

THOMAS DE COLMAR  
AND PAYEN ARITHMOMETERS

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# 1 Introduction.

This is a very rough and preliminary draft of a report concerning the serial numbers of Thomas de Colmar and Payen arithmometers. The intent is to catalog as many machines as possible, and to gather together as much information about Thomas de Colmar and Payen arithmometers as can be reasonably put into what hopefully will be a more detailed listing of known machines. This version makes much use of secondary material, and may change radically before it reaches a final form.

In the current state of writing, information about arithmometers is arriving on a regular basis. This new information has caused a number of rewritings of this document, and several changes of direction. Thus, in its present state, it will be found to be rather awkward.

## 2 Historical Information.

Charles Xavier Thomas was born in 1785 in Colmar, Alsace, France. He died in April 19, 1870 at the age of 84. He was a business man whose primary activity was fire insurance.

Quoting from Richard [14], “Thomas de Colmar was a former officer of the Army of Marshall Soult in Spain.<sup>1</sup> He directed the *Soleil-Incendie* from 1829 to 1870. His son Thomas de Bojano then succeeded him and remained as director until his death in 1881.”

In the Février 1822 *Bulletin de La Société D’Encouragement pour L’Industrie Nationale*, reprinted in [2] he is referred to as “M. le chevalier Thomas, de Colmar, directeur honoraire de la Compagnie d’assurance du Phénix, rue de l’Echiquier, no. 33, á Paris.” Stern states in [16] that he added the “de Colmar” to his name when he married the duchesse de Bojano.

It is not clear if he inherited wealth, married into money or made a fortune on his own. But it is clear that at the time of his death he was well off. A book [16] was written about his home, *Château de Maisons*, which he purchased at auction in 1850. It refers to his *grande fortune*, which enabled him to make numerous repairs and improvements to the château, including extensive gardening on the surrounding land. Quoting from the book:

M. Thomas de Colmar died the 13th of May, 1870, after having given sumptuous parties at the estate (Château de Maisons). He left numerous children and grand children. The château and its surrounds were assigned to his widow (valued) at the sum of one million. She died in her turn the 12th of October, 1874, and the property, left undivided by the heirs, was sold the 28th of May, 1877,...

Of the “numerous” children and grand children, only the son, Thomas de Bojano and the grandson, the Comte de Ronseray, appear to have had any connection with calculation. In addition to taking over his father’s business, de Bojano’s name appears on one or more of the patents. In particular, the patent of 1880 states: *ARITHMOMETRE DE M. THOMAS DE COLMAR PERFECTIONNÉ PAR M. THOMAS DE BOJANO*. The conclusion here

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<sup>1</sup>Nicolas Jean de Dieu Soult, Duke of Dalmatia, was in charge of the French armies in Spain from around 1809 to 1812.

is that de Bojano had an active part in the design of the arithmometer in its later years. He could have been responsible for the design of the carrying mechanism, an essential part of the design.

The Comte de Ronseray supplied portraits, etc., to the June 1920 exposition of calculating machines sponsored by *La Société d'Encouragement pour l'Industrie Nationale*. This meeting, discussed in [2], was put on because of the perceived slight of the accomplishments of France in the area of calculation.

In particular, there was a meeting and exhibition held in Edinburgh in 1914 to celebrate the discovery of logarithms by Baron Napier in 1614 [7]. That celebration gave very short shrift to the considerable French efforts in calculation in general, and to Thomas de Colmar and his machines in particular. His only mention was as follows:

The first satisfactory arithmometer of this nature was that of C. X. Thomas, which was brought out about 1820. It is usually called the Thomas de Colmar Arithmometer. It is still a useful machine, but its place is now being taken by lighter and better types.

### 3 The Arithmometer in Perspective.

First of all, it should be noted an invention may not be made or implemented just because the basic technology for the invention is available. Indeed, significant time may pass from conception of an idea until it finds a market place. James Burke [3] mentions the fact that three hundred years went by from the time spectacles appeared to the time that telescopes were invented. He states:

“This is another examples of the connection between invention and social need. As the European economy picked up after the centuries of the invasions (the ‘Dark’ Ages) any device that would prolong the working life of aging scribes would be welcomed. But there was no demand for the telescope in this period, which was prior to the invention of gunpowder and the use of cannon on the battlefield, when the view of the universe precluded the existence of planetary bodies as three-dimensional, observable phenomena. This is why the moment of invention is often identified with the moment in which the artifact comes into use. In many cases there are times when an invention is technologically possible – and in which it may indeed appear necessary, as the telescope may have – but without a market the idea will not sell, and in the absence of the technical and social infrastructure to support it, the invention will not survive.”

