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# An Early (1844) Key-Driven Adding Machine

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*LORIA*

This article presents Jean-Baptiste Schwilgué's 1844 adding machine, which was equipped with a number of unique features, in particular with what was apparently the first numerical keyboard.

The first calculating machines—by Wilhelm Schickard (1623), Blaise Pascal (1642), Gottfried Leibniz (1671), Charles-Xavier Thomas (1820), Didier Roth (1841), and others—featured various ways to enter numbers. Some, like Pascal's, had dials, similar to those on older telephones. Others had sliders.[1]

In the second half of the 19th century, users could increasingly set numbers on calculating machines by depressing the appropriate keys. According to historian Georges Ifrah, progress on numerical keyboards was influenced by the development of typewriters.[2] Several typewriters had been invented before the 1840s, some of which had keys.

Until recently, researchers believed that the first key-driven calculating machine was Du Bois D. Parmelee's machine from 1850 (see Figure 1). Parmelee's patent shows a configu-
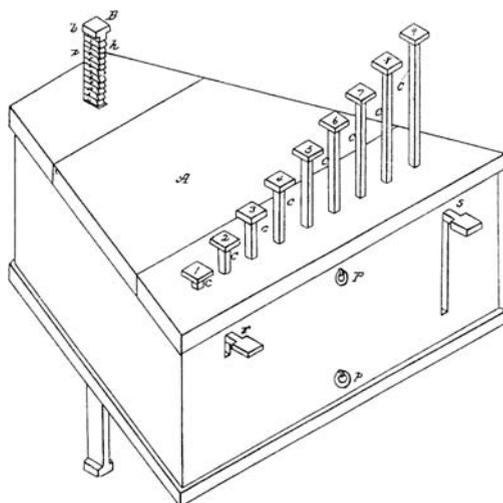


**Figure 1. Du Bois D. Parmelee's key-driven adding machine (1850). The keys are numbered from 1 to 9 and have increasing heights. Typing on a key raises a graduated rule which then represents the sum of the keyed digits. This drawing is excerpted from the patent application;[3] no copy of the machine is known.**

ration with nine keys and a vertical rod, but he wrote explicitly that "there are many methods of obtaining the same results." The keys could, for instance, be on the front of the machine, and they could move in slots "of a length proportioned to the purpose required." He remarked that the result need not be given on a rod but could be given on a wheel, or a series of wheels, one indicating "tens," another "hundreds," and so on.[3]

The next known key-driven calculating machine was the one by Victor Schilt, which was shown in 1851 at the Great London exhibition (see Figures 2, 3, and 4). Interestingly, Schilt's machine embodies several of Parmelee's ideas, without having been influenced by him, as we will see.

Thomas Hill built a key-driven calculating machine in 1857 (see Figure 5) in which a totalizing wheel was used, and—apparently—for the first time all keys were controlled by different positions of a lever, thereby producing different rotations of the totalizing wheel. Neither Parmelee's machine nor Hill's had a provision to avoid errors if typing was done too quickly.[5]

Other key-driven machines were introduced in the following years, in particular by Friedrich Arzberger (1866) and G.W. Chapin (1870), among others. Changes in these machines led to the famous Comptometer by Dorr E. Felt, introduced about 1885. It had a full keyboard—that is, nine keys to accommodate every digit (except 0) of a figure.

## Schwilgué's adding machine

In 2003, by browsing patent records I discovered that Parmelee's machine was not the first key-driven calculating machine, but that one was patented as early as 1844—see Figure 6—by Jean-Baptiste Schwilgué (1776–1856), together with his son Charles.[6] Jean-Baptiste Schwilgué was the architect of Stras-
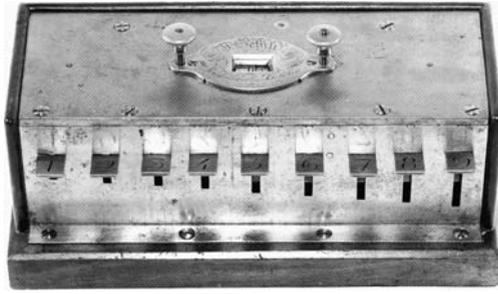
Figure 2. Victor Schilt's adding machine (1851). The inscription is ''V. Schilt, Mechaniker in Solothurn.'' (Courtesy of the Smithsonian Institution.)
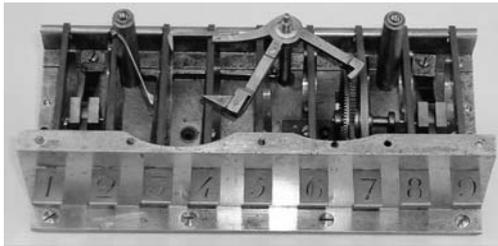


