WERNER SIEMENS AND HIS CONTRIBUTIONS IN THE FIELD OF TELEGRAPHY

Introduction
The motivation for writing this article was the recent acquisition of a very rare and very special 'high-speed telegraph' that was made by the Siemens & Halske company and was used in the Crimean War.
First I'm going to outline briefly a part of the life of Werner Siemens. Then I will explain in short his work in the field of telegraphy, thereby concentrating on his first telegraphs, which will bring me to the Crimean War. And finally I will show, with some small comments, pictures of different telegraphs made by Siemens & Halske.

1. A Little History
The globally known company of Siemens was founded by (Ernst) Werner Siemens, the fourth child of a family of fourteen. He was born on 13 December 1813 at Lenthe near Hannover. After his grammar school education he began graduate studies at the Prussian army's School of Artillery and Engineering in Berlin. After three years of ardent study he left this institution with the rank of lieutenant. In the autumn of 1840 he was transferred to the garrison at Wittenberg, where he could devote himself to scientific studies, making his first major discovery as early as 1842. He managed to develop a system that made it possible to silver and gild small metallic objects by electrolytic means and for which he got his first patent.

Werner Siemens

A little later he was transferred to the artillery workshops in Berlin. This move was decisive for his future career. Berlin then was one of the most beautiful capitals in Europe and offered many ways to relax. But Werner preferred to remain in the company of people who liked to enhance their knowledge of everything related to science and technology. So he spent whole evenings in the 'Physikalisches Institute' [Physics Institute].

In the army he was confronted with the problems of long distance communication (the word 'telecommunications' was not yet known at that time; it was first coined by Professor Edward Estaunié in 1904 in his book *Traité Pratique de Télécommunication Electrique*). Back in the 1840s Germany was using mechanical-optical telegraphs (semaphores, like the 'Pistor' system), whose drawbacks are well known. And Siemens, as a result of his research, learned about the existence in England of the electric ABC telegraph (also called dial telegraph) developed by William Cooke and Prof. Charles Wheatstone and which seemed to offer excellent opportunities. He started a project with a lot of assiduity to make a version of his own that avoided the major problem of the English telegraph, namely the great risk of losing synchronisation between the transmitter and the receiver (the same problem was present also in the dial telegraph by Louis Breguet in France). In 1846, when he was 30 years old, he could show an operational model to his friends of the 'Physikalische Gesellschaft' [Physical Society]. He had managed to solve the problem of synchronisation through the use of a simple principle already used in each electrical bell of that time!

One of his friends, (Johann) Georg Halske (1814-1890), a talented mechanical engineer, was so excited that he offered his services for the production of such telegraphs. Then, Werner Siemens, still active as an officer in the Prussian army, together with Georg Halske opened a small workshop in a rented house. And on October 1, 1847 the 'Siemens & Halske Telegraphen Bauanstalt' company was formally established. His nephew Werner Johann Georg Siemens, adviser to the royal court, took care of financial funding. A week later, Werner got a patent on his dial telegraph. Then in 1847 he was appointed by the Prussian army as a delegate of the 'Committee for Telegraphy', which was to pave the way for the conversion of the optical telegraph into the electric telegraph; a very interesting proposition indeed. Also in 1847 he developed a press tool for covering metallic cables with a sustainable insulating jacket of 'gutta-percha' (a kind of rubber). This latter invention proved later to be extremely valuable, particularly for submarine cables.

