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ELECTRON EMITTER AND PROCESS OF MAKING SAME

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FIG. 1

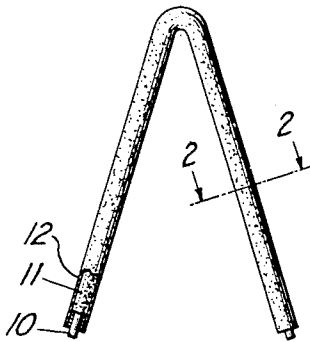


FIG. 2

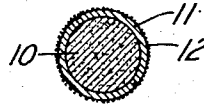
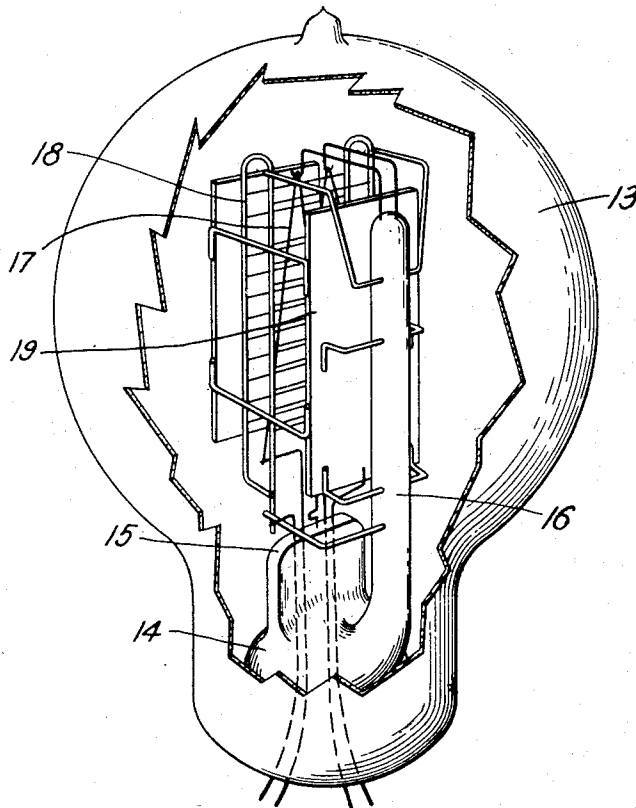


FIG. 3



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This invention relates to electron emitters and the process of making them.

An object of this invention is to increase the efficiency and thermionic activity of oxide-coated cathodes.

Another object of the invention is to increase the uniformity of the coating of cathodes of the oxide coated type.

In accordance with a broad aspect of the invention, a cathode is produced in which an electro-positive element is combined with an electro-negative metal or alloy to form a core. A comparatively thin and uniform layer of oxide of the electro-positive element contained in the core may be formed thereon or an oxide layer of a combination of elements may be formed upon the core. An adsorbed layer of the electro-positive element is then formed on the exterior of the oxide layer to produce a highly efficient active cathode for electron discharge devices.

In a more specific aspect of the invention a platinum iridium filament core is alloyed with alkaline earth metals, such as barium and strontium in vacuum. The alloy core is then treated in an oxidizing atmosphere to form a layer or layers of oxide of barium and strontium on the core and thereafter heated in vacuum to such a temperature that some of the metallic barium and strontium will diffuse through the oxide layer and form a thin film or monomolecular layer of active metal on the oxide layer. The important features of the invention are the diffusion of alkaline earth metal through the oxide coating, the formation of the alkaline earth metal on the oxide coating which imparts increased thermionic activity to the cathode and the formation of oxide layers of controllable thickness which forms a complete binder for the active metallic film.

These and other features of the invention will be clearly understood from a study of the following detailed description in connection with the accompanying drawing in which:

Fig. 1 shows a filamentary cathode or emitter produced in accordance with this invention;

Fig. 2 is an enlarged cross-sectional view on the line 2—2 of a portion of the cathode shown in Fig. 1, illustrating the relative thickness of the different materials in the cathode; and

Fig. 3 illustrates one embodiment of the invention in a three-electrode discharge device.

Referring to Fig. 1 the cathode or electron emitter made in accordance with this invention comprises a metallic core 10 preferably consisting of an alloy of electro-negative metal and

one or more elements of the electro-positive group. Such a core may be made in accordance with this invention by heating platinum or a platinum iridium alloy and a supply of electro-positive elements in an evacuated vessel or a reducing atmosphere. The electro-positive material may consist of one or more elements of the alkali group, alkaline earth group or metals of the rare earth group. A desirable material which may be obtained in a relatively pure state consists of metallic barium or a combination of metallic barium and strontium. Barium is particularly desirable since this metal has a low work function while the addition of strontium to barium increases the ability of the barium to adhere to the oxide layer at high temperatures. The alloy produced in this manner may then be drawn into wire form suitable for a cathode core. The drawing operation is preferably performed in a non-oxidizing atmosphere. The alloy core 10 is heated in an oxidizing atmosphere to diffuse some of the barium and strontium to the surface of the core where it forms a coating of barium and strontium oxide 11. Any thickness of oxide coating 11 may be produced on the core 10 by controlling the amount of heating, the time, or the gas pressure employed during the oxidizing treatment. Similarly, any number of layers may be produced on the core by repeated diffusion of the metallic barium and strontium from the core and oxidizing the surface layer. However, for the purposes of this invention all of the barium and strontium is not diffused from the core, but only sufficient diffusion takes place to secure a desirable coating of oxide on the core base 10. It is desirable that this oxide coating be neither too thick nor too thin; 10 to 100 molecular layers is sufficient. The oxide coating produced on the core in accordance with this invention is distinctly oxide and no particles of metallic barium or strontium are contained therein. Furthermore, the oxide coating produced in this manner is more uniform over the whole surface of the core 10.

