

**Gebrauchs-Anleitung**  
für die  
**Rechenmaschine**  
**„Millionär“**

Patent O. STEIGER



Goldene Medaille Dresden 1903

H. W. Egli A-G

vormals

**HANS W. EGLI, Ingenieur**  
**ZÜRICH II**

Fabrikation von Rechenmaschinen

Format des Originals 13 x 22 Zentimeter Zürich, o.J. (um 1905)  
Die Typografie und das Layout wurden mit Ausnahme des Blocksatzes so weit als möglich  
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# Rechenmaschine „Millionär“

Patent O. Steiger



The machine is intended for the execution of all simple and compound tasks of calculation, which are solvable using: addition, subtraction, multiplication and division. The enormous advantage, which the calculator offers over manual calculation, is sufficient well-known that it does not bear repeating here.

**The main advantage of the Millionaire calculating machine over other calculators is its astonishing rapidness, particularly for Multiplications and divisions.**

For each place of the multiplier or quotient only one crank turn is used, during which the necessary shift of the result automatically carries out itself. Whoever doubts in the efficiency and security of the Functions implemented by the „Millionaire " calculating machine, may try and use manual calculation or use another machine to try and implement the following examples in the times shown here.

### Beispiele.

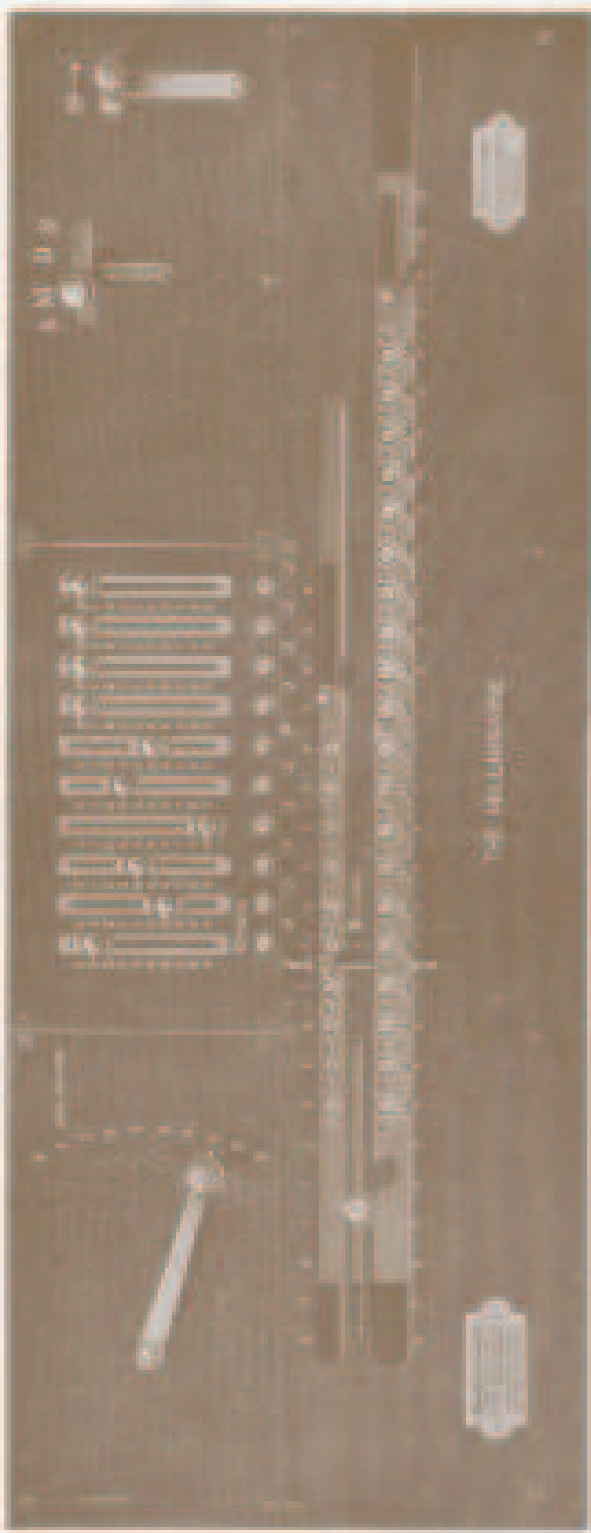
<i>a) Multiplikationen:</i>	In Sekunden
$350 \cdot 729 \times 357 = 125 \cdot 210 \cdot 253$	2-3
$18 \cdot 769 \cdot 423 \times 23 \cdot 769 \cdot 814 = 446 \cdot 145 \cdot 693 \cdot 597 \cdot 322$	6-7
$435 \cdot 176 \times 4 \cdot 444 = 1 \cdot 933 \cdot 922 \cdot 144$	2
$54 \cdot 351 \cdot 769 \times 77 \cdot 777 \cdot 777 = 4 \cdot 227 \cdot 359 \cdot 768 \cdot 637 \cdot 513$	4
<i>b) Quadrate:</i>	
$716^2 = 512 \cdot 656$	2-3
<i>c) Summe von Quadraten:</i>	
$716^2 + 535^2 = 798 \cdot 881$	8-9
<i>d) Differenz zweier Quadrate:</i>	
$716^2 - 535^2 = 226 \cdot 431$	8-9
<i>e) Differenz zweier Produkte:</i>	
$645 \times 348 - 438 \times 287 = 98 \cdot 754$	9-10
<i>f) Summe mehrerer Produkte:</i>	
$\left. \begin{array}{l} 125 \times 37 \cdot 572 \\ 4 \cdot 212 \times 8 \cdot 014 \\ 9 \times 277 \\ 50 \cdot 803 \times 7 \cdot 899 \end{array} \right\} 439 \cdot 746 \cdot 858$	30-35
<i>g) Divisionen:</i>	
$393 \cdot 638 : 217 = 1814$	6-7
$393 \cdot 638 : 143 = 2752 \text{ und } 102 \text{ Rest}$	6-7
<i>h) Proportionen:</i>	
$\frac{2856}{89518} = \frac{3478}{X}; X = 109 \ 013$	$\frac{2476}{2856} \quad 20$
<i>i) Quadratwurzeln:</i>	
$\sqrt[2]{4 \cdot 14 \cdot 74 \cdot 28 \cdot 06} = 20 \cdot 365 \text{ und } 9581 \text{ Rest } 18$	

