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PHOTO-ELECTRIC TUBE AND THE METHOD OF MAKING SAME

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Fig. 1

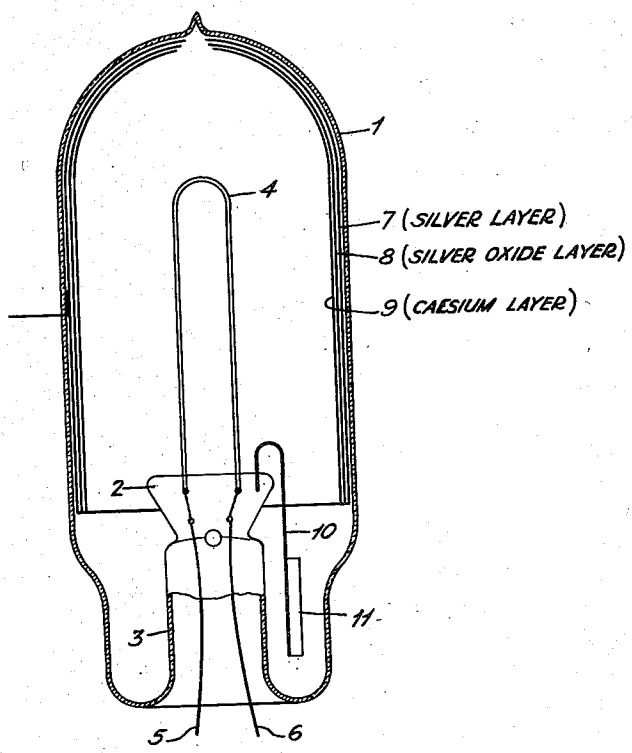
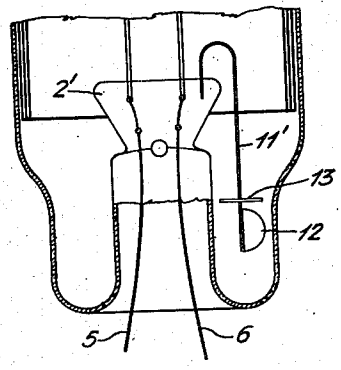


Fig. 2



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PHOTO-ELECTRIC TUBE AND THE METHOD OF MAKING SAME

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11 Claims. (Cl. 250—27.5)

As is well known, a photo-electric tube contains an electrode which consists partly or entirely of a light-sensitive electric material, frequently of alkali-metal, for instance, caesium. When making such a tube a quantity of alkali-metal or other light-sensitive electric substance is introduced for this purpose into the tube. As a rule this quantity is materially more than the quantity exactly required for making said electrode.

It has been found that the excess of this material unfavorably affects the properties of the tube. For this reason it has already been proposed to render this excess inoffensive by introducing a quantity of carbon into the tube, this carbon absorbing the excess of alkali-metal. However, carbon has the unfavorable property of largely absorbing almost all gases, especially oxygen, nitrogen, carbon oxide and also hydro-carbon. Due to this it is very difficult to introduce carbon into the tube in a degasified state. Under certain circumstances the gases absorbed by the carbon are liberated in the finished tube due to which the tube is rendered entirely defective in most cases.

The present invention has for its purpose to avoid the said drawbacks and to simplify the process of manufacture.

According to the invention the excess of alkali-metal is bound or absorbed by one or more metals disposed outside the photo-electric electrodes, said metals forming readily an alloy with alkali-metals at temperatures below 150° C. It has been found that the metals included in the sub-group of the second and fourth groups of the periodic system are particularly active. The sub-group of the second group includes the metals, zinc, cadmium and mercury, the sub-group of the fourth group including the metals, tin, lead and germanium. Especially the metals of the sub-group of the fourth group may be advantageously used. Since germanium is too expensive for being used to a large extent, the metals tin and lead enter particularly into consideration. Both metals readily form an alloy with alkali-metals at room temperature.

