Vol. 49 • No. 2

February 2006

Microwave Journal

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SALVAN: CRADLE OF WIRELESS

How Marconi Conducted Early Wireless Experiments in the Swiss Alps

On September 26, 2003, the IEEE dedicated a "Historical Milestone," acknowledging some of the first wireless experiments conducted in 1895 by Guglielmo Marconi in Salvan, Switzerland, a picturesque resort in the Swiss Alps. This historical development had been described in detail by an elderly citizen, who had assisted Marconi during his short stay in Salvan.

In 1965, inhabitants of Salvan, Switzerland, located above Martigny in the Mont Blanc region, "remembered" that a senior citizen of their village had lived a very unusual experience seventy years before, when he was a young boy. A radio reporter was vacationing nearby, and Maurice Gay-Balmaz, by then 80 years old (see ***Figure 1***), told him how he had met a "nice young man," who had arrived with heavy equipment along the mule path ascending from the Rhone valley.[1] The recordings made at the time describe a crucial episode in the development of wireless communications, which was until then unknown to Marconi's "official" biographers.

Fig. 1 Maurice Gay-Balmaz. ▼

AN OLD MAN TELLS AN OLD STORY

The young Gay-Balmaz, born in 1885, was playing near his home in Salvan, when he noticed some odd-looking bits and pieces lying in the grass. Seeing the boy's interest, Marconi, who was then a tenant in the uncle's house, supposedly said: "So, you're interested in that, are you, young'un? If you'd like to work with me, I'll take you on."[2] In this manner, ten-year-old Gay-Balmaz became Marconi's little helper, very excited at the idea of carrying such fascinating equipment. He enjoyed helping this kind and generous summer resident, a man very different from the area's customary tourist. Without realizing it, Gay-Balmaz was about to play a role in one of the most significant adventures of our time.[3]

Overlooking the village of Salvan is a flat-topped erratic rock called "Pierre Bergere" (The Shepherdess Stone) (see ***Figure 2***), on which Marconi installed his transmitter. His equipment consisted of a battery, a Ruhmkorff induction coil, a Righi spark generator and an antenna (see ***Figure 3***). A few meters away from the rock, the boy held a two-and-a-half-

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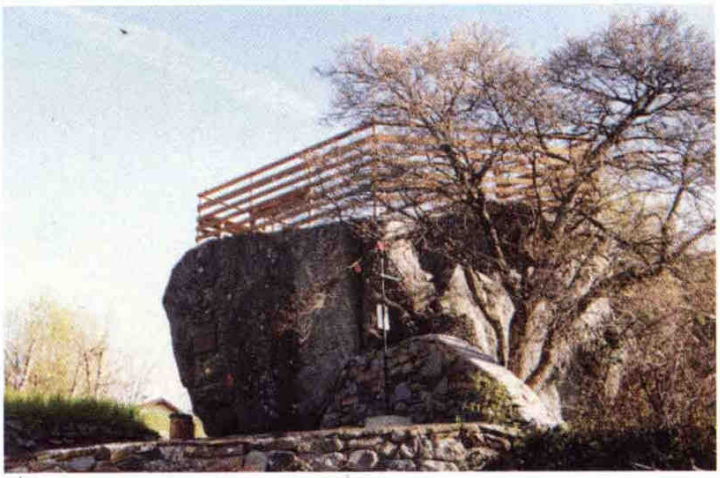


Fig. 2 The Shepherdess Stone in Salvan.

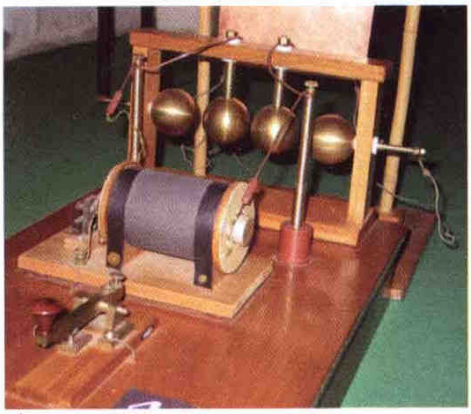


Fig. 3 Reconstruction of Marconi's transmitter at the Salvan Marconi Museum.

