Francisco Salvá's ELECTRIC TELEGRAPH

A contemporary of such important figures as Laplace, Coulomb, Herschel, Jefferson, Kant and Betancourt, the Spaniard Francisco Salvá y Campillo (1751–1828) was a prominent late Enlightenment scientist who dedicated his whole life to researching on different topics related to diverse fields of knowledge by applying scientific method. Five years before Samuel Thomas von Sömmering (1755–1830) demonstrated his electrochemical telegraph to the Munich Academy of Sciences, Salvá proposed a very innovative electric telegraph based on two elements: on the one hand, the use of a Volta's pile to generate an electric current and, on the other hand, the electrolytic decomposition of water to detect such a current flow. Salvá reported his electric telegraph to the Barcelona Academy of Sciences, Spain, on February 22, 1804, leaving his thoughts written in a not very well-known paper titled: "Second report about galvanism as applied to telegraphy."

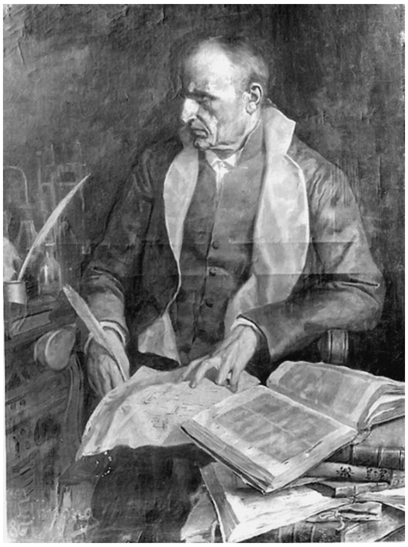

Fig. 1. *Portrait of Francisco Salvá y Campillo painted by Juan Llimona in 1886. Source: Royal Academy of Good Letters of Barcelona.*

This article takes a look at the life and accomplishments of Francisco Salvá of Spain, including his work with an electric telegraph system. The author states that information herein is based on the original report and some practical demonstrations that Salvá presented to the Barcelona Academy of Sciences in 1804.

I. LIFE OF SALVÁ

Francisco Salvá y Campillo was born in Barcelona, Spain, on July 12, 1751 [1]–[4], although some authors refer to his birth date as July 11 [5], [6]. His father was a Doctor of Medicine, who served as a Staff Physician at Barcelona General Hospital, Spain, and his mother was the daughter of a well-off Pharmacist. Salvá studied for three years at the University of Valencia, Spain, receiving his B.Phil. degree in medicine from the University of Huesca, Spain, in 1771. Next, he continued his studies at the University of Toulouse, France, where he received his Ph.D. degree in medicine.

He established a medical practice in Barcelona in 1773 at the age of 22, and entered the Academy of Practical Medicine located in the same city, now called the Royal Academy of Medicine of Catalonia. At that time, this institution supported a more scientific and less traditional kind of medicine, as a way to improve the cure of serious diseases. Along the years, Salvá became first the Vice Secretary and then the Secretary of this Academy.

Influenced by the Enlightenment ideas coming from France, Salvá not only devoted his life to medicine, but also dedicated time to researching and developing ideas in other fields of knowledge. In 1780, he started his meteorological activities, collecting some atmospheric variables by means of some self-made instruments located at his home on Petritxol Street, Barcelona. In 1783, he made, together with his colleague Francisco Santponç, a new fiber-removing machine for hemp and flax. Salvá and Santponç also developed a new type of portable burner that was safer and cheaper than other existing ones [7]. A year later, both men together with Priest Mariano Oliveres carried out the first hot-air balloon experiences ever conducted in Barcelona [9]. At the turn of the century, Salvá was involved in two amazing projects: a dry canal for goods transportation [4] and a submarine vessel to rescue castaway people [6].

His studies in physics led him to become a member of the Royal

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Academy of Natural Sciences and Arts in Barcelona, taking his seat on February 8, 1786 [1]. His main field of interest in this Academy was electricity, to which he made some remarkable advances, as will be shown in the next section.

He lived in the capital of Spain, Madrid, from 1796 to 1799, where he lobbied to obtain a Chair in Clinical Medicine managed by the Academy of Practical Medicine in Barcelona. Thanks to his effort, Salvá obtained permission from the Academy to create the Chair and became a joint holder of it, in 1801, along with his colleague Vicente Mitjavila [5].

In his last years, Salvá carried on with his medical practice and lectures in medicine in spite of his frequent memory losses. Salvá died on February 13, 1828, from a cerebral disease, receiving a humble burial, as was his wish. At that time, he had become an important figure in the scientific scene of Barcelona, to the point where Pedro Díaz de Valdés, the Bishop of Barcelona, came to say that while he was not the Prince of Physicians, he was worthy of being called the Physician of Princes [6].

