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ELECTRON GUN WITH POSITIONER FOR EMISSIVE SURFACE OF CATHODE

Filed May 11, 1962

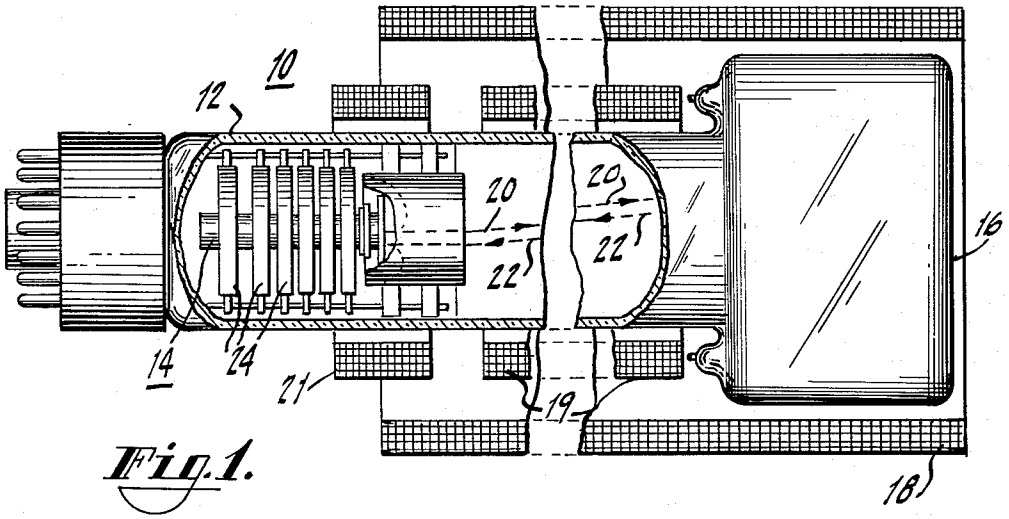


Fig. 1.

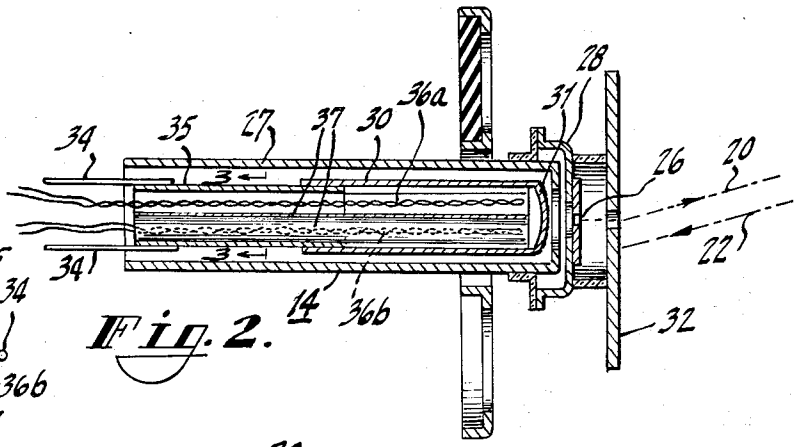


Fig. 2.

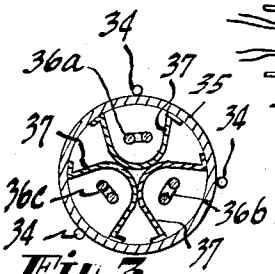


Fig. 3.

