Marconi's History

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The roots of the future are in the past.

This paper remembers the main events of the history of radio, events in which Guglielmo Marconi gave his fundamental contribution to the development of the new system of communication.

This paper covers the period from the first transmission at Villa Griffone, near Bologna (Italy), in 1895, to the transmission across the Atlantic Ocean from Poldhu (Cornwall) to St. John's (Newfoundland) in 1901.

Keywords*—*History, radio communication.

Guglielmo Marconi was born in Bologna, Italy, on April 25, 1874. Therefore, he was only 21 years old when, in the spring of 1895, at Villa Griffone in Pontecchio (Bologna), he transmitted the first signal using a free propagating electromagnetic wave as a carrier.

However, radio was not born in one day. Rather, it had to go through a long labor, which ended in 1901, at Signal Hill (St. John's, Newfoundland), with the first transmission across the Atlantic Ocean. We can reasonably hypothesize that if the activity Marconi carried out between 1896 and 1901 had not been successful, the 1895 experiments would have only opened the way to plain radio telegraphy. In fact, as we will further discuss below, in 1895, the instrumentation was not syntonic, and the ionosphere had not been discovered yet.

As a consequence, the words "invention of radio" do not identify a single event but rather a whole period.

The scenery where the initial part of the history of radio communication took place is today known as *Villa Griffone* (Fig. 1), but in Marconi's times it was called *Il Griffone*. The building, elegant and impressive, was actually a large country mansion with a residential part, a stable, a barn, and a granary where Marconi's father reluctantly let him build the first laboratory, thanks to the insistent requests of his mother, Annie Jameson.

During the autumn–winter 1894–1895, Marconi worked in his laboratory with the aim of putting into practice what he had learned from the activity of other researchers.

In the spring of 1895, Marconi opened the windows of the granary and brought the receiver outside the building, further and further away from the transmitter that was left inside.

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Fig. 1. Villa Griffone, Pontecchio Marconi, Italy.

Once he had placed also the transmitter outside Villa Griffone, Marconi resumed his experiments until he had the stroke of genius of a great inventor. At the conference of Stockholm, when in 1909 he received the Nobel Prize, he said:

> In August 1895 I hit upon a new arrangement which not only greatly increased the distance over which I could communicate but also seemed to make the transmission independent from the effects of intervening obstacles.
>
> This arrangement [Figs. 2 and 7] consisted in connecting one terminal of the Hertzian oscillator, or spark producer to earth and the other terminal to a wire or capacity aerea placed at a height above the ground and in also connecting at the receiving end [Figs. 3 and 6] one terminal of the coherer to earth and the other to an elevated conductor. [1]

The new system immediately proved extremely effective, either to increase the distance between the transmitter and the receiver or "to overcome hills, mountains, large metallic obstacles . . . intervening between the places where the link must be established."

Thanks to the new arrangement, the distance between the transmitter and receiver was progressively increased, to the point that the inventor's assistants finally found themselves at the upslope of the *Celestini Hill* (Fig. 4), situated about one mile from Villa Griffone. According to

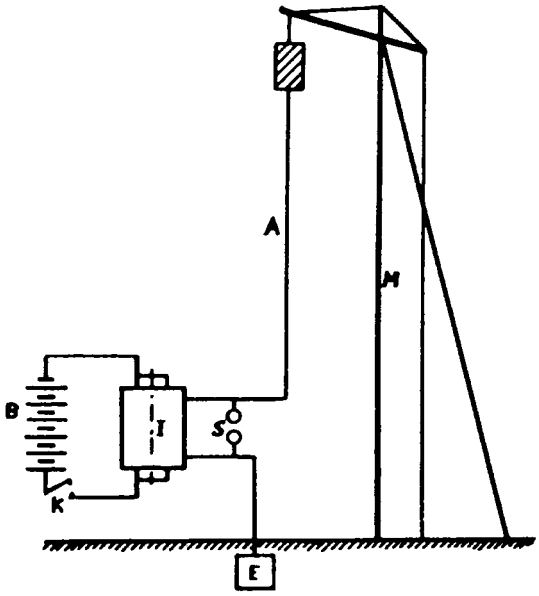

Fig. 2. Scheme of the transmitter used by Marconi at Villa Griffone (1895).