Figure 3. The inside of Schilt's machine (1851). The upper left arm probably broke at some time and received a new extension. (Photograph by David Todd, Smithsonian Institution.)
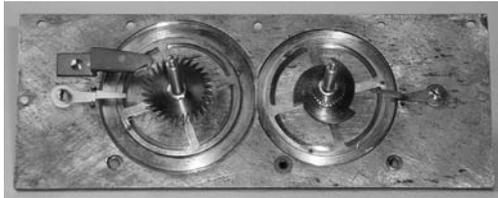


Figure 4. Under the top plate of Schilt's machine (1851). (Photograph by David Todd, Smithsonian Institution.)
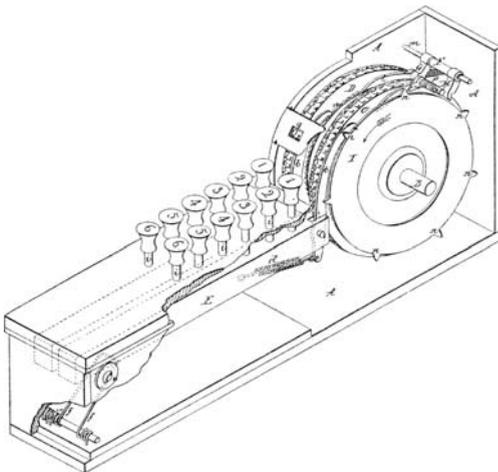


Figure 5. Patent drawing of Thomas Hill's machine (US patent #18692, 24 Nov. 1857).[4] Hill's patent model survives in the collections of the Smithsonian Institution.

bourg's third astronomical clock during the years 1838–1843. He was trained as a clockmaker, but also became professor of mathematics, weights and measures controller, and an industry man, whose particular focus was on improving scales. The Strasbourg clock contains intricate mechanisms, such as a mechanical Gregorian computus and a device that accurately calculates the inequalities of the moon (corrections needed to account for the moon's irregular motion). After the completion of the clock and following a change in the French patent laws, Schwilgué, with or without his son, patented several inventions, including a small adding machine (French patent number 623, applied in December 1844[7]). This adding machine appeared in the 1846 catalogue of Schwilgué's tower clock company.[8]

As of now, several copies of the machine are known: one dated 1845 is in a private collection, at least two are in a Strasbourg museum, and one dated 1851 is in the collections of the Swiss Federal Institute of Technology in Zurich (see Figures 7, 8, and 9).

Schwilgué's machine is actually very similar to Victor Schilt's machine. When closed, it is a box with nine numbered keys, an opening showing two or three digits in two parts, and two knurled knobs. It is about 25 cm long, 14 cm wide, and 10 cm tall without the knobs (see Figure 7). The inside of one of the machines (see Figure 10) is almost identical to the patent drawing (see Figure 11).

### Principle of Schwilgué's machine

Schwilgué's machine has three main functions: addition, carrying, and setting.

Figure 11 shows Figures I, II, III, and IV of Schwilgué's patent. Figure IV shows how the keys operate. Each key can move downward by an amount corresponding to its value and moves the wheel G, but only when the key is released. (Schwilgué stated, however, that this can be changed.[7]) This wheel meshes with wheel H (horizontal on Figure III), and the unit wheel moves counterclockwise by as many digits as the pressed key. The unit wheel is the wheel on the right of Figure II. It contains each digit three times.

The carrying operation's description is based on the construction shown in Figure 10. The unit wheel has a cam U made of three identical parts. As the units progress toward 9, the right arm A is raised (see Figure 12, left), and as soon as the digit 0 appears (as a final value, or just as a passing value), A suddenly falls (see Figure 12, right). This position is

shown on Figure II of the patent drawing in Figure 11. Arm *A* is linked to two other arms, of which only one, *B,* appears in the patent. These two arms act on a ratchet wheel *R* for the tens and hundreds. *R* can be viewed as an escape wheel, and the two arms *B* and *C* engage and disengage alternately. *R* turns by half a tooth alternately because of the pressure exerted by a stabilizing spring *S,* or because of the penetrating arm *B* when 0 is reached. The triple arm *ABC* is always kept in contact with the cam *U* through a spring, which can be seen in the patent drawing in Figure 11.