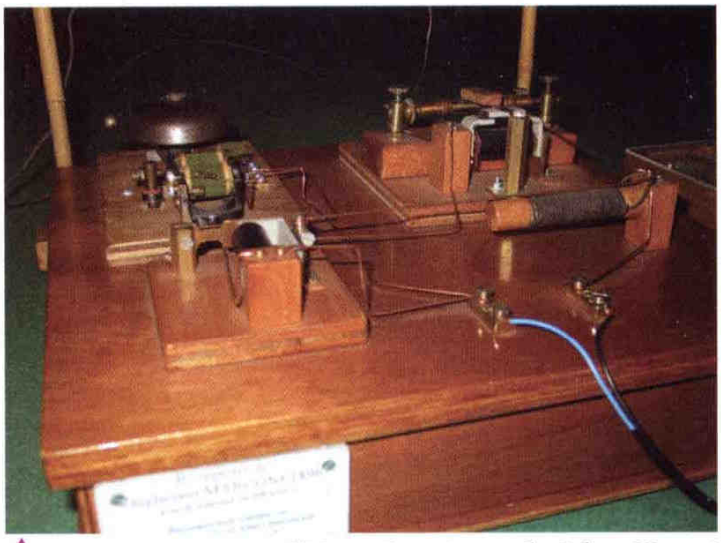


Fig. 4 Reconstruction of Marconi's receiver at the Salvan Marconi Museum.

meter long pole, along which ran a metallic wire connected to a receiver, probably consisting of a Branly coherer, a battery and a bell (see ***Figure 4***). Actually, the Italian word for pole is "antenna." This term, introduced at the time by Marconi, has since been used worldwide to designate what was previously called an "aerial." Part of the equipment had been brought from Bologna by Marconi and his elder brother Alfonso, who by then had returned to Italy.

A lot of time and effort was needed to get the system to operate. Gay-Balmaz recalled the long waiting periods: "At first the bell would not ring, and then, after careful trials, evaluations and adjustments of his apparatus, it did ring at such a distance. Marconi's face was beaming, and he shouted to me 'it is fine, now it is starting to work!' He asked me to move farther, maybe a hundred meters away. And then it took some time, maybe half a day of trials before the bell rang again. But it did ring! And we went along in the same way."[2]

With a broken voice full of emotion, the old man showed the places where he had placed the receiver and described how the tests progressed. Soon, the distance became too large to talk or to shout to each other, and flags were used to exchange messages. Whenever the bell rang, the boy raised a red flag to show that the signal had been received, while a white flag meant "not yet, keep trying!" The receiver was moved farther and farther away from the Shepherdess Stone, the four or five initial meters soon becoming hundreds of meters, finally reaching a location at the top of the next village of "Les Marécottes," at a distance of roughly one and a half kilometers (see ***Figure 5***). The transmitter's location was not always visible from the receiver, and then Gay-Balmaz had to change his position in order to indicate the result of the test. The first transmission without direct visibility was thus realized in Salvan.

This last information is particularly significant because, at that time, people believed that electromagnetic waves could only propagate along straight lines — just like light — and therefore could not reach the other side of hills and mountains. It was also felt that the curvature of the earth would drastically limit the transmission length. But such beliefs had not been verified, and Marconi proved that they were incorrect.

After several weeks of testing, Marconi returned to Italy, leaving in Salvan only some copper wire forgotten in his room. But he did not forget his young helper, who received a letter from Italy. Gay-Balmaz remembers, "I did not realize that he would become so famous. So when he wrote inviting me to come to Rome for a few days, I did not even keep the letter. Alas, I was still very young, and my parents did not let me go." For the rest of his life, Gay-Balmaz resented this irrevocable decision. He became a carpenter and spent his whole life in and around Salvan, working as a general handyman in a sanitarium. He died in 1975 at the age of 90.

Marconi's life, on the other hand, was extremely active. A few months after the Salvan episode, a gunshot sounded in the grounds of Villa Griffone, near Bologna in Italy. It announced the successful transmission of a message over two and a half kilometers.[5] By then, flags were no longer sufficient for signaling. In 1896, Marconi filed patent No. 12-039 in London, followed in 1897 by

1. Les Marécottes; 2. La Combaz; 3. Ladray; 4. Creté dy Serré; 5. Les Maraiches

Fig. 5 Panorama from the Shepherdess Stone, showing the places where Gay-Balmaz carried the receiver.

the wireless transmission over all of fourteen kilometers, between Lavernock Point and Flat Holme Island in the Bristol Channel, officially recorded by the British Post Office.[6] A signal crossed the English Channel in 1899, and in 1901 Marconi managed the incredible feat of sending a wireless message across the Atlantic Ocean, from Poldhu in England to Signal Hill in Newfoundland.[7]

Marconi's realizations were acknowledged by the highest honors, among them a dozen "honoris causa" doctorates (quite a feat for a man who had failed the entrance exams for the University of Bologna) and many scientific awards throughout the world, including the Nobel Prize in physics in 1909. He kept traveling all around the globe and kept a close watch on the evolution of his commercial ventures, until a heart attack ended his activity in the early hours of July 20, 1937.[8] What followed is well known. Is it possible to imagine the world today without radio, television and cellular phones?

