Did Marconi Receive Transatlantic Radio Signals in 1901? - Part 1

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We are again fortunate to have another article from Henry Bradford on the early years of the Marconi transatlantic stations. Henry presents a thought-provoking discourse on the controversy associated with Marconi's earliest transatlantic experiments. There's no doubt in my mind that, due to Marconi's misunderstanding of the limitations of his receiving equipment, the letter "S" was really heard on HF, not on MF as the inventor claimed.
Give this article a whirl and see if you are convinced. If you are convinced, you might speculate, as I did, where communications technology would be today if the communications effectiveness of HF was uncovered at the turn of the 20th. century, instead of some 25 years later.-- Frank J. Lotito, Editor, "Below 535"

In December 1901, Marconi claimed to have received, at St. John's, Newfoundland, a radio test signal transmitted by his high-powered spark transmitter station at Poldhu, Cornwall, England. This was the first reported transatlantic radio transmission, and it convinced Marconi that a transatlantic radio service was possible. In spite of his subsequent successes in transatlantic wireless communications, his celebrated original claim has remained the subject of controversy.
The doubts today centre around the reported wavelength and time of day: 366 metres (820 kHz), around midday and early afternoon at St. John's. At this time, much or all of the transatlantic path was in daylight. In the light of modern knowledge about radio propagation, Marconi could hardly have picked a worse combination of frequency and time of day for the transatlantic experiment. Imagine attempting

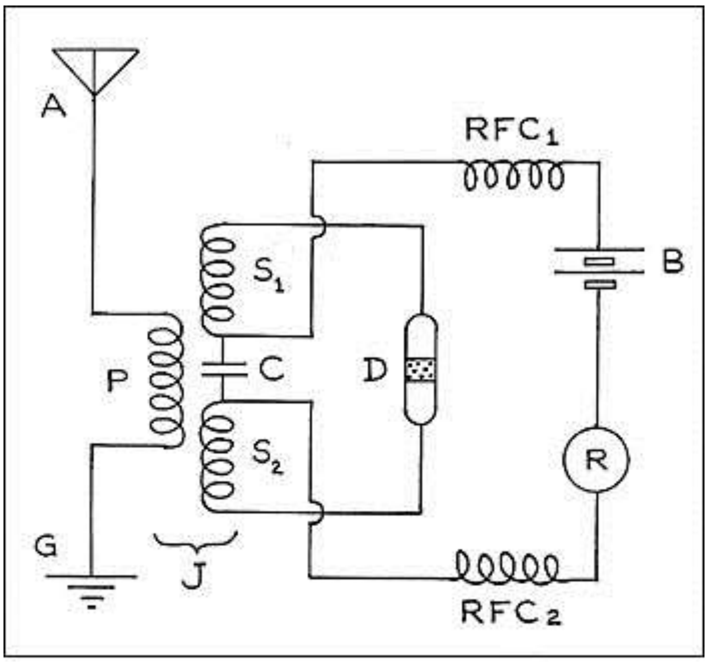

Fig. 1. Schematic of untuned receiver. A = antenna; g = ground; J = r.f. antenna transformer (called a "jigger"); P = primary coil; S1, S2 = halves of split secondary coil; D = coherer detector; C = r.f. bypass capacitor; RFC1, RFC2 = r.f. chokes; B = Battery; R = relay. When triggered by an r.f. signal voltage from J, the resistance of the coherer dropped,, increasing the current in the d.c. circuit consisting of D, S1, S2, RFC1, RFC2, B and R. The relay circuit was isolated from the r.f. circuit by RFC1, RFC2 and C. The relay typically activated a paper chart recorder and a tapper (not shown). The tapper decohered the metal filings in the coherer to restore it to a sensitive (high resistance) state for the next signal.

transatlantic transmission on the North American AM broadcast band in the middle of the day!

As most radio listeners know, reception at these frequencies typically is restricted to within a few hundred miles from the station in the daytime, though it may extend many times further at night. The reason for this is this is that the D-layer of the ionosphere absorbs the energy of radio waves in this frequency range during the day, but disappears at night, allowing long distance reception via reflections from higher levels in the ionosphere.

So how did Marconi receive transatlantic radio signals in the middle of the day in what now is the AM broadcast band --if indeed he did? Let us examine all his early efforts at long distance radio communications for an explanation. (See References [1] through [3] for full descriptions of the events and equipment.) In 1900, Marconi built a powerful new shore station at Poldhu, Cornwall for ship-shore radio communications and experimentation. It was designed by Professor J. A. Fleming, a prominent electrical engineer. The station employed a spark transmitter, but unlike its battery-powered predecessors it was powered by a 35 kilowatt alternator. Encouraged by ranges of several hundred miles obtained with the new station, Marconi decided to attempt transatlantic transmission.

