Nov. 21, 1933. S. ASAO ET AL 1,936,419

PHOTO ELECTRIC TUBE

Filed May 22, 1931

Fig. 1.

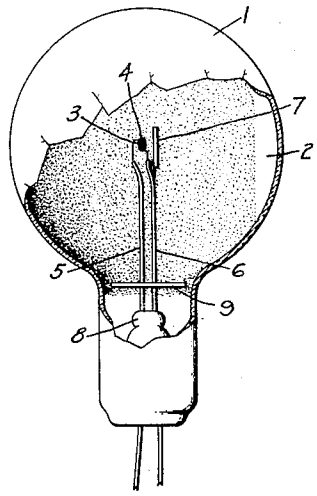
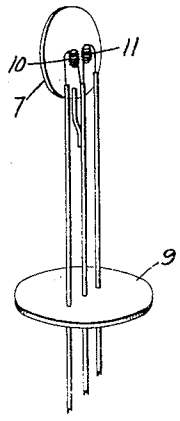


Fig. 2.



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Patented Nov. 21, 1933

1,936,419

UNITED STATES PATENT OFFICE

1,936,419

PHOTO-ELECTRIC TUBE

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Application May 22, 1931, Serial No. 539,383, and in Japan June 3, 1930

4 Claims. (Cl. 250—27.5)

The present invention relates to a photo-electric tube comprising an evacuated envelope, a cathode for emitting photo-electrons and a co-operating electrode, both sealed in said envelope, said cathode being formed of a thin layer of alkaline metals adsorbed on a foundation surface. The object of the invention is to provide a tube of the type mentioned with greater sensitivity. This increased sensitivity is obtained, in accordance with our invention, by coating the usual light-sensitive layer with a metal, such as nickel, gold, platinum or silver.

The invention will be better understood when reference is made to the following description and the accompanying drawing in which Fig. 1 is a front view of a photo-electric tube embodying the principles of the present invention and Fig. 2 shows in perspective enlargement, the anode of the improved tube, together with means for generating metallic vapor for forming the foundation surface referred to and for generating additional metallic vapor for enhancing the sensitivity of the tube in accordance with our invention.

It is generally known that alkali and alkaline earth metal, both of which may be generically termed for convenience, as "alkaline metal", are ordinarily used as light sensitive material. The ordinary form of photo-electric tube is provided with a sensitive layer consisting of one or more of these metals deposited as a thin film on the inner walls of the envelope or on a separate electrode plate. The extremely thin film, i. e. the monatomic film so-called, of alkaline metal adhering to the foundation layer has been found to be superior in its sensitiveness to a relatively thick film formed by mere coating or condensing, as is present in the ordinary type of potassium photo-electric tubes. A tube improved in accordance with our invention has several times the sensitivity of these tubes of the prior art. The metals which have been found to increase the sensitivity of the tubes when used in conjunction with alkaline metals are platinum, gold, silver, nickel and the like, whose light sensitivity is less than that of the alkaline materials. In spite of their poor light sensitive quality, the photo-electric activity of the tubes employing this metal suddenly increases when they are added to the aforesaid alkaline metals and the reasons for this decided increase are not fully known to us at the present time. However, it appears that this unusual result is obtained by the combination of a monatomic layer of the alkaline metal and a very thin film of the aforementioned metals deposited on the alkaline metal.

The following process is preferred in the fabrication of the improved photo-electric tube. A metallic film for the foundation surface of the cathode is deposited on the inner walls of an envelope 1, by the well known process of electrolysis or vaporization leaving a portion 2 as a window, for receiving light. A heating element 3 is formed by winding a tungsten wire as a helix into which is inserted a pellet 4 of a metal, such as silver, which is electrically conductive, also readily oxidizable. In order to protect the window 2 from the silver vapor, a metal disc 7 is secured to the conductor 6 of the heating element and in order to protect the stem 8 from the vapor, a glass disc 9 is attached to said conductor. This heating element is positioned in the bulb and supplied with current through conductors 5, 6, after which the envelope is exhausted and the silver vapor distilled on the walls by heating the silver pellet. If desired, a foundation layer of silver may be formed on any of the electrodes disposed in the bulb instead of on the envelope, as is well known in the art. After completing this process, a layer of oxygenous substance which tends to absorb alkaline metals, i. e. alkali or alkaline earth, is formed on the surface of said silver by supplying the proper amount of oxygen to the envelope. The bulb may then be connected to an exhaust machine and the excess oxygen and other unnecessary gases pumped out, after which the vapor of any alkaline metal, such as cæsium or potassium, may be introduced. The cæsium vapor may be supplied from a side tube (not shown) connected to the bulb, or by introducing into said bulb, a pellet containing compounds of the said metals, and heating the pellet to obtain the required metal vapor which condenses on the oxidized silver. The bulb is again connected to the exhaust machine and heated to the proper temperature according to the kind of alkaline metal used so as to remove the free or excess alkaline metal, leaving therein only a thin light-sensitive film adsorbed on the oxidized silver.

According to the present invention, the platinum, gold, silver or nickel, is then deposited on the formed light-sensitive film. In the case of silver for the outer coating, which is similar to the foundation surface, the vapor-generating means used in the process for forming the foundation material can be used again, but the amount of vapor to be condensed at this time is considerably less than that used before. It is preferable to form this additional metal layer so thin as to pro-

duce only a faint discoloration, by which the kind of metal used can be detected, and also so thin as to allow most of the light impinging on the exterior layer to reach the under layer of oxidized cæsium or potassium.

It is therefore necessary to be careful when the silver is revaporized by the heating element. When silver is employed for the foundation layer, and gold, platinum or nickel for the outer layer, it is preferable, as can be seen in Fig. 2, to segregate the respective materials into two heating elements 10, 11 positioned behind the disc 7 and to provide connections with which to supply the elements with current.

The sensitivity is greatly increased if the cathode surface is heated to moderate temperatures, for example, 200° C.–250° C., after the film-forming treatment has been completed.

The sensitivity of the improved photo-electric tubes utilizing a silver outer layer, has been determined with the following results: In the blue and green portion of the light spectrum, it is about 1.5 to 2.0 times higher than the prior art cæsium photo-electric tubes and for the red range of the spectrum it is about 50.0–60.0 times higher.

On the other hand, incandescent lamps which are most commonly used as the light source for photo-electric devices contain a large amount of light of long waves and the total sensitivity measured in connection with these incandescent lamps has been found to be about five times or more that exhibited by the cæsium tubes operating under the same conditions. Nickel has a remarkable effect, though it is somewhat difficult to vaporize, while gold and platinum are much easier to vaporize but produce only a fair increase of sensitivity.

What we claim as new and desire to secure by Letters Patent of the United States, is,—

1. A photo-electric cathode comprising a light-sensitive material comprising an oxidized metal layer coated with alkali material and then coated with nickel.

2. A photo-electric tube comprising an envelope containing an electrode and a layer of nickel deposited on a layer of alkali material superposed on a foundation metal.

3. A photo-electric tube comprising an evacuated envelope containing an electrode and a coating of foundation material on said envelope, said coating consisting of silver, an alkali material deposited thereon and nickel deposited on the alkali material.

4. The process of fabricating a photo-electric tube which comprises evaporating and condensing the following material on the envelope, a foundation metal, a superposed coating of alkaline material, and a layer of an element of a group which comprises nickel, gold, silver and platinum.

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