



# MARCONI'S MYSTERY

This is the ninth in a series titled **Jurassic Telecommunications** that began by describing the late Victorian, non-electronic roots of modern telecommunications. This chapter's writing concerns new views about the mystery surrounding Marconi's epochal transatlantic transmission of December 12, 1901.

When Guglielmo Marconi told the world he had spanned the Atlantic Ocean by wireless at 12:30 p.m. (Atlantic Standard Time) on December 12, 1901, he was greeted with both acclaim and skepticism. The prevailing scientific view was a sort of “flat earth theory”—that wireless waves could not travel beyond the optical horizon. Marconi had spent a couple of fortunes of family money (backed by his Irish Jameson in-laws of whiskey fame) in repeated and ever-expanding demonstrations of longer and longer range. He had managed to get his Marconi Marine business into operation, which gave him an even larger database of transmission reports. But in general, scientific experts of the day poo-pooed his claims of having succeeded in transatlantic transmission.

## Proof of a Radio Path

To date, nobody can prove with certainty that Marconi did indeed succeed in creating a radio path on that day on which we all memorize as the occurrence of a step function in telecommunications technology. Indeed, Marconi himself could not explain in detail how or why he heard the Morse letter “S” on that occasion. And his only witness was his most trusted assistant, George Kemp, who had been seconded to Marconi by the chief engineer of the British Post Office, William Preece, to give Marconi aid and support in developing his wireless. (Other government minds had less gracious views of Marconi than did Preece.) Despite having been greeted and given space and physical help by part of Newfoundland's government, there were no other witnesses to the occasion. The lack of independent observers only increased the suspicion of skeptics.

Lawyers tell us that witnesses really don't lie. Rather, lawyers and psychologists know that humans who desperately believe in a particular conclusion from a set of facts will manufacture the conclusion by selecting the facts that support their case. When subsequently questioned, people typically will mentally downplay or disregard facts they don't want or need—or indeed, didn't have at the time of the incident under examination. Here, we have a case of two people who desperately wanted to achieve a particular outcome.

## Ionospheric Propagation

The most commonly held explanation all these years after the claimed fact is ionospheric propagation, commonly called “skip.” But that theory arose from a third party who also wanted Marconi to succeed. Electrical engineer Arthur Kennelly had already established an eminent name by giving engineers a working concept of impedance so that complex number calculations could

be used in AC systems. Kennelly noted that if indeed Marconi's transmission worked, the wave propagation had to be far better than any current theory. Kennelly therefore sought an explanation. In 1902, he found that physicists had learned there was a rarified layer of Earth's atmosphere about 50 miles above the surface. He postulated that layer had to have conductivity several times greater than sea water. (Old AM radio and submarine cable engineers know the conductivity of sea water is thousands of times that of dry land, so the conductivity Kennelly proposed was truly phenomenal.) Kennelly postulated there was a sort of “radio roof” surrounding the planet, and when later wireless work proved that “skip” worked, albeit generally at much higher frequencies than Marconi's early work, it supported Kennelly's theory how Marconi succeeded. British physicist Oliver Heaviside independently arrived at the conclusion that there was such a layer in the upper atmosphere, giving rise to the name Kennelly-Heaviside layer for what we today title the “E” Layer.

Several generations of technology students have been taught to accept that reason for

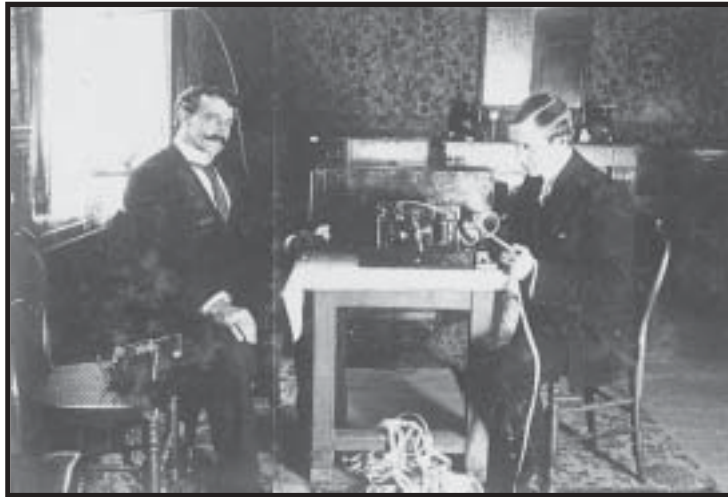
Marconi's claimed success. Few have dared question that orthodox view. Marconi claimed it; Kennelly came up with what seemed to be a reasonable explanation. The world took off in a dizzying spiral advancing the use of the wireless. While the 1950s saw some real glory days of radio achievement, the radio remained an art in the hands of a few practitioners until advances in the materials of radio began to make it a commodity for general use.

