March 28, 1939. H. G. LUBSZYNSKI ET AL 2,151,785

ELECTRON DISCHARGE DEVICE

Filed June 25, 1938

FIG. 1

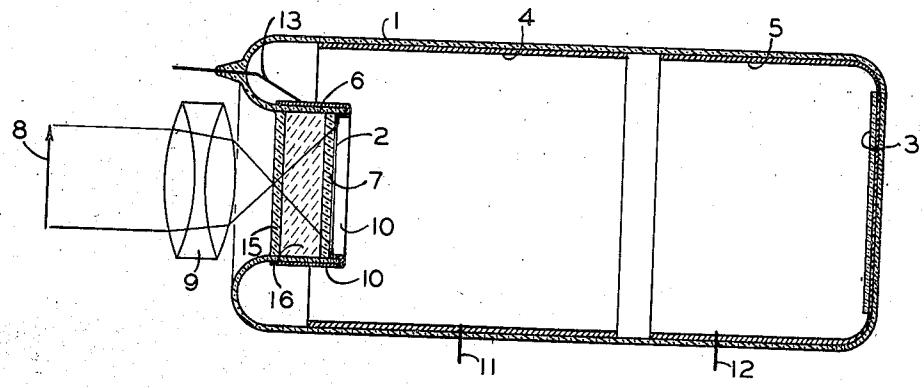


FIG. 2

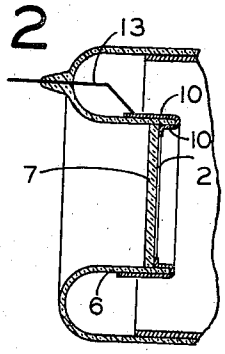


FIG. 3

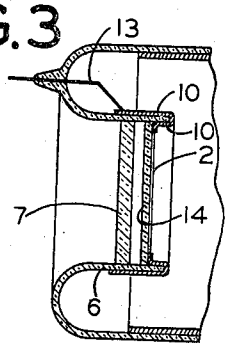


FIG. 4

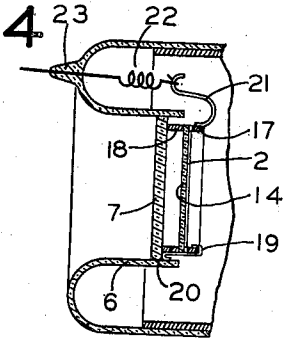
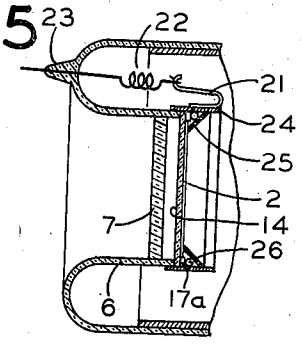


FIG. 5



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ELECTRON DISCHARGE DEVICE

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11 Claims. (Cl. 250—165)

This invention relates to electron discharge devices and particularly to such devices provided with a photosensitive electrode structure capable of emitting electrons which are focused on a target electrode.

In television transmitting systems it has been proposed to project an optical image of a subject for transmission upon a photosensitive cathode and to focus the photoelectrons emanating from the cathode upon a target such as a mosaic electrode having a plurality of mutually insulated elements which are scanned by a beam of electrons to restore the elements of the mosaic electrode to a datum potential and to generate in an associated signal plate signals representative of the optical image which are suitable for transmission. In other electron discharge devices it has also been proposed to project an optical image onto a photosensitive cathode and to focus the photoelectrons emanating therefrom upon a target of the fluorescent screen type. Such devices may be employed as electron telescopes or as light transformers. In these devices it has been customary to deposit the photosensitive layer of the cathode upon a support such as a mica disc which is mounted in the envelope of the device but such arrangements have been unsatisfactory in that longer focal length lenses are required for focusing the optical image on the cathode and difficulty has been experienced in arranging the electrostatic focusing electrodes in proper relationship with the cathode.

It is the principal object of the present invention to provide an improved electron discharge device employing a photosensitive cathode in which the above disadvantages are avoided and with a view to improving the construction and simplifying the manufacture of the device.