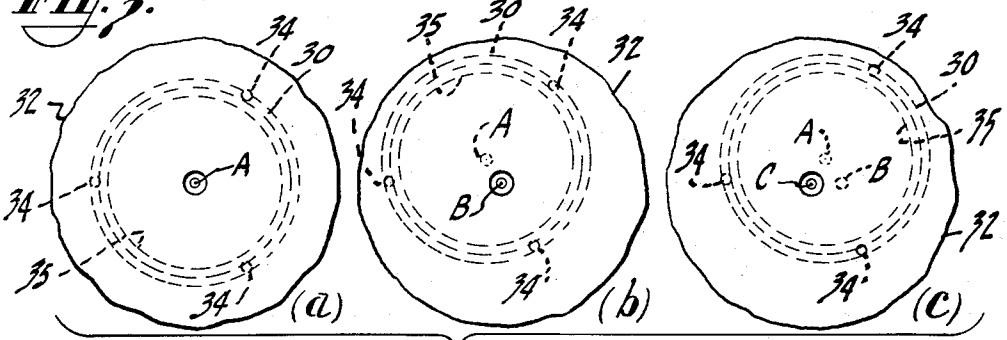


Fig. 4.

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ELECTRON GUN WITH POSITIONER FOR EMISSIVE SURFACE OF CATHODE

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8 Claims. (Cl. 313—146)

This invention relates to electron guns. In particular, this invention relates to cathode structures for electron guns.

In the prior art there are many tube types in which a finely focussed primary electron beam is produced, by an electron gun. The finely focussed beam is directly through a series of apertures including a beam limiting aperture in an accelerating electrode. One of the conventional tube types utilizing this structure is the well-known image orthicon. In the image orthicon, as well as the other tube types using this type of structure, the electron beam is a finely focussed beam which originates primarily from a relatively small spot of the emissive area of the cathode. The small spot on the cathode is positioned on the axial region directly in line with the beam limiting aperture in the accelerating electrode. Because of this position this particular area, or spot, on the cathode will tend to become depleted of electrons before adjacent areas which are not positioned directly beneath the beam limiting aperture.

Due to the axial arrangement of the accelerating electrodes in the electron gun, the electron emitting spot, directly beneath the beam limiting aperture, is vulnerable to ion bombardment during the activation processing of the tube when using standard manufacturing techniques. Also, because of the axial arrangement, the relatively small emitting spot of the cathode is subject to ion bombardment during tube operation due to its normal operating potential.

Thus, because of the use of a finely focussed electron beam, and because of ion bombardment, the axially aligned spot on the cathode will tend to become deteriorated either through electron depletion or an actual loss of cathode material by ion bombardment much more rapidly than other adjacent areas of the cathode which are not aligned with the apertures in the electron gun.

Because of the depletion of the electrons and the bombardment by ions, the life of a tube having a finely focussed, axially aligned electron beam is often limited due to the destruction of the cathode in the small area directly behind the beam limiting aperture.

It is therefore an object of this invention to provide a new and improved tube.

It is a further object of this invention to provide a novel cathode structure.

It is a still further object of this invention to provide an improved tube characterized by the long life of its cathode.

These and other objects are accomplished in accordance with this invention by providing an electron discharge device having an electron gun in which the cathode thereof is supported in such a manner as to be movable or displaced, under controlled conditions, with respect to the beam limiting aperture.

The invention will be more clearly understood by reference to the accompanying single sheet of drawings wherein:

FIG. 1 is a partial sectional view of an image orthicon in accordance with this invention;

FIG. 2 is an enlarged partial sectional view of the electron gun shown in FIG. 1;

FIG. 3 is a sectional view of the cathode structure taken along line 3—3 of FIG. 2; and,

FIG. 4 is a group of schematic illustrations of the electron gun taken along line 3—3 of FIG. 2.

Referring now to FIG. 1 there is shown an image orthicon tube 10. The image orthicon tube 10 is shown as a preferred example of a tube type in which this invention is particularly useful. It should be clearly understood that this invention is equally applicable to other tube types especially those which use an electron gun having a well focussed electron beam which uses electrons from a fractional area of the cathode. The tube 10 comprises an evacuated envelope 12 having an electron gun 14 in one end thereof.

The electron gun 14, shown more clearly in FIG. 2, comprises a cathode electrode 30 having a coating 31 of electron emissive material thereon. The cathode electrode may comprise a tubular member having a closed end and may be made of a material such as nickel. The coating 31 of electron emissive material may be any conventional material such as barium and/or strontium oxide for example.

