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METHOD OF MANUFACTURING A RADIATION-SENSITIVE DEVICE

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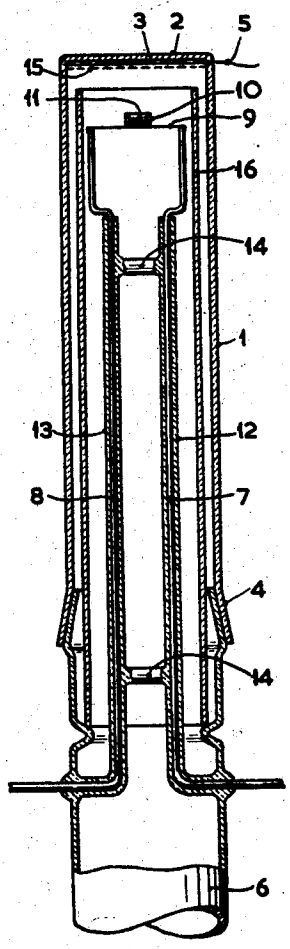


FIG.1

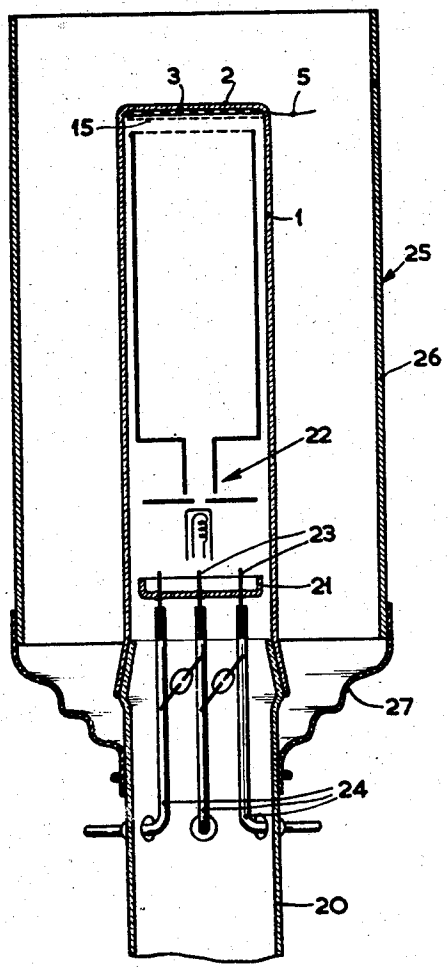


FIG.2

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METHOD OF MANUFACTURING A RADIATION-SENSITIVE DEVICE

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6 Claims. (Cl. 316—20)

A method of manufacturing television camera tubes provided with a photoconductive target electrode is known in which the photoconductive layer is applied after the electrode system, which comprises inter alia the electron gun, has been mounted in the bulb or envelope. In this method, the tube is evacuated after the system has been mounted and subsequently the photoconductive substance is deposited from a vapour onto a signal electrode provided on the tube window. This deposition from vapour is effected by heating a certain amount of radiation-sensitive, photoconductive substance or its constituents in a side tube which communicates with the envelope or in a cup which can be moved from such a side tube to a position in front of the window. During the process of deposition, all parts of the tube with the exception of the signal electrode are maintained at a temperature which as far as possible prevents the substance from depositing on surfaces other than that of the signal electrode. When the deposition process has been completed, the side tube is sealed off.

The method described has a limitation in that the deposition of the radiation-sensitive substance is not readily controllable and that, owing to the presence of the electrode system, the position of the cup containing the substance to be deposited cannot be chosen at will. This may result in an uneven thickness of the deposited layer and frequently the substance to be deposited cannot be prevented from precipitating on part of the electrode system also, for example on the grid electrode, which is usually provided in camera tubes having a photoconductive target electrode in close proximity to this latter electrode. In addition, the sealing off of the side tube results in an extension projecting beyond the circumference of the tube, which increases the size of the tube and may be inconvenient in the operation of the tube.

