Herbert Metcalf and the Magnavox Type A Tube

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In the early 1920s it became evident that radio broadcasting was becoming an important feature of American life, and companies large and small began producing radios to meet the growing demand. In some cases the companies became major manufacturers with familiar brand names. At the other extreme, there were firms that eventually filed for bankruptcy or simply closed their doors. But The Magnavox Company followed a unique path.

Magnavox was established as a manufacturer of loudspeakers, public address systems, and other electrical products before the advent of broadcasting. As such, it had some of the necessary facilities for radio manufacturing, engineers familiar with radio-related products, and the expectation of being able to produce innovative designs using major components of their own invention. However, after producing radios for a short period in the mid 1920s, the firm left that field entirely for several years. Yet it remained a major corporation until becoming a part of North American Philips in 1981.

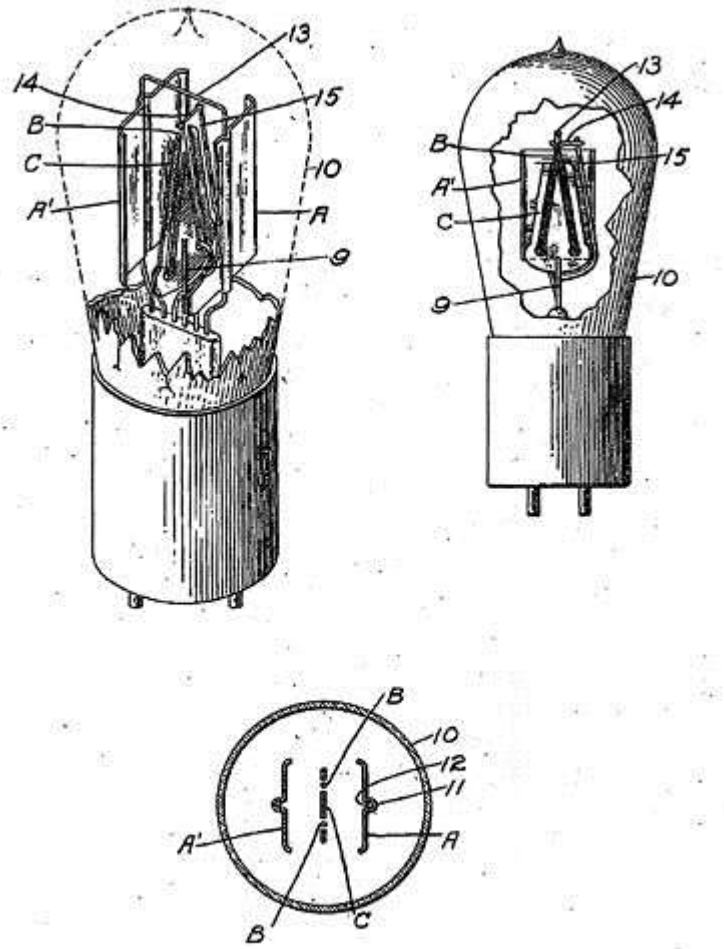

Fig. 1. Illustrations from Metcalf patent of July 23, 1924. See text for details.

When originally entering the radio field, Magnavox had a special interest in producing a new type of vacuum tube. This was at a time when the Radio Corporation of America controlled the deForest triode patent, which had not yet expired. The all-important feature of deForest's "Audion"

was the placement of the control grid between the filament and the plate.

In efforts to circumvent the deForest patent, several inventors had demonstrated tubes with a controlling element at other locations, but none of these had been successfully produced and marketed. Nevertheless, an inventive Magnavox engineer named Herbert E. Metcalf had come up with an alternative that looked promising. When Magnavox decided to produce radios, it also committed to the development and manufacture of Metcalf's invention.

Originally, Metcalf avoided positioning the controlling element between the filament and the plate. In fact, his first vacuum tube patent (in the order of the filing date) disclosed several configurations featuring the control element close to the filament, but not in a direct path of the electron flow to the plate [1]. Important objectives were high sensitivity and low control element-to-plate capacitance, the latter being a desirable feature for radio frequency amplification.

The patent, filed on February 28, 1924, may have been primarily intended for broad coverage protection against competition, because his next filing, just a few months later in July, was much more specific. The control element (Figure 1) was a metal sheet ("C" in all views) located in the same plane as a hairpin-style filament ("B" in all views) and slotted to accommodate it.

With this arrangement, the electrostatic field produced by a negative charge on the electrode strongly affects the paths of electrons leaving the filament, providing the necessary control of their flow to the plate. Figure 1 also shows the structure that positions the control electrode and the filament. The latter, lying within the slotted control electrode, is held at the top by arm 14 projecting from supporting member 15. The plate ("A") is in two physically separate pieces, one on each side of the filament-control-electrode assembly.