## Neglected Facts and Wishful Thinking

Although our knowledge of radio wave propagation broadened and stabilized, a few facts have been neglected—facts that might lead to a different conclusion were we to revisit Marconi's situation on December 12, 1901. Looking at those facts with cold logic might prove that, indeed, the claimed transmission was impossible, but not a deliberate hoax. Perhaps it was the intense wishful thinking of people desperate for a particular outcome.

Here's why it might not have worked.

Remember we are speaking here of an occurrence before the world had electronics. There was no amplification; no heterodyne conversion or gain. Even detectors as sensitive as the galena crystal were not yet in use. Whenever a signal was received using the coherers and earphones of the day, it had to be one of what we would now consider blistering strength. Notions of antenna efficiency were in the future. A path budget of Marconi's link would show gigantic losses.



*George Kemp with Marconi, several years before the transatlantic attempt.*

## Jurassic, continued

One of the facts in common evidence that led toward the conclusion of “skip” was that Marconi did have a simple tuning device, and he noted he did not succeed until he removed it from his receiver. That leads one to conclude what Marconi received must have had some higher frequency components – the sort of radio waves that do, indeed, skip around the planet.

But here is where Kennelly’s explanation for Marconi’s claim starts to fall apart. Marconi’s non-electronic Poldhu transmitter consisted primarily of a 252 kilowatt alternator with its output interrupted by a rotary spark gap. Ambrose Fleming later explained Marconi’s reserves were so heavily expended by 1901 that he had to purchase the largest used alternator he could find with limited funds. That was only 25 kW. Even if the whole 25 kW were useful RF, the link budget would have to be extremely favorable.

After the event, both Marconi and Fleming gave only sketchy guesses as to the actual transmitted frequency on December 12, 1901. They both guessed that the working wavelength transmitted by Poldhu was in the vicinity of 1000 feet or more. The issue of antenna at Poldhu adds some confusion. Marconi first tried to construct a ring of 20 wooden masts that would support a conical screen of wires as an antenna device, much like the rather broadband conical antennas we have seen for years in aeronautical radio systems. Marconi ordered these be built at both Poldhu and Cape Cod, Massachusetts, his first two choices for transatlantic wireless stations. However, storms at both locations blew each ring of towers down. A hurried rig of just two wooden masts supporting a vertical fan of wires was built at Poldhu. But because Marconi had reports of strong signals to his station at Crookhaven, Ireland, he changed to use a kite-supported wire at Newfoundland on the North American end. This was on a bearing much the same as Crookhaven from Poldhu. The path would be an extension of what already worked. The difference was that the path would be just over 2,000 miles rather than 225 miles. The path was one of the shortest across the Atlantic, running roughly the same as the submarine telegraph cables from Valentia, Ireland to Newfoundland.

Sketches with rough dimensions of the Poldhu antenna of 12/12/1901, and the likely parameters of any antenna coupling devices were thoroughly analyzed in 1995 and again in 2001 (see references at the end of this article for detail). Computer analysis rather thoroughly shows the Poldhu antenna was sharply resonant at around 850 kilohertz. The chances of any effective HF transmission from Poldhu have been rather effectively ruled out.

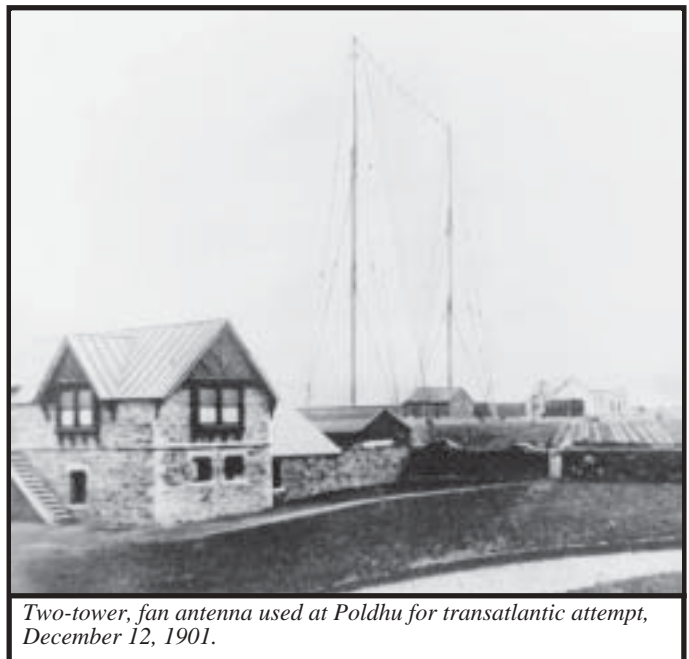
That leaves us at a point where we must posit E layer skip at 850 kHz from the remaining evidence. But nobody knew about ionospheric refraction on that day. And, in 1902, it was only theorized as an explanation for the success. Nobody had proof positive that it was a success. Also, nobody really revisited the scenario in the light of subsequent knowledge to determine if E layer skip was possible that day. E layer daytime skip is often called “sporadic E” simply because it tends to occur in spots around the Earth under conditions of intense solar radiation—at the peak years of solar activity.