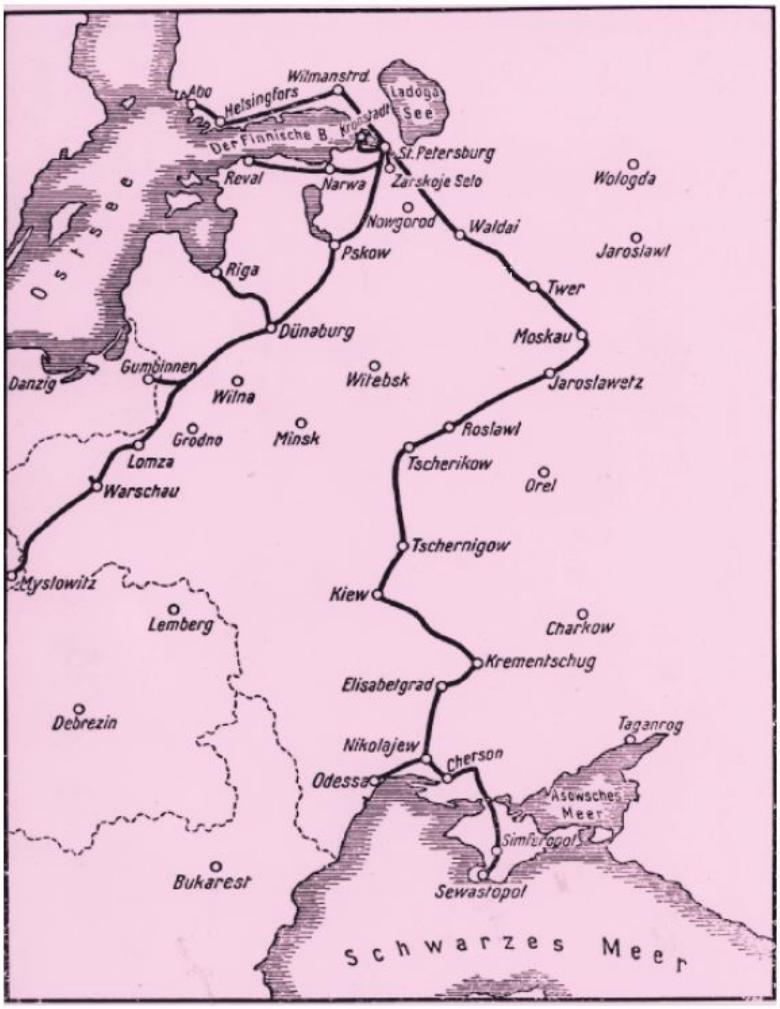
With these achievements and other testimonials it was not surprising that the young company Siemens & Halske was commissioned to install an important telegraph line, more than 500km long (the longest line at that moment in Europe). It had to interconnect Berlin, the seat of government, and Frankfurt, where the first parliament was located. The project was completed successfully and so the future of the young company was assured. Werner was also instructed in 1849 to extend this line to Cologne and Aachen, and then further down to Verviers in Belgium. The ultimate aim was to connect Berlin to London via Brussels and Paris. In 1850 France achieved a connection with England via the Calais-Dover cable and in 1851 Belgium was interlinked with France (the line Brussels-Paris). Note that the Ostend-Dover cable became operational 'only' in 1853.

Back to the year 1849. Involved in all those commercial activities, Werner Siemens found that combining these with a position in the army was becoming untenable, so he resigned for logical reasons. Early in 1850, on the occasion of the interconnection of the two networks, he received an invitation from the Belgian king Leopold I. He was to give a presentation on the electric telegraph at the royal court. But alas, it did not give commercial results; Belgium was too involved with Wheatstone and Cooke and continued using their needle telegraphs. The same year he went to Paris, where he could give a lecture at the Academy of Sciences on the same subject as in Brussels. He earned the admiration of all present and also got an interview with Louis Breguet, the authorised provider of telegraphs to the French administration. So he achieved no commercial results here either. In 1851 he went with his brother Wilhelm (who later on called himself William, see below) at the first world exhibition that was held in London's Crystal Palace (built especially for that occasion in Hyde Park). There they received the highest distinction, the Gold Medal awarded by the Council of the Society of Arts, for their dial telegraph, which was well deserved.

When competition arose in Germany, Werner Siemens turned his gaze to the vastness of Russia, which he considered should certainly have communication problems to be solved by 'modern means'. He went on a long trip, made mostly in stage coaches and troikas, to the distant city of St. Petersburg, where Tsar Nicolas resided. He succeeded in obtaining an order to install a line between St. Petersburg and Kronstadt. He put his brother Carl at the head of the team that had to build this line and to connect the telegraph apparatus. In 1855 he established an independent subsidiary in St. Petersburg under the direction of Carl.
Later in 1880, he built a factory for the manufacturing of cables and telegraph equipment.

In 1854 the Crimean War broke out.