This construction ensures that the left wheel doesn't move by more than a unit, much as the second hand in a clock doesn't advance more than a second at a time. Finally, the total number of carries is 29, and so the machine can count from 0 to 299.

In the patent drawing in Figure 11, there is no arm *C* and the mechanism may have been a bit less safe, as a loose spring *S* could have led the wheel *R* to turn by more than one unit. The Zurich machine has a slightly different construction, with no arm *C,* an arm *B* at the position of arm *C,* arm *A* located on the other side of *U,* and a much larger ratchet wheel *R.* Moreover, cam *U* is also equipped with a ratchet wheel whose teeth are not used.

The units and tens wheels can be set using the knurled knobs, so that before an addition the openings would show 00. On the Zurich machine, resetting the wheels is made easier by pins located under the wheels. When the knobs are pushed downwards, *R* or *U* disengage, but the pins are put in the way of stops so that one merely has to turn the knobs until it is no longer possible.

## Purpose of Schwilgué's machine

It may seem surprising to see such an invention, long after more sophisticated calculating machines such as Thomas's Arithmomètre (1820), or even the Roth machine (1841). It must, however, be understood that Schwilgué's machine was never meant as a general adding machine.

Schwilgué, who had obtained a number of patents since the 1820s, was no doubt well aware of Thomas's machine and other general calculating machines. We know, for instance, that Schwilgué had a copy of the description of Roth's machines as well as a copy of a history of calculating instruments published in 1843 by Olivier.[10] It is possible that these articles were an incentive for Schwilgué to build his calculating machine, or they may have been part of his research for his own machine.
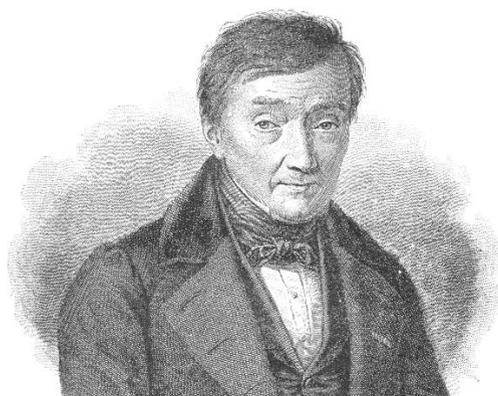


**Figure 6. Jean-Baptiste Schwilgué (1776–1856) (from A. Ungerer, *Description de l'Horloge astronomique de la Cathédrale de Strasbourg,* Strasbourg, 1920, p. 2.)**



**Figure 7. The Schwilgué machine located in Zurich (1851). (Photograph by the author, courtesy of the Swiss Federal Institute of Technology, Zurich.)**
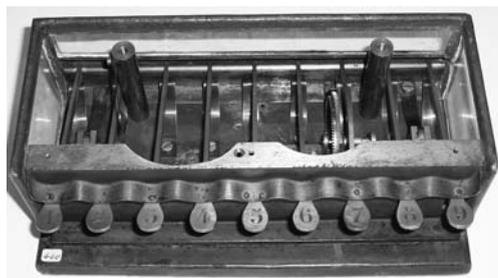


**Figure 8. The inside of Schwilgué's adding machine in Zurich (1851). (Photograph by the author, courtesy of the Swiss Federal Institute of Technology, Zurich.)**



**Figure 9. Under the top plate of the Zurich machine (1851). (Photograph by the author, courtesy of the Swiss Federal Institute of Technology, Zurich.)**
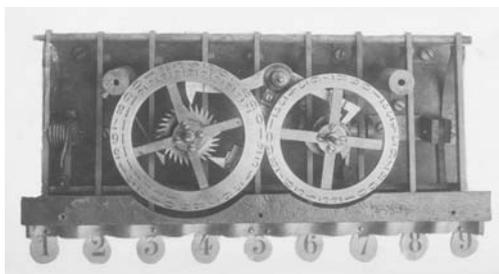
Figure 10. The mechanism of an early Schwilgué machine. One can notice a difference from the patent, namely an additional arm toward the left. The two arms on the left act like a clock escapement. (Archives départementales du Bas-Rhin, Strasbourg, courtesy of the Boutry-Ungerer family.)