In accordance with our invention an electron discharge device employing a photosensitive cathode is provided wherein the end of the envelope which supports the photosensitive cathode is provided with a re-entrant substantially cylindrical portion and within the cylindrical portion of which there is provided a light transmitting plate or window on the inner surface on which or adjacent thereto the photosensitive layer is provided. The window may be of glass and when provided with the photosensitive layer is preferably sealed in position in the cylindrical portion before the photosensitive layer is applied thereto. A ring-shaped electrode is mounted adjacent the photosensitive cathode and, in the preferred form, the said electrode may be formed by silvering the surface of the cylindrical re-entrant portion in the interior of the envelope, such portion preferably extending slightly beyond the plate or window on which the photosensitive layer is formed, the silvering extending over the projecting edges of the cylindrical portion and in contact with the photosensitive layer.

A better understanding of our invention will be obtained and other objects, features, and advantages will appear from the following description taken in connection with the drawing in which:

Figure 1 is a longitudinal sectional view of an electron discharge device incorporating our invention;

Figure 2 is a fragmentary view of a portion of structure shown in Figure 1,

Figure 3 is a fragmentary sectional view of a modification of our invention, and

Figures 4 and 5 are fragmentary sectional views of further modifications of our invention.

Referring to Figure 1, which shows an electron discharge device of the light transformer type, the envelope or bulb 1 preferably made of glass, has at one end a photosensitive cathode 2 and at the opposite end a fluorescent screen 3 on which electrons from the photocathode may be focused by the combined action of the electrostatic focusing fields generated by the anodes 4 and 5. The end of the bulb 1 enclosing the photo-sensitive cathode 2 is, in accordance with our invention, provided with a re-entrant open ended cylindrical portion 6 which is tubular and extends inwardly of the bulb 1. The re-entrant portion is made of insulating material such as glass, and is closed adjacent its inner or open end by a light transmitting window 7 which may be in the form of a glass plate, the said window, in the modification shown in Figure 1, having on its inner surface the photosensitive cathode 2 referred to above. The photocathode 2 is preferably of the translucent type so that an optical image such as represented by the arrow 8 may be focused thereon through the window 7 by the lens system 9. Surrounding the window 7 and preferably extending around that section of the cylindrical re-entrant portion 6 which extends within the envelope from the window, there is provided a ring-shaped electrode 10 which is in electrical contact with the photosensitive cathode 2. This electrode may be formed of thin sheet metal as shown in Figure 1 but may be made as shown in the fragmentary view of Figure 2 by metallizing the surface of the cylindrical re-entrant portion which extends beyond the window 7, the metallizing such as a film of silver preferably extending over the projecting edge of the re-entrant portion. The ring-shaped

electrode 10, if formed by metallizing the desired section of the re-entrant portion 6, is preferably formed after the window 7 has been sealed to the re-entrant portion but prior to the formation of the photosensitive cathode 2.

The photosensitive cathode 2 may be formed, as well known in the art, by depositing on the interior surface of the window 7 a very thin film of silver which is oxidized and photo-sensitized by depositing caesium or other alkali metal thereon followed by proper heat treatment to increase the photosensitivity of the cathode to a maximum value.

The anodes 4 and 5 are preferably of electrically conducting material and may be of silver or of platinum deposited directly on the cylindrical wall of the envelope. The anode 4 preferably encloses about half of the tubular re-entrant portion and is in telescopic relation therewith for the purpose of providing a more uniform electrostatic field around the cathode. Leads 11 and 12 connected such as by welding to the anodes 4 and 5 respectively, extend through the cylindrical wall of the bulb 1 and are provided for the purpose of impressing suitable operating potentials on the anodes 4 and 5 to focus electrons from the photocathode 2 upon the fluorescent screen 3. The lead 13 is similarly connected to the ring-shaped electrode 10 and in the present construction may be brought to the exterior of the envelope without effecting the electrostatic field generated during the operation of the device by the cooperative action of the potentials applied between the cathode 2 through the said lead 13 and the anode 4. This arrangement also permits the lens 9 to be made of a shorter focal length for focusing the optical image onto the cathode since the lens can be disposed closer to the cathode than in known constructions; in addition, the present arrangement is generally of a more simplified construction compared with the known devices.

