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PHOTOELECTRIC TUBE

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Fig. 1

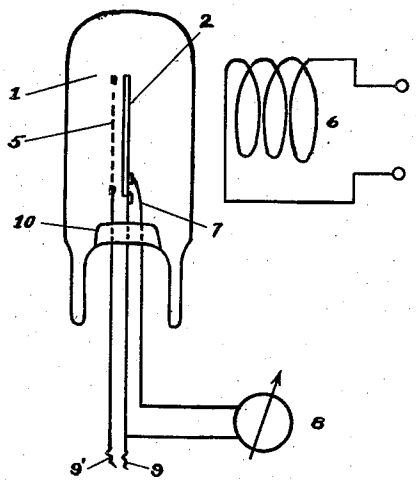
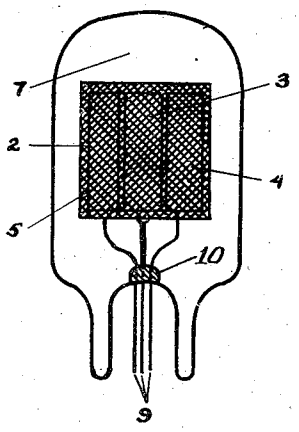


Fig. 2



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PHOTOELECTRIC TUBE

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17 Claims. (Cl. 250—27.5)

Our invention relates to novel methods of manufacturing light sensitive deposits, and more particularly to methods of manufacturing electrodes for photoelectric tubes.

Heretofore, photoelectric tubes have been constructed with the light responsive surface formed as a deposit of alkali metal on a conducting base such, for example, as a silver mirror. Such tubes however, have been found to have an operating range of very definite value with regard to the spectrum, one of these limits of the spectrum being within the range of red light.

To correct for this so-called red light boundary limit and to extend the responsiveness of the tube to longer wave lengths; that is, a reduction of the expulsion energy, required for liberating the electrons from the solid electrode surface, it has been suggested to apply alkali metal to an oxidized metallic surface rather than to a pure base. Thus, for example, a potassium deposit on oxidized copper shifts the light selectivity of the tube to yellow-red while the selectivity maximum of a potassium deposit on pure copper is approximately 4300 angstroms, that is, in the blue-violet. This extension of the selectivity of the tube, however, is still not sufficient for the most desirable operations.

Accordingly, an object of our invention is to provide a novel method of manufacturing deposits of light sensitive material especially for photoelectric tubes, in which the boundary and selective maximum responsiveness thereof to light is extended toward the longer wave lengths.

A further object of the invention is to provide a method of producing light sensitive deposits, to insure increased light sensitivity and emitting efficiency, as compared with similar methods known according to the prior art.

In one form of our invention, we have found that the red boundary of a photoelectric tube can be shifted further towards the longer wave length and also the selectivity maximum can be shifted greatly towards the long wave lengths, when, instead of the ordinary oxide as the base for the alkali metal deposit such as of cæsium, we use a heavy metal oxide, especially thorium or uranium oxide. Light responsive layers of this kind also show an increase of sensitivity, as compared with ordinary potassium layers. They produce, when compared with the latter, even with a very low applied potential quite a strong effect. This is of very great importance in that less amplification is required resulting in more faithful reproduction and economy in operation.

Light responsive layers of this new kind can be produced, for example, in the following preferred manner: First, a cathode made of any kind of a base metal is covered in a chemical way with a layer of some suitable salt, for instance, a nitrate or azide of the desired heavy metal. After this, the tube is evacuated; filled with oxygen under reduced pressure, and a direct current applied to produce a glow discharge in the interior; the surface to be made light responsive is connected to the negative pole.