Unlike that of the general-purpose calculating machines, Schwilgué's purpose was to ease a particular operation, the hand checking of addition. In these cases, only small values were handled, and Schwilgué didn't bother to build a machine with 10-digit inputs, although it could probably have been done with his carrying mechanism. Instead, Schwilgué could see that the existing machines, although powerful in principle, were of little use for everyday accounting. Schwilgué's machine was designed to fill that gap by using keys to input numbers. Schwilgué could see their potential, even though he never claimed to have invented the keyboard. After all, keyboards already existed on musical instruments.

It is interesting to note what René Taton and Jean-Paul Flad wrote about the key-driven input. According to them,

the discovery achieved a progress … in the manipulation of the machine … the inscription of a digit can be done with only one finger and requires the operator's attention for only a very short time. This simplification amply justifies the complication of the mechanism. It is rather curious to remark, with Mr. Couffignal, [*Author's note: Louis Couffignal was a French mathematician who was also a pioneer in calculating machines and wrote on their history.*] that this progress has been, at the beginning, associated with a kind of regression in the conception of mechanical computation. Indeed, the first key-driven calculating machines had a unique totaling wheel which made it possible to add only one-digit numbers. Adding numbers with several digits was done, like by hand, by first adding the units, then starting a new addition with the tens and the previous carry, and so on. This procedure was slow and obviously didn't make the best of the possibilities of mechanical computation.[11]

And, in fact, adding machines for single columns were developed much later. We can, for instance, cite the German Adix adding machine (1903) and its derivatives[12] or the French Gab-Ka machine.[13] These machines could all add up to 999 instead of the 299 limit of Schwilgué's machine.

### Schilt's copy

In 1851, Victor Schilt (1822–1880) received a bronze medal at the Great London exhibition[14] for the machine that has until now been considered the earliest existing key-driven calculating machine, but which now appears was a copy of Schwilgué's machine, as can be seen when the machine is opened (see Figure 3). The similarity between Schilt's machine and ideas expressed by Parmelee therefore appears purely coincidental.

Indeed, information obtained by J.A.V. Turck in 1925 from Schilt's sons shows that Schilt was employed by Schwilgué for two years, probably around 1847, and that he built his machine around 1848. At the 1851 exhibition, he received an order for 100 machines, but refused to build them, probably because he wasn't the inventor.[15] Schilt was likely assigned by Schwilgué to build these machines, and he may have built one for himself. One can wonder if Schwilgué knew about the exhibition of this machine in London.[16]

That Schilt's machine was the earliest key-driven machine has been proclaimed by several historians, in particular Maurice d'Ocagne, who stated it in 1920[17] and again in 1928.[18] This information was then repeated by other historians again and again. In 1921, Turck found that Parmelee's machine was earlier.[19] It seems that it was actually an omission that left Schwilgué's machine forgotten, because d'Ocagne was aware of Schwilgué's machines, as they were mentioned a few pages after his 1920 article.[20] However, he probably didn't have an opportunity to see the machines (now located in the Musée des arts décoratifs in Strasbourg), and for some reason he didn't check the 1844 patent that would have clarified the matter.

Ernst Martin,[21] Jean Marguin,[22] and Georges Ifrah[23] do not mention Schwilgué's machine and don't seem to have seen the 1844 patent. All claim that Parmelee or Schilt was the first to build a key-driven calculating machine.[24]

