MARCONI'S 1901 TRANSATLANTIC WIRELESS COMMUNICATION EXPERIMENT

-- The Vision, the Design and its Impact in the 20th century and beyond

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ABSTRACT

On the occasion of its hundredth anniversary, Guglielmo Marconi's epoch making transatlantic wireless communication experiment of December 1901 is respectfully remembered. Historical documents have been researched and analyzed to ascertain the detailed facts surrounding this experiment. The role of Mrs. Annie Jameson Marconi, Marconi's mother, in setting up his private wireless telegraph company and the role of Professor J. Ambrose Fleming of University College London in the design of the high power wireless transmitter at Poldhu, Cornwall are critically examined. Special historical investigative attention has been focused on the detection device that made the reception of the first transatlantic wireless signal at Signal Hill, Newfoundland possible. The origin of this device, the iron-mercury-iron coherer (in present day terminology, a solid state diode detector) with a telephone has been traced and Marconi's statements at various times throughout his life time regarding his use of this device have been documented. The significance and importance of this experiment in world wide wireless communications to follow are appreciated with critical acclaim.

Figure 1. Marconi at Signal Hill, Newfoundland, December 1901.

1. INTRODUCTION

Guglielmo Marconi knew what he was doing. During August-September 1895 Marconi made a fundamental discovery and an invention that launched the revolutionary new era in communications with wireless waves [1,2]. By consciously attaching the transmitted Hertzian waves (radiation wireless) to the ground and by using a grounded receiving aerial in resonance with the transmitting aerial, Marconi was able to communicate with wireless waves over distances of a mile and more, hithertofore impossible. By connecting a telegraph key in series with the power supply to the wireless transmitter Marconi was able to modulate the grounded Hertzian waves with digital Morse codes making wireless intelligence communications possible.

2. MARCONI'S BRILLIANCE IN HISTORICAL PERSPECTIVE

Marconi's brilliance can be understood by comparing these achievements with the thoughts of contemporary scientists elsewhere in Europe. Prof. Oliver J. Lodge, a renowned British Scientist of the day admitted that scientists like him did not think of grounding the Hertzian waves as it will amount to taking unfair advantage by compromising t he 'space' waves. But Marconi's focused attention was on conquering distance ! Further, Prof. Lodge and Prof. S. P. Thompson, working as expert evaluators on behalf of the British Post Office at fees of 100 Guineas each [3] certified that Marconi's employment of wireless telegraphy constituted an original invention. Whereas, in 1889, Heinrich Hertz in reply to an inquiry from one H. Huber, stated [4] that continent size dishes will be necessary to send audio frequency range wireless waves for voice communications. The concept of modulation did not occur to Hertz !

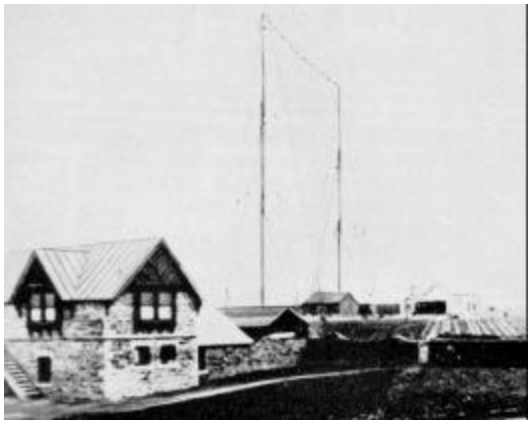

Figure 2. A scene from Poldhu with the array antenna actually used for Transatlantic digital wireless transmission. December 1901

Figure 3. A scene from Signal Hill with the kite antenna being hoisted by Marconi and his support personnel. (Newfoundland December 1901)

3. PIVOTAL ROLE OF ANNIE JAMESON MARCONI

The academic establishment of Italy including the University of Bologna could not detect signs of Marconi's brilliance. Accordingly Marconi did not have formal college or university education. It was Mrs. Annie Jameson Marconi, Marconi's mother (Figure 4) who alone sensed the clear hints of extraordinary scientific and entrepreneurial promise in him. The Italian Government failed to appreciate the practical usefulness of Marconi's discoveries and inventions in wireless communications for maritime applications and their commercial potentials. It was Mrs. Annie Jameson Marconi again who decided to bring Marconi to Great Britain, got him and his work introduced to the British Post Office through her cousins leading to the establishment of the first private wireless telegraph company in June 1897. The details surrounding

these historical events are well-known [1]. We, those of us who communicate with wireless waves and are directly benefited by their use are all indeed grateful to Mrs. Annie Jameson Marconi for her pivotal role in believing in her son, and launching the wireless communication revolution that has touched and improved the life of every human being in the 20th century and beyond.