All of this resulted in an arrangement that the Magnavox Company believed would free it from the problems and costs of negotiating an RCA license to manufacture a de Forest type triode. The claims outlined in the patent stressed high sensitivity, a high amplification factor, the elimination of microphonics, and other advantages. (Microphonic response to shock or vibration was often present with triodes of that period.)

Metcalf commented that the construction was easy to manufacture, and mentioned that the spacing between the edges of the control electrode and the filament be "as close as consistent with commercial production." But from a following patent filed Jan. 21, 1925 [3] it is evident that he had encountered some problems.

The straight-edged control electrode was now modified because, with the earlier planar configuration, the narrow but intense electrostatic field between the control electrode and the filament "acted to choke off the flow of electrons from the filament to the anode." Difficulty in aligning the control electrode and the filament wire was also mentioned, which is understandable considering the close tolerances required by the small separation between the two elements.

Metcalf addressed these problems by serrating the edges of the control electrode, with the resulting teeth projecting alternately on each side of the filament wire. He described how to form electrodes of this type by stamping them out in a single operation, stating that the process was considerably less expensive than

constructing a conventional grid.

Further production problems were revealed in the disclosures of still another patent filed by Metcalf and an associate in March of 1925 [4]. Regardless of earlier claims about low microphonic noise characteristics, they had found that "while noises appearing in the output circuit of the device are small, nevertheless when the device is used as a detector of electric waves and the output amplified, the noises are objectionable." This condition was said to have been eliminated by making certain structural changes that also provided a rigid alignment of the control electrode and filament during assembly and thereafter.

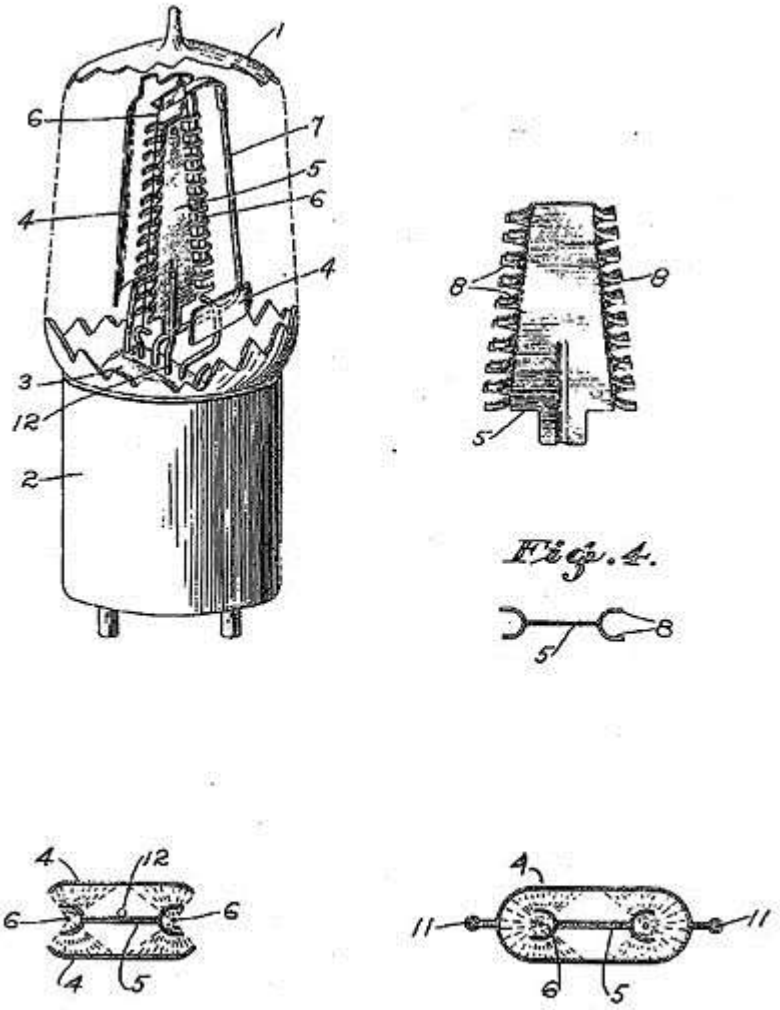

Fig 2. Illustrations from Metcalf's second patent of March, 1925 show control element partially in path of electron flow.