The reason for the quotation is to emphasize the fact that the Thomas arithmometer was successful not because it was a unique invention (it was not), but rather that Thomas began his work at that point in time where the it could be produced and when there was at least one application for it with major economic benefits.

First of all, the predecessors:

- Blaise Pascal invented his adding machine in about 1642. This was the first practical mechanical calculating device.<sup>2</sup>

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<sup>2</sup>Wilhelm Schickard may have produced a machine at an earlier date. Whether or not he actually did is irrelevant to this discussion, as the machine was never produced and was unknown until quite recently.

- Gottfried Wilhelm Leibniz designed a calculating machine around 1673, two of which were built. They employed as their main calculational device the stepped cylinder which was invented by Leibniz.
- Philipp Matthäus Hahn starting in 1774 produced a circular stepped cylinder machine whose concept derived from Leibniz.
- Not long after (1783) Johann Helfreich Müller also produced a circular stepped cylinder machine.

Consult sources such as Chase [4], Martin [11] and others for the details of the above inventors and their machines.

The calculator designed by Leibniz and produced by Hahn and Müller were made by hand using technology developed for clock and instrument making. They were made before the industrial revolution began, and would have been extremely expensive by current standards<sup>3</sup>.

The last three were not the only calculating devices made between Pascal and Thomas, but they all employed the stepped cylinder, which was to be an integral part of all Thomas designs.

### 3.1 Calculations Done by Actuaries.

In order for the calculator to succeed as a commodity, there had to be two ingredients: a specific calculational need not easily satisfied by other means and an economic reason for supporting the very high cost of these devices. These two items were to be found in the insurance business.

Insurance is a form of gambling. Very mathematical gambling, but gambling nevertheless: a company owning a ship bets the insurer that their ship will sink on a given voyage; the insurer bets that it will not. The money that the ship owners wager is the premium, while the bet of the part of the insurer is the amount of the insurance. In this shipping example, insuring is perhaps more of an art: the insurer must know the value of the ship and cargo, the duration of the voyage, the dangers that might be encountered, the capabilities of the crew, the integrity of the captain and owners, etc.

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<sup>3</sup>The mechanical calculators made in the United States (Friden, Marchant and Monroe) were expensive even though they were mass produced. For example, in 1957 the Friden SRW model had a list price of \$1,378. This would have been close to 50% of the take home pay of an average worker at the time.

Based on these, the insurer makes his best estimate of what the premium must be. If he consistently prices the insurance policy too high, he may not get the business; too low and he faces the possibility of having made too many risky bets that may bankrupt him. In order to prosper, the insurer must use prior knowledge of the shipping industry and have some specific method of evaluating the risk of the sinking.

Additionally, the insurer must act the part of a gambling casino: the insurer must make a large number of insurance bets must, each of which is theoretically favorable to the insurer, in order that the risks average out in his favor.

A large amount of computation must be performed in order to make this sort of endeavor profitable: statistics must be computed from risk data; the aspects of an individual policy must be calculated; tables must be made available for use; rate schedules prepared for sales people and so forth.

As shown in [12], there were computational alternatives:

- Tables of logarithms were employed for this purpose.
- Quarter square tables could be employed. Making use of the fact that

$$ab = \frac{1}{4}(a + b)^2 - \frac{1}{4}(a - b)^2$$

one could calculate  $(a + b)$  and  $(a - b)$ , find the quarter squares of the sums and differences in a table, subtract them and thus find the product with three additions (or subtractions) and the two table look-ups.