Figure 4. Mrs. Annie Jameson Marconi (Marconi's mother)

4. MARCONI'S VISION

One good thing that happened to Marconi by not his being able to receive regular University education is that Marconi's thought processes were not preconditioned by the academics who thought that wireless waves travel in straight lines and could not be bent to the curvature of the earth thus enabling communications over long distances. Marconi dreamt all along (since September 1895) of conquering longer and longer distances with wireless waves and signaling across the Atlantic ocean. His dream began taking shape with the appointment in May 1899 of Professor John Ambrose Fleming, the first Professor of Electrical Engineering at the University College London. Prof. Fleming is known world wide as the inventor (1904) of vacuum diode (the Fleming valve).

[Marconi also had a competition in his Transatlantic wireless communication venture. Nikola Tesla of New York also engaged in an effort to send signals across the Atlantic in the opposite direction -- from Long Island to the coast of Portugal. He received financial backing of $125,000 from American Financier J. Pierpont Morgan in early 1901. His scheme was based on a theoretically unsound and bizarre concept of conduction wireless[5]. Marconi beat him and Tesla's faulty experiment never took place.]

5. PROFESSOR JOHN AMBROSE FLEMING AS TECHNICAL ADVISOR

Realization of Marconi's vision of sending wireless signals across the Atlantic ocean began with the appointment of Professor John Ambrose Fleming as the Company's technical Advisor in May 1899. Prof. Fleming was a direct student of James Clerk Maxwell at Cambridge University with whom he began his doctoral work. Dr. Fleming was appointed the first Professor of Electrical Engineering at University College London and had first hand practical experience in designing high power AC power plants in Great Britain. Marconi wanted to utilize this expertise for designing the first high power wireless transmitter at the Atlantic coastal village of Poldhu, Cornwall, England. Accordingly Prof. Fleming was contacted in May 1899 by H. Jameson Davis and he very eagerly accepted the offer to be the Technical Advisor to Marconi's Signaling and Wireless Telegraph Company at an annual fee of 300 British pounds per year. As the design work began in the second half of 1899, demands on Professor Fleming's consulting time by Marconi's engineers and technicians increased tremendously. Some what angry and agitated Fleming wrote to Mr. Davis explaining the demands on his time and the dangers of working with switching power plants. He demanded an increase in his annual fee to be 500 pounds per year. After consultation with Marconi, Mr. Davis wrote to Fleming fully agreeing with Fleming's new terms but Davis wrote explicitly that in case the transatlantic wireless communication experiment is successful, the full credit for that achievement will be and will for ever be solely Marconi's and it should be left fully to the Board of Directors as to the recognition of Fleming's contributions to this venture. Fleming agreed to this

Figure 5 Prof. John Ambrose Fleming

condition in writing saying that he will not claim anything that he did not do and will be comfortable with the though that the board of Directors will be just in giving full credit to what he actually contributed. Upon achieving this agreement, Marconi who was behind this explicit agreement offered, on his own, some shares of his Company to Fleming, saying that these shares will be very aluable if 'we' could go across the Atlantic. As it will be learnt soon after Marconi's great success, this offer of 500 shares of his company to Prof. Fleming was not known to the company managing director and other directors, when Fleming claimed those shares soon after the experiment. At that young age of 26, Marconi made this very shrewd maneuver by himself in which he kept Prof. Fleming's devotion to the success of the experiment very strong while eliminating any threat of claim of personal credit to it by Prof. Fleming.

6. THE DESIGN OF THE HIGH POWER WIRELESS TRANSMITTER AT POLDHU

The circuit diagram [6] of the high power wireless transmitter at Poldhu, Cornwall, England, is available from Prof. Fleming's Notebook of 1901 and is reproduced below :

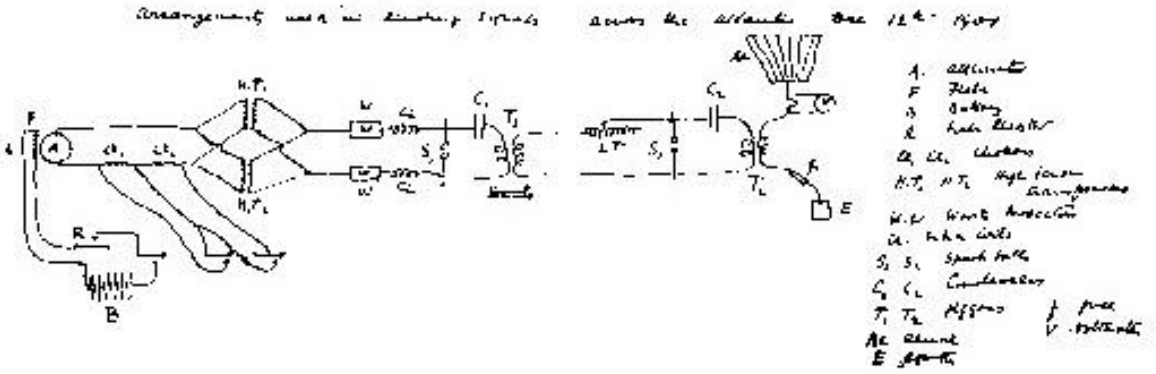

Figure 6. The circuit diagram of the Poldhu Transmitter in Prof. Fleming's handwriting