FUZZINESS OF HEARSAY HISTORY

For a historian, oral testimony like the one given by Gay-Balmaz always contains some elements of doubt. It is well known that memory does not register facts, but interpretations made by the observer. In addition, when a story is reported seventy years after the event, one may expect some inaccuracies. Independent testimony, or some written documents would be welcome, to complete and corroborate oral descriptions. Unfortunately, Marconi did not leave any report describing his experiments in Salvan, so that one can only rely on hearsay gathered many years later.[9] In his testimony, Gay-Balmaz recalled that he was about twelve years old, in which case the encounter should have taken place in 1897, but this cannot be true, because by then Marconi's waves were traveling over much longer distances. Gay-Balmaz also reports that Marconi was then around 26 or 27 years old,[1] which is some five or six years older than he actually was at the time. This is not too significant, perhaps, because it is notoriously difficult for young children to estimate the age of adults. The chronological sequence of events shows that Marconi's experiments in Salvan were made during the summer of 1895, but a discrepancy of several years in the testimony of Gay-Balmaz does not shed doubt upon its validity. Who can remember, within plus or minus one or two years, what was going on when he or she was ten years old?

Two articles[10,11] describe Marconi's stay in Salvan as shrouded in a thick veil of mystery; the first of which even wonders whether Gay-Balmaz might not have made up the whole story, supposedly to impress his wife. But the honesty of the old man was proverbial, and only someone who did not know him could shed any doubt on his testimony. Many inhabitants of Salvan told of this young gentleman, roaming around the rocky woods and steep meadows with a local boy, carrying odd machines, poles and flags, and the story remains part of the "collective memory" of the village. Gay-Balmaz's testimony is remarkably detailed and precise, describing in a plausible way how Marconi operated, and it provides interesting information about what took place at that time.[1] One should also note that, in the absence of written documents, Marconi's official biographers are faced with the very same situation concerning this part of his life. They must also rely on oral reports told much later by family members, servants or guests at the Villa Griffone. For instance, a servant remembered digging a hole in the ground to bury a large metal plate. It is known now that, among other things, Marconi discovered that by earthing his equipment he could lengthen the transmission range considerably. Marconi was a man of action, who did not take much time off to "look back" and to write his memoirs, so that some questions may remain forever unanswered.

THE BEGINNINGS OF RADIO

For a long time, a recurring question has been frequently asked, "Who actually invented radio?" To answer it properly, an indisputable manner of what is meant by 'invent' and by 'ra-

dio' should be defined. For reasons of national prestige, several countries claimed at various times that the sole and unique "inventor of radio" was one of their outstanding citizens. For many years, unfortunate priority quarrels poisoned the scientific community. Fortunately, these sterile disputes have somewhat quieted by now. The invention of radio, or rather its development, is a long adventure in which many scientists took part during the nineteenth and twentieth centuries. This saga was marked by many, more or less important, milestones. The existence of electromagnetic waves was first predicted by theory and then confirmed by experiment. It was then found that these waves could transmit messages, equipment was developed for this purpose and information was forwarded over increasingly longer distances, reaching by now the confines of the solar system. At first, the messages were primitive, made up of spark noise modulated by the dots and dashes of the Morse code. Later on, technical developments made possible the transmission of voice, music, images and, finally, of computer data. New technologies appeared: solid-state detectors, electron tubes, transistors, integrated circuits, masers, sophisticated transmission codes and so on.

