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PHOTOELECTRIC DISCHARGE DEVICE

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2,601,208

Fig. 1

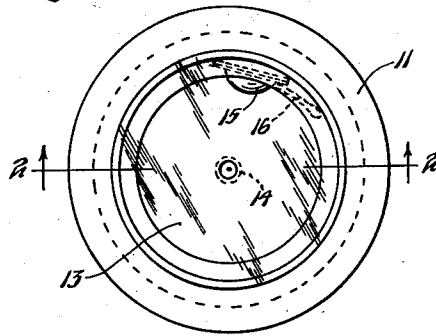


Fig. 2

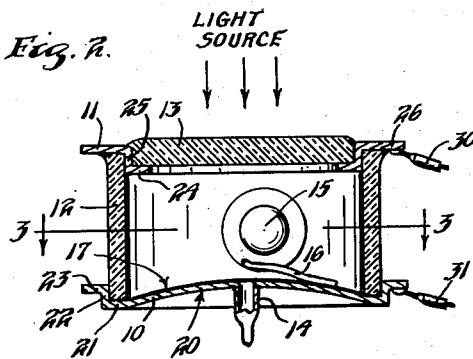
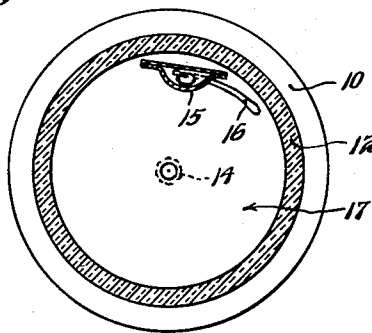


Fig. 3



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PHOTOELECTRIC DISCHARGE DEVICE

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14 Claims. (Cl. 313-102)

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This invention relates to electron discharge devices of the light sensitive type and especially to those devices wherein the electrodes form part of the envelope. It is an object of this invention to devise an electron discharge device of extreme simplicity.

Another object of the invention is to produce an electron discharge device of very small dimensions.

Another object of the invention is to devise an electron discharge device which will have a small number of parts and a sturdy construction and be capable of taking a great deal of abuse and still not affect its operation.

Another object of the invention is to devise an electron discharge device which will require no lead-in wires into the envelope nor any prongs necessitating plugging said device into a socket.

Another object of the invention is to devise a photo-electric tube in which the light passes through a window mounted to cover a removed portion of the anode.

These objects are accomplished by designing the electron discharge device in such a manner that the anode and cathode electrodes form parts of the envelope of the device and by making a portion of the anode in the form of an annulus.

Other objects and advantages will become apparent in the following, more detailed, description and by reference to the drawings in which:

Figure 1 is a top plan view of a photo-electric tube embodying the features of the invention;

Figure 2 is a cross sectional view of the tube shown in Figure 1 along the line 2-2 in the direction of the arrows; and

Figure 3 is a horizontal sectional view of the tube shown in Figure 1 taken along the line 3-3 in Figure 2 in the direction of the arrows.

Referring now to Figure 2, the cathode 10 and the anode 11 are joined together by a short glass cylinder 12 which acts as a hollow cylindrical housing member. A flat circular piece of glass 13 covers the opening in the anode 11. A short hollow metal tube 14 is shown joined to the cathode 10. A cesium pellet capsule 15 is joined to the cathode 10 by a wire 16. A light sensitive surface 17 is shown on the cathode.

The cathode 10 has a curved portion 20 shaped in the form of a spherical surface so as to be convex on the side facing the anode 11. A flat portion 21 of cathode 10 provides a surface or pocket to seat the glass cylinder 12. A bent cylindrical portion 22 perpendicular to the flat portion 21 of cathode 10 centers the cylindrical wall 12 with respect to the light sensitive surface 17 of the

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cathode. The outside portion of cathode 10 is bent outwardly to form a circular flange 23.

In this drawing, the cylinder 12 is shown to be glass but it is understood that any satisfactory electrically insulating material would do. The glass cylinder 12 is placed on the flat portion 21 of cathode 10. Cathode 10 is then heated to approximately 1000° C., which is sufficient to melt that portion of the glass cylinder 12 resting in contact with cathode 10 and cause the cylinder 12 and cathode 10 to fuse together.

The spherical surface 20 of cathode 10 can then be coated with silver in any manner desired, for example, plating. A cesium pellet which is composed of cesium dichromate and aluminum, calcium, zirconium or any other suitable metal is contained between two nickel plates having two apertures from the pellet to the outside. This type of pellet is old in the art as shown in Spencer Patent 2,088,070 and has been described for illustration only. The pellet capsule 15 is fastened to cathode 10 by means of wire 16. Its position in the tube can perhaps be better seen by examination of Figure 3 which shows the capsule adjacent to a portion of the glass cylinder 12. The reasoning for this positioning will be described later on in the specification.

The anode 11 has an annulus portion 24 which is the operative portion of the anode receiving the electrons emitted from the light sensitive surface 17 on cathode 10. A cylindrical portion 25 of the anode 11 is formed at right angles to the annulus portion 24 of the anode. The outer portion 26 of the anode 11 is bent outwardly to form a circular flange. The cylindrical portion 25 and the flange 26 center the anode 11 on the glass cylinder 12. This also has the effect of centering the annulus portion 24 of the anode 11 with respect to the light sensitive surface 17 of the cathode 10.

