Dec. 8, 1964 P. P. COPPOLA 3,160,780

INDIRECTLY HEATED CATHODE

Original Filed Aug. 12, 1955

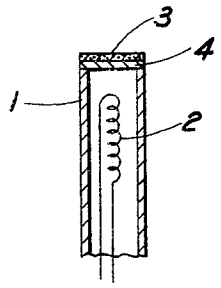


Fig. 1a.

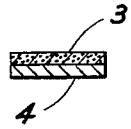


Fig. 1b.

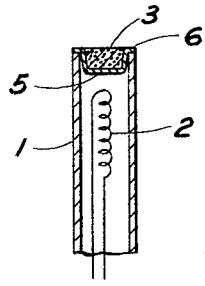


Fig. 2a.

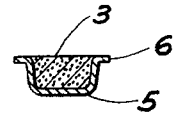


Fig. 2b.

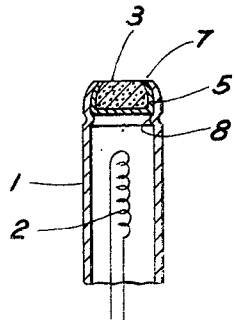


Fig. 3a.

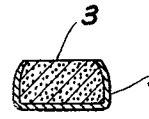


Fig. 3b.

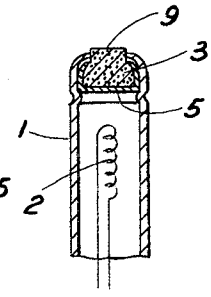


Fig. 4a.

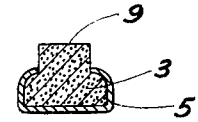


Fig. 4b.

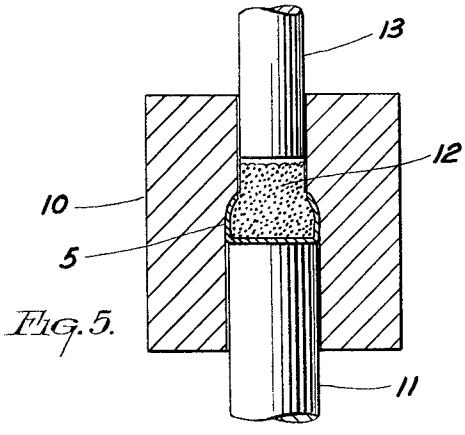


Fig. 5.

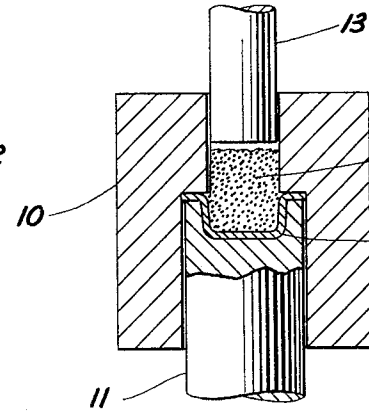


Fig. 6.

INVENTOR
PATRICK P. COPPOLA

BY

Fred M Vogel
AGENT.

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INDIRECTLY HEATED CATHODE

Patrick P. Coppola, Fayetteville, N.Y., assignor to North American Philips Company, Inc., New York, N.Y., a corporation of Delaware

Continuation of application Ser. No. 527,952, Aug. 12, 1955. This application Jan. 17, 1961, Ser. No. 83,862
6 Claims. (Cl. 313—346)

The invention relates to an indirectly heated cathode and in particular to an indirectly heated dispenser cathode.

This application is a continuation of application Serial No. 527,952, filed August 12, 1955, now abandoned.

In a dispenser cathode, the emissive surface is continually supplied with alkaline earth metal, such as barium, from a supply of an alkaline earth material contained in one or more cavities in the body by reaction with the refractory metal constituting the body. Thus, in certain types of dispenser cathodes, not only is the barium metal furnished to the emissive surface but also to surfaces of the body from which no emission is desired. Moreover, in one form of dispenser cathode in which the alkaline earth material is distributed in the pores of a porous refractory metal body and which is raised to the operating temperature by a separate heating element, undesired emission may take place between the cathode and heating element unless provision is made to prevent such emission.

It is a principal object of the invention to provide an indirectly heated dispenser cathode in which emission between the cathode and the heating element is prevented.

It is a further object of the invention to provide an indirectly heated dispenser cathode of simple, inexpensive construction.

It is a still further object of the invention to provide an indirectly heated dispenser cathode in which emission between the cathode and heating element is prevented and which is simple and easy to fabricate.

These and further objects of the invention will appear as the specification progresses.

According to the invention the electron-emissive element which comprises a porous body of refractory metal whose pores are filled with an alkaline earth material which thermally reacts with the refractory metal to furnish alkaline earth metal to the surface of the body is mounted on a refractory metal member supported by and secured to a tubular refractory metal housing for a heating element. This refractory metal member may be plate- or cup-shaped and serves to support the electron-emissive element and prevent emission between the cathode and the heating element.

The electron-emissive element preferably comprises a pressed and sintered mixture of tungsten, or an alloy of tungsten and molybdenum, and a fused mixture of at least 60% by weight of barium oxide and aluminum oxide. However, use may be made of other refractory metals such as molybdenum, tantalum and hafnium and alloys of those metals as well as other alkaline earth materials such as fused mixtures of alkaline earth oxides with acid-forming oxides such as silicon dioxide, beryllium oxide and boric oxide.

