	518	=	524216

3. A series of multiplications, obtaining grand total of the products (and multipliers).

Example:

15	Pieces	at	£ 42
22	„	„	£ 37
18	„	„	£ 23
29	„	„	£ 13
37	„	„	£ 32

= £

Carry out the first multiplication in the usual way, clear revolution-register and setting-levers, not, however, the result-register. The product remains there and in doing the second multiplication the second result is automatically added to the first, and so on. The machine will show the following figures:

Revolution-register	Setting-levers	Result-register
15 (to be cleared)	42 (to be cleared)	630 (remains)
22 „	37 „	1444 „
18 „	23 „	1858 „
29 „	13 „	2235 „
37 „	32 „	£ 3419 „
		Result.

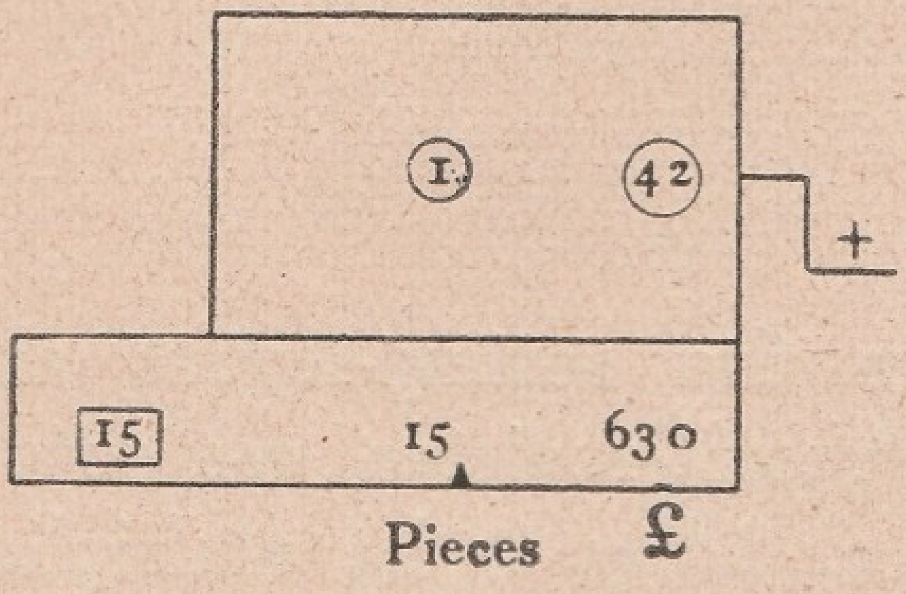


Fig. 12.

If it is desired to obtain the total number of pieces at the same time, you simply have to set lever No. 9 to 1 and leave it there throughout the calculation. The machine will show:

Revolution-register	Setting-levers		Result-register	
15 (to be cleared)	1 (remains)	42 (changed)	15	630 (remains)
22 „	1 „	37 „	37	1444 „
18 „	1 „	23 „	55	1858 „
29 „	1 „	13 „	84	2235 „
37 „	1 „	32 „	121	3419 „

Grand total: 121 pieces £ 3419.

(Size of figures depends on capacity of model used.)

On models MH and MDIIR the addition of the multipliers is performed without any extra setting in the second revolution-register.

4. Compound multiplication.

Example: 2456 × 468 × 24

Multiply 2456 by 468 in the ordinary way, obtaining 1149408 as the result. Clear setting-levers and transfer the result 1149408 to the setting-levers, using the respective levers above each figure. Turn the crank backwards once, to make sure that the correct figure has been transferred; clear revolution-register, multiply by 24, obtaining the final-result 27585792.

5. Division with multiplication following.

Example:

$$\frac{423}{313} \times 197$$

Carry out the division in the usual manner; result is 1·3514376 Clear only result-register, retaining the quotient in the revolution-register. Set levers Nos. 3—1 to 197 and reduce all figures in the quotient-register, 1·3514376, to zero, turning the crank forward and spacing the carriage (actually multiplying 197 × 1·3514376). The result is 266·2332072. (Observe rule of decimals!)

6. Second method of division — by multiplication.

This method, when once mastered, is in many cases easier and quicker than the ordinary one, for some calculations it is quite indispensable. It requires only one setting — of the divisor.

The method is based on the fact that

Divisor × quotient = dividend.

For instance if

$$12 \div 3 = 4, \quad \text{then}$$
$$3 \times 4 = 12.$$

If we therefore set the divisor 3 in the setting-levers and **build it up** to the given dividend 12 in the result-register, we obtain the quotient 4 in the revolution-register, i. e. 3 has to be multiplied by 4 to give 12. In other words: instead of **subtracting** the divisor from the dividend (as it is done in method I), we start from zero and **build** the divisor up to the given dividend; the number of revolutions must of course be the same, with the difference only, that in method I they are minus-turns in method II plus-turns.

If the given division will leave a remainder and the result is to show decimals, then (in building up), 1 is deducted from the dividend and 999 .... added in the decimal-places. For instance, if the dividend is 83, then the divisor is built up to 82·99999 ....

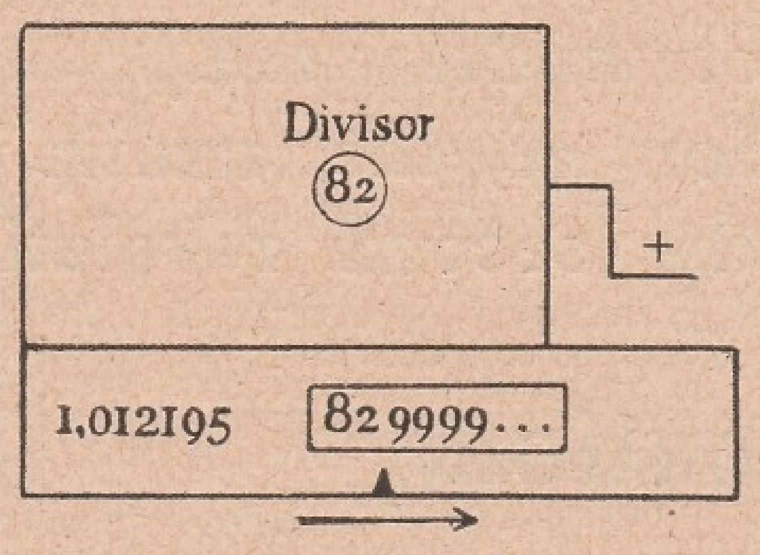


Fig. 13.

Example:

$$83 \div 82 = ?$$

Carriage to the extreme right.

