Aug. 5, 1941. H. A. BERG, JR 2,251,653

PHOTOELECTRIC TUBE

Filed March 25, 1937

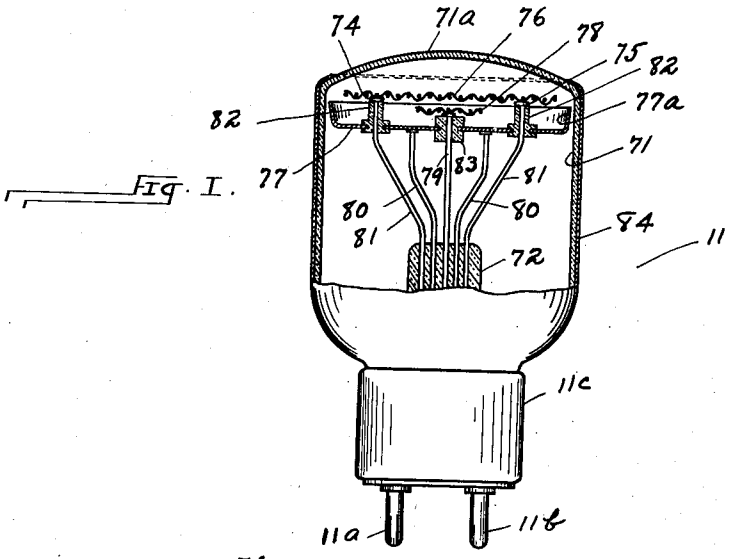


Fig. I.

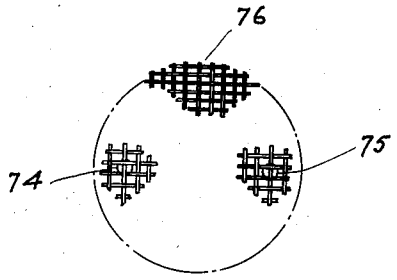


Fig. II.

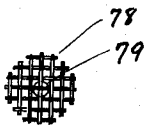


Fig. III.

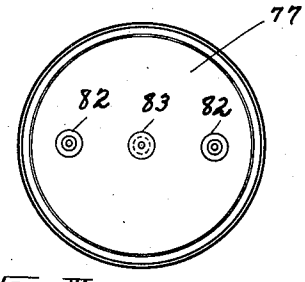


Fig. IV.

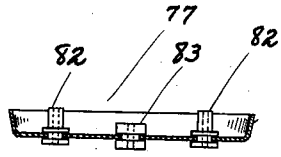


Fig. V.

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PHOTOELECTRIC TUBE

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6 Claims. (Cl. 250—169)

My invention relates to photo-electric tubes, and consists in improvements and refinements in structure.

In application for Letters Patent Serial No. 127,867, filed February 26, 1937, now Patent No. 2,219,976, dated October 29, 1940, I illustrate and describe apparatus for automatically controlling the head lights of automobiles. Such apparatus essentially includes a photo-electric tube that is installed in an automobile in such position as to receive light from the headlight beams of cars approaching in opposite direction. Under the temporary influence of such light beams, the photo-electric tube in known way is adapted to modify the electric conditions of a circuit, in such manner that an energizing current flows through one or more electric relays, or other circuit-controlling devices. The energized relays, or other devices, are arranged to effect automatically the temporary dimming or deflecting of the light-beams of the headlights of the car equipped with the apparatus.

In accordance with the invention, I provide a photo-electric tube which is particularly, though not exclusively, designed for service in such apparatus. I provide my improvements in the construction of photo-electric tubes, with the following objects, among others, in view:

(1) That the tube shall be of increased mechanical strength.

(2) That the tube shall with greater sensitivity respond to light-beams, not only beams that are directed upon the tube in normal direction, but also beams that play upon the tube angularly, in the manner that the headlight beams of one car play at varying angles upon the windshield of another car that approaches and passes on the highway.

(3) That the usual electronic flow or glow discharge of the tube shall be quickly suppressed when the illumination thereof (by the beams of an approaching and passing car) is terminated, so that the apparatus shall be more quickly responsive to conditions of service.

In the accompanying drawing, Fig. I is a view, partly in side elevation and partly in axial section, of a photo-electric tube embodying the invention.

Fig. II is a fragmentary view in plan of the particular anode element embodied in my tube.

Fig. III is a view in plan of a suppressor grid which is interposed between the anode and cathode elements of the tube.

Fig. IV is a view in plan of the cathode element of the tube.

Fig. V is a view in transverse section of the cathode element.

Referring to Fig. I of the drawing my photo-electric tube 11 consists in bulb or envelope 71 of glass, including a glass stem 72 sealed in usual manner in the base of the bulb. In accordance with known practice a metal contact ring 11c is secured upon the base of the assembled stem and bulb, and mounted in such base, in electric isolation from the contact ring 11c and from one another, are two contact prongs 11a and 11b. As will presently appear, the ring 11c and prongs 11a and 11b are severally connected to the photo-electric elements included in the bulb, and in known way the assembled structure is adapted to be mounted in a supporting socket (not shown), in which the ring 11c and prongs 11a and 11b engage complementary contact elements and severally complete electrical connections between the photo-electric elements in the bulb and certain circuit wires of the apparatus to be operated.

In accordance with my invention, each of the essential anode and cathode elements 76 and 77, respectively, of the photo-electric tube extends in a plane that is normal to the axis of the bulb 71. The atmosphere within the bulb may be any suitable one of the known gases or gaseous mixtures now used, although I prefer an inert atmosphere of helium. The anode and cathode elements 76 and 77 are spaced apart axially of the bulb within which they are sealed, and between such elements I interpose a suppressor grid 78.

The cathode 77 comprises a dish-shaped member of thin sheet copper, integrally mounted on the upper ends of two supporting rods 80, with its dished face directed towards the end-wall 71a of the glass bulb or envelope. The rods 80 are formed, as usual, of metal of high electric conductivity, and, as usual, the lower body portions of the rods are sealed and rigidly supported in the glass body of the stem 72. At least one, if not both, of the rods extends through the stem 72, and within the basal portion of the assembled tube is welded or soldered to the contact prong 11b. The dished face of the copper cathode 77 is coated with a light-sensitive material. More specifically, the dished surface of the copper cathode is in known way oxidized, and a film of caesium applied to the cuprous oxide. Alternately, and in further refinement, the cathode may be provided first with a coating or plating of metallic silver, and the silver coating oxidized, before the surface of the cathode is sensitized in usual way in the presence of caesium vapor (or other suitable alkali vapor).

The anode 76 consists of a fine mesh, circular screen of metal wire, say a fine wire of nickel, the size of wire and mesh being shown on exaggerated scale in the drawings. It will be perceived that the diameter of the sccreen 76 (Fig. I) is less than that of the dished cathode 77, so that the periphery of the screen lies within the compass of the upturned edge 77*a* of the cathode. In assembly, the anode 76 is soldered or otherwise electrically and mechanically integrated, as at 74 and 75, to the upper ends of two metal supporting rods 81, that extend downward through the floor of the cathode 77 and are sealed in the glass stem 72. Within the base of the tube structure, the electrically conductive metal rods 81 are united to the contact prong 11*a*.

The suppressor grid 78 consists in a relatively small circular screen of fine mesh wire, such as the wire of which the anode 76 is made, and is soldered, or otherwise integrated to the upper end of a metal supporting rod 79. This supporting rod, as the rods 81 already described, extends through the floor of the cathode 77, and is rigidly integrated with and sealed in the body of glass stem 72, and within the base of the tube assembly such rod 79 is electrically united with the contact sleeve 11*c*.

It will be understood that the rods 79 and 81 are electrically insulated from the cathode 77 through which they extend. Advantageously, tubular insulators 82 and 83 are provided for insulating the rods from the cathode, and for mechanically reinforcing and strengthening the assembly of elements 76, 77, and 78 within the bulb 71. As shown in the drawing, these insulators may be formed of glass, or other suitable electrical non-conductive material, which is molded and firmly integrated with the floor of the cathode, such floor being initially perforated to receive the insulators, as indicated in Fig. V. Thus, within the glass bulb or envelope 71, the anode 76 and cathode 77, spaced apart axially of the tube structure 11, are mounted in sturdy assembly, with the suppressor grid 78 interposed between. The supporting rods 80 electrically connect the cathode 77 to the contact prong 11*b*; the rods 81 connect the anode 76 to the contact prong 11*a*; and the rod 79 connects the grid 78 to the contact ring 11*c*. And it is important to note that the several photo-electric elements 76, 77, and 78 lie in spaced-apart planes which extend normal to the axis of the tube structure. Manifestly, by virtue of the recticulated or meshed structure of the anode 76 and grid 78, these elements readily permit the passage of light. They may be said to be light pervious.

The theory of operation of photo-electric tubes is well-known in the art, and suffice it to say herein that when a suitable electric potential is applied across the anode and cathode, and the cathode 77 within the tube 11 is illuminated there is an electronic flow from the cathode to the anode element within the tube, in consequence of which an electric current is caused to flow through an external circuit connected to such elements, to effect the operation of associated electric instrumentalities. In the case in mind such electric instrumentalities comprise means for deflecting or dimming the headlight beams of an automobile.

In my structure the grid element 78 may be connected to negative side of a power supplying circuit, and in the operation of the photo-electric tube the grid 78 serves a dual purpose. First: When the photo-electric tube is subjected to light, the grid element serves to accelerate the electronic flow from the cathode to the anode. This acceleration in electronic flow increases the power of the tube, and renders its operation more quickly responsive to illumination. Second: When such illumination of the tube is terminated, the electronic flow from cathode to anode tends to continue, due to the conductivity of the gas in the tube, so that photo-currents continue to flow in the external circuits, and continue to effect operation (operation of headlight-deflecting or dimming apparatus in this case) for a longer interval than is desired. This undesired, continuing electronic flow, known in the art as glow discharge and fringe discharge, is harmful to, and shortens the life of, the tube. In my structure the grid element both suppresses this undesired electronic flow and attracts the flow toward itself, thereby minimizing the danger of damage to the tube, and insuring a longer effective life of the cathode.

In gaining these ends, I have found that it is desirable, if not essential, to arrange the suppressor grid 78 concentrically of the cathode and between the anode and the cathode. The area of the suppressor grid equals from 25% to 33⅓% of the effective area of the anode, so that the grid does not control the entire electronic flow within the tube, but chiefly controls the glow discharge which has its inception at the center of the anode. The grid is removed from the usual fringe discharge of electrons that emanates from the peripheral portion of the cathode.

In further accordance with the invention, I provide an electrical canopy for inhibiting, or neutralizing the effect of, the electronic fringe discharge of the tube. This canopy may consist, as shown in this case, of a jacket or coating 84 of electric conductive material upon the side wall of the glass bulb 71. This jacket may consist in a sprayed-on coating of silver or other metal of high conductivity, and, as shown in Fig. I, the jacket entirely covers the side wall of the glass bulb or envelope, extending from above the assembled anode and cathode within, down to and into electric communication with the contact ring 11*c*. Indeed, the jacket 84 may be applied before the contact ring 11*c* is assembled upon the base of the tube. In service, the fringe discharge of the tube is attracted by the jacket 84 and lead to the same contact terminal (11*c*) that is connected to the suppressor grid 78. By virtue of such structure, advantages of the nature indicated are obtained.

I claim as my invention:

1. A photo-electric tube including a glass envelope having therein a light-pervious anode, a cathode coated with a photo-electrically sensitive material, means supporting said anode and cathode in closely spaced relation, an inert atmosphere in said envelope, an electronic-glow-discharge-suppressing grid supported in position between said anode and cathode, and an electronic-fringe-discharge-suppressing band of electro-conductive material spaced from and extending in encompassing relation with respect to the peripheries of the assembled anode, cathode and grid.

2. A photo-electric tube including a glass envelope having therein a cathode, said cathode comprising a dished member having an upstanding peripheral rim, said member coated on its dished surface with a photo-electrically sensitive material, an anode comprising a light-pervious disk of electro-conductive material included in

said envelope, the periphery of the anode disk extending in proximity to the edge of the upstanding peripheral rim of the dished cathode, and a support structure within said tube mechanically integrating the anode and cathode in isolation with respect to conductive electrical currents.

3. A photo-electric tube including a glass envelope having supported therein a cathode, said cathode comprising a dished member having an upstanding peripheral rim, said member coated on its dished surface with a photo-electrically sensitive material, an anode comprising a light-pervious disk of electro-conductive material supported in said envelope in closely spaced relation with respect to the dished surface of said cathode, and an electronic-glow-discharge-suppressing grid supported within the compass of the upstanding rim of said cathode and between the cathode and anode and in electrically conductive isolation from both cathode and anode.

4. A photo-electric tube including a glass envelope having therein a light-pervious anode and a cathode, an inert atmosphere in said envelope, said cathode comprising a disk-like body coated with a photo-electrically sensitive material, said disk-like body of the cathode including a perforation, an insulator secured in said perforation, and a member connected to the anode and extending through said insulator, said structure providing mutual reinforcement of the assembled anode and cathode and providing a support therefor, with mechanical integration and electrical-conductive isolation of said anode and cathode.

5. A photo-electric tube structure including a glass envelope having therein a light-pervious anode, a cathode, and a grid between said anode and cathode, an inert atmosphere in said envelope, said cathode comprising a disk-like body coated with a photo-electrically sensitive material, a support for said cathode in the tube, the disk-like body of the cathode having two insulators secured thereto and extending therethrough, and two members anchored to the tube structure and extending severally through said two insulators and secured severally to said anode and to said grid, providing mutual reinforcement of the assembled anode, cathode and grid.

6. A photo-electric tube structure including a light-pervious anode and a cathode in an inert atmosphere within an envelope, said cathode comprising a disk-like body coated with a photo-electrically sensitive material, a support for said cathode in the envelope, the disk-like body of the cathode including two perforations, two insulators severally positioned in said perforations, and two rods anchored to the tube structure and extending severally through said insulators and supporting said anode securely in closely spaced relation with respect to said cathode, a grid positioned between said anode and cathode, said grid being of relatively small area with respect to said cathode, said cathode including a third perforation, with an insulator positioned in said third perforation, and means including said last insulator securing said grid in such position between the anode and cathode.

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