This outstanding efficiency and large simplification in the operation of the „Millionaire " calculating machine is due to the fact that it is a real multiplication machine, which uses a built-in multiplication table for direct multiplication and division. With all other systems of calculating machines and adding machines, multiplications and divisions are only by a sequence of an appropriate number of additions or subtractions.

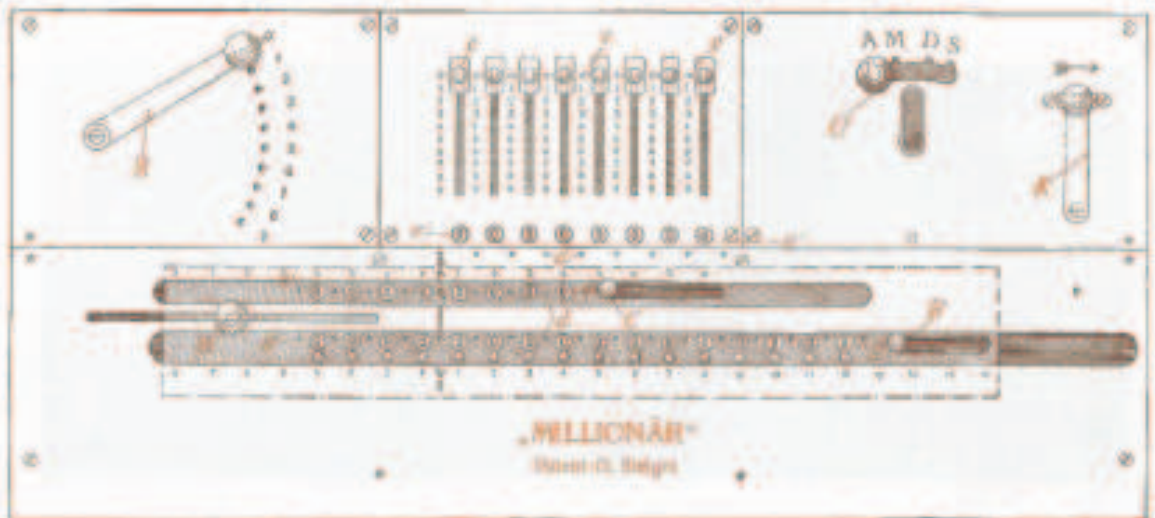
!! It is inconceivable that a multiplication machine could be designed simpler than one using a Multiplication table. !!



8 X 8 = 16-stellige „Millionär“.



10-bit 10 to 20-stage (Millionaire)



### Zeichenerklärung und Regeln zur Behandlung der Rechenmaschine „Millionär“.

- K** = Kurbel (1) Die Kurbel muss sich stets in der normalen (gesprochenen) Stellung befinden, wenn irgend ein Teil des Apparats verstellt wird!!!  
Die die Kurbel zu drehen, habe diesen Knopf in die Höhe (zur Seite des Kästges der Drehung nach rechts) und vollständig über seine Um-  
setzung in der Hochrichtung!
- D** = Umstellung muss sich in einer der mit A, M, S und Z beschrifteten Stellungen befinden, je nach der vorzunehmenden Rechenart!!!  
Zur Umstellung habe den Knopf D in die Höhe und schob ihn in die gewünschte Stellung!
- M** = Multiplikationshebel muss sich in einer der mit 0-9 beschrifteten Stellungen befinden, je nach der Zahl, mit der vermultipliziert oder  
dividiert werden soll. (Für Addition von Prozentsätzen „%“). Das Geometrische verfahren mit dem Knopf in die Höhe.
- W** = Wagenverschiebegerät dient dazu, aus der Basisstange und Kontrollreihe verstellbaren Wagen von links an irgend eine der  
9 zufälligen Stellungen zu heben; der Knopf W wird hierbei schrägschräg nach unten gedrückt, während  
der Wagen in die gewünschte Stelle verschoben wird, wenn man den Knopf wieder in die Höhe schiebt!
- E** = Einstellknöpfe Summe, Differenz, Multiplikand, Divisor werden dadurch eingestellt, dass man die Knöpfe (links der vertikalen  
Einstellreihe) verschiebt, bis die Lippe auf die gewünschte Zahl zeigt.
- K** = Einstellkontrolle zeigt die richtige oder falsche eingestellte Zahl in ganzer Höhe.
- K** = Kontrollreihe, Multiplikator und Quotient entstehen darin während der Zahleneingabe automatisch der Kontrolle.
- R** = Resultatreihe (Summe, Prod., Produkt, Divisor). Wird eine Zahl durch Erhöhen der einzelnen nach oben verstellbaren Resultatstange  
eingestellt, so drehen die Zahnräder, mit Ausnahme der ersten Zahl, welche steht von 9 auf 8, nach von 8 auf 7 und  
so weiter, bis sämtliche Zahlenstellung in die folgende übergeht.
- R** = Anschliehvorrichtung der Resultatreihe wird nach rechts gezogen, wenn es für die verstellbaren Wagen eine bestimmte  
Stellung erfordert, und wieder in seine normale Stellung links zurückgeführt.  
! ! Diese Arbeit wird abgelesen (lesen)!
- K** = Anschliehvorrichtung der Kontrollreihe wird nach rechts gezogen, wenn es für die verstellbaren Wagen eine bestimmte  
Stellung erfordert, und wieder in seine normale Stellung links zurückgeführt.  
! ! Diese Arbeit wird abgelesen (lesen)!
- K** = Kammastifte werden, wenn nötig, in die Reihe 6, 7, 8 und 9 eingesetzt!

