Aug. 21, 1934. E. F. LOWRY 1,971,076

METHOD OF COATING A FILAMENT WITH OXIDE

Filed March 3, 1928

Fig. 1.

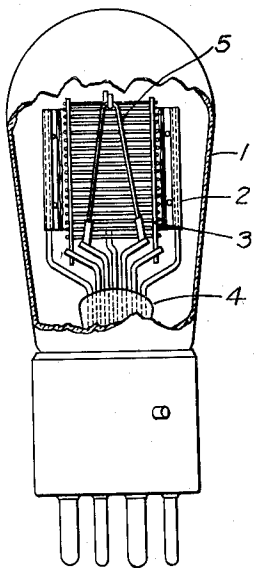


Fig. 2.



Fig. 3.

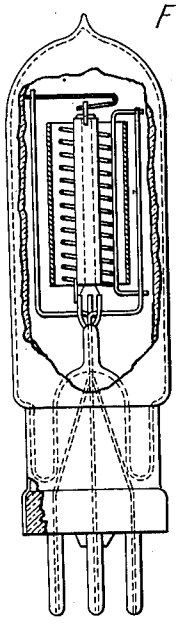
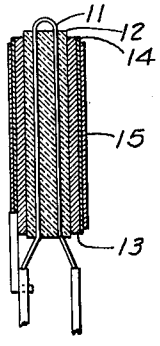


Fig. 4.



INVENTOR

Erwin F. Lowry

BY

ATTORNEY

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METHOD OF COATING A FILAMENT WITH OXIDE

Erwin F. Lowry, Wilkinsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company, a corporation of Pennsylvania

Application March 3, 1928, Serial No. 258,733

3 Claims. (Cl. 250—27.5)

My invention relates to thermionic cathodes and particularly to thermionic cathodes having coatings of electron emissive oxides.

One object of my invention is to provide an oxide coated cathode, the electrical characteristics of which shall be permanent and not subject to progressive change in course of use.

Another object of my invention is to provide an oxide cathode capable of delivering a high electron emission at a lower temperature than oxide cathodes of the prior art.

Further objects of my invention will be apparent upon reading the following specification taken in connection with the drawing, in which:

Figure 1 is an elevational view, partly in section, showing a radio tube of a conventional type provided with a cathode embodying my invention;

Fig. 2 is an enlarged view of a section of a cathode filament made in accordance with my invention and illustrating certain features thereof;

Fig. 3 is an elevational view, partly in section, of a radio tube of the uni-potential cathode type embodying the principles of my invention; and

Fig. 4 is a sectional view of the cathode of the type illustrated in Fig. 3.

In the prior art, thermionically emissive cathodes comprising a base filament of some refractory metal, such as platinum covered with a thin coating of oxides of the alkali metals, such as barium and strontium, are well known. When heated to an elevated temperature by current flow through the base filaments, the oxide coatings emit electrons in an amount dependent upon their temperature. When, however, it has been attempted to employ base metals or alloys for the heater material, in the conventional manner of filaments of the prior art, it has been found that the characteristics, such as the temperature and, consequently, the electron emission at a given current input to the heater element, undergo a gradual change. Continual adjustments by means of variable resistance or the like are, therefore, necessary to maintain the filament at its proper operating temperature. A slight overheating of the filament quickly ruins it and a slight underheating cuts down the electron emission very seriously. Consequently, it is necessary to maintain the adjustment of the filament temperature within relatively close limits if satisfactory operation and life of the cathode are to be attained.

The renewals of batteries for heating the filaments amount to a serious item in the cost of operating radio sets and, consequently, it has always been desirable to operate the filaments at the maximum temperature at which they have a satisfactory life, since the higher the operating temperature the smaller may be the filament diameter and the smaller the heating current required to furnish a given electron emission. One of the principal limitations of the permissible operating temperature has been the volatilization of the base metal and of the oxides composing the electron emissive coating above described. In consequence of the foregoing relation, anything which permits a lowering of the filament temperature for a given electron emission or what is the same thing, an increased electron emission for the same temperature, is of decided advantage.

In the course of numerous experiments on electron emissive oxide coated filaments, I have discovered that in the majority of instances when oxide coatings are provided between the base filaments and the emissive oxides, the electronic emissivity of the latter at a given temperature is greatly increased over the emmissivity obtained at the same temperature for the same oxides deposited on a platinum base; or, in other words, the temperature at which the filament operates when producing a given electron emission is considerably less than that at which an oxide coated platinum filament must operate. In consequence of this decreased temperature, the filament, operating with a given electron emission, undergoes less thermionic change due to volatilization of the oxides than would be the case with a platinum base filament. The amount of heating current that is required is less, and the base filament has a greatly increased life due to its lower operating temperature. Thus, also, troubles from deposition of the volatilized oxides on other electrodes in the tube are avoided. The advantages resulting from the use of my improved cathode are, accordingly, both numerous and important.

