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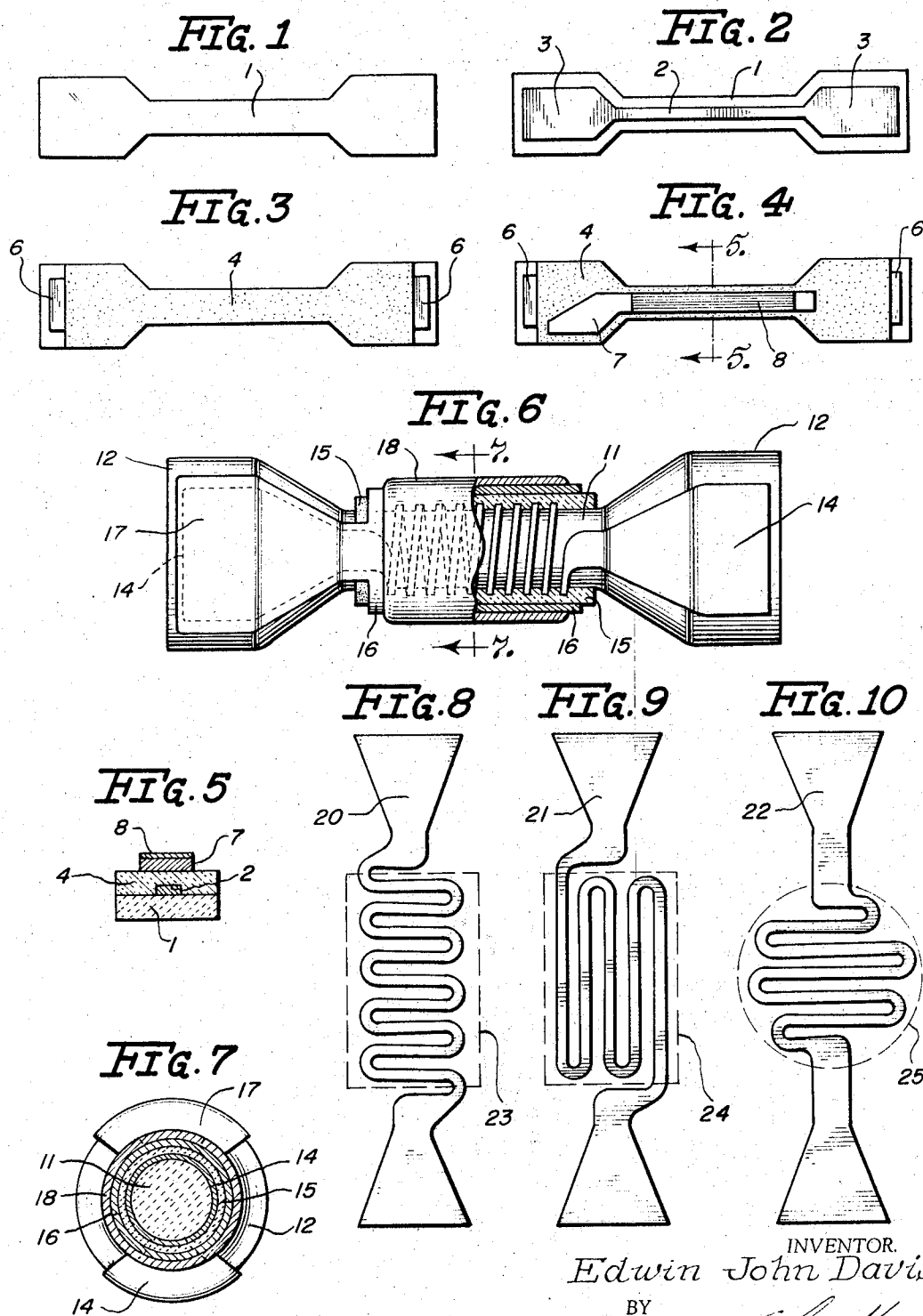
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3,307,974