With this glow discharge, the salt of the heavy metal is wholly or partially converted into oxide by means of concurrent heating and the bombardment of the ions of oxygen. Finally, the oxygen is evacuated, the tube is warmed up and alkali metal, preferably cæsium, is admitted. It is desirable under these conditions to keep the mass of the alkali metal very small and also to carry on an extended heating to 200° or 350° centigrade, and preferably a simultaneous glow discharge in the tube, so that the alkali metal deposit can penetrate into the oxide layer. At the end of this forming process, the excess alkali metal can be removed from the tube by heating at a temperature above the evaporation point while the infinitesimal part required for light responsive action is bound by some special forces (probably Werner's side valencies).

In order to secure on the light sensitive layer, the highest order of light responsiveness, this layer must undergo a forming process with carefully regulated course of temperature condition during which the alkali metal reacts with the oxide and the chemical reaction is thereby completely carried out. It has been found difficult to properly regulate the course of temperature condition during the formation process of a tube of the present art so as to insure that the complete layer will be uniform. The layer is therefore mostly very irregular. In order to control the course of temperature condition, the carrier surface is supplied with two current leads of different thermo-electric properties so that the resulting thermo-electric potential can be used for continuously guiding the temperature from the outside. The heating itself can be carried out within an oven.

It has been shown, however, that the most desirable guidance of the course of temperature condition during the formation can be most easily carried out when the carrier of the layer is brought to the formation temperature in an electrical manner and preferably by the action of eddy currents, since in that case the temperature of the remaining parts of the tube can be

held only slightly above the evaporation temperature of the alkali metal in order to remove the deposits thereon.

In the drawing, Figures 1 and 2 are front and side elevations respectively of two embodiments of our invention in the form of a multiple photoelectric tube.

Figures 1 and 2 show two examples of the carrying out of the invention in the form of a multiple tube, Figure 1 in front elevation and Figure 2 in side elevation. In the tube vessel 1 there are leads 9 for the carriers of the light electric layers 2, 3, and 4, which may have a silver surface; the leads are brought in the usual manner through the press 10. In front of the surfaces 2, 3, and 4, there is an anode 5 in the form of a net with a lead 9'. In the manufacturing process, the silver surfaces 2, 3, and 4 are first oxidized by glowing in attenuated oxygen and then formed by introduction of cæsium in the tube with the required heating. The formation then follows by the location of a high frequency coil 6 in the manner usual with the metallic parts of a vacuum tube. As seen from Figure 1, there is welded on back of the carrier surface 2 an additional lead 7. This second lead consists of a metal which has, relative to the carrier plate 2, the highest possible thermo-electric potential so that the thermal current arising from the welding spot of this lead can be measured by means of a meter 8 and continuous control of the course of temperature condition of the carrier 2 thus achieved.

Another application of our invention refers to glow tubes such as glow or gaseous discharge relays where the use of the alkali metal assures an extraordinarily low cathode drop while the disadvantages with the usual alkali layers of spreading over all parts of the tube are entirely avoided. In this case, the cathode drop is so low that the tube with a normal spacing of electrodes will ignite at 80 or 90 volts. In especially advantageous cases it is possible even to secure an ignition potential of about 70 volts.

A further advantage of a tube in accordance with the invention, especially when it is used as a light source, consists in the fact that relatively high currents may be applied to it. With the alkali layers used up to now it was necessary to take care that the surface loading of the cathode is held low so that the deposit would not be destroyed through use.

The relatively high photoelectric sensitivity, especially to long waves, of the glow tube in accordance with the invention, which is objectionable in certain applications (glow relays) can be made ineffective by providing colored walls for the discharge vessels, especially making them out of blue glass. It is better, however, to provide the tube after preparation in any known manner by a suitable coating impervious to light (lacquer, bakelite, and so on). This last way of making it ineffective with regard to light sensitivity is especially preferable, as in this way, it is possible to continuously inspect the coloring of the cathode during formation process. It is easiest to determine when the tube reaches the correct condition by this coloring. This well known means of providing the discharge vessel with an opaque coating has therefore a special importance in connection with the present invention.