There was no portrait of Salvá made during his lifetime, but there were two portraits made after his death. One of them was painted by Juan Llimona in 1886, and other was painted by José María Marqués in 1900. The first one, which is shown in Fig. 1, is now exhibited at the Royal Academy of Good Letters of Barcelona.

II. HIS WORK ON ELECTRICITY

In addition to his remarkable contributions to medicine, meteorology, and mechanics, Salvá also used his time to research what was, at that time, the emerging field of electricity. First, he started the study of the atmospheric electricity coming from thunderstorms and lightning. In relation to this, in 1787, he improved the lightning rod conductor previously devised by Benjamin Franklin.

On January 9, 1788, Salvá presented a report to the Barcelona Academy of Sciences on the positive and negative electricity, with the idea of probing that the electric charge could be attributed to an excess or a defect of a single class of electricity. In June of 1788, Salvá wrote about St. Elmo's fire and, on March 20, 1793, he presented a new work to the Barcelona Academy of Sciences related to the invention and uses of the electrophorus [1].

At that time, Salvá ran some of the experiments that were being carried out by Volta and Galvani, before presenting the report that was going to give him a well-earned reputation. This report, titled "Electricity applied to telegraphy," was related to a new type of electrostatic telegraph based on Leyden jars, which was presented to the Barcelona Academy of Sciences on December 16, 1795 [10].

In his report, Salvá preferred the electric telegraph as a better option for communications than the optical telegraph, so, working on the basis of the experiments carried out by Watson and Bewis in which a Leyden jar was discharged through a wire, he proposed his well-known electrostatic telegraph [14]. Salvá's apparatus called the attention of the Spanish Counselor of State Manuel Godoy (this position is equivalent to a current Prime Minister), who invited him to show his electrostatic telegraph in the presence of the Spanish Royal Family in Aranjuez, which he did in 1796 during his stay in Madrid.

In the following years, Salvá conducted some experiments on galvanism that he reported again to the Barcelona Academy of Sciences. The first one was presented on February 19, 1800, under the title "On the galvanism" [11], and the second one was presented on May 14, 1800, under the title "On the application of the galvanism to the telegraphy" [12]. In this work, Salvá used the method of twitching the limbs of frogs to communicate.

Meanwhile, some remarkable progress was being achieved in Europe: Alessandro Volta (1745–1827), in Italy, as a result of a disagreement over the galvanic response advocated by Galvani, had invented the electric battery, which was able to produce a steady electric current; and William Nicholson (1753–1815) and Anthony Carlisle (1768–1842), in the United Kingdom, had discovered the electrolysis process leading to the decomposition of water when a direct current passed through it, producing bubbles of oxygen and hydrogen.

Salvá immediately devised the advantages that these two discoveries could have over his previous telegraph systems because, on February 22, 1804, he presented a new report to the Barcelona Academy of Sciences, titled "Second report about galvanism as applied to telegraphy" [13], where he reported his ideas on making use of a voltaic pile to generate an electric current, in preference to Leyden jars, and on the electrolysis of water to detect such a current flow, instead of the electric shock, the attraction of a pith ball, or the twitching of a frog's leg that were all previously used.

III. SALVÁ'S ELECTRIC TELEGRAPH

Salvá begins his 1804 report by reviewing the state of the art in optical telegraphy, with special references to the line projected and constructed by the Spaniard Agustín de Betancourt y Molina (1758–1824), between Madrid and Aranjuez, in 1799. He also mentions his previous telegraph systems based on static electricity and galvanic electricity, saying that electric telegraphs were more favorable for long distance communication than optical telegraphs.

After that, he describes the state of the art of Volta's electric battery, including a detailed explanation on its positive and negative aspects but remarking, above all, on its capacity to produce a steady and long-lasting electric current in contrast to electrostatic machines or frog legs.

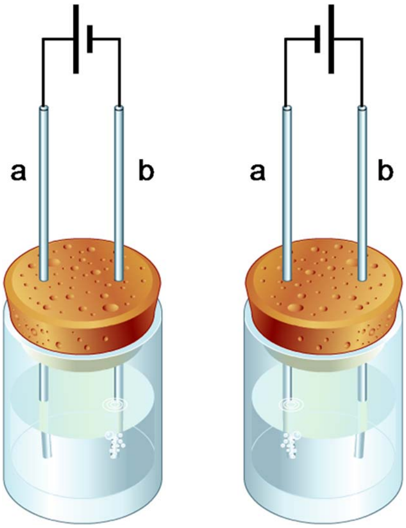

Fig. 2. *Salvá's proposal to encode two different signals by using only one jar of water. Source: Antonio Pérez Yuste.*

Afterwards, Salvá explores two different phenomena for detecting a current in a wire: the melting of metals and the decomposition of water, paying stronger attention to the second one. He writes that when an electric circuit is closed through a mass of water, the end of the wire that is in contact with the zinc disc in the voltaic pile (negative pole) produces visible hydrogen bubbles that accumulate around the other end of the wire (cathode), whereas the wire that is in contact with the silver disc in the voltaic pile (positive pole) causes an oxidation in the other end (anode).

