Dec. 16, 1958 C. E. WARD 2,864,968

CATHODE STRUCTURE

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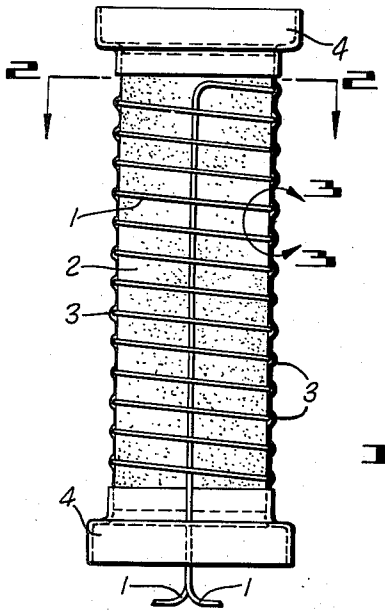


FIG. 1

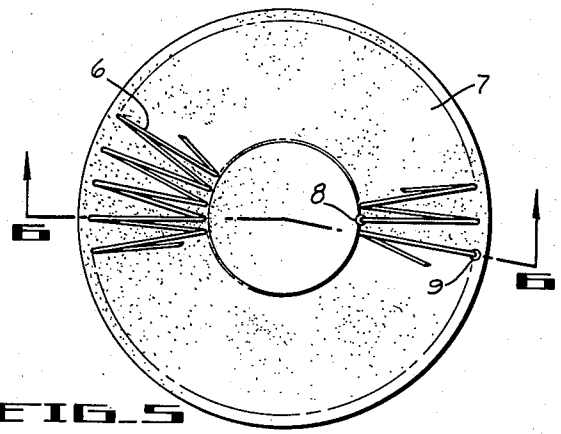


FIG. 5

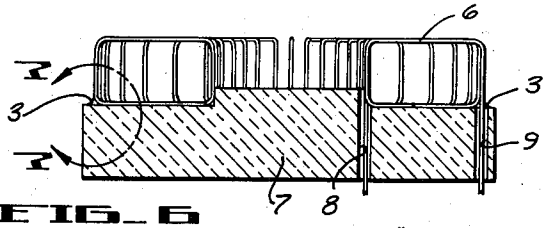


FIG. 6

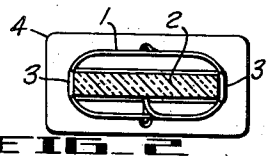


FIG. 2

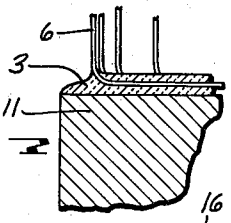


FIG. 2

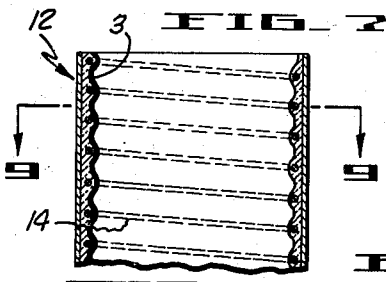


FIG. 8

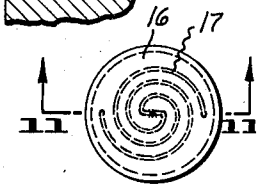


FIG. 10

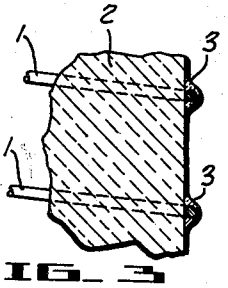


FIG. 3

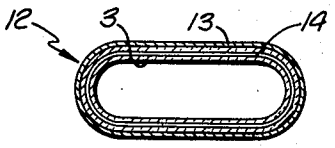


FIG. 9

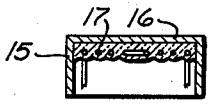


FIG. 11

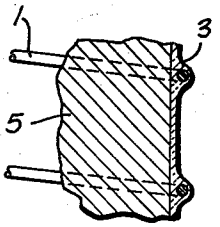


FIG. 4

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CATHODE STRUCTURE

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11 Claims. (Cl. 313—275)

This invention relates in general to electron emitting cathodes and more particularly to novel direct-heated and indirect-heated cathodes which are extremely rugged in construction and capable of operation at high temperatures.

The principal object of the present invention is to provide a novel cathode structure in which the current-carrying filament is securely affixed to a rugged body or base which serves to lend strong support to the filament.