In order to prevent definitely the oxidation of the electrodes which must be held non-responsive to light, it has been proved advisable to make them of some nobler material or else to cover them with a nobler metal than that used for the electrode, to serve as a light responsive element. Thus, for instance, the electrodes which are to be non-responsive to light can be gilt, while the electrode which is to be responsive to light may be silvered or nickel.

We claim:

1. The method of manufacturing light responsive electrodes for photoelectric tubes which comprises coating a conductor in said tube with a salt of a heavy metal, producing a glow discharge in an atmosphere of attenuated oxygen within said tube thereby converting the said salt into an oxide, admitting cæsium into said tube, and applying heat to coat the cæsium on the oxide.

2. The method of producing a deposit of light sensitive materials upon a base of heavy metal, consisting of coating said base with a chemical combination of the base metal, converting said combination into a different chemical combination admitting light sensitive material and heating said base for applying said light sensitive material to the converted coating upon said base.

3. The method of producing a deposit of light sensitive material upon a base of heavy metal, consisting of covering said base with a salt of said heavy metal, converting said salt into an oxide of said heavy metal, admitting light sensitive material to said oxide and applying heat to deposit said light sensitive material on said oxide.

4. A photoelectric tube comprising a positive electrode and a light responsive electrode, comprising a base of radio active substance, and a film of alkali metal coated thereon.

5. A photoelectric cathode comprising a base of oxide of thorium coated with alkali metal.

6. A photoelectric cathode comprising a base of oxide of radio-active metal coated with a light sensitive material.

7. A photoelectric cathode comprising a base of oxide of uranium coated with alkali metal.

8. A photoelectric cathode comprising a base of oxide of thorium coated with cæsium.

9. A photoelectric cathode comprising a base of oxide of uranium coated with cæsium.

10. The method of producing light responsive electrodes for photoelectric tubes which comprises coating a conductor with a salt of thorium producing a glow discharge in an atmosphere of attenuated oxygen with said conductor serving as a cathode thereby converting said salt into an oxide, admitting alkali metal, and applying heat to said cathode to coat the alkali metal on the oxide.

11. A photoelectric tube comprising an envelope, a light sensitive cathode and an anode therein, a thermo-couple formed partially by said cathode with leads to the outside of said envelope for electrically indicating the temperature of said cathode.

12. A photoelectric tube comprising an envelope, a light sensitive cathode and an anode therein, said cathode consisting of a base electrode with a light sensitive film formed thereon, and a metallic member connected to said cathode forming a thermo-couple therewith, outside leads from said cathode and said member for electrothermally ascertaining the temperature of said cathode.

13. The method of producing a light sensitive electrode for photoelectric tubes consisting of coating a conductor within the tube with a layer of salt of a heavy metal; producing a glow discharge in an atmosphere of attenuated oxygen within the tube thereby converting said salt into

an oxide; admitting light sensitive material and applying heat to the conductor to coat said oxide with said light sensitive material.

14. The method of producing a light sensitive electrode for photoelectric tubes consisting of coating a conductor in the tube with a layer of a chemical combination of a radio active material, converting said layer into a different chemical combination of said radio active material, admitting light sensitive material and applying heat to coat the light sensitive material on the converted layer.

15. The method of producing a light sensitive electrode for photoelectric tubes consisting of coating a conductor in the tube with a layer of a salt of a radio active material, converting said layer into an oxide of said radio active material; admitting light sensitive material, and applying heat for coating said light sensitive material to said oxide layer.

16. The method of producing a light sensitive electrode for photoelectric tubes consisting of coating a conductor in the tube with a layer of radio active material, producing a glow discharge in an attenuated oxygen atmosphere in said tube thereby converting said salt into its oxide; admitting light sensitive material and applying heat to coat said light sensitive material on said oxide layer.

17. The method of producing a light sensitive electrode for photoelectric tubes consisting of coating a conductor in the tube with a layer of a salt of radio active material producing a glow discharge through an attenuated oxygen atmosphere in said tube thereby converting said salt into its oxide, admitting cæsium and applying heat to said conductor for coating the cæsium on the converted oxide layer.

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