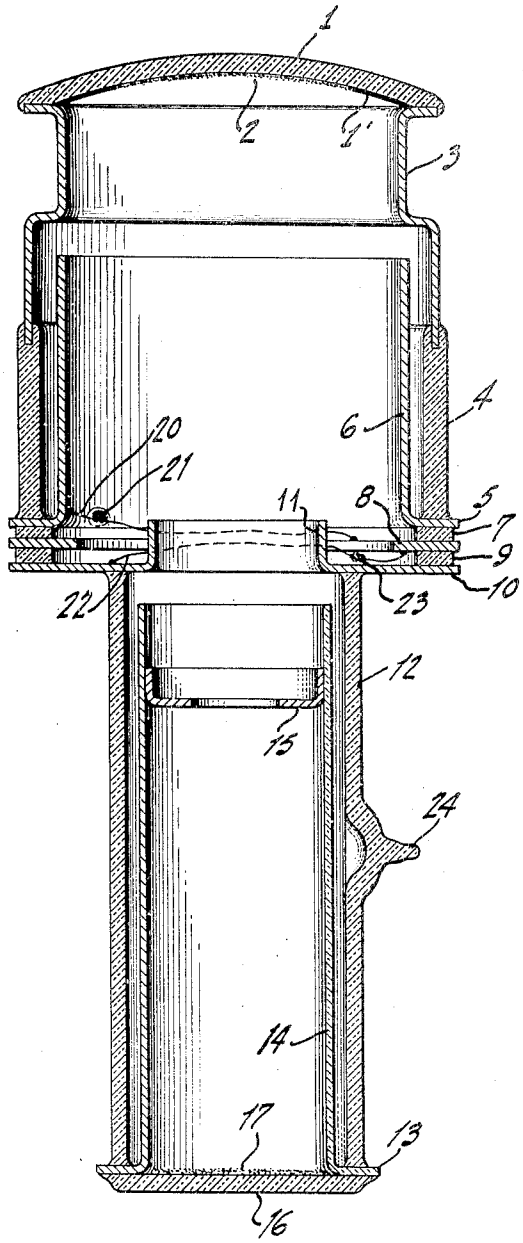
Nov. 8, 1949 G. A. MORTON ET AL 2,487,665

IMAGE TUBE

Filed May 2, 1947



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Patented Nov. 8, 1949

2,487,665

UNITED STATES PATENT OFFICE

2,487,665

IMAGE TUBE

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Application May 2, 1947, Serial No. 745,574

6 Claims. (Cl. 250—165)

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This invention relates to electron devices for rendering objects visible in faintly lighted areas or in total darkness.

In prior art devices, such as disclosed in the co-pending application of Ruedy, Flory and Morton, filed October 5, 1946, Serial No. 701,538, the electrode structures have been held together inside a glass envelope by wires and glass beads. The electrodes have been made of very thin metal tubing to reduce the mass and minimize movement from the aligned positions by handling of the tubes. With this construction the points and sharp edges gave rise to cold emission when the overall voltage was around 5,000 volts. This construction also made it difficult to maintain proper alignment and spacing between the electrodes while being mounted in the envelope, especially between the photocathode formed on the inside surface of the glass and the adjacent metal tubing electrode.

It is an object of this invention to provide a new type of image device that is free of sharp corners and edges to permit use of much higher voltages without cold emission taking place.

Another object of the invention is to mount the electrodes by a ring seal construction that gives a well aligned rigid structure of great stability.

Another object is to provide an image tube structure that uses a smaller fraction of the aperture of the electron lens near the cathode, thus reducing aberrations.

Another object of the invention is to simplify the electrode system of an image device and reduce the number of electrodes with no appreciable loss in resolution or image quality.

Other objects will appear in the following description, reference being had to the drawing in which the single figure of the drawing is a longitudinal section of an image tube containing the invention.

Referring to the drawing, the tube comprises a transparent face plate 1 of appropriate material such as glass for visible light and near infra-red waves or rock salt for far infra-red waves. This lens may be somewhat convex outwards as referred to in said co-pending application. A ring 1' of metal film is formed on the inside surface of the disc near the periphery and the photosensitive coating 2 on the inside surface of the disc makes contact with this ring.

