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MANUFACTURE OF ELECTRICAL DISCHARGE DEVICES

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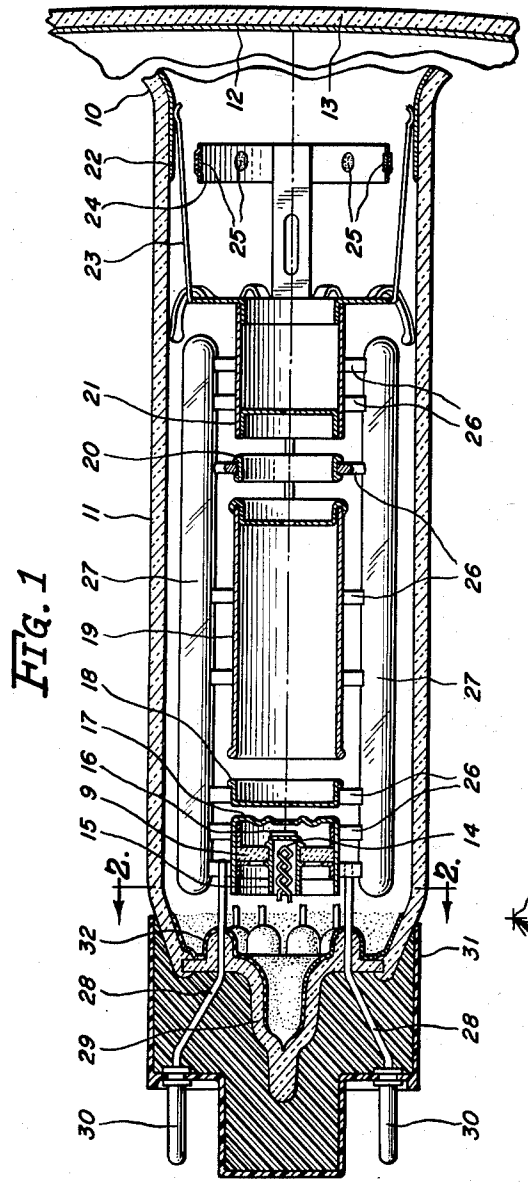