The transmitter is the world's first high power digital wireless transmitter. Some of its specifications were: Power of the generating plant was about 25 kilowatts.

The arrangement of transmitting antennae which was used at Poldhu is shown in Figure 2, and consisted of a fan like arrangement of wires supported by an insulated stay between masts only 48 meters high and 60 meters apart.

7. THE EXPERIMENT

The reception of the first transatlantic wireless signal took place during the day at around 12:30 PM local time at Signal Hill, Newfoundland. The entire propagation path from Poldhu to Signal Hill was in daylight. At the time of this experiment experimental techniques of measuring wave lengths of wireless waves did no exist. No approximate reliable

theoretical calculations could be made either. Intelligent guesses that were made varied wildly. The opinion has been that long waves were involved. One hundred years later, the propagation path has been analyzed to indicate that day light waves (short waves, discovered by Marconi in 1924 for transoceanic propagation during day time) had a favorable propagation condition and the Poldhu transmitter was capable of excellent short wave radiation. Preliminary investigations [8] indicate that short waves could well have been responsible for Marconi's first transatlantic success !

8. THE SENSITIVE SOLID STATE CONTACT DETECTOR AND ITS TRUE ORIGIN

The highly sensitive detector device that made Marconi's historic effort a success is the iron-mercury-iron self restoring coherer with a telephone invented by Sir J. C. Bose. The work was published in the April 27th issue of the Proceedings of the Royal Society, London [9]. The research and development work was done at the Physics Department laboratory of the Presidency College, Calcutta, India and was communicated to the Proceedings of the Royal Society, London by Lord Rayleigh.

For very delicate adjustments of pressure I used in some of the following experiments an U-tube filled with mercury, with a plunger in one of the limbs; various substances were adjusted to touch barely the mercury in the other limb. A thin rod, acting as a plunger, was made to dip to a more or less extent in the mercury by a slide arrangement. In this way, the mercury displaced was made to make contact with the given metal with gradually increasing pressure, this increase of pressure being capable of the finest adjustments. The circuit was completed through the metal and mercury. Sometimes the variation of pressure was produced by a pressure bulb. In the arrangement described above the contact is between different metals and mercury -- metals which were even amalgamated by mercury still exhibited sensitiveness to electric radiation when the amalgamation did not proceed too far. Another coherer was found apparently irresponsive to radiation, there being the merest throb(sometimes even this was wanting) in the galvanometer spot, when a flash of radiation fell on the receiver. Thinking that this apparent iimmobility of the galvanometer spot may be due to response, followed by instantaneous recovery, the galvanometer needle being subjected to opposite impulses in rapid succession, I interposed a telephone in the circuit: each time a flash of radiation fell on the receiver the telephone sounded, no tapping being necessary to restore the sensitiveness. The recovery was here automatic and rapid.

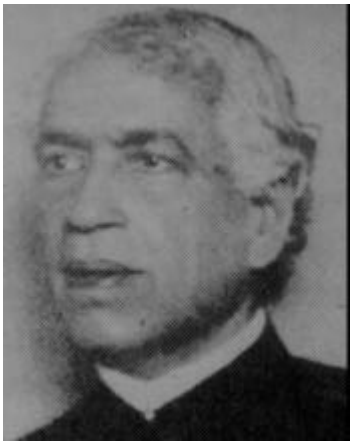

Figure 7. The Invention of the self-restoring Mercury Coherer with a telephone detector (the Bose Detector) [9] and the Inventor Sir Jagadis Chunder Bose.

The detailed circumstances surrounding Marconi's use of this device to detect the first transatlantic wireless signal at Signal Hill, Newfoundland based on recent forensic research is as follows:

As written by Marconi himself in an article in the Marconigram of 25th June 1903 [10] and many many years later, (near the end of his life) in the book of Dunlap [1] that Marconi himself corrected, edited and approved, Marconi himself experimented with the mercury coherer with a telephone detector and found it to be an extremely sensitive detection device for wireless waves. Marconi, in his own words described the event in the Marconigram of 25th June 1903 [10]:

I ran my wires through a window in the barrack, thence to an old telephone pole, where it was attached to the kites. For this especial experiment I had devised an especially sensitive coherer of a new type and instead of depending on the ordinary Morse Inker for printing the signals I had substituted a telephone receiver, believing that I could then detect much fainter signals, should the wave effects be very light.