Another patent filed on the same date [5] provided details of the redesigned tube structure. Figure 2, showing illustrations from the latter patent, shows a view of the assembled tube and some of its components, including alternatives for plate structure. In particular, the control electrode teeth, 8, are still supported by sheet metal, 5, but now they are partially in the path of electron flow from the filament, 6, to the plate, 4.

It could be argued that there was now at least some conventional grid effect present, but fortunately for Metcalf and for Magnavox the deForest Patent had expired in February of that year, so infringement was no longer a consideration. Note the distinctive shape of the glass envelope (identified as "1" in Fig. 2). This appeared in the production version, making the Type A tube identifiable on sight.

Metcalf was probably confident about the performance of the new tube at this point, because an article by him appeared in the March 1925 issue of *QST* [6]. According to an accompanying Editor's note, Metcalf was by then in charge of

research and development in the Vacuum Tube Division. The article gave details of the tube structure, with photographs of components before and after partial assembly.

Average data for the Magnavox tube were compared with an average for other storage battery tubes, and showed a control-to-plate capacitance of less than 50% of the grid-to-plate capacitance of the latter type. (This very likely was the much-used '201A of the period.) The Type A was recommended for RF and AF amplifiers, detector, and oscillator applications. Metcalf wrote that it gave "a beautiful clarity of reproduction" for audio frequency circuits.

A partial assembly photograph, including the control electrode, that appeared in the QST article, matches the electrode in the patent application of January, 1925. However, it does not match the improved control in the March application of Fig. 2. Of course, the improvements could have been made at any time during the production run.

According to Stokes [7] advertising first appeared as early as October of 1924 and continued until the end of 1926--beginning prior to the article and patent applications of March 1925 and continuing well afterwards. There are questions about how many improved tubes may have actually reached the marketplace, and if they did, whether some later complaints about the tube were based solely upon the earliest version. Advertisements for Magnavox radios appeared in various publications and some of these included the Type A tube.

Historian Alan Douglas reproduced examples in his three-volume work covering radio manufacturers of the 1920's [8]. The first tube advertisement may have been the one that appeared in the September 1924 issue of QST [9] with some technical details and enthusiastic claims. The photography with flattering commentary in Magnavox ads was no different from that in the ads of most other companies during that intensely competitive period.

Of course there was no hint of the problems that the company was experiencing at the same time. According to Douglas [8] the unconventional design of the Type A tube "was prone to shorts and misalignment," and production and distribution to retailers of Magnavox products led to large and unexpected expenses. Some of these problems were recalled years later by Edwin S. Pridham, one of the founders of the Magnavox Company.

Regarding the tube situation, Douglas quoted him as saying that the tube factory was found to be unable to produce tubes that lasted for more than five hours of continuous operation before failure. At some point after the expiration of the de Forest patent, tube production was shifted to conventional types. Also, great efforts were made to solve the problems associated with manufacturing and distributing receivers.

Nevertheless, in mid 1927 Magnavox stopped production and abandoned its line of radios and tubes altogether, concentrating on its more successful products. It was not until the mid 1930's that the company returned to the broadcast radio market with a selection of high quality radio-phonographs [7, 10].

References

1. Metcalf, Herbert E., Vacuum Tube. Patent 1,626,858, filed Feb. 28, 1924; issued May 3, 1927.
2. Metcalf, Herbert E., Vacuum Tube. Patent 1,646,626, filed Jul. 23, 1924; issued Oct. 25, 1927.
3. Metcalf, Herbert E., Vacuum Tube. Patent 1,655,619. filed Jan. 21, 1925; issued Jan. 10, 1928.
4. Metcalf, Herbert E., and Valentine Ford Graves, Vacuum Tube. Patent 1,657,221, filed Mar. 23, 1925; issued Jan. 24, 1928.5. Metcalf, Herbert E., Vacuum Tube. Patent 1,558,111, filed Mar. 23, 1925; issued Oct.20, 1925.
5. Metcalf, Herbert E., Vacuum Tube. Patent 1,558,111, filed Mar. 23, 1925; issued Oct.20, 1925.
6. Metcalf, Herbert E., "The New Magnavox Tube." *QST*, March, 1925, p. 24.
7. Stokes, John W., 7*0 Years of Radio Tubes and Valves*, p32. The Vestal Press, Ltd., Vestal, N.Y., 1982.
8. Douglas, Alan, *Radio Manufacturers of the 1920s*, Vol.2, p.133. The Vestal Press, Ltd., Vestal, N.Y., 1989.
9. Advertisement in QST, Sep., 1924, p.67.
10. Eckland, John, "The Magnavox Company," *Antique Radio Classified*, Vol. 24, Sept., 2007, p.l0.