May 25, 1937.

E. A. VEAZIE

2,081,415

ELECTRON EMITTER

Filed Sept. 5, 1934

FIG. 1

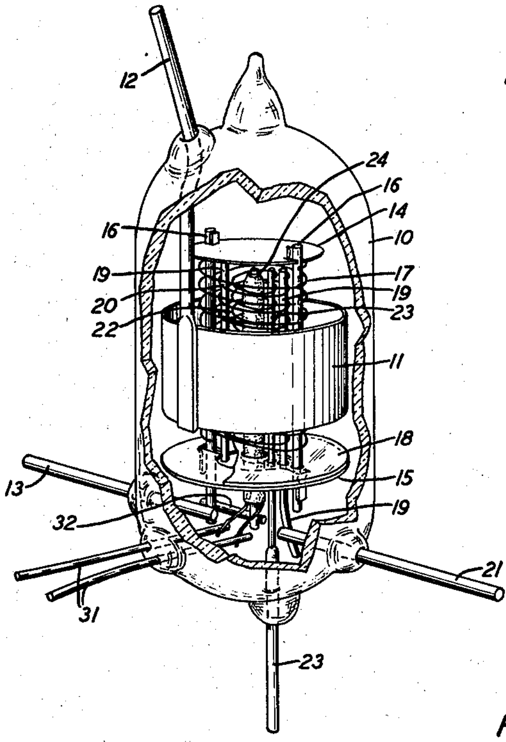


FIG. 3

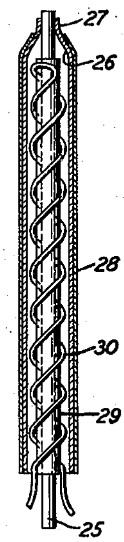


FIG. 4

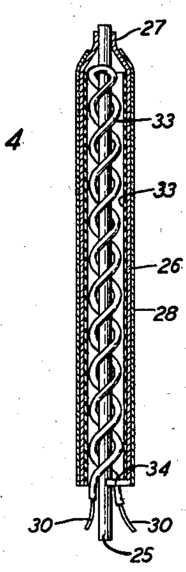
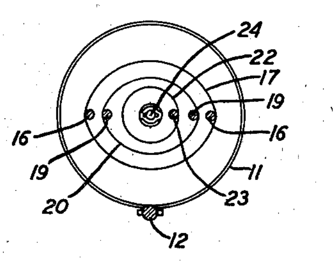


FIG. 2



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ELECTRON EMITTER

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2 Claims. (Cl. 250—27.5)

This invention relates to electron emitters and more particularly to heater type equipotential cathodes for electron discharge devices.

Heater type cathodes usually comprise, in general, a metallic member serving as the cathode element and having a coating of thermionic material upon a portion of one surface, and a heater element associated with the metallic member. Electrical connection is established with the metallic member through a conductor secured to one thereof.

It has been found that the conductor dissipates some of the heat so that the portion of the metallic member adjacent the point where the conductor is secured to the member is materially cooled. Hence, because of this cooling, if one entire surface of the member is coated with a thermionic material, non-uniform emission results. On the other hand, only a limited portion of the metallic member is heated to a substantially uniform temperature and if this portion alone is coated with thermionic material, a large cathode is necessary to obtain a desired high electron emission so that excessively high interelectrode capacities may result.

One object of this invention, therefore, is to heat all portions of the cathode element in heater type cathodes to a substantially uniform temperature whereby substantially uniform electron emission from all portions of the element is assured and a relatively small cathode size for a desired high emission and hence, low interelectrode capacities are obtained.

In one embodiment illustrative of this invention, a cathode comprises a metallic support or rod which is encompassed by a cylindrical metallic member having a thermionic coating, for example, alkaline earth metal oxides, upon its outer surface. The metallic member is suitably secured at one end to the support or rod so that the latter may serve as a leading-in conductor. A heater element, which may be a helical wire, is disposed within the metallic member and encompasses the support or rod. The wire may be insulated from the support or rod by a tubular insulator and may be coated with an insulating material to insulate it from the metallic member. The wire may be electrically separate from the support or rod and provided with leading-in conductors secured to its ends.

The heater wire heats not only the metallic member but also the support or rod so that cooling of the portions of the metallic member secured to the support or rod is prevented and a uniform heating of all portions of the metallic member is obtained. Hence, the entire outer surface of the metallic member may be coated with a thermionic material and uniform emission obtained, so that a relatively small cathode may be utilized for a desired electron emission. Because of the relatively small size of the cathode thus enabled, the interelectrode capacities of an electron discharge device in which the cathode may be embodied will be small. This factor is of particular importance in devices operated at ultra-high frequencies.

In devices operated at ultra-high frequencies, it is desirable that the length of the leading-in conductor to the cathode be relatively short so that the high frequency impedance of this conductor is small. For these reasons, the end of the metallic member opposite to that which is secured to the support or rod may be electrically connected to the support or rod by a thin wire which will not dissipate an appreciable amount of heat.