METHOD OF FORMING THERMIONIC CATHODES

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2 Sheets-Sheet 1



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FIG. 11

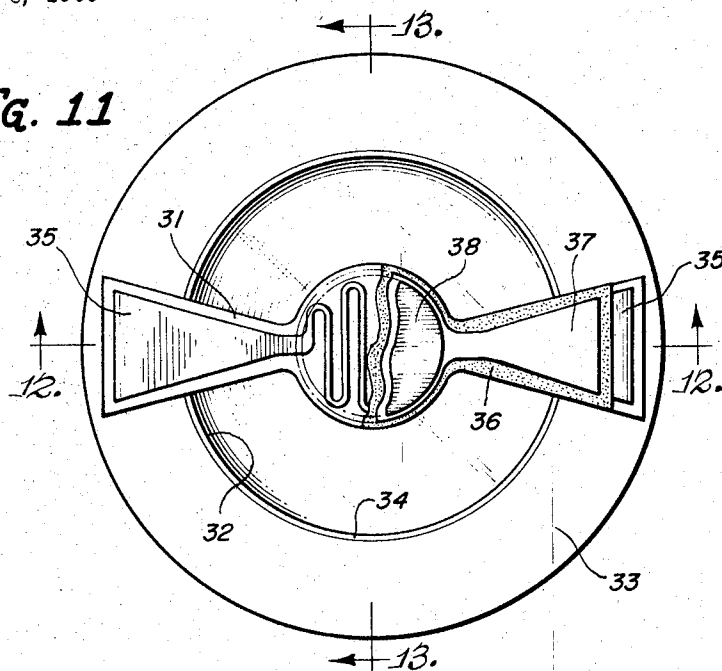


FIG. 12

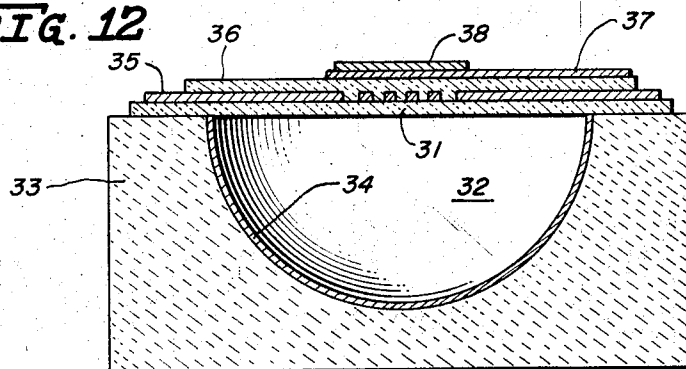
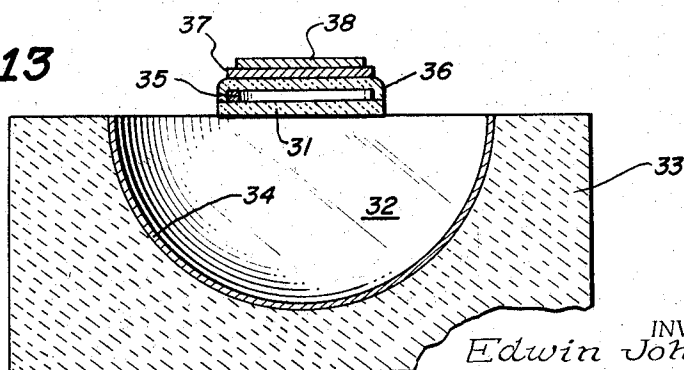


FIG. 13



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3,307,974 METHOD OF FORMING THERMIONIC CATHODES

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6 Claims. (Cl. 117—212)

This invention pertains to improvements in thermionic cathodes of the type used as electron sources in thermionic tubes and cathode-ray tubes and is especially directed to an improved method of forming such cathodes.

According to conventional techniques a thermionic cathode is constructed by providing a metal body of appropriate form, of which one surface is rendered electron emissive by the addition of a coating of electron emissive material and adjacent to which is provided means for heating it to an appropriately high temperature. Thus a common form of cathode for a thermionic valve comprises a tubular metal cathode body upon the outer surface of which is deposited a layer of a mixture of finely powdered carbonates of alkaline earth and other metals and within which is inserted an insulated resistance-wire element through which a current is passed to heat the cathode to its operating temperature.

