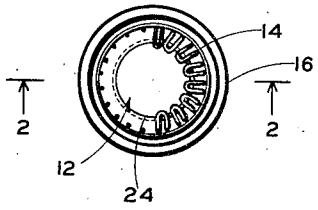
Dec. 21, 1948. G. F. ROUSE 2,456,649

CATHODE

Filed June 12, 1943

FIG. 1.



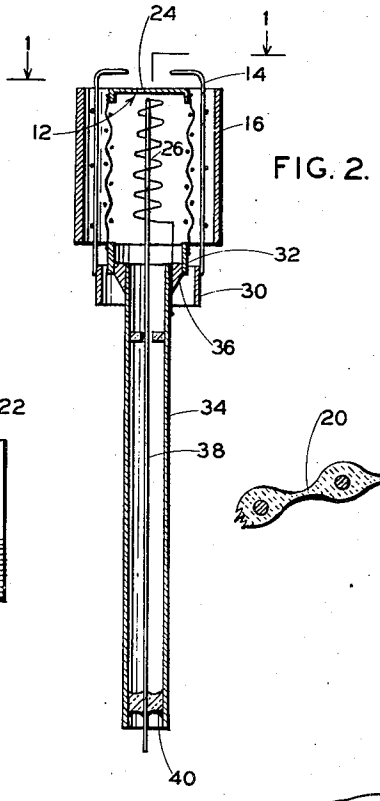


FIG. 2.

FIG. 3.

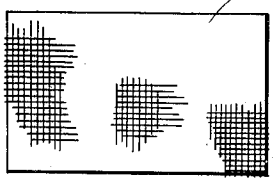


FIG. 4.



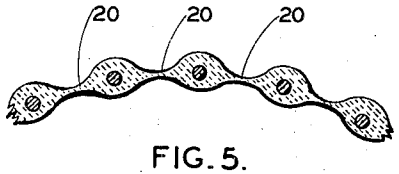


FIG. 5.

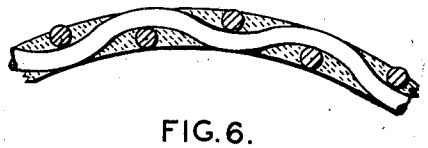


FIG. 6.

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CATHODE

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

Application June 12, 1943, Serial No. 490,624

3 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.

With such a cathode, particularly when used for transmission, there is a tendency for the outside coating to scale or flake off. Another difficulty is the tendency for some of the oxide material to move from the cathode to the grid, thus encouraging electron emission from the grid, a difficulty known as grid contamination. Furthermore, the total amount of emission depends on the cathode area, and that in turn is dependent on the diameter and length of the cylinder when using a cylindrical cathode.

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 minimize the effect of grid contamination. Another important object of the present invention is to provide a cathode having increased electron emission area without necessitating a corresponding increase in the apparent physical area of the cathode (for example, the diameter and length of the cylinder when using a cylindrical cathode).

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 2;

Figure 2 is a vertical section taken approximately in the plane of the line 2—2 of Figure 1;

Figure 3 illustrates a piece of wire screen used as a base of foundation for the cathode;

Figure 4 shows how the screen may be bent

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to cylindrical configuration to provide a cylindrical cathode;

Figure 5 is a fragmentary horizontal section drawn to enlarged scale through the wire screen, after coating the same with electron emissive material, said section being taken between horizontal wires of the screen; and

Figure 6 is a similar section taken at one of the horizontal wires of the screen.

Referring to the drawing, and more particularly to Figures 1 and 2, 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 cathode and grid are shown in Figure 2, and the coating of electron emissive material has also been omitted in Figure 2. 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 sealed glass stems. The present invention centers primarily in the structure of the cathode 12.

