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ELECTRON DISCHARGE DEVICES

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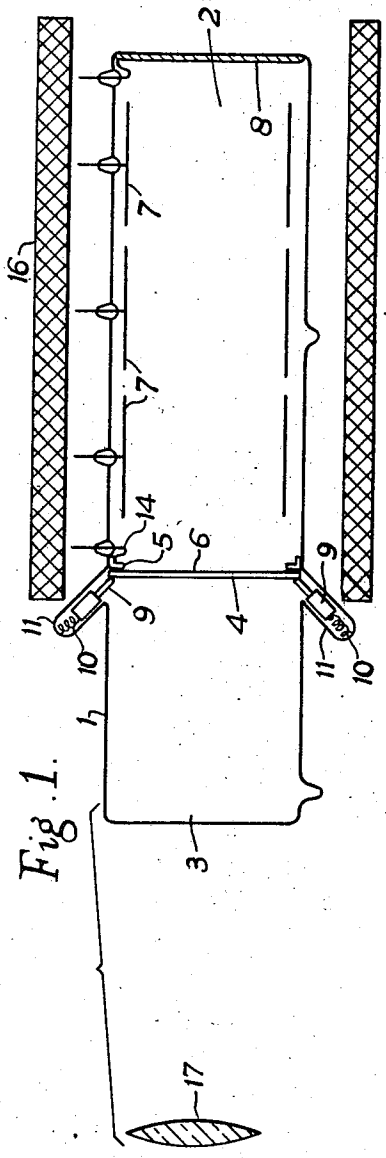


Fig. 1.

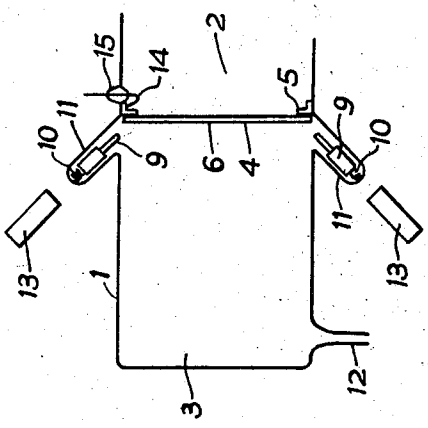


Fig. 2.

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ELECTRON DISCHARGE DEVICES

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This invention relates to electron discharge devices and particularly to photo-electric tubes having a photo-cathode and electrodes which are maintained at a high potential relatively to one another.

The formation of a photo-sensitive surface must of necessity be carried out after the electrodes have been introduced into a vessel and the vessel evacuated. The most sensitive types of photo-cathode surfaces include caesium in their composition. Normally, this caesium is introduced into the vessel in the form of vapour which condenses on and reacts with a base metal, for example antimony, of the cathode to form the required photo-sensitive surface.

If other electrodes are also exposed to the caesium vapour, condensation will occur on these electrodes as well as on the cathode and similar reaction of the caesium with the base metal may occur. The resultant surface has a low work-function and electrons may be drawn from the surface due to the high potential electric field present in operation of the device.

This effect limits the maximum voltage which can be applied to a photo-electric tube, and hence the useful overall gain of an image intensifier.

The caesium vapour may also result in positive caesium ions in operation, which drift back to the photo-cathode there liberating more electrons.

These spurious electrons are accelerated towards the anode and, in an image converting device, cause a rapid rise in background illumination, with consequent loss of contrast.

The object of the present invention is to provide a novel method of coating and mounting a condensation coated electrode in an electron discharge device so that condensation of the vapour on other electrodes is substantially avoided.

Another object of the invention is to provide an electron discharge device having a condensation coated electrode in which other electrodes are not contaminated by the vapour so that, in the case of an image intensifier for example, with a photo-cathode formed by vapour condensation, it is possible to attain a much greater brightness intensification.

According to the invention, an electron discharge device comprises a vessel having first and second chambers connected by way of an aperture, the first chamber containing at least one electrode and the second chamber being adapted for the admission of vapour thereto, the device also comprising an electrode coated while inside the vessel by vapour condensation thereon and adapted to occupy first and second alternative positions, the first serving to close the said aperture during the coating operation and the second being in operative relationship to the electrode or electrodes in the first chamber.

A method according to the invention makes use of a vessel for the electron discharge device which is shaped to have first and second chambers connected by way of an aperture and the said method comprises arranging

an electrode to be coated in a first position in which it closes the aperture, admitting vapour into the second chamber so that condensation occurs on a face of the electrode and subsequently arranging the electrode in a second position in which the coated surface faces into the first chamber, whereby vapour is substantially excluded from the first chamber during the coating operation.

Most conveniently, the coated electrode is held in position for coating and then held in its operative position by at least one magnetically releasable catch.

In order that the invention may be readily carried into effect, one embodiment will now be particularly described, by way of example, with reference to the accompanying drawings, of which:

Figure 1 shows an image intensifier tube arranged for operation and

Figure 2 illustrates a stage during the manufacture of the tube, part only of the tube of Figure 1 being shown.

In Figure 1 the image intensifier tube is constructed in a vessel 1 having a first chamber 2 which is the working section of the tube and a second chamber 3 which is a processing section used during the formation of a photosensitive surface 6 on a surface of a cathode plate 4. The chambers 2, 3 of the vessel 1 are connected by way of an aperture in a member 5 which, in this example, is a metal member sealed into the glass vessel and having an inwardly extending annular flange.