- Slide rule devices such as the Arithmeter of Elizur Wright. See Kidwell, [9]

## 4 Thomas Patents.

Thomas patents are as follows:

Date	Country	Number	Name
18 novembre 1820	France	1420	Thomas de Colmar
8 decembre 1850	France	II,21,p.7,pl.2.	
A.D. 1851	England	13,504	Thomas de Comlar
30 septembre 1865	France	II,94,c.12,5,p.7,pl.7.68923	
29 septembre 1880	France	138912	Thomas de Bojano

Table 1: Patents associated with Thomas de Colmar.

Conveniently, these patents were granted during different years. This makes it possible to refer to them by their year of issue:

- **1820.** This first machine is ribbon (belt) driven. The patent was granted for five years.
- **1850.** Helical drive model. That is, the ribbon drive was replaced with a helix apparatus.
- **1851.** English version of the 1850 patent. This is also a helical drive.
- **1865.**
- **1880.** The Thomas de Bojano patent issued a year before he died.

## 5 Characteristics of Thomas Arithmometers.

An article by M. Sebert [15] states that Thomas machines were sold as follows:

DATES	NUMBER	TOTAL
From 1821 to 1865	500	
From 1865 to 1870	300	800
From 1870 to 1875	400	1200
From 1875 to 1878	300	1500

Table 2: Dates of machines sold from Sebert.

This material is also quoted in Martin [11]. Sebert also states that 3/10ths of these were six place, 6/10ths were 8 place and 1/10th were 10 place machines. The number of machines made appears to be consistent with the known sales of machines to the Prudential Assurance Company. But note that many if not most of the early machines were of the 5x0x10 variety. That is, 5 digits in the multiplicand, zero *shown* for the multiplier and up to ten digits in the product.

In summary, the following would appear to be the case:

- According to d'Ocagne [6], states that Thomas had the good fortune to find a helper both intelligent and adroit in the person of a young clockmaker of Neuilly-sur-Seine by the name of Piolaine to work with him at the beginning.
- Later, the Thomas machines were made by Payen. Apparently, Payen started making them under contract to Thomas around 1848.
- Machines made until about 1870, the year de Colmar died, will be referred to simply as *Thomas* machines. Apparently, Payen took over the company at the death of Thomas. Thereafter, *Thomas style* machines were made by Payen with the Thomas name.
- At some point Payen more or less kept the style, but changed the name on the machine to Payen; these are *Payen machines in the Thomas style*.

- Around 1908 Payen came out with his (their) own design: tilting base and nine slides; this is the *Payen style*.
- Finally, some time around 1920, M. A. Darras, 123 boulevard Saint-Michel, Paris (5<sup>e</sup>) succeeded Payen. See [2], page 638.
- Thomas machine serial numbers run from about 1 to around 800. These (generally) have a case with an ebony (black) finish with the word *Arithmomètre* inset in brass on the lid. One early version (now) has a teak case.
- Thomas style machine serial numbers run from around 800 to perhaps as high as 2301 or higher. From around 800 to 1500 they usually have ebonized cases with the word *Arithmomètre* in brass on the lid or in oak with *Arithmomètre* in ebony inlay on the lid. Thereafter, the oak cases seem to become more common.
- Payen machines in the Thomas style appear to have serial numbers in the very approximate range of 29xx to 32xx. These have oak cases. Later ones may have the index number on metal strips riveted to the bedplate.
- Examples of the Payen style machines have serial numbers running from 606 to over 5000.

The above numbers would seem to indicate that about 8,000 machines in total may have been made. On the other hand, a 1908 advertisement by Payen states “Plus de 18,000 Machines en usage.” It is not clear which machines are included in this number. As they were made until well after 1920, the grand total must be quite large. It is strange that relatively few of the Payen style machines have shown up in the antique scientific instrument market.

Note that the machines listed on the following pages have not necessarily been observed in detail, so that some of those listed in Tables 3, 4 and 5 could be examples of the 1908 model.

## 6 Early Thomas Arithmometers

This era starts in about 1820 when Thomas began to actively work on the arithmometer until around 185x when what became the standard machine began to be produced. It include the *ribbon* and *helical* machines.

Later machines multiply by having the operator turn a crank. Each turn added the contents of the multiplicand (setting) register to the product register. The multiplier is formed either mentally, or by observing the multiplier register on machines that have them.