Use of the electric telegraph was slow in being assimilated into military planning, and had to await the urgent requirements of the Crimean campaign in 1854-56, at a time when its commercial use was already well established. For the allies — Britain, France (under Napoleon III), Sardinia and Turkey — a major aim of this war was to check the expansion of Russia towards Constantinople (now Istanbul), and preventing the disintegrating Ottoman Empire from falling within the Russian sphere of influence. To this end, capturing the Russian naval base at Sevastopol near the Black Sea was seen as an essential first step. Even before the start of the campaign the Russians held the advantage in communications since a working semaphore system, based on the Chappe system, was in place between their headquarters in Moscow and Sebastopol. *(A little reminder, we know from the Crimean War the heroine Florence Nightingale, 'the lady with the lamp'; and it was also the first war in which newspapers reported in detail to the homelands by telegraph. But these are stories for another time…)*



In early 1854 the Russians placed an order with Siemens & Halske to construct, as quickly as possible, an overhead telegraph line from Warsaw to St. Petersburg. This was followed by extensions in the north and by a long extension in the south from St. Petersburg to Odessa and Sevastopol on the Black Sea. This telegraph network now covered a total distance of 10,000km, extending from present-day Poland and Finland down to the Crimean Peninsula (see the map). These lines, completed by 1855, were of considerable assistance to the Russian authorities in controlling the movement of troops and war material, and, not least, in enabling direct communication with Berlin to arrange for the shipment of heavy war equipment from Germany. The high-speed telegraph from Siemens & Halske, my latest acquisition, which I will describe below, was the standard equipment on this huge network.

The allies began installing telegraph circuits only in 1855. The French arranged for a 'mobile' network that could follow the movement of the troops. The English laid a submarine cable of 550km on the bottom of the Black Sea between Varna (Bulgaria) and Sevastopol.

Also, and with the help of the French telegraph regiment, they built a connection to London (the War Office) and Paris, making use of the existing Austrian network.

S & H had established a representative office in London already in 1850. This situation came to an end with the creation of its own subsidiary in 1858 under the direction of Wilhelm Siemens who as of then named himself William. And in 1863, under the direction of William, a cable manufacturing plant was erected in Woolwich, near London. It was in 1865 that the company name was changed into Siemens Brothers (the brothers being Werner, William and Carl). Two years later Georg Halske took retirement amicably. The company retained his name in the name of the company until 1967, in recognition for his enormous contribution to the success of the company.

I would like to mention here another 'tour de force' of Werner Siemens related to telegraph networks. Between 1867 and 1869, he managed to make a connection that brought worldwide fame to the company: the telegraph line from London to Calcutta. The realisation of this vast project was supported by the cooperation of the Werner's two brothers, William and Carl. Of this 10,000km-long Indo-European line, some 6,000km still remained to be completed. The project, awarded to the consortium of Siemens & Halske and Siemens Brothers, put this line in service in 1870 (it remained operational until 1930). Regarding this line from Europe to Asia, a book was published by the Museum of Telecommunications in Bern with the title *In 28 Minuten von London nach Kalkutta* This title obviously refers to the time required to transmit, via many intermediate stations, a short message from one end to the other; an incredible performance in 1870 indeed.

So that was a short retrospective of part of the life of Werner Siemens. I now turn to the last period of his life. In 1888 he was knighted and from that day on he became Werner *von* Siemens (in German names the word *von* implies aristocracy or nobility). And it was at the age of seventy-four (on 31 December 1889) that he decided to withdraw from company management. At that time the company had 6,000 employees, including those from the subsidiaries in London and St. Petersburg. He could now use much of his spare time to write his memoirs. On 6 December 1892, a few days after the publication of his book *Lebenserinnerungen*, following a brief illness, Werner von Siemens died at his home in Charlottenburg (near Berlin). Among the mass of flowers at the foot of his coffin was a floral tribute from, amongst others, Thomas Alva Edison.

For the many other interesting achievements of Werner 'von' Siemens, I refer you to the many books that have been written about him, and especially his own work which had already been translated into English in 1893: *Werner von Siemens - Recollections*. In 2008 his book was reissued with amendments and it is still available (see the Bibliography at the end).

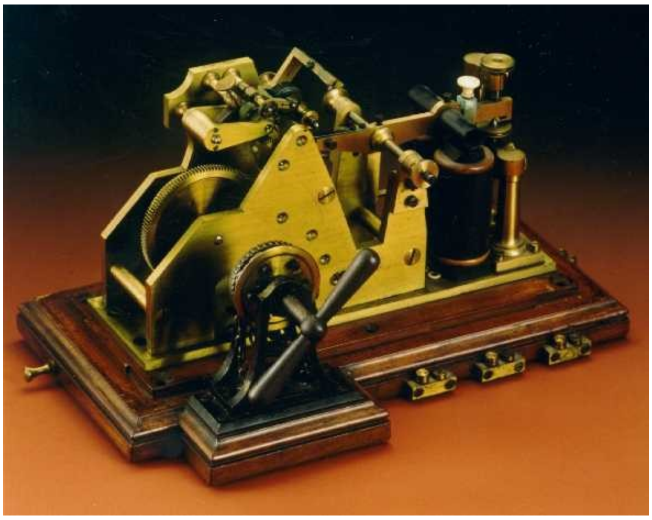
2. His Telegraphs

Here I present some telegraph instruments that were designed by Werner Siemens and, in part by his colleague and great expert in the art of manufacturing, Georg Halske. I have tried to be concise and as simple as possible (the purpose of my article is not to teach a course in telegraphy...).