Figure 1 The Labeled Parts of the Millionaire Calculator

## Rules for the treatment of the „Millionaire " calculating machine.

The crank K must always be in the normal, secured position, if a part at the apparatus is possibly adjusted. If this rule is not carefully observed, then either operating with the apparatus is at all impossible, or the same can suffer damage with use of force.

### Crank „K ".

In order to turn the crank K, its button must be lifted, until the safety lock pin pointing downward leaves the safeguard gutter; then one turns the crank to the right (direction of arrow–[clockwise]). By lowering the button again against the cover plate, the safety lock pin engages again into the safeguard gutter [on the top plate]. It is advisable to hold the crank button with the thumb and index finger of the right hand firmly and turn the crank with easy momentum, however not turning it too rapidly. Beginners often make the error of holding the button for the whole duration of the turn at full height. One should release the button immediately after beginning of the turn and put the weight of the front arm on the crank button. Then at the end of the turn, the pin will register surely into the gutter! [at the 12 o'clock upper position]. It is recommended practicing the rotation of the crank as described above carefully at the beginning.

The crank must always be turned a full revolution in the Direction of arrow [clockwise]. Counter-clockwise turning of the crank supplies wrong results, but does not harm the apparatus if carefully turned.

*[Editorial note: some machines have had the “safeguard gutter” removed. This does not seem to harm normal operation of the machine and in fact eliminates some of the problems described above]*

### Function Selector „U“.

The function selector „U " serves to select the different methods of calculation:

- A - Addition
- M - Multiplication
- D - Division
- S - Subtraction .

For this purpose the button on „U' is to be pulled up, until the selector-pin is free from the cover plate. Then one moves the button to one of positions named A, M, D and S and leaves it loosely, so that the selector-pin is held in the appropriate slot [See Figure 1.] . If U does not stand exactly in one of these four positions, the crank cannot be turned.

*[Editorial note: Turn crank „K “ to the 3 o’clock (90 °) position before moving „U”. If not quite at the right position jiggle it a few degrees forward or back. „U” should move very smoothly and the knob lock into one of the detent slots for A, M, D, S]*

### **Multiplication lever „H “.**

The lever „H“(multiplication or division lever) is used to select the numbers the 0 to 9 at their designated positions [See Figure 1]. One pulls its button up, until the pin pointing downward withdraws from the round hole in the cover plate, swings the lever until it points to the desired number and then releases the button, so that the safety lock pin can engage the hole concerned. It is absolutely necessary that the lever is held exactly in the designated number positions, otherwise a rotation of the crank „K “ is impossible.

### **Adjusting knobs (markers) „e-e “.**

The adjusting knobs „e-e“ serve for numerical entry of either the: addend, subtrahend, multiplicand or divisor. The Buttons „e“ along the number setting board can be slid vertically until they point exactly to the appropriate number and under that Button the attached feather/spring catches. In the eyehole present under the button then in each case the same number appears, which the button „e“ selects. The visible numbers shown in the eyeholes „é-é“ makes it possible to easily control the setting position of several digits in the setting board for e-e easily and rapidly. [See Figure 1]

*[Editorial Note: Should the setting board be removed (or may have been removed previously at some time) to clean the number dials etc. it will be seen the buttons have a long “finger” which should catch the associated gear for each digit top and bottom. If the setting board is not re-installed carefully, it may seem that digits are not being added, multiplied etc. to the result register. This is because the buttons are not moving the gears underneath for each digit as they are slid. Line all of the digit gears in parallel at one digit position before re-installing the setting board and make sure the fingers engage the gears].*

### **Result register „g-g“.**

The digits in the result „g-g“ are moveable by hand. It is to be noted that (with exception of the first place left) that when the crank K is at rest, the number disks are moveable neither directly from 0 to 9 [clockwise turn of the knob associated with each digit] nor from 9 to 0 [counter-clockwise rotation].