A circular member 13 of glass is then placed upon the annulus portion 24 of the anode and fitted against the cylindrical portion 25 of the anode to constitute a window. The circular glass member 13 is then fused to the anode 11 and the anode is then fused with the glass cylinder 12 by the method already described.

The general operation of making the surface of the cathode sensitive to light is well known, but due to peculiar problems arising from the unique construction of this tube the process will be gone over briefly. It is to be understood, however, that the method to be described is but one method which will be satisfactory in making a light sensitive surface on the cathode.

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The silvered surface of the spherical portion 20 of the cathode is oxidized to a depth of approximately 10^{-4} or 10^{-5} centimeters. This oxidation of the silver is done under approximately 0.1 millimeter of oxygen pressure.

The tube is then re-evacuated and the cesium pellet is fired at a temperature of approximately 900°C ., by means of an induction heater. The cathode 10, anode 11, cylinder 12 and window 13 are all cooled by cold water so that the cesium is caused to condense over the entire interior surface of the tube. The cesium pellet capsule is placed near one portion of the glass cylinder 12 so that it may be heated by the induction heater without necessitating the heating of the cathode 10 and the anode 11. Due to this positioning the capsule covers a very small portion of the light sensitive surface of the cathode. When the cesium is released from the pellet the dichromate combines with the other metals in the pellet to form aluminum dichromate, calcium dichromate, zirconium dichromate or a dichromate of any other metal which might be present. During this operation of firing the cesium pellet it is necessary to heat the cathode at a temperature below 220°C . so as not to decompose the silver oxide.

The cesium is then driven off the glass wall 12, window 13 and anode 11 by heating them with a jet of hot air at approximately 200°C . This hot air jet is applied by external means, not shown, to the outer surfaces of the glass wall 12 and window 13. The cathode may be kept cool by cold water causing the cesium to condense on the cathode and combine with the silver oxide to form a coating of what is believed to be cesium oxide, silver and free cesium.

The tube is then baked which process will drive off the excess cesium. The baking is continued until the tube is at optimum sensitivity which must be determined by experience.

The hollow tube 14 provides the aperture for evacuating the envelope, adding the oxygen, and withdrawing the excess cesium. After the envelope has been evacuated for the last time, the tube 14 is sealed off near the cathode as shown.

Light from a light source is shown to enter through window 13 where it passes on through until it strikes the photo-sensitive surface 17 on the cathode 10. The spherically shaped portion 20 of the cathode 10 causes the electrons leaving the light sensitive surface 17 to be more directly deflected toward the annulus portion 24 of anode 11. Also this shape enables the cathode 10 to better withstand the effects of air pressure. Because of the flanged portions 23 and 26 on cathode 10 and anode 11, respectively, it is possible to position the tube so that these flanges 23 and 26 may rest on conductive rings. Electrical contacts could also be made to the cathode and anode by means of wires 30 and 31 fastened onto the flanges 23 and 26 as is shown in Figure 2. As can be seen, this external flange arrangement of the cathode and anode lends itself easily to a variety of methods for making contact to the electrodes. By utilizing the cathode and anode as part of the envelope, it is possible to make this tube using simple construction and in a very small size and thus it can profitably be used where space is at a premium.

While we have illustrated but one embodiment of the invention, it is to be understood that modifications may be made without departing from the spirit or scope thereof, and that we wish to limit ourselves only to the extent shown in the appended claims.

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We claim as our invention:

1. An electron discharge device comprising an envelope, an annular anode, and an electron emissive cathode forming a portion of a surface of a sphere convex toward said anode, said cathode and anode forming portions of said envelope.

2. A photoelectric tube comprising an envelope, an annular anode at that end of the envelope to be exposed to the light rays, and a photoemissive cathode shaped to form a portion of a surface of a sphere convex toward said anode, said cathode and anode being at opposite ends of said envelope and forming portions of said envelope.

3. A photoelectric tube comprising an evacuated envelope, an annular anode electrode at one end of the envelope and forming a portion thereof and surrounding that portion of said envelope to be exposed to the light rays, and a photoemissive cathode shaped to form a portion of a sphere convex toward said anode and placed at the opposite end of the envelope from the anode and forming a portion of said envelope.

4. A photoelectric tube comprising an anode with a portion thereof removed, a light transmitting member covering the aperture resulting from said removed portion of said anode, a light sensitive cathode for impingement by the light waves, said cathode being convex toward said anode so that the electrons leaving the light sensitive surface will be deflected toward said anode, and means positioning said cathode with respect to said anode in such a manner that said anode and cathode are electrically insulated from each other.

5. A photoelectric tube comprising an anode with a portion thereof removed, a light transmitting member covering the aperture resulting from said removed portion of said anode, a light sensitive cathode for impingement by the light waves, said cathode being convex toward said anode so that the electrons leaving the light sensitive surface will be deflected toward said anode, and means positioning said cathode with respect to said anode in such a manner that said anode and cathode are electrically insulated from each other, said cathode having an aperture therethrough for evacuating said tube.

6. A photoelectric tube comprising an anode with a portion thereof shaped in the form of an annulus, a member permitting passage of light therethrough positioned on said annulus portion of the anode and fused thereto, a cathode having a light sensitive surface on a portion thereof, said light sensitive surface being circular and shaped in the form of a spherical surface convex toward the anode, and means positioning said cathode with respect to said anode in such a manner that said anode and cathode are electrically insulated from each other.

7. A photoelectric tube comprising an anode with a portion thereof shaped in the form of an annulus, a member permitting passage of light therethrough positioned on said annulus portion of the anode and fused thereto, a cathode having a light sensitive surface on a portion thereof, said light sensitive surface being circular and shaped in the form of a spherical surface convex toward the anode, and means, in the shape of a cylinder fused to said anode and cathode, electrically insulating said anode from said cathode and centering said annulus portion of said anode with respect to said light sensitive surface on said cathode.

8. A photoelectric tube comprising an anode with a portion thereof shaped in the form of an

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annulus, a member permitting passage of light therethrough positioned on said annulus portion of the anode and fused thereto, a cathode having a light sensitive surface on a portion thereof, said light sensitive surface being circular and shaped in the form of a spherical surface convex toward the anode, a source of photo sensitive material supported by said cathode, and means, in the shape of a cylinder fused to said anode and cathode, electrically insulating said anode from said cathode and centering said annulus portion of said anode with respect to said light sensitive surface on said cathode.

9. A photoelectric tube comprising a cylindrical housing member and anode and cathode circular sheet metal discs sealed to opposite ends of said cylindrical member, said anode disc having a deformed portion to provide a shoulder to fit snugly against said cylindrical member, said anode having a central aperture therethrough, and a window member of transparent material sealed within said aperture and covering said aperture, said cathode having the inner surface thereof coated with a photoemissive material and having a deformed portion to provide a shoulder to fit snugly against said cylindrical member.

10. A photoelectric tube comprising a cylindrical housing member and anode and cathode circular sheet metal discs sealed to opposite ends of said cylindrical member, said anode disc having a central recessed portion extending into said housing member and providing a shoulder of the same exterior diameter as the interior member of said housing member, said recessed portion having a central aperture therethrough, and a window member of transparent material sealed within said recessed portion and covering said aperture, said cathode having the inner surface thereof coated with a photoemissive material and having the outer portion thereof deformed so as to provide a shoulder closely surrounding said cylindrical housing member.

11. A photoelectric tube comprising a hollow cylinder of insulating material, a cathode member comprising a metal disc deformed about the edge thereof to form a pocket for one end of said hollow cylinder and sealed thereto, said cathode having a photoemissive layer formed on the surface thereof, an anode member comprising a metallic member having an aperture therein, said anode member being deformed with an inner shoulder arranged to project within the other end of said hollow cylinder and sealed to the other end of said cylinder, and a window of electric insulating material sealed over said aperture.

12. A photoelectric tube comprising a hollow member of insulating material, a cathode member comprising a metal member deformed about the edge thereof to form a pocket for one end of said hollow member and sealed thereto, said cathode having the central portion thereof projecting within said hollow member and having a photo-

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emissive layer formed on the surface thereof, an anode member comprising a metallic member having an aperture therein, said anode member being deformed about the edge thereof to provide a shoulder arranged to project within the other end of said hollow member, and a window of insulating material sealed in said aperture.

13. A photoelectric tube comprising, a cathode member comprising a metal member deformed about the edge thereof to form a pocket, said cathode member having a photoemissive layer formed on the surface thereof, a metallic anode, and a hollow member of light pervious insulating material sealed at one end in said pocket so that said cathode projects within said hollow member and supporting said anode so that said anode is parallel to said cathode with a portion of said anode outside of said hollow member and with the projected area of said anode within said member on said cathode being less than the area of said cathode, said photoelectric tube being sealed at the end opposite said cathode by means formed of light pervious insulating material so that light may pass through the last named sealed end to said cathode.

14. A photoelectric tube comprising, a cathode member comprising a metal member deformed about the edge thereof to form a pocket, said cathode member having a photoemissive layer formed on the surface thereof, a ring-shaped metallic anode, a hollow member of light pervious insulating material sealed at one end in said pocket so that the photoemissive surface of said cathode projects within said hollow member and supporting said anode so that the plane of said anode is parallel to said cathode with a portion of said anode projecting outside of said hollow member, said photoelectric tube being sealed beyond said anode by means formed of light pervious insulating material so that light may pass through the open portion of said anode to said cathode.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,722,280	DeForest	July 30, 1929
2,161,859	Geffcken et al.	June 13, 1939
2,166,124	Breyer	July 18, 1939
2,401,737	Janes	June 11, 1946
2,404,343	Henderson et al.	July 16, 1946
2,431,402	Janes	Nov. 25, 1947

FOREIGN PATENTS

Number	Country	Date
712,542	France	July 22, 1931