The earlier machines are more automatic: they have a setting slide to the left of the multiplicand slides for inputting the multiplier one digit at a time. To multiply 395 by 137, the 395 would be set in the multiplicand slides, and the multiplier slide set to 7. The ribbon would be pulled (or the crank turned on the helical machine) until the action stopped. The ribbon would retract, and the next digit, 3 in this example, would be input to the multiplier slide and the ribbon pulled again, and so on until the multiplication was completed.

The helical machine was an improvement of the ribbon version. The ribbon mechanism was replaced by a helix with a groove running along its length. The bottom of the multiplier setting slide sat in this groove. Turning the crank the proper It is easy to imagine that the ribbons wore and became torn.

Figure 1: An example of the ribbon machine. Photograph courtesy of the Smithsonian Institution.

Figure 2: The helix driven arithmometer from the patent.

## 7 Manufactured Thomas Arithmometers

Table 3 lists machines believed to have been made while Thomas de Colmar was alive.

SN	WHERE LOCATED
	November 1986. 6x7x12.
104	Braunschweigisches Landemuseum. 8x0x16.
118	Deutsches Museum. 5x0x10.
404	Sold for DM7241 in Hannover (IFHB No. 26/87).
502	USA. Sold for DM5510 in London (IFHB No. 15/86).
524	Braunschweigisches Landemuseum. 5x0x10.
532	Deutsches Museum. 5x0x10.
633	Braunschweigisches Landemuseum. 6x7x12.
659	Sotheby's (Sept. 1984 est. £800 - 1200). Sold for £1210. Ebonized case. 6x7x12.
696	Kensington Science Museum (ca. 1860, on exhibit). 6x7x12. Inventory date of 1868.
743	Sold for DM910 in London (IFHB No. 5/84).
747	NMAH collection. Paris, 1867. 8x9x16.
759	Informatiksammlung IMMuD Erlangen. 6x7x12.

Table 3: Thomas arithmometers assumed to have been made while Thomas was alive.

The machine with serial numbers 747 is shown in [10]. This informative article by Dr. Peggy Kidwell has some interesting comments about the use of calculators by American scientists. She notes that No. 747 was purchased at the Paris Exposition of 1867 by F.A.P. Barnard, who was president of Columbia University.

Far too many of the machines in Table 3 are lacking detailed descriptions.

Figure 3: An early Thomas arithmometer. The approximate date is 1850.

Figure 4: A later Thomas arithmometer.

## 8 Thomas Style Arithmometers.

Tables 4 and 5 show models with the Thomas name on them, but are believed to have been made after Thomas died and Payen took over the business.

The machines shown in Table 4 generally have the following characteristics:

- The cases are made of ebonized wood.
- The word *Arithmomètre* appears in inlaid brass letters on the top of the case. Also, there is inlaid brass trim.
- Clearing knobs are ebonized.
- Buttons on the function shift, operating crank and window are ivory like.
- The glass window is standard.

The machines listed in Table 5 are very similar to those in Table 4 with the following differences:

- The cases generally are oak.
- The word *Arithmomètre* appears on the case lid in Gothic script done in ebony inlay with no brass trim.

Items 1667 and 2201 pose problems. Both have the addresses *44, Rue de Châteaudun* and *16, Rue del la Tour-des-Dames*. The former, which apparently was the office, was struck over at some point in time on both machines. It is possible that these machines were sold as used and refurbished machines at some point in time by Payen, who scratched out the old address on the plate in the process of preparing them for resale. Later advertising of Payen mentions only the Tour-des-Dames address.

The machine with serial number 1068 is also shown in [10]. Serial numbers 747, 1068 and 1372, shown in [1], are in the Smithsonian collection.

Serial number 1372 is very interesting, as the photograph in [1] clearly reads “PRUDENTIAL ASSURANCE COMPANY LTD.” on the carriage. Documents found in that company’s archives [8] indicate that this machine and others like it were purchased in the year 1876.