A method of manufacturing a television camera tube incorporating a radiation-sensitive layer deposited on an electrode is known which does not have the disadvantages of the above-described method. On the other hand, however, in this latter method, the vacuum must be interrupted after the deposition of the radiation-sensitive substance, for in this method an envelope which is open at one end is moved over the container of the radiation-sensitive substance or its constituents, which container is connected to an evacuating device, after which the bulb is evacuated and the radiation-sensitive substance is deposited from vapour on a suitable electrode provided in the envelope. After the deposition, the envelope is removed from the evacuation device and mounting of the tube is finished, the open end of the envelope being provided with a sealing member, and the envelope being again evacuated simultaneously or subsequently. If the tube to be manufactured is provided with an electrode system inserted in the envelope, this system is previously mounted on the sealing member. Of course, interrupting the vacuum and thus exposing the newly-deposited radiation-sensitive layer to air has the tendency to impair its

desirable properties and is thus considered unsatisfactory.

The present invention relates to a method of the kind described of manufacturing an electrical device provided with a layer of a radiation-sensitive substance from which the atmosphere is excluded, and provides means by which the newly produced radiation-sensitive layer is prevented from being exposed to the air when the envelope is removed from the evacuation device. The invention is not limited to a method of manufacturing high-vacuum tubes but may also be used in the manufacture of tubes which are provided with a permanent gas filling at a later stage.

The method according to the invention is characterized in that, after the deposition of the radiation-sensitive substance, the envelope is filled with an inert gas at atmospheric pressure which does not react with the radiation-sensitive substance, after which the envelope is removed from the evacuation device and immediately, substantially without the gas being replaced by the air, transferred to and connected to a second pipe or tubulation of the same or another evacuating device. This second tubulation is provided with a sealing member or closure for the envelope, which member may be provided with an electrode system to be introduced in the envelope, the envelope being subsequently connected to the sealing member in a vacuum-tight manner. It should be noted that the term "radiation-sensitive layer" as used herein is to be understood to mean a layer the electrical resistance and/or the dielectric constant of which can be reversibly varied by irradiation with electromagnetic or corpuscular rays or which is capable of electron emission. The application of a radiation-sensitive layer by means of cathode sputtering is to be considered as equivalent with deposition from vapour and hereinafter references to deposition should be read as including cathode sputtering.

In order to deposit the radiation-sensitive substance from vapour, the envelope is preferably connected to the evacuating device with its open end downwards, and then transferred in this position to the second tubulation, the inert gas used being lighter than air. It will be evident that the reverse position, i.e. with the open end upwards, of the envelope may also be used, in which case the inert gas should have a weight equal to or heavier than that of air.

In a preferred embodiment of the method in accordance with the invention, the electrode system is degassed before being inserted in the envelope provided with the radiation-sensitive layer. In order to prevent the degassed electrode system from being exposed to the air during the transfer of the bulb, the system is surrounded after degassing with a protective gas at atmospheric pressure, which is substantially not displaced by the ambient air during said transfer. To this end, the gas fills a vessel which is open at one end and encloses the end of the vacuum pipe provided with the sealing member for the envelope and the electrode system.

In order that the invention may be readily carried out, one embodiment thereof will now be described, by way of example, with reference to the accompanying drawing, in which:

Fig. 1 is a diagrammatic sectional view of a television camera tube provided with a photoconductive electrode during a first stage of manufacture, and

Fig. 2 illustrates a later stage.

To the open end of an elongated cylindrical glass envelope 1 having a flat bottom or window 2 a ground glass piece 4 is fused. The bottom or window 2 of the tube is internally provided with a transparent conducting electrode 3, which may be a stannic oxide layer. This constitutes the signal electrode of the camera tube. The electrode 3 is provided with a current supply lead 5 which is passed through the wall of the tube 1.

The tubular envelope 1 is arranged bottom up so that

the ground piece 4 fits the end of a vacuum pipe or exhaust tubulation 6 which is connected to an evacuating device (not shown), which may be the usual exhaust pump. The ground glass part 4 provides a hermetically-tight connection to the pipe 6. Two sturdy current supply wires 7 and 8 are passed through the wall of the pipe 6 so as to extend vertically into the bulb. The ends of the current supply wires 7 and 8 are connected to one another by a metal heating strip 9, which at its centre carries a small metal cup 10. This cup contains an amount of lead monoxide 11, which constitutes the radiation-sensitive substance. In order to increase the mechanical strength of the assembly, the vertical parts of the current leads 7 and 8 are surrounded by glass tubes 12 and 13 which are connected to one another at various points, for example at 14.

Within the tube, there is provided a cylindrical glass screen 16 which surrounds the deposition device comprising the wires 7 and 8, the strip 9 and the cup 10.