So it all started in 1846-1847 with the dial telegraph. Its basic design was brilliant in its simplicity with a ‘self-interrupting’ electrical circuit (as used in electrical trembler bells). With this ‘trick’ he ensured that the transmitter and the receiver remained constantly in sync during the emission of the pulse trains between each character. The first photo shows such a dial (ABC) telegraph of the early days. The model shown is a replica and is not in my collection. All other telegraphs that I will now present here are part of my collection (or have been previously). The second photo shows the later model from 1856. Here no battery was required, as he used the motion of the crank (that had to be pointed successively to each character of the message) to drive a dynamo that was placed inside the telegraph box.

Already in the early 1850s, Werner began also to develop the manufacture of Morse telegraphs. The Morse system, launched by Samuel Morse in 1844, was indeed becoming a competitor to the telegraph dial. Its big advantage was that the message was ‘printed’ on a paper tape in the form of the well-known ‘dots’ and ‘dashes’. A small disadvantage of the Morse system was that one had, after having received the message, to decode those dots and dashes. Here you can see in the next photos what are the very first two models of telegraph instruments that were made by Siemens & Halske.

Note that initially the Morse signals were not printed with ink on the paper tape, but embossed in it. That was done with a steel point that impressed the Morse signals in the paper tape, somewhat like the Braille system. This was the case with all Morse devices of that era, also in the U.S.A. The Austrian Thomas John developed in 1854 a relatively simple method for printing Morse signals with ink on the tape. It was the French company Digney (in Paris) that bought the rights and launched the first telegraph with this device. A few years later Siemens and Halske brought out new products using this novel system. Over time, where possible, the company updated existing instruments, replacing the old ‘relief writing’ system by printing in ink, this was indeed a relatively simple procedure.

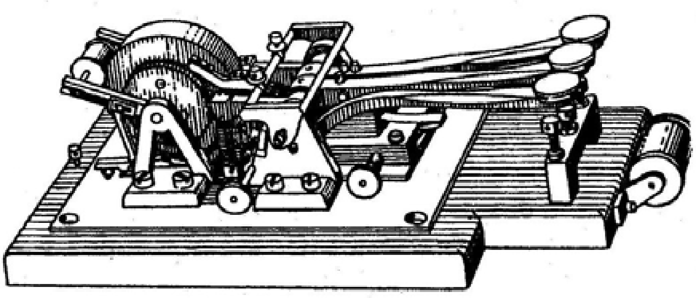


We see the very first Morse telegraph, from 1850, in the two images above (after the modification). Its serial number is 115!

The next four photos show a companion telegraph instrument, the model from 1852. This is the model that was used primarily on the Russian network as explained above. I will describe it a little more in detail, especially as it is reason that led me to write this article.

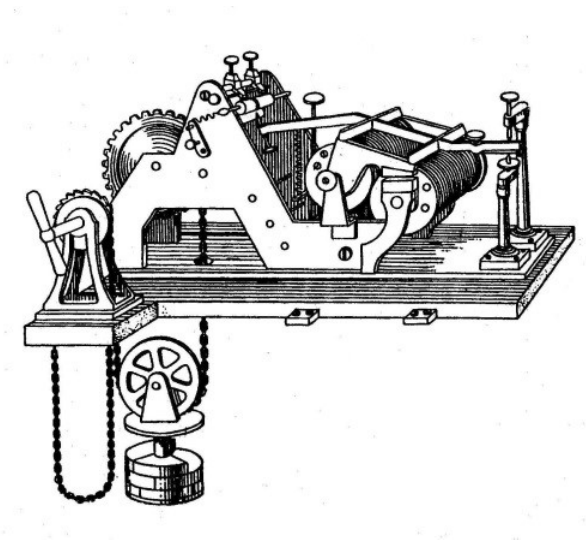
For a long time it was the only model of telegraph that could work at ‘high speed’, only the second design of telegraph by Werner Siemens. Therefore — and here I become sentimental! —it must *certainly have passed through the hands of Georg Halske (and possibly those of Werner as well) and have been on active service during the Crimean War. It too has a very low serial number (360) and was the first that I saw after some 25 years of searching (where have all the other instruments gone?).*