All metal parts are of substantial thickness, say 1/32 of an inch, formed with well rounded and polished edges. One end of cathode cylinder 3 is sealed to the disc 1 in electrical contact with the metal film ring 1' so that the potentials of

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this tubular electrode and the photocathode are the same. The rear half of the electrode 3 is of greater diameter than the first half. Glass tube 4 is sealed to the larger end of electrode 3 at one of its ends and at its other end is sealed to the annular flange 5 of the tubular electrode 6 which is of the same diameter as the small end of tubular electrode 3. A glass ring 7 is sealed to the flange 5 and to a ring conductor 8, and glass ring 9 is sealed to ring 8 and to the flange 10 of a shorter tubular electrode 11 of lesser diameter than the tubular electrode 6. A glass tube 12 of diameter intermediate those of electrodes 6 and 11 is sealed at one end to the flange 10. The other end of glass tube 12 is sealed to the flange 13 of tubular electrode 14 which has an aperture disc 15 near the end of glass tube 12 attached to the flange 10. The electrodes 11 and 14 are of substantially the same diameter. Glass disc 16 is sealed to flange 13 and its inner surface carries a fluorescent coating 17. All the tubular electrodes and the tubular glass envelopes are coaxial.

One end of an arcuate conductor 20 is joined to flange 5 and its other end to the ring 8. Silver material 21 on the conductor 20 is adapted to be vaporized by applying voltage between flange 5 and ring 8. An arcuate conductor 22, carrying caesium material 23, is joined at one end to flange 10 and at the other end to ring 8.

In assembling the parts, the flat glass disc 16 and the glass cylinder 12 are fusion sealed in a known way to the flange 13 of anode 14. Fluorescent coating 17 is then deposited on the inside of disc 16 by settling or centrifuging it from an aqueous suspension. This coating may be willemite or if higher efficiency is desired a phosphor such as zinc sulphoselenide may be used. When dried this is then coated with an electron permeable aluminum film (not shown) by known methods. At the high voltages used the latter phosphor even with the aluminum film is more efficient than willemite, which would not be true if the lower voltages of prior art tubes are used. The flange 10 of anode 11 is fusion sealed to the open end of glass envelope 12, a mandrel being used to secure accurate alignment and spacing of electrodes 11 and 14. This is important since the gap between the two electrodes forms the main electron lens of the tube. The glass ring 9, metal ring 8, glass ring 7, flange 5 and glass tube 4 are assembled in this order on flange 10, using a mandrel to obtain accurate axial alignment and spacing of the parts after which they are fusion sealed together. Con-

ductor 20 carrying silver bead 21 is now welded to flange 5 and ring 8, conductor 22 carrying caesium-bearing material 23 is welded to flange 10 and ring 8. The curved glass face-plate 1 is next fusion sealed to the small end of metal envelope 3 using a mandrel to keep the center of curvature of the face-plate accurately on the axis of the metal tube 3. The ring of metal film 1' is then applied to make contact between the electrode 3 and the sensitive photo-surface 2 applied as later referred to.

As a final step in the assembling of parts, the larger end of electrode 3 is fusion sealed to the remaining end of glass tube 4 using an external jig to keep the parts 3 and 4 concentric and to maintain the proper gap between electrodes 3 and 6. The tube may now be exhausted at 24 and the silver material 21 vaporized to deposit silver at 2 on the inside of the face plate by applying voltage between flange 5 and ring 8. The caesium material 23 is vaporized by applying voltage between flange 10 and ring 8 to caesiate the silver coating in a well-known way.

Various voltages and electrode dimensions may be used but as an example the electrode 3 may be 7/8 inch long with a diameter of 1 3/8 inches at the smaller end and a diameter of 1 5/8 inches at the larger end. This may have the voltage of the photocathode, that is, zero volts. The electrode 6 may be 1.039 inches long with a diameter of 1 3/8 inches and have a positive voltage of 2000 to 5000 above the cathode. The electrode 11 may be .171 inch long and 3/4 inch in diameter. This may also have a positive voltage of 2000 to 5000 volts. The ring 8 may be connected to the same positive terminal. It is used only for a terminal for vaporizing the silver and caesium material and the dimensions are not important. The electrode 14 may be 2 1/4 inches long and its diameter 3/4 inch. The voltage of this electrode may be 20,000 volts to 35,000 volts. The diaphragm ring 15 may be spaced .360 inch from the free end of electrode 14 and may have an opening with a diameter of 1/4 inch. The distance between the free end of electrode 6 from the small end of electrode 3 may be .563 inch. The free end of electrode 14 may be spaced 1/8 inch from the plane of the flange 10. With 20,000 volts on electrode 14, the voltage applied to electrodes 6 and 11 with the above dimensions may be varied between 2000 and 3000 in adjusting the focus of the electrons. To decrease pin cushion effect the glass face plate may be a section of a sphere of 2.375 inches radius. It will, of course, be understood that the voltages and dimensions of parts may be altered to fit particular cases.

