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Foreword from the Associate Editor

This issue of the Historical Corner hosts a paper by John Belrose, focusing on Reginald Aubrey Fessenden (East-Bolton, Quebec, Canada, October 6, 1866 – Bermuda, July 22, 1932) (Figure 1).

As is well known, the earliest radio experiments, by G. Marconi (Bologna, Italy, April 25, 1874 – Rome, Italy, August 20, 1937) concerned Morse-signal-based radio-telegraphy. These experiments, which cost years of preparation and a major financial commitment, opened then the way to radio diffusion. This was made possible by a *crescendo* of technical results that allowed moving from a simple “binary” Morse signal – relatively easy to generate and receive – to a human-speech signal, with its dynamic range and its frequency content. The voice signal must be faithfully modulated and demodulated. Many scientists and inventors helped in developing the required technology. General Henry H. C. Dunwoody patented the use of carborundum crystals as a detector and demodulator of the signal, at the beginning of the century. Greenleaf W. Pickard used silicon crystals for the same aim. Subsequently, other minerals, among which the most famous is galena (lead sulphite), permitted the diffusion of the first receivers for home use. Almost simultaneously, John A. Fleming (who, among other things, contributed to the design of Marconi’s station in Poldhu) invented the vacuum diode in 1904. Lee de Forest invented the triode in 1906. The triode in particular led to the development of oscillators to generate radio frequencies, and allowed dropping the inconvenient and inefficient spark generators. Diodes – galena-based or vacuum – allowed the demodulation of the signal. It must be remembered that the phone, invented a few decades earlier, did not require modulation or demodulation of the signal.

Fessenden was himself a radio pioneer, devoted to voice transmission. Almost simultaneously with the transatlantic experiences of Marconi in Morse code, Fessenden performed experiments on short-distance voice links. An example was a link in Washington on December 23, 1900, which is acknowl-

edged as the first voice radio transmission. However, having to deal with spark transmitters, results were disappointing. By dropping sparks and developing more advanced technology, he finally achieved the first voice and music radio broadcasting on Christmas Eve, 1906.

As sometimes happens to pioneers, his achievement was examined by later historians, some of whom deny that such broadcasting ever took place, or indeed that it was utterly impossible with Fessenden’s equipment. Belrose presents here an accurate reconstruction of the events in 1906, and a convincing search for clues that such a transmission indeed took place and was heard by listeners, especially at sea.



Figure 1. Reginald Aubrey Fessenden (October 6, 1866 – July 22, 1932).

A Fessenden Christmas Eve Broadcast Retrospective

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Reginald Aubrey Fessenden made the world's first wireless broadcast on Christmas Eve, 1906. It was indeed a "broadcast," and not just a station-to-station demonstration, as was his December 21, 1906, major demonstration. Three days before Christmas Eve, 1906, Brant Rock Station staff notified (by wireless telegraphy) ships of the US Navy and the United Fruit Company to listen for special broadcasts on Christmas' and New Year's Eves. These ships had previously been fitted with Fessenden radio receivers, and so they were able to receive AM radio broadcast transmissions. "Special" applied, since the broadcast was a prepared program of voice and music for the holiday season. After wishing all listeners a "Merry Christmas," Fessenden added: "Will all those who heard these words and music please write to R. A. Fessenden at Brant Rock, MA." His concluding remark was, "We will speak to you again on New Year's Eve." We are told letters reporting reception of the broadcast were received, but today none can be found. We can also read that astonished wireless operators sent reception reports at the time, by wireless telegraphy.

I have written many papers and articles on Fessenden. Readers may reference an overview paper, and a chapter in a book [1, 2]. *Fessenden is indeed the principal pioneer of radio, as we know it today.*

The centenary of this first wireless "broadcast" from Brant Rock, MA, on Christmas Eve 1906, was celebrated world wide: by the BBC and by US broadcast stations (particularly, by NPR, and WATD-FM, Marshfield, MA); by radio-amateur groups, particularly two groups of amateurs, on the west side of the Atlantic ocean at Brant Rock, MA, and on the east side at Machrihanish, Scotland; and in Bermuda.

Today, those who now know about the "broadcast" consider it to be "common knowledge," but three historians have wondered whether the Christmas Eve broadcast was made. Donna Halper and Christopher Sterling [3], and James O'Neal [4], published articles in the centennial year of the broadcast, 2006, that questioned whether the broadcast on Christmas Eve 1906 was in fact made, since they could find no reference to it at the time it was made.

I have already written a countering article (posted on the Web), claiming that in my view, and my colleagues' views, that the broadcast was indeed made [5]. Donna Halper [6] has

also expressed a comment on O'Neal's 1906 article. However, O'Neal is still at it (his "Next Chapter" [7]). Continuing in the same negative vein, O'Neal has told us that if the broadcasts were made, it would have been impossible to have received them at the distances Fessenden said they were heard, because the power of Fessenden's HF alternator was low, the percentage modulation level of the carrier was low, and the radiation efficiency of his antenna system was low [8]. All of this is to further discredit what Fessenden wrote in his letter dated January 29, 1932, addressed to S. M. Kintner (in reply to Kintner's letter dated January 9, 1932). Fessenden's letter was copied in [5].

References [4, 7] are to O'Neal's *Radio World Online* articles. Edited versions were republished in the IEEE Broadcast Technology Society online *Newsletters*, winter 2006 and summer 2009, and reference [8] refers to a Broadcast Technology Society *Newsletter*.

O'Neal has not changed his mind, but neither have I nor my colleagues [9], and I have continued my research, so let me begin.

O'Neal cannot claim that Fessenden could not technically have made the "Broadcast." The December 21, 1906, demonstration was a point-to-point (*not a broadcast*) show-and-tell demonstration to an invited professional and media audience. This demonstration, transmitting words and music, was observed by John Grant, and favorably described in the *American Telephone Journal* [10].

In O'Neal's 2006 *Radio World Online* article [4], O'Neal wrote (paraphrased): "It appears that Fessenden's historic claim (of a) first 'hangs' on a single letter he wrote late in life (29th January, 1932) – 'a deathbed claim' – which should not guarantee automatic entrance into the 'broadcasting hall of fame' and the title 'the world's first broadcaster'."

Continuing my view, not noted by O'Neal, there was at least one earlier reference to the broadcast by H. P. Davis, Vice President of Westinghouse, in a lecture he gave at Harvard University in 1928. Obviously, in Davis's view, the broadcast happened. Fessenden must have said that the broadcast was made during litigation briefings ongoing in this time period, concerning the unauthorized use of Fessenden's patents, albeit some 20 years after the event.

The tone of O’Neal’s articles (“articles,” since they are not an in-depth study of the event) is somewhat arrogant. One is left with the impression that O’Neal, since he could find no evidence that the broadcast was made or heard before the referenced 1932 letter, set out to prove that the broadcast did not take place, rather than make an investigation of the circumstances of the claim (he does not say so: that is my view). His 2006 article was (in my view) an “attention grabbing” article, published in the year of the centennial, and his follow-on articles continue in the same vain! The words highlighted above are not what a historian should write.

A Google Advanced Search (by me) for ships that might have heard the “broadcast,” found a highlighting to a Web site on “The History of Radio, First Thirty Years,” which I copy, as it was when I saw it: “...although best known for his 1906 Christmas Eve broadcast of voice and music from Brant Rock.... The *La Touraine* **caught** it, the *Kroonland* **heard it**; the *Seydlitz* **found** it.” Great, this is what I was looking for. But what is the source for these words?

The bold underlined words match what I would expect, considering the variability of ionospheric radio propagation, and particularly the state of the art of receivers used in 1906. Most ships at sea in 1906 had receivers of uncertain vintage manufactured by Marconi, which may or may not have been able to receive an amplitude-modulated signal. The *La Touraine* was the oldest ship of the three, built in 1891 in Saint-Nazaire France, for the France-to-New-York service. The *La Touraine* could have “caught” the broadcast. This ship was involved in follow-ups on several wireless distress calls, and with the *Kroonland* and other ships, participated in rescue operations. The *Kroonland* is the only referenced ship (printed word) that the broadcast was “heard” (see below). There are many references to the *Seydlitz*, but most of them refer to the German battleship, not launched until 1910. The *SS Seydlitz* could have “found” the broadcast. It was built by F. Schau, Danzig, Germany, for the Bremerhaven-New-York service, launched in 1903.

The *SS Kroonland* was built by William Cramp & Sons, Philadelphia. When launched in 1902, she was the largest US steamship ever built. Photographs of the ship show that she had four tall masts, and the center two supported a multi-wire flat-top antenna (see Figure 1). The antenna system was probably an inverted-L antenna system. Reception by the wireless operator on the *SS Kroonland* was the only published document on reception by a ship at sea, but it was not published at the time of the “broadcast.” Edward Bliss, in his book [11], clearly stated that the “broadcast” was heard. I copy below what Bliss wrote:

One of the most intriguing stories in early radio is the story of Fessenden’s achievement on Christmas Eve, 1906. On that night, out in the Atlantic, the wireless operator of the *S.S. Kroonland* was amazed to hear in his earphones the sound of a woman singing. This was followed by recordings of Handel’s “Largo,” then poetry reading, and more music from phonograph records. To the wireless operator, accustomed to hear dots and dashes on his

receiver, it seemed like a miracle. The impromptu program came from Fessenden’s new transmitter at Brant Rock, Massachusetts, near Plymouth. Fessenden himself gave a “live” performance of Gounod’s “O Holy Night,” on his violin. Robert St. John calls it *the first real broadcast of history.*”

The wording of the details of the broadcast are similar to those we read published and republished, but what is new is that the “broadcast” was said to have been heard by the wireless operator on a named ship, the *SS Kroonland*. I can find no independent reference telling us that indeed the *Kroonland* heard the “broadcast.” However, the World-Wide Web has certainly latched onto Bliss’s claim that it was. Edward Bliss (1912-2002) was a distinguished American broadcast journalist. Robert St. John (1903-2003) was a well-known journalist, broadcaster, and author (he wrote a three-volume *History of Broadcasting*). He was a friend of Edward Bliss. They were at one time both working for the NBC – but unfortunately, neither Robert or Edward are still walking on the Earth, so we cannot now question them.

Continuing, I read with interest James O’Neal’s article on several of Fessenden’s antenna designs, published in the Spring 2009 issue of the IEEE Broadcast Technology Society *Newsletter*. I had of course studied and described (see [2]) the umbrella-top-loaded antenna system Fessenden patented and used for his transatlantic experiments. He erected one at Brant Rock, MA, and one at Macrihanish, Scotland. O’Neil has said that this antenna design was a first, and I agree with that. Reading the 1905 patent, one can appreciate that Fessenden had (probably) a better understanding of the basics of antenna design compared with other engineers in that time period, using various forms of antennas, and he certainly knew that the antenna system had to be well grounded. Base-fed umbrella-top-loaded antenna systems are in use today.

O’Neal has said he could find no description of the ground system Fessenden used with this antenna. I agree with that. That is unfortunate. However, the ground system was certainly not “just a few stakes pounded into the ground.” Fessenden certainly had at least one electrically short wire running from the base of the tower to the sea, and terminated in the sea (we know that Marconi did, for his station at Poldhu, Cornwall).

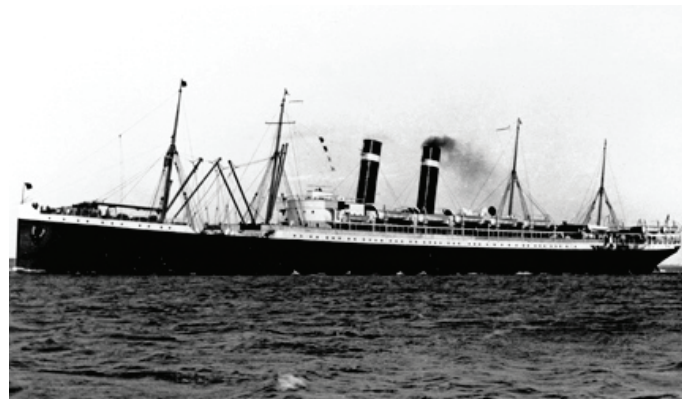


Figure 1. The *SS Kroonland*.

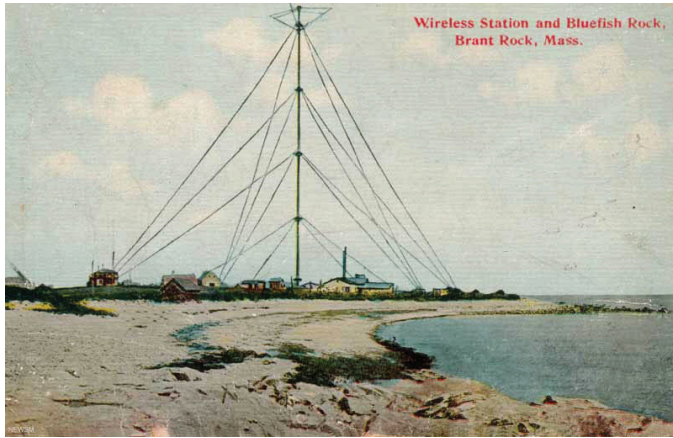


Figure 2. Fessenden’s Brant Rock, MA, wireless station.

Certainly, Fessenden knew he had to have a good ground “connection.”

However, what O’Neil did not know – his short reference list did not reference me – is that one does not need a multi-radial wire ground system. O’Neil’s reference to 120-radial-wire systems, which Fessenden did not have, does not mean that the radiation efficiency of Fessenden’s antenna system was poor. One (preferably) resonant elevated radial is quite sufficient to radiate – in the direction that radial runs away from the tower – field strengths equivalent to those produced by 120-radial-wire systems [12]. The difference is that the multi-radial wire system is omnidirectional; the one-radial antenna system is directional, and the field strength is a maximum in the azimuthal direction of the radial wire away from the tower. Certainly, an electrically short radial wire terminated in the ocean would be a very efficient antenna system for transatlantic communications. That is why Fessenden erected his Macrihanish, Scotland, and Brant Rock, MA, stations so close to the ocean (see Figure 2). It is certainly very unfortunate that Fessenden’s Macrihanish, Scotland, station’s tower fell during a severe winter storm on December 5, 1906.

Certainly, the power of Fessenden’s 1906 HF alternator was low – low compared with follow-on developments – and the percentage modulation was low (inserting a carbon microphone in series with the antenna system). However, what O’Neil did not tell us was that Fessenden’s Brant Rock station, employing his November/December 1906 HF alternator, modulated as it was, was heard by chance on a night when propagation conditions were very good in Macrihanish, Scotland, in late November 1906 [13]. It was heard with such clarity that the voice of Adam Stein, the operator at Brant Rock, MA, at the time, was recognized by James Armor at Macrihanish, Scotland. “By chance,” since it was not an intended transmission to Macrihanish: Adam Stein was telling the operator at Plymouth, MA, how to tune his station antenna connected to an HF alternator.

In conclusion, with regard to O’Neil’s reference that an avid wireless listener, Francis Hart, at the time of the broadcast did not log hearing the broadcast, one can question whether Hart

was listening at the time of the broadcast, on the right frequency of the broadcast, and what kind of a detector Hart was using. Certainly, there were observers and wireless listeners who claimed that the broadcast was made. Dave Riley’s old friend Harold Mansfield, Plymouth, MA, was a boy in 1906, who continually “haunted” the transmitter site. Harold vouched for the broadcast. He was a tireless radio history collector and junk radio dealer. Arthur Donovan, WIHM, claimed – according to Riley (private communications with Arthur in the early 1950s) – to have copied the broadcast, and other traffic from the Brant Rock station, BO. However, Harold and Arthur are no longer with us.

In a paper by Quinby [14], we can read in his text and his Acknowledgement that he was particularly grateful to Helen Fessenden. In her biography of her husband, she revealed an astonishing familiarity with his work and his struggles as well as the early development of radio in general, as set forth in *Fessenden, Builder of Tomorrows* (Coward-McCann, Inc., New York, 1940). In 1932, the year Reginald wrote his referenced January 29, 1932, letter, Reginald had heart problems, but he was mentally active. Helen observed the broadcast. Reginald died on July 22, 1932. Helen was still alive when Quinby did the research for the two-part article he wrote. I do not know whether Quinby corresponded directly with Helen, but he certainly believed what Helen wrote: that the broadcast was made.

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Introducing the Author



John S. (Jack) Belrose was born in Warner, Alberta, in 1926. He received his BSc and MSc in Electrical Engi-

neering from the University of British Columbia in 1950 and 1952. He joined the Radio Propagation Laboratory of the Defence Research Board, Ottawa, ON, in September 1951. In 1953, he was awarded an Athlone Fellowship, was accepted by St. John's College, Cambridge, England, and by Cambridge University, as a PhD candidate to study with the late Mr. J. A. Ratcliffe, then Head of the Radio Group, Cavendish Laboratories. He received his PhD from the University of Cambridge (PhD Cantab) in Radio Physics in 1958. From 1957 to 1998, he was a Research Scientist with the Communications Research Centre, Canada (formerly Defence Research Telecommunications Establishment). When he retired, he was Director of the Radio Sciences Branch. Presently, in honor of a more than fifty-year career in radio science, he has the status of an Emeritus Researcher at CRCC.

He was Deputy Chair and then Chair of AGARD (Advisory Group for Aerospace Research and Development) Electromagnetic Propagation Panel from 1979-1983. He was a Special Rapporteur for the ITU-Radiocommunications Study Group 3 concerned with LF and VLF propagation, and in this capacity authored two major reports concerned with propagation in these frequency bands. He is Technical Advisor to the American Radio Relay League, Newington, CT (since 1981) in the areas of radio-communications technology, antennas, and propagation. He is a Fellow and currently a Member of the Board of Directors of the Radio Club of America; a Life Member of the Antique Wireless Association and the Quarter Century Wireless Association; and a Life Senior Member of the IEEE. He has been a licensed radio amateur since 1947, advanced certificate dated February 26, 1949 (present call signs VE2CV, VE3CVV). At the 98th annual meeting of the Radio Club of America, November, 2007, Jack was awarded the Armstrong Medal for important contributions to radio art and science. In 2011, he was appointed to the Canadian Amateur Radio Hall of Fame. He is author or coauthor of over 150 papers, articles, and technical correspondence letters written relevant to the fields of radio communications, radio science, antennas and propagation, and the history of wireless. He is currently Technical Editor, *Proceedings of The Radio Club of America*. 