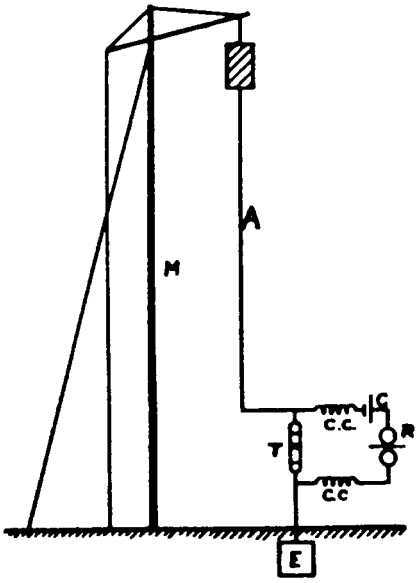

Fig. 3. Scheme of the receiver used by Marconi at Villa Griffone (1895).

what was reported in an interview published in 1897 by English journalist H. J. W. Dam, Marconi declared that in September 1895, one of his receivers, which had been placed on the other side of the hill, reacted to the signals transmitted from Villa Griffone.

During 1896, Marconi moved to Great Britain, where on June 2, he filed a patent entitled "Improvements in Transmitting Electrical Impulses and Signals, and in Apparatus Thereof."

The first practical demonstrations took place in London, in summer 1896, and in September of the same year in the plain of Salisbury. The technical report that H. R. Kempe of the Engineer in Chiefs Office sent to the General Post Office on the Marconi system reads:

> The experiments which were made with the above system on Salisbury Downs and which were concluded on Friday last have to a very great extent been successful ones and I am certain by now that the system is likely to prove of considerable value when further developed. In many respects the results obtained were most remarkable. [2]

The tests of Salisbury were followed by a long series of experiments and applications, which testify to the huge amount of work that was necessary to achieve the complete invention.

In May 1897, some messages were exchanged between *Lavernock Point* and the *Isle of Flatholm*, in the Bristol Channel, at a distance of nine miles.

In the same year, Marconi came back to Italy and carried out some experiments in Rome and at La Spezia. In the Gulf of La Spezia in particular, he obtained satisfactory results up to a distance of 18 km on sea, between *Cape s. Bartolomeo* and the battleship *San Martino*.

Assisted by the Wireless Telegraph and Signal Co., Ltd., a company he had founded with a group of English financiers in July 1897, Marconi began to build two telegraphic stations, one at *Alum Bay*, in the Isle of Wight, and the other, 14 miles distant, at *Bournemouth*, in the village of *Poole*. The same distance was also covered while transmitting from the Isle of Wight to a steamboat. This last experiment was evidence that bad weather conditions do not prevent successful communications.

During May 1898, upon a request by the Lloyds, radio transmissions took place between *Ballycastle* and the isle of *Rathlin*.

On July 1898, aboard the boat *Flying Huntress*, Marconi followed the Kingstown regatta for the *Daily Express* of Dublin, and he sent messages that were afterwards published in the evening edition of the newspaper. A connection was also established between the boat *Osborne* and *Osborne House*, in the Isle of White, to permit Queen Victoria to communicate with her son, the Prince of Wales. In the last case, about 1000 messages were transmitted in a satisfactory way, and Marconi commented:

> I consider the results of this service particularly interesting, because many people doubted the possibility of establishing regular radiotelegraphic communications over long stripes of land. [3]

The ease of use and the reliability of the apparatus were again underlined in the connection between the lightship *East Goodwin* (Fig. 5)—moored 12 miles off the lighthouse of *South Foreland*—and the lighthouse itself. On March 3, 1899, the *East Goodwin* accidentally collided with a steamboat that was sailing in fog, and the S.O.S. message received at South Foreland allowed the rescue of the entire crew.

A regular radio-telegraphic service between England and France was opened on March 27, 1899, between the station installed in the lighthouse of *South Foreland* and the station of *Chalet l'Artois*, at *Wimereux*, not far from Boulogne, where Marconi's parents had married.

Fig. 4. View from the rear of Villa Griffone, toward the west. Celestini Hill is on the left.

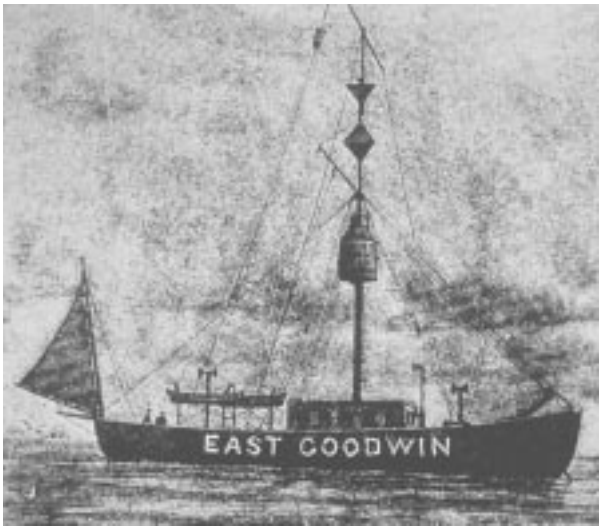

Fig. 5. The lightship *East Goodwin*.

