

Nov. 13, 1934.

E. L. KOCH

1,980,804

THERMIONIC TUBE

Filed March 21, 1931

4 Sheets-Sheet 1

Fig. 1

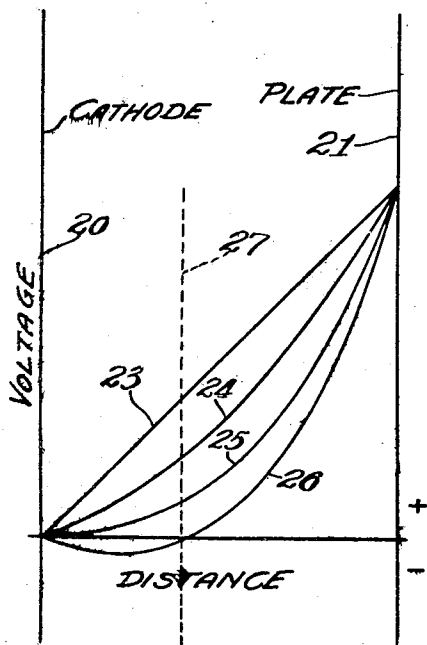


Fig. 2

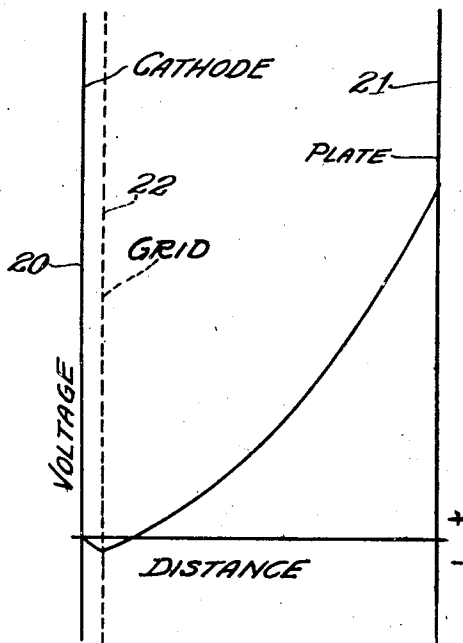


Fig. 3

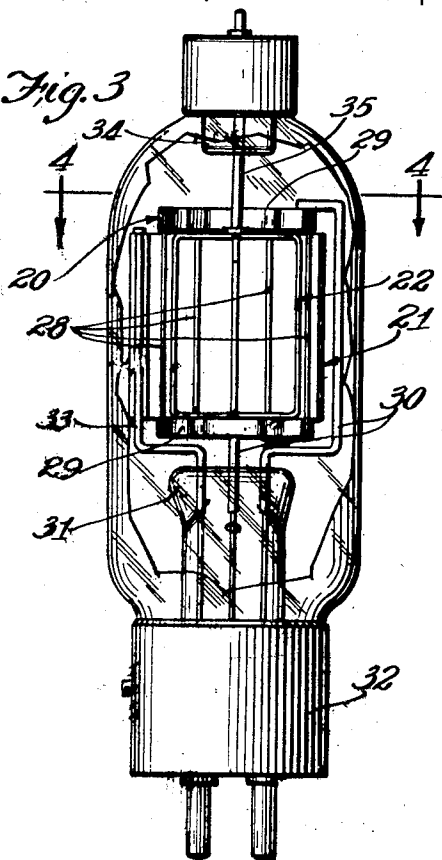
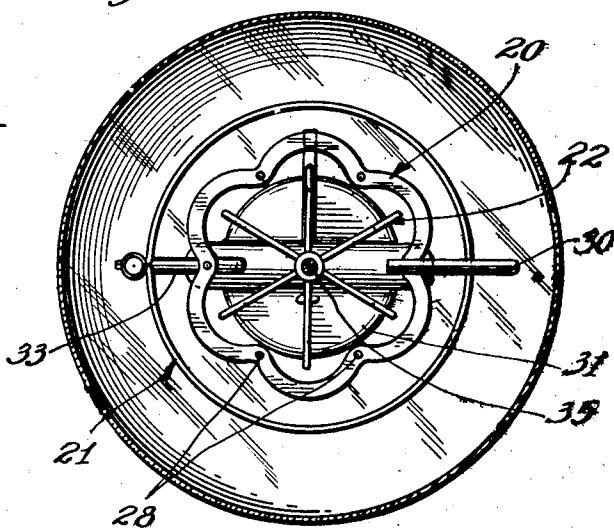