One feature of the present invention is the provision of a direct-heated cathode of the wound filament type in which the filament is fixedly secured to a solid mounting structure at a plurality of spaced points along the filament, the greater part of the filament being free from contact with any of the mounting structure. In one embodiment of the invention the direct-heated cathode filament is mounted on a rigid insulator member while in another embodiment it is mounted on but insulated from, by a high temperature glaze, a metallic support member.

Another feature of the present invention is the provision of a novel indirect-heated cathode structure wherein the electron emissive cathode shell has a spirally wound filament wire mounted on the inside surface thereof by means of an insulating glaze.

These and other features and advantages of the present invention will become apparent from a perusal of the following specification taken in connection with the drawings wherein,

Fig. 1 is an elevation view of a direct-heated cathode made in accordance with the present invention,

Fig. 2 is a plan view of the cathode structure shown in Fig. 1 taken along line 2—2 therein,

Fig. 3 is a cross section view of a fragmentary portion of the cathode structure encircle by section line 3—3 in Fig. 1,

Fig. 4 is a fragmentary section view of another novel cathode structure similar to that shown in Fig. 1,

Fig. 5 is a plan view of another novel indirectly-heated cathode structure,

Fig. 6 is a cross section view of the cathode of Fig. 5 taken along section line 6—6,

Fig. 7 is a fragmentary cross section view of a modification of Fig. 6, taken in the section labeled 7—7 in Fig. 6,

Fig. 8 is a fragmentary longitudinal cross section view of a novel indirect-heated cathode embodying the invention,

Fig. 9 is a cross section view of the cathode shown in Fig. 8 taken along section line 9—9,

Fig. 10 is a plan view of another embodiment of this invention involving a button type of indirectly-heated cathode, and

Fig. 11 is a cross section view of the cathode shown in Fig. 10 taken along section line 11—11.

Referring now to Figs. 1, 2 and 3, there is shown a direct-heated cathode structure comprising a spiral wound filament 1 which may be a direct metallic emitter, such as tungsten, or may be an oxide coated type of filament.

This filament 1 is wound about a relatively flat rectangular mounting member 2 which is of a rigid insulating material, for example ceramic, and is fixedly secured at each contact point on the opposite edges of the mounting member 2 by a high temperature insulating glaze 3. This glaze 3 serves to rigidly secure the windings of the coiled filament in a spaced-apart relationship to prevent shorting between windings. It is noted that the filament 1 contacts the supporting member 2 only at the edges of the supporting member and thus the greater part of the filament coil is positioned in free space and is not contacting any other object, thus enhancing the electron emission characteristics. Although the greater part of the filament is not contacting the member 2, the free lengths of filament between points of glazing are relatively short and any tendency for the windings to sag when hot will not produce deflection sufficient to cause a shorting of the windings.

The ends of the mounting member 8 are fixedly secured, as by crimping, to metallic end caps 4 by which the cathode structure may be mounted in an electron discharge device. The ends of the cathode filament 1 extend from the lower end of the cathode structure where they may be connected to suitable electrical leads.

In Fig. 4 a direct-heated cathode structure is shown utilizing a metal mounting structure 5 similar in size and shape to ceramic structure 2, the cathode filament 1 being mounted on and insulated from the member 5 by a coating of high temperature glaze material 3.

In both of the above structures the ceramic or metallic mounting members 2 and 5 and the associated mounting caps 4 serve to conduct a great deal of heat generated by the current in the filament from the cathode structure so that the temperature of the structure is maintained well below the melting point of the glaze material 3. This efficient heat conduction along with heat radiation enables higher filament current to be utilized, resulting in more efficient electron beam production.

Referring to Figs. 5 and 6 there is shown another embodiment of this invention involving a directly-heated cathode structure. The wound cathode filament 6 is curved to form an annular shape and is securely mounted on a circular ceramic base 7 by a high temperature insulating glaze 3. The ends of the filament are brought out through openings 8 and 9 in the ceramic.

In Fig. 7 there is shown a cathode structure similar to that in Figs. 5 and 6 in which the mounting base 11 is metallic, the filament 6 being mounted on the base and insulated therefrom by a high temperature glaze 3.

A further embodiment of this invention is shown in Figs. 8 and 9, this embodiment relating to an indirect-heated cathode. An elongated oblong cathode shell 12 is provided having a suitable electron emissive coating on the outer surfaces 13 of the two wider sides thereof. The spiral wound heater filament 14 is securely mounted within the hollow cathode shell 12 by a high temperature insulating glaze 3. This method of fixedly mounting the heater filament within the cathode shell produces a cathode structure having an extremely rugged filament. The heat conduction from the filament through the glaze and cathode shell is extremely good, reducing the temperature required of the heater to produce the desired cathode shell temperature. In addition there is no possibility for the turns of the filament wire to short between each other or with the cathode shell.