Set up the divisor 82 in setting-levers. The machine shows:

Rev.-reg.			
		0	Result-register.
↓	+	82	Setting-levers.
1▲		82▲	Result-register.
	+	82	
2▲		164▲	Result-register; as 164 is greater than the dividend 83, turn backwards once.
	—	82	
1 · 0		82▲0	Space carriage to the left.
	+	8 2	
1 · 1		90▲2	is greater than 83, therefore turn back.
	—	8 2	
1 . 00		82▲00	Space carriage to the left.
	+	82	
1 . 01		82▲82	
	+	82	
1 · 02		83▲64	is greater than 83, therefore turn back.
	—	82	
1 · 010		82▲820	Space carriage to the left.
	+	82	
1 · 011		82▲902	
	+	82	
1 · 012		82▲984	
	+	82	
1 · 013		83▲066	is greater than 83, therefore turn back.
	—	82	
1 · 0120		82▲9840	Space carriage to the left.
	+	82	
1 · 0121		82▲9922	
	+	82	
1 · 0122		83▲0004	is greater than 83, therefore turn back.
	—	82	
1 · 01210		82▲99220	Space carriage to the left.
	+	82	
1 · 01211	+	82▲99302	and so on.

Continued to the full capacity of a 9 column machine the result-register will show 82·9999982 and the revolution-register the result 1·012195.

The general decimal rule must be applied for setting the indicators.

Practise the following examples by this method:

4926 · 73 ÷ 22 · 89 = 215·23504
5968493 ÷ 13·759 = 433788·28
37·58213 ÷ · 00238 = 15790·811

7. Simultaneous multiplication and division.

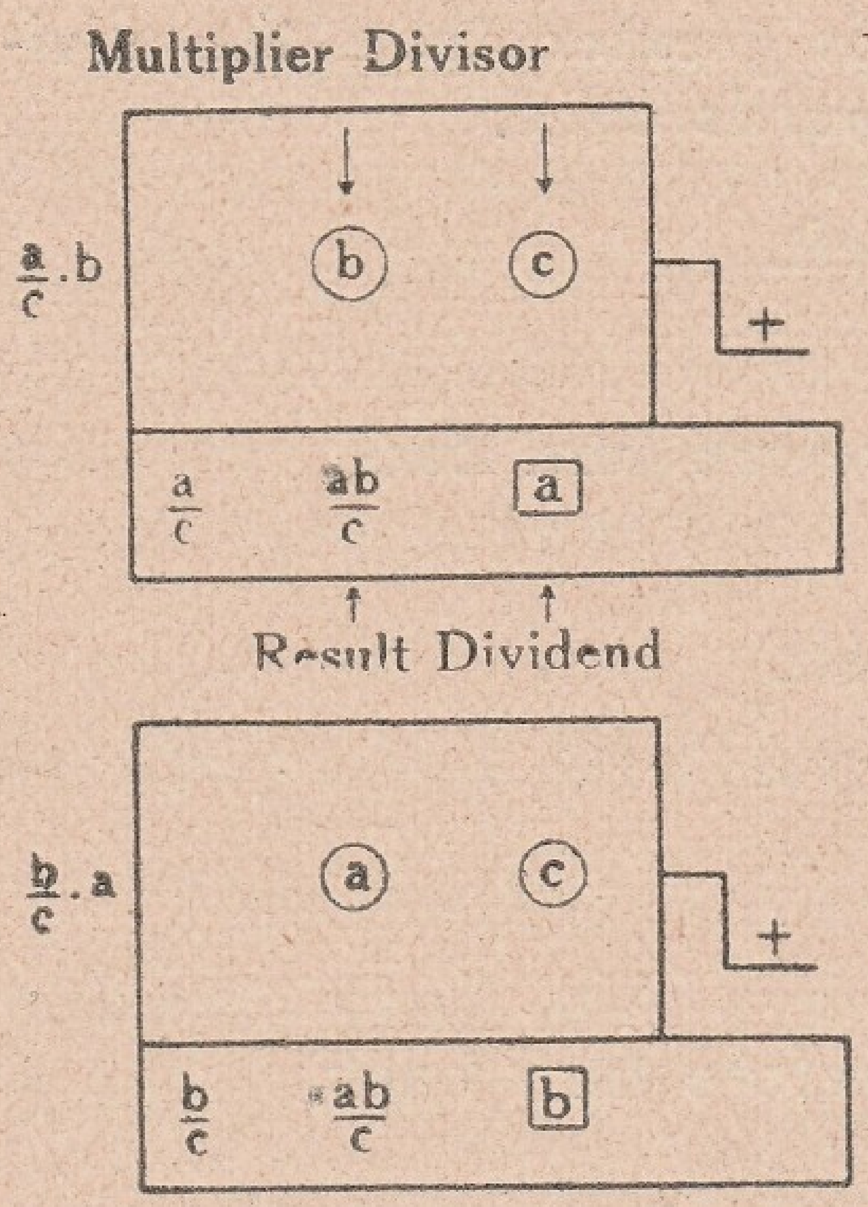


Fig. 14 and 15.

Examples of the form: $\frac{a \cdot b}{c}$ can be solved on the Brunsviga in **one operation,** by solving the division $\frac{a}{c}$ (or $\frac{b}{c}$), in the method, explained under 6, and at the same time multiplying the quotient by b (or a). The process is explained in Figs. 14 and 15.

Example: $\frac{253 \times 78}{52} = ?$

Insert the divisor 52 with setting-levers 2 and 1 and the multiplier 253 with levers 9, 8, 7 at the same time. Building the divisor 52 up to the dividend 78, the machine will show the following figures:

Revolution-register	Result-register		
	0		Carriage to the 5-th position
1,	253,	52,	Set indicators.
2,	506,	104,	104 is greater than 78, therefore turn backward.
1,	253,	52,	Space carriage to left.
1,1	278,3	57,2	
1,2	303,6	62,4	
1,3	328,9	67,6	
1,4	354,2	72,8	
1,5	379,5	78,0	
Result of $\frac{78}{52}$	Result of $\frac{253 \times 78}{52}$	Dividend,	to which the divisor has been built up.

Beside the final result 379·5 the machine also shows the result of $\frac{78}{52} = 1{\cdot}5$ which is of great advantage, in some calculations. Of course, the same example can be solved by setting 78 in setting-levers 9 and 8 and building the divisor 52 up to 253; in this case the subresult of $\frac{253}{52}$ would be obtained.

