May 15, 1951 H. LEMS 2,553,197

PHOTOELECTRIC TUBE

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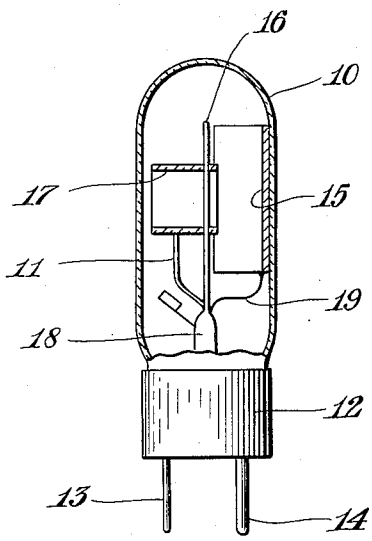


Fig. 1.

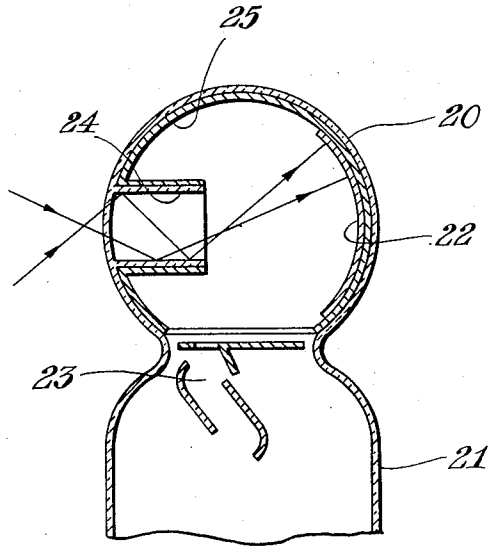


Fig. 2.

INVENTOR.
HENDRIK LEMS.

BY

ATTORNEY.

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PHOTOELECTRIC TUBE

Hendrik Lems, Eindhoven, Netherlands, assignor, by mesne assignments, to Hartford National Bank and Trust Company, Hartford, Conn., as trustee

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1 Claim. (Cl. 250—165)

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The present invention relates to a photo-electric tube. The use of such tubes frequently involves the drawback that the incident light originates from different directions and does not always reach the most appropriate portion of the photo-electric cathode.

To avoid this drawback, it is already known to provide photo-tubes with external means to confine the incident light to a definite part of the photo-sensitive cathode. A known construction is one wherein the photo-tube is surrounded by a tubular member guiding the light from the exterior to the photo-cathode. It is also known to provide lenses at the outside of the wall of the photo-tube, said lenses concentrating the light in a definite part of the cathode. These known constructions, however, have the common disadvantage that these means must be provided separately or are fixed to the outside of the wall of the photo-tube, so that these photo-tubes cannot be used without additional expedients, for any purpose in any apparatus. This is particularly of importance for sound film reproducing apparatus where minimum dimensions of the photo-tube are desirable so as to permit the latter of being easily incorporated in the sound scanning-system.

According to the invention, the photo-tube comprises a light-conductive body arranged in the interior of the bulb opposite the cathode. The light incident on the photo-tube is now collected by the light-conductive body in a definite direction and thrown upon a confined part of the photo-sensitive cathode. Such photo-tubes are on the outside entirely smooth and can therefore be used in any apparatus without particular measures.

The present invention is particularly of importance for photo-tubes in which the electrons released from the photo-sensitive cathode are concentrated by the focusing action of this cathode to the first electrode of an electron multiplying tube, as described, for example in Dutch Patent No. 57,179. In this construction the electron beam must be guided through a narrow opening in the anode of the photo-electric system to the electrodes of an electron multiplier. This is only possible for electrons originating from a definite part of the photo-cathode. Electrons released beyond this part are lost for further amplification so that the light which falls beyond the definite part of this cathode is useless.

It is already known to provide a screening bushing in the interior of a photo-tube. This bushing, however, serves to prevent the light falling

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through the photo-tube from reaching the photo-cathode.

The light-conductive body according to the invention preferably consists of a glass tube or rod sealed at the inside to the glass wall of the photo-tube. On providing the interior of the photo-tube with a silver coating, the outer circumference of this tube being also silvered, this increases the light-conductive effect.

This silver plating is necessary when use is made of a tube as a light-conductive body. If use is made of a solid glass rod, total reflection occurs against the outer wall of this glass rod so that in this case the silver coating may be omitted if desired.

The present invention applies to photo-electric tubes whose photo-cathode is deposited on the glass wall of the bulb, as well as to photo-tubes having a photo-cathode arranged on a plate-shaped support which is not in contact with the glass wall of the bulb. In the latter case it is advisable in view of the limited surface of the photo-cathode that highly concentrating light-conductive means should be used, such as a solid glass rod. If necessary, the shape of this glass rod is adapted to the light path to be traversed.

In order that the invention may be more clearly understood and readily carried into effect, it will be explained more fully by reference to the accompanying drawing.

Figure 1 shows how the invention is applied to an ordinary photo-tube comprising an anode and a photo-sensitive cathode.

Figure 2 shows its application to a photo-tube series-connected with an amplifier which operates with secondary emission of electrons.

In Figure 1, 10 is a glass bulb containing all the electrodes of the photo-tube either in vacuum, or in a gaseous atmosphere. With the aid of a base 12 having two differently shaped plug pins 13 and 14, the photo-tube can be arranged in the apparatus. The photo-electric cathode 15 is deposited on part of the wall of the glass bulb. With the aid of a wire 19 sealed in a press 18, this cathode is connected to one of the contact pins. The anode 16 is made in the form of a U-shaped rod which is also supported in the press 18 and is connected electrically to the other contact pin. In the interior of the glass bulb opposite the cathode 15 there is provided a piece of glass tube 17 in the path which is followed by the light rays incident on the cathode. This tube is supported by a supporting wire 11 sealed in the press 18. The light falling from the outside on the part of the glass wall opposite to the tube 17 is reflected,

so far as the light rays reach the wall of the tube 17, and is conducted to the cathode 15. The part of the cathode 15 which is exposed to incident light rays is consequently confined to a surface being approximately equal in size to the surface of the tube 17. In this manner even with oblique incident light on the photo-tube the exposed area on the cathode 15 is substantially confined to the above-mentioned surface so that variations in the sensitivity of the photo-tube as a result of changes in the exposed areas are thus obviated. The limbs of the U-shaped anode rod 16 are spaced apart to such an extent as to be unable to intersect the light beam from the tube 17 to the cathode 15 and consequently do not throw a shadow on the cathode surface.

For applications of this photo-tube in which the light can reach the glass bulb from all sides it is advisable for the remaining part of the bulb which is not located opposite the tube 17 to be made opaque. This may be effected, for example, by means of the internal silver coating of the bulb. If the tube is arranged in a closed holder which has only a limited aperture, as is the case, for example, with sound reproducing apparatus, then a silver coating will in most cases be superfluous.

The embodiment shown in Figure 2 is constituted by a glass bulb having a spherical part 20 and an adjoining cylindrical part 21. In the spherical part 20 the photo-electric cathode 22 is provided against part of this spherical wall. The adjoining cylindrical part contains the electron amplifier 23 which operates with secondary emission. Such a photo-tube is described and explained in greater detail in Dutch Patent 57,179 so that here a further description is superfluous. With regard to the operation of this photo-tube it is only mentioned that light rays reaching the cathode 22 liberate from it electrons which are beamed owing to the self-focusing spherical shape of the cathode and are conducted in this beam to the first electrode of the secondary-emission amplifier. The correct direction of this beam depends upon the place where these electrons are released from the cathode 22 so that it is of great importance that the cathode 22 should be exposed only on a limited and a very definite area. This result is obtained in the described embodiment by sealing to the inside of the glass bulb 20 opposite the cathode 22 a glass tube 24 externally provided with a silver coating. The incident rays from various directions are collected by this glass body and practically all conducted to that part of the cathode 22 which is in line with the tube 24. Consequently, the cathode 22 need have only limited dimensions. For the concentrating action, however, it is necessary that substantially the whole ball is given the same potential as the photocathode 22. This ball is consequently internally provided with a conductive metal coating 25 which also extends at the outer circumference of

the tube 24. The coating of the ball also serves for screening all parts, except the wall adjoining the tube 24 opposite the point of the incoming rays from the exterior. Though it can be expected that the cylindrical coating 25 on the outside of the tube 24 will bring about a certain deformation of the focusing field in the ball 20, it has been found that the field deformation is not of such nature as to disturb the beaming action. The focused electron beam will probably be slightly displaced but this field deformation practically does not impair the operation of the tube owing to the limited exposed surface of the cathode 22 and the resulting contraction of the electron beam. In any event it is possible for the aperture in the focusing anode and the focusing potentials to be so adjusted that the electron beam is conducted through this opening in the anode.

When use is made of moulded glass bulbs instead of the blown bulbs, it is possible for the light-conductive body to be moulded simultaneously with the bulb in one piece. In this case a lens-shaped thickening may be provided, for example, at the inside of the bulb opposite the photo-cathode. In particular when use is made of a plate-shaped photocathode which is not in contact with the bulb wall, the use of such a highly concentrating light conductive body as a lens is highly efficient.

What I claim is:

A photoelectric tube of the electron multiplier type comprising an envelope having a cylindrical portion and a spherical portion communicating with said cylindrical portion, a concave photosensitive cathode abutting one side of said spherical portion, a tubular light-conducting member disposed within said spherical portion and secured at one end to the side opposite said cathode, the other end of said member being disposed to direct light rays onto a predetermined section of said cathode whereby said cathode emits an electron beam, and a series of multiplier electrodes within the cylindrical portion of said envelope to amplify the electron beam projected by said cathode.

HENDRIK LEMS.

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