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W. E. PHILLIPS ET AL

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ELECTRON GUN FOR CATHODE-RAY TUBES

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Fig. 2

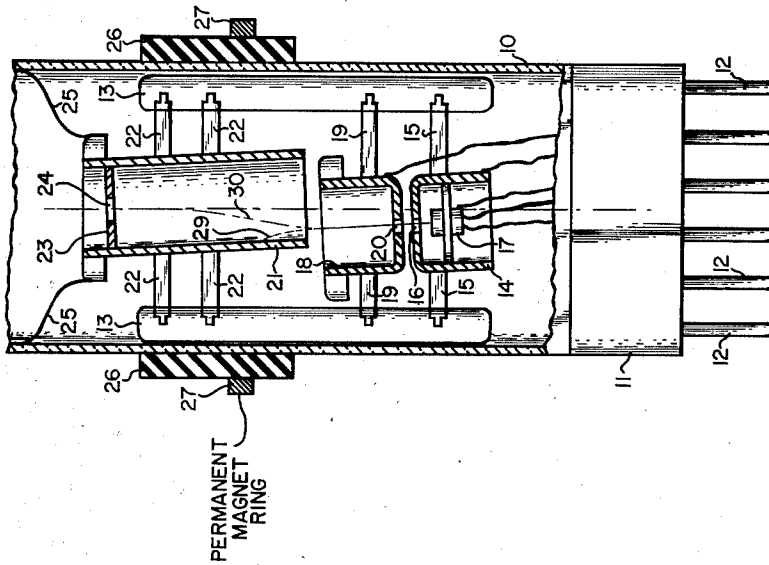
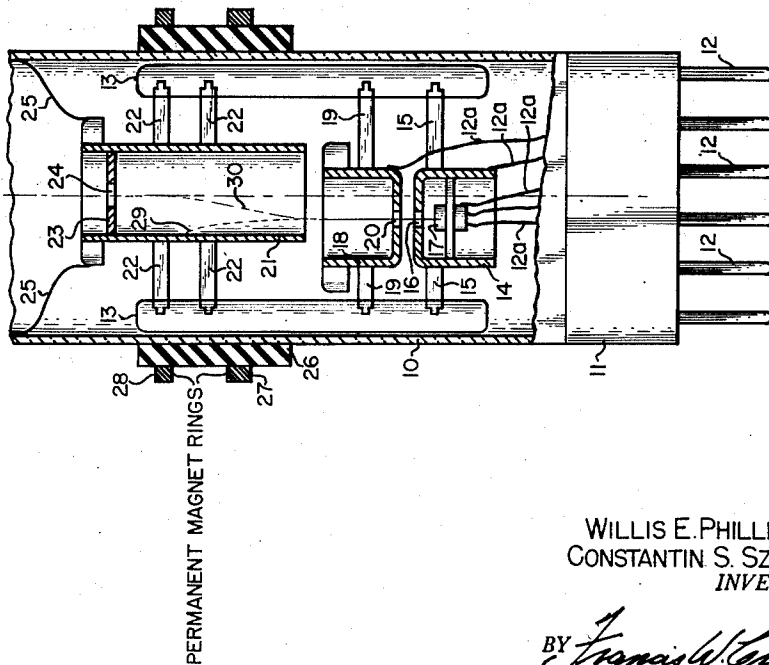


Fig. 1



WILLIS E. PHILLIPS
CONSTANTIN S. SZEGHO
INVENTORS.

BY *Francis W. Croft*
THEIR ATTORNEY

UNITED STATES PATENT OFFICE

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ELECTRON GUN FOR CATHODE-RAY TUBES

Willis E. Phillips, Deerfield, and Constantin S. Szegho, Chicago, Ill., assignors to The Rauland Corporation, a corporation of Illinois

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This invention relates to cathode-ray tubes suitable for use in television receivers and pertains, more particularly, to an improved electron-gun structure for such tubes.

In cathode-ray tubes utilized in present-day television receivers, an electron beam is developed by an electron gun mounted at one end of the tube, and is directed thereby to a fluorescent screen disposed at the opposite end. In many instances the electron beam in such tubes is deflected over the screen area by means of an electro-magnetic yoke which responds to periodic line- and field-scanning signals. When magnetic deflection is utilized a dark spot sometimes appears on the screen after the tube has been in operation for an appreciable time. This spot is caused by the bombardment of negative ions which appear to originate in the vicinity of the cathode of the electron gun and which have a mass that is materially greater than that of the electrons.