Rule: Always set the **divisor** at the right of the setting-levers and build it up to one of the factors, setting the other one at the left.

8. Constant divisor.

In cases where it is necessary to divide a number of figures by the **same divisor,** it is not necessary to carry out each division separately. Much time can be saved by finding the **reciprocal** of the divisor and **multiplying** each figure by it.

If $\frac{12}{3} = 4$, then $12 \times \frac{1}{3}$ also $= 4$.

The reciprocal value of any figure is found by dividing it into 1. This division is best carried oud by method II, setting the figure and building it up to 1 (or ▲9999 ....). For checking the decimal point the following rule can be applied: if the figure in question is greater than 1, its reciprocal value must contain as many ciphers, as the figure has whole numbers, pointing the first nought off with the decimal-point. For instance, the reciprocal value of 2456 is 0·00040717.

Example: 27·15 ÷ 2456
136·40 ÷ 2456
275·95 ÷ 2456

Find the reciprocal value of 2456, which is ·00040717. Set ·00040717 as constant multiplier and multiply successively by 27·15, 136·40, 275·95, simply changing one figure to next, as explained in No. 2.

The results are: ·0110547, ·0555380, ·1123586.

III. Calculations with £ s. d.

It is often argued that the „Brunsviga" cannot be used advantageously for money-calculations. This is, howewer, very far from being the case, as the conversion of shillings and pence into decimals of £ 1 is extremely easy once the principle is grasped, and certainly such calculations are much quicker and simpler on the machine than doing the same conversions on paper, with the aid of ready reckoners, etc.

For calculations which have to be very accurate or where large figures are involved, our tables, giving pence and pence-fractions in 7 decimals of £ 1, should be used.

For ordinary purposes however, the simple system of conversions, as described below, can be used, doing away with all tables:

1 shilling = $\frac{1}{20}$ of £ 1 or = ·05
2 shillings = 2 × ·05 or = ·10
3 „ = 3 × ·05 „ = ·15 and so on, as per table below.

1 d. = $\frac{1}{240}$ of £ 1 = ·0041666 or = ·004
2 d. = 2 × ·004 „ = ·008
3 d. = 2 × ·004 „ = ·012

and so on, as per table below; to adjust the slight difference in the decimals, 1 is added to the values of 4 d. up to 9 d. and 2 to 10 and 11 d.

1/—	= ·05 £	6/—	= ·30	11/—	= ·55	16/—	= ·80
2/—	= ·10	7/—	= ·35	12/—	= ·60	17/—	= ·85
3/—	= ·15	8/—	= ·40	13/—	= ·65	18/—	= ·90
4/—	= ·20	9/—	= ·45	14/—	= ·70	19/—	= ·95
5/—	= ·25	10/—	= ·50	15/—	= ·75	20/—	= 1·00

1 d.	= ·004 £	7 d.	= ·029
2 d.	= ·008	8 d.	= ·033
3 d.	= ·012	9 d.	= ·037
4 d.	= ·017	10 d.	= ·042
5 d.	= ·021	11 d.	= ·046
6 d.	= ·025	12 d.	= ·050

When **converting** shillings and pence into decimals of £ 1, **multiply** the **shillings by 5** the **pence by 4** (adding 1 or 2 as explained), and put them down in the right places after the decimal-point.

When **reading off** a result in decimals of £1, **divide** the **first two decimals by 5,** and the **remainder of the second with the third decimal by 4** (allowing for the additional 1 or 2), and put the result down in shillings and pence.

Examples:

£ 3.12. 6	=	3·00
		·60
		·025
	=	3·625
£ 25.17.11	=	25·000
		·85
		·046
	=	25·896
£ 10.11.3½	=	10·000
		·55
		·014
	=	10·564

£ 112·221	=	112·000	=	£ 112.	—.	—
		·20			4.	—
		·021				5.
			=	£ 112.	4.	5.
£ 7·684	=	7·000	=	£ 7.	—.	—
		·65			13.	—
		.034				8¼
			=	£ 7.	13.	8¼

Addition and subtraction of £. s. d. without conversions.

For adding or subtracting long columns of £. s. d. the following method will be found to be extremely simple and handy.

Example:

Adding:	£ 31.	3.	9
	53.	5.	7
	75.	8.	5
	99.	10.	2
	122.	13.	11
	135.	18.	10
	518.	—.	8

Use levers Nos. 9, 8, 7 for setting the pounds, 6, 5, 4 for setting the shillings, and 3, 2, 1 for setting the pence.

The machine will show:

Setting-levers	Result-register	
031003009	31▲003▲009	set
053005007	84▲008▲016	indicators!
075008005	159▲016▲021	
099010002	258▲026▲023	
122013011	380▲039▲034	
135018010	515▲057▲044	

To convert the pence into shillings and the shillings into pounds, we have to divide the pence by 12 and the shillings by 20. This is done in the following simple manner: set levers 2 and 1 to 88 (the complement of 12), and lever 3 to 9; turn the crank **forward** until less than 12 pennies remain in dials 2 and 1; in our example 3 turns bring the dials to 8 d. Change lever 1 to zero (80 = the complement of 20), space carriage 3 stops to the right and again turn the crank forward until less than 20 shillings remain; in our case 3 turns bring the dials to 0. Now read the result off in £.s. d. : £ 518. — .8.

For **subtractions** the same principle applies with reverse turns of the crank. Subtract the given amounts by **minus turns** of the crank and **subtract** 988 and 980 in the pence and shiiling columns.

When once perfomed, this method will prove extremely easy and practical.

If larger amounts than hundreds of pounds are to be added and a 9 lever-capacity machine is used, proceed thus: frist neglect the thousands and anything above, adding the hundreds, shillings and pence; then space carriage as many places as there are 1-, 10-, or 100- thousands, and run these off on the machine.

IV. Important practical examples.

(Numbers of setting-levers and dials refer to $9 \times 8 \times 13$ capacity.)

1. Percentages and discounts.

Example a:

£ 325. 10. 6 + $12^1/_4$ % = ?
Increase = ?

Take carriage to sixth position (arrow pointing to sixth dial).

Set 325525 with levers Nos. 6—1 and transfer to result-register.

Set indicator on **result-register,** marking off the units of the pounds (between 9th and 8th dials), on revolution-register marking off 100 % (between 4 th and 3rd dials). (£ 325·525 is the basis of our calculation, the whole amount of which represents 100 %.)

Adding $12^1/_4$ % to 100 % we must obtain as the result 112·25 %; therefore simply change the 100 in the revolution-register to 112·25 by turns of the crank, and the result £ 365·4018125 = £ 365. 8. 0. will appear in the result-register.