FIG. 1

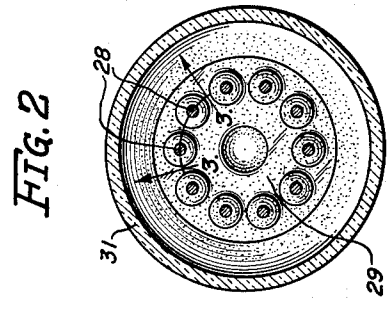


FIG. 2

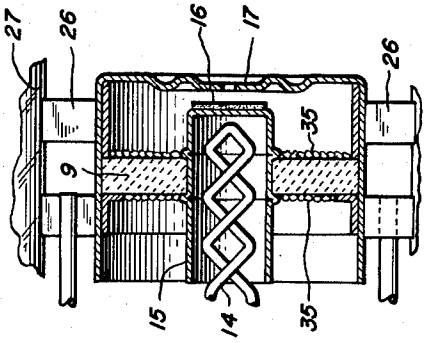


FIG. 5

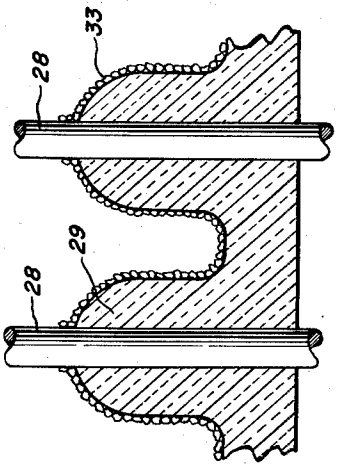


FIG. 3

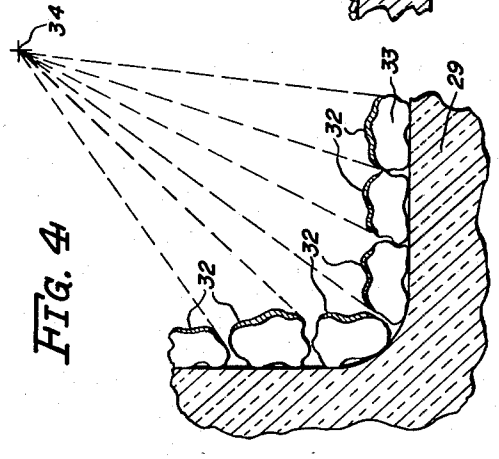


FIG. 4

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MANUFACTURE OF ELECTRICAL DISCHARGE DEVICES

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Application February 27, 1959, Serial No. 796,074

7 Claims. (Cl. 316—4)

This invention relates generally to electron-discharge devices and more specifically to a new and improved method of manufacture of such devices. The application is a continuation-in-part of a co-pending application of Nathan D. Levin, Serial No. 646,165, filed March 14, 1957, and assigned to the same assignee as the present application.

In the manufacture of electron-discharge devices, such as radio receiving and cathode-ray type image-reproducing tubes, the various electrode elements are fixedly mounted within an envelope in predetermined operative relation to one another. Electrical connections are made to the electrode elements by respectively welding thereto a plurality of lead-in conductors which, in turn, are sealed in and extend through an insulating press member bonded to the envelope. After the electrode elements are properly mounted, the press is sealed to the tube envelope and the device is then evacuated, gettered, and based according to well known techniques in the art.

However, when the getter, which is normally composed of such metal as Misch metal or barium is sputtered during the gettering process, a portion of the getter material frequently settles onto the surface of the insulating press. This results in the formation of an electrically conductive coating which substantially decreases the electrical leakage resistance across the surface of the press between the lead-in conductors and thus destroys the desirable insulating properties of the press. In addition, during activation, and in fact, even during normal operation of the finished tube, the electrodes and also the connecting straps may emanate a metallic vapor when heated to their normal operating temperature. Thus, through the process of sublimation, an electrically conductive sublimate is again deposited on the innermost surface of the press.

Various deterrents have been employed in the past to prevent formation of these leakage paths between the lead-in conductors to facilitate continued operation and thus obtain the maximum usefulness of the device in operation. For example, it has been proposed to coat the press with a granular insulating material whereby the effective surface area of the press is increased several hundred times. In addition, each granule of the coating is "shadow-casting" and thereby prevents formation of a continuous film of electrically conductive material between the lead-in conductors. The formation of such granular coatings to date, however, has necessitated the use of expensive materials and involves several steps of costly and time consuming manufacturing operations. In addition, the coatings also tend to introduce deleterious impurities into the tube.

The formation of such a continuous film of conductive material on the press has also been prevented by the use of eyelets which are individually welded to the lead-in conductors and provided with flanges parallel to and closely spaced from the press surface; a third method utilized the formation of a plurality of slots on the surface of the press intermediate the lead-in conductors. However, the

use of such eyelets is highly undesirable from the standpoint of economy as they are relatively expensive and involve several costly and time consuming steps in order to complete the necessary welding operations, and the use of slots has the disadvantage of weakening the press and also involves costly construction techniques.

Another commonly encountered problem, especially in cathode-ray tubes, is electrical leakage between the cathode and the first grid of the electrode assembly. The cathode is customarily mounted in telescopic relation to the first grid electrode and is supported and insulated from it by a transversely disposed ceramic wafer. The insulating wafer, having a flat surface of relatively large area, tends to accumulate an electrically conductive sublimate in a manner similar to the accumulation on the inner surface of the press.

Therefore, one of the principal objects of the present invention is to devise a new and improved method of preventing or substantially reducing electrical leakage between conductive elements, such as the lead-in wires or a pair of electrodes, of an electron-discharge device in a simple, economical, yet highly effective manner.

A further object of the present invention is to devise a new and improved method of manufacturing cathode-ray tubes in which electrical leakage between the cathode and the first grid is prevented or greatly reduced.