Most scientists of the time felt this was impossible. That opinion was based on the belief that radio waves, like light, should travel in straight lines, limiting radio communications to about horizon distances. Marconi knew that he had already exceeded that limit, and believed that radio waves, for some reason, followed the curvature of the Earth. Therefore he reasoned that with stations of sufficient size and power, he should be able to span the Atlantic. No one at the time knew that reflections from the ionosphere could greatly extend the range of radio transmissions.

Marconi chose Newfoundland as the receiving site for his first transatlantic experiment in order to minimize the length of the propagation path. In December, 1902, he sailed to St. John's with portable receiving equipment and set it up on Signal Hill, about 2100 statute miles, or 3500 kilometres, from Poldhu. The transmitting antenna at Poldhu was a fan, broadside to the Atlantic, made up of 54 vertical wires. The top of the fan was 60 metres (about 200 feet) wide, and was suspended 48 metres (about 160 feet) above the ground. The wires came together at the lower end where they were connected to the feed line to the transmitter. (See page 36 of Reference [3] for a good photo of it.)

The test schedule required Poldhu to transmit sequences of S's (three dots) in Morse code, together with short messages, interspersed with five-minute breaks at intervals. The transmissions took place from 11:30 AM to 2:30 PM Newfoundland time each day beginning December 11 [4]. The reported wavelength was 366 metres (820 kHz), and although there has been some controversy about this figure, it seems consistent with detailed modern analysis of the Poldhu transmitter [5,6].

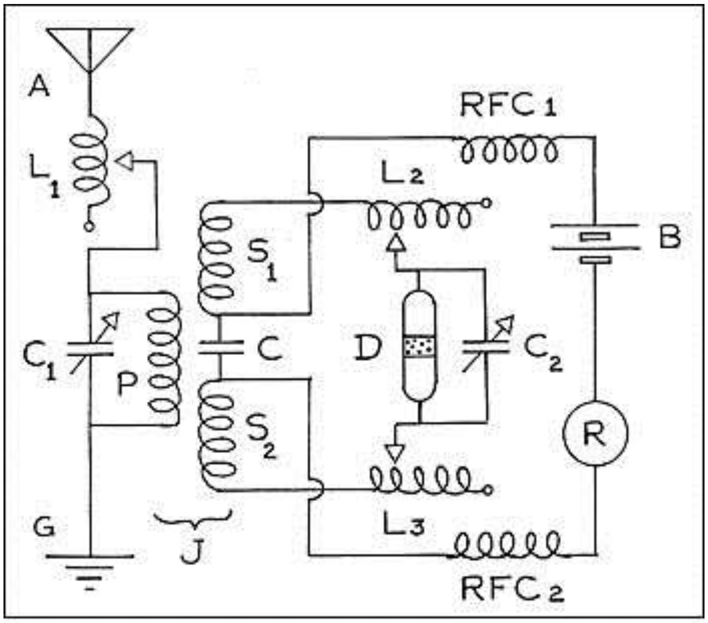

Fig. 2. Schematic of tuned receiver. The basic circuit is the same as the untuned one shown in fig. 1. L1, C1, L2, L3 and C2 were added for tuning. The circuits of Fig. 1 and Fig. 2 were adapted from reference [2].

Descriptions of the receiving equipment used are sketchy, and the details reported by different sources vary. I believe that the combined descriptions best fit two types of receiver developed by Marconi prior to 1900: an untuned receiver and a tuned ("syntonic") receiver. (See Figures 1 and 2.) Since there was no electronic amplification, the critical component in these receivers was the detector.

The detector used was called a "coherer," and there were two principal types. The best known of these consisted of a glass tube containing metal filings held between two metal plugs that served as electrodes.

When a RF signal voltage was applied across its electrodes, the filings cohered, lowering the resistance of the device and causing the direct current in a battery circuit containing the coherer to increase.

This direct current typically operated a relay which fed a larger current to a paper tape recorder. The latter current also operated a tapper which decohered the filings after the receipt of each signal. Basically, the coherer acted like a voltage-controlled switch that closed when a radio signal was received. Many people were involved in the development of the coherer, including Sir Oliver Lodge, who gave the device its name.

In the second type of coherer, a drop of mercury was used in place of the metal filings. It was called a self-restoring coherer because it did not require a tapper. The behavior of this instrument is not well understood, but its detector action may have been principally due, like that of a diode, to its non-linear I-V characteristic. Although known as the "Italian Navy Coherer," this detector, used in conjunction with a "telephone" (earphone), probably was developed originally by Sir J. C. Bose of India [7]. Since there is a potential node and current antinode at the bottom of a grounded vertical aerial, Marconi stepped up the signal voltage applied to the coherer by means of a RF transformer, called a "jigger," in both his untuned and tuned receivers. The principal difference between the tuned and untuned receivers was that the primary and secondary circuits of the jigger were tuned in the former by means of variable inductors and capacitors, whereas no effort was made to tune the circuits of the latter.

End of Part 1.

References

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