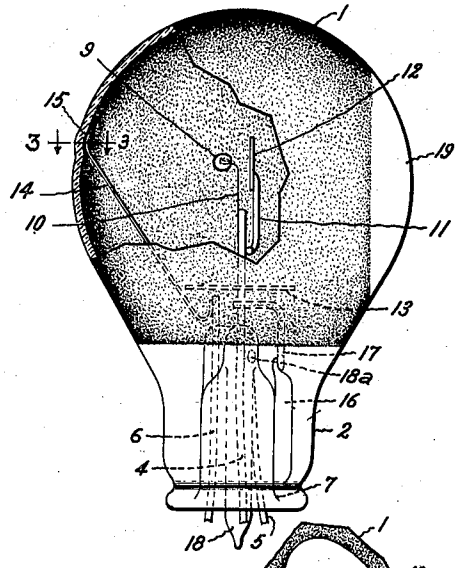
May 30, 1939. A. J. KLING 2,160,593

PHOTOELECTRIC TUBE

Filed Sept. 18, 1937

Fig. 1.



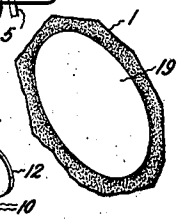


Fig. 2.

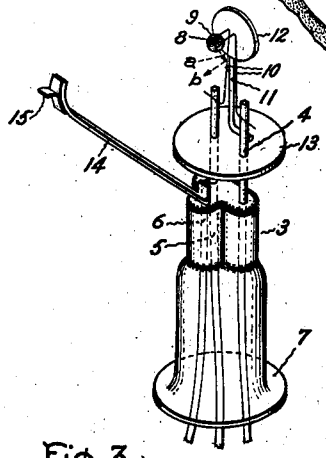


Fig. 3.



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PHOTOELECTRIC TUBE

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2 Claims. (Cl. 250—165)

The present invention relates to light-sensitive devices and more particularly to a photo-electric tube of the type in which the light-sensitive layer is positioned on the interior surface of the envelope. A tube of this character has been shown and described in the Ruggles Patent No. 1,568,694, and the present invention is an improvement on this type of photo-electric tube.

As explained in the patent, a metal foundation layer is formed on the envelope of a tube by vaporizing a globule or bead of silver, causing the vapor to condense on the envelope except at a place which is left clear for a window. Light-sensitive material is then deposited on the foundation layer. In order to prevent the deposition of metal at the window position, a shield is provided which casts a circular shadow on the envelope. This shield serves to intercept the vapor particles as they travel outwardly in straight lines from the silver globule so that the vapor is condensed over the entire envelope interior except at the position where the shadow is cast. Electrical connections are taken from the light-sensitive layer which serves as a cathode, and from the shield or silver globule which serves as an anode.

While thousands of satisfactory tubes have been fabricated in accordance with the structure and technique described in the said patent, I have found that on occasion the window becomes blurred or hazy and its circumferential edge is not clearly defined. This lack of transparency is due to the deposition of metal particles at various places on the window, which particles have not been intercepted by the shield. Upon investigation, I found that this undesired deposition is due to the reflection of the particles by certain elements within the tube, particularly the leads of the heater which is used for vaporizing the metal globules. These leads are heated to an elevated temperature by the heater current so that when the metal particles strike the leads, the metal does not condense but is reflected away in a direction normal to the tangential surface of the leads. This direction usually intercepts the window.

The primary object of the present invention is to provide an arrangement of parts, including filament or heater leads, which will not give rise to undesired reflection of the metal particles and consequently, will provide a window which is transparent and perfectly free from deposited material over its entire area. This object is attained in brief by so arranging the metal parts including the conductors that the metal particles striking them will be reflected away from the window.

Another feature of the invention is an improvement in the electrical connection which contacts with the light-sensitive layer. According to the prior art, connections are usually made by means of a spring wire forced against the layer but not rigidly secured to the layer. Such a contact is not altogether satisfactory in that a perfect electrical contact is not always assured. Moreover, there is a tendency for the conductor to move with respect to the layer and thereby introduce disturbances into the output of the tube. As will be pointed out presently, I have improved on this type of connection by securely joining the lead to the light-sensitive layer. In fact, a part of the lead is fused directly to the envelope and the light-sensitive layer is formed over that part so as to make perfect electrical contact.

The invention will be better understood when read in connection with the following specification and the accompanying drawing in which Fig. 1 is an elevational view partly in section of a tube made in accordance with the invention; Fig. 2 is an isometric view of the glass mount and the electrodes and conductors in place; while Fig. 3 is an enlarged sectional view taken along line 3—3 of Fig. 1.

Referring to the drawing, numeral 1 designates a bulbous form of envelope terminating at the bottom in a reduced diameter portion 2 which the electrode mount is secured. As shown more clearly in Fig. 2, this mount 3 consists essentially of a vertical glass stem, triangular in cross-section and containing three leading-in conductors 4, 5, 6. The mount is increased in size at the lower end and terminates in a flare 7. A coiled filament 8 is encased within a metal bead or globule 9, and the fine wire of the filament is extended vertically downward at 10 and is secured as by spot-welding to the rigid leading-in conductors 4, 5. A rigid metal arm 11 is also welded to the conductor 4, and the top of the arm carries a circular metal disk 12. It will be noted that the plane of the disk is preferably parallel to the vertical planes which contain the conductors 10 and the leading-in conductors 4, 5. The disk is positioned quite close to the metal globule 9. Intermediate the upper ends of the conductors 4, 5 and the top surface of the stem 3, there is positioned a comparatively large circular disk 13 of mica or other insulating material which can be secured in any suitable man-

ner to the conductors. The purpose of this disk will be explained later.