Fig. 4



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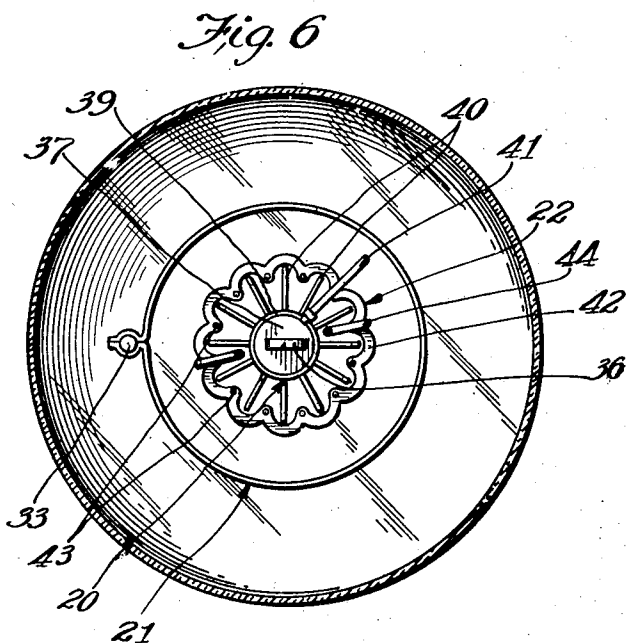
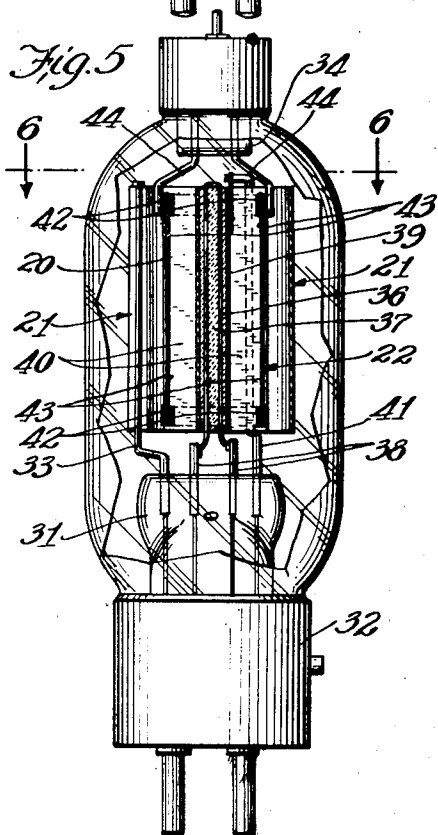
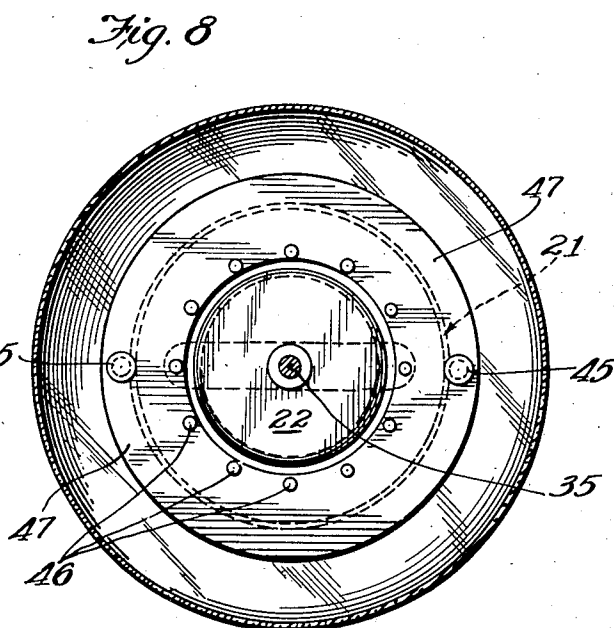
