# THE ARITHMOMETER
## CALCULATING MACHINE

(system Thomas, of Colmar)

CONSTRUCTED AND IMPROVED BY

# L. PAYEN

ENGINEER (machine constructor)

**Firm established in 1820**

SUPPLYING MINISTERIES — STATE-ESTABLISHMENTS, — RAILWAY-COMPANIES — FRENCH AND FOREIGN SCIENTIFIC, INDUSTRIAL AND FINANCIAL ESTABLISHMENTS

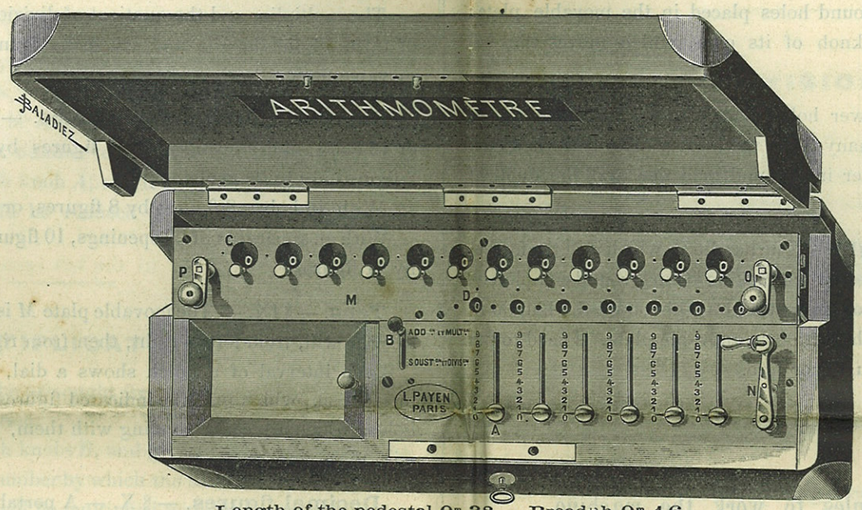
## Vve L. PAYEN, Successor

**PARIS. — 16, rue de la Tour-des-Dames, 16 — PARIS**

**DECLARED**
**ABOVE ALL COMPETITION**
Paris 1897, Rochefort 1898

**FIRST PRIZES**

**DIPLOMAS OF HONOURS**
Rochefort 1883,
Paris 1894, Bordeaux 1895,
Amsterdam 1895,
Innsbruck 1896, Rouen 1896
and Brussells 1897.




Length of the pedestal 0m,38. — Breadth 0m,16.

**GOLD MEDALS**
Paris 1889-1900
Society for encouragement
1851-1880,
Metz 1861,
London 1851-1862,
Moscow 1863,
Santiago 1875, Sidney 1879.

**SILVER MEDALS**
Paris 1878-1867-1855-1849.

### EXPLANATION OF THE ABOVE DRAWING

**A** Knob sliding in grooves marking the figures which are to be used in the operation.

**B** Knob showing what operation is required.

**C** Openings showing where the results of the operations are to be seen.

**D** Openings showing multiplier and quotient.

**M** Movable plate upon which are the dials.

**N** A handle that must be turned to set tho machine in motion.

**O** handle of the riglit handside to put the figures of the openings to nought or zero.

**P** Left handside handle for putting the figures of the *C* openings to nought.

**Nota.** — These two handles are also used to raise the plate *M* and to make it slide.

The Arithmometer performs with rapidity, safety and without any fatigue the four fondamental arithmetical operations; besides it will extract the square and cube roots.

By reason of the simple way in which it is made, the most intricate calculations are made with the greatest speed and the most absolute accuracy.

The Arithmometer invented by Mr Thomas de Colmar in 1820 is entirely of French manufacture.

The care which, for the last forty years, Mr Payen, engineer, has given to the making of this machine, **makes it the most exact of all.** It is also impossible that this apparatus should get out of order, owing to the extreme simplicity of its make. For these reasons **it is used constantly** in all state and private offices.

What proves the **usefulness,** the **rapidity** and the **exactness** of the Arithmometer is that a multiplication of 8 figures in both the multiplicand and the multiplicator is done in 18 seconds; a division with 16 figures in the dividend and 8 in the divisor in 24 seconds; and only one minute and a quarter is necessary to extract a square root of 16 figures, with the proof at the same time.

The preceeding lines will enable one to appreciate the great services it renders. With it, in half an hour without the least fatigue and with the greatest mechanical exactness a whole day's work in calculation is done. So it is easy to see the enormous economy of time and money which is to be made by using it.