In accordance with the present invention a thermionic cathode is formed on an insulating body by the following steps: a first layer of conductive material is deposited onto the insulating body to form a heater for the cathode, thereafter at least a part of the heater is coated with a layer of insulating material, and then a layer of electron emissive material is deposited on at least a portion of the insulating layer.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The invention together with further objects and advantages thereof may best be understood, however, with reference to the following description taken in connection with the accompanying drawings in the several figures of which like reference numerals identify like elements and in which:

FIGURES 1 to 4 illustrate the different steps in the production of one embodiment of thermionic cathodes in accordance with this invention;

FIGURE 5 is a cross sectional view taken along the line 5—5 in FIGURE 4;

FIGURE 6 shows a part sectional elevation of a partially manufactured cathode according to another embodiment of the present invention;

FIGURE 7 is a cross sectional view along the line 7—7 in FIGURE 6;

FIGURES 8 to 10 show different modifications of the heater element which may be used in cathodes constructed according to the invention;

FIGURE 11 is a plan view of a further embodiment of the invention;

And FIGURES 12 and 13 are cross sectional views taken along lines 12—12 and 13—13, respectively in FIGURE 11.

When a cathode in accordance with the present invention is required for use in a conventional thermionic tube the insulating body may take the form of a rod, or preferably a tube. Where emission from a planar or curved surface is required, as in many types of cathode-ray tubes and in some thermionic tubes, the insulating body will be given the appropriate form. The material of which this insulating body is made may be quartz or a suitable ceramic material such as is well known in the art. Al-

ternatively an element formed of synthetic sapphire may be employed.

Upon the insulating body or substrate a conductive layer is deposited by an appropriate method such as vacuum evaporation, cathodic sputtering, electrodeposition or the use of a suitable conductive paint. The layer so deposited, which forms the heater for the cathode, may be serpentine or plicated so as to provide between terminal portions thereof at which current-carrying connections will be made, a heater path of a length substantially exceeding the shortest distance between the heater terminals. Alternatively, a continuous layer extending over at least the whole emissive area may be used. In this case it may be found to be advantageous to vary the thickness of the layer to produce substantially uniform heating of the emissive area.

Over the conductive heater layer formed as described above there is now applied a layer of insulating material. Suitable insulating materials for this purpose are tantalum oxide, magnesium oxide, silicon dioxide or aluminum oxide. This insulating layer may be formed, for example, by initially depositing a layer of the metal and then oxidizing this layer, for example by anodization, or by evaporation or vapor deposition of the oxide directly. In a modification of the first-mentioned process, the surface of the conductive layer may itself be oxidized to form the required insulation.

Superimposed upon the insulated heater element formed as described above there is now applied a further conductive layer of a material suitable to form the base of the cathode proper. Again, this layer may be vacuum evaporated, sputtered, electrodeposited, or applied as conductive paint. The metal employed for this layer is suitably nickel, or a suitable nickel-base alloy of which many are known in the art, or platinum.

The cathode base layer having been deposited, a further coating of material capable of yielding a supply of thermionic electrons over an extended period is applied over it. This coating may be any known emissive coating, for example of the single or multiple-carbonate type, or may be a combination of a supply of electron-emissive material with a superimposed spongy or sintered porous metal coating such as is well known in the art.

In FIGURE 1 the cathode body or support 1 is suitable for use in the manufacture of a linear thermionic cathode according to the method of the present invention. The support may be formed of ceramic, fused silica or any suitable insulating material as mentioned above.

In practicing the invention a first layer of conductive material is deposited on support 1 to form a heater element for the cathode. As shown in FIGURE 2, a laminar heater element 2 is applied to body 1. The heater may be deposited onto body 1 by any suitable method, for example by evaporation through a mask of appropriate configuration and dimension. The heater element 2 has enlarged end portions 3 which serve as terminals and which reduce the temperature of those points of the heater to which connections will be made.

Having formed the heater, it is at least partially coated with a layer 4 of insulating material. As indicated in FIGURE 3, the ends 6 of the heater terminals are left exposed so that connections may be made to them.

