Oct. 20, 1953 G. T. FORD 2,656,489

ELECTRON DISCHARGE DEVICE AND PROCESSING THEREOF

Filed April 14, 1951

FIG. 1

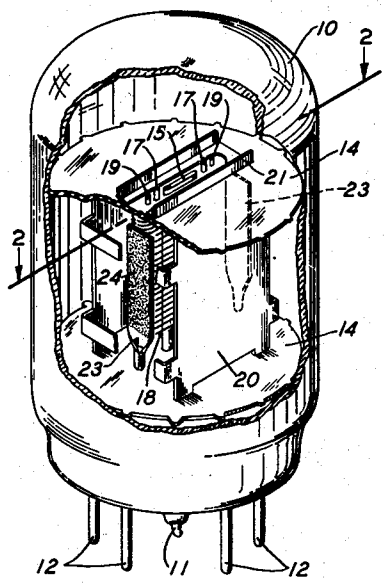


FIG. 2

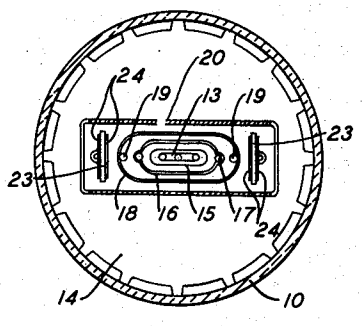
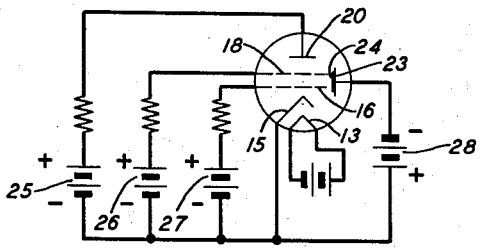


FIG. 3



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ELECTRON DISCHARGE DEVICE AND PROCESSING THEREOF

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1

This invention relates to electron discharge devices and more particularly to the processing thereof.

It is desirable during the fabrication of electron discharge devices to remove from the elements of the device and from the atmosphere therein all materials that might subsequently contaminate the cathode or in other ways interfere with the operation of the device and shorten the life of the device. Oxygen is particularly undesirable in electron discharge devices, and especially so where the cathode is coated, as with calcium, barium and strontium oxides. In the past these contaminants, including oxygen, have been removed by a gettering action wherein a material having an affinity for oxygen and the other contaminants is flashed within the device after evacuation, the material vaporizing and forming a thin film over a portion of the interior of the bulb of the device.

Such a gettering action is only partially successful however and has certain inherent disadvantages. For example, with certain electrode structures the vaporized material will also form a thin film on the insulators, such as end micas, that are within the device, and provide conducting paths between the electrodes. Additionally, in electron discharge devices operable at high frequencies the metallic film formed by the getter flash on the bulb acts as an element causing unwanted coupling between nearby circuit elements and the electrodes of the device.

It is therefore one object of this invention to improve the operation of electron discharge devices and to lengthen the lives of such devices.

It is a further object of this invention to improve the fabrication of electron discharge devices and more particularly to improve the decontamination of the atmospheres of such devices.

It is a further object of this invention to obviate the necessity of flashing getter material, thereby preventing high frequency coupling via the flashed material between nearby circuit elements and the electrodes of the device and possible shorting of the electrodes by flashed material being deposited onto insulator supports or separators.

These and other objects of this invention are achieved in accordance with one specific embodiment of the invention by the employment of decontaminator electrodes adjacent the other electrodes of the device. The decontaminator electrodes have coated onto one or more surfaces a getter material having a marked affinity for the contaminating agents present in the atmosphere

2

of such devices, particularly oxygen. During the aging or activation process, there is applied to the decontaminator electrodes a high negative potential with respect to the cathode. The decontaminator electrodes will thus have an increased facility for attracting and collecting ions in the atmosphere within the enclosing vessel or given up to the atmosphere during the activation of the cathode. After the aging and decontamination procedures, the decontaminator electrodes preferably are connected to the cathode so as to be at cathode potential during the operation of the device. Thus, they are not likely to be bombarded by electrons during the operation of the device, which bombardment would cause the getter material to surrender the contaminating material back into the atmosphere of the device. Additionally, the decontaminator electrodes are maintained cooler during normal operation than during the activation process, so that the collected ions are not given up during the operation of the device.