There are many similarities between the two designs but the striking difference between the two is the way how the electromagnets are mounted. The assembly of the coils of the first electromagnets is vertical, the standard in all subsequent model because it is the easiest way, and horizontal in the second model (with a rotating iron core in one of the coils). This is one of the ‘tricks’ that Werner and Georg employed to make this receiver operate faster. During the design process they thought that they could achieve speeds of 300 characters per minute (I think that this was very optimistic but don’t know what the rate was in reality…). To make the entire system rapid, obviously the transmitter had to be made operate faster too. This was done by making it ‘automatic’. The way chosen to achieve this was to prepare a punched paper tape ‘off-line’ and then transmit this tape automatically using a paper tape reader (more or less the same principle as used by the telex system in the 20th century).



The three-key punch was similar to that of the later Wheatstone automatic system (patented in 1858, put into use only as of 1867). Indeed, Werner Siemens noted that, “Wheatstone made good use of my three-key punch for his electromagnetic express writer, without however naming the source whence he derived it”. Of course by using the automatic paper tape reader, telegraphists could send messages much faster than manually with a Morse key, thereby making maximum usage of the capacity of the line.

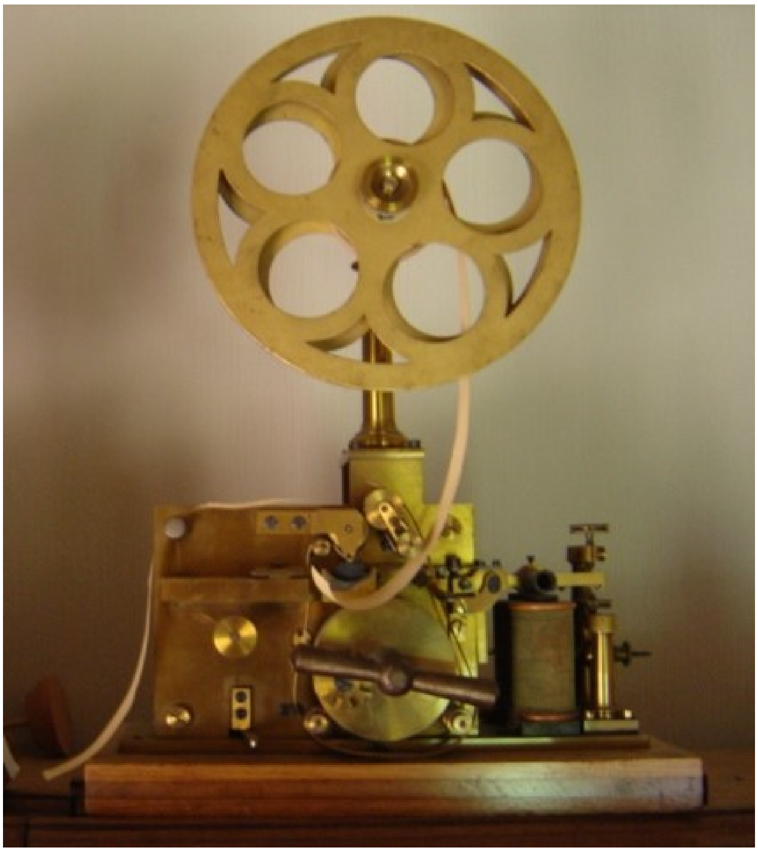
The left-hand tapper was used to send a Morse ‘dot’ and when actuated, it punched a single round hole in the paper tape, followed by a small forward movement of the tape. The tape transmitter detected this hole and responded by applying a short electric pulse to the line. The second tapper corresponded to a Morse ‘dash’ and made two holes in the tape and also advanced the paper tape. When the reader detected two holes in the tape, it sent a longer electrical pulse on the line. The third tapper did not create a hole but merely advanced the paper tape a short distance. So this was the ‘space’ key and served to separate one Morse character from another. I know that the museum of Deutsche Telecom has a punch, but not a paper tape reader/transmitter). So if you ever find such a puncher and/or reader in your attic, then just send it to me!).



And below are two pictures of Siemens & Halske ‘embossers’. The first one is the older design; it was used by the railways in Germany. The other two show a later one -from 1872- and the detail of the ‘dry point (the ‘stylus’)’.