For a more complete understanding of the invention, reference is made to the accompanying drawing in which:

FIGS. 1*a* and 1*b* show one embodiment of a cathode according to the invention;

FIGS. 2*a* and 2*b* show another embodiment of the cathode according to the invention;

FIGS. 3*a* and 3*b* show still another embodiment of the cathode according to the invention;

FIGS. 4*a* and 4*b* show still another embodiment of the cathode according to the invention;

FIGS. 5 and 6 show apparatus for fabricating cathodes according to the invention.

As shown in FIG. 1*a* the cathode assembly comprises a molybdenum tube **1** which may be formed by rolling a sheet of molybdenum into a tube with the edge overlapping. If desired, the overlapped edges may be welded using a tantalum flux or an inert atmosphere but this step may be omitted. This tube houses a heating element **2** and supports at one end an electron-emissive wafer **3** mounted on a molybdenum plate **4** (shown in greater detail in FIG. 1*b*).

The electron-emissive wafer **3** is formed by mixing together about 90% by weight of a 25% W–75% Mo alloy and 10% by weight of a fused mixture of about 5 moles of BaO and 2 moles of Al_2O_3. This mixture is then pressed and sintered at about 1370° C. for about 20 minutes to form a coherent body and the temperature raised for about 20 seconds to the melting point of the fused mixture of BaO and Al_2O_3 (about 1650–1750° C.) brightness in order to degas the composition. Alternately, this wafer can be formed as described in U.S. Patent 2,700,000 to R. Levi et al.

In order to securely attach the electron-emissive wafer **3** to support **4**, it is preferred to weld the element to the disc. Alternatively, the pressed mixture of tungsten and fused mixture of barium oxide and aluminum oxide may be placed on the molybdenum disc and the bodies sintered together to form a unitary assembly.

The molybdenum disc **4** is then welded, as described above to the walls of tube **1**, for example, by passing an electric current of sufficient density to produce localized heating without unduly heating the emissive body.

As will be evident, the plate **4** effectively prevents any emission from the wafer **3** to the heating element **2**.

Instead of using a plate-shaped support, the electron-emissive element **3** may be mounted in a cup-shaped support **5**, as shown in FIGS. 2*a* and 2*b*, having a rim **6** adapted to be secured to the end of the molybdenum tube **1**.

The cup-shaped support may also be secured within the molybdenum tube, as shown in FIGS. 3*a* and 3*b*, by peening over the ends **7** of the tube and the edge of the cup and by providing a reentrant portion **8** in the tube below the cup.

As a further alternative, the emissive body may have a portion **9** extending beyond the cup, the cup being recessed in the molybdenum tube as shown in FIGS. 4*a* and 4*b*.

A simple die structure for fabricating the cathode shown in FIGS. 3*a* and 3*b* and FIGS. 4*a* and 4*b* is shown in FIG. 5. The cup-shaped member is placed in a cylindrical die **10** provided with a cupped pin **11** to seat the body while pressing. A measured quantity of the emitter mixture **12** is placed in the die above the cup and the mixture pressed into the cup by pressing pin **13**.

FIG. 6 shows a similar die for forming an emitter element of the type shown in FIG. 2*b*. The cupped pin **11** is designed, in this case, to receive a rimmed cup **5**.

After pressing, the emitter bodies are sintered in the aforesaid manner. As a result of this sintering, a tight bond is obtained between the emitter and the cup which insures better heat transfer to the emitter, less evaporation of Ba and BaO from the sides of the cup and less likelihood of fracturing or chipping the emitter body.

While the invention has thus been described with reference to specific examples and applications thereof, other modifications will be apparent to those skilled in the art without departing from the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. A thermionic cathode comprising a metal tube adapted to house a cathode heater, a block of compacted

and sintered metallic material held in the said tube, a projection from the face of the said block formed of active material which is a compressed and sintered mass of refractory metal powder mixed with thermionically active material, and a metal shield enclosing the said block with the end of the said projection being spaced from said metal shield.

2. A thermionic cathode comprising a metal tube adapted to house a cathode heater, a block of compacted and sintered metallic material held in the said tube, a projection from the face of the said block formed of active material which is a compressed and sintered mass of tungsten powder mixed with thermionically active material, and a metal shield enclosing the said block with the end of the said projection being spaced from said metal shield.

3. A thermionic cathode comprising a metal tube adapted to house a cathode heater, a block of compacted and sintered metallic material held in the said tube, a projection from the face of the said block formed of active material which is a compressed and sintered mass of a tungsten-molybdenum alloy powder mixed with thermionically active material, and a metal shield enclosing the said block with the end of the said projection being spaced from said metal shield.

4. A thermionic cathode comprising a metal tube adapted to house a cathode heater, a block of compacted and sintered metallic material held in the said tube, a projection from the face of the said block formed of active material which is a compressed and sintered mass of refractory metal powder mixed with thermionically active material composed of a fused mixture of barium oxide and aluminum oxide, and a metal shield enclosing the said block with the end of the said projection being spaced from said metal shield.

5. A thermionic cathode comprising a metal tube adapted to house a cathode heater, a block of compacted and sintered metallic material held in the said tube, a projection from the face of the said block formed of active material which is a compressed and sintered mass of refractory metal powder mixed with thermionically active material composed of a fused mixture of at least 60% by weight of barium oxide and aluminum oxide, and a metal shield enclosing the said block with the end of the said projection being spaced from said metal shield.

6. A thermionic cathode comprising a metal tube adapted to house a cathode heater, a block of compacted and sintered metallic material held in the said tube, a projection from the face of the said block formed of active material which is a compressed and sintered mass of refractory metal powder mixed with thermionically active material, and a cup-shaped metal shield enclosing the said block with the end of the said projection being spaced from said metal shield.

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