June 22, 1937. F. M. PENNING ET AL 2,084,865

LIGHT SENSITIVE ELECTRON DISCHARGE DEVICE

Filed June 27, 1936

Fig. 1

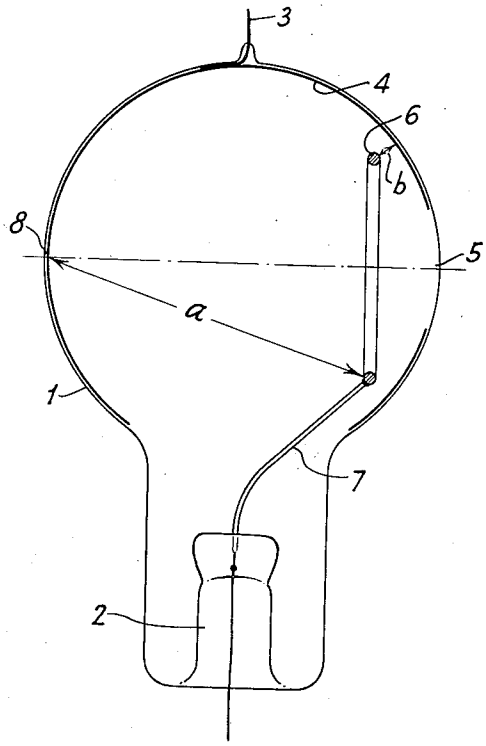


Fig. 2

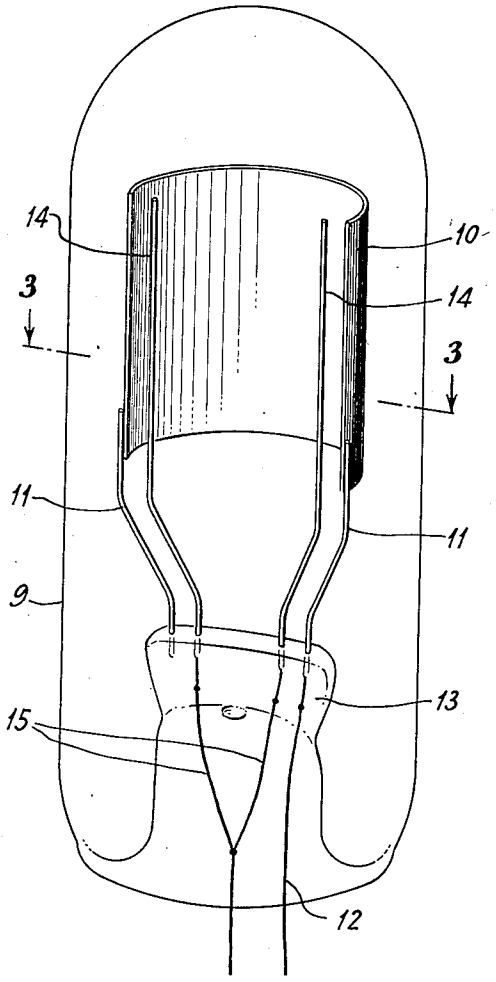
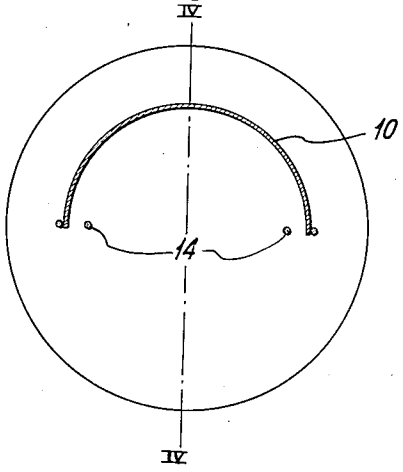


Fig. 3



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LIGHT SENSITIVE ELECTRON DISCHARGE DEVICE

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2 Claims. (Cl. 250—27.5)

Our invention relates to light sensitive electron discharge devices, more particularly to improvements in the electrode arrangement of light sensitive electron discharge devices of the gas type.