SN	WHERE LOCATED OR WHEN PURCHASED
879	Munich Technical University.
899	Sotheby's (May 1991). 6x7x12.
910	Braunsvigasammlung. 6x7x12.
955	Deutsches Museum. 8x9x16.
1014	Auktion Team Breker (May 1990, est. DM 7000 to 10000, sold for 7475). Ebonized case, rated (3,3). 8x9x12.
1068	NMAH collection. Circa 1876. (10x11x20)
1144	Braunsvigasammlung. 10x11x20.
1199	USA. Sold for \$3500, 1988. Ebonized case.
1273	Kensington Science Museum.
1274	Sotheby's (March 1987 est. £1000 - 1500). Sold for £1155. Ebonized case. 10x20.
1370-5	Purchased by Prudential in 1876. 8 figures, £20
1373	In the NMAH collection.
1380	Sold for DM3350 in Dusseldorf (IFHB No. 15/86).
1452	Purchased by Prudential in 1876, 6 figures, £15.
1455	Purchased by Prudential in 1876, 6 figures, £15.
1457	Purchased by Prudential in 1876, 6 figures, £15.
1458	Purchased by Prudential in 1876, 6 figures, £15.
1494	Deutsches Museum. 6x7x12.

Table 4: Thomas style arithmometers, part 1. The purchase dates of machines noted as being "Prudential" where found in the archives of that company.

SN	WHERE LOCATED OR WHEN PURCHASED
1617	Arts et Metiers, Paris. Displayed without a case and with bedplate cut away. 6x7x12.
1667	Offered by Brioux in Paris for 35000 Fr. in their Sept. 1990 catalog. Oak case. 6x7x12. Marked 16, Rue de la Tour des Dames (scratched over) and 44, Rue de Chateaudun. Oak case with "Arithmomètre" on lid. 8x9x16.
1776	Cristies (March 1919). 8x9x16.
1933	Sotheby's (May 1989, est. £1600 - 2400). Sold for £2090. Oak case. 6x7x12.
2019	Auktion Team Breker (Dec. 1989, est. DM 7500 to 10000, sold for 10350). Ebonized case, rated (2,2). 10x11x20.
2034	Kensington Science Museum.
2048	USA. Marked 16, Rue de la Tour des Dames and 44 Rue de Chateaudun. Oak case with "Arithmomètre" on lid in ebony. 8x9x16.
2103	Auktion Team Breker (Apr. 1991, est. DM 5500 to 85000, sold for 8197). Picture looks very similar to 2048 above. 8x9x16.
2201	Tesseract catalog, Fall 1990, \$3950. The 44 Rue de la Tour des Dames address is stamped over, and the 16 Rue de la Tour des Dames address is repeated twice. Index numbers on plates. 8x9x16
2230	Offered by H. Wynter, April 87 for £2200. Sold at Sotheby's June 86 for £1430. 8x9x16 Attributed as a Thomas; 44 Rue de Chateaudun, Paris.
2301	Sold for DM4350 in London (IFHB No. 3/84). Sotheby's June 84, £1100. Advertised as a Thomas. Address not given. Round slide buttons. 8x9x16

Table 5: Thomas style arithmometers, part 2. These machines tend to have oak cases.

## 9 Payen Machines in the Thomas Style.

The machines shown in Table 6 are similar to the later machines in the Thomas style, but are definitely marked as being Payen. Some differences:

- The ebonized knobs on the carriage are replaced with small metal cranks.
- The slide buttons on the main plate have changed from being round to having a left to right ridge.
- The one with serial number 3277 has many characteristics in common with the 1908 model.

SN	WHERE LOCATED
xxxx	Auktion Team Breker (April 91 – DM7612) No serial number, without index plates.
2808	Braunsvigasammlung. 8x9x16.
2958	Sotheby's (June 87 – L2860 (\$4560)). Attributed as a Payen. No index plates 8x9x16.
2976	Sotheby's (May 1990. 8x9x16.
3152	Arts et Metiers, Paris. No index plates. 8x9x16.
3277	Sotheby's (June 87 – L770 f(\$1310)), 6x7x12. Attributed as a Payen. With index plates. Apparently offered again by Auktion Team Breker April 1991, sold for DM6441.

Table 6: Marked as Payen arithmometers, but generally have characteristics similar to previous machines.

Figure 5: Payen arithmometer in Thomas style.

## 10 Payen Arithmometers.

Table 7 lists machines that are classified as Payen style arithmometers. This model was announced in 1908.

