Did Marconi Receive Transatlantic Radio Signals in 1901? Part 2 (conclusion): The Trans-Atlantic Experiments

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We apologize for not mentioning in February that the installment of this article published then comprised only Part 1 and that the second and final part would follow in this issue.--MFE

On December 11, 1901, Marconi and his party used balloons to support the receiving aerial wire which was about 500 feet long. According to Marconi's assistant, George Kemp, "Marconi tried all the detectors from time to time" until a heavy gust of wind blew the balloons away, ending the day's experiment. "Signals appeared at intervals on a telephone in series, when using our sensitive tube (coherer) circuit, and, at times, the dots threatened to appear on the tapper." [8]. The receiver was the syntonic (tuned) type.

On December 12, a kite was used to support the aerial wire, and Marconi switched to the untuned receiver because the erratic changes in elevation of the kite made tuning the aerial too difficult. Later, in a recorded address, Marconi said that he "tried various microphonic self-restoring coherers placed in the secondary circuit of a transformer, the signals being read on a telephone. In many cases a succession of S's being heard distinctly (also heard by Kemp) although, probably in consequence of the weakness of the signals and the unreliability of the detector, no actual message could be deciphered. The coherers which gave the signals were one(s) containing loose carbon filings, another designed by myself, contained a mixture of cobalt and carbon filings, and thirdly the 'Italian Navy Coherer,' containing a globule of mercury between two (conducting) plugs" [4].

Marconi recorded in his diary: signals received at 12:30, 1:10, and 2:20 Newfoundland time [2]. Marconi said later "At 12:30 PM, while I was listening on the telephone receiver there came to my ear, very weakly, but with such clarity that there could be no possible doubt, a rhythmic succession of the 3 dots corresponding to the letter "S" of the Morse code..." [4]. Some signals also were received December 13 during the brief time that a kite could be kept aloft.

When Marconi announced his reception of transatlantic radio signals to the world, the Anglo-American Telegraph Company, which held a monopoly on telegraphy in Newfoundland, threatened court action if Marconi continued his wireless work there. That ended transatlantic radio experiments in Newfoundland. His announcement of success met with some scepticism, especially in England, based on preconceived notions about radio waves travelling in straight lines.

To counter this and fully satisfy the Board of his company, his next long range experiment was carried out on a voyage from Britain to New York aboard the SS Philadelphia in February, 1902. In this experiment, he continually monitored signals from the Poldhu transmitter, which was unchanged and still operating at a nominal

820 kHz (366 metres).
Judging from Kemp's description, the receiving antenna was a four-wire horizontal cage about 150 feet above the deck [8]. A syntonic (tuned) receiver was used. Morse code messages were received to a maximum range of 700 miles during the day and 1550 miles at night. The repeated Morse letter S (the test signal used in the Newfoundland experiment) was received up to about 2100 miles at night, approximately the distance from Poldhu to St. John's. Marconi tested the range of the Poldu station again in 1902 on voyages aboard the Italian naval vessel Carlo Alberto, presumably with a tuned receiver. The results were consistent with those obtained on the SS Philadelphia.
During a summer voyage around the European coast, signals were received about 1600 miles from Poldhu at night (not necessarily the maximum range), but only to about 500 miles by day. On an east-west transatlantic voyage in October, signals were received right into the harbour at Sydney, Nova Scotia at night, at a reported wavelength of 1100 metres (about 273 kHz). Although these voyages vindicated Marconi as far as proving that trans-Atlantic radio communications were possible, they indicated that they could only be made at night at wavelengths of hundreds of metres, raising questions about the daytime experiment in Newfoundland.
Marconi was finding by trial and error that better results were obtained at longer wavelengths. He used a wavelength (at least sometimes) of 1650 metres (about 182 kHz) at his first trans-Atlantic station at Glace Bay, but still was confined to intermittent night-time operation. When he finally opened a commercial trans-Atlantic radio service in 1907 between another station near Glace Bay ("Marconi Towers") and Clifden, Ireland, he was using a wavelength of about 5000 metres (60 kHz). This provided reliable daytime communications and usable, but more variable, night-time communications.
What does all this tell us about the first transatlantic experiment between Poldhu and St. John's? Firstly, all the results obtained with tuned receivers were at least qualitatively consistent with modern experience and knowledge about radio propagation, although the long ranges obtained with such primitive equipment might come as a bit of a surprise to the reader [9]. Though daytime ranges at 820 kHz were limited to several hundred miles, the night-time ranges were several times longer.
The fact that no definite signals were received at St. John's on the tuned receiver (December 11) is no surprise to broadcast band listeners, and is consistent with radio propagation theory. According to the Austin-Cohen radio propagation formula [10], the daytime field strength at 820 kHz at St. John's would have been about 1/1500 of the field strength at the maximum daytime range achieved in the SS Philadelphia experiment.
The only result that seems inconsistent with modern knowledge was the claim of daytime reception of the 820 kHz transatlantic test signal at St. John's on December 12, which was made with an untuned receiver. It has been suggested that Marconi may have mistaken atmospheric interference ("static") for the three dots of the letter S repeated continuously. I doubt this because Marconi was an experienced radio listener, and his description of the event, quoted above, sounds very convincing.

Assuming then that he did hear the test signal, the most reasonable explanation is that his untuned receiver detected it at some frequency or frequencies other than the nominal transmission frequency of 820 kHz. Spark transmitters were notorious for their broadband emissions, and it is quite probable that the spectrum of the Poldhu transmitter contained significant power in the HF (short wave) band. [5]. Propagation curves indicate that the daytime strength of a 7.5 MHz signal at St. John's would be about six times greater than the field strength of a 820 kHz signal 700 miles from a source of the same power (the maximum daytime range in the SS Philadelphia experiment), if ionospheric absorption is neglected [11]. However, only a fraction of the broadband HF spectrum of the Poldhu transmitter would likely reach Newfoundland; the ionosphere would absorb all of it except for a band a few MHz wide below the maximum usable frequency (MUF), which would have been about 12 MHz.
Add to this a host of more uncertain factors such as the relative performances at 820 kHz and HF of the transmitter, the antennas, and the receivers, and about all you can say is that spurious HF radiation from the Poldhu spark transmitter provides the most plausible explanation of the first transatlantic radio transmission. Ironically, improvements in tuning prevented this from happening again in transatlantic work, and the potential of short wave for long distance communications was not realized for another two decades.

References and Endnotes

[8] Kemp, George, "Extracts from the diary of G. S. Kemp.," Vol. 3., *Marconi Archives*, Marconi plc.

[9] Typical ranges for shipborne 1.5 kW spark transmitters and receivers of the early 1900's (no electronic amplification) were a surprising 100 nautical miles at 1 MHz, and 185 nautical miles at 150 kHz. Factors contributing to such good results with such primitive equipment probably were: large receiving antennas with good ground connections to the hull of the ship, resulting in low antenna circuit losses; propagation over salt water; and the large impulsive power of a spark transmitter.
The voltage-controlled coherer detector was well suited to detection of the peak signals provided by the spark transmitter impulses. Ratcliffe (Reference 5) estimates the RF power output of the Poldhu transmitter during the damped wave spark impulses to have been a few tens of megawatts, whereas the average power input was only 35 kilowatts! This large ratio of impulse power to average power was due to the spark being produced by the relatively short discharge of a capacitor.

[10] P. David and J. Voge, *Propagation of Waves*, Pergammon Press, 1969.

[11] Bremmer, Dr. H., *Terrestial Radio Waves*, Elsevier Publishing Co., 1949.