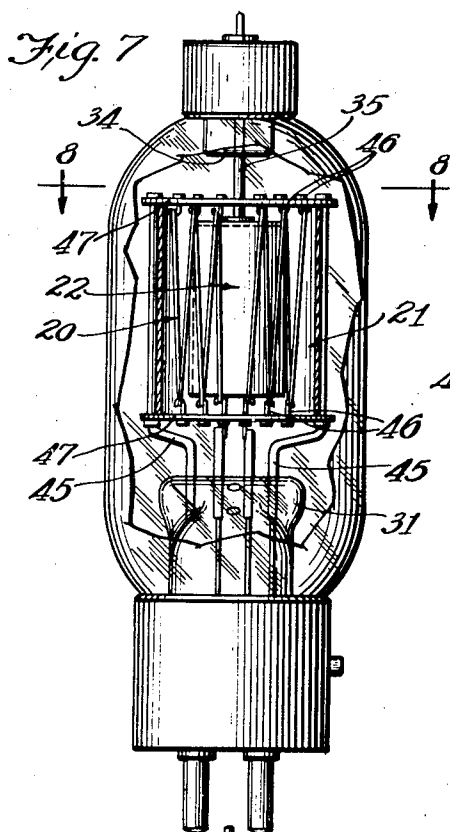
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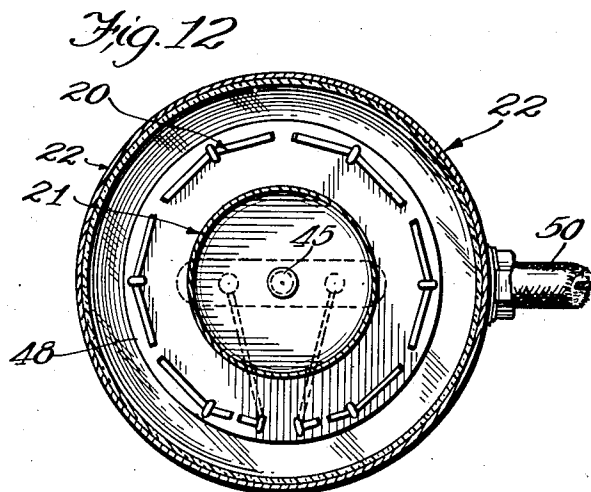
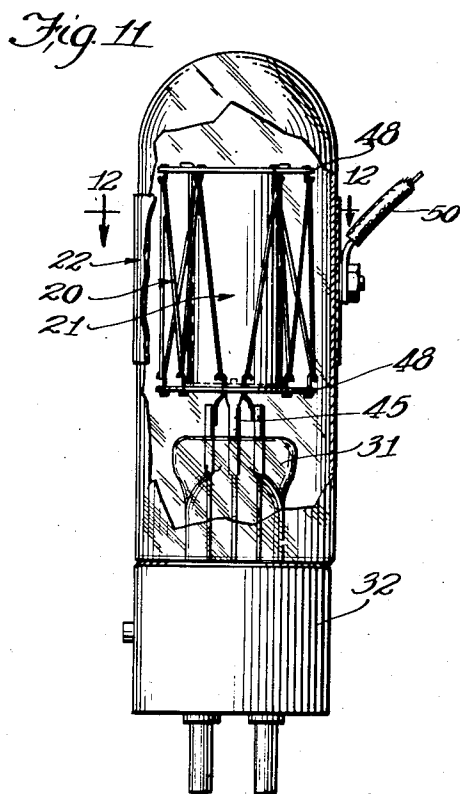