Photo-electric tubes have been provided with a gas filling having a low pressure (smaller than 1 mm.), the mean free path of the electrons being of the order of magnitude of the distance between the photo-electric cathode and the anode. The emitted electrons cause ionization of the gas filling and the electrons and positive ions thus formed increase the emitted electron current. In these tubes a filamentary or rod-shaped anode is preferably used, i. e. an anode having a comparatively large surface, since in this case the electrons are more easily intercepted and a better saturation is achieved.

A very commonly used electrode configuration of such tubes consists of a semi-cylindrical cathode, which is coated with a photo-electric layer on the inner side, and a rod-shaped anode extending in the axis of the cathode, or a hairpin-shaped anode, the legs of which are arranged at a short distance from each other and parallel to the axis of the cathode.

Another frequently used electrode configuration is formed by a substantially spherical cathode and a ring-shaped anode having a comparatively small diameter, which ring is arranged about in the center of the spherical cathode.

With the use in gas filled tubes of cathodes provided with an alkali metal layer adsorbed to a salt layer the difficulty is often encountered that shortly after operating them for the first time the sensitivity of the tube becomes much less than its initial sensitivity.

The present invention has for its object to avoid or at least appreciably to reduce this defect inherent in gas-filled tubes having a photo-electric cathode provided with an alkali metal layer adsorbed to a salt layer, and having a filamentary or rod-shaped anode.

For this purpose the anode, according to the invention, is arranged in such a manner with respect to the cathode that the distance between the anode and the nearest part of the cathode is at most one-fifth of the distance between the anode and the middle of the cathode part opposite the window of the tube. The very uneven field distribution brought about by this arrangement of the electrodes, appears to be of great influence in avoiding the decrease of the sensitiveness. Indeed, due to this field distribution only a small portion of the positive ions formed by ionization reaches the cathode part opposite the window, that is, the part which is most active during operation. Moreover, the ions striking this part will have a low speed due to the locally weaker field, so that the energy with which they impinge on the cathode is very small. By far the greatest part of the positive ions impinge on the cathode at the portion nearest the anode where the electric field is purposely made much stronger than at the middle of the part to be exposed. Deterioration of the photo-electric layer of this cathode part nearest the anode only slightly affects the sensitivity of the tube.

Thus, with the use of a semi-cylindrical cathode and a hairpin-shaped anode the distance between both legs of the anode is made as large as possible, so that the distance between these legs and the nearest part of the cathode is very small, whereas the distance from the anode to the cathode portion opposite the window of the tube, which portion is principally struck by the light rays, is comparatively large. Preferably, an anode is used which is not shaped as a hairpin but consists of two rods.

With the use of a substantially spherical cathode and an annular anode the latter is also removed as much as possible from the cathode portion opposite the window and arranged as closely as possible to the remaining part of the cathode.

When making use of a filamentary or rod-shaped anode, i. e. an anode having a comparatively large surface, which is advantageous, the electrode arrangements above produce an uneven field distribution so that the positive ions are drawn as little as possible to the most active portion of the cathode surface.

The novel features which we believe to be characteristic of our invention are set forth with particularity in the appended claims, but the invention itself will best be understood by reference to the following description taken in connection with the accompanying drawing in which Figure 1 is a section of a substantially spherical photo-electric tube made in accordance with our invention, Figure 2 is a perspective view of a modification of a photo-electric tube made in accordance with our invention, Figure 3 is a transverse section through III—III of the tube shown in Figure 2.

In Figure 1 the glass envelope of the substantially spherical tube is provided with a stem **2** of common construction. In the upper part of the tube a supply conductor **3** passes through the wall, which conductor is electrically connected with the photo-electric cathode **4** coated on the inner wall of the envelope, a window **5** being left through which the light rays by which the cath-

ode is struck can enter the tube. The tube is provided with an annular anode 6 consisting, for instance, of nickel wire having a thickness of 1.5 mm. and being secured on the stem 2 through the intermediary of the wire 7.

The photo-electric cathode comprises a silver layer applied to the glass wall, which layer initially contacts with the supply conductor 3 and supports a layer consisting of a mixture of caesium oxide, silver particles and caesium particles to which mixed layer a thin caesium layer is adsorbed.