The Arithmometer is indispensable to calculators and all those in counting-houses, statistic-offices, astronomical departments, geometrical, architectural, industrial, banking and commercial departments.

It has been **in constant use** for **30 years** back in the finance, marine and public building departments; in banks of deposits and consignments; at the "Conservatoire national des Arts et Métiers"; at the following railway companies: "Le Nord", "Paris-Lyon-Méditerranée", "l'Ouest"; "Orléans", etc.; in the following insurance companies: "Assurances générales", "l'Union", "le Phénix", "la New-York", "le Soleil", etc.; in the following large banking firms: "Banque de France", "Crédit Lyonnais", etc., and finally in a great number of financial and industrial establishments.

## PRICE-CURRENT

| | | | | | |
|---|---|---|---|---|---|
| The machines giving a result of | **12** | figures . . . . . | **450** | francs. |
| — — — | **16** | — . . . . . | **550** | — |
| — — — | **20** | — . . . . . | **800** | — |

*For the French provinces and Foreign Countries, the carriage and packing expenses are to be paid by buyers.*

## Names of the different parts and how to use them.

**N. Motor of the machine.** — It is at the bottom corner; at the right handside, it has an ivory handle lowered or raised at will. It can only be moved from left to right.

**Knobs A.** — Copper-knobs sliding in the grooves placed to the left of the handle (crank).

To write a number with the *A* knobs or bottons you must slide them till they are opposite the figures which form the number.

**Knob B.** — This knob on the left handside of the grooves is used to point out the operation which is to be done, by sliding it to one side or the other of the groove.

**Movable Plate M.** — Upper part of the machine: It can be raised by holding it by one of the handles which are on the left or the right handside; and then you can make it slide out of the machine, so as to be able to clear or free the holes, but only when raised.

**Openings C.** — Little round holes placed in the movable plate: Each hole has a little copper-knob of its own, which moves the dial containing the figures.

**Openings D.** — Small lower holes placed on the right handside of the plate which indicate how many times the handle must be turned and, by the way, shows the multiplier in the multiplication and the quotient in the division.

**Handles to put at nought.** — The handle *O*, which is at the farther end of the movable plate, is used, when making it turn round completely, to put back again the dials of openings *D* to nought; and the handle *P*, which is at the farther end to the left of the movable plate, is used to put back the dials of holes *C* to nought, or *zero*.

## Fundamental rules to work the machine.

§ I. — Each turn of the handle transfers into the holes *C*, in minus or plus, according to the indications of knob or botton *A*, the figures on which the knobs *B* are placed.

The operation of carrying the figures, in plus or minus, to the other columns is mechanically done, without any help required.

No further explanations should be required for the directions of the working of the machine than those contained in this paragraph.

§ II. — The operations are made according to the rules of arithmetic.

When all being at nought (*zero*) every operation consists as follows:

1st Of the position of knobs *A* which indicate sum submitted the to the operation;

2ly Of the position of knob (botton) *B*;

3ly Of the number of turns of the handle (to be given);

4ly For division and subtraction, of the placing in the openings (holes) of the number on which you have to operate.

**To put back again to nought (zero).** — § III. — The movable plate is to be drawn up; with the right hand the handle *O* is to be turned till there are only noughts in the holes *D*, then you let go; with the left hand, you turn the handle *P* till there are only noughts in holes *C*.

**How to place a number in openings C of the plate.** — § IV. — Knobs *A* are to be slid till they are facing the figures which compose the number with which you wish to operate, so that the hands of the bottons (knobs) faces the figures, the units in the last column to the right, the tens to the left of the units, the hundreds to the left of the tens and so on.

Botton (knob) *B* being at *addition*, then you give a turn to the handle and the number appears in holes *C*.

If you wish a number to appear in the openings or holes, you can do this by turning the knobs belonging to them, in holding up the plate.

**How to put the machine in motion.** — § V. — Turn the handle from left to right; but always turn completely round, and stop at the notch which marks the stopping point.

The handle must not be turned from right to left.

If by inadvertency you go beyond the notch, the turn should be finished; then push knob *B* to the opposite direction and give the handle another turn, so as to bring back the figures to the same place, where they were before the mistake occured.

**How to indicate the operation which is to be made.** — § VI. — Knob *B* is to be pushed with a firm hand to the extremities of the groove to either operation which is indicated.

§ VII. — The result of additions and multiplications is shown in openings *C*, as well as the remaining numbers of divisions and subtractions.