To find the increase, which is $12^1/_4$ %, do not clear anything on the machine but deduct the 100 (by taking the carriage to the 6th position and turning handle once backwards), and the result £ 39·8768125 = £ 39. 17. 6. will show up in the result-register.

Example b:

£ 177. 13. 7 minus a discount of $7^1/_2$ % = ?
discount = ?

Take carriage to the sixth position.

Set 177·679 with levers 6—1 and transfer to result-register.

Set indicators as in example a.

To deduct $7^1/_2$ % from 100 % turn the crank 7·5 times backward, starting in the fourth position, and the net amount, equalling £ 164·353 = £ 164. 7. 1 will appear in the result register.

The revolution-register shows 107·5, indicating that 7·5 % has been deducted from 100%. (Revolution-register with tens transmission on models MJR, MH, MDIIR, will show 92·5, the actual subtraction.)

To ascertain the amount of the discount clear result-register and change 107·5 in revolution-register to 100 by plus-turns of the crank (actually multiplying 177·679 by $\frac{7 \cdot 5}{100}$ and the answer in the result-register will be £ 13 · 325 = £ 13. 6. 6.

Example c:

Of two given figures £ 433. 15. 10
and £ 13. 10. 6

what percentage is the second of the first?

Take carriage to extreme right.

Set 433·792 with levers 6—1 and transfer to result-register.

Set indicators correspondingly to examples a and b (between 11th and 10th dials on result-register, and between 6th and 5th on revolution-register.)

433·792 represents 100 %; to find out how many percent of this figure the second amount 13·525 represents, take the 433·792 out of the machine by one revolution backwards and build up to the figure 13·525 (as explained in II, 6). Having done so the revolution-register will show the answer 3·11 %.

Example d: The total mileage for a given period has been 476524, for a second given period it has been 539875.

What is the percentage of **increase?**

Take carriage to the extreme right.
Set 476524 with levers 6—1 and transfer to result-register.
Set indicators to mark off 100 % and 476524.

Without clearing, build 476524 up to 539875 (II, 6); having done this the revolution-register will show 113·29439 % that means the increase amounts to 13·29 %.

Example e: Supposing 539875 is the figure for the first period and 476524 that for the second period.

What is the percentage of **decrease?**

Carriage to extreme right.
Set 539875 with levers 6—1 and transfer to result-register.
Set indicators to mark off 100 % and 539875.

Without clearing **build down** to the second figure 476524 by minus-turns of the crank. When finished the revolution-register will show 111·73438, that means the decrease amounts to 11·73 %.

2. Exchanges.

Example a: Given rate of exchange: £ 1 = $ 4.45.

£ 25 = ? $
„ 170 = ? „
„ 250 = ? „
„ 575. 10. 6. = ? $

Take carriage to 6th position.
Set 445 with levers 3—1 and transfer to result-register.
Set indicators to mark off £ 1 and $ 4 (between 5th and 6th dials on revolution-register and 7th and 8th dials on result-register).

The machine now shows the value of £ 1 being $ 4.45.

To find the value of £ 25, simply change the 1 to 25 in the revolution-register, and the corresponding value of $ 111.25 will appear in the result-register.

Continue changing to 170, 250, 575·525, and the answers will be $ 756.50, 1112.50, 2561.08625.

Example b: Given rate of exchange £ 1 = Fr. 45.76
Fr. 1500. = £?

Carriage to 6th position.

Set 4576 with setting-levers 4—1 and transfer to result-register.

Set indicators to mark off £ 1 in revolution-register and Fr. 45 in result-register.

Fr. 45.76 represent the value of £ 1. To find the value of Fr. 1500, take the 45.76 out of the machine by one minus-turn of the crank and build up to 1500 by plus-turns of the crank. Having done this the result £ 32 . 15 . 7 will appear in the revolution-register. (Actually, you have divided 1500 by 45.76 by the second method.)

Example c: Supposing the given rate of exchange is the same as in example b, however a whole column of franc-amounts is to be converted into pounds. In this case it would be much easier to follow instructions explained in II, 8, i. e. find the reciprocal of 45.76 and multiply all the amounts successively by it.

Rate of exchange: £ 1 = Fr. 45.76.

Fr.	1500	= £ ?
„	3750	= „ „
„	5685	= „ „
„	11250	= „ „
„	13378.75	= „ „ etc.

Find the reciprocal value of 45.76 by setting it in levers with carriage at extreme right and building up to 1,(·9999).

Answer: ·021853147. (Fr. 1.— equals £ ·021853147.)

Set ·02185315 as constant multiplier in levers 8 to 1 and multiply successively by 1500, 3750, 5685, 11250, and 13378.75 (II, 2), obtaining as answers £ 32 . 15 . 7, £ 81 . 19 . 0, £ 124 . 4 . 8½, £ 245 . 16 . 11, £ 292 . 7 . 4 d. (The units of the Francs must appear in dial Nr. 3/).

3. Averages and Pro-Ratings.

Example a: The total returns on one given line (trains, buses, cars etc.) for a certain period have been £ 256. 4. 8 for 2653 miles.

What has been the return per mile, expressed in pence, correct to 2 decimal places?

Carriage to extreme right.

Set 256·233 in levers 6 to 1 and multiply by 240 to convert the given amount to pence. Clear revolution-register, set number of miles 2653 in setting-levers above 61495·92, mark decimals by indicators (between 8 and 9 in result-register and 6 and 5 in revolution-register), and divide by method I. The result will be 23·18 d. per mile.

Example b: The expenses of five different departements for a given period have been:

A. =	£ 1575.
B. =	„ 986.
C. =	„ 1250.
D. =	„ 563.
E. =	„ 1400.
Total =	£ 5774.

What percentage of the total amount does each department represent?

£ 5774 represents the total amount, i. e. 100 %;

then £ 1 = $\frac{100}{5774}$ %.

Find this value by setting 5774 and building up to 100. The answer is: ·0173169017.

Now set ·017319017 as constant multiplier and multiply by each of the given figures 1575, 986, 1250, 563, 1400 (II, 2); the results will be:

A. =	27·28 %
B. =	17·07 „
C. =	21·65 „
D. =	9·75 „
E. =	24·25 „
Added =	100 %

4. Extraction of square root.

The following method, which was originally invented for the Brunsviga, enables the operator to extract square-roots in a very simple manner, by a purely mechanical process.

1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	30
31	32	33	34	35	36

Fig. 1.