Referring in detail to the drawing, Fig. 1 shows a radio tube 1 having an anode 2 and a grid 3 of conventional form supported on a press 4 therein. The cathode 5 comprises a U-shaped filament supported in the usual manner and having a structure shown in more detail in Fig. 2. In the latter, 6 designates the base filament proper which may be nickel, or may be one of the alloys of nickel, cobalt and ferro-titanium described and claimed in my copending application, Serial No. 144,911, entitled Thermionic

cathodes, filed October 28, 1926 and assigned to the Westinghouse Electric & Manufacturing Company. I have found that a base filament comprising nickel and ferro-titanium operates very satisfactorily in connection with the inventions described herein and alternatively that filaments of molybdenum, chromium, titanium, vanadium, manganese and tungsten may be used satisfactorily.

In accordance with still another modification of my invention, a base filament comprising such an alloy of nickel, cobalt and ferro titanium as is described in my copending application above mentioned, may be heated in contact with oxygen to produce a coating of oxide on its surface. To provide an emissive coating, equal parts of barium carbonate and strontium carbonate may be ground to a thin paste with a 5% solution of barium nitrate and the base filament thus oxidized drawn through this paste. The filament may then be dried and baked in an atmosphere of carbon dioxide at a temperature approximately 850° C.

Oxide cathodes made up in the foregoing manner have been found to give as high a thermionic emission at 900° C. as cathodes comprising the same emissive oxides deposited on a platinum iridium base does at a temperature of 1075° C.

In an alternative form of my invention, a base filament comprising an alloy of nickel or any other element in the iron group with chromium, or of any element in the iron group with ferro-manganese, or with ferro-silicon, or with ferro-vanadium, may be heated in contact with oxygen to form a surface oxide and subsequently coated with barium oxide or with barium and strontium oxide in a manner similar to that already described. It will be evident that where one component of the base filament yields an oxide which is thermionically emissive, the additional coating, applied as a paste in accordance with the foregoing, may be dispensed with in certain cases.

In addition to this utility for filamentary cathodes, such as has been described in the foregoing, my invention may advantageously be used to provide emissive coatings for so-called uni-potential cathodes having independent heating elements such as are shown in Figs. 3 and 4 and have recently come to be well known in the radio art in connection with alternating current cathode tubes. Such cathodes may comprise a heating filament 11, preferably in the shape of a hairpin, the straight legs of which pass through two holes in a core 12 of porcelain or other suitable refractory material. Surrounding the refractory core is a sleeve 13 which may be of nickel or of any of the materials previously described as used for base filaments. The surface of the sleeve 13 may be provided with a protective coating 14 by oxidizing it. This coating corresponds in an obvious way to the coatings underlying the emissive oxides on the filamentary cathodes already described; and a coating 15 of alkali oxides may be deposited upon it in the same manner as has been described in the case of the filaments in the foregoing. For similar reasons to those which account for the increased life and emissivity of the filaments treated in accordance with my invention, the uni-potential cathode shown in Fig. 4 will have analogous advantages over cathodes employing oxide coatings deposited on platinum or nickel or other metallic sleeves not provided with protective interposed layers such as I have described.

It will be evident to those skilled in the art that while I have described the oxidation of the base material as a separate step in the process of manufacture, it is within the purview of my invention that it shall occur spontaneously as a result of heating the cathode after application of the thermionic coating, as during the baking thereof.

It will be evident, therefore, that I have disclosed methods of providing electron emissive cathodes of the oxide type having greater life and greater constancy of electrical characteristics than cathodes of the prior art. The broad principles of the invention which I have here disclosed will be capable of embodiment of many structures different from the specific ones described. I, therefore, desire that the terms of the following claims shall be accorded the greatest breadth to which they are entitled in view of their express limitations and of the prior art.

I claim as my invention:

1. An electron emissive cathode comprising a coating of thermionically emissive oxide supported by a base and having an oxidized layer of an alloy consisting essentially of nickel, cobalt and ferro-titanium interposed between the base and said coating.

2. An electron emissive cathode comprising a coating of thermionically emissive material comprising barium oxide supported by a base and having an oxidized layer of an alloy containing 80 to 95 percent of nickel and cobalt, the cobalt comprising 5 to 95 percent of the total cobalt-nickel aggregate and the remainder of said alloy comprising one or more metals of the iron group, titanium, vanadium or silicon, said layer being interposed between the base and said coating.

3. A thermionically emissive cathode having a base containing 5 to 15 percent ferro-titanium, the remainder being cobalt and nickel, an appreciable oxidized layer on the surface of said base and a coating of thermionically emissive oxides on said appreciable oxidized layer.

ERWIN F. LOWRY.