Another object of the present invention is to devise a new and improved method for the purposes aforesaid whereby deleterious impurities are not introduced into the device as an incident of the process.

A corollary object of the present invention is to devise such a new and improved method which is readily adaptable to mass production techniques.

The present invention provides a new and improved method for use in the manufacture of an electron-discharge device comprising, within an enclosing envelope, a pair of conductive elements requiring the application of different operating potentials, and an insulating member contacting both of the conductive elements. The inventive method comprises the steps of coating the insulating member with a liquid suspension of magnesium hydroxide and heating the insulating member to a temperature sufficient to reduce the coating to an adherent granular magnesium oxide insulating coating, whereby the formation of an electrically conductive sublimation on the insulating member between the conductive elements, as an incident to subsequent fabrication and operation of the device, is prevented. In actual practice, the heat applied during the sealing of the press to the envelope or as an incident to the evacuating operation, in which a baking cycle is normally employed, is sufficient to reduce the magnesium hydroxide to magnesium oxide, so that no additional heating step is required.

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 by reference to the following description taken in connection with the accompanying drawing, in the several figures of which like reference numerals identify like elements, and in which:

Figure 1 is a cross-sectional view of a cathode-ray image-reproducer incorporating the present invention;

Figure 2 is a cross-sectional view taken along the line 2—2 of Figure 1;

Figure 3 is a fragmentary cross-sectional view taken along the line 3—3 of Figure 2;

Figure 4 is an enlarged fragmentary cross-sectional view diagrammatically illustrating the details of the granular coating; and

Figure 5 is an enlarged fragmentary cross-sectional view showing the invention as applied to reduce electrical

leakage between the cathode and first grid electrode of the device of Figure 1.

With reference to Figure 1, there is shown, for illustrative purposes only, a typical cathode-ray image-reproducer incorporating the present invention. The particular reproducer shown comprises an enclosing glass envelope having a bulb portion 10, a rearwardly projecting neck portion 11, and a fluorescent screen 12 deposited on the innermost surface of faceplate 13. A conventional electron gun assembly is mounted within neck portion 11 and comprises essentially an aluminum oxide coated filament 14 mounted within a nickel cathode sleeve 15. A carbonate coating 16, composed of barium carbonate and a suitable binder added thereto or a mixture of barium carbonate with the carbonates of other alkaline-earth metals, is sprayed or otherwise applied to the exposed face of cathode sleeve 15 and is rendered thermionically emissive when reduced to an oxide. An apertured control electrode 17 is insulated from cathode 15 by ceramic insulating wafer 9 and completely encompasses cathode 15 with the aperture thereof in close proximity to coating 16.

The electron gun further includes apertured electron-beam-forming anodes 18 and 19 followed by beam focusing anodes 20 and 21. A final accelerating anode 22, consisting of a colloidal graphite coating sprayed or otherwise formed on the innermost surface of the envelope, is electrically connected to anode 21 by contact spring members 23 mounted thereon in contact with coating 22. A getter strap 24 is affixed to anode 21 and supports a plurality of globules of barium getter material 25 which is sputtered by the application of an external magnetic field to generate eddy currents in strap 24, as is well known in the art. The electrode elements are secured in a fixed position operatively related to one another by metallic straps 26 welded thereto and heat-fused to glass support rods 27. Electrical connections are made to the electrodes by a plurality of lead-in wires 28 respectively welded thereto and which are sealed in and extend through an insulating press member 29 which, in turn, is fused to the end of neck 11. The lead-in wires are cut to proper lengths and respectively welded to a plurality of pins 30 mounted on a phenolic base member 31 secured to neck portion 11 and completely enclosing lead-in wires 28 and press 29.

After the tube elements are properly mounted, the envelope is evacuated to a pressure of approximately 3×10^{-4} millimeters of mercury. An alternating voltage of approximately four volts (R.M.S.) is applied to filament 14 for approximately fifteen seconds to heat cathode 15 to a temperature of approximately 680° C. At this point, the cathode coating binder material is driven off and the voltage applied to filament 14 is increased to approximately eight volts to raise the temperature of cathode 15 to approximately 875° C. After a time lapse of approximately fifteen seconds, reduction of carbonate coating 16 to an oxide begins, after which, the voltage applied to filament 14 is raised to ten volts to increase the temperature of cathode 15 to approximately 950° C. After approximately thirty seconds, the reduction is completed and with continued heating, coating 16 is rendered thermionically emissive; thereafter the tube is gettered to remove any residual contaminating gases and is based according to principles well known in the art.

It is to be appreciated, of course, that the exact details of this activation process are entirely conventional and may vary greatly in actual commercial production.

As before mentioned, however, during the activation, ageing and gettering processes and also during normal operation of the device, an electrically conductive coating, shown as 32, is deposited on the innermost surface of press 29 and wafer 9 and thereby greatly increases the electrical leakage between lead wires 28 and between cathode 15 and control electrode 17. However, before the envelope is evacuated and in accordance with the

present invention, press 29 and wafer 9 are coated by brushing, spraying or the like with a finely divided insoluble suspension of magnesium hydroxide, commonly known as milk of magnesia. In order to prevent the introduction of water vapor and other deleterious impurities into the tube envelope during processing, it is preferred that the magnesium hydroxide coating either be dried or allowed to dry before the press and electron gun assembly is sealed to the neck. During the sealing-in operation in which heat is applied to fuse press 29 to the neck of the tube envelope, the magnesium hydroxide coating is simultaneously reduced to form a granular adherent insulating coating of magnesium oxide on the press as shown diagrammatically as 33 in Figures 3 and 4. Subsequent processing of the device during the exhaust cycle involves the application of sufficient heat to reduce the magnesium hydroxide coating on ceramic wafer 9 to a granular adherent insulating coating 35 of magnesium oxide, as shown in Figure 5.

With reference to Figure 4, if it is assumed, for illustrative purposes only, that the entire source of metallic vapor is remotely located at point 34, and as it is well known that the metallic vapor will be deposited on coating 33 along straight line projections, it can be seen that, in addition to effectively increasing the surface area of the press, each granule of coating 33 is shadow-casting and consequently prevents the formation of a continuous film of electrically conductive material, thereby preserving the desirable high electrical potential characteristics of press 29. Even though the entire source of metallic vapor is not in reality remotely located at a single point, coating 33 nevertheless provides sufficient shadowing effect to prevent the formation of a continuous conductive film on the press. Similarly, granular coating 35 on insulating spacer 9 prevents conductive vapor from cathode 15 or its emissive surface 16 from forming a continuous film on the surface of spacer 9.

The use of magnesium hydroxide as a coating material has several distinct advantages over the various expedients utilized in the past. First of all magnesium hydroxide is relatively inexpensive and commercially available. It does not necessitate any special preparations nor the exercise of special cautions before or during application and may be used directly as purchased. In addition, neither magnesium hydroxide nor magnesium oxide introduces deleterious impurities into the tube either during processing or even during operation of the device and is readily adaptable to application by automatic techniques.

Therefore it is quite apparent that in accordance with the present invention, there has been provided a new and improved method of substantially preventing electrical leakage along an insulating member extending between conductive elements of an electron-discharge device in a simple, economical, yet highly effective manner, and the method is readily adaptable to mass production techniques thereby maintaining the cost of the finished product at a minimum.

While a particular embodiment of the invention has been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspects, and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of the invention.

I claim:

1. In the manufacture of an electron-discharge device comprising, within an evacuated envelope, a pair of conductive elements requiring the application of different operating potentials, and an insulating member contacting both of said conductive elements, the method of substantially preventing electrical leakage between said conductive elements comprising the steps of: coating said insulating member with a liquid suspension of magnesium hydroxide; and heating said insulating member to a temperature sufficient to reduce said coating to an

adherent granular magnesium oxide insulating coating, whereby the formation of a continuous film of an electrically conductive sublimate on said insulating member between said conductive elements, as an incident to subsequent fabrication and operation of said device, is prevented.