The tube is filled with argon at a pressure of 0.15 mm. During normal operation of the photo-electric tube the filament or wire anode 6 has applied to it the usual positive voltage relatively to the cathode 4 so that the gas becomes ionized. The positive ions thus formed are attracted by the cathode and since they impinge with a certain energy thereon the emissivity of the cathode may be decreased by them due to breaking down of the cathode surface. The electric field between the cathode and the anode is made very uneven due to the position of the electrodes. As appears from the Figure 1, the anode is so arranged that the spacing from the cathode portion opposite the window is large whereas the spacing from the anode to the cathode portion surrounding the window, is small. If the spherical portion of the envelope has an internal diameter of say 4 cm. the distance (*a*) from the annular anode to the point of intersection 8 of the cathode and the axis of the tube extending through the center of the window 5 may have a value of 3.4 cm. whereas the shortest distance (*b*) from the anode to the cathode may only be 2 mm. Due to the very uneven field distribution thus caused the greatest part of the positive ions is drawn to that cathode portion which surrounds the window 5, whereas the cathode portion opposite the window is struck only by a very small number of positive ions. The last mentioned portion is struck by the light rays centering through the window 5, whereas the cathode portion surrounding the window 5 is struck by very few light rays. For this reason deterioration of this cathode portion by the positive ions practically does not affect the sensitivity of the tube.

The cylindrical photo-electric tube 9 shown in Figures 2 and 3 is equipped with a photo-electric cathode 10 shaped as a semi-cylindrical plate and is supported on the stem 13 through the intermediary of the supporting rods 11 one of which is connected to the supply conductor 12. This plate 10 consists of copper and is coated on the inner side (concave side) with a layer consisting of a mixture of caesium oxide, silver particles and caesium particles, to which layer an extremely thin caesium layer is adsorbed.

The filamentary or wire anode of the tube consists of two nickel rods 14 arranged on the stem 13, which rods are connected to supply conductors 15, united outside the tube. Of course, the connection between both of the rods 14 may also be established within the tube. If desired, one of the rods may be dispensed with. The anode rods are positioned in a plane passing through the vertical edges of the cathode. With a radius of the cathode surface of say 12 mm. the shortest distance from the anode rods to the cathode surface may have a value of say 2 mm. Also in this case this shortest distance is only a small fraction of the distance from the anode rods to the intersecting line of the cathode surface and the plane of symmetry IV—IV, so that also in this case the distance from the anode to the middle of the cathode portion opposite that portion of the cell wall through which the light rays enter is long in comparison with the shortest distance from the anode to the cathode surface.

Also in this case the very uneven field distribution caused by this arrangement of the electrodes results in the positive ions formed upon ionization of the gas filling in the tube to strike for the greater part that portion of the photo-electric cathode surface which is least irradiated by the light.

Preferably, the ratio between the distance from the anode to the nearest cathode portion and the distance from the anode to the middle of the cathode portion opposite the tube window is rendered as small as possible. It has been found that good results are obtained when this ratio does not exceed 1:5. Preferably, this ratio will even be reduced and be smaller than say 1 to 6 or 1 to 8.

While we have indicated the preferred embodiments of our invention of which we are now aware and have also indicated only one specific application for which our invention may be employed, it will be apparent that our invention is by no means limited to the exact forms illustrated or the use indicated, but that many variations may be made in the particular structure used and the purpose for which it is employed without departing from the scope of our invention as set forth in the appended claims.

What we claim as new is:

1. A phototube having an envelope containing a gas filling, a semi-cylindrical photocathode within said envelope and having a photo-sensitive coating on the inside surface thereof, and a rod anode close to and parallel to a longitudinal edge of said semi-cylindrical photocathode with the distance between the rod anode and the edge of said photocathode not greater than one-fifth the distance from the rod anode to the center of said semi-cylindrical cathode.

2. A phototube having an envelope containing a gas filling, a semi-cylindrical photocathode within said envelope and having a photo-sensitive coating on the inside surface thereof, and a pair of rod anodes one anode being close to each longitudinal edge of said semi-cylindrical photocathode with the distance between the rod anode and the edge of said photocathode no greater than one-fifth the distance from the rod anode to the center of said semi-cylindrical cathode.

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