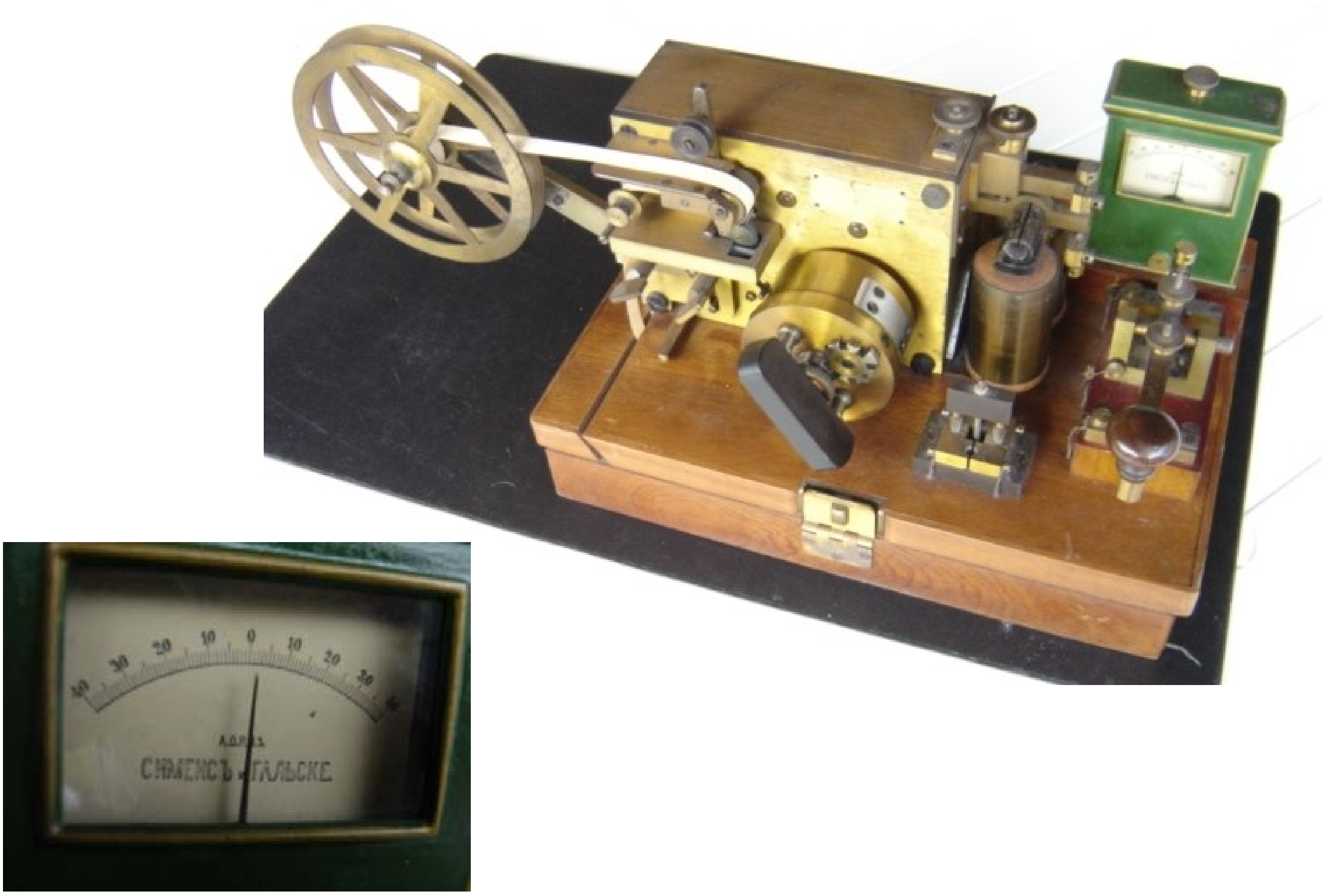
Strange at first sight, this second model has been very long in service. I think that this example was used probably in hot countries, where ink might dry too rapidly. They were certainly more reliable and demanded less maintenance and attention (there was no need to mess around with ink). On the other hand, it was less easy to distinguish the dots and dashes of Morse code clearly.

Here you see his telegraph of 1861. It was the first model by Siemens & Halske using an ink-well.