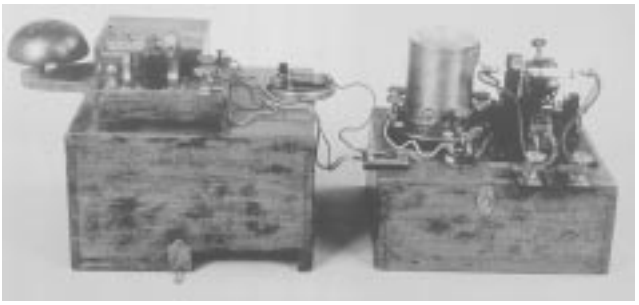

Fig. 6. The first receiver.

Other tests were carried out in 1899: a service for two American journals, on the occasion of the America's Cup regatta; and a transmission between two ships of the U.S. fleet—the *New York* and the *Massachusetts*.

Finally, in 1900, Marconi managed to accomplish multiple transmission on a single apparatus by exploiting the phenomenon of syntony or tuning and he had, once again, a stroke of genius.

The text of the conference Marconi held at the Society of Arts on May 15, 1901, reads:

> I now wish to describe ... further improvements I carried out, regarding in particular the results I obtained while tuning or syntonizing the apparatus. As long as it was possible to operate only two apparatus within what I'll call the sphere of their influence, a great limit was set to the practical use of the system.
>
> Using simple wires, placed vertically, connected directly to the coherer and to the spark gap of receiver and transmitter, as I used to do before 1898, it was not possible to get any satisfactory syntony. The new tuning methods which I adopted in 1898 [Fig. 6] consisted in the connection of the receiving aerial to the ground instead of connecting it to the coherer, and in introducing a suitable form of oscillations transformer coupled with a condenser; in this way I had built a tuned resonator which better answered to the waves emitted by an aerial of a determined length. [4]

Soon, also the transmitter was changed (Fig. 7), until its configuration became very similar to the receiver previously described, and the whole system—transmitter and receiver—became syntonic.

At the Nobel Prize conference in Stockholm, Marconi affirmed:

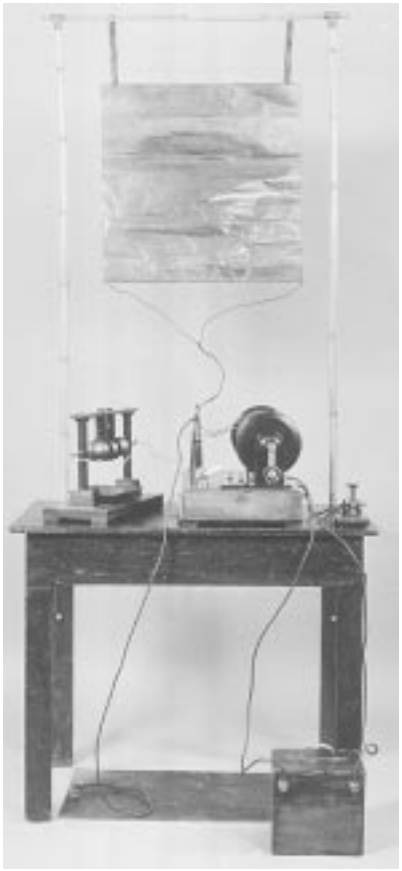

Fig. 7. The first transmitter.

> In 1900 I constructed and patented (it is the patent N. 7777 issued on 26 April) transmitters which consisted of the usual kind of elevated capacity aerea and earth connection, but this was inductively coupled to an oscillation circuit containing a condenser, an inductance and a spark gap, the conditions which I found essential for efficiency being that the periods of electrical oscillation of the elevated wire or conductor should be in tune or resonance with that of the condenser circuit.

At the end of 1900, Marconi was ready to look at the most ambitious goal, and the reading of the conference of Stockholm becomes fascinating. Here are his words.

> In January 1901 some successful experiments were carried out between two points on the South Coast of England 186 miles apart, i.e., St. Caterine's Point (Isle of Wight), and The Lizard in Cornwall.
>
> The total height of these stations above the sea level did not exceed 100 meters, whereas to clear the curvature of the earth a height of more than 1600 meters at each end would have been necessary.
>
> The results obtained from these tests ... seemed to indicate that electric waves produced in the manner I had adopted, would most probably be able to make their way round the curvature of the earth, and that therefore even at great distances, such as those dividing America from Europe, the factor of the earth's curvature would not constitute an insurmountable barrier to the extension of Telegraphy through space.
>
> The belief that the curvature of the earth would not stop the propagation of the waves, and the success obtained by syntonic methods in preventing mutual interference led me in 1900 to decide to attempt the experiment of testing whether or not it would be possible to detect electric waves over a distance of 4000 kilometers, which, if successful, would have immediately proved the possibility of telegraphing without wires between Europe and America.