It is therefore one feature of this invention that a decontaminator electrode be positioned within an electron discharge device adjacent the other electrode elements of the device.

It is a further feature of this invention that a negative potential with respect to the cathode be applied to a getter material or surface within an electron discharge device during the processing of the device. More particularly it is a feature of this invention that the negative potential be applied to decontaminator electrodes having a getter material coated thereon and positioned adjacent the other electrode elements of the device. In accordance with this feature of the invention, the decontaminator electrodes are biased during the normal operation of the device so as to diminish the likelihood of electron bombardment. Advantageously, in accordance with this feature, the decontaminator electrodes are at cathode potential during subsequent operation of the device.

A complete understanding of this invention and of these and other features thereof may be gained from consideration of the following detailed description and the accompanying drawing, in which:

Fig. 1 is a perspective view of an electron discharge device incorporating one specific illustrative embodiment of this invention, portions of the envelope and other elements having been broken away;

Fig. 2 is a sectional view of the device of Fig. 1,

the view being taken just below the upper insulator; and

Fig. 3 is a schematic representation of one activating and decontaminating circuit employable in accordance with this invention.

Referring now to the drawing, the electron discharge device illustrated in Fig. 1 comprises an envelope 10 having an exhaust tabulation 11 and leads 12 in the base thereof. The electrode structure is situated within the envelope 10 between two insulators 14, as of mica, and includes a flat hollow cathode 15 having a heater element 13 located therein, a control grid 16 mounted by side rods 17, a screen grid 18 mounted by side rods 19, and an anode 20. A shield 21 is advantageously located on each insulator 14 between the side rods 17 and 19 and the remainder of the tube.

Two decontaminator electrodes 23 are directly attached to the ends of two leads 12 extending through the lower of the insulators 14 and are positioned on each side of the cathode and grid structure. The decontaminator electrodes 23 have coated on their surfaces a gettering material 24 such as zirconium, thorium, a thorium-caesium composition known commercially as "Ceto," or other gettering material as is known in the art. The particular material chosen will depend on the configuration of the electron discharge device and the temperatures attained by the device and the decontaminator electrodes, particularly during the activation process.

After the elements have been assembled in the device the envelope 10 is exhausted and the metallic elements within it are out-gassed, as is known in the art. Generally this is accomplished by heating the anode and the other elements by high frequency induction. In the illustrative embodiment of this invention disclosed, the two decontaminator electrodes would be parallel to the direction of the induced field if it is applied normal to the major anode surfaces, as is generally done. To provide an improved coupling with the high frequency induction field, the two decontaminator electrodes 23 may be joined by straps adjacent the insulators 14. The temperature attained by the decontaminator electrodes 23 during this process should be sufficient to outgas the metallic electrodes but insufficient to cause the gettering material 24 positioned on the electrodes to remove any substantial amounts of impurities from the atmosphere, as it is more desirable that contaminants and impurities evolved during the out-gassing be exhausted from the envelope.

The temperature to be attained by the decontaminator electrodes during this out-gassing process will also depend on whether the gettering material itself needs to be activated prior to the aging or activation process. Thus, if zirconium hydride is coated onto the decontaminator electrodes 23, it must be heated to break the hydride down to metallic zirconium.

Another method of attaining the desired heating of the decontaminator electrodes that may advantageously be employed in the illustrative embodiment of the invention disclosed is to have the anode 20 a completely enclosed member thereby serving as an oven to raise the temperature of the decontaminator electrodes 23. It is thus apparent that numerous variations may be made by those skilled in the art in the particular structure disclosed in order to attain the desired correlation between the temperature of the decontaminator electrodes during the out-gassing and the exhausting of the device and the particular gettering material coated thereon.