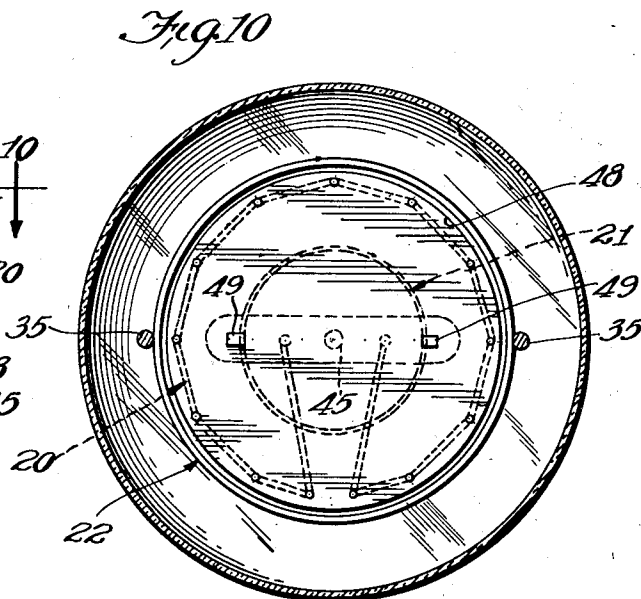
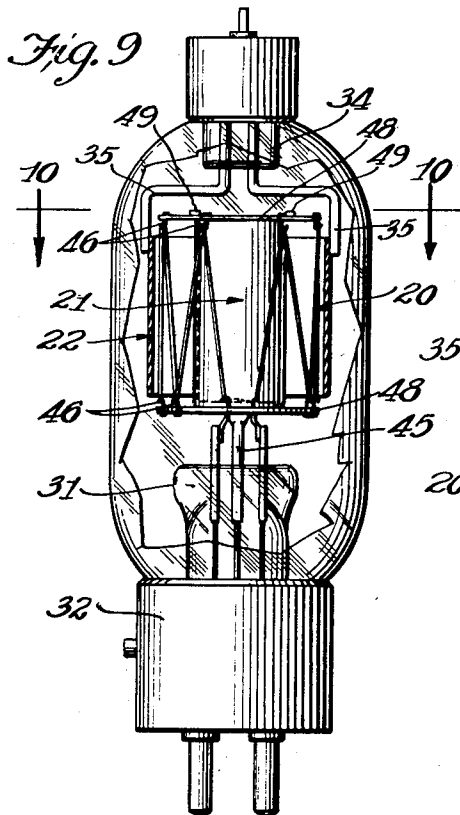
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THERMIONIC TUBE