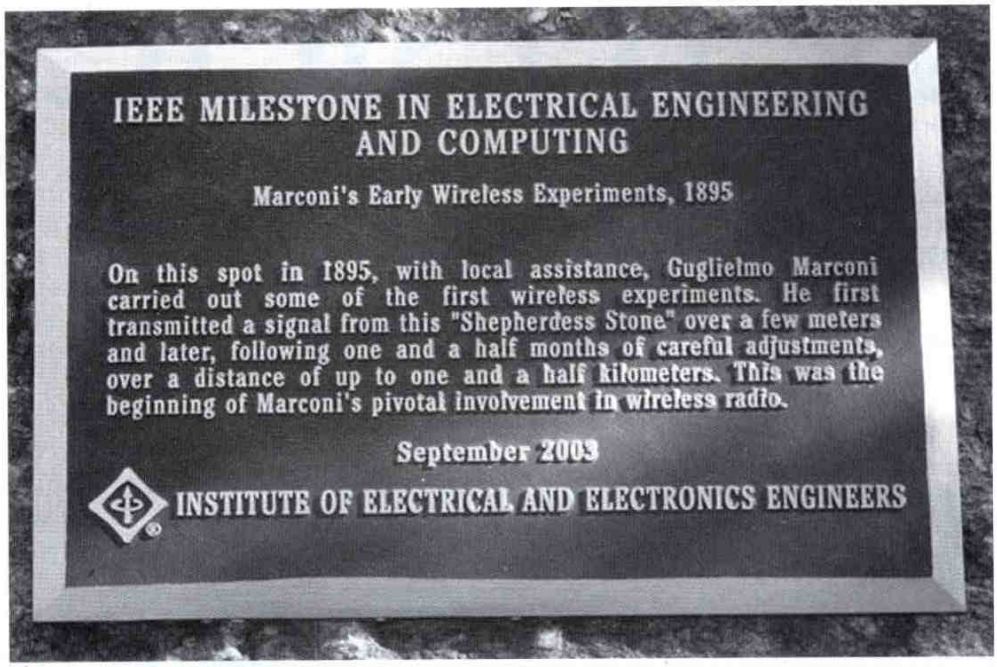
It is generally accepted that the original "forerunner" of radio was the Danish physicist Hans Christian Oersted, who in 1820 showed that an electrical current could rotate the magnetized needle of a compass, demonstrating for the first time that electricity and magnetism are somehow related to each other. One year later, the French mathematician André Marie Ampère repeated and completed the experiment, and developed a theory to account for it. Michael Faraday (1791–1867) discovered magnetic induction and introduced the concept of lines of force. Since he was an experimental researcher without an academic background (like Marconi later on), however, this concept was disputed until the great physicist James Clerk Maxwell made use of it to establish his famous equations in 1864. Maxwell's theory predicted the existence of electromagnetic waves. It still had to be discovered whether these waves actually existed.[6] During the winter of 1886–1887, Heinrich Hertz, experimenting in Germany with spark generators and dipoles, detected for the first time the presence of electromagnetic waves and thus validated the theory developed by Maxwell in 1864. His detector had a very low sensitivity, so that the transmission range did not exceed a few meters. Hertz died in 1894 at the age of 34. Hertz's work had been closely monitored by Oliver Lodge, in England, who carried out a detailed study of tuned circuits. In 1893, he introduced in his receiver a "coherer" recently developed in France by Edward Branly, who noticed that the resistivity of iron filings decreased sharply when close to an electric spark discharge. Lodge could then transmit signals up to some tens of meters, which was sufficient for demonstrations to the Royal Institution and to his students. But he was a fundamental scientist and did not look for practical applications until Alexander Muirhead, a telegraph engineer, pointed out that waves could carry messages. The two collaborated later on to develop wireless systems. Lodge's main contribution was probably the memorial lecture presented at the Royal Institution in 1894, in which he described Hertz's work and some of his own experiments. This lecture, and several articles published shortly afterwards,[13,14] had a very strong impact. The whole world heard of developments that had remained mostly confidential until then, and scientists in many places started experimenting with electromagnetic waves, among them Augusto Righi at the University of Bologna.

Many other scientists developed interest in electromagnetism and obtained more or less conclusive results or filed patents, but did not contribute significantly to the development of wireless before Marconi's first successful transmissions.[15] A certain amount of technical background had been established at that time, in theory as well as in practice, but the spark of genius had yet to be fired. This was the situation encountered by Marconi when he started experimenting. People believed then that electromagnetic waves propagated along straight lines and traveled only over short distances. It was not obvious that they could be used in practical applications. In addition, telegraphic transmission across several continents and oceans had been available for some time. Why should one spend time and effort to develop another system, which, if it did work, would only duplicate an existing one? Apparently, no one had thought of the potential use of wireless transmission for maritime communications.

