March 29, 1932. A. A. FREY 1,851,699

SPACE CURRENT DISCHARGE DEVICE

Filed Dec. 21, 1923

Fig. 1.

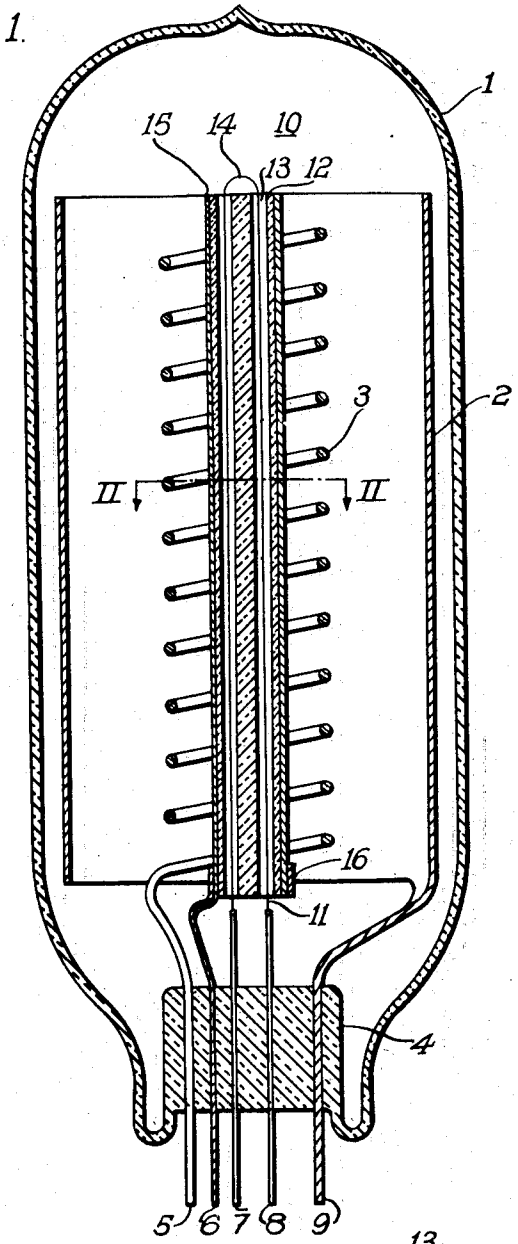
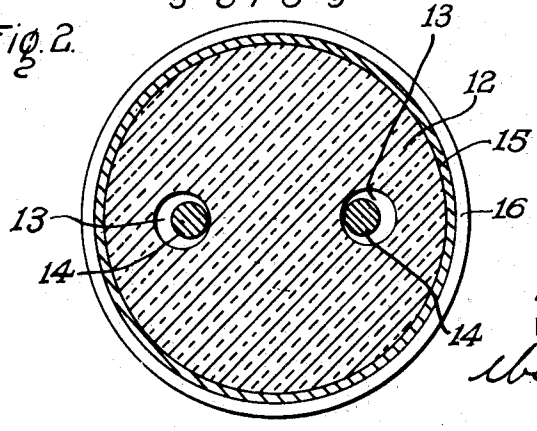


Fig. 2.



WITNESSES:
A. G. Schiefelbein
H. P. Hineline

INVENTOR
Albert A. Frey.
BY
Wesley G. Carr
ATTORNEY

Patented Mar. 29, 1932 1,851,699

UNITED STATES PATENT OFFICE

ALBERT A. FREY, OF WILKINSBURG, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA

SPACE-CURRENT DISCHARGE DEVICE

Application filed December 21, 1923. Serial No. 682,079.

My invention relates to space-current devices and more especially to the cathode structure of such devices.

Broadly speaking, one object of my invention is to produce a unipotential cathode which shall be easily heated and suitable for use in thermionic discharge devices.

Another object of my invention is to produce a unipotential cathode in which the conducting surface will be securely bound to the base framework.

Another object is to produce a unipotential cathode structure suitable for treatment which will increase its electron emission.

Another object of my invention is to produce a closely adherent metallic coating suitable for electron emission.

In the application of Freeman and Wade, Serial No. 611,263, filed January 8, 1922, and assigned to the Westinghouse Electric & Manufacturing Company, is described a cathode structure which has a unipotential surface. This surface is adapted to be heated to an electron-emitting temperature without modulation of the electron stream by the electro-magnetic influence of the heating current. This structure consists of a refractory cylinder perforated with a pair of lengthwise holes in which a heating filament is inserted. It is surrounded by a metallic coating which forms the conducting unipotential surface from which the electron stream is emitted. This cathode structure is mounted in a container with the usual anode, or grid and anode, structures.

Some difficulty has been experienced heretofore in the construction of cathodes of this type in fitting the metallic coating to the refractory core in such way as to provide for rapid heat transfer between the refractory core, which is heated by the filament, and the surrounding metal covering, because of the presence of air spaces between the smooth inner surface of a metal cylinder and the unavoidable roughness of the refractory core.

My device provides a method of applying a conducting coating to the surface of the refractory core in such way as to produce a closely adherent conducting coating. Air spaces are accordingly avoided and the condition best adapted for the transfer of heat from the refractory core to the metal coating is secured.