The invention and the features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing, in which:

Fig. 1 is a perspective view of an electron discharge device including a cathode constructed in accordance with this invention, portions of the enclosing vessel and of the electrode assembly being broken away to show the electrode structure more clearly;

Fig. 2 is an end view of the electrodes of the device illustrated in Fig. 1, showing the configuration and relative disposition thereof;

Fig. 3 is an enlarged side view partly in cross-section of a cathode constructed in accordance with this invention; and

Fig. 4 is a view partly in cross-section of a modification of the cathode shown in Fig. 3.

Referring now to the drawing, the electron discharge device shown in Fig. 1 is of the pentode type and comprises an enclosing vessel 10, from the walls of which a plurality of electrodes are supported. A cylindrical anode 11, which may be a band of nickel, is supported by a single wire 12 suitably secured, as by welding, to the anode and sealed in the enclosing vessel 10 adjacent one end thereof. A suppressor electrode or grid assembly is supported from a single wire 13 sealed in a side wall of the enclosing vessel 10 and comprises a metallic disc 14, an annular metallic disc 15, and a pair of parallel rigid supports or wires 16 extending between the discs 14 and 15. The supports or wires 16 are suitably secured, as by welding, to the discs 14 and 15 and carry a helical grid 17 coaxially disposed with the anode 11, each or any suitable number of turns of the grid 17 being secured, as by welding, to the supports or wires 16. Mounted upon the annular disc 15 is an insulating spacer member 18, which may be a disc of mica or the like.

A pair of parallel wires 19 are frictionally fitted in apertures in the insulating member 18, extend through the central aperture in the disc 15, and carry a helical shield electrode or grid 20 which is disposed coaxially with the anode and suppressor grid, each or a suitable number of the turns of the grid 20 being secured, as by welding, to the wires 19 to form a rigid structure. One of the wires 19 is secured to a rigid wire 21 sealed in the side of the enclosing vessel 10 and diametrically disposed with respect to the wire 13, the wire 21 serving as a leading-in conductor for the shield electrode or grid.

The control electrode comprises a wire helix 22, disposed coaxially with the anode and with the screen and suppressor electrodes or grids, which is supported by a rigid wire or rod 23 extending through the insulating member 18 and the central aperture in the disc 15, and sealed in the end of the enclosing vessel opposite to the end in which the anode leading-in conductor 12 is sealed.

Disposed within the control electrode or grid and coaxial therewith is a heater type cathode generally designated as 24. The cathode 24, as shown clearly in Fig. 3, comprises a rigid metallic support or wire 25 which is suitably secured, as by welding, to a rigid wire 32 in turn secured to the suppressor electrode supporting wire 13. The support or wire 25 carries a cylindrical metallic shell 26 which may be secured at one end to the support or wire 25 by crimping, as indicated at 27, and has substantially its entire outer longitudinal surfaces coated with a thermionic material 28, for example, barium and strontium oxides. Fitted about the support or wire 25 is an insulating sleeve 29 which may be of a suitable ceramic material, for example, beryllium oxide. The sleeve 29 is surrounded throughout substantially its entire length by a double helical heater filament 30. The ends of the filament 30 are suitably secured to leading-in conductors 31 sealed in the side of the enclosing vessel 10 at points substantially midway between the shield and suppressor electrode or grid conductors 21 and 13, respectively.

The support or wire 25 serves as the leading-in conductor for the cathode and inasmuch as it is encompassed by the filament 30, it is heated throughout its entire length. As a result, it does not convey heat away from the portions of the shell 26 adjacent the end of the shell to which it is secured so that the entire shell is heated to substantially the same temperature. Hence, uniform electron emission may be obtained from substantially all outer longitudinal surfaces of the shell and a relatively small cathode and uniform operating characteristics obtained.

As illustrated in Fig. 4, the heater filament 30 or it and the inner surface of the shell 26 may be coated with an insulating material 33, such as beryllium oxide, and the insulating sleeve 29 omitted.

The metallic shell 26 may be electrically connected at its lower end to the support or rod 25 by a short wire 34 which preferably is disposed within the shell. The wire 34 is of very small gauge so that it will not dissipate an appreciable amount of heat and thereby cool the portion of the shell 26 to which it is attached. A wire of 5 mil molybdenum has been found to be satisfactory. This construction reduces the length of the leading-in system to the cathode so that the high frequency impedance thereof is small and a device in which the cathode may be embodied may be operated efficiently at ultra-high frequencies.

Although specific embodiments of the invention have been shown and described, it will be understood, of course, that modifications may be made therein without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. An electron emitter for electron discharge devices, comprising a metallic support, a metallic shell encompassing said support and adapted to emit electrons when heated, a heater element within said shell and encompassing said support, said support being secured to said shell at one end thereof and serving as a leading-in conductor therefor, and an electrical conductor of small area and low heat conductivity connecting the other end of said shell to said support, said conductor being within said shell.

2. An electron emitter for electron discharge devices, comprising a metallic rod fixedly supported at one end, a tubular metallic member encompassing said rod and having a coating of thermionic material on its outer surface, said tubular member being mechanically and electrically connected at one end to the other end of said rod whereby said rod constitutes a leading-in conductor for said tubular member, a heater element within said tubular member and encompassing said rod, said heater element being electrically separate from said rod, and a wire of small gauge within said tubular member electrically connecting the other end of said tubular member to said rod adjacent the fixedly supported end of said rod.

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