The method is based on the following scheme: To extract the square-root of 36 we will divide the number in 36 equal parts, each square representing one unit. (Fig. 1.)

Now we successively **take away** first 1 square-unit, then 3, then 5, then 7, then 9 and at last 11, so that nothing at all is left. (See Fig. No. 2.) If we count the number of subtractions, which we have made, we find that they are six, and 6 is the square-root of 36.

If we apply the same method to 16 units, we see, that only 4 subtractions are necessary to leave nothing over, and so on.

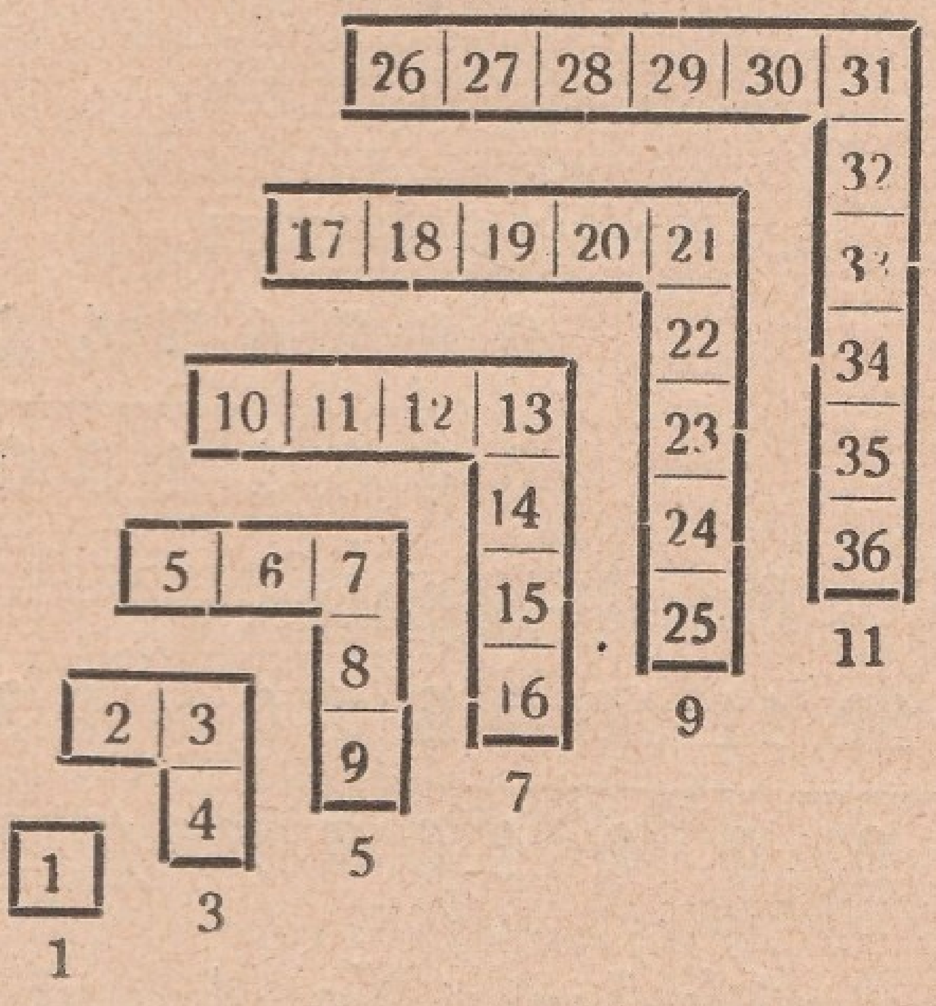


Fig. 2.

The theory of the method therefore consists in **subtracting the odd numbers,** 1, 3, 5, 7, 9, etc. from the radicandus, until nothing is left over.

Applied to the Brunsviga, the method works out in the following manner:

Example a):

$$\sqrt{536398}$$

Set the radicandus in setting levers 6—1.

Take carriage to 5-th position and transfer 536398 to result-register.

The number of decimals in the answer (revolution register), must always be half as large as the number of decimals in the radicandus (res.-reg.). Having inserted the radicandus with 4 decimals (set indicator in res.-reg. between 4-th and 5-th dial), the answer therefore will have 2 decimals (set indicator in rev.-reg. between 2-nd and 3-d dial).

Now we have to find the starting point for the subtraction of the odd numbers. This will always be in that position of the carriage, which equals the number of groups (of 2 figures each), in the radicandus. Our radicandus possesses 5 groups of 2 figures each (including the decimal noughts), therefore we have to start in the 5-th position of the carriage and with the 5-th setting lever.

Having cleared revolution-register and setting levers, set lever No. 5 to 1 and start subtracting the odd numbers, until the bell will ring.

We subtract 1; then change lever No. 5 to 3, turn backwards once; change to 5, subtract; set 7, subtract; set 9, subtract; after 9 comes 11, so take lever No. 5 back to 1 and bring lever No. 6 also to 1, subtract; set 13, subcract; set 15, subtract; here the bell rings, therefore correct your last subtraction by 1 plus-turn of the handle, take 1 off the figure in the setting levers (setting lever No. 5 back to 4), and space carriage to left.

The machine will now show the following figures:

Revolution-register.

8	7	6	5	4	3	2	1
0	0	0	7	0	0	▲0	0

Setting levers.

9	8	7	6	5	4	3	2	1
0	0	0	1	4	0	0	0	0

Result-register.

13	12	11	10	9	8	7	6	5	4	3	2	1
0	0	0	0	4	0	3	9	8	▲0	0	0	0

Now carry out the subtractions with lever No. 4, until the bell rings. Subtract 1, 3, 5, 7; the bell rings, therefore turn the other way once, set lever No. 4 back one and space carriage.

The machine shows:

Revolution-register.

8	7	6	5	4	3	2	1
0	0	0	7	3	0	▲0	0

Setting levers.

9	8	7	6	5	4	3	2	1
0	0	0	1	4	6	0	0	0

Result-register.

13	12	11	10	9	8	7	6	5	4	3	2	1
0	0	0	0	0	3	4	9	8	▲0	0	0	0

Continue with lever No. 3; subtract 1, 3, 5; the bell rings, turn the other way once, set lever No. 3 back one, space carriage.

The machine shows:

Revolution-register.

8	7	6	5	4	3	2	1
0	0	0	7	3	2▲	0	0

Setting levers.

9	8	7	6	5	4	3	2	1
0	0	0	1	4	6	4	0	0

Result-register.