And in the Dunlap book [1] published in 1937 near the end of Marconi's life, Marconi again stated:

The critical moment had come, for which the way had been prepared by six years of hard and unremitting work, despite the usual criticisms directed at anything new. I was about to test the truth of my belief. In view of the importance of all that was at stake, I had decided not to rust entirely to the usual arrangement of having the coherer signals record automatically on a paper tape through a relay and a Morse instrument, but to use instead a telephone connected to a self-restoring coherer. The human ear being much more sensitive than the recorder it would be more likely to hear the signal.

During the intervening 33 years Marconi never talked about this detector device, not even in his Nobel lecture of December 1909[11]. Near the end of his life in 1937, as can be very clearly seen in the above mentioned statement, Marconi no longer claimed that he devised that self-restoring coherer. Instead, the Dunlap book, which Marconi himself personally edited, devoted full one and a half page in a tribute to Sir Jagadish Chunder Bose[1] for providing crucial support to Marconi at the critical juncture when Marconi needed it most ! Critical contribution of Prof. Bose's invention in Marconi's success finally found a dramatic correct expression in a banner newspaper headline by Ms. Mita Mukherjee [12] in November 1997.

Prof. J. C. Bose was in London, England during August 1900 through September 1902 working in the Royal Institution. The 'Proprietor of a very well-known Telegraph Company' who was none other than Major Stephen Flood Page, the Managing Director of the Marconi's Wireless and Telegraph Company telegraphed Prof. Bose on 17th May 1901 before a Royal Institution lecture given by Bose and within a hour personally visited Prof. Bose with a patent application at hand. In a letter [13] to his personal friend Nobel laureate (1913, Literature) Rabindranath Tagore, Prof. Bose described this meeting relevant portion of which written in Bengali language is reproduced below (with an English translation) :

A short time before my lecture, a multi-millionaire proprietor of a very famous telegraph company telegraphed me with an urgent request to meet me. I replied that I had no time. In response he said that he is coming to meet me in person and within a short time he himself arrived with patent forms in hand. He made an earnest request to me not to divulge all valuable research results in today's lecture : "There is money in it -- let me take out patent for you. You do not know what money you are throwing away" etc. Of course, " I will only take half share in the profit -- I will finance it" etc.

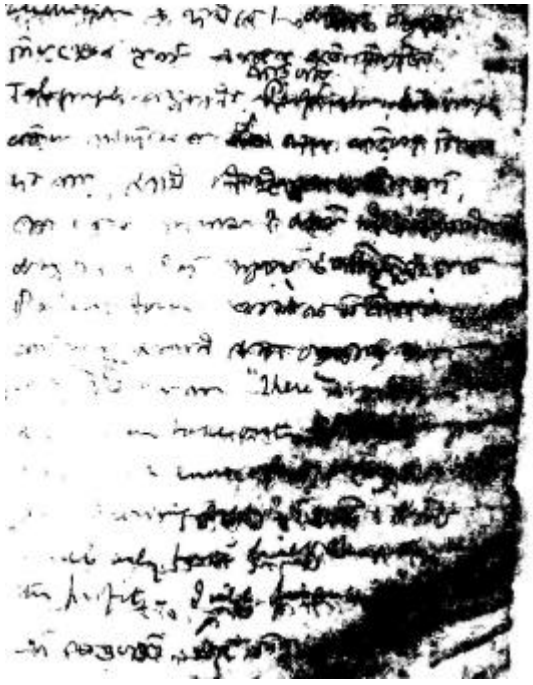

Figure 8. Excerpts from Prof. J. C. Bose's 17th May 1901 letter to Nobel Laureate Poet Rabindranath Tagore[13].

This multi-millionaire has come to me like a beggar for making some more profits. Friend, you would have seen the greed and hankering after money in this country, - money, money - what a terrible all pervasive greed ! If I once get sucked into this terrible trap, there wont' be any escape ! See, the research that I have been dedicated to doing, is above commercial profits. I am getting older - I am not getting enough time to do what I had set out to do -- I refused him.

Marconi's statements in the Royal Institution Lecture[14] of 13th June 1902, for tactical reasons, were not in tune with the whole truth ! On this hundreth anniversary of this epoch-making event, we salute Guglielmo Marconi for the Spirit of this Great Discovery!

9. ACKNOWLEDGMENT

This author is grateful to Marconi's daughter late Gioia Marconi Braga for getting him interested in the pioneering works of her illustrious father.

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