Alternatively, the apertured member may be conductively coated.

As shown in Figure 1, the plate 4 is arranged with its photo-sensitive surface 6 facing into the chamber 2. The chamber 2 contains electrodes 7 which are maintained at a high potential and a fluorescent screen 8. With the plate 4 arranged as shown in Figure 1, the electrodes contained in chamber 2 constitute an image intensifier of known type so that these parts and their operation need not be further described.

The cathode plate 4 is a circular plate which, prior to coating, is arranged against the flange 5 so as to close off the chamber 2. The abutting surfaces of the plate and the flange are coated with colloidal graphite. The plate 4 is held securely in this position by catches 9 of magnetic material which are spring loaded by coil springs 10 and arranged in obliquely inclined side tubes 11 formed in the vessel 1.

Caesium vapour is introduced into the chamber 3 from a side tube, not shown, which is connected to the chamber 3 by way of entry means such as an exhaust tube 12 or otherwise as is convenient.

Condensation of the vapour occurs on the surface 6 of the plate 4 and elsewhere on the inner surface of chamber 3, but this latter is of no consequence. Penetration of the vapour into chamber 2 is substantially avoided, the colloidal graphite tending to absorb any caesium vapour which might otherwise diffuse through. Contamination of the electrodes 7 and screen 8 is thereby avoided.

After suitable heat treatment to form the photo-sensitive, surface 6, the complete vessel is sealed off at the exhaust tube 12.

The catches 9 are released by manipulating magnets 13 outside the vessel 1 so as to draw back the catches 9 against the springs 10, as shown in Figure 2.

By careful shaking of the tube, the plate 4 is moved away from the flange 5, turned over and replaced on the flange 5 so that the coated surface 6 now faces into the chamber 2. The magnets 13 are removed so that the catches re-engage the plate 4 thus holding the photo-cathode in the position shown in Figure 1.

In this position, an electrical connection is made to the

photo-sensitive surface 6 by way of the conducting flange 5. A lead 14 is connected to the flange 5 and taken out through a seal 15.

When the tube is arranged for operation, it is provided with a conventional electron lens such as the solenoid 16. An optical image is projected on the photo-sensitive surface 6 by a lens system 17 and an electron image is produced on the fluorescent screen 8.

While the invention has been described with reference to a simple high voltage image intensifier, by way of example, it is not restricted to this type of tube and may be applied to multi-stage image intensifier tubes and in the image intensification section of television pick-up tubes.

I claim:

1. An electron discharge device comprising a vessel having first and second chambers connected by way of an aperture, the first chamber containing at least one electrode and the second chamber having entry means for the admission of vapour thereto, the device also comprising an electrode coated while inside the vessel by vapour condensation thereon and adapted to occupy first and second alternative positions, the first serving to close the said aperture during the coating operation and the second being in electrically operative relationship with the electrode or electrodes in the first chamber.

2. An electron discharge tube comprising a vessel containing an electrode to be coated by condensation of vapour thereon and at least one electrode upon which the condensation of the said vapour is to be avoided, in which the vessel has first and second chambers connected by way of an aperture, the electrode or electrodes upon which condensation is to be avoided being arranged wholly in the first chamber, the second chamber having entry means for the admission of the vapour thereto and the electrode to be coated being adapted to close the said aperture while presenting a surface to vapour in the second chamber during the coating operation and subsequently to be movable to a second position in which the said surface faces into the first chamber.

3. A method of coating and mounting an electrode for an electron discharge device including a vessel having first and second chambers connected by way of an aperture, comprising arranging said electrode in a first position in which it closes the aperture, one surface of the electrode facing into the first chamber, admitting vapour into the second chamber, so that condensation occurs on the other face of the electrode and subsequently reversing the electrode from that position, so that the coated surface faces into the first chamber, whereby vapour is substantially excluded from the first chamber during the coating operation.

4. A method as claimed in claim 3, in which the surface of the electrode and the surface surrounding the aperture, which are in contact in the first position of the electrode, are coated with colloidal graphite.

5. A device as claimed in claim 1 in which the vessel is cylindrical, being substantially rectangular in longitudinal section, and is divided into first and second chambers by a conductive annular flange arranged intermediately of the ends of the vessel, and the electrode is a circular disc.

6. A device as claimed in claim 2 in which the vessel is cylindrical, being substantially rectangular in longitudinal section, and is divided into first and second chambers by a conductive annular flange arranged intermediately of the ends of the vessel, and the electrode is a circular disc.

7. A device as claimed in claim 5 in which the electrode is held in its first and second positions by at least one releasable catch.

8. A device as claimed in claim 2 in which the electrode is held in its first and second positions by at least one releasable catch.

9. A device as claimed in claim 7 in which the coated electrode is the photo-cathode of an image intensifier tube, the associated electrodes and screen being arranged in the first chamber of the vessel.

10. An electron discharge tube comprising a vessel containing an electrode to be coated by condensation of caesium vapour thereon to form a photocathode and at least one electrode upon which the condensation of the said vapour is to be avoided, in which the vessel has first and second chambers coated by way of an aperture, the electrode or electrodes upon which condensation is to be avoided, being arranged wholly in the first chamber, the second chamber having entry means for the admission of vapour thereto and the electrode to be coated being adapted to close the aperture while presenting a surface to vapour in the second chamber during the coating operation and subsequently to be movable to a second position in which the caesium-coated surface faces into the first chamber.

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