THEN MARCONI CAME

In 1894, Marconi was on vacation with his family in Andorno, near Santuario di Oropa in the Italian Alps. He learned of the death of Heinrich Hertz, and became fascinated by a technical article describing electromagnetic waves. Marconi had lived in Leghorn, the main port of central Italy, and right away foresaw that

▲ *Fig. 6 How the village of Salvan looked in 1937.*



▲ *Fig. 7 IEEE milestone plaque placed on the Shepherdess Stone. (Photo by J.F. Zürcher)*

these waves would offer tremendous possibilities for maritime communications. He decided that he would "transmit a message without any metallic connection between transmitter and receiver." Marconi had seen Augusto Righi's equipment in the University of Bologna and probably started by repeating Hertz's experiments in the Villa Griffone attic. He increased the distance covered by the transmission across a room, then along a passageway, and then between the house and the surrounding fields. It must be realized that, at that time, he did not have technical manuals, nor suitable measuring instruments, neither analysis nor simulation tools, and could not call any specialized troubleshooter to repair defective equipment, all things taken for granted by engineers nowadays. It is hard to visualize what difficulties he encountered. He was on his own, a young beginner with a limited technical background, who had failed the entrance examinations for Leghorn Naval Academy and for the University of Bologna. In addition, he generally met with a climate of skepticism and incredulity, and even with hostility from his father, who did not approve of his son's manual activities. But from his youngest age, Marconi had been a genial tinkerer, interested in everything mechanical or electrical, and he possessed the exceptional practical sense and indomitable motivation that allowed him to carry on in the face of adversity and failure.[12] As Marconi kept increasing the transmission range, the attic in the family house became too small and he had to move his equipment into the garden, in full view of the whole family, servants and visitors. At first, he was pleased with the interest encountered, but later on he disliked the time-consuming interruptions. He looked for a quiet and remote place to pursue his experiments, and selected a "climacteric" alpine resort well known at that time: Salvan (see ***Figure 6***). He had only crude equipment to start his activity, and he wanted to avoid disturbance while adjusting it. Marconi already knew that his cut-and-try endeavors, if successful, would lead to a very significant breakthrough and he wanted to avoid any premature disclosure. Marconi's youngest daughter, princess Elettra Marconi-Giovanelli, visited Salvan in March 2001 and described how her father was looking for a quiet place, where nobody would understand what he was doing. As he said later on, "the idea was so elementary, so simple in logic, that it seemed difficult for me to believe that no one else had thought of putting it into practice. There must be many more mature scientists than myself who had followed the same line of thought and arrived at an almost similar conclusion."[16] In his biography, his

▲ *Fig. 8 Prince G. Marconi-Giovanelli, Prof. F. Gardiol, Princess E. Marconi-Giovanelli, Prof. J. Mosig, Prof. G. Falciasecca, Prof. Y. Fournier. (Photo by S. Vaccaro)*

daughter Degna indicates that her father was afraid that someone would discover his secret, as if a ghost was haunting him.[5] Marconi did not accept any limitation, and devoted his entire life to fulfilling the vision he had had in 1894 in Andorno, the validity of which he started to check the following year in the scenic surroundings of Salvan. In spite of the overall skepticism, he obstinately pursued an endeavor that went contrary to generally accepted beliefs, and was never discouraged by difficulties and failures. He succeeded in doing what many others had considered impossible. A key to his success is that he realized, quite early in his research, that his activity had to be self-supporting. Therefore, he set up a commercial wireless telegraph service that ensured his financial independence. In rather sharp contrast, several other researchers spent considerable time and effort locating and trying to convince sponsors, and some even died in abject poverty. As Marconi's daughter Elettra said,[4] "The village of Salvan can pride itself in having offered its ideal setting for the first stages of one of the most important discoveries of our time, wireless telegraphy."

IEEE HISTORICAL MILESTONE

Feeling that this major episode in the development of radio deserved more widespread recognition, the authors started the procedure to having the location "officially" acknowledged by the IEEE. The necessary documents were formulated and submitted to the IEEE History Center, where experts scrutinized them and gave a positive response. The History Committee of the IEEE acknowledged Marconi's early wireless experiments in Salvan as a "Historical Milestone" and a commemorative plaque (see ***Figure 7***) was dedicated on behalf of the IEEE by Raymond Findlay, IEEE Past President, on September 26, 2003, in the presence of both Princess Elettra Marconi-Giovanelli, youngest daughter of Guglielmo Marconi (see ***Figure 8***), and Pascal Couchepin, president of Switzerland.[17,18] The speakers recalled that Salvan had been the theatre of a major event in the history of electrical engineering and of mankind, as Marconi's discovery brought people closer together. Through his intelligence and doggedness of purpose, Marconi, father of wireless communications, provided an example of creativity and inventiveness to younger generations. Couchepin concluded hoping that this ceremony would prompt us to meditate on the importance of science and technical progress in our civilization. ■

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