The multiplier and the quotient of divisions are shown by the number of turns of the handle and are to be found in the lower holes of the movable plate.

**Size of the different machines.** — § VIII. — With a machine of 12 holes, multiplications of 6 figures by 6 figures, or 5 figures by 7 figures are to be made.

With 16 holes, 8 figures by 8 figures, or 7 figures by 9 figures.

With an apparatus of 20 openings, 10 figures by 10 figures, or 9 figures by 11 figures.

**Tens.** — § IX. — The movable plate *M* is raised and glides, according to your will, from left to right, then from right to left.

Each interval of a notch shows a dial, which is detached from the mechanism, which puts the indicated figures in contact with the posterior holes, which are corresponding with them, and which allows to operate with these figures.

**Decimal figures.** — § X. — A portable comma in metal, is used to indicate the number of decimals and to separate them from the integer number; it is put into the little hole made between the openings, and so replaces the comma of the written operations.

## How to proceed with the different operations.

### ADDITION

For this propose put all to nought (*zero*):

Push knob *B* to *addition*.

Each turn of the handle reproducing, in the openings *C*, the inscribed number by knobs *A*, it is enough to write, one after another, with these knobs the numbers which are to be added, and to give to each written down number, a turn with the handle. All these numbers will, one after another, be added up, and the total will be found in the openings.

**Example.**

| | |
|---|---|
| To add . . . . . | 307 |
| to . . . . . | 785 |
| | 1,092 |

Push the three last bottons *A* (those to the right) to 307; give the handle a turn, and this first number 307 will be carried to holes *C*. Then bring back the botton *A* of units from 7 to 5, slide the knob or botton for the tens from 0 to 8, and the one for the hundreds from 3 to 7, thus 785 will be written; then give the handle another turn. This number will

add itself to 307, already carried before to the openings. in which 1092 will be seen, which is the total of 307 added to 785.

And so on for all other sums.

## SUBTRACTION

First of all put all to nought (*zero*) :

1st Make the number to be subtracted (subtrahend) appear in *C* openings.

2ly Push knob *B* to *subtraction*.

Each turn of the handle will reproduce in minus, in the openings, the number inscribed by the knobs *A*, it will be sufficient to operate as for addition, to write one after another each number which is to be subtracted from the sum inscribed in the openings *C*, and to give, for each one, *one* turn of the handle. When the operation is over the remainder is to be seen in the openings.

**Example :**

757 — 689 — 68.

757 must be slid into the openings, and mark 689 by knobs *A*.

Push knob *B* to *subtraction*, and give the handle a turn, then the sum inscribed in the openings will be reduced to 68.

If there should be another number to subtract, for instance : 57; this number should be written with knob *A*, and then give another turn with the handle; the number would be reduced to 11, which would be the remainder of the subtraction.

## MULTIPLICATION

For multiplying, all must be at nought (*zero*) :

Push knob *B* to *multiplication*.

Write the multiplicand with knobs *B*, and give as many turns with the knob as there are units in the number by which the sum is to be multiplied, namely the multiplier : so it will be multiplied with the units. Then the movable plate of an opening is to be pulled out to give the units full play, so as to have only to operate with the tens ; and then there is to give as many turns with the handle as there are units of tens. To multiply by hundreds, the same thing must be done as for the tens ; and so on for the thousands, ten thousands, etc.

**Example.**

| | |
|---|---|
| multiply . . . . | 35,695 |
| by . . . . | 29,072 |
| | 71,390 |
| | 2,498,65 |
| | 0,000,0 |
| | 321,255 |
| | 713,90 |
| | 1,037,725,040 |

First of all :

Push the five knobs *A* to the figures of the *multiplicand*, that is to 35,695.

After that, for multiplying by 2, which is the figure of the units of the multiplier 29,072, give *two* turns with the handle, and in the openings will appear the first partial product 71,390.

To multiply by 7, first figure of tens of the multiplier, the plate must be carried *one* notch to the right, in order to free the units ; and in order to add the result of the tens to the tens, according to the ordinary rules of arithmetic, give *seven* turns to the handle ; this being done the openings will show the two first partial results : 2,570,040.

For multiplying the hundreds, the plate must be carried again one notch to the right ; but as the figure of hundreds of the multiplier is *nought*, and as the multiplication by *nought* is nought, the plate must be carried again one notch further to the right and multiply immediately by 9, which is the figure of the units of thousands of the multiplier, that is to say, you have to give *nine* turns with the handle ; after this the openings *C* will show the whole of the first four partial results : 323,825,040.