SN	WHERE LOCATED
606	USA. Purchased in Paris, 1987.
1143	USA. Purchased from Brioux in 1986.
1388	Sotheby's, 18 April 88 for £1430.
3171	Offered by David Weston, April 87 for £1250.
5544	Arts et Metiers, Paris.

Table 7: Known Payen arithmometers of 1908 and later.

These machines have the following characteristics:

- The mechanism is 9x9x16.
- The case is attached to a separate base by hinges on the front of the machine which permits the case to swivel forward for ease of use. There is a nut on each end of the case to lock it into position after an angle has been selected.
- The numbers next to the slides are on metal strips which were riveted to the case rather than having been stamped directly into the plate.
- The carriage has three upright metal knobs, each about 3cm high; the one at the left end is fixed and would be used to shift the carriage while the two on the right are used to clear it.
- There is a clearing lever on the right of the carriage which is below the level of the carriage and base plate. This clears both registers on the carriage at the same time.
- The case is of oak with brass corner pieces.
- Reference [2] shows the machine in Figure 21, page 638, with the title *Arithmomètre Thomas-Payen moderne (M. A. Darras, constructeur)*.

On page 637 it states that *M. A. Darras, 123, boulevard Saint-Michel, Paris (5<sup>e</sup>), est le successeur de Thomas de Colmar et de Payen.*

Figure 29, page 61 in Martin [11] (page 57) is of this type, and is labeled as being “present execution.”

Figure 6: A Payen arithmometer.

## 11 Arithmometers of Unknown Type.

The following individuals or museums are known to have Thomas/Payen arithmometers, but details are not known:

Various private collections.  
Boston Computer Museum (xx63?).  
Chase article (May 1952) 1870.  
Oxford Science Museum.  
Tekniska Museet, Stockholm. Late Thomas or  
early Payen.  
Smithsonian. Very early ribbon drive model on  
display.  
Auction June, 1986, Herve-Chayette,  
Laurence-Calmels, Paris (10000 Fr).

Table 8: Known arithmometers with unknown serial numbers or of unknown type.

## A Material from Martin.

The following section has a translation of Martin [11], pages 57 through 62. The footnotes were added to clarify several points.

### A.1 The Translation.

Charles Xavier Thomas of Kolmar (1785-1870), founder and director of the Compagnie D'Assurances Le Phénix, 33 rue de L'Echiquier and of the Compagnie D'Assurance Le Soleil, 13, rue du Helden, both in Paris, in 1821 submitted the calculating machine constructed by him known as the “Arithmometre”, to the Société d'Encouragement pour l'Industrie Nationale in Paris. By all accounts he is the founder of the calculating machine industry, since Pastor Hahn would probably not be so considered, for he and his assistants manufactured only a relatively limited quantity of their calculating machines, whereas Thomas dedicated himself to this industrial sector until his death in 1870 and over the decades brought it to quite a high level. Thomas' workshop was, until the establishment of the calculating machine industry in Germany by Arthur Burkhardt (1878), was the only company in this sector and supplied the whole world with its products. We know, for example that

from 1821 – 1865	500
from 1865 – 1870	300
from 1871 – 1875	400
from 1875 – 1878	300

were produced by the Thomas workshop. Of these, approximately 30% were six-digit, 60% were eight-digit and 10% were ten-digit machines. Out of each 100 machines produced, 60 were exported and only 40 remained in France. A 16-digit machine cost 500 Fr., which at the time was generally considered too expensive to allow the machine a high turnover.

The 1820 machine: It had only three setting slides and therefore also three stepped cylinders, yet six digits in the results. To the left of the setting slots is a fourth slot, also equipped with a slide and the scale 1–9, carrying the inscription “Multiplicateur.” Underneath this slide, that is inside the machine, is a drum around which a silk ribbon is wound and which is fastened to the drum at one end. The other end of the ribbon extends out to the

