The New Magnavox Tube

By Herbert E. Metcalf*

MODERN radio reception has changed radically in several ways in the last few years. First, in the almost universal use of radio frequency amplification for broadcast reception; and second, in the adoption of low-wave transmission and reception for amateur traffic, more particularly in continuous waves.

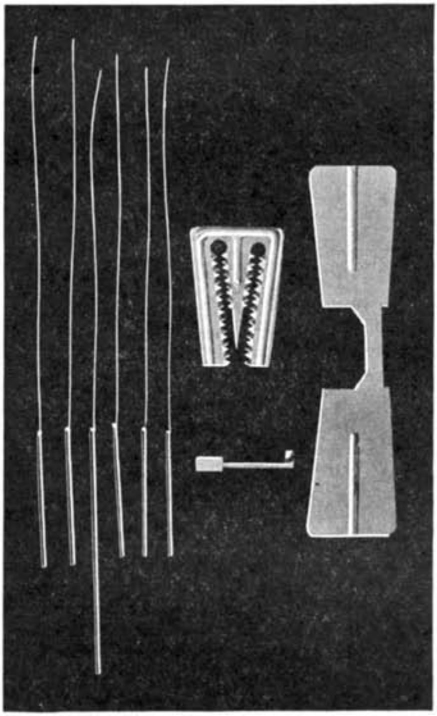

FIG. 1. METALLIC ELEMENTS USED IN TYPE A TUBES.

The vacuum tube I am about to describe was developed with the idea of meeting the needs of both these changes. The secret of efficiency in radio-frequency amplifications, oscillation and detection in the wave band of from 20 to 600 meters, lies in making a vacuum tube having a low internal capacity and yet being able to handle a fair amount of power.

Magnavox Type A Tubes are a radical departure from standard tube practice and have a low inter-element capacity without loss of other essential characteristics.

Referring to Figure 1, it will be seen that not counting the lead wires and filament, only three metal parts are involved—control electrode, anode and filament spring. These parts are all die stamped and are therefore, always alike. The control electrode is formed of a single piece of metal, slotted to receive the filament. This slot is provided on its edges with teeth, the teeth being bent laterally, away from the plane of the filament. This lateral bending not only gives increased electron control, but also widens the control field and makes it possible to secure uniformity in tube characteristics despite slight mechanical variations in manufacture. The writer has found that such teeth or serrations are necessary in order to obtain proper control action. The teeth alone control the electron stream and the remainder of the control electrode acts simply as a support for the teeth. By varying the number, size, shape and position of the teeth, tubes can be made to duplicate the characteristics of standard grid tubes, in much the same way as the number of grid wires control the characteristics of the grid tube.

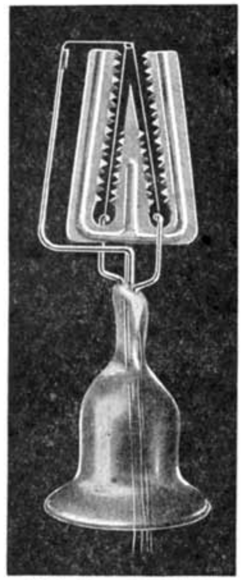

FIG. 2. PARTIAL ASSEMBLY SHOWING CONTROL ELECTRODE AND FILAMENT RELATION.

After the control electrode is mounted the filament is placed within the slot as shown in Figure 2, the anodes are placed in position. The complete assembly is shown in Figure 3. It is to be noticed that the anodes are not parallel to the plane of the filament but are spread slightly at the bottom. The tube is then sealed and pumped by a new method which removes all undesirable gasses in about 80 seconds. The finished tube is shown in Figure 4, which also shows the method of insulating the prongs in the base.

Electrical Characteristics

The audio frequency characteristics of Type A tubes are practically identical with those of the Radio Corporation, Cunning-

* In charge of Research and Development, Vacuum Tube Division of the Magnavox Company, Oakland, California.

ham, or DeForest Storage Battery Tubes, with the exception that the output impedance is slightly lower, with consequent greater mutual conductance. The characteristic curve of the tube is practically a straight line which gives wonderful tone quality when used in broadcast reception. The filament of special "no-boil-off" material burns dully at 900° with a current consumption of .22 to .23 amperes. Plate current is 2.5 to 3.5 milliamperes under load. Total filament emission with control electrode and plate tied together is from 40 to 50 milliamperes at 90 volts. The tube is designed so that 120 volts may be used on the plates if desired.

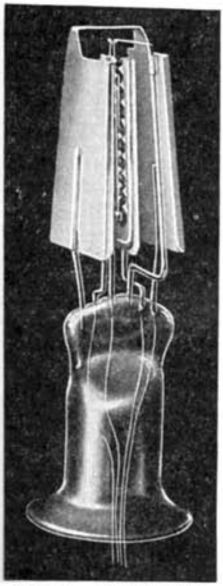

FIG. 3. COMPLETE INTERNAL ASSEMBLY WITH PLATES IN PLACE.

Inter-element Capacity

For comparative figures a number of Type A tubes and a number of standard storage battery tubes were measured on a General Radio Precision Capacity Bridge, and the averages are given in the following table:

	Control Electrode to Filament μμfds.	Plate to Filament μμfds.	Control to Plate (Fil. Free) μμfds.	Control to plate (Fil. Gndd) μμfds.
Average Type "A" Tubes	5.0	5.0	5.0	2.4
Average Other Tubes	6.5	6.0	11.2	5.5

Thus it is seen that the highest internal capacity is not over 5 μμfds. and that the filament-grounded control-electrode-to-plate capacity is only 2.4 μμfds. and less than half that of standard tubes. There are two reasons for this low capacity. The control electrode is composed of just one flat piece of metal instead of a cylindrical grid. This alone reduces the control-electrode-plate capacity greatly. The other factor lies in the greater plate spacing employed in the Type A tube. The fact that electrons are free to pass to the anodes without obstruction, allows greater spacing for the same impedance. In practice I have found that the same impedance can be obtained with about double the spacing of the ordinary grid tube. The writer is now working on elimination of capacity to a still greater extent by reducing the actual amount of metal to practically the teeth only. This should bring the internal capacity of the tube to very close the capacity of the leading-in wires.

This low internal capacity makes Type A tubes hard to oscillate in tuned plate circuits. This means that tuned R. F. amplifiers are practically self-neutralizing when Type A tubes are used. When using electromagnetic feedback, however, they become highly oscillatory and oscillate freely and steadily for C. W. reception down as low as 20 meters without the least trouble. I am inclined to believe that tubes used without the base can be made to oscillate at lower wavelengths, but no experiments have yet been made to determine the extreme bottom range.

In conclusion, I will say that Type A tubes in audio frequency circuits give a beautiful clarity of reproduction. Careful

FIG. 4. COMPLETED TUBE AND VIEW OF BASE SHOWING BAKELITE INSULATION.

experiments have indicated that Type A tubes will operate with maximum efficiency as follows:

1. Detector using control-potential control-current characteristics for rectification.
2. Detector using control-potential plate-current characteristics for rectification.
3. Radio frequency amplifier at low wave lengths.
4. Intermediate frequency amplifier.
5. Oscillator both low and high wave lengths.