13	12	11	10	9	8	7	6	5	4	3	2	1
0	0	0	0	0	0	5	7	4▲	0	0	0	0

Continue with lever No. 2; subtract 1, 3, 5, 7; the bell rings, turn the other way, set lever No. 2 back one, space carriage.

The machine shows:

Revolution-register.

8	7	6	5	4	3	2	1
0	0	0	7	3	2▲	3	0

Setting levers.

9	8	7	6	5	4	3	2	1
0	0	0	1	4	6	4	6	0

Result-register.

13	12	11	10	9	8	7	6	5	4	3	2	1
0	0	0	0	0	0	1	3	4▲	7	1	0	0

Continue with lever No. 1; subtract 1, 3, 5, 7, 9; (the next figure is 11; in subtracting 9 you actually subtracted . . . 69; therefore to subtract 2 more, you have to subtract . . . 71; set lever No. 2 to 7; and lever No. 1 to 1 and subtract) 11, 13, 15, 17, 19; the bell rings, therefore turn the other way.

The Result is 732·39 (with a remainder of 2·8879.)

If you want to check the result, leave the remainder in the result-register, set up the figure 732·39 in setting levers No. 5—1 and multiply this figure by itself, simply bringing the revolution-register to 00000. The result of the multiplication must give you the radicandus, 536398.

Example b):

$\sqrt{34672}$; the result to have 3 decimal places.

Set 34672 in setting levers 5—1;

We know that the radicandus, in the machine, must have twice as many decimals as the result; therefore take carriage to 7-th position and insert the radicandus 34672 with 6 decimal ciphers.

Set indicators between 6 and 7 on res.-reg. and between 3 and 4 on rev.-reg.

Find the starting point: the radicandus bas 6 groups of 2 figures each; (always start counting from the right side in the machine; the last figure, the 3, in such cases counts as a whole group).

Space carriage to 6-th position and proceed with the subtractions, as explained in example a.), starting with the 6-th lever.

The result will be: 186·204.

Check the result in the same way as above.

Example c):

$$\sqrt{\cdot 0034572}$$

Set 34572 with levers No. 5—1.

Take carriage to 6-th position and transfer the radicandus to result-register. In this position the radicandus will have 12 decimals, the result consequently 6 decimals.

Set the indicators.

The machine will show:

Revolution-register.

8 7▲6 5 4 3 2 1

Result-register.

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

0▲0 0 3 4 5 7 2 0 0 0 0 0

The first group, containg a figure larger than O, counting from the right end, is group No. 5; therefore space carriage to the 5th position and start the subtractions with lever No. 5.

Having completed the subtractions in the same manner, as above, the result will be: ·058797.

The check is also carried out in the usual way.

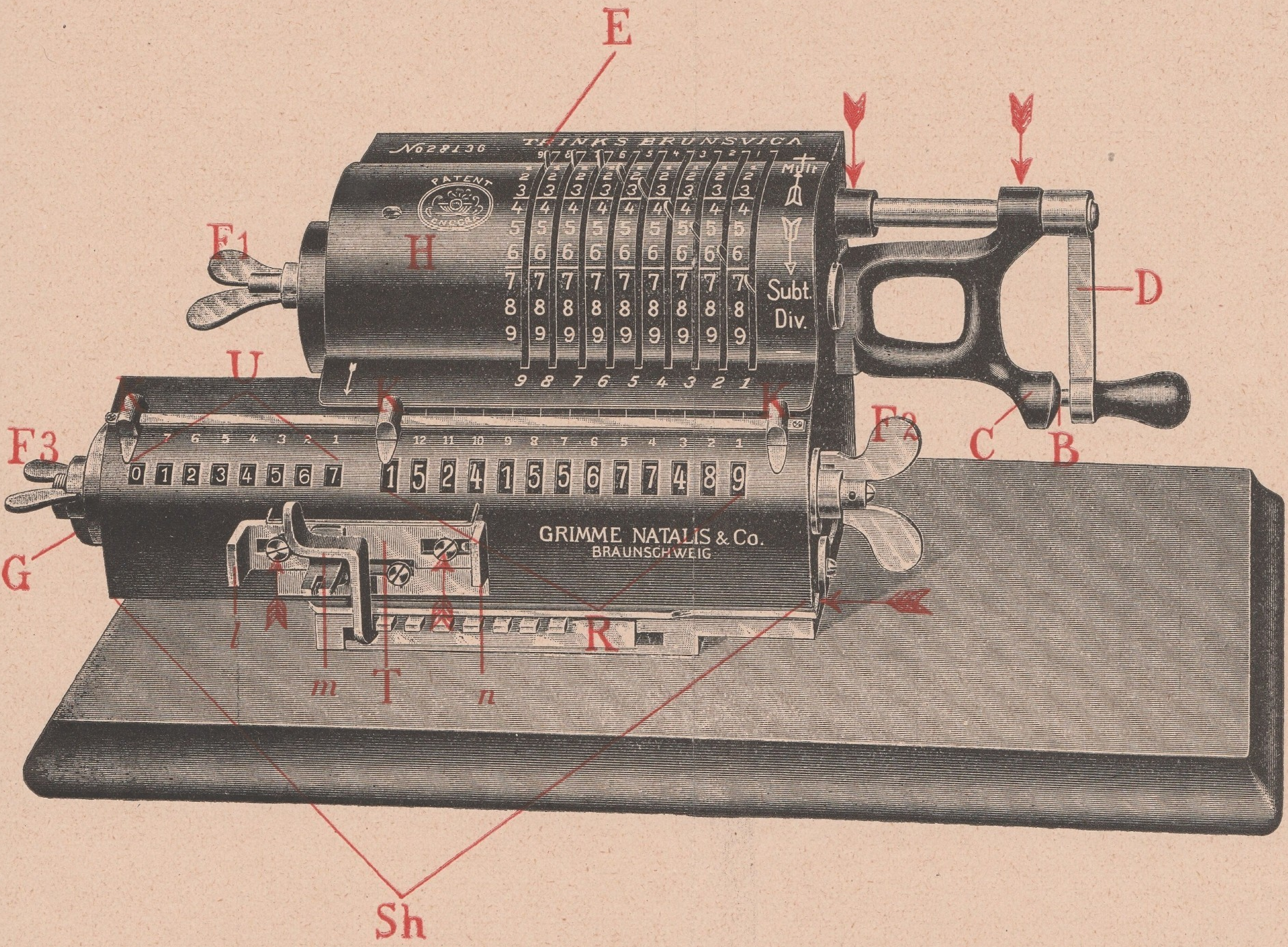
In extracting Square-Roots pay special attention to the following points:

1. Always insert the radicandus in such a way into the result-register, that is shows an even number of decimal places.

2. If rule No. 1 is observed, the number of decimals in the result must always equal half the number of decimals in the radicandus.