### **Carriage shifter „W “.**

The button „W“ allows shifting the carriage [with result register g-g] which is under the cover plate by hand to align digits [*i.e. result digits g-g with the setting board e-e*]. The button „W“ is depressed for this purpose and shifted to the right or left, until the carriage is in the desired place, after which one lets the button „W“ jump up again. “When multiplication and division takes place, the necessary arithmetic shift of the carriage [*left or right*] occurs automatically during the crank turn”. If the carriage is to be always



shifted by hand, the crank must be, „K“ in the normal secured position. Neglect of this regulation can damage the apparatus.

### **Clearing Knobs [*extinction devices*] „R “and „C “.**

The button, „R“ clears register, „g-g“ (Result row) by setting all the number disks into the position zero. For this purpose one pushes the button, „R“ as far right as the slot attached in the adjustable carriage permits and releases back, „R“ again slowly completely into the end position at the left.

!! It is not well, to release the knob, letting the feather/spring bounce back to the left. !!

The button, „C“ clears the control row „FF“ is exactly in the way described above. The crank, „K“ must itself here, like always, be in the normal Position [*vertically upward, 12 o'clock*]

If the crank „K “ demonstrates unusual opposing resistance, then this can have been caused due to disregard of above regulations.

#### **Remarks:**

1. With appropriate treatment the life span of this calculating machine is an unlimited.
2. There are many machines in constant use over 10 years (since 1897), without up to now having the smallest repair required.
3. The factory provides a 2 year warranty for each machine.
4. If the machine is not used and is closed and protected against penetration by dust and foreign bodies, then oiling only after several years is necessarily.
5. The disassembly of the machine is very simple, and may be undertaken by specialists in accordance with special instructions available from the factory - repair specialists are seriously warned, to not disassemble the apparatus in unapproved fashion!

#### **Addition.**

„Crank in normal position “.

1. Conversion, „U“ to „A“ = addition.
2. Lever, „H“ on, „I“ (addition subtraction).
3. Carriage, „W“ favorably in outermost position left

*Adjust the individual addends at the buttons „t “ with the units digit and/or the smallest decimal right and uniquely turn the crank for each individual addend. Here possibly shift of the carriage, „W“ by hand, around equivalent places addends perpendicularly in order to bring over those appropriate places of an existing sum*

already in register, g-g'. In the row, e-e' put in comma plugs so that in the result row, g-g' must stand perpendicularly one above the other here.

### Examples.

The ordinal numbers standing over the Arab numbers I to VIII correspond to the adjusting knobs, e' from left to right. Carriage is in outermost position left.

1. Addition of several whole numbers up to 8 places

I	II	III	IV	V	VI	VII	VIII
-	-	3	5	6	7	2	3
1	4	0	2	1	2	0	5
-	-	-	2	3	8	1	0
-	5	5	4	1	7	6	1
1	9	9	4	3	4	9	9

Comma plug except width unit hole right! [units/decimal digits separator (comma in Europe, decimal point elsewhere) is right of digit VIII]

2. Addition of several fractional numbers, whereby the sum of the whole ones and decimal places = 8 digits

I	II	III	IV	V	VI	VII	VIII
5	5	5,	1	7	0	0	0
-	2	7,	4	7	2	1	4
7	5	8,	1	0	0	0	0
1	3	4	0,	7	4	2	1

Here one supplements through appending of zeros to all Decimal fractions for five places and thus the one places at the button, e' III a comma plug directly to the right beside it. [i.e. decimal point is located mentally at digit III]

3. Addition of whole numbers with more than 8 places.

VI	VII	VIII	I	II	III	IV	V	VI	VII	VIII
			-	8	7	1	2	5	3	5
		1	7	0	0	2	7	7	1	2
2	5	8	9	9	3	0	7	8	4	6
2	6	0	7	8	0	4	8	0	9	9

Here one, beginning with units digits on the right, only enters the eight last places of the three addends. Add these and leave the carriage in the outermost position left. Then shift the carriage to the right eight places with the 9<sup>th</sup>, 10<sup>th</sup> and 11<sup>th</sup> digits not added yet. Add the 9<sup>th</sup>, 10<sup>th</sup>, and 11<sup>th</sup> digits in columns VIII, VII and VI. [The 11 digits of the total are now in the result register „g-g” including any carry-digits from column I ]

4. Addition of several fractional numbers, whereby the sum of the whole places and decimals digits is greater than 8.

V	VI	VII	VIII	I	II	III	IV	V	VI	VII	VIII
			2	5	9,	2	7	-	-	-	-
		1	5	7	8,	1	7	8	-	-	-
				7	9,	4	3	2	1	4	6
1	2	7	3	5	5,	5	-	-	-	-	-
1	2	9	2	7	2,	3	8	0	1	4	6

The carriage is in the outermost position left. Supplement only in thoughts all decimals on six places [*since there are only 6 decimal digits, place the decimal point after column II*], add then the eight last places, shift the carriage eight places to the right and treat the places on the left of like usual four digit numbers [*since the result register „g-g” has 16 places in all*]

## Subtraction

If the minuend is not already available in register „g-g“ from previous calculation, it can be entered using the knob dials into register „g-g“. Here it is to be observed that the number disks may be directly turned either from 9 to 0 [*counter clockwise*], or from 0 to 9 [*clockwise*], but this is not possible if the crank K is not in the normal position.

1. Conversion „U“ to subtraction „S“.
2. Lever „H“ on „1“ (ADD. - Subtr.),

then enter the subtrahend at the buttons „e-e“ and turn crank K once. Comma plug with „é-é“ perpendicularly over that with „g-g“. [*Ed. Note. Use the W knob to shift the carriage if necessary to the desired position under the subtrahend before turning the crank. This aligns the “comma plug” or decimal point separator of „e-e“ and „g-g“.*]

## Example

$$792615 - 5728 = X.$$

The apparatus shows „g-g“ = 792615 in the row „g-g“. [*Ed. Note either from a previous calculation or by setting the dial digits*] The carriage „W“ is in the outermost position left. The subtrahend 5728 is entered at the buttons „e“ in such a way that the one’s digit is aligned perpendicularly over the one’s digit of the existing minuend in „g-g“. The crank K is turned once, after which the remainder 786887 is in „g-g“. With decimal places and with subtractions of larger than eight-digit numbers one proceeds as with the appropriate examples shown for addition, with the only differences that the function selector „U“ must be set to „S“ = subtraction.

## Multiplication.

„Crank in normal position.“

1. Function Selector, „U“ to multiplication = M,
2. Carriage, „W“ normally in outermost position right.

Necessarily the carriage need only shift as many places to the left, as the number of digits in the multiplier. If the carriage however is in its outermost position right and one enters the highest place of the multiplicand, „e-e“ at the first button left adjusted, one has the large advantage of being able to perform multiplication immediately, using the full capacity of the machine.

For the execution of a multiplication it is necessary to:

- a) Enter the multiplicand at the buttons, „e-e“ (normally beginning with the highest place at the first button, „e“ left),
- b) Point the lever, „H“ successively to the digits of the multiplier (beginning with the most significant digit of the multiplier) while simultaneously turning crank K once for each place of the multiplier (also for 0).

The multiplier appears then as a check in, „FF“, while the product will appear in, „g-g“ with the final digit perpendicularly under the last digit of the multiplicand in, „e-e“.

When the multiplicand was entered at the first left digit of, „e-e“, then the first number of the result is perpendicular under the first control digit in control register, „FF“. Note this first control digit can be zero. Here one can see the number of digits of the product immediately. If the first digit of the multiplier is non-zero, then the number of digits of the product is equal to the sum of the places of the factors. If however the first digit of the multiplier is a zero, then is the number of digits of the product equal to the sum of the places of the factors minus 1.

By overviews of the row ordinal numbers finding under the row, „g-g“ one keeps the number of digits of the product immediately, by one under first and the latter To place of the product see (only one-digit) ordinal numbers present in the head added. [Ed Note *This seems to say that at each crank turn the product of multiplier digit “n” times the multiplicand appears in, „g-g“ and one could write these rows down and add them up, as with manual multiplication? Subsequent cranks continuously add these rows unless you were to clear, „g-g“ after each single digit multiplication.*] The cases, in which one of above multiplication rules is deviated from, are more clearly described on the basis of the examples shown below.

Here it is to be still noticed that, if the machine is set for to addition (or subtraction) and the carriage shift is set is made by hand, all multiplications (or divisions) likewise can be implemented, by as many crank turns, as each individual place in the multiplier and/or divisor, as with the machines which are based on the addition principle such as (Thomas, Burkhardt, Saxonia, Brunsviga etc. etc.).

## Examples.

*It is not necessary to stop the larger factor with „e-e “. Shifting these buttons requires the same time as the execution of an appropriate number of crank turns. [?]*

1.  $A \times b = X.$

Simple multiplication.

a) Whole numbers.

$2698 \times 735 = 1983030.$

The Roman numbers of IV III mean the adjusting knobs, „e-e“ from left to right.

With the carriage is in outermost position right, then place in, „e-e“

I	II	III	IV	V	VI	VII	VIII
-	2	6	9	8	-	-	-

and set lever, „H“ successively to 7, 3, 5 while turning the crank at the same time once for each position of, „H“: Number of digits:  $3 + 4 = 7.$

b) Fractional numbers.

$2.698 \times 735 = 1983,030.$

Proceed like above, put comma plugs in behind, „e I“, then whole places are  $3 + 1 = 4.$

Sum of products.

The sum of several products is to be formed, directly for example

2.  $ab + cd + ef + gh = X.$

a) Whole numbers

Multiplikator	×	Multiplikand	
125	×	37572	} 439'746'858,
4212	×	8014	
9	×	277	
50503	×	7899	

The multiplicands are entered into, „e“ in such a way that a separator at the last button, „e VIII“ is implied. [all multiplicands are entered right adjusted into „e “ ] Before beginning of the calculation place the carriages into the extreme left position and push it for each single multiplication by hand around so many places to the right, when the multiplier [“Multiplikator”] concerned has places. One notes only that the latter digit of the row, „FF“ comes perpendicularly under this number of digits corresponding the white ordinal number. At the end of each single multiplication the carriage comes again to the outermost position left and a bell signal sounded. Control row, „FF“ is to be set then to zero. Then the next multiplicand is to be entered into, „e“, the carriage shifted around the number of digits of the new multiplier to the right and the multiplication carried out . Simultaneous addition to the previous product occurs. In the end the final result appears in, „g-g“: [Ed Note: another method is to enter each multiplier with the number of digits of the largest multiplier. So, above multiply by “00125”, “04212” etc. This keeps all of the products aligned to form the sum of products].

b) Fractional numbers.

If the sum of several products of fractional numbers is to be calculated, then use the same computation as implemented above. [Align all numbers around a common position for the decimal point for the multiplicands and multipliers]

Multiplikator						Multiplikand							
						I	II	III	IV	V	VI	VII	VIII
1	2,	7	-	-	×	3	7	5,	7	2	5	4	
4	2,	1	2	-	×	8	0	1,	4	-	-	-	
-	9,	-	-	-	×	2	7	7,	-	-	-	-	
5	0,	8	0	3	×	-	7	8,	9	9	3	-	
													45032,7619590

One assigns a favourable decimal separator location in such a way into the row, "é-é" that right of it are still 4 places. Into the control row assign the separator in such a way that right of it are still 3 digits. For each single multiplication set the carriage so far to shift from its outermost position left to the right, until the "FF" separator is aligned behind that ordinal number, which corresponds to the whole places of the multiplier. The separator for the result is perpendicularly under that with, "é-é", if the separator for, "FF " aligns perpendicularly under the ordinal number 0.

**Squares.**

3.  $a^2 = A \times A = X$

$7162 = 716 \times 716 = 512656$

direct simple multiplication as with 1.

**Sum of squares.**

4.  $a^2 + b^2 = X$

$7162 + 5352$

to implement as with 2

$716 \times 716)$

$535 \times 534) = 798881$

**Sums several squares.**

5.  $a^2 + b^2 + c^2 + d^2 = X$

$7162 + 5352 + 40.772 + 55.22 = X$

form products with the same number of decimal places

						II	III	IV	V	VI	
7	1	6,	-	-	×	7	1	6,	-	-	
5	3	5,	-	-	×	5	3	5,	-	-	
-	4	0,	7	7	×	-	4	0,	7	7	
-	5	5,	2	-	×	-	5	5,	2	-	
											803590,2329

The carriage is as with example 2 in the outermost position left and must, in order to be multiplied by 716,00, be shifted 5 places to the right. Here again, one selects a suitable decimal point separator as shown above in example 2.

### Difference of two products or squares.

$$\begin{aligned} 6. \quad ab - cd &= X \\ a^2 - b^2 &= X \\ 7162 - 5352 &= 226431. \end{aligned}$$

Picture only the larger square like above, clear, FF; change to, D'-division and proceed otherwise exactly as with a sum of squares.

### Cubes.

$$7. \quad a^3 = a^2 \times A = X.$$

Fig. only  $a^3$  and regard this as multiplier or as multiplicand. The latter causes a new attitude with, é-é'.

$$716^3 = 367061696.$$

Place 716 into e-e' and multiply it by itself. The result 512656 forms the new multiplier. Set both, FF' and, g-g' to zero before the second multiplication.

### Division

,Crank in normal position."  
Function Selector,,U'to,,D'- division.

The divisor is entered in the normal way beginning with the first adjusting knob,,e'left. If the dividend not available already from some earlier Calculation in row,,g-g', then it is entered into ,,g-g' through [tricks of] the buttons under,,g-g'. Here it is to be noted that the number disks (with exception of the first one on the left) may be turned either from 9 to 0 or 0 to 9. This is impossible unless the crank is in the normal position.

*The dividend must be set perpendicularly under the divisor but must be smaller than the divisor!*

One gets accustomed therefore to adjust the first place of the dividend at the second digit left. The adjustable carriage is set at the start of the division in the outermost position right.

## Examples

0393638 : 217 = 1814									
			2	1	7				
			0	3	9	3	6	3	8
			2	1	7				Division mit 1
	0		1	7	6	6	3	8	-
			2	1	7				Division mit 8
	0	0	0	3	0	3	8	-	-
			2	1	7				Division mit 1
	0	0	0	8	6	8	-	-	-
									Division mit 4

One always compares the 2 first places of the divisor with the 3 first places of the dividend and estimates the quotient. The (2 digits) perpendicular under the words engraved in the cover plate, „divisor“ must be compared with the „dividend“ (3 places) underneath. Then adjust the lever, „H“ to the estimated quotient and turn the crank once. In the above case compare first 21 with 039 and estimate the quotient as „1“. After division with this first quotient as remainder is 176638. Now the 2 first places of the divisor are compared with the first 3-digits of the quotient remaining. Thus compare 21 with 176 which gives 8 as quotient. Now set the lever, „H“ to 8 and make a single crank turn etc. so that the quotient appears in „FF“. For a quotient digit of zero a crank turn must be made, with lever, „H“ in position 0.

If one puts a decimal separator both into the row, „é-é“ behind the last place of the divisor as into the row, „g-g“ behind the last place dividend, then the division without decimal places is terminated after that crank turn, after which the separators stand perpendicularly one above the other.