The bulb 1 is now evacuated through the pipe 6 at this first location illustrated in Fig. 1. An electric current is passed through the wires 7 and 8 so that the cup 10 containing the lead monoxide 11 is heated. As a result the lead monoxide is deposited from the cup 10 onto the electrode 3 so that a layer 15 is formed on this electrode. The cylindrical screen 16 prevents the lead monoxide from precipitating on other points of the bulb wall.

When the layer 15 has become about 5 microns thick, the deposition process is discontinued, and the envelope 1 is filled through the pipe 6 with pure helium, the pressure of which is raised until it is equal to the ambient pressure. A different inert gas lighter than air and not influencing the deposited lead monoxide, such as hydrogen or neon, may be used instead of the helium. Subsequently, the envelope 1 is removed from the pipe 6, and transferred while maintained in a vertical position to the end of a second vacuum pipe 20 (Fig. 2), which fits within and hermetically seals off the ground piece 4. To this vacuum pipe 20 located at this second location illustrated in Fig. 2 there is connected a sealing member or closure 21 for the envelope 1, which member 21 is provided with or supports an electrode system 22 shown diagrammatically only. Lead-in pins 23, which are provided in the sealing member 21 and are connected to the electrodes, are connected electrically and mechanically to separate vertical current wires 24 which are comparatively robust and are passed through the wall of the pipe 20. By means of these current wires 24 the operation of the tube can be controlled electrically before it is finished.

The end of the pipe 20 is surrounded by a spacious jacket or vessel 25 which is open at the top and is held by means which are not shown. This jacket surrounds the electrode system 22 and extends above it. The jacket 25 comprises a length 26 of glass tube which at the lower end is provided with a plastic sleeve 27 which may be made of polythene. This sleeve is clamped about the pipe 20, for example by means of a rubber ring 28.

Before the envelope 1 is transferred from the vacuum pipe 6 to the vacuum pipe 20, the electrode system 22 is degassed. To this end, an auxiliary envelope which is connected to the pipe 20 and may be shaped in a form similar to the envelope 1 is placed over this system. This auxiliary envelope is evacuated and subsequently the electrode system is degassed, for example by means of the usual high-frequency heating. After degassing, argon is introduced into the auxiliary envelope through the pipe 20, until the argon pressure is equal to the pressure of the ambient atmosphere. While the argon supply is continued, the auxiliary envelope used in the degassing process is raised slightly from the end piece of the pipe 20—this may be effected by means of a slight excess pressure of the argon above atmospheric pressure—so that the argon flows into the jacket 25 and displaces the air contained therein. When the jacket or

vessel is entirely or substantially entirely filled with argon, the auxiliary envelope is carefully lifted off. Instead of argon another inert gas such as nitrogen, krypton or xenon may be used. The function of this gasfilling in the jacket is to protect the degassed electrode structure against coming into contact with the ambient air during the transfer of the envelope. As the jacket is arranged with the open end upwards, the gas should be at least of equal weight as air, preferably heavier. Argon is therefore preferred. Subsequently the envelope 1, which is filled with helium and provided with a lead monoxide layer 15, is transferred in the manner described above from the vacuum pipe 6 to the vacuum pipe 20, the electrode system 22 being inserted into the envelope 1. The envelope 1 is then evacuated through the pipe 20 and mounting of the tube is finished. In mounting, the wall of the envelope 1 is fused to the protruding rim of the sealing member 21 in a manner known in the manufacture of electron tubes having no exhaust tube.

Owing to the protective helium atmosphere in the envelope 1, the newly formed lead monoxide layer 15 is not exposed to the air during the transfer to the pipe 20, while owing to the argon atmosphere within the jacket 25, the previously degassed electrode system 22 does not come into contact with the air either. Thus, the lead monoxide layer 15, which forms the photoconductive target electrode of the television camera tube to be produced, cannot absorb constituents from the air to thus alter its characteristics, which might have a detrimental effect upon its operation.

It has been found that the properties of television camera tubes manufactured in the above-described manner are always satisfactory. The fact that the electrode system is degassed outside the tube to be manufactured, which is made possible by the use of an atmosphere protecting this system, eliminates the need for the system to be degassed at a later stage during which the target electrode 15 might still be adversely affected.