The electron gun 14 also comprises a control electrode 27, and a first accelerating electrode 28, which includes aperture 26 which is axially positioned and which limits the dimensions of a primary electron beam 20 in its exit from the gun 14.

Positioned in the opposite end of the envelope 12 and on the inner surface of a face plate 16 is a photocathode (not shown in detail). The photocathode may be made of any conventional materials examples of which are the S–10 photosurface described in U.S. Patent No. 2,682,479 issued to Johnson on June 29, 1954, and the multi-alkali photosurface described in U.S. Patent No. 2,770,561 issued to Sommer on November 13, 1956.

In the envelope 12 and spaced between the photocathode and the electron gun 14 is a storage target (not shown in detail). The storage target may comprise any conventional structure such as, for example, a thin membrane of glass or oxidized metal.

During operation of the image orthicon 10, light from a scene to be reproduced is directed through the transparent face plate 16 onto the photocathode which produces a photoelectron image corresponding to light from the scene. The photoelectron image is focussed and accelerated, for example, by use of focus coil 18, onto the storage target where it produces a charge pattern. The primary electron beam 20 from the electron fun 14 is focussed onto and scanned over the opposite side of the storage target to remove the charge pattern therefrom. The focussing of the beam 20 is done by means of the focus coil 18 while the scanning is done by a deflection yoke 19. The electron beam is reflected back as a return electron beam 22, which is also focussed by the focus coil 18, toward the electron gun 14 where it is fed onto a conventional multiplier structure 24 which produces electrical output signals from the tube. The output signals correspond to light from the scene to be reproduced.

The focus coil 18, the deflection yoke 19 and an alignment coil 21 all focus the electrons so that both the primary electron beam 20 and the return electron beam 22 are substantially on the axis in the plane of a first accelerating electrode 28.

Because of the various focussing fields, both the electrons, and any positive ions that remain, travel in a substantially axial path when in the plane of the first accelerating electrode 28. Dut to this axial positioning any positive ions which remain in the tube 10 are focussed by the focus coil 18 onto the axis and are accelerated toward the most negative potential, namely the cathode 30. Thus, the fields tend to focus the positive ions through beam limiting aperture 26 where they will bombard a small area of the cathode 30. As is obvious, the small

area of the cathode 30 which is bombarded most heavily, is the area directly beneath the beam limiting aperture 26. Also, the area of the cathode 30 which is bombarded most heavily by the positive ions, is the area which is primarily responsible for the production of the electron beam 20. The cathode 30 is supported in such a manner as to be movable or displaceable with respect to the beam limiting aperture 26. Thus, different small areas of the cathode 30 may be positioned, by controllable means, directly in line with the beam limiting aperture 26. When a given area of cathode 30 has become deteriorated, for example, by ion bombardment, a different area of the cathode is moved into alignment with the beam limiting aperture 26, and the tube is ready for longer use.

Any means which will provide a controlled movement of the cathode 30 may be used. A particular but perferred example of a controllable cathode movement means is illustrated in FIGS. 2 and 3 wherein the cathode 30 is made of a high thermal conduction material, e.g. nickel, and is supported on a cylinder 35 of low thermal conduction material, for example, tantalum or molybdenum. The cylinder 35 is in turn supported on three (only two appear in FIG. 2) spaced elongated support rods 34. Adjacent to each of the support rods 34 are spaced different heater electrodes 36*a*, *b* and *c* which may be made of conventional material. Spaced between and around each of the heaters 36 is a diffrent heat reflecting shield 37 which may also be made of a material such as molybdenum or tantalum. The heat reflecting shields 37 may be connected to the support cylinder 35 as shown in FIG. 3 By means of this structure, when one of the heaters 36 is energized, the cathode 30 will operate in a certain position. When a different heater 36, or different combination of the three heaters, is energized, the cathode 30 will operate in a different position due to its non-uniform expansion caused by the adjacent cathode support rod or rods, 34 and/or the unequal expansion of the support cylinder 35, and the cathode 30.