Finally, for multiplying by 2, which is the figure of tens of the ten thousands of the multiplier, you have, for the last time, to carry the plate one notch to the right and give *two* turns with the handle ; the openings *C* will show the total result of 1,037,725,040, which is the one of 35,695 multiplied by 29,072.

The proof of the exactness of the operation is given by looking if the inscribed number in the openings *D* is the one with which you were multiplying ; and to give the proof of the operation, you only have to divide the result (openings *C*) by the multiplier (openings *D*), according to the rules which are indicated further on for division.

You see that the multiplication with the machine is made by the same rules as if you should have written it on paper. The *Arithmometer* has the great advantages of rapidity and infallibleness.

The same observation may be done for division (see hereafter).

## DIVISION

For division : put all at nought (*zero*) :

1st Carry the plate to the right, by raising it, so as to place the last opening above the first knob (botton) *A* to the left ;

2nd Place the dividend, or the sum which is to be divided, in the left openings or holes (see explanations infull § IV) ;

3rd Inscribe below the dividend, with knobs *A*, the figures of the divisor ;

4th Push knob (botton) *B* to *division*.

This being done :

Turn the handle till the number which remains in the openings *C* is inferior to the divisor.

Each turn of the handle retrenching once the sum marked by bottons *A* from that one placed in the openings *C*, the number of turns will show the number of times the sum has been retrenched and, consequently, the first figure of the quotient.

This figure will be shown, by the machine, in openings *D*.

Push in the movable plate one figure (which is the same as if you brought down the following figure) ; and then operate as before ; the number of turns will be the second figure of the quotient, and will be inscribed on the right side of the one already obtained ; then proceed as before till all figures placed in openings *C* have been submitted to this operation. The different figures which have been obtained will form the quotient, which will be inscribed in openings *D*.

**Example :**

4,300 to divide by 357.

Slide the plate to the right by raising it up, so as to be able to place the last opening above the first left knob *A*.

Place 4,300 in openings *C* ; mark 357 with knobs *A*.

The sums are put down as follows :

4,300 in openings *C*,
357 knobs *A*.

Push knob *B* to *division*.

Turn the handle : one turn will reduce the dividend to 73, which is an inferior number to 357.

1 is the first figure of the quotient, and will be indicated in openings *D*.

Push in the plate one notch to the left, the figures will be marked as follows :

730 in openings *C*.
357 knobs *A*.

Turn the handle : *two* turns will reduce the dividend to 16, which is an inferior number to 357 ; 2 will be the second figure of the quotient ; then 12 will be the quotient, inscribed in openings *D*, with a remainder of 16 in the openings *C*.

To make the proof, leave the remainder 16 in the openings and multiply the divisor 357 by quotient 12, and pushing knob *B* to *multiplication*, then you will find, in openings *C*, the first number 4,300 ; and openings *D* will be back to nought (*zero*).

## Extraction of the square root.

To extract the square root of 897,650,000 :

1st Show the number in openings *C*, as it has been explained and, afterwards, push all knobs *A* to nought (*zero*) ;

2nd Push knob *B* to *division* ;

3rd Divide or separate the number in parts of two figures (if the number is composed of an odd number of figures, the last part to the left will have only one figure) ; the root will have as many figures as there are parts in the square ; an equal number of knobs *A* will help to find the figures of the root ; let us call these knobs, beginning by the left : $A_1$, $A_2$, $A_3$, $A_4$, $A_5$, etc. ;

4th Slide the movable plate from left to right till the first part of the square (figure 8) is to be seen above knob *A* ; all other knobs at nought (*zero*) ;

5th Extract the square root of 8, which is 2, and place knob $A_1$ to the figure 2 ;

6th Give *two* turns of the handle ; figure 4 will replace figure 8 in the openings ;

7th Put in the plate one notch ; figure 9 will appear above the root of the first figure (2) marked by knob $A_1$, and figure 7 above knob $A_2$, which indicates the second figure of the root ;

8th Double the root 2 of the first figure by carrying this knob to figure 4 ;

9th Figure 4 will be the divisor of the two left figures 49, on porpose to have the second figure of the root.

But although 4 is contained *twelve* times in 49, it is necessary, for the reason that figure 9 is following, to suppose that it is only contained nine times (whatever may be the figure of the root of a number, it never can be more than 9) ; the second figure of the root will be 9 ;

10th Push knob $A_2$ to figure 9 and give *nine* turns to the handle. As knob *B* is pushed to *division*, the machine has omitted the multiplication 9 by 49, marked by knobs $A_1$ and $A_2$ ; so number 497 of the three first openings will be reduced to 56.