### Solar Activity and the “Grayline”

It seems nobody checked to see what the solar activity was like on December 12, 1901. Reference to historical archives of solar scientists is easy. They reside in several databases on the Internet, making the information accessible. The sunspot count on December 12, 1901 was zero. Zilch. Nada. The solar flux for that day was 63, which is the minimum solar background of our part of the universe. It can’t get any lower until our sun fades away several millennia from now. In other words, 12/12/1901 simply wasn’t a

day for E layer propagation, particularly anything as low as 850 kHz. That’s a fact, no matter how much Arthur Kennelly wanted his theory to work in support of Marconi. Afternoon along the path from Cornwall to Newfoundland was perhaps the worst possible time to expect an 850 kHz signal to be propagated by completely non-electronic means. The explanation teachers have used for years does not seem to be valid.

There remains one other possible explanation to investigate: a wireless phenomenon called the “grayline” by radio people. This is the region of twilight at sunrise and sunset that propagates all manner of radio waves along its length, which can extend to opposite sides of the earth. This occurs *if* its position at the time of interest has both locations of interest in or near sunrise or sunset twilight. At the time Marconi claimed success, the grayline was approaching Poldhu, but it was nowhere near Newfoundland. There are even potential cases of “skip” getting



*Two-tower, fan antenna used at Poldhu for transatlantic attempt, December 12, 1901.*

on and off the “grayline” at one end or the other of a path. But we have already seen the reasons why no “skip” was possible at this date and time. Scratch the grayline as a possibility.

Another negative to consider: The recent analyses of Marconi’s apparatus and techniques reveal that, due to the parameters of the components Fleming had to use to construct the Poldhu transmitter, the spark rate had to be so low that a Morse Code “dot” would sound only like a “click” in the headset receiver at Newfoundland. That’s not bad, but all the static and lightning one might hear would sound like “clicks,” too.

And, the last part of the enigma: Why was the experiment not repeatable? Marconi’s intent was to build a transatlantic telegraph to compete with the submarine cables. He did that, but could not produce a commercially reliable system for about five years. During those five years, he wound up building different iterations of transmitting plants on ever lower and lower frequencies, until he wound up in the 30 to 35 kilohertz portion of the radio spectrum, using 300 kilowatt transmitters and huge, long antennas with directivity. These were a far cry from his first claimed success in terms of power, frequency and antenna efficiency. Clearly, his several interim tries were not commercially reliable.

## Jurassic, continued

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### Lightning Activity

So, what did Marconi hear on that fateful day in 1901? He heard clicks, and clicks were being transmitted. But, at any point in time, there are about 100 lightning discharges occurring around the planet. This was happening in 1901 also, but there were no observers to know that at the time. And, since 1901, three foci of lightning activity in Southeast Asia, South America and Africa have been found. Thus, it's highly likely that Marconi and Kemp, wanting to hear three clicks so badly, could have heard three clicks from lightning. Adding to that possibility are the facts that the fundamental frequency of lightning bolts is mostly below 200 kHz, in that region where Marconi finally did make his wireless work effectively. Furthermore, add to that the fact that RF signals do propagate best on north-south paths and that Newfoundland is

due north of the South American lightning epicenter.

One comes to the conclusion that Marconi and Kemp really heard clicks of lightning from South America, and not clicks of their Poldhu transmitter. One can surmise they had a desperate need to hear those clicks, and all the evidence we now have shows why they could not hear Poldhu and why it took another five years of development before they had a commercially viable product. They did not intend to commit a hoax. They hoaxed themselves. They merely convinced themselves of success, and the world so bought into that success that it developed a whole story to fit the conclusion. It's going to take a while for the historians to catch up to what really happened.

Today, we know more and we know better. For that, we have a whole planet of wireless devices. Ω

### Here are a few Internet References for those of you wanting to delve into further detail:

- [http://ewh.ieee.org/reg/7/millennium/radio/radio\\_differences.html](http://ewh.ieee.org/reg/7/millennium/radio/radio_differences.html)—Belrose's analysis of September, 1995
- [http://www.telecommunications.ca/Edited\\_Manuscript.pdf](http://www.telecommunications.ca/Edited_Manuscript.pdf)—Belrose's revisited study -2001.
- [http://www.ewh.ieee.org/reg/7/millennium/radio/radio\\_radioscientist.html](http://www.ewh.ieee.org/reg/7/millennium/radio/radio_radioscientist.html)—Belrose's study of the first speech transmissions, September, 1994.
- <http://home.online.no/~kgroenha/bondy.pdf>—P. Bondyopadhyay's analysis and story of J.C. Bose's detector as used by Marconi
- <http://www.batteryradio.com/Pages/Marconi.html>—Marconi anecdotes