The upper end of the conductor 6 terminates just beyond the top surface of the stem 3 and carries at its end a spring strip member 14, preferably of rectangular cross-section, which extends outwardly and upwardly from the stem as shown. The end of the strip 14 terminates in an arcuate portion and has secured thereto a short, thin strip of platinum 15 or other metal which can be readily sealed to glass and preferably has the same coefficient of thermal expansion as the glass.

In addition to carrying the metal disk 12, the lead 4 also carries a metal capsule 16 to which it is secured by an angular piece of wire 17 (see Fig. 1). Within this capsule there is a compound which gives off caesium upon being heated, for example, the combination of caesium chromate, aluminum, and chromic oxide. The capsule is preferably made from thin strip material folded about the compound to form a container and leaving crevices through which the vapor can escape.

When all of the elements thus far described have been mounted on the stem 3, the elements are inserted into the main envelope and when in position, the flare 7 is sealed to the neck portion 2. There is usually no difficulty in maneuvering the mount in such a manner as to introduce the strip 14 into the envelope. The height of the globule 9 and disk 12 is predetermined so as to position these elements in the geometrical center of the bulb 1. The strip 14 will press against the glass, holding the platinum tab 15 between the strip 14 and the glass. A gas torch may then be played on the outside of the envelope opposite to the position of the tab, and the outward force exerted by the strip 14 is sufficient to cause the tab to be fused to the glass.

The tube is then ready to be evacuated and for this purpose an evacuating tubulation 18 is provided which communicates through an opening 18*a* with the interior of the envelope. The lower end of the tubulation is sealed to a pump. After a high degree of evacuation has been obtained, for example 1/100 micron, current is passed through the heater 8 which causes the globule 9 to evaporate and to radiate metal particles in all directions from the point source. These particles in the form of vapor condense uniformly over the entire envelope except at the position 19 which is shielded by the disk 12. It is apparent that this shield casts a shadow on the envelope and intercepts all of the particles which tend to move within a cone subtended by the shield and having the apex or point source at the globule. Obviously, a layer of metal is also formed over at least a part of the arcuate or end portion of the strip 14 and makes a perfect electrical contact therewith. The disk 13 prevents the deposition of the metallic vapor on the lower end of the envelope 8 on the upper surface of the stem 3 where it would otherwise cause short-circuit between the leading-in conductors.

Oxygen is then admitted through the tubulation 18 to oxidize the silver deposit, after which a high frequency coil is placed around the neck 2 so as to heat the capsule 15 to a temperature sufficient to cause a chemical reaction and volatilize the pure caesium thus produced. The caesium vapor will deposit on the oxidized silver; some of it will react with the oxide, some will remain as a thin layer in the free state, and the remainder can be pumped out or absorbed in any well-known and suitable manner. It is therefore apparent that a cross-section taken through the envelope at the line 3—3 and as illustrated in Fig. 3, would show the platinum tab directly on the glass and fused thereto, with the metal of the strip 14 next to the platinum, and finally, the silver, oxygen, and caesium in order. The latter three elements on the envelope combine in such a manner as to constitute very sensitive light-reactive material so that when a potential is applied between conductors 4 and 6 and light is caused to impinge on the deposited layer through the window 19, photo-electrons are generated which move toward the globule 9 and the shield 12.

It has been found that when making photo-electric tubes according to the above described technique, the window 19 is not absolutely transparent over its entire area but becomes blurred in places. Examination has shown that the cause of the blurring is due to the condensation of the metal vapor at the position of the window notwithstanding the fact that the shield 12 has been provided to intercept the metal particles which move in straight lines from the globule. I have found that this undesired deposition of metal is the result of an improper position of the metal parts within the tube, particularly the heater leading-in conductors. These conductors are at an elevated temperature during the silver vaporizing step and unless properly positioned, will intercept some of the silver particles and redirect them toward the window in sufficient numbers to cause a haze or blur on the envelope. Fig. 2 graphically depicts the manner in which these reflection effects are minimized in accordance with the present invention in that the conductors 10 are located between the globule 9 and the shield 12 and are positioned in such a manner that any particle striking them will be immediately reflected in a direction opposite from the window. The directions taken by a particle leaving the globule 9 and first striking the heated conductor 10 and then reflected away from the window are indicated respectively by the dotted arrows *a* and *b*. By deflecting the particles which strike the conductors into a direction away from the window, these particles will simply add their number to the particles which have already reached the envelope directly from the globule, and consequently, can do no harm.

As stated hereinbefore, another feature of applicant's invention is the positive connection between a flexible strip 14 and the light-sensitive layer. It is apparent that inasmuch as the platinum tab 15 is fused directly to the glass, and further, since the light-sensitive layer including the silver is deposited over at least a part of the end portion of the strip, the latter makes perfect contact with the light-sensitive layer and is rigidly secured thereto.

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

1. A photo-electric device comprising an envelope, a body of vaporizable metal supported within the envelope, a heater in thermal contact with the body of metal and effective when energized to vaporize the same, thereby to cause deposition of the metal on the walls of the envelope, a shield positioned near said heater for reflecting vapor away from a portion of the envelope to leave a window, and common means intermediate between the metal body and the shield for conducting current to said heater and for directing particles vaporized from said body and intercepted by the means away from the window.

2. A photo-electric device including an envelope, a layer of vaporizable metal deposited upon the wall of the envelope, a filamentary heater centrally mounted within the envelope and useful during fabrication of the device to cause vaporization of the said metal from a supply of the same retained in contact with the heater, a shield positioned between the heater and a portion of the envelope which serves as a window and a pair of lead-in wires connected to the said heater for conducting heating current thereto, said lead-in wires being both mounted in a plane between the heater and the shield to deflect particles of vaporized metal proceeding from the heater away from the said window.

AUGUST J. KLING.