One characteristic feature of my improved cathode is that the foundation or base is rough or irregular, in order to give the coating a rough or irregular surface, so as to increase the electron emitting area for a given size of cathode base. This is clearly shown in Figure 5, in which it will be seen that the outside surface has indentations 20, which give the same a kind of "waffle-like" surface. Although this may be done by using a rough or irregular sheet metal surface for the foundation, I have found that it is simpler, cheaper, and more convenient to employ a wire screen such as that shown at 22 in Figure 3. Such a screen has the important additional advantage that a coating sprayed or otherwise applied thereon will tenaciously adhere to the screen, for it penetrates the interstices of the screen and surrounds the wires of the same, instead of merely lying on the surface, as would be the case with sheet metal.

In the present case, the cathode is cylindrical, and it is necessary to bend the wire screen 22 from the flat condition shown in Figure 3 to the cylindrical shape shown in Figure 4. The upper end is preferably closed, as by means of a disc of metal 24, best shown in Figure 2. The cathode is heated by means of a heater filament 26 disposed inside the cathode can. It will be understood that when making a cylindrical cathode as here shown, the bending of the cathode screen is preferably completed before applying the electron emissive coating thereto.

It is important that the mesh and wire size of the screen and the thickness of the coating be so interrelated and selected as to produce the desired surface effect. For a given screen, an increase in thickness of the coating will tend to produce a smooth surface, while a decrease in thickness will tend to produce a rough surface or waffle-like effect. If this change is carried still further, a very thin coating will not even fill the interstices in the screen, thus leaving small windows or holes therethrough. For most purposes, I prefer to avoid these holes because the object in view is maximum electron emitting surface, and this is best obtained by reducing the thickness of the coating in the interstices to a minimum, without however actually forming openings through the screen.

In some special cases it may be deemed desirable to purposely provide holes through the cathode. An example of this is when it is sought to intentionally heat the grid **14** in order to help control or minimize the effect of grid emission. In such case, the provision of holes through the grid will permit some of the radiant heat from the filament to pass through the screen, so as to heat the grid to so high a temperature as to clean it off.

The nature of the surface obtained on the cathode depends not only on the thickness of the coating, but also on the dimensional characteristics of the screen. For example, a coarse mesh tends to produce holes, while a fine mesh tends to fill up solidly with the electron emissive material. Similarly, for a given mesh, the use of a fine wire tends to produce holes, while the use of a coarse wire tends to prevent the formation of holes. This assumes the coating to be the same in all cases.

It is because of the foregoing considerations that the general statement is made that the mesh of the screen, the wire size of the screen, and the thickness of the coating must all be properly interrelated and selected to produce the desired surface, whether it be a waffle-like surface, or a perforated surface.

In a specific case I used a 100-mesh cathode screen made of 4½ mil. nickel wire. The liquid coating was made thin enough to use in a spray, the cathode preferably being rotated while being sprayed. The final coating is built up of a number of coats with drying periods therebetween. With one or two coats and drying periods the coating still had perforations therethrough. With three to five coats and drying periods, the holes were filled, but left with a waffle-like effect. With, say, ten coats and drying periods, the final coating was built up to a level condition, and the desired waffle-like effect was lost.

It should be understood that the waffle effect is a coarse roughness or irregularity different from a grainy texture or surface, the latter being obtainable even when using a smooth metal can for the cathode. To produce a grainy surface, the spray gun is preferably held a substantial distance, say ten inches, from the cathode. This permits some drying of the material on its way from the gun to the cathode, and is in contrast with the much smoother surface obtained when the gun is held close to the cathode. In the present invention a grainy surface may be obtained on the waffle-like surface, if so desired.

The electron emissive material is usually an alkaline metal oxide, for example, barium oxide, preferably with the addition of strontium oxide. These materials are initially applied as carbonates which are later reduced to the oxides. The carbonates are mixed with a cellulose acetate binder or adhesive, and the mixture is diluted by means of a preferably highly volatile solvent or vehicle, such as methyl alcohol or amyl acetate.