In the final step of the method, a layer of electron emissive material is deposited over insulating layer 4. As illustrated in FIGURE 4, the thermionically emissive layer 7 is deposited over insulating layer 4 and may comprise a conductive substrate upon which an emissive layer 8 is deposited. Layer 8 is preferably confined to that area (the shaded area in FIGURE 4) which is required to emit electrons.

In the modification shown in FIGURES 6 and 7 the in-

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insulating support or body portion 11 is of cylindrical formation with enlarged ends 12. Upon this support there is deposited a layer 14 of conductive material to serve as the heater which may be a continuous cylindrical film but preferably is of helical form with enlarged terminal portions to which connections may conventionally be made. An insulating coating 15 is provided over heater element 14 and a second conductive layer 16 is formed over this coating extensions 17—17 of layer 16 are provided on the enlarged ends 12 of the support 11. Finally, a layer 18 of electron emissive material is deposited on conductive layer 16. While support 11 has been shown as a rod, it may be a hollow tube through which connections may be made to the terminal portions of heater layer 14.

FIGURES 8 to 10 show alternative serpentine shaped forms of heater elements 20, 21 and 22 which are suitable for heating areas of the electron emissive surface indicated by broken lines 23, 24 and 25 respectively.

In the modification of FIGURES 11, 12 and 13 the insulating body of the cathode is a shaped strip of insulating material 31 secured across a hemi-spherical recess 32 in an insulating body 33. The recess 32 is coated with a layer 34 of heat reflective material which may be made of a vacuum evaporated nickel, platinum or similar metal of suitable high melting point.

A heater element 35 of the shape shown in FIGURE 10 is formed on support 31 and an insulating coating 36 is placed over the heater. A second conductive layer 37 may be deposited onto this insulating layer and the central portion 38 thereof is rendered electron emissive by a coating of one or more carbonates or other known process.

Thus a very simple and convenient method of manufacturing cathodes is provided which is advantageous, for example, in the fabrication of cathode-ray tubes.

While a particular embodiment of the present invention has been shown and described, it is apparent that various changes and modifications may be made, and it is therefore intended in the following claims to cover all such modifications and changes as may fall within the true spirit and scope of this invention.

I claim:

1. A method of forming a thermionic cathode on an insulating body comprising in the order named the steps of: depositing a first layer of conductive material onto said body to form a heater for the cathode; coating said heater at least in part with a layer of insulating material; and depositing a layer of electron emissive material on at least a portion of said insulating layer.

2. A method of forming a thermionic cathode on an insulating body comprising in the order named the steps of: depositing a first layer of conductive material onto

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said body to form a heater for the cathode; coating said heater at least in part with a layer of insulating material; forming a second layer of conductive material on at least a part of said insulating coating; and depositing a layer of electron emissive material on at least a portion of said second conductive layer.

3. A method of forming an indirectly heated thermionic cathode on an insulating body comprising in the order named, the steps of: depositing onto said body a layer of conductive material to form a heater element having enlarged terminal portions and having a length substantially exceeding the shortest distance between said terminal portions; coating said heater element, except for said terminal portions thereof, with a layer of insulating material; and depositing a layer of electron emissive material on said insulating coating.

4. In the manufacture of an electron discharge device, the method of forming an indirectly heated thermionic cathode on an insulating body comprising in the order named, the steps of: depositing a first layer of conductive material of variable thickness onto at least a part of said body to form a heater for the cathode; forming an insulating layer on said heater; applying a second layer of conductive material on said insulating coating; and depositing a layer of electron emissive material on said second conductive layer.

5. A method of forming an indirectly heated cylindrical thermionic cathode on a cylindrical insulating body comprising in the order named, the steps of: depositing on said body a layer of conductive material to provide a helical heater element having enlarged terminal portions; coating said heater element, except for said terminal portions thereof, with a layer of insulating material; forming a second cylindrical layer of conductive material on said insulating coating; and depositing a layer of electron emissive material on said second conductive layer.

6. A method according to claim 1 in which said insulating coating on said heater is formed by oxidizing the metallic surface of said first conductive layer.

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