2. In the manufacture of an electron-discharge device comprising an enclosing envelope, a press sealed to said envelope, a plurality of lead-in wires sealed in said press, and a plurality of electrodes respectively connected to said lead-in wires, the method of substantially preventing electrical leakage between said lead-in wires comprising the steps of: coating said press with a liquid suspension of magnesium hydroxide; and heating said press to a temperature sufficient to reduce said press coating to an adherent granular magnesium oxide insulating coating, whereby the formation of a continuous film of an electrically conductive sublimate between said lead-in-wires, as an incident to subsequent fabrication and operation of said device, is prevented.

3. In the manufacture of an electron-discharge device comprising an enclosing envelope, a press sealed to said envelope, a plurality of lead-in wires sealed in said press, and a plurality of electrodes respectively connected to said lead-in wires, the method of substantially preventing electrical leakage between said lead-in wires comprising the steps of: coating said press with a liquid suspension of magnesium hydroxide; drying said coating; and thereafter heating said press to a temperature sufficient to reduce said press coating to an adherent granular magnesium oxide insulating coating, whereby the formation of a continuous film of an electrically conductive sublimate between said lead-in wires, as an incident to subsequent fabrication and operation of said device, is prevented.

4. In the manufacture of an electron-discharge device comprising an enclosing glass envelope, a glass press sealed to said envelope, a plurality of lead-in wires sealed in said press, and a plurality of electrodes respectively connected to said lead-in wires, the method of substantially preventing electrical leakage between said lead-in wires comprising the steps of: coating said press with a liquid suspension of magnesium hydroxide; placing said press in contact with said envelope; and heating the envelope and press throughout the mutually contacting surfaces thereof to effect fusion therebetween and to simultaneously reduce said press coating to an adherent granular magnesium oxide insulating coating, whereby the formation of a continuous film of electrically conductive sublimate between said lead-in wires, as an incident to subsequent fabrication and operation of said device, is prevented.

5. In the manufacture of an electron-discharge device comprising within an enclosing envelope, a tubular control grid, a cathode, and means including an insulating spacer for supporting said cathode within said tubular control grid, the method of substantially preventing electrical leakage between said cathode and said control grid comprising the steps of: coating said insulating spacer with a liquid suspension of magnesium hydroxide; and heating said spacer to a temperature sufficient to reduce said coating to an adherent granular magnesium oxide insulating coating, whereby the formation of a continuous film of an electrically conductive sublimate on the surface of said spacer between said cathode and said control grid, as an incident to subsequent fabrication and operation of said device, is prevented.

6. In the manufacture of an electron-discharge device comprising within an enclosing envelope, a tubular control grid, a cathode, and means including an insulating spacer for supporting said cathode within said tubular control grid, the method of substantially preventing electrical leakage between said cathode and said control grid comprising the steps of: coating said insulating spacer with a liquid suspension of magnesium hydroxide; drying said coating; and thereafter heating said spacer to a temperature sufficient to reduce said coating to an adherent granular magnesium oxide insulating coating, whereby the formation of a continuous film of an electrically conductive sublimate on the surface of said spacer between said cathode and said control grid, as an incident to subsequent fabrication and operation of said device, is prevented.

7. In the manufacture of an electron-discharge device comprising an enclosing glass envelope and an electrode system including a tubular grid electrode, a cathode, and means including an insulating spacer for supporting said cathode within said tubular grid electrode, the method of substantially preventing electrical leakage between said cathode and said grid electrode comprising the steps of: coating said insulating spacer with a liquid suspension of magnesium hydroxide; assembling said electrode system including said coated spacer inside said envelope; and heating the envelope and said electrode system while evacuating said envelope to simultaneously reduce said press coating to an adherent granular magnesium oxide insulating coating, whereby the formation of a continuous film of electrically conductive sublimate on said insulating spacer between said cathode and said control grid, as an incident to subsequent fabrication and operation of said device, is prevented.

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