Referring now to FIG. 4*a* assuming that heater 36*a* is in operation, then a particular spot, labeled A, on the cathode 30 will be axially aligned with the beam limiting aperture 26. Now, assuming that heater 36*b* is energized (FIG. 4*b*), and heater 36*a* is not, cathode support rod 34 will expand and move the original cathode spot A out of axial alignment with the beam limiting aperture 26 and present a new area of the cathode 30 as the principal electrode beam emitter area.

Likewise, as shown in FIG. 4*c*, if heater 36*c* is energized, and heaters 36*a* and 36*b* are not, cathode areas A and B will be moved out of axial alignment with the beam limiting aperture 26, and a new emitting area C of cathode 30 will be presented.

As is obvious, different combinations of heaters 36*a*, 36*b* and 36*c* will product still other spots positioned in axial alignment with beam limiting aperture 26.

With the structure described, it can be shown mathematically that a 200° C. temperature differential will displace a cathode that is 2 cm. long and 0.5 cm. in diameter about 8.6 mils.

It should be noted that the electronic emitting surface of the cathode 30 adjacent to the flat surface of the electrode 28 containing the beam limiting aperture 26 is hemispherical in shape. This shape permits the cathode 30 to rotate about the center of curvature of the sphere while the spacing between the active area of the cathode 30 and the beam limiting aperture 26 remains constant.

Although any means of relative movement between the cathode and the beam limiting aperture may be employed, the one described provided by a differential thermal expansion means for movement of the cathode is particularly simple, of rugged construction, avoids bearings or the like, and is highly advantageous.

By use of this invention it has been found that different active areas of the cathode may be axially aligned with the beam limiting aperture 26. The use of different areas tends to prolong tube life, since the different area of the cathode 30 has not been bombarded by positive ions to the extent that the area directly beneath the beam limiting aperture has been bombarded and thus deteriorated.

What is claimed is:

1. An electron gun for an electron discharge device comprising:
(a) a tubular cathode electrode;
(b) a control electrode having an aperture therein for the passage of electrons from said cathode electrode;
(c) means for moving said cathode electrode with respect to the aperture in said control electrode for succesively presenting different emitting areas of said cathode in register with said aperture, said means comprising:
(1) a support engaging a portion of said cathode remote from said emitting area and normally disposing one area of said cathode in register with said aperture,
(2) heating means within said cathode for differentially heating longitudinal wall portions of said cathode, said cathode being made of a material having a sufficiently high coefficient of expansion for causing displacement of said cathode in response to said differential heating of a magnitude to cause said cathode to present an area different from said one area, in register with said aperture.

2. An electron gun for an electron discharge device comprising:
(a) a tubular cathode electrode;
(b) a first electrode adjacent to said cathode and having an aperture therethrough for the passage of electrons from said cathode electrode; and,
(c) means for producing a controllable transverse relative movement between the cathode lectrode and the aperture in said first electrode, said means comprising:
(1) a support made of a material having a lower coefficient of expansion that said cathode electrode and engaging one end portion only of said electrode, and
(2) a plurality of independent, elongated and substantially coextensive heaters within and parallel to the axis of said cathode electrode, said heaters being adjacent to angularly-spaced inner wall portions of said electrode.

3. An electron discharge device comprising:
(a) an envelope including an electron gun;
(b) said electron gun including a tubular cathode electrode spaced from an apertured first electrode; and,
(c) means for producing relative movement between said cathode electrode and said apertured first electrode, said means comprising:
(1) a support engaging one end portion only of said cathode electrode and
(2) a plurality of heaters within and spaced transversely of said cathode electrode, said heaters having independent conductors extending outside of said envelope,
(3) said cathode electrode being made of a material having a sufficiently high coefficient of expansion to cause said electrode to move transversely on said support in response to heat from at least one of said heaters,
(4) the magnitude of said lateral movement of said cathode electrode being sufficient to move a different surface area of said electrode into register with the aperture in said apertured first electrode.