The machine has made the following operation : $497 - (49 \times 9) = 56$ ;

11th As the root is to be doubled to find the third figure, and as the first figure, or knob $A_1$ has already been doubled, knob $A_2$, which is at 9, is to be put to figure 8 ; then add to the first one unit, which will make it 5, and will show 58, which is the double number of 29, the known root ;

12th Push in the plate one notch ; the first 6 of the square given will be above knob $A_1$ marking 5, and the second 6 above knob $A_2$ showing 8. Figure 5 will be above knob $A_3$, which will show the third figure of the root ;

13th See how many times figure 5 may be contained in the two first figures 56.

As number 5 of knob $A_1$ is followed with an 8, it will be noticed that 5 is nearly equal to 6, and it is to be said : how many times 5 is contained in 56 ? Say *9* times ;

14th Carry knob $A_3$ to 9, and give nine turns of the handle ; there will remain 364 above knobs or bottons $A_1$, $A_2$, $A_3$ ; so the third figure of the root must be 9 ;

15th This 9 must be doubled on knobs *A*, that is, put botton or knob $A_3$ to figure 8, and bring forward knob $A_2$ one unit, which will bring it to figure 9 ; knobs *A* will show 598, the double of the three first figures of the root 299 ;

16th Push in the plate one notch ; and still divide the two figures 36 in the openings above knob $A_1$, by figure 5 marked by this knob, and considered as 6 on account that 8 is following it ; then 36 divided by $6 = 6$ ; the fourth figure of the root will be 6 ;

17th Push knob $A_4$ to figure 6 and give *6* turns with the handle, there will remain nought (*zero*) above knob $A_1$ and 484 above the three other knobs ;

18th Double root 6, by pulling knob $A_4$ to figure 2, and add one unit to that of knob $A_3$, which changes it from 8 to 9 ;

19th Push in the plate one notch ; you will see 4 above knob $A_1$ which is showing 5.

5 is not contained in 4 ; the fifth figure of the root will be therefore nought (*zero*) and knob $A_5$ remains at nought (*zero*).

So the total root will be 29,960 with a remainder of 48,400 shown in the openings.

The root will be indicated by the machine in openings *D*.

For making the proof, you have only to multiply 29,960 by 29,960, that is to say the root by itself, by leaving in the holes the remainder which is already there ; and the total sum of 867,650,000, of which the root was to be extracted, will be in the openings.

## Extraction of the cube root.

For extracting the cubic root of 79,507 :

1st Show this number in the left openings *C*, as for division, and put all knobs to nought (*zero*) ;

2nd Divide or separate the given number in parts of three figures, beginning from the right to the left ; the left part will have only two figures ; the root will have as many figures as there are parts ;

3rd Glide the movable plate from the left to the right side, till the left last figure is to be found above the last knob *A* ;

4th Take the largest cube contained in the first part 79, be it 64, which root is 4 ; write this figure apart, indicate with knobs *A*, beginning by the left, number 64, subtract it from the first part 79, and the remainder 15 will be seen in the openings ; then 4 is the first figure of the root ;

5th Make the treble square of the first figure of root 4, be it 48 ;

6th Indicate this number with the left knobs *A* ;

7th Take down the second part 507 near the remainder 15, and we will have 15,507, of which the three first figures 155 are to be divided by 48 ; quotient 3 will be the second figure of the root ;

8th Make the cube of 43, which is 79,507.

Consequently, the cubic root of 79,507 is 43.

## How to remedy the non-observance of the precautions

INDICATED IN THE INSTRUCTION.

If the handle should resist, instead of trying to master this resistance, let it go at once where it stops.

Put all the knobs *A* to nought (*zero*) ; and finish the turn which was begun.

All being put in its place, begin again the operation, taking care at first to give one or two turns with the handle, keeping up plate *M*.

Then the handle will turn freely ; should it not do so so, mething will have slidden in the machine, which has given rise to this resistance.

Then you have to take the machine out of its box, taking away these two big screws, which are on the left and right side.

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For the duration of the machine, and to facilitate its motion, it is good to put, from time to time, refined sheep's-foot oil, or watchmaker's oil, but always in small quantities.

PAUL DUPONT'S Printing-Offices, 4, rue du Bouloi, Paris.