Jan. 9, 1968 S. PAKSWER 3,363,136

THERMIONIC CATHODES

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FIG. 1

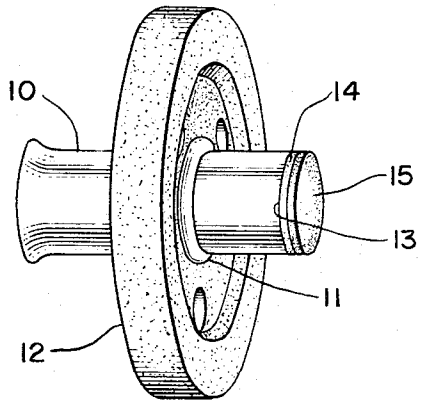
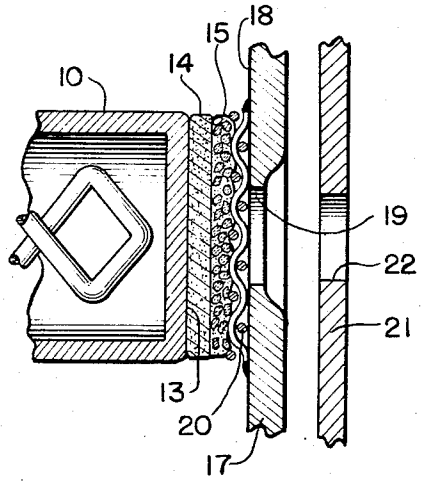


FIG. 2



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THERMIONIC CATHODES

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Continuation of application Ser. No. 354,253, Mar. 24, 1964. This application Mar. 22, 1966, Ser. No. 536,474
4 Claims. (Cl. 313—268)

This application is a continuation of application Ser. No. 354,253 filed Mar. 24, 1964, which is now abandoned.

The present invention is directed to thermionic cathodes and particularly, though not exclusively, to thermionic cathodes for use in cathode-ray tubes and the like.

Television receivers at the present time are following in the footsteps of the development of radio; namely, the transition from bulky, non-portable tube type radios to small battery operated, hand-held, transistorized radios which are highly portable. In the same way television receivers are becoming lighter in weight, transistorized, and as the art develops the battery operated sets will become feasible from a practical sandpoint. One of the major considerations in developing a transistorized battery operated television receiver is the production of a cathode ray viewing tube which has "low drive" characteristics. In other words, the electron gun of such a tube may be driven by a video signal of limited voltage range. To achieve a low drive gun, the control grid must be closely and accurately spaced from the emissive surface of its cathode. At the same time arc-over between the cathode and grid electrodes must be prevented and the electron-optical qualities of the electron gun maintained.

It is a principal object of the present invention to provide an improved thermionic cathode for a cathode ray tube or the like.

It is another object of the invention to provide an improved grid-cathode assembly.

It is yet another object of the invention to provide an improved cathode particularly adapted for use in an electron gun which has low drive characteristics.

It is still another object of the invention to provide a grid-cathode assembly which has improved resistance against grid-cathode electrical shorting.

It is yet another object of the invention to provide an improved grid-cathode assembly which provides for accurate and close spacing of the control grid with respect to the cathode emissive surface.

It is another object of the invention to provide a cathode having an improved resistance against ion burn.

In accordance with the invention, a grid-cathode assembly for a cathode-ray tube or the like comprises a tubular metallic cathode substrate having a single flat end face. Means, including an electrical heating element contained within the tubular substrate, are provided for heating the end face to a predetermined temperature. A thermionically emissive coating deposited on the end face has a smooth surface for emitting electrons along a predetermined electron-discharge path when heated to this predetermined temperature. The grid-cathode assembly further comprises a metallic control electrode having a flat apertured face and means, including a uniform and continuous electron-transparent electrically insulating layer interposed in said electron-discharge path between and in contact with both the emissive surface and the apertured face and chemically inert with respect to both the coating and the electrode face at the predetermined temperature, for determining the spacing therebetween.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The organization and manner of operation of the invention, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing in the several figures of which like reference numerals identify like elements, and in which:

FIGURE 1 is a perspective view of a cathode sub-assembly embodying the invention; and

FIGURE 2 is a fragmentary cross-sectional view of a portion of an electron gun embodying the cathode sub-assembly of FIGURE 1.

In FIGURE 1, the cathode sub-assembly includes a ceramic insulating disk **12** which has an aperture **11** through which is inserted a tubular metal cathode sleeve **10** having a closed end face **13** which serves as a substrate for an emissive layer **14**. The emissive layer **14** may be applied by methods already known in the art which provide a smooth surface on the cathode, but it is preferable to use the method disclosed in the concurrently filed copending applications of Serge Pakswer, Ser. No. 354,252 entilted "Electron Tubes" and of Irwin Kachel, Ser. No. 354,251 entitled "Electron Tubes," assigned to the present assignee. These applications disclose and claim novel methods of forming smooth and dense thermionic cathodes. Emissive material **14** may be of the alkaline earth oxide type.