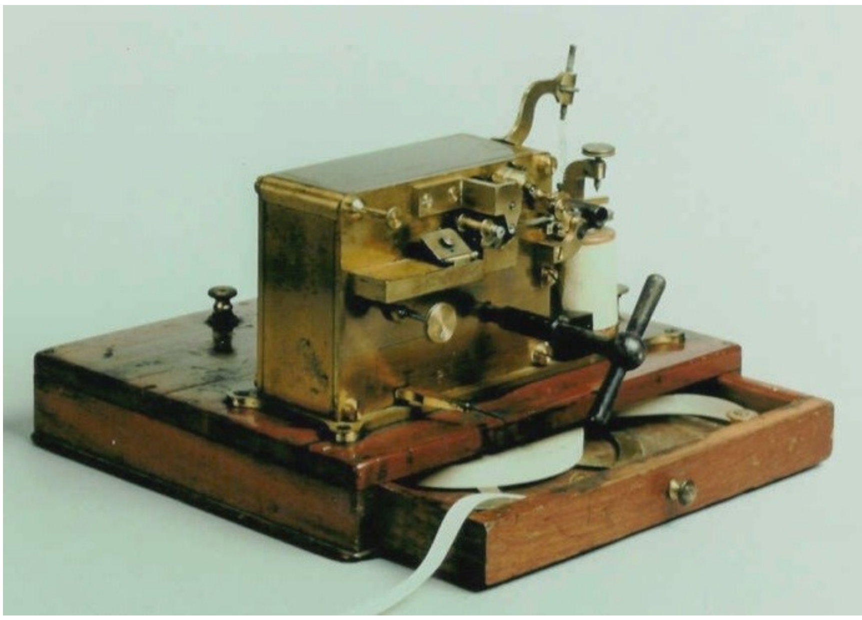


the next image shows the ‘Normalfarbschreiber der Deutsche Verwaltung’ It became the standard model of the German telegraph administration as from 1867-1870, according to which source you believe. This is the model in which the spring of the motor is mounted on the outside, contained in a cylindrical enclosure made out of brass. In addition it has an ‘integral relay’ function, enabling received signals to be relayed automatically direct to another receiver connected to the same line (either in cascade along the line or at the distant end). The black ‘block’ on the left is the ink-well. The horizontal part contains the ink and the vertical part can be raised if the ink level drops too low. As it was the standard model, it was very popular and was manufactured by a number of other manufacturers (e.g. Lorenz). In the second version, the spring was incorporated within the engine block.

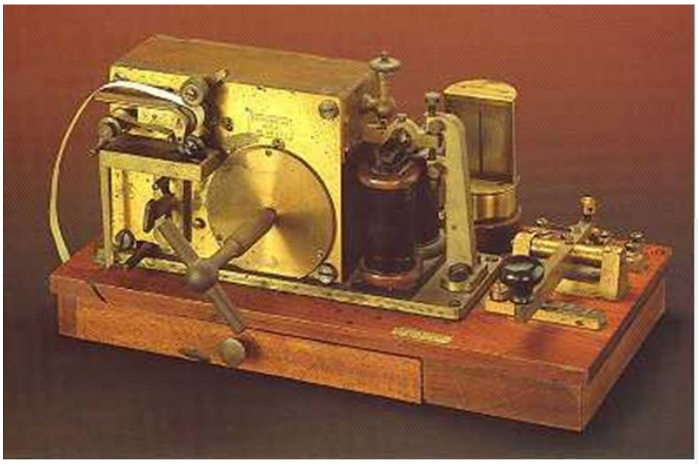
Then comes a model that was manufactured in St. Petersburg. You can see the name of Siemens & Halske in Cyrillic script in the inserted image.

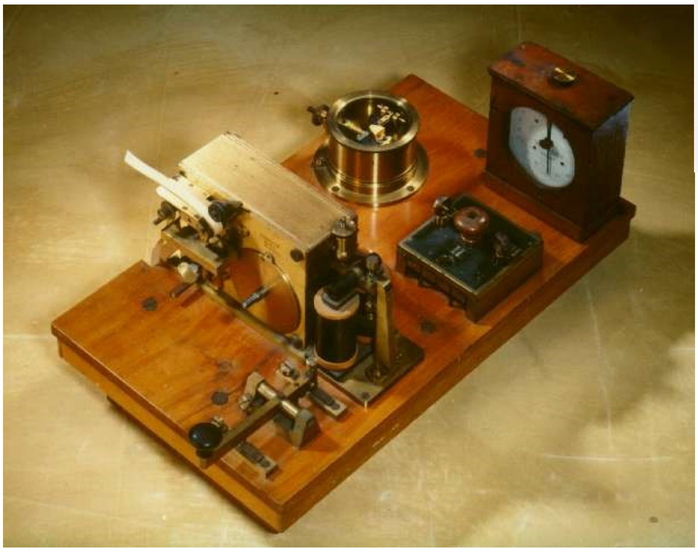


And here is a receiver manufactured at Woolwich by Siemens Brothers.