Following the exhausting of the device it is sealed and is ready to be aged or activated. One such activation circuit in accordance with this invention is shown in Fig. 3. As there shown, the anode 20 and screen electrode 18 are held positive with respect to the cathode 15 by voltage supplies 25 and 26, respectively. If desired, the anode and screen electrode could be electrically tied together to a single voltage supply. The control electrode 16 may also be held positive with respect to the cathode 15 by a voltage supply 27. The decontaminator electrodes 23, however, are connected to the negative side of a voltage supply 28 so as to be negative with respect to the cathode 15.

During the aging process, positive ions produced by electron collison or by bombardment of the elements are collected by the negative decontaminator electrodes and then held by the getter material thereon. The natural affinity that the getter material has for the impurities or contaminants present in the atmosphere of the envelope and generated from the elements during the aging process is thus accentuated and increased because of the negative potential applied to the decontaminator electrodes whereby the positive ion impurities are more easily attracted to the getter material.

Subsequently, during normal operation of the device the decontaminator electrodes are advantageously operated at cathode potential, as by being directly connected to the cathode lead, or by being connected together in the external circuit. As the decontaminator electrodes 23 are outside of the electron paths and are at cathode potential, they do not enter into the operation of the device.

Additionally, the electron bombardment of the decontaminator electrodes by electrons impinging thereon is negligible so that the impurities trapped by the getter material thereon are not released to the atmosphere of the device during its operation.

While this invention has been disclosed as incorporated in a particular tetrode and with the getter material on decontaminator electrodes of a particular configuration, it is, of course, apparent that the invention is capable of employment in devices including different numbers of electrodes and of different configuration. Similarly, the invention is not limited to the getter material on the decontaminator electrodes as shown, for the getter material and the decontaminator electrodes could be of various forms to which the negative potential could be applied during the aging process. It is, therefore, to be understood that the above-described arrangements are illustrative of the principles of the invention and that numerous other arrangements could be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. The combination of a cathode, at least one electrode cooperating with said cathode and defining discharge means therewith, a gettering material adjacent said discharge means, and means applying a potential to said gettering material negative with respect to said cathode during the aging of said cathode whereby positive ion impurities are attracted to said gettering material.

2. In combination with an electron discharge device comprising an envelope, a cathode within

said envelope, an electrode adjacent said cathode, and a gettering material in said envelope, means creating an electron discharge between said cathode and said electrode to age said cathode, and means applying a potential to said gettering material negative to said cathode during the aging of said cathode.

3. The combination of a cathode, at least one electrode cooperating with said cathode and defining discharge means therewith, a second electrode adjacent said cathode, a coating of getter material on said second electrode, and means applying a potential negative with respect to said cathode to said second electrode during the aging of said cathode.

4. The combination of a cathode, at least one electrode cooperating with said cathode and defining a discharge path therewith, a decontaminator electrode having a coating of getter material thereon adjacent said cathode but removed from said path, and means applying a potential negative with respect to said cathode to said decontaminator electrode during the aging of said cathode.

5. In the fabrication of electron discharge devices, the method of decontaminating an electron discharge device which comprises positioning getter material within said device, maintaining a discharge within said device, and applying a negative potential to said getter material while maintaining said discharge.

6. In the fabrication of electron discharge devices, the method of decontaminating an electron discharge device which comprises positioning a getter material within said device, evacuating

said device, maintaining a discharge within said device between the cathode and anode thereof, and applying a negative potential to said getter material while maintaining said discharge.

7. In the fabrication of electron discharge devices, the steps comprising positioning a getter material within the device, evacuating said device, applying a potential to the getter material negative with respect to the cathode within said device during the activation of said cathode, and connecting said getter material electrically to said cathode subsequent to the activation of said cathode.

8. The method of decontaminating an electron discharge device which comprises coating a getter material on an auxiliary electrode, positioning said auxiliary electrode within said device removed from the discharge path between the cathode and anode of said device, maintaining a discharge between said cathode and anode to activate said cathode, and applying a potential to said auxiliary electrode negative with respect to said cathode while maintaining said discharge.

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