After the oxidizing treatment the coated cathode is placed in a vessel which has been highly evacuated and the cathode is heated to such a temperature that some of the barium or barium and strontium in the core is diffused through the oxide onto the surface of the filament and forms an adsorbed layer 12 of thermionically active metal containing principally metallic barium or metallic barium and metallic strontium. In accordance with this invention it is not necessary that the layer of pure metal 12 on the oxide

layer 11 be a continuous layer or film. In fact, the barium or barium and strontium may cover the surface in an atomic or molecular form or else form colloidal particles on the oxide coating. The relative thicknesses of the materials in the cathode core is shown more clearly in Fig. 2 in which the metallic layer 12 is a relatively thin film compared with the oxide coating 11 and the diameter of the core 10. The combination of the metal coating 12 and the layers of oxide 11 is responsible for the increased thermionic activity of a filament made in accordance with this invention. Furthermore, in the operation of this type of filament the life of the cathode may be increased by the continuous diffusion of additional barium or barium and strontium from the core and their adsorption on the oxide coating. The barium in the core acts as a reservoir to replenish the active layer 12 upon the oxide layer 11. A suitable thermionically active cathode may also be produced by combining the electro-positive material such as metallic barium and strontium with any other electro-negative metal in wire form by forming an alloy on the wire. The oxidation and diffusion steps heretofore described may then be applied to the alloy wire core to form an improved cathode or electron emitter in accordance with this invention.

While the incorporation of the thermionically active metal in the core prior to the oxidizing and diffusing treatment is preferable the cathode of this invention may also be produced by forming oxides of alkaline earth metal on any suitable core for a cathode and thereafter forming a thin layer of pure metals of the alkaline earth group on the oxide coating by heating in a vacuum or a deducing atmosphere.

One type of electron discharge device to which this invention is applicable is shown in Fig. 3. It comprises an enclosing vessel 13 having a reentrant stem 14 terminating in a press 15 in which are sealed the leading-in wires for the electrodes. A glass arbor 16 is fused to the side of the stem and extends substantially parallel to the axis thereof. A cathode of electron emitter 17, produced in accordance with this invention, is resiliently supported from the arbor 16. A grid electrode 18 and an anode or plate electrode 19 are supported in cooperative relation to the cathode 17 by wires extending from the arbor 16.

The invention is applicable to other types of electron discharge devices than that shown in Fig. 3, and it is to be limited only by the scope of the appended claims.

What is claimed is:

1. The process of making an electron emitter having a core composed of an electro-negative element, and an electro-positive element, which comprises forming an alloy of said elements, drawing said alloy in a reducing atmosphere into a form suitable for a cathode core, treating said core to form a layer of oxide thereon, and diffusing some of said electro-positive element from said core through said oxide layer to the surface thereof.

2. The process of making an electron emitter having a core composed of an electro-negative

element and an electro-positive element, which comprises forming an alloy of said elements suitable for a cathode core, in a reducing atmosphere, heating said alloy in an oxidizing atmosphere to form an oxide layer of said electro-positive element thereon, and heating said cathode at a high temperature in a non-oxidizing atmosphere so as to diffuse a layer of said electro-positive element from said core to form an adsorbed layer upon said oxide layer.

3. An electron emitter comprising a cathode core containing an alloy of an electro-negative element and an electro-positive element, an oxide layer on said core, and an adsorbed film of said electro-positive element on said oxide layer.

4. An electron emitter comprising a cathode core containing an alloy of an electro-negative metal and an electro-positive metal, an oxide layer of an electro-positive metal thereon, and a thin film of said electro-positive metal superimposed on said oxide layer.

5. An electron emitter comprising a cathode core containing an alloy of a refractory metal and a metal of the alkaline earth group, a layer of oxide of said metal on said core, and a molecular layer of said metal on said oxide layer.

6. A cathode comprising a core of an alloy of a refractory metal and a metal of the alkaline earth group, a layer of alkaline earth oxide on said core, and an adsorbed thermionically active layer of said metal on said oxide layer.

7. A cathode comprising an alloy core of electro-negative and electro-positive metals, a layer of oxide of the electro-positive metal thereon, and a film of active electro-positive metal on said oxide.

8. A cathode comprising an alloy core consisting of platinum and barium, a layer of barium oxide on said core oxide, and a coating of metallic barium on said oxide layer.

9. The process of making an electron emitting cathode composed of a core of an electro-negative element and an electro-positive element, which comprises forming an alloy of said elements, diffusing some of the electro-positive element to the surface of said core, and oxidizing the surface element.

10. The process of making an electron emitting cathode composed of a core of an electro-negative element and an electro-positive element, which comprises forming an alloy of said elements, diffusing some of the electro-positive element to the surface of said core, oxidizing said surface element, and diffusing an additional quantity of said electro-positive element from the core through the oxide layer to the surface thereof.

11. The process of making an electron emitting cathode composed of a core of platinum and barium and strontium, which comprises forming an alloy of platinum, barium and strontium, diffusing said barium and strontium to the surface of said core, oxidizing the surface of said core, and diffusing barium and strontium through the oxide layer from within the core to the surface of the oxide layer.

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