In some cases instead of forming the photosensitive layer directly on the glass wall or window 7, the photosensitive cathode 2 may be formed as shown in Figure 3 on an additional transparent support, such as a sheet of mica 14, which is mounted in position adjacent the inner surface of the glass plate window 7 in the re-entrant portion. Furthermore, in some cases the ring electrode 10 may be preformed and applied to the cylindrical portion of the re-entrant stem, and in such case the ring electrode so formed may serve to maintain the mica plate carrying the photosensitive layer in position.

In some applications and especially in those applications where mono-chromatic sensitivity of the cathode is desired we provide a novel light filter for filtering the light projected onto the photosensitive cathode. A further glass plate 15 or additional window may be provided in the re-entrant portion, the plate 15 being suitably sealed in position and spaced from the window 7 upon which the photosensitive cathode is preferably formed, the space between the two walls being filled with a suitable solution 16 according to the filter required. If the photo-sensitive cathode is more sensitive to the red portion of the spectrum the solution 16 may be a solution of copper sulphate which accentuates the sensitivity of the cathode in the green portion of the spectrum.

Instead of forming the window 7 of glass it may be formed of various other materials, particularly in cases where the photo-sensitive cathode is intended to be excited by the projection thereon of invisible radiation. The term "window" is therefore to be construed broadly and not to be limited to cases in which transparent substances are employed.

Figure 4 of the drawing illustrates a further form of the invention in which the photo-sensitive cathode is formed on a sheet of transparent material 14, such as mica, which is supported adjacent to the window 7 and carried on the re-entrant portion 6 through the medium of a pair of rings 17 and 18. The metal rings are held together with the photo-sensitive cathode between them by a plurality of clamping members 19 one of which is shown in Figure 4. The clamping members preferably each comprise a piece of metal which is bent over, as shown in Figure 4, to embrace the edge of the upper ring 17 and which is riveted to the lower ring 18 so as to clamp the two rings together with the photo-sensitive cathode between them. Preferably, three of said clamping members are provided equi-distantly arranged. The lower ends of the clamping members are bent as indicated at 20 and these bent portions 20 serve to locate the clamping rings and the photo-sensitive cathode relatively to the window 7 and within the end of the re-entrant portion 6 which projects beyond the window 7, as shown. In order to retain the unitary structure constituted by the rings 17 and 18 and the cathode 14 in the position shown, a plurality of hooks 21 are provided, one of which is shown in Figure 4. Preferably, three of the hooks are employed disposed intermediate each clamping member 19 the hooks 21 co-operating with springs 22, one of which is shown in Figure 4, and which are secured in glass seals 23. The hooks 21 and the springs 22 thus serve securely to retain the photo-sensitive cathode in its position adjacent the window 7, as shown in Figure 4. The ring 17 constitutes the equivalent of the electrode 10 of Figure 1 and in order to secure good electrical contact between the ring 17 and the photo-sensitive cathode the mica plate 14 on which the cathode is formed may be provided with a silvered annulus 17a with which the ring 17 engages, the photo-sensitive cathode being deposited after the plate 14 is mounted between the rings 17 and 18 and a connection to the exterior of the envelope may be established through the hooks 21 and the springs 22.

In the embodiment of the invention shown in Figure 5, the mica plate 14 on which the photosensitive layer is formed is mounted directly against the end of the re-entrant portion 6, as shown, and is held in position there by a metal ring 24 provided with an inwardly projecting oblique annular flange 25. In contact with the edge of the plate 14 is a helix 26 which abuts against the inner surface of the flange 25, the ring 24 forcing the helix 26 into contact with the plate 14 through the medium of the flange 25 under the action of a plurality of springs 22 connected to hooks 21 attached to the ring 24 similar to the arrangement of Figure 4. The ring 24 also serves as the aforesaid electrode and the plate 14 may be provided with a silver annulus 17a with which the helix 26 makes electrical contact. It will be observed from Figure 5 that the end of the re-entrant portion 6 fits into the ring 24 so that lateral displacement of the ring with respect to the re-entrant portion is prevented.