Referring to Figure 6, which is a section taken at one of the wires, it will be seen that the thickness of the coating is such that small points of metal are exposed at the outside of the cathode. This practice is optional and is intended to reduce the resistance to heat conductivity through the coating. The conductivity across the coating is increased by the presence of the metal, even when the metal does not project through, but the increase is greatest when it does.

Most of the features and advantages of the present cathode are obtained when using a screen wrapped closely around a sheet metal can. I made cathodes of that type first, and may point out the precaution that the screen should preferably be spot welded to the can at numerous points in order to insure uniform heating of the screen and oxide material. However, it is even simpler to eliminate the sheet metal can, and to use the screen itself as the can, instead of merely as a binder for the oxide material.

Reverting to Figure 2, 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 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 is used in 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, and in a copending application of Harold A. Zahl, Glenn F. Rouse, and John E. Gorham, Serial Number 496,654, filed July 29, 1943, which issued as Patent No. 2,454,298 on November 23, 1948.

The cathode **12** may be supported in any suitable manner, but that here shown is deemed preferable. The cathode can is reenforced by means of a ring **32**, and this is carried on a tubular lead-in **34** of substantial diameter, said lead-in being secured coaxially of the can at the open end thereof, a filler ring **36** being used to make up for the difference in diameter between the cathode can and the tubular lead-in. The heater filament **26** is supported and energized by means of a heating current lead-in wire **38**, which preferably runs coaxially through the tubular lead-in **34**. The center lead-in wire **38** is sealed at **40**, and the entire coaxial lead-in assembly ordinarily passes through and is sealed to a glass stem projecting outwardly from the main glass envelope of the tube. The large diameter tubular lead-in **34** may be used as a radio frequency path for cathode tuning purposes, and is also used as one side of the power supply circuit for heating the filament **26**.

It is believed that the method of constructing and using my improved cathode, as well as the advantages thereof, will be apparent from the foregoing detailed description. The electron emitting area is substantially increased without increasing the physical area of the cathode, e. g., the length and diameter in the case of a cylindrical cathode. There is a substantial reservoir of electron emitting material corresponding to a relatively thick oxide coating, yet the oxide material is securely held by the screen foundation, and cannot readily blister or flake off. Holes may be pro-

vided through the cathode if it is desired to heat the grid.

It will be apparent that while I have shown and described my invention in a preferred form, many changes and modifications may be made in the structure 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 comprising a piece of wire screen made of high temperature metal bent to cylindrical configuration, and closed at one end by a disc, the opposite end being carried by a tubular lead-in of substantial diameter coaxial with the cathode, a heater filament inside said cathode, a lead-in wire for said heater filament passing coaxially through the aforesaid tubular lead-in, and a coating of metal oxide electron emissive material applied in varying thickness to the aforesaid cylindrical screen.

2. A cathode for an electron emission tube, said cathode comprising a piece of wire screen of high temperature metal bent to cylindrical configuration, and closed at one end by a disc, the opposite end being carried by a tubular lead-in of substantial diameter coaxial with the cathode, a heater filament inside said cathode, a lead-in wire for said heater filament passing coaxially through the aforesaid tubular lead-in, and a coating of metal oxide electron emissive material applied to the aforesaid cylindrical screen, said screen having a roughened waffle-like surface on the outside of the cathode, thereby increasing the electron emitting area of the cathode for a given length and diameter of cathode can.

3. An electrode assembly comprising a cylindrical cathode, a cylindrical grid surrounding said cathode, and a cylindrical anode surrounding said grid, said cathode comprising a piece of wire screen of high temperature metal bent to cylindrical configuration, and closed at one end by a disc, the opposite end being carried by a tubular lead-in of substantial diameter coaxial with the cathode, a heater filament inside said cathode, a lead-in wire for said heater filament passing coaxially through the aforesaid tubular lead-in, and a coating of metal oxide electron emissive material applied to the aforesaid cylindrical screen to completely cover said wire screen.

GLENN F. ROUSE.

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