Other objects and structural details of my invention will be apparent from the following description when read in connection with the accompanying drawings, in which:

Figure 1 is a view in vertical section of a thermionic discharge device, in this instance a triode, embodying my invention, and

Fig. 2 is a view in cross-section of a unipotential cathode constructed according to my invention.

Referring to Fig. 1, a thermionic tube comprises a container 1, an anode 2, a grid 3, a press 4 and lead wires 5, 6, 7, 8 and 9 as in the prior art. A cathode structure 10 consists of a base 12 of refractory material, perforated with holes 13, in which is positioned a filament 14 that is connected to lead wires 7 and 8. A metal coating 15, formed in accordance with the method of my invention, surrounds the refractory core 12. A collar 16 surrounds the lower end of the cathode structure. It makes contact with the metal coating 15 and is attached to lead wire 6.

It will be noted that, when the cathode lead wire 6 is positioned between the heater lead wires 7 and 8 and the grid lead 5, as shown, the lead wire 6 serves as an electrostatic shield to prevent electrostatic coupling between the heater leads and the grid lead.

In practicing my invention, I produce a cylindrical structure of refractory material, such as zircon, which is an electrically non-conducting natural silicate of zirconium. The operations of producing this cylinder consist of mixing zircon with a suitable binder, extruding the mixture from a press and baking the formed material at a temperature high enough to sinter the particles of zircon together. During the baking, the binder is completely driven off, leaving a substantially porcelain-like foundation structure. This cylinder is extruded with two or more lengthwise holes. The cylinder is cut to length, and a tungsten or other suitable filament is threaded through these holes to serve as heating means for the cathode.

I then produce a metallic coating upon the

outer surface of the zircon cylinder in any one of several ways. The zircon structure with its contained heating filament may then be supported in an atmosphere of nickel carbonyl. This substance is the gaseous compound of metallic nickel and carbon monoxide. It is formed by chemical action between metallic nickel and carbon monoxide at room temperature, or a very few degrees above, and it is decomposed into metallic nickel and carbon monoxide at a temperature somewhat below a dull red heat.

Having mounted the zircon cylinder with its contained filament heater in an atmosphere of nickel carbonyl, a current is passed through the filament heater to raise the temperature of the entire structure almost to a dull red heat, thereby causing the decomposition of nickel carbonyl vapor at the surface of the refractory cylinder. The liberated nickel is deposited in a film on the zircon cylinder, while the carbon monoxide being a gas, diffuses away. This treatment gives a deposit of nickel upon the surface of the cathode structure which may be built up to the desired thickness by continued heating in the nickel carbonyl vapor.

When a satisfactory thickness of nickel coating is obtained, it may be toughened by further heat treatment, in the manner well known in the art of heat treating metals. The electron-emitting properties of the nickel surface thus obtained may be increased by treatment with the customary alkaline earth oxides. The cathode is then ready for mounting in the usual way in a thermionic discharge device.

A conducting coating may also be produced upon the zircon foundation by depositing metal from a colloidal solution thereof such as a colloidal solution of gold, platinum, silver, or other metal. For some purposes, the coating obtained from the colloidal solution is sufficient. For other purposes, it may be too thin and, in such cases, it may serve as a conducting layer upon which to deposit a thicker layer of metal by electro-chemical methods, which layer may be compacted by heat treatment, as in the case of the first-mentioned nickel coating. It may likewise be treated with the customary oxides to increase its electron emission.

It is also possible to produce a satisfactory coating by spraying upon the surface of the zircon cylinder, fused metal in droplet form from a spray pistol, after a fashion which is also well known in the art. In this instance, as well, a further thickness of metal may be deposited, if desired, by electro-chemical methods and the metal coating may be treated with the customary oxides to increase its electron emission.

It is likewise possible to produce a conducting coating upon the surface of the refractory cylinder by first giving it an application of varnish and graphite, this conducting coating serving as a foundation upon which to deposit more metal by electro-chemical methods. In practicing this process, the varnish and graphite are burned out by a heat treatment following the deposition. This heat treatment may also serve to improve the quality of the deposited metal.

By practicing my invention as described in its various modications, I am enabled to produce a unipotential cathode structure which can be heated by alternating current without the production of magnetic modulation of the electron stream which ordinarily occurs when alternating current is employed. I am also able to produce a cathode structure, of the type just mentioned, which is more easily heated, due to the better heat conductivity from the refractory base to the metal coating. I am able to produce this unipotential cathode more easily than is possible by previous methods and the coating obtained is more suitable for emission of electrons.

My invention is capable of changes and modifications without departing from the spirit and scope thereof, and I desire, therefore, that only such limitations shall be placed thereon as are indicated in the prior art or in the appended claims.

I claim as my invention:

1. The method of producing a unipotential cathode which comprises heating a zircon base in an atmosphere of nickel carbonyl.

2. The method of producing an electrode adapted to operate continuously in a high vacuum electrode tube which comprises heating a zircon base in an atmosphere of nickel carbonyl.

3. The method of preparing an equi-potential cathode which comprises heating a zircon base in an atmosphere of nickel carbonyl to produce a nickel coating and heat treating said coating.

4. The method of preparing an equi-potential cathode for an electron tube which comprises heating a zircon base in nickel carbonyl to deposit thereon a nickel coating, heat treating said coating and treating said coating to increase its electron emission.

In testimony whereof, I have hereunto subscribed my name this 17th day of December, 1923.

ALBERT A. FREY.