The kind of filter shown in Figure 1 may, if desired, be applied to the constructions shown in Figures 4 or 5.

In manufacturing the device the re-entrant portion 6 is conveniently formed separately from the envelope or bulb 1 and after the glass plates

or windows are sealed in position in the re-entrant portion, the latter is sealed to the bulb.

While we have indicated the preferred embodiments of our invention of which we are now aware and have indicated the specific application as directed to an electron discharge device of the light transformer type, it will be apparent that our invention is by no means limited to the exact forms illustrated or to the use of our invention in electron discharge devices of the type indicated, but that many variations may be made in the particular structure and the applications for which it is employed, such as in tubes utilizing a photosensitive cathode and a mosaic electrode wherein the mosaic electrode is scanned by a beam of incident energy, such as a light beam or beam of cathode rays, without departing from the scope of our invention as set forth in the appended claims.

We claim:

1. An electron discharge device having an envelope open at one end, an inwardly flared portion of smaller diameter than said envelope sealed to said envelope at said open end, a window extending transversely across and sealed to said inwardly flared portion at a point slightly removed from the inner end of said portion, and a photosensitive cathode between said window and said inner end of said portion.

2. An electron discharge device including an envelope, an inwardly extending open ended tube integrally sealed to said envelope, a light transparent window sealed to said tube at a point slightly removed from the open end of said tube, a photosensitive coating on the inner surface of said window and an electrode between said window and the open end of said tube and extending over the open edge of said tube electrically connected to said photosensitive coating.

3. An electron discharge device having an envelope, an inwardly extending tube at one end of and sealed to the wall of said envelope, a window in said tube extending transversely thereof and sealed to said tube at a point slightly removed from the end of said tube opposite the end sealed to said wall, a photosensitive cathode between said window and the open end of said tube, a second window between said first mentioned window and the said wall of the envelope and a light filter between said windows.

4. An electron discharge device including an evacuated envelope, an open ended tubular member sealed to one end of said envelope and extending inwardly of said envelope, a plurality of windows sealed transversely to said tubular member between said open end and the opposite end of said tubular member, a photosensitive cathode between the window adjacent said open end and the open end of said tubular member, a ring-shaped electrode connected to said cathode and surrounding the open end of said tubular member and an anode on the wall of said envelope in telescopic relationship with said open ended tubular member.

5. An electron discharge device comprising an envelope, a re-entrant portion at one end of said envelope, a light transmitting window in said re-entrant portion and a photo-sensitive cathode comprising a plate mounted within said envelope and means supporting said plate on the re-entrant portion adjacent to said window.

6. An electron discharge device according to claim 5 wherein the photo-sensitive cathode is supported directly on the window through the medium of a conducting electrode in electrical contact with the photo-sensitive cathode.

7. An electron discharge device comprising an envelope, a re-entrant portion at one end of said envelope, a light transmitting window in said re-entrant portion, a pair of annular rings supported by said transparent portion, a photosensitive cathode supported between said rings and means maintaining said rings in compression against said transparent portion.

8. An electron discharge device according to claim 7 wherein the said means comprises leads of resilient material sealed in said envelope.

9. An electron discharge device comprising an envelope, a re-entrant portion at one end of said envelope, a light transmitting window in said re-entrant portion between said one end of the envelope and the inner end of said re-entrant portion, a light transparent plate of larger diameter than the internal diameter of said re-entrant portion adjacent the inner end of said re-entrant portion, a photosensitive cathode on the side of said plate opposite the inner end of said re-entrant portion, and resilient means maintaining said photocathode against said re-entrant portion.

10. An electron discharge device including an envelope, an inwardly extending open-ended tube integrally sealed to said envelope, a light transparent window sealed to said tube at a point slightly removed from the open end of said tube, a photosensitive cathode supported on the inner end of said tube, a metallic ring surrounding the end of said tube, a second ring supported by said first ring, and a helix between said rings and said cathode maintaining said cathode against the open end of said tube.

11. An electron discharge device according to claim 10 wherein the said first mentioned ring is held in position by resilient leads connected to said ring and to the envelope of the device.

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