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4 Sheets-Sheet 3



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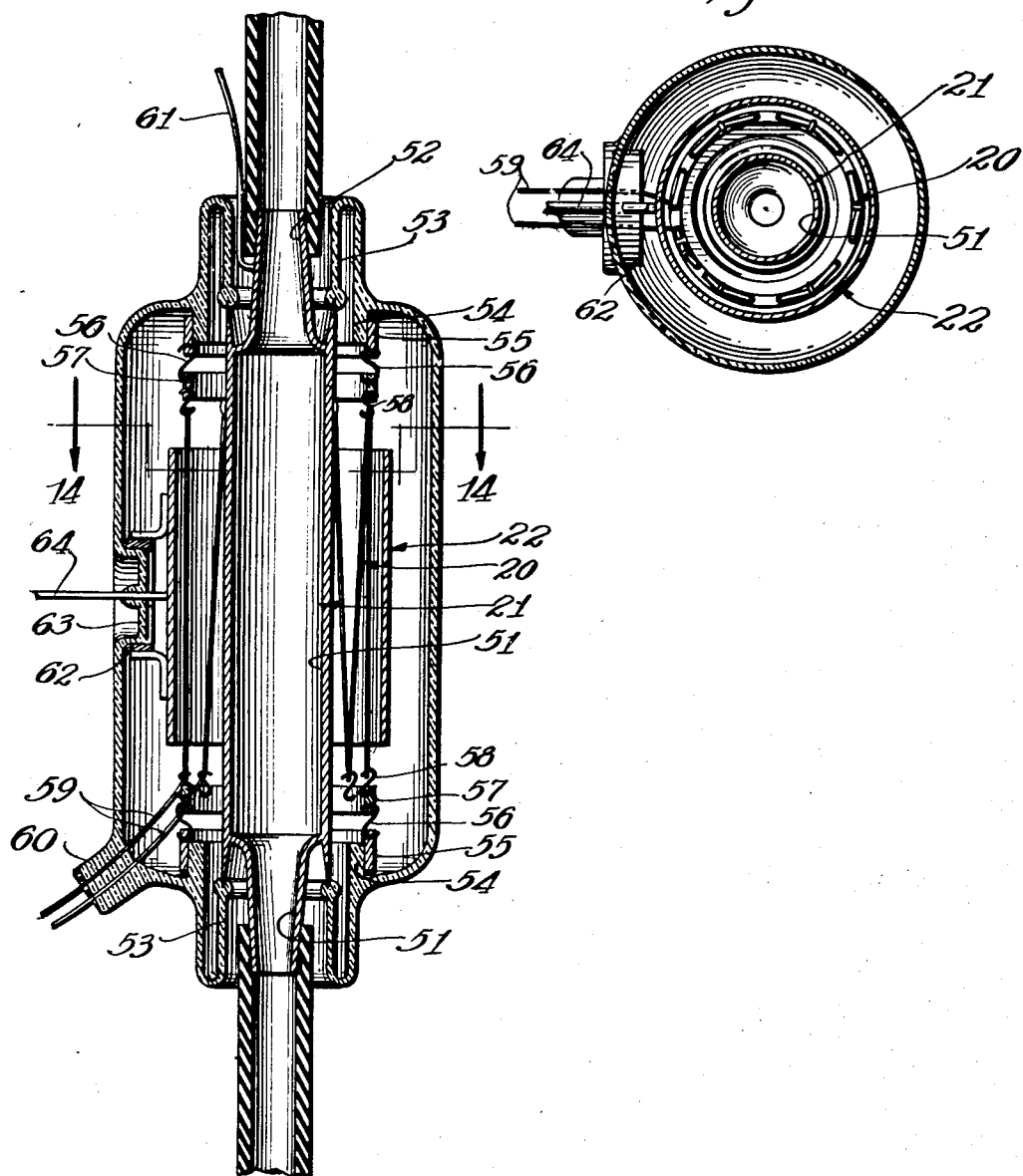
THERMIONIC TUBE

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Fig. 13

Fig. 14



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UNITED STATES PATENT OFFICE

1,980,804

THERMIONIC TUBE

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Application March 21, 1931, Serial No. 524,254

2 Claims. (Cl. 250—27.5).

This invention relates to thermionic tubes, and particularly to such tubes which are employed in radio or wireless telegraphy and telephony.

Thermionic tubes of the three element type, including a cathode, an anode and a grid, are open to serious objection, particularly with respect to capacity effects between the grid and plate. This objection is more pronounced with high frequency oscillations, for example when the tube is used for radio amplification.

One of the principal objects of the invention is to provide a thermionic tube in which this objection is obviated without the introduction of additional elements or circuits.

Other objects and advantages will appear from the following description taken in conjunction with the accompanying drawings, in which

Figure 1 is a diagrammatic view showing the voltage gradient between a cathode and a plate when the cathode is heated to various degrees.

Fig. 2 is a similar view illustrating diagrammatically one form of the present invention.

Fig. 3 is an elevational view of one embodiment of the invention.

Fig. 4 is an enlarged sectional view thereof on the line 4—4 of Fig. 3.

Figs. 5 and 6 are similar views of a further embodiment of the invention.

Figs. 7 and 8 are similar views of a still further embodiment of the invention.

Figs. 9 and 10 are similar views of still another embodiment of my invention.

Figs. 11 and 12 are similar views of another embodiment of my invention; and

Figs. 13 and 14 are similar views of a further embodiment of my invention.

Referring to the drawings, the cathode is designated 20, the plate 21, and the grid 22, in all views.