4. An electron discharge device comprising:
(a) an envelope including an electron gun;
(b) said electron gun having an axis;

(c) said electron gun including a tubular cathode and a first electrode;

(d) said cathode having an end portion substantially perpendicular to said axis and extending across said axis;

(e) said first electrode having a portion substantially perpendicular to said axis and including an aperture substantially on said axis; and,

(f) means for positioning a different area of said end portion of said cathode on said axis and directly adjacent to said aperture, said means including:

(1) a support for the opposite end portion only of said cathode, and

(2) at least two heaters within and transversely spaced along said cathode, said heaters being adapted to be independently energized,

(3) said cathode being made of a material having a sufficiently higher coefficient of expansion than the material of said support, to cause said cathode to move transversely on said support in response to heat from only one of said heaters, thereby causing a different surface area of said end portion to be moved into register with said aperture.

5. An electron gun comprising:

(a) a hollow tubular cathode having a closed end and an open end;

(b) an electrode having an apertured portion positioned adjacent to and substantially parallel with said closed end of said cathode;

(c) means for positioning successively different areas of said closed end of said cathode adjacent to said aperture, said means comprising:

(1) a support engaging said open end,

(2) a plurality of heaters extending into said cathode from said open end,

(3) a heat reflector adjacent to each heater, each reflector being oriented to reflect heat to a different longitudinal inner wall portion of said cathode,

(4) said heaters being adapted to be energized independently,

(5) whereby energization of only a selected group of said heaters is adapted to heat a predetermined longitudinal wall portion of said cathode to a higher temperature than other wall portions of the cathode,

(6) said cathode being made of a material having a sufficiently high coefficient of expansion to cause said cathode to move transversely on said support in response to said higher temperature in a magnitude of motion sufficiently large to position a different area of said closed end adjacent to said aperture than that disposed adjacent said aperture upon energization of others of said heaters.

6. An electron gun as in claim 5 wherein said closed end of said cathode is hemispherical in shape.

7. A television pickup tube comprising:

(a) an elongated envelope having an axis;

(b) an electron gun substantially on said axis;

(c) said electron gun including a tubular cathode having a close end and an open end;

(d) said closed end being substantially hemispherical in shape and having an electron emissive coating thereon;

(e) a hollow tubular control electrode positioned substantially coaxially around said tubular cathode;

(f) said control electrode having an end positioned substantially normal to said axis and having an aperture therein; and,

(g) differential heating means for positioning a selected area of said closed end of said cathode adjacent to the aperture in said control electrode, said differential heating means comprising:

a plurality of heaters adapted to be independently energized and circumferentially spaced around the inner periphery of said tubular cathode.

A television pickup tube comprising:

(a) an elongated envelope having an axis;

(b) an electron gun substantially on said axis;

(c) said electron gun including a tubular cathode having a closed end;

(d) said closed end being substantially hemispherical in shape and having an electron emissive coating thereon;

(e) a hollow tubular control electrode positioned substantially coaxially around said tubular cathode;

(f) said control electrode having an end positioned substantially normal to said axis and having an aperture therein, one area of said closed end being normally adjacent to said aperture, and,

(g) means including at least three independently energizable heater coils within said cathode for selectively heating only a side of said cathode to cause said side to expand axially and move said cathode transversely in a magnitude of movement sufficient to cause said cathode to present an area of said closed end thereof adjacent to said aperture, that is different from said one area.

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GEORGE N. WESTBY, *Primary Examiner.*

ARTHUR GAUSS, *Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,197,665 July 27, 1965

Appleton Danforth Cope

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 15, for "directly" read -- directed --; column 2, line 46, for "fun" read -- gun --; line 65, for "Dut" read -- Due --; column 3, line 60, for "electronic" read -- electron --; column 4, line 38, for "lectrode" read -- electrode --; line 42, for "that" read -- than --; column 6, line 5, for "close" read -- closed --; line 21, before "A television" insert -- 8. --; same column 6, line 55, for "256,966" read -- 265,966 --.

Signed and sealed this 19th day of April 1966.

(SEAL)

Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents