

From: Susan Burgess
Sent: Thursday, June 28, 2007 8:59 AM
To: 'tom@cw.com'
Subject: FW: importance of vacuum tube to wireless between 1910-1914

Tom,

I've added new information to this and made a correction, which I've colored in red for you to find easily.

Let me know if you have any other questions,
Susan

From: Susan Burgess
Sent: Wednesday, June 27, 2007 1:47 PM
To: Clay T. Whitehead
Subject: importance of vacuum tube to wireless between 1910-1914

Tom,

You asked me if the vacuum tube was important as a device for receiving voice prior to WWI. If not, you'd like to know how the vacuum tube was important to wireless telegraphy before 1914. You said that you're not interested in the period when AT&T bought most of the rights to the vacuum tube and used it in transcontinental telephone (which took place in 1913 / 1914).

The short answer is that important vacuum tube development work was still occurring between 1910 - 1914 so its impact on wireless telegraphy hadn't really happened. Here is a timeline of events between the audion's manufacture (1906) and AT&T's purchase of significant licenses to it (1913-14):

* In October 1906, De Forest announced the invention of a new receiver, the audion. Susan Douglas, *Inventing American Broadcasting at 169*. De Forest's audion was remarkably similar to a device John Ambrose Fleming had created – an oscillation valve, or the Fleming valve – until De Forest added a third element – a tiny grid with bars of fine wire supported by a separate connecting wire and fused through the glass of the bulb. This grid amplified the signal enormously, distinguishing the audion from the Fleming valve, which could receive the human voice, but not amplify or oscillate. *Id.* at 170. De Forest invented this grid audion in late autumn 1906 – the exact date is unknown. He filed the patent for it January 29, 1907 and publicly introduced it March 14, 1907. *Id.*

* The grid audion, though sophisticated, did not come into general use due to its significant practical drawbacks – the filaments burned out much too quickly, it “would not hold its adjustment very long and would glow at times and block the signal.” “It was too mysterious and uncertain a device. No two bulbs were alike, their life short, and they would block with blue haze.” The early audions were also very expensive. *Id.* at 170-71.

* No important development work was done on the audion (later to be known as the vacuum tube) between 1906 and 1909. Hugh Aitken, *The Continuous Wave* at 225.

* De Forest was too distracted by personal affairs to develop the audion further between 1906-09. *Id.* at 224.

* The vacuum tube's true potential wasn't discovered until 1911-12. *Id.* at 224.

* In 1912, Fritz Lowenstein and John Hays Hammond, Jr. created a vacuum tube amplifier that would enable radio guidance of boats and torpedoes. *Id.* at 229.

* By 1910, Telefunken had developed a tube that operated by ionization of rarefied gas like de Forest's audion that worked as a telephone amplifier. *Id.* at 230.

* By 1913, GE Research Lab had developed a successful vacuum tube amplifier, realizing that a tube with a high vacuum

was more sensitive than the de Forest audion. Id. at 231. Ernst Alexanderson was beginning to speculate about using the vacuum tube in transmitters. Id.

* In July and August 1912, de Forest designed a vacuum tube amplifier that he later pitched to AT&T. Id. at 236-38.

* **In later litigation**, De Forest claimed that he knew **in October 1912** that his amplifier could generate continuous waves - i.e., create radio frequencies. Id. at 239-41. (Apparently there was significant dispute over which inventor first recognized the audion's potential as a radiofrequency oscillator.)

* In 1913-14, AT&T acquires from de Forest many significant licenses to the audion. Id. at 246.

Let me know if you have further questions,
Susan