### Schwilgué's other innovations

Besides the key-driven input and several ideas suggested by Parmelee in 1850, there are
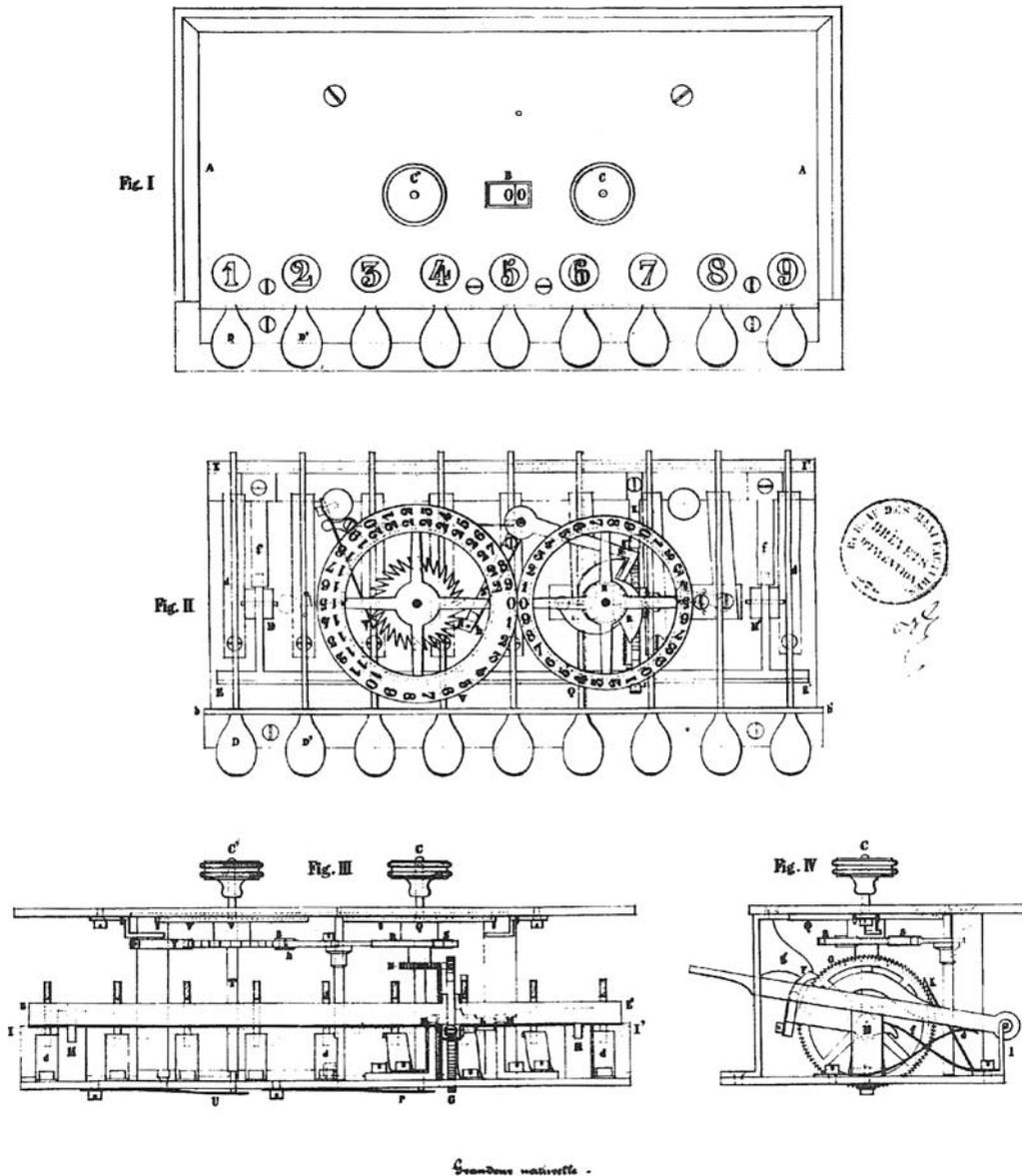
## ADDITIONNEUR SCHWILGUÉ



**Figure 11. Schwilgué's patent drawing (1844).**

other interesting features in Schwilgué's machine or mentioned by Schwilgué in the patent.

The one I have already mentioned is the use of a clock escapement-like way of adding the carry, although Schwilgué never qualified it that way. This feature seems also present on Schilt's machine, according to Figure 3, which shows the three arms.

The patent drawing in Figure 11 also shows that the keyed figures are only taken into account when the keys are released. However,

Schwilgué stated explicitly that both are possible, either upon pressing or upon release and that the patent covers both.

Schwilgué also mentioned an interesting feature which he called "tout ou rien" (all or nothing). Besides the name, which alludes to binary logic and may have been borrowed from Julien Le Roy in the context of repeating watches that had to ring all chimes or none,[9,25] it was here an optional feature ensuring that a digit was only taken into account when the key had been completely
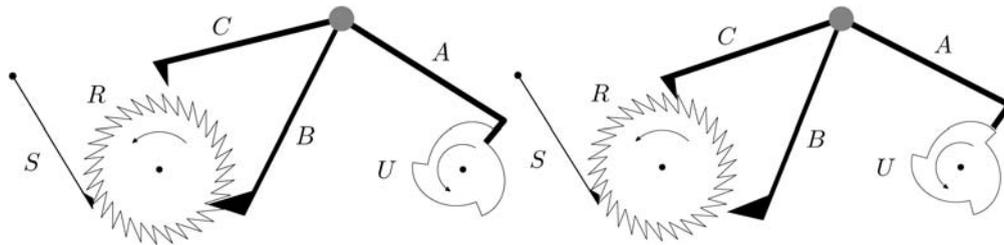
Figure 12. Left: A ''warning''[9] occurs sometime before the unit wheel reaches 0. This is the step where arm *B* leaves the ratchet wheel *R,* the arm *C* having already come in reach of *R*. The spring *S* then pushes *R* so that a tooth hits the upper arm *C*. This is a safety measure ensuring that only one digit is added. Notice that when arm *B* leaves the wheel *R,* this wheel has some recoil and the position of the spring *S* has to take this into account. However, this recoil is greatly decreased by a mobile part at the end of arm *B*. (This mobile part cannot turn in the second phase.) When the unit finally has to be added, arm *B* again enters the teeth of *R*, forces *R* to turn, and forces the spring *S* to go over one tooth, which it wouldn't have done by itself. Right: The mechanism immediately after carrying. Arm *B* has entered a tooth and forced *R* to turn by one tooth, that is one unit. The spring *S* is positioned in such a way that *R* will rotate counterclockwise when arm *B* leaves *R*.

pressed. However, according to Schwilgué, this was not really needed as one learned quickly to operate the machine and not make mistakes.

A similar safety measure was introduced only in 1913 on the Comptometer. On that, an automatic blocking device prevents errors and forces the operator to repeat pressing a key that was not adequately depressed.[26]

### Conclusion

Schwilgué's machine exhibits a number of interesting features, in particular some of which were obviously influenced by clockmaking.[27] Some of these features formed a type of error correction system in which disallowed states were prevented by technical means. The examination of several Schwilgué machines also shows that Schwilgué experimented with new constructions, and it would not be surprising that other Schwilgué machines would again slightly differ from those seen here.

According to current knowledge, Schwilgué's is now the earliest key-driven calculating machine. However, we should keep in mind that there is no certainty, just as there was no certainty that Parmelee's machine was the ''first.'' The vagaries of history sometimes hide important artifacts for years or even centuries. Schwilgué's machine was well known to Alfred Ungerer, Schwilgué's successor, and had he not passed away in 1933, he would certainly have published a description of the machine. But this lack of luck was also compounded by several writers who had only partial information, at a time when access to details was much more difficult than it is now. Neither d'Ocagne, nor Martin, nor more recently Marguin checked Schwilgué's patent, although it is well indexed in the French patent office indices. If the patent had been found, it would still have

been uncertain whether actual copies existed and still exist. Fortunately, this is the case.

## Acknowledgments

## References and notes

1. An overview of mechanical computers can be found in G.C. Chase, ''History of Mechanical Computing Machinery,'' *Annals of the History of Computing*, vol. 2, no. 3, 1980, pp. 198-226, but Chase did not address the present material.

2. G. Ifrah, *The Universal History of Computing*, vol. 2, John Wiley & Sons, 2001, p. 503.

3. *Calculating-Machine, Specification of Letters*, US patent 7,074, to D.D. Parmelee, Patent and Trademark Office, 5 Feb. 1850.

4. J.A.V. Turck, *Origin of Modern Calculating Machines: A Chronicle of the Evolution of the Principles that Form the Generic Make-Up of the Modern Calculating Machine*, Western Soc. of Engineers, 1921, p. 33.

5. Ibid., pp. 18, 26.

6. Hereafter, ''Schwilgué'' refers to Jean-Baptiste Schwilgué and his son, when I discuss ''Schwilgué's machine.'' Otherwise, ''Schwilgué'' refers to Jean-Baptiste Schwilgué.

