Jan. 25, 1949. G. F. ROUSE 2,459,841

CATHODE

Filed June 8, 1943

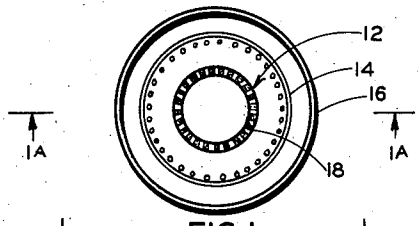


FIG. 1.

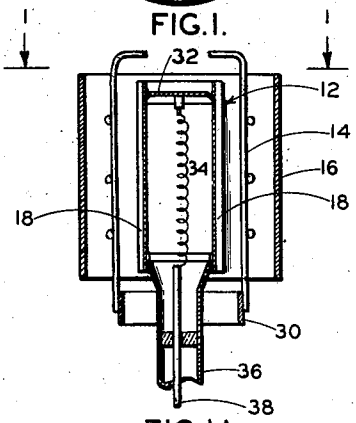


FIG. 1A.



FIG. 2.

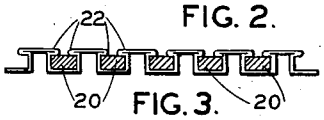


FIG. 3.



FIG. 5.



FIG. 6.



FIG. 4.



FIG. 7.



FIG. 8.

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Patented Jan. 25, 1949 2,459,841

UNITED STATES PATENT OFFICE

2,459,841

CATHODE

Glenn F. Rouse, Long Branch, N. J.

Application June 8, 1943, Serial No. 490,036

4 Claims. (Cl. 250—27.5)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to electron emitting cathodes, particularly of the oxide type.

Oxide-coated cathodes have long been known, and have the advantage of copious electron emission at relatively low temperature. They have been used very successfully in receiver tubes, but have not proved equally successful in transmitter tubes. It has been customary to use a smooth metal cathode can coated with the oxide material. In practice, a mixture of barium carbonate and strontium carbonate is applied, this being later reduced to form the oxides. The electron emission is believed by some to originate from a thin film of metallic barium which forms on the outside of the oxide layer, there being uncertainty, however, as to how the oxygen of the barium oxide disappears, some believing that it passes outwardly by electrolytic action, and others believing that it passes inwardly to the nickel can and there forms an oxide with the nickel.

With such a cathode, particularly when used with high potentials, there is a tendency for the oxide coating to scale or flake off. Another difficulty is the tendency for some of the barium or barium oxide material to move from the cathode to the grid, thus encouraging electron emission from the grid, a difficulty known as grid contamination.

The primary object of the present invention is to generally improve electron emission tubes, and particularly oxide type cathodes. A more particular object is to provide a cathode of the oxide type which will be characterized by long life, and will not be subject to flaking off of the oxide material. An ancillary object is to devise an oxide type cathode which will cause only a minimum of grid contamination.

To accomplish the foregoing, and other objects which will hereinafter appear, my invention resides in the electrode elements and their relation one to the other, as hereinafter are more particularly described in the specification and sought to be defined in the claims. The specification is accompanied by a drawing in which

Figure 1 is a horizontal section through an electrode assembly embodying features of my invention, said section being taken approximately in the plane of the line 1—1 of Figure 1A;

Figure 1A is a vertical section taken approximately in the plane of the line 1A—1A of Figure 1;

Figure 2 is an end view, drawn to enlarged scale,

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of sheet metal for a cathode can, partially formed to desired shape;

Figure 3 shows a further step in shaping the sheet metal to provide cavities;

Figure 4 shows the sheet metal bent, and filled with oxide material;

Figures 5, 6, and 7 correspond to Figures 2, 3, and 4 respectively, but show a modification in which the cavities are dovetail-shaped in section; and

Figure 8 is explanatory of a further modification of the invention.

Referring to the drawing, and more particularly to Figures 1 and 1A, the electrode assembly there shown comprises a cathode generally designated 12, surrounded by a grid 14, and an anode 16. In order to simplify the drawing, only the edge wires of the grid are shown in Figure 1A. It will be understood that in practice the electrode assembly is enclosed within an evacuated glass envelope, the various electrodes being supported by suitable lead-ins passing through appropriate sealed glass stems. The present invention centers primarily in the structure of the cathode 12.

One characteristic feature of my improved cathode is that it is provided with a large number of small recesses containing material characterized by high electron emissivity. In the specific case here shown, the cathode can is generally cylindrical, and the recesses are narrow slots extending longitudinally of the can. These recesses are indicated at 18 in Figures 1 and 1A, and preferably contain a metal oxide material such as barium oxide, with a certain amount of strontium oxide. In Figure 1A the oxide material has been omitted. This material may be initially applied as a carbonate, which is later reduced to the oxide.

The slots are preferably so shaped as to effectively retain the said material therewithin. For this purpose the channels may be made deep and very narrow, or, if desired, the channels may be given an undercut shape when viewed in section. Figures 2, 3, and 4 illustrate the production of T-shaped undercut channels while Figures 5, 6, and 7 illustrate the production of dovetail-shaped undercut channels.

It will be understood that the cathode has outside surfaces between the recesses or slots, onto which surfaces a thin layer of oxide or metal from the reservoir of oxide material may spread or creep when the cathode is heated. If the area of the cathode which is coated in this way is not too great, relative to the area carrying the body of oxide material, certain advantages are ob-

tainable without sacrificing electron emission. One advantage is that the cathode resistance is reduced. Another is that evaporation of the coating material is decreased. Still another advantage is that flaking of the coating is minimized.