Finally, Salvá puts all these things together to conclude that to make an electric telegraph system is perfectly feasible, describing next how to do it. He first suggests a way to encode two different signals with one jar of water, by only changing the polarity of the voltage applied to the ends of the wires submerged in water. In such a way, hydrogen gas will be seen to bubble up at one of the immersed wires or at the other, depending on the polarity of the battery. In short, he was able to encode two signals with only one circuit, as shown in Fig. 2.

Next, he suggests making use of several circuits with a common return wire to encode as many signals as required. In this way, to encode "n" signals, "$n/2+1$" wires would be required, if n were even, or "$(n+1)/2+1$" wires would be required, if n were odd. However, this fact is not clear enough in Salvá's report because he talks about using six wires to build a complete telegraph system but, at the same time, he admits that this fact can be difficult to understand, so he finally prefers to deal with the explanation in subsequent experiments. This is why it seems that Salvá was able to carry out some practical experiments before the members of the Academy of Sciences the same day he presented his report to them, although it is not possible to conclude from the text that he ever showed a long-distance communication system. This opinion is also maintained by Prof. Sánchez Miñana who says that Salvá was not able to make long-distance trials, since he regretted not having enough time to prepare the required wires [1]. Suárez Saavedra, a 19th century Salvá's biographer, is also confused about this part of the report, although he finally assumes that the system could be similar to the one shown in Fig. 3 [8].

In this figure, there are two plugs on the left-hand side of the table, which are connected to an electric battery. There are also two metallic sheets in front of each water jar and a common metallic sheet in the center of the table, which is connected to one of the previous pair of metallic sheets at every water jar. So, by connecting one plug of the electric battery to the free sheet of a water jar and the other one to the common sheet in the center of the table, a signaling communication system can be finally established.

IV. CONCLUSION

The electric telegraph conceived by Francisco Salvá was presented to the Barcelona Academy of Sciences, Spain, on February 22, 1804, five years before a very similar one was developed by the German scientist Samuel Thomas von Sömmering which is, by contrast, more recognized today. A brief description of the life and work of Salvá has been presented, paying special attention to his developments in the field of electricity. Data included in this paper are based on the original report that

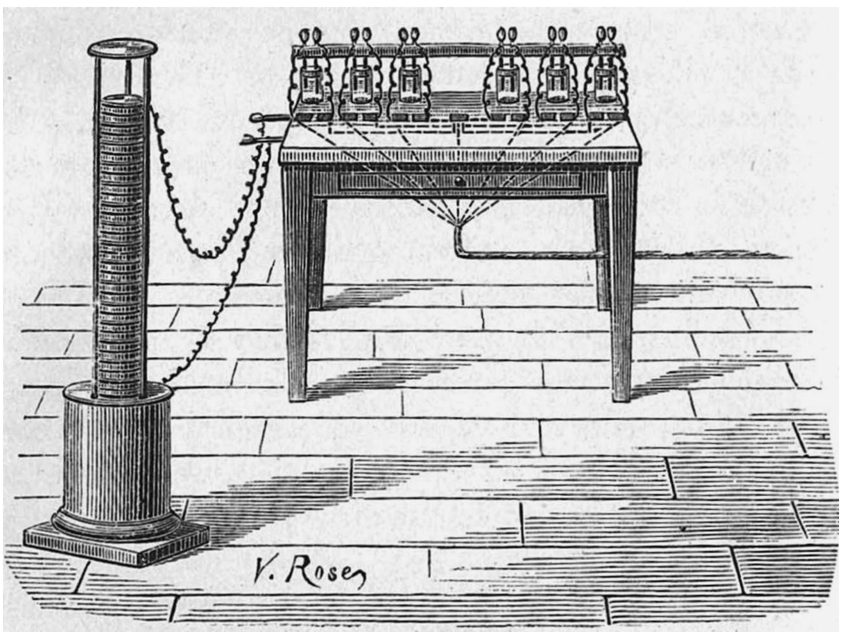

Fig. 3. *View of Salvá's electric telegraph as was imagined by Suárez Saavedra. Source: [8].*

Salvá presented to the Barcelona Academy of Sciences in 1804. It seems that Salvá carried out some practical experiments before the members of the Academy of Sciences the same day he presented his report to them, but it is not clear whether he was able to develop a long-distance communication system. In spite of this fact, there is no doubt of his pioneering contributions to electric telegraphy and the importance that his 1804 report has now in the history of telecommunications. ■

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