A button type of cathode structure is shown in Figs. 10 and 11 in which the cathode shell 15 has an electron emissive coating on its upper surface 16. On the under surface of the button a flat spiral type of heater filament 17 is fixedly secured by an insulating glaze 3. The cathode button and its associated mounting structure (not shown) serve to effectively conduct the heat from

the filament. It is noted that the heater filament, although insulated from the cathode button, is mounted very close to the cathode emitter surface through the medium of the insulating glaze and therefore the heat from the filament passes quickly and very efficiently to the electron emissive surface.

The high temperature glaze successfully utilized in embodiments of this invention was composed of the following ingredients shown in their approximate parts per 100: lithium carbonate ($LiCO_3$)—12.9, calcium carbonate ($CaCO_3$)—8.9, borium carbonate ($BaCO_3$)—17.9, aluminum oxide (Al_2O_3)—17.2, silicon dioxide (SiO_2)—43.1. These ingredients were mixed in acryloide and allosolive acetate to obtain the glaze.

In all of the above embodiments it is noted that the cathode structures are very rugged, the electron emissive filaments and heater filaments being in all cases securely affixed to a rigid insulator or metallic member. The possibility of shorted windings occurring in the current carrying filaments is extremely remote even in the case of closely spaced windings in which a large portion of the winding is not fixedly attached to the supporting member as in the filament in Fig. 1. Those familiar with directly-heated cathodes will appreciate the fact that the spring tensioning apparatus found on such cathodes heretofore used, for taking up the slack and sag produced by the intense heating of the filament, are eliminated. It will also be appreciated that a very rapid warm-up of the electron emissive surface is produced, especially in the directly-heated cathode filaments, and also in the indirectly-heated cathode types as in Figs. 8 and 10 due to the close physical contact between the heater filament and the electron emissive surface.

Since many modifications in and variations from the described apparatus may be made without departing from the spirit of the invention, the foregoing embodiments of the invention are to be considered as exemplary and not in a limiting sense.

What is claimed is:

1. A cathode structure comprising a filament of the electron emissive type for carrying a cathode current and a mounting member on which said filament is securely affixed, the filament being secured to the mounting member at a plurality of contact points spaced apart along the length of said filament, the filament segments between said contact points being freely suspended so as to be free from contact with said mounting member.

2. A cathode structure as claimed in claim 1 wherein said filament is substantially spirally shaped, said contact points occurring at least once in every turn of the spiral filament.

3. A cathode structure as claimed in claim 2 wherein said mounting member is positioned within said substantially spiral filament, the filament being supported on said member at opposite contact points on each turn of the filament.

4. A cathode structure comprising a filament of the electron emissive type for carrying a cathode current and a mounting member on which said filament is securely affixed by a high temperature insulating glaze, the filament being secured to the mounting member at a plurality of contact points spaced apart along the length of said filament, the filament segments between said contact points being freely suspended so as to be free from contact with said mounting member.

5. A cathode structure comprising a filament for carrying a cathode current and a mounting member on which said filament is securely affixed by a high temperature insulating glaze wherein said filament is a spiral wound filament of the electron emissive type and wherein said mounting member is a substantially flat rectangular member of insulation material fitted within the spiral filament, the filament being secured at each contact point with the mounting member on opposite edges of the flat mounting member by said insulating glaze.

6. A cathode structure as claimed in claim 5 including metallic end caps fixedly mounted on both ends of the mounting member for the rapid conductance of heat from the cathode structure.

7. A cathode structure comprising a spiral filament for carrying a cathode current and a mounting member on which said filament is securely affixed by a high temperature insulating glaze wherein said mounting member is a flat rectangular metallic member fitted within the spiral filament, the filament being secured to the mounting member and insulated therefrom at each contact point on opposite edges of the flat mounting member by said insulating glaze.

8. A cathode structure as claimed in claim 7 including metallic end caps fixedly mounted on both ends of the mounting member for the rapid conductance of heat from the cathode structure.

9. A cathode structure comprising a wound filament bent to form an annular configuration and a circular mounting member, the annular filament being fixedly secured on the circular mounting member by a high temperature insulating glaze, the filament being affixed to the mounting member at a plurality of contact points spaced apart along the length of said filament, the filament segments between said contact points being freely suspended so as to be free from contact with said mounting member.

10. A cathode structure as claimed in claim 9 wherein said mounting member is ceramic.

11. A cathode structure as claimed in claim 9 wherein said mounting member is metallic, said insulating glaze serving to both mount said filament on said metallic mounting member and insulate it therefrom.

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