Fig. 8. View of Signal Hill from the sea.

Today we know about the existence of the ionosphere and the fundamental role it had in the Transatlantic transmission, but in 1901 it was completely unknown. All the analyses carried out by electromagnetic field experts of the time, based on an incomplete propagation model, resulted in the impossibility of the closure of such an extremely long link. If Marconi had not been a strong-minded man and an ingenious experimenter, he would have probably quit the challenge and would not have discovered the physical phenomenon of the ionosphere. But how much struggle and hard work to reach the final results.

First, Marconi and his staff built up the transmitter station in Poldhu (Cornwall), with about 15 kW of power for a nominal wavelength of 1800 m. It must be noted, however, that this transmitter had a large spurious harmonic content; therefore, Marconi was certainly using also wavelengths shorter than 1800 m.

The receiver was in St. John's, Newfoundland, at a distance from Poldhu of 3684 km on top of a hill baptized with the prophetic name *Signal Hill* (Fig. 8) because it was used for flag signaling to the ships. During the historic days of the experiment, a blustering wind prevented the use of balloons to hold the receiving antenna wire vertical. At the end, Marconi decided to use a kite (Fig. 9) that soared, tied to a copper wire 120 m long, which was actually the antenna. The receiving apparatus was again nonsyntonic and used as a detector a "mercury-drop" or "Italian Navy coherer" and earphones in order to increase sensitivity. On December 12, 1901, around 30 minutes past noon, three weak but detectable signals transmitted from Poldhu reached Marconi's ears (Fig. 10). He handed the earphones to his trusted assistant Kemp to have a confirmation of what he had heard, asking him: "Can you hear anything,

Fig. 9. Marconi (left) and his assistants at Signal Hill (1901).

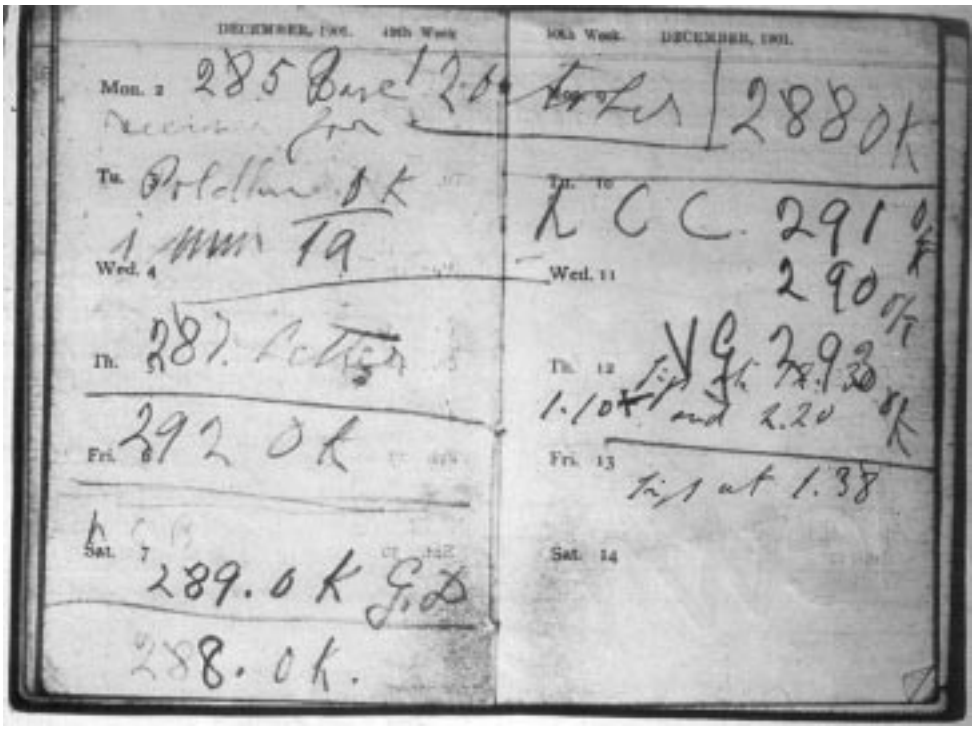

Fig. 10. The agenda where Marconi wrote he received a signal at 12:30, 1:10, and 2:20 on December 12, 1901.

Mr. Kemp?" The positive answer to this simple question started the age of Marconi's heritage, the age of radio, the age of wireless communications.

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