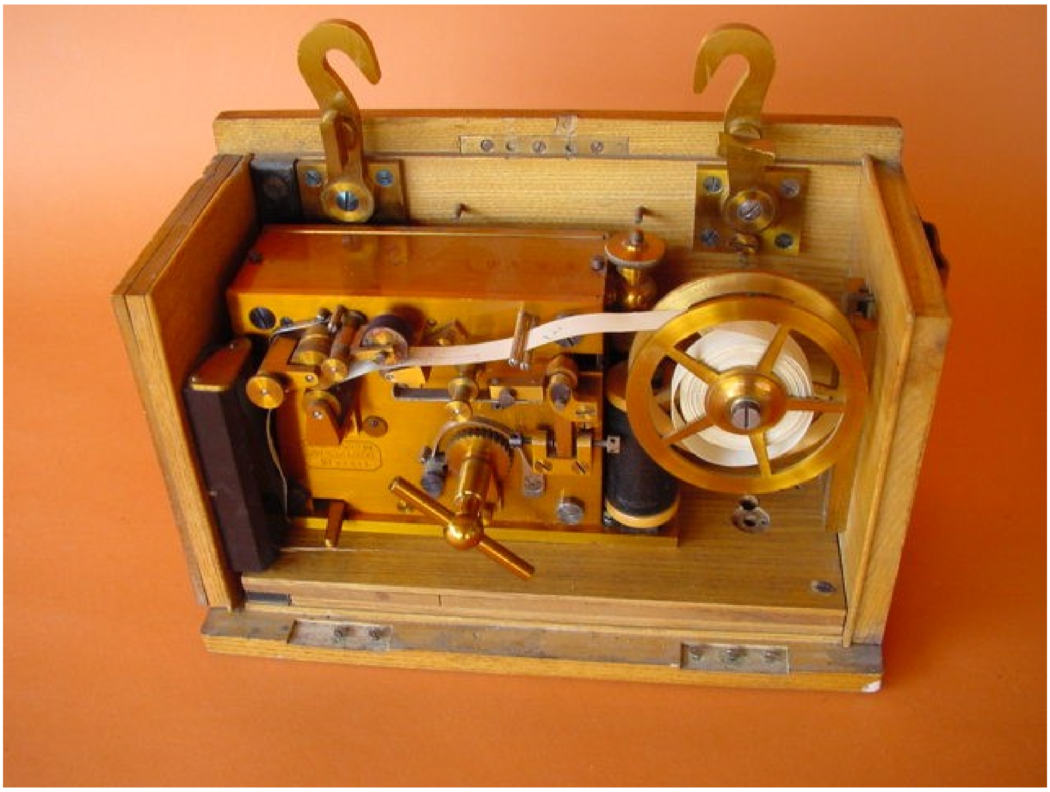


The following four photographs show what is called 'small telegraph tables'. They always have the Morse key on board (the transmitter) and, according to the specific application, a galvanometer (which measures the current in the line), a relay, a lightning detector, a changeover switch or commutator. The first one has a label with the name of the vendor: 'De Mey, Oostende'.





And here we see a nice small portable telegraph (most probably for military use) in its transport case.



Then comes an intermediate station capable of transmitting to and receiving from one of the two stations at each end of the line. The operator can also interconnect those two remote stations (the so-called 'translator' or 'repeater' function), while observing the transmission. The two relays are present for this purpose. And both galvanometers can act as 'single-needle' receivers. This set had no maker's name but everything indicates that it was made by Siemens Brothers.

In **Photo 14** we see a telegraph with a keyboard as transmitter and a paper tape printing system as receiver. It was, amongst others, used as a terminal for receiving stock exchange prices and information.

Siemens & Halske made also 'auxiliary' telegraph items such as test test instruments. The one on the left is a 'universal tester' from1901 and the one on the right shows a cable test system from 1888.

And finally one of my favourites (together with the ‘Crimean telegraph): a Hughes printing telegraph (patented in 1852) made by Siemens & Halske. The model shown is the oldest model whereby the mechanism is driven by weights (60kg in total…).

$$1 \text{ SIEMENS} = \frac{1 \text{ AMPERE}}{1 \text{ VOLT}}$$

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Halle (Belgium), 27 April 2014

www.telegraphsofeurope.net