What is claimed is:

1. A method of manufacturing a radiation-sensitive electrical device, comprising providing in an envelope open at one end a layer of radiation-sensitive material whose characteristics may be altered by exposure to the atmosphere, thereafter filling the envelope with an inert gas, thereafter transferring the gas-filled envelope, in a position preventing substantial displacement of the inert gas, to a location at which a closure may be sealed to the open end of the envelope, and sealing the closure to the envelope, whereby the inert gas protects the radiation-sensitive layer from exposure to the atmosphere during the transfer step.

2. A method of manufacturing a radiation-sensitive electrical device, comprising providing an envelope open at one end at a first location at which the envelope may be evacuated and a radiation-sensitive material provided therein, evacuating the envelope at said first location and vapor-depositing in said envelope a layer of radiation-sensitive material whose characteristics may be altered by exposure to the atmosphere, thereafter filling the evacuated envelope with an inert gas approximately at atmospheric pressure, thereafter transferring the gas-filled envelope, in a position preventing substantial displacement of the inert gas, to a second location at which the envelope may be evacuated and a closure sealed to the open end of the envelope, and, at the second location, evacuating the envelope and sealing the closure to the envelope, whereby the inert gas protects the radiation-sensitive layer from exposure to the atmosphere during the transfer step.

3. A method of manufacturing a radiation-sensitive electrical device, comprising providing, at a first location, in an envelope open at one end a layer of radiation-sensitive material whose characteristics may be altered by exposure to the atmosphere, thereafter filling

the envelope with an inert gas; providing at a second location within a vessel having an open end a closure supporting an electrode system, thereafter degassing the electrode system at the second location, thereafter filling the vessel with an inert gas that is not substantially displaced by the atmosphere to protect the electrode system against contamination; transferring the gas-filled envelope, in a position preventing substantial displacement of its inert gas, from the first location to the second location and placing same within the vessel and over the electrode system and closure, and sealing the closure to the open end of the envelope, whereby the inert gas protects the radiation-sensitive layer from exposure to the atmosphere during the transfer step.

4. A method of manufacturing a radiation-sensitive electrical device, comprising providing at a first location and in a vertical position an envelope open at its downwardly-facing end, evacuating the envelope at said first location and vapor-depositing in said envelope a layer of radiation-sensitive material whose characteristics may be altered by exposure to the atmosphere, thereafter filling the evacuated envelope with an inert gas lighter than air and approximately at atmospheric pressure, thereafter transferring the gas-filled envelope, while maintaining it in its vertical position preventing substantial displacement of the inert gas, to a second location at which the envelope may be evacuated and a closure sealed to the open end of the envelope, and, at the second location, evacuating the envelope and sealing the closure to the envelope, whereby the inert gas protects the radiation-sensitive layer from exposure to the atmosphere during the transfer step.

5. A method of manufacturing a radiation-sensitive electrical device, comprising providing at a first location and in a vertical position an envelope open at its upwardly-facing end, evacuating the envelope at said first location and vapor-depositing in said envelope a layer of radiation-sensitive material whose characteristics may be altered by exposure to the atmosphere, thereafter filling the evacuated envelope with an inert gas heavier than

air and approximately at atmospheric pressure, thereafter transferring the gas-filled envelope, while maintaining it in its vertical position preventing substantial displacement of the inert gas, to a second location at which the envelope may be evacuated and a closure sealed to the open end of the envelope, and, at the second location, evacuating the envelope and sealing the closure to the envelope, whereby the inert gas protects the radiation-sensitive layer from exposure to the atmosphere during the transfer step.

6. A method of manufacturing a radiation-sensitive electrical device, comprising providing at a first location and in a vertical position an envelope open at its downwardly-facing end, thereafter evacuating the envelope at said first location and vapor-depositing in said envelope a layer of radiation-sensitive material whose characteristics may be altered by exposure to the atmosphere, thereafter filling the envelope with a first inert gas lighter than air and approximately at atmospheric pressure; providing at a second location within a vessel having a closed bottom and an upwardly-facing open end a closure supporting an electrode system, thereafter degassing the electrode system at the second location, thereafter filling the vessel with a second inert gas heavier than air so that it remains within the vessel and protects the electrode system against contamination; transferring the gas-filled envelope, while maintaining it in its vertical position preventing substantial displacement of the first inert gas, to the second location and placing same within the vessel and over the electrode system and closure, and thereafter, at the second location, evacuating the envelope and heat-sealing the closure to the open end of the envelope, whereby the first inert gas protects the radiation-sensitive layer from exposure to the atmosphere during the transfer step.

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