## Remarks

Once one has estimated a place of the quotient and committed it by turning the crank, then one keeps any resulting errors (too large or too small remainder) perpendicular after the crank turn under the divisor. In the latter case on the left „9s“ will appear with bell signal. If such an error shows up, then one adds or subtracts („U“ on „S“ or „A“ „H“ on 1 = ADD. - Subtr.) the divisor to the wrong remainder, until the correct result is reached. This is correct when perpendicularly under the divisor a remainder appears which is smaller the divisor and on the left there are only zeroes.. Control register „FF“ will then show the correct quotient to that point in the calculation. Usually a single addition or Subtraction are sufficient to correct errors. Notice that in the control row no



Decimal transmission [*carry*] takes place and therefore during corrections neither the zero nor the 9 should be exceeded! During continuation of the calculation however in this case do not forget to change back to division. [Ed.Note: *Set Function Selector „U“ back to „D“ - division.*]

If a larger dividend should start at the beginning of a division perpendicularly under the divisor, then the first place [*of the quotient*] is to be determined and noted by the subtraction process, by turning the crank, until a remainder, which is smaller than the divisor, appears. This case cannot arise, if one obeys dividends the rule indicated above with adjusting, i.e. enters the dividends, beginning at the second digit ,g“. For the guessed quotient of zero make a crank turn with the lever ,H“on,,0“. If the dividend and the divisor have decimals, then put in the decimal separator behind the one. The decimal separator for the quotient is positioned with the zero, if the two different decimal points lie perpendicularly one above the other.

b) In very many cases it is sufficient to compare the first place of the divisor with the 2 first places of the dividend in order to estimate the quotients.

0393638 : 217 = 1814									
		I	II	III					
		2	1	7					
		0	3	9	3	6	3	8	Division mit 1
		2	1	7					
	0	1	7	6	6	3	8	-	Division mit 8
		2	1	7					
	0	0	3	0	3	8	-	-	Division mit 1
		2	1	7					
0	0	0	8	6	8	-	-	-	Division mit 4

Compare always the first place of the divisor with the first right place being under it and estimates the quotient. Place the lever ,H“on this guessed quotients and turn the crank once. In the above case with division with the quotient 1 the remainder is 176638; now the first place of the divisor right under the divisor is a 2-digit number, thus compare with 17 which gives 8 as quotient. Now set the lever ,to H“to 8 and make a single crank turn etc, the quotient appears with ,FF“. If one puts the decimal separator both into the row ,é-é“behind the last place of the divisor as into the row ,g-g“behind the last place dividend, then the division without decimal places is terminated after that crank turn, after which the decimal separators line up perpendicularly over each other. All due corrections remarks from (a) apply.

c) Division using the Help Tables

A purely mechanical kind of division is possible, using the Help Tables attached in the [*lid*] of the calculating machine (containing all products from 1 x 1 to 9 x 99).The application of the Help Table is shown in the following example:

$$218163: 1729 = 126,17671..$$

After entering the dividend (W in outermost position right) into the row, g-g, with the highest place beginning on the left, and the divisor in the first place left in, e-e beginning at the second digit, one moves the one Slidegate [cursor] of the Help Table, until the red number 17 appears (rounded off for 1729) in the center of the eyehole. Then check the three-figure number in, g-g, which stands under, dividend. Look across the Slidegate for a number smaller [i.e. the number closest to but less] than the [3 digits of this] dividend. The [single digit above the window on the Slidegate] indicates the number, to which the lever, H is to be set, before one turns the crank once. If the dividend is smaller in, g-g than the number located in the slidegate window under the quotient 1 [left most number in the row], then the quotient digit is zero. Corrections are extremely rarely when using the Help Tables. If this should be the case nevertheless, then one receives by unique addition of the divisor to (or subtraction of) the divisor from the wrong remainder the correct result.

D) Once again note that if the apparatus is set for subtraction, with lever, H adjusted to, I; all division examples can be implemented on this calculating machine as with the calculating machines of Thomas, Burkhard etc.. This happens, i.e. by so often turning the crank until under the divisor there is a smaller remainder than appears perpendicular [above in the divisor] and one makes arithmetic shifts by hand [once for each digit].

e) Determination of a quotient with as much as desired Decimal places.  
393600: 217 exactly to 12 decimal places:

Set the decimal separator behind the last place of, e-e and, g-g. The whole places of the quotient stand perpendicularly one above the other with, FF.

In above example we receive 4 whole places for that Quotient. The apparatus permits directly only the determination one and we receive 2-digit quotient for the time being  
1813,8248.

For the determination of the further 8 decimal places one considers exactly the [remainder] under the divisor in, g-g.

2 1 7 divisor,  
1 8 4 0 0 0 0 remainder,

Clear both the control row, FF and the result row, g-g, after noting the remainder. Move the adjustable carriage into the extreme right and stop above the remainder of 184 left with, g-g; so that again the same picture shows up like above, thus which is to be compared first place of the divisor (2) with 18. Now can the division be further driven and one receives for 5 to 12. Decimal places 8 4 7 9 2 6 2 6. Thus the complete quotient is; 1813,824884792626. If one wants still further decimal places, then one proceeds with that remainder of 15800000 remaining now similarly as above.

f) If a dividend is to be divided by many different divisors, then it is favourable, after each single division, to change over the apparatus to multiplication and after correct adjustment of the carriage (the first place in, FF behind the line) to multiply by the

quotient. This way, one saves a clearing of the quotient and resetting of the dividend. Row, FF' is set to zeros and in row, g-g' sits the original dividend.

g) If different numbers [*dividends*] are to be divided by the same divisor, then the best approach is to form the reciprocal value of the divisor and multiply each dividend with this factor.