Fig. 1 illustrates graphically the voltage relation between the cathode and the plate of a thermionic tube at various cathode temperatures. The oblique straight line 23 between the points cathode and plate corresponds to an unheated cathode which is not emitting electrons. The curves 24, 25 and 26 correspond to increasing cathode temperatures, the cathode progressively emitting electrons at a greater rate. The progressively increasing deviation of these curves from the straight line 23 graphically illustrates the so-called space charge effect. This effect results from the presence of innumerable electrons between the cathode and the plate, the concentration of such electrons being greater closer to the cathode. It will be seen from the curve 25 that

there is no voltage gradient adjacent the cathode at the cathode temperature corresponding to this curve, which is substantially horizontal adjacent the cathode. The curve 26 corresponds to operating conditions of the tube, and it is to be noticed that the concentration of electrons adjacent the cathode is sufficient to produce a zone within a surface around, and in spaced relation to the cathode, which is diagrammatically indicated by the line 27, in which zone there is an actual negative voltage. For convenience I hereinafter refer to the zone within the surface 27 as the virtual cathode region.

According to the present invention the grid is located near or within the cathode structure which may be cylindrical, such as the zig-zag filament 20 of Figure 7, the grid being located within this filament structure as shown at 22, Figure 7. This separates the grid from the plate (for example Plate 21, Figure 7) under operating conditions by a cloud of electrons to substantially reduce or nullify the capacity effect between the grid and plate. The grid 22 is preferably located within the virtual cathode region as defined above. In this relation the grid is enveloped in a cloud or atmosphere of electrons and the normal capacity between it and the plate, that is, the capacity which exists when the tube is cold, is effectively reduced or nullified when the tube is operated.

In Fig. 2 I have illustrated graphically a construction in which the grid 22 is located very close to the cathode 20 so that it is well within the virtual cathode region as shown by the voltage curve. This manner of construction calls for very careful manufacturing methods, and accordingly I have evolved more easily constructed devices embodying the invention.

In Figs. 3 and 4 I have shown a thermionic tube comprising a cathode consisting of a plurality of parallel filaments 28, which extend between two rings 29. The two rings 29 are supported by pillars 30 which extend through the lower press 31 and may be connected in the usual way to prongs provided in the base 32. The plate 21 surrounds the filament and may be supported by the pillar 33 which also extends through the lower press 31. The grid 22 may suitably consist of a cage-like structure formed from a suitable number of rectangular loops of wire which are relatively orientated as shown in Fig. 4, and are welded together at axial points where they cross one another. The grid is supported from the top press 34 by means of a conducting pillar 35. The longitudinal lengths

of the grid structure and the parallel filaments 28 are so arranged that they lie substantially on the surface of a cylinder. The rings 29 are corrugated as shown in Fig. 4 so as to permit the tube elements to be assembled without difficulty. As shown in Fig. 3 it is preferred to extend the rings 29 above and below the plate and grid so as to prevent or minimize capacity effects between the ends of the plate and grid.

In Figs. 5 and 6, I show a modification in which the invention is embodied in a heater type of tube. The heating filament 36 passes through longitudinal openings in a rod 37 of refractory material, said filament being connected to leads 38. The cathode comprises a cylinder of conducting material 39 provided with radially projecting fins 40. A post 41 which passes through the lower press 31 supports the cathode and provides a conducting lead therefor. The plate 21 is supported by a pillar 33 as in the modification above described. The grid 22 comprises rings 42 which are connected by wires 43 to provide a rigid structure. This structure is supported by pillars 44 which pass through the upper press 34, one of which provides an electrical connection for the grid. As shown in Fig. 6 the ring 42 is corrugated and the wires 43 are so located that they are positioned between adjacent fins 40 when the tube is assembled. It will readily be understood that in this way the grid structure is located within the virtual cathode region as described above.