7. J.-B. Schwilgué and C. Schwilgué, Brevet 623 pour un additionneur mécanique [Patent #623 for a mechanical adding machine], 1844, Institut National de la Propriété Industrielle [French Patent Office], (in French).

8. J.-B. Schwilgué and C. Schwilgué, *Des horloges du système Schwilgué, pour églises, chemins de fer, établissements publics et particuliers* [Schwilgué-type clocks for churches, railway stations, public companies, and private citizens], Dannbach, Strasbourg, 1846 (in French).

9. F.J. Britten, *The Watch & Clockmakers' Handbook, Dictionary and Guide,* 14th ed., Chemical Publishing Co., 1938. "All or Nothing Piece," p. 5, and "Striking Work," p. 417, entries.

10. T. Olivier, "Nomenclature chronologique des instruments à calcul," *Bulletin de la société d'encouragement pour l'industrie nationale* [Chronological list of calculating instruments], Sept. 1843, pp. 415-421 (in French).

11. R. Taton and J.-P. Flad, *Le calcul mécanique*, [Mechanical computing], vol. 367 of "Que sais-je?," Presses Universitaires de France, 1963 (in French).

12. E. Martin, *The Calculating Machines* (Die Rechenmaschinen): Their History and Development, translation of the original 1925 German edition, MIT Press, 1992, pp. 137-139.

13. A. Berthier, "Machines à calculer" [Calculating machines], *Cosmos*, no. 1117, 1906, pp. 687-690.

14. According to James Glaisher, who doesn't mention Schilt, the main calculating machines shown at the exhibition were those of Staffel (which could compute square roots) and Thomas. It is easy to guess that Schilt's machine received little attention. J. Glaisher, "On Philosophical instruments and processes, as represented in the great Exhibition," *Lectures on the results of the Great Exhibition of 1851 delivered before the Society of Arts, Manufactures, and Commerce, at the suggestion of H.R.H. Prince Albert*, David Bogue, pp. 323-402.

15. Schilt was born in Grenchen, near Solothurn in Switzerland, and went to work in Strasbourg in Schwilgué's workshop, where he was mainly busy working on tower clocks. When he returned to Switzerland, he built many tower clocks around Solothurn. (Information on Schilt from P. Kidwell, Smithsonian Institution.)

16. Schwilgué did not attend this exhibition, as it appears from a letter he wrote to Richard Roberts on 31 July 1851; MS 1481/2, Science Museum Library, London.

17. M. d'Ocagne, "Histoire des machines à calculer" [History of calculating machines], *Bulletin de la société d'encouragement pour l'industrie nationale*, vol. 132, Sept.-Oct. 1920, pp. 554-559 (in French); pp. 545-760 cover mechanical calculating machines.

18. M. d'Ocagne, *Le Calcul Simplifié*: Graphical and Mechanical Methods for Simplifying Calculation, MIT Press, 1986; translation of the 1928 French edition.

19. Turck, *Origin*, p. 11.

20. "Exposition publique de machines à calculer anciennes et modernes," catalogue explicatif des objets déposés [Public exhibition of ancient and modern calculating machines, catalogue of the exhibited items, with descriptions], *Bulletin de la société d'encouragement pour l'industrie nationale*, vol. 132, Sept.-Oct. 1920, pp. 608-644 (in French).

21. *Martin, Calculating Machines.*

22. J. Marguin, *Histoire des instruments et machines à calculer—Trois siècles de mécanique pensante, 1642–1942* [History of calculating instruments and calculating machines—Three centuries of thinking mechanics], Hermann, 1994 (in French).

23. Ifrah, *Universal History*, p. 132.

24. Note that Marguin mentions Schwilgué obliquely, not in the context of key-driven calculating machines.

25. S. Le Normand and A. Janvier, *Nouveau manuel complet de l'horloger, ou guide des ouvriers, qui s'occupent de la construction des machines propres à mesurer le temps* [New complete clockmaker's manual, or guide of the workers who construct machines for measuring time], Paris: Librairie encyclopédique Roret, 1837 (in French).

26. Turck, *Origin*, pp. 159-162.

27. There have been other cases of clockmakers who built calculating machines, among them Philipp Matthäus Hahn (1739–1790), Izrael Abraham Staffel (1814–1884), and Curt Dietzschold (1852–1922).

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