Describing the formation of the slotted cathode in greater detail, a thin sheet of nickel or other suitable metal, having a width equal to the desired length of the cylindrical cathode, and having a length adequate to provide for the slot formation, is preliminarily bent to the corrugated shape shown in Figure 2. At this stage of manufacture, the width of the slots (exaggerated in the drawing) is approximately that desired, but the height of the slots is made greater than desired. Suitable bars of steel **20** are then placed in the slots and the excess sheet metal above the bars is pressed downwardly to fold the same outwardly as shown at **22**. The steel bars are then removed, leaving the sheet metal with undercut slots. The resulting sheet of metal is then bent to cylindrical shape, a part of the cylinder being indicated in Figure 4. The barium carbonate or equivalent material is then applied to the outside of the cathode, the slots being substantially filled but the outside surfaces **24** being left bare. Subsequently, when the cathode is heated, the carbonate is reduced to the oxide, and barium metal from the oxide creeps outwardly from the slots onto the outer surfaces **24**.

Undercut slots of dovetail section may be formed somewhat easier than the undercut T-shaped slots provided in Figure 4. This may be explained with reference to Figures 5, 6, and 7, in which it will be seen that a thin sheet of nickel or other metal is preliminarily formed into corrugated or slotted shape as shown in Figure 5, following which the sheet is compressed from one side edge toward the other while confining the corrugated metal between flat top and bottom plates. This produces the dovetail shape shown in Figure 6. The metal is then bent to cylindrical configuration, as is partially shown in Figure 7, following which the slots are filled with the barium carbonate or equivalent material. The functioning of this cathode is substantially the same as previously described.

It is not essential that the slots be undercut. Open slots may be used, but in such case are preferably made very narrow, say only 10, or at most 20 thousandths of an inch in width, and are made deep relative to their width, say 40 thousandths of an inch. Such a slot formation is represented in Figure 8, but in this figure, as in others, the width of the slot is exaggerated for clarity. The corrugated sheet is bent to cylindrical shape and thereafter loaded with the electron emissive material.

In all cases, the slot must not be made unduly large or coarse, for it has been found that with too great a cross-section of oxide material in the slot, the material is not sufficiently degassed throughout its depth during evacuation of the tube, and later the tube will prove to be gassy.

Reverting to Figure 1A, it will be understood that the grid ring **30** is supported by means of suitable lead-ins, not shown; and that the anode **16** is also supported by appropriate lead-ins, not shown. If the electrode assembly forms a part of an oscillator tube containing resonant loops, the electrodes may be supported by the said loops. This is the case when the electrode assembly forms a part of a so-called VT-158 tube, described and claimed in a copending application of Harold A. Zahl, Serial Number 473,556, filed January 25, 1943.

The cylindrical cathode can is closed at the top by means of a top disc **32**, and is heated by means of a heating filament **34** disposed within the can. The cathode may be supported in any suitable manner, but that here shown is deemed preferable. The cathode can is carried on a tubular lead-in **36** of substantial diameter, said lead-in being secured coaxially of the can at the open end thereof. The heater filament **34** is supported and energized by means of a heating current lead-in wire **38**, which preferably runs coaxially through the tubular lead-in **36**. It will be understood that while coaxial lead-ins **36** and **38** have been broken off short in Figure 1A, for convenience in arranging the figures of the drawing, these lead-ins in practice may be substantial in length, and ordinarily pass through a glass stem projecting outwardly from the main glass envelope of the tube. The large diameter tubular lead-in **36** is used as a radio frequency path, and is also used as one side of the power supply circuit for heating the filament **34**.

It is believed that the method of constructing and using my improved cathode, as well as the many advantages thereof, will be apparent from the foregoing detailed description. The reservoir of available electron-emitting material is very large, for a given size of cathode. It is equivalent to a smooth cathode coated with an extremely thick oxide coating, but the present arrangement is far superior to such a supposed cathode for two reasons. In the present arrangement, the oxide material is securely held by the cathode can, and cannot blister or flake off. In operation, the cathode has all the advantage of using an exceedingly thin oxide coating. In fact, the working coat on the outside of the can is far thinner than any which would be obtainable when directly coating a can, and consequently adheres tenaciously to the can, thus minimizing grid contamination.

It will be apparent that while I have shown and described my invention in several preferred forms, many changes and modifications may be made in the structures disclosed without departing from the spirit of the invention as sought to be defined in the following claims.

I claim:

1. A cathode for an electron emission tube, said cathode having a relatively extensive metal surface provided with a large number of small recesses, said recesses having a smaller width at their outer ends than at their bases containing a metal oxide material of high electron emissivity at relatively low temperature.

2. A cathode for an electron emission tube, said cathode having a surface provided with recesses, said recesses having a smaller width at their outer than at their inner ends and containing a metal oxide of high electron emissivity at relatively low temperature, the cathode being cylindrical, and the recesses being slots extending longitudinally of said cylinder, said slots being relatively deep, narrow slots, retaining the oxide material therewithin.

3. A cathode for an electron emission tube, said cathode having a surface provided with recesses, said recesses having a smaller width at their outer than at their inner ends and containing a metal oxide of high electron emissivity at relatively low temperature, the cathode being cylindrical, and the recesses being slots extending longitudinally of said cylinder, said slots being

dovetail-shaped in section, retaining the oxide material therewithin.

4. A cathode for an electron emission tube, said cathode having a surface provided with recesses, said recesses having a smaller width at their outer than at their inner ends and containing a metal oxide of high electron emissivity at relatively low temperature, the cathode being cylindrical, and the recesses being slots extending longitudinally of said cylinder, said slots being T-shaped in section, retaining the oxide material therewithin.

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