In Figs. 7 and 8 I show a modification in which the grid 22 is located within the filament structure. In this case the grid 22 may suitably be in the form of a cylinder having its upper end closed. This cylinder is supported by a conducting support 35 which extends through the upper press 34. I provide two pillars 45 which are mounted in the lower press 31, for supporting the plate 21, one of the pillars providing the electric connection therefor. The cathode 20 may suitably be in the form of a zigzag filament which is strung in zigzag manner upon hooks 46 mounted upon spaced rings 47 of mica or other suitable insulating material. The rings 47 may abut upon the opposite ends of the plate 21, and may be held in assembled relation by crimping adjacent portions of the pillars 45 which extend through said rings 47. The ends of the filament 20 are connected to leads which pass through the bottom press 31.

In the modification shown in Figs. 9 and 10, the relative positions of the plate and grid are reversed, that is, the grid 22 is arranged outside the filament structure, and the plate 21 is arranged inside the filament structure. In this modification the plate may consist of a cylinder which is closed at the bottom and is supported from the lower press 31 by a central pillar 45. A disk 48 of mica or other suitable insulating material abuts against the underside of the cylinder and is held against same by crimping the pillar 45. A similar disk 48 is secured to the upper end of the cylinder 21, for example by means of lugs 49 carried to the upper end of the cylinder and projecting through suitable openings in the upper disk 48. The disks 48 carry hooks 46 adjacent their peripheries and the cathode 20 in the form of a zigzag filament is strung upon these hooks. The grid 22 is in the form of a relatively large cylinder arranged on the outside of the filament structure, and supported from the upper press 34 by means of two pillars 35.

In the modification shown in Figs. 11 and 12, the plate and filament structure is the same as that shown in Figs. 9 and 10. The grid, however, is located outside the glass tube and is provided with an outer lead 50. It will readily be understood that the grid is consequently insulated from the stream of electrons which it controls.

The modification shown in Figs. 13 and 14 is generally similar to that shown in Figs. 9 and 10, the plate 21 being located within the filament structure and the grid 22 being located around the outside of said structure. In this embodiment the plate 21 is in the form of a metal tube 51, preferably copper, which is provided internally near its ends with nipples 52 whereby hoses for cooling water may be connected thereto. The ends of the tube 51 are tapered to a sharp edge which is sealed into inwardly directed necks 53 of the glass body of the tube. Adjacent and around each end of the tube 51 the glass body is provided with an inwardly extending collar 54 upon which is secured in known manner metal bands 55. The bands 55 extend inwardly beyond the collar 54 and are provided with openings whereby a series of hooks 56 may be mounted. The hooks 56 support rings 57 of glass or other suitable insulating material, and the rings 57 provide supports for circumferential series of hooks 58 upon which the cathode 20, in the form of a zigzag filament, is strung. The grid 22 which is in the form of a relatively short cylinder is located around the cathode and is supported by means of a metal collar 62 upon a boss 63 formed in the side of the glass body of the tube. A conductor 64 extending through the boss 63 provides a lead for the grid 22. Leads 59 of the cathode may suitably extend through the press 60 provided at a suitable position on the glass body of the tube. A conductor 61 which is welded to one of the nipples 52 of the tube 51 provides a plate connection. It will readily be understood that this construction provides a thermionic tube of the water-cooled type which embodies characteristic features of my invention.

It is, of course, to be understood that the cathode and plate and optionally the grid, are enclosed in an evacuated vessel which may suitably be wholly or partly of glass.

Although the invention has been disclosed in connection with the specific details of preferred embodiments thereof, it must be understood that such details are not intended to be limitative of the invention except insofar as set forth in the accompanying claims.

What I claim as new and desire to secure by Letters Patent is:

1. A thermionic valve comprising a filament, a grid, said filament and said grid comprising a plurality of straight lengths of material alternately disposed relative to each other and forming a cage, and an anode of cylindrical form disposed parallel to said straight lengths of material and equi-distant therefrom.

2. A thermionic valve comprising a filament, a grid, said filament and said grid comprising a plurality of straight lengths of material alternately disposed relative to each other and forming a cage, and an anode of cylindrical form embracing said cage and disposed parallel to and equi-distant from said straight lengths of said filament and grid.

EARL L. KOCH.