In accordance with the invention, an insulating layer **15** covering substantially all of the surface of emissive material **14** is provided. The insulating material is of a type which is non-reactive with the emissive material at its operating temperature and, in addition, is non-emissive itself. Thus, for example, if the emissive material is of the barium-strontium oxide type, the insulating material **15** may be magnesium oxide, obtained by thermal breakdown of a suitable magnesium compound such as magnesium carbonate. Its thickness may be comparable to that of the emissive material **14**. It has been found that layers of magnesium oxide of from 1.0 to 3.0 mils in thickness are sufficiently porous to permit the efficient passage of electrons therethrough. It has been observed that the electrons emitted from the electron emitting material **14** apparently fill the pores of insulating layer **15** with a space charge comparable to the space charge formed in a vacuum above a normal cathode. Surprisingly, the emission current density from smooth cathodes with an overlay of porous insulator **15** is comparable to that of such cathodes without such an overlay.

The following is an example of a cathode which has been prepared with an insulating overlay in accordance with the invention. An emissive layer **14** was prepared on cathode substrate **13** by the jet-impaction and electrostatic charge attraction method described in the above-described Kachel application. The cathode-forming material used was an equimolecular mixture of barium carbonate and strontium carbonate. This was deposited to a thickness of approximately 1½ to 2 mils. Subsequently, a layer **15** of magnesium carbonate was applied over the base emissive layer **14** by the same electrostatic charge attraction method. The thickness of layer **15** was estimated at approximately 2 mils. The cathodes were processed, activated and aged in a conventional manner. Completed cathode-ray tubes incorporating the above cathodes were tested and yielded emission density and emission life characteristics similar to tubes having cathodes without an insulating layer **15**.

A smooth emissive base surface is necessary in order to provide an insulating layer **15** which is thin enough to allow the passage of electrons. In a conventional cathode, the roughness of the surface requires either an excessively thick insulating layer which serves as an electron block or alternatively, when a thin insulating layer is used, it is susceptible to arc-over because of the high peaks of the emissive material piercing the insulating layer.

Cathodes constructed in accordance with the invention exhibit an improved resistance to ion bombardment and against grid cathode electrical shorting. The latter char-

acteristic may be advantageously utilized in an electron gun of high trans-conductance where the control grid must be closely spaced to the emissive surface of the cathode. This is illustrated in FIGURE 2 in which a portion of an electron gun is disclosed. More specifically, these portions include a first control electrode **17** having a substantially planar portion **18** with a central aperture **19** over which is placed a conductive mesh **20** which improves the characteristics of the electrostatic field. Planar portion **18** and its associated mesh **20** are in contact with insulating layer **15**. Mesh **20** may be eliminated in many applications and as shown in the drawing is greatly enlarged. It may either be constructed by a photo etching process or woven as illustrated.

The first anode **21** has a central aperture **22** in alignment with aperture **19** and is normally operated at an accelerating voltage in a manner well known in the art.

The remainder of the electron gun may be identical with any of those disclosed in co-pending application Ser. No. 195,566 filed May 17, 1962 in the name of Constantin S. Szegho entitled "Cathode Ray Tube" and assigned to the present assignee. In that application an insulating ring is disclosed which spaces the control electrode from the cathode emissive surface. However, a hole is provided in the insulator for the passage of the electrons from the emissive surface. This differs from the present invention where the insulating layer covers substantially all of the emissive layer and the porosity of the insulator allows the transmission of electrons through it.

With the use of insulating layer **15** covering substantially all of the emissive surface of layer **14**, the control electrode can be accurately and closely spaced to the emissive surface thus providing a "low drive" electron gun of superior quality. The insulating layer **15** is easily applied and its thickness can be accurately controlled. Finally, the overall coverage of the insulating layer provides a superior resistance to arc-over between the cathode and grid electrodes.

While a particular embodiment of the present invention has been shown and described, it is apparent that various changes and modifications may be made, and it is therefore intended in the following claims to cover all such modifictaions and changes as may fall within the true spirit and scope of this invention.

What is claimed is:

1. A grid-cathode assembly for a cathode-ray tube or the like comprising: a tubular metallic cathode substrate having a single flat end face; means comprising an electrical heating element contained within said tubular substrate for heating said end face to a predetermined temperature; a thermionically emissive coating deposited on said end face, and having a smooth surface for emitting

electrons along a predetermined electron-discharge path when heated to said predetermined temperature; a metallic control electrode having a flat apertured face; and means, comprising a uniform and continuous electron-transparent electrically insulating layer interposed in said electron-discharge path between and in contact with both said emissive coating and said apertured face and chemically inert with respect to both said coating and electrode face at said predetermined temperature, for determining the spacing therebetween.

2. A grid-cathode assembly for a cathode-ray tube or the like comprising: a tubular metallic cathode substrate having a single flat end face; means comprising an electrical heating element contained within said tubular substrate for heating said end face to a predetermined temperature; a thermionically emissive coating deposited on said end face and having a smooth surface for emitting electrons along a predetermined electron-discharge path when heated to said predetermined temperature; a tubular metallic control-electrode coaxially surrounding said cathode substrate and having an apertured end wall parallel to and axially spaced from said emissive coating; and means, comprising a uniform and continuous electron-transparent electrically insulating layer integumentally deposited on said emissive coating and interposed in said electron-discharge path between and in contact with both said emissive coating and said apertured end wall and chemically inert with respect to both said coating and electrode face at said predetermined temperature, for accurately maintaining a predetermined spacing therebetween.

3. A grid-cathode assembly as set forth in claim **2**, in which said insulating coating is of a thickness from 1 to 3 mils and is non-emissive at said predetermined temperature.

4. A grid-cathode assembly as set forth in claim **3**, wherein said insulating coating is of magnesium oxide.

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