3. To find the starting point for carriage and lever count the groups (2 figures each), in the radicandus, from the right, including decimals. If the last group consists of one figure only, it counts as a whole group.

4. If rule No. 1 is observed, the number of the setting lever, with which the subtractions are carried out, must always correspond with the number of the position of the carriage, during the entire calculation.



BRUNSVIGA CALCULATOR (System Trinks)

Model "B" ("M B", "M A", "M D")

(Capacity 9×8×13)

(Model "M B" is the miniature type of Model "B")
(„ "M A" „ similar to "M B" only with a larger capacity of 9×10×18)
(„ "M D" has a still larger capacity of 12×12×20)

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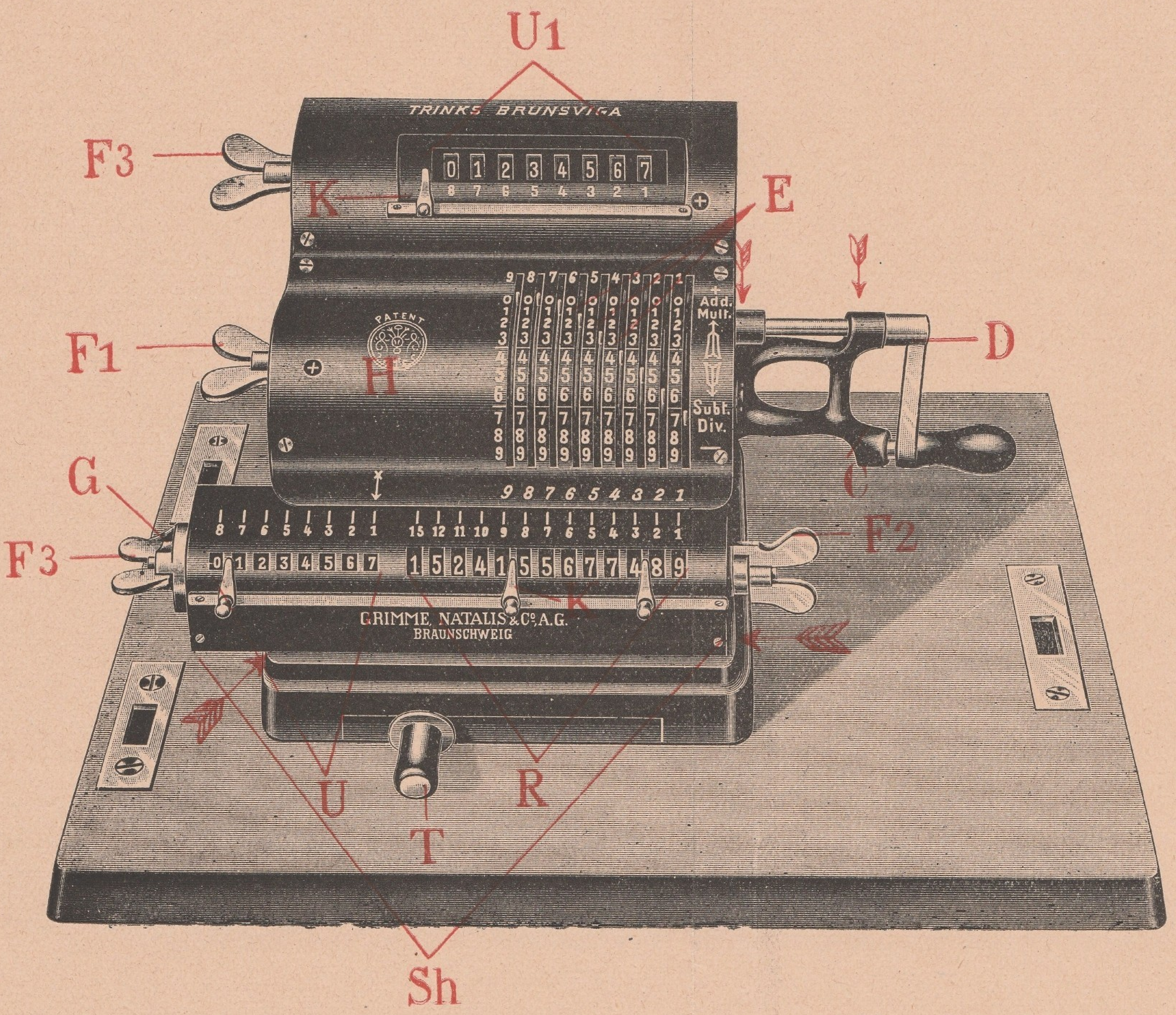

BRUNSVIGA CALCULATOR (System Trinks)

Model "M H"

Capacity 9×8×8×13

(Two revolution-registers)

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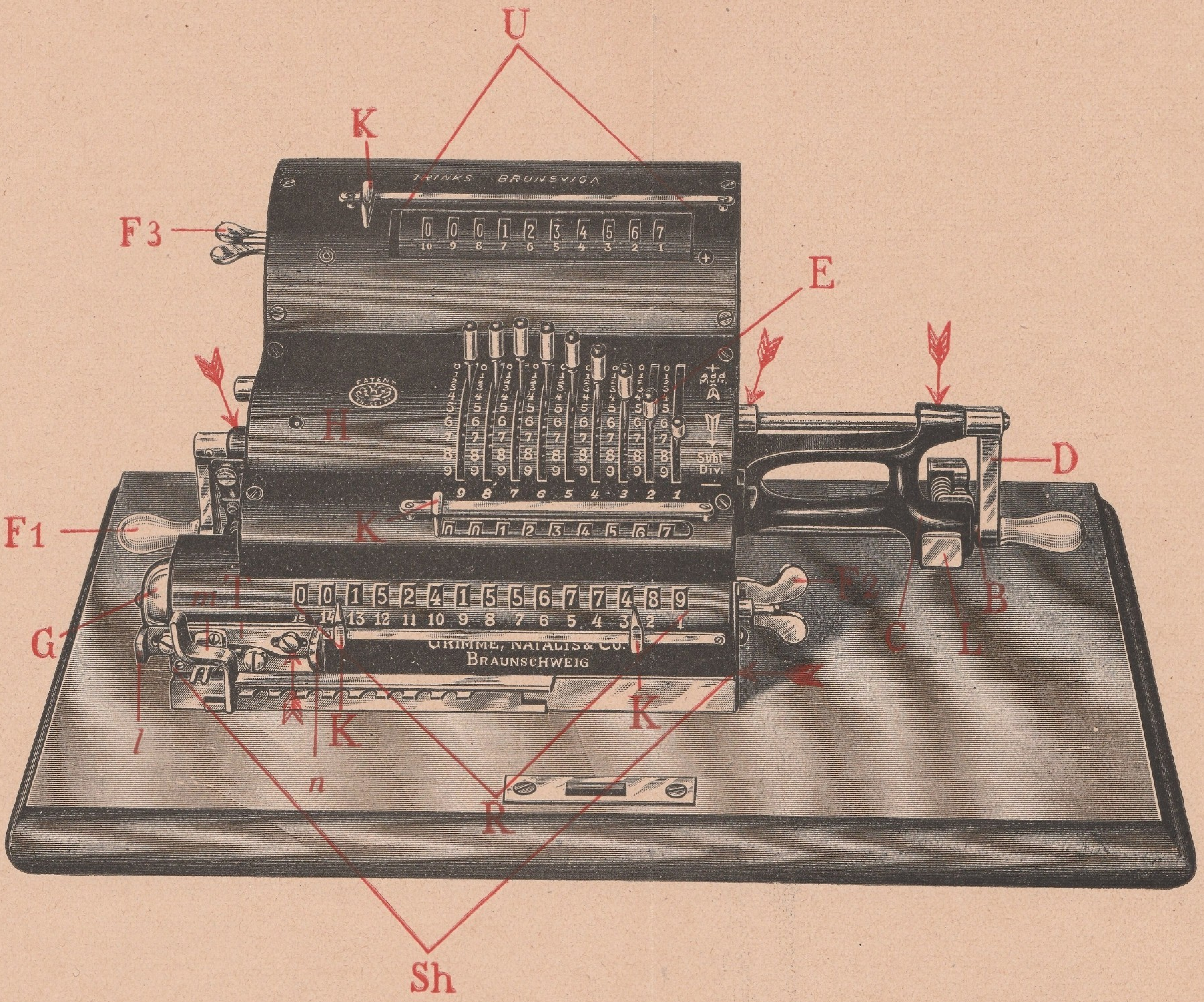

BRUNSVIGA CALCULATOR (System Trinks)

Model "MJR"

Capacity 9×10×15

(Special setting-levers, check-register for settings, carry-over device in revolution-register)

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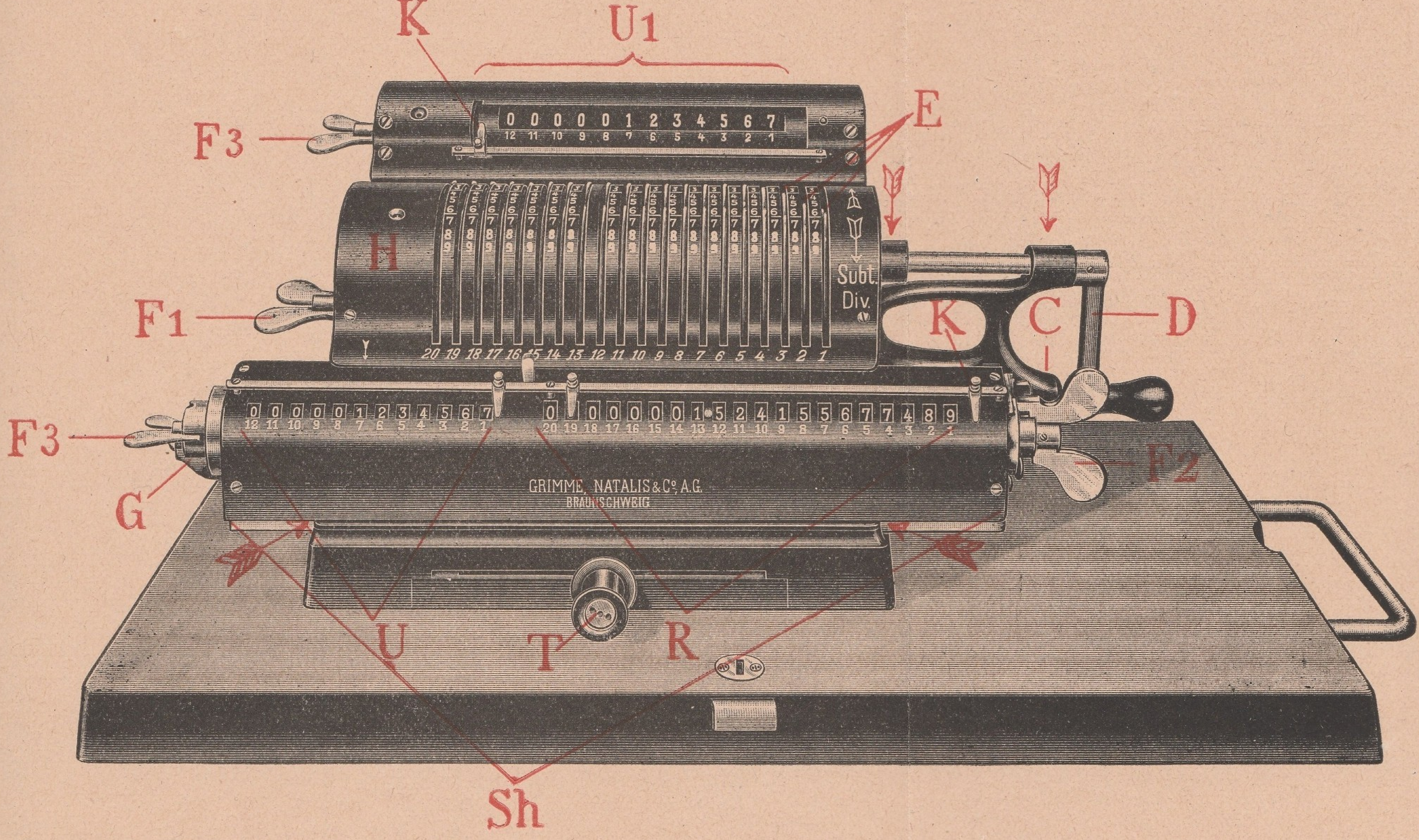

BRUNSVIGA CALCULATOR (System Trinks)

Model "Triplex R" ("M D II R")

Capacity 20×12×12×20

(Two revolution-registers. Special split device)

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