surface of the machine at the left. To the left of the ribbon drum, also inside the machine, an additional drum is located which has nine graduations and a spring in a casing mounted on its upper portion. The drums are connected to each other by gearwheels. The aforementioned spring causes the ribbon drum to maintain a particular position, i.e., through the pressure of the spring, the silk ribbon pulled out during calculation is always automatically rewound around the ribbon drum. The three stepped cylinders are also connected to each other and to the ribbon spindle by gearwheels. When the ribbon is pulled the ribbon spindle turns, which in turn causes the three stepped cylinders to turn. If an amount was set on same by way of a slide and the slide at the multiplication device is at on the scale, this amount is transferred to the result display device by way of the rotation of the spindles. This ribbon winding device thus replaces the crank used in our contemporary machines. How, then, does multiplication occur on such a machine? We return to the multiplication slide already mentioned, which can be slid along a scale from 1 to 9. This slide works on the aforementioned drum with nine graduations such that, if, for instance, the slide is set to 3 and the ribbon is pulled, the ribbon drum can perform exactly three rotations, through which, since same is connected to the three stepped cylinders by gearwheels, these also rotate exactly three times on their axles and thus transfer the corresponding three-digit amount one by one into the display windows. Since the carriage can be shifted sideways after being raised, multi-digit numbers can be multiplied using the machine.

The carriage has six double display windows. Each of the number discs located under the two result display windows grouped together carries the numbers 0–9 twice — on an outer number rim which displays black numbers and on an inner one which displays white. The black numbers appear in the left-hand display windows and the red in the right-hand. The former display the results of addition and multiplication, the latter of subtraction and division. In order to avoid confusion, a perforated strap is attached which leaves the left-hand display windows open during addition or multiplication and the right-hand windows open during subtraction or division, but covers other windows.

Subtraction occurs in the same fashion as addition but the larger amount can be set directly with aid of knobs located below the display windows, the display windows are opened, the amount to be subtracted is set on the setting area, the multiplication button is set to one and the strap is pulled

out. Division occurs in the same way, but with the difference that the carriage is shifted as in multiplication.

The 1848 machine: Has the same 5 slide slots and multiplication slide already mentioned. It has 10 digits in the result and only a single display window, since the conversion from addition-multiplication to subtraction-division is made operational using a lever. Instead of the inconvenient ribbon mechanism, a crank is mounded on the side wall. The individual stepped cylinders now have 9 teeth instead of 18.

The 1858 machine: The main improvement is the additional register mechanism<sup>4</sup> without tens carry (rotational counting mechanism). Its operation is known from the general description of the stepped cylinder machines in the introduction.<sup>5</sup> The machine was also equipped with a reset device for both the result and multiplier display windows, whereas previously the number display wheels had to be set to zero individually using knobs located underneath them. The reset mechanism takes the form of a knob that is turned to the right until all of the values in the result windows show zeros. The resetting mechanism for the result is located on the carriage to the right and for the multiplier on the left.<sup>6</sup>

The 1878 machine: In this embodiment the setting slides were equipped with small springs, which when the slide is set to a certain number fit into notches located there, so that a belated sliding of the setting knobs during cranking is avoided. Carrying over of the tens was substantially improved. A device was mounted to prevent over-spinning.

Thomas naturally never manufactured the machines himself, rather he had them manufactured. In the 1870s, V. M. Hoart conducted production in the building of the Soleil Insurance Company, 13, rue de Helder. Later, production was transferred to L. Payen, then to L. Payen succ., 16 rue de la Tour des Dames. Today the Arithmometre is produced in France by Alph. Darras, 123 Bld. St. Michel, Paris V with 12, 16 and 20 digits in the result. Fig. 28 shows a machine from the current producer. An older original Thomas machine is located in the Deutsche Museum in Munich.

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<sup>4</sup>For the multiplier.

<sup>5</sup>That is, the introductory chapter of the Martin book.

<sup>6</sup>This is wrong: Martin has them reversed.

## A.2 Comments.

The above quotation from Martin has a great deal of information. Martin could have gleaned it from a number of sources. Some likely ones are [2], patents, advertisements, etc. A number of collectors refer to Martin as “the Bible.”

One would perhaps be better off not to regard his book with total religious awe. As an example, he makes a comment, probably based on [15] that implies that the machine were mainly 6, 8 or 10 digits in their input capacity (how many slides). In fact, the early machines with no multiplier register tended to have 5 digits. That is, of the 5x0x10 style.

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