The advantages of the method according to the invention consist, among other things, in that the metals used can be readily completely degasified, so that there is no risk that gases are set free by these metals within the tube. Furthermore, no gases are liberated when the excess of photo-electric substance is consumed, so that this excess need not be removed. Moreover, this elimination generally occurs at a lower temperature than with the known method realized with the aid of a chemical reaction, viz. at temperatures below 150° C. At these temperatures the photo-electric electrode is not damaged. Furthermore, metals may be readily introduced as a cohesive aggregate into the tube, whereas a chemical compound must in most cases be introduced in powder form, thus helping an undesired diffusion of the reaction within the tube.

The active surface of the metal used for removing the excess of alkali-metal may advantageously be rendered very large, by forming it as a thin layer by evaporation.

The invention will be more clearly understood by reference to the accompanying drawing, in which Fig. 1 represents one modification, and Fig. 2, a fragmentary view of another modification.

The tube illustrated in Fig. 1 comprises a cylindrical glass wall 1, to which is sealed a stem comprising a pinch 2 and a stem tube 3. The anode 4 is mounted on the pinch 2 and consists of a hairpin-shaped bent metal wire which is connected to the supply wires 5 and 6. The cathode of the tube consists of a silver layer 7 coated with a silver oxide layer 8 to which is applied a very thin caesium layer 9.

The wire 10 which is sealed into the pinch has secured to it a piece of tin 11 serving for binding the excess of caesium. It goes without saying that it is also possible to provide the tin in another manner in the tube. It is possible, for instance, to coat the stem tube 3, before sealing the stem to the bulb of the tube, with a thin tin layer, which may be effected by evaporation and condensation of the tin in a vacuum.

When making the tube one may proceed as follows. A small quantity of silver is secured to the anode 4, and thereupon the latter is introduced into the tube. After the tube has been exhausted, a heating current is passed through the anode 4, so that the silver evaporates and deposits on the wall of the tube. Part of the wall of the tube is protected in a known manner against the silver deposit by means of a screen (not shown). This shielded portion of the wall of the tube forms a window through which the light rays producing the photo-electric current may enter the tube.

After the silver layer has been provided it is superficially oxidized. For this purpose a small quantity of oxygen is introduced into the tube and an electric discharge is established between the silver layer, which serves as a cathode, and the anode. After the excess of oxygen has been removed, a quantity of caesium is introduced through the upper end of the tube. Part of the

caesium is taken up by the layer of silver oxide, whereas the remainder or excess is bound by the tin 11, the tin forming an alloy with the excess of caesium. This manner of eliminating the excess of caesium is extremely simple and reduces considerably the time required for making the tube.

Instead of tin it is also advantageous to use lead which, just like tin, readily forms an alloy with caesium at room temperature.

It is also possible, for instance, to use metals of the sub-group of the second group of the periodic system, viz., zinc, cadmium and mercury. When using mercury care should be taken that it is disposed in such a manner that it does not run over the cathode. For this purpose the mercury may be introduced into the tube in a special manner, for example, in form of an amalgam, for instance, a non-liquid cadmium amalgam.

According to the second modification of the invention the substance used for eliminating the excess of light-sensitive electric material, is introduced into the tube in such a state that it cannot combine with the light-sensitive electric material. Only after the layer, in which the particles of a chemical compound and of a photo-electric substance are contained, has been formed, is it transformed into a state, in which binding of the light-sensitive electric substance is possible. This enables one to choose at will the moment at which this substance must fulfill its task, thus avoiding the premature elimination of the excess of photo-electric material. Advantageously the substance may be introduced into the tube in such a manner that it is separated from the space in which the mixed layer is formed, the obturation being destroyed after this layer has been formed. The substance may be enclosed, for instance, in a hollow glass bead which is provided, for example, with a breakable point and which is disposed within the tube. After the mixed layer has been formed, the wall of the bead may be destroyed, so that the excess of light-sensitive electric material contacts with the substance.

Furthermore it is possible to introduce the substance in a metal container into the tube and, after the mixed layer has been formed, this container is heated by means of induced currents to such an extent that it is opened.