While certain specific embodiments have been illustrated and described, it will be understood that various changes and modifications may be made therein without departing from the spirit and scope of the invention.

What we claim as new is:

1. An image device comprising a cathode cylinder, a plate transparent to radiant energy sealed across one end of said cylinder, a cathode on the inside surface of said plate in contact with said cylinder, a plurality of spaced anode cylinders each having an annular flange, said anode cylinders being place coaxially with the unflanged ends extending in the same direction, a transparent disc sealed across the end of the anode cylinder farthest from the photocathode, a fluorescent coating on said disc and an envelope of insulating material sealed to said flanges and to the remaining end of said cathode cylinder.

2. An image device comprising a cathode cylinder, a plate transparent to radiant energy sealed across one end of said cylinder, a cathode on the inside surface of said plate in contact with said cylinder, a plurality of spaced anode cylinders each having an annular flange at one end, the other ends extending towards said cathode, a disc transparent to light sealed across the flanged end of the anode cylinder farthest from said cathode, a fluorescent coating on the inner surface of said disc, glass tubing sealed between the flange of the anode cylinder nearest said photocathode and the remaining end of said cathode cylinder and glass tubing sealed between each flange and the succeeding flange whereby all said anode cylinders are supported by their flanges.

3. An image device comprising a cathode cylinder, a glass face plate sealed across one end of said cylinder, a cathode one the inner surface of said face plate in contact with said cylinder, a first anode having an annular flange at one end, the other end extending toward said cathode, a glass tube sealed between the remaining end of said cathode cylinder and said flange, a second anode cylinder of lesser diameter than the first anode cylinder having an annular flange at one end, the other end extending toward the first anode cylinder, two glass rings and a metal washer sealed between said flanges, a third anode cylinder of substantially the same diameter as the second anode cylinder having an annular flange at one end, the other end extending toward and adjacent to the flanged end of the second anode cylinder, a glass tube sealed between the last mentioned two flanges, a disc transparent to light sealed across the flanged end of the third anode and a fluorescent coating on the inside of said disc.

4. An image device comprising a cathode cylinder, a plate transparent to radiant energy sealed across one end of said cylinder, a cathode on the inside surface of said plate in contact with said cylinder, a plurality of spaced anode cylinders each having an annular flange at one end, the other ends extending towards said photocathode, all said cylinders being coaxial and free of exposed sharp edges, a transparent disc sealed across the flanged end of the anode cylinder farthest from the photocathode and a fluorescent coating on said disc and an envelope of insulating material sealed to said flanges and to the remaining end of said cathode cylinder.

5. An image device comprising a cathode cylinder, a plate transparent to radiant energy sealed across one end of said cylinder, said plate having surfaces of revolution convex outwards of the device with centers in the axis of said cylinder, a cathode on the inside surface of said plate in contact with said cylinder, a plurality of spaced anode cylinders coaxial with the first cylinder, each having an annular flange at one end, the other ends extending towards said cathode, a disc transparent to light sealed across the flanged end of the anode cylinder farthest from said cathode, a fluorescent coating on the inner surface of said disc, glass tubing sealed between the end of the anode cylinder nearest said photocathode and the remaining end of said cathode cylinder and glass tubing sealed between each flange and the succeeding flange whereby all said anode cylinders are supported by their flanges.

6. An image device comprising a cathode cylinder having a portion of larger diameter than the

remaining portion, said portions being joined by a flange with rounded edges, a glass face plate sealed across the smaller end of said cylinder having surfaces of revolution convex outwards of the device with centers in the axis of said cathode cylinder, a cathode on the inner surface of said face plate in contact with said cylinder, a first anode having an annular flange at one end, the other end extending toward said cathode, a glass tube sealed between the remaining end of said cathode cylinder and said flange, a second anode cylinder of lesser diameter than the first anode cylinder having an annular flange at one end, the other end extending toward the first anode cylinder, two glass rings and a metal washer sealed between said flanges, a third anode cylinder of substantially the same diameter as the second anode cylinder having an annular flange at one end, the other end extending toward and adjacent

to the flanged end of the second anode cylinder, a glass tube sealed between the last mentioned two flanges, all said anode cylinders being coaxial with said cathode cylinder and having rounded edges, a disc transparent to light sealed across the flanged end of the third anode and a fluorescent coating on the inside of said disc.

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REFERENCES CITED

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

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Number	Name	Date
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Certificate of Correction

Patent No. 2,487,665 November 8, 1949

GEORGE A. MORTON ET AL.

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows:

Column 3, line 71, for the word "place" read *placed*; column 4, line 21, for "one the" read *on the*;

and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 30th day of May, A. D. 1950.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.