### Combined Calculations Proportion

$$\frac{2856}{89518} = \frac{3478}{X}$$

$$X = 109013 \frac{3478}{2856}$$

Multiply only 89518 x 3478. The best approach, like with the later compound tasks of calculation, where multiplications will be followed by divisions, is to set the adjustable carriage fully right then one place to the left. In this case the first place of the product is never set in the first digit of the row, g-g', so that division can follow without adjustment. The first place of the product appears at digit 3. Then with the following division do not set the carriage to the outermost position right, or if fully right, one must divide with the quotient 0 as the first digit. (Such practical tricks as well as the introduction or elimination of decimal points). [will become obvious through use of the apparatus]. Decimal points which are put into, g-g'; push the result row to the appropriate place with the carriage back into the outermost position on the right of, but subordinate to the first button digit of the divisor. The decimal point in row ,g-g' should align perpendicularly the last place of the divisor.

### Calculations of interest.

Calculate the interest of 7257 Fr. in 129 days at 4%

1. The year has 360 days.

Multipliziere  $\frac{7257}{100} \times 129$

Enter the capital at buttons, e' beginning at the left. Put a decimal separator behind the hundreds, multiply by 129, whereby the carriage a place from that extreme situation on the right of to the left, with decimal point shifted into, g-g' after completed multiplication perpendicularly under those with, e'-e', arrange interest factor 90 as divisor (with comma plug) entered at, e' II', push carriage back completely to the right, after, FF' was cleared. The unit digits of the quotient arise again, if the decimal separators in, e-e' and ,g-g' stand perpendicularly one above the other. In this case we receive as interest

$$\text{Fr. } 104 \frac{01}{00}$$

2. The year has 365 days .

Multiply only  $129 \times 4 = 516$  (days and interest rate) and regard this as new multiplier, place capital like a while ago on, e-e, and multiply by 516. Carriage position like above, after, FF, and, g-g, cleared. Decimal separator in, g-g, again clear, FF, carriage in outermost position right, then divide with 365 as divisor. The number of digits for the interest arises like above

$$\text{Zins Fr. } 102 \frac{59}{00}$$

3. If many calculations of interest are to be made, then the best approach to use small tables containing the interest-number-factors, with these multiplication factors to be used for the different interest percentages.

### Square roots.

Square roots are calculated according to the formula  $(A + b)^2 = a^2 + 2ab + b^2$  and implemented using divisions.

a)  $\sqrt{4734976}$

The square is indicated above again. As for divisions enter the number beginning at the 2<sup>nd</sup> left digit, into the row, g-g, the decimal point is behind the last place (respectable whole place) and also after organization into groups of 2 places.

Set Function Selector, U to, D = division.

Now is the square root from  $4 = 2$ , the first A; around the first b to find,  $a^2$  must be subtracted above all. One places 2 to Button, e I on the left of and the lever, an H on the same number of 2 and turn the crank once.

$a^2 = 2^2$	$\sqrt{4734976} = 2176$
	4
$(2a + b) \cdot b = 41 \times 1$	734976 41
$(2a' + b') \cdot b' = 427 \times 7$	324976 2989
$(2a'' + b'') \cdot b'' = 4346 \times 6$	26076 26076
	00000

Now one forms x for  $2a = 2 \cdot 2 = 4$  with e I, estimates the quotient for  $b = 1$ , adjusts this both with e II and with, H, and turns the crank, whereby  $(2a + b) \cdot b$  are taken off. Now the number with two digits is in, FF, is 21. To adjust the estimate this doubled with, e-e, and adjust both with e III and with, H, as new  $b' = 7$  and those as new  $a'$ . Turn crank. The determination of the 4th place is to be regarded now with 217 as A, to adjust 2 A

" = 434 as divisor, the new b " with 6 is estimated to adjust with e IV and, H " and turn the crank. Purely mechanically one has to always make certain that those last places in , e - e " and the lever position, H " agree, then immediately the latter after crank turn place with, e " to double (a resulting in decimal is possible to transfer to the left), so that with, e - e " adjusted number always double those with, FF " is, on that one estimates the new quotient. It is to be noted that by attaching, the b " the divisor, particularly in the beginning that calculation is often substantially increased, and before the crank turn a new estimation of the quotient for first places is indicated.

$$b) \quad \sqrt{70459236} = 8394$$

Setup again like above, the first place of the root 8 is in this case to 2. Button e II in - 30 - set, in order to make possible the formation of  $2a = 16$ . Then one proceeds like above. If one has with estimating made an error of one place and thus with the division got the wrong remainder, one can then correct by withdrawing of the carriage around a place and multiplication with continuous adjustment of, e - e " and, H " to get the old remainder before the last division, but one must also return the carriage to position 2, [Marks reset?], before one makes an adjustment , e - e " and, H " and again starts dividing. This manipulation requires much attention, and one is better off with such an error to note the digits already calculated and to being the calculation again.

\*            \*  
                 \*  
                 \*            \*

Further combined calculations leave themselves open to application of the methods aforementioned, and are easily solved after some consideration of the examples above, and experience with other such calculations.