Another manner of providing the substance in the tube consists in that it is introduced into the latter in the form of a compact body, for instance, a rod, which is placed in the vicinity of a heating member. This heating member consists, for instance, of a helically wound heating wire, within which the rod-like substance is arranged. This substance has a small surface so that substantially no binding of the photo-electric material occurs when the layer is formed. Only when a current is passed through the heating member and the substance is vaporized, which occurs after the mixed layer has been formed, the excess of light-electric material can be entirely eliminated.

In those cases in which the substance is vaporized, care must be taken, that it condenses at points, at which it cannot contaminate the working of the tube. A suitable point for vaporizing the substance is, for instance, the space surrounding the stem of the tube. If need be, the deposit of condensation products between the supply conductors which are taken out through the pinch may be avoided by the use of screens.

The preferred form of this modification is shown in Fig. 2 wherein a metal container or capsule 12 containing tin or lead is secured to the pinch 2' of the tube by means of a supporting wire 11', a mica screen 13 being provided above this container at a short distance thereof. This lower part of the tube is placed in a high frequency magnetic field so that alternating currents are induced in the metal capsule, due to which currents the capsule partly melts and the substance contained therein is vaporized, and deposits in form of a thin layer on the wall of the tube in the vicinity of the capsule. The screen 13 prevents the substance from penetrating into the part of the tube in which the photo-electric electrode is arranged or from depositing on the pinch. The caesium excess is bound by this thin metal layer because tin or lead alloys with the caesium excess. The production of this alloy occurs readily at room temperature.

The substance contained in the capsule need not always consist of tin or lead. It is also possible to use other metals alloying with the light-sensitive electric material. Furthermore, it is possible to use according to the known methods chemical compounds, for instance, lead oxide, which can react with the photo-electric material.

We claim:

1. A photo-electric tube comprising an anode and a photoelectric electrode containing alkali-metal, and a metal capable of alloying with the excess alkali-metal of said tube disposed outside the vicinity of said electrode.

2. A photo-electric tube comprising an anode and a photo-electric electrode containing alkali-metal, and a metal of the sub-group of the second group of the periodic system capable of alloying with the excess alkali-metal of said tube disposed outside the vicinity of said electrode.

3. A photo-electric tube comprising an anode and a photo-electric electrode containing alkali-metal, and a metal of the sub-group of the fourth group of the periodic system capable of alloying with the excess alkali-metal of said tube disposed outside the vicinity of said electrode.

4. A photo-electric tube comprising an anode, a cathode containing caesium, and a metal within the tube capable of alloying with the excess caesium.

5. A photo-electric tube comprising an anode, a cathode containing caesium, and a metal within the tube capable of alloying with the excess caesium, said metal being included in the sub-group of the second group of the periodic system containing zinc, cadmium and mercury.

6. A photo-electric tube comprising an anode, a cathode containing caesium, and a metal within the tube capable of alloying with the excess caesium, said metal being included in the sub-group of the fourth group of the periodic system containing tin, lead, and germanium.

7. A photo-electric tube comprising an anode, a light sensitive electrode containing caesium, and a metal within the tube but at a point remote from the electrodes capable of adsorbing the excess caesium at temperatures below about 150° C.

8. A photo-electric tube comprising an anode, a light sensitive electrode containing caesium, and a metal within the tube but at a point remote from the electrodes capable of adsorbing the excess caesium at temperatures below about 150° C., said metal being included in the sub-

group of the second group of the periodic system containing zinc, cadmium and mercury.

9. A photo-electric tube comprising an anode, a light sensitive electrode containing caesium, and a metal within the tube but at a point remote from the electrodes capable of adsorbing the excess caesium at temperatures below about 150° C., said metal being included in the subgroup of the fourth group of the periodic system containing tin, lead, and germanium.

10. The method of preparing the light sensitive cathode of a photo-electric tube, which consists in depositing an alkali-metal on the cathode surface, introducing within the tube a metal which upon being heated forms with the excess alkali metal a non-volatile alloy at substantially low temperatures, and then heating said metal to bind said excess.

11. The method of cleaning up excess alkali metal within a vacuum tube during its manufacture, which consists in introducing within said tube a metal which upon being heated forms with the excess alkali metal a non-volatile alloy at temperatures below 150° C., and then heating said metal to bind said excess.

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