The accelerating fields of the cathode-ray tube accelerate the negative ions along with the electrons constituting the cathode-ray beam although the negative ions travel at a much slower rate than the electrons due to their greater mass. It is well known that the force exerted on a charged particle by a magnetic field is a function of the velocity as well as the mass of this particle. For this reason, the electrons of the cathode-ray beam are readily deflected over the entire screen area of the cathode-ray tube by the magnetic field set up therein by the deflection yoke, but the negative ions are not affected by this field to any appreciable extent. Therefore, the negative ions impinge upon a very limited portion of the screen area, usually in the immediate vicinity of the undeflected beam, and after the tube has been in use for some time, this impingement causes contamination of the screen and gives rise to a so-called "ion spot" at the point of impingement.

Several arrangements have been proposed for preventing the harmful negative ions from reaching the screen of the cathode-ray tube. These arrangements usually utilize the combined effects of electro-static and magnetic fields to trap the ions. An electro-static field is used to deflect the mixed beam of electrons and ions away from the fluorescent screen and towards a trapping surface, while a magnetic field is used to return solely the electrons of the beam to a path directed to the fluorescent screen.

Many ion trap arrangements presently known to the art require the assembling of parts that are asymmetrically shaped, and of cumbersome configuration. This adds materially to the difficulty and cost of construction, and renders it difficult to attain the required high degree of alignment of these components. Other arrangements require off-set apertures in the various components of the electron gun, but the necessary working tolerances make the commercial use of such arrangements infeasible. Yet other ar-

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rangements require peculiar configurations of certain components of the gun which renders the construction and assemblage thereof unduly costly and complicated.

It is, accordingly, an object of the present invention to provide an improved ion-trap type of electron-gun structure for a cathode-ray tube which overcomes the aforementioned disadvantages of the prior art.

A further object of the present invention is to provide an improved ion-trap type of electron-gun structure which utilizes standard symmetrical component parts well known to the art, and which may be constructed conveniently and economically.

The features of this invention which are believed to be new are set forth with particularity in the appended claims. The invention itself, however, together with further objects and advantages thereof may best be understood by reference to the following description when taken in conjunction with the accompanying drawing, in which:

Figure 1 shows one embodiment of the improved electron gun of the present invention, and,

Figure 2 shows a second embodiment of the invention.

Figure 1 shows a section 10 of the neck portion of a cathode-ray tube in which the electron gun of the present invention may be mounted. The neck 10 may have the usual base 11 affixed thereto which, in turn, has a plurality of pins 12 extending therethrough and electrically connected to various elements of the electron gun, by way of terminal connections 12a, to establish these elements at desired operating potentials. These elements are supported by glass rods 13 which extend longitudinally within the tube and are held securely therein by any suitable means. More specifically, the electron gun includes a tubular control electrode 14 supported by lugs 15 extending into supporting rods 13, and having a centrally located aperture 16 in its upper surface. A usual cathode structure 17 is mounted coaxially within electrode 14 with its upper activated surface aligned with aperture 16 and spaced therefrom by a fixed axial distance determined in any well-known manner.

A second tubular electrode 18 is also secured to supporting rods 13 by means of lugs 19. This electrode is mounted coaxially with control electrode 14 and has a central aperture 20 in its lower transverse surface aligned with aperture 16. A tubular anode electrode 21 facing electrode 18 is secured to supporting rods 13 by means of lugs 22, and has a transverse wall 23 closing its upper end and having a central aperture 24 formed therein. The electrode 21 may be established at a desired operating potential by means of terminal connections 25 which connect, in well-known manner, to the internal conductive surface of the tube (not shown).

In accordance with this embodiment of the

invention, anode 21 is mounted coaxially with the longitudinal axis of the tube. However, electrodes 14 and 18 are mounted on a common axis parallel to the longitudinal axis of anode 21 and off-set therefrom by a preselected amount which is small compared with the diameters of electrodes 14, 18 and 21. A tubular member 26 is mounted on the external surface of neck 10, and supports a pair of axially spaced permanent-magnet rings 27, 28. This member may be moved longitudinally or rotated on the neck surface, for reasons to be described.

In utilizing the electron gun of the present invention, anode 21 is established at a fixed positive potential that is large relative to the potential of electrode 18. The difference in potential between electrodes 18 and 21 gives rise to an electro-static field therebetween, and since these electrodes are off-set with respect to one another, the electro-static field deflects the mixed beam of electrons and ions, originating at cathode 17 and projected through apertures 16 and 20, to the inside surface of electrode 21 along a path such as that represented by broken construction line 29. Under these conditions, neither the electrons nor ions are directed to aperture 24 in disc 23.

The permanent magnet ring 27 is magnetized to produce a magnetic field within neck 10 to direct solely the electrons of the mixed beam to the longitudinal axis of the cathode-ray tube and through aperture 24 to the fluorescent screen, (not shown) along a path such as that indicated by broken construction line 30. It is preferable in this type of construction to include the second permanent magnet ring 28 which produces a magnetic field in the opposite sense to the field of magnet 27, to compensate for any over-shooting effect of the field of magnet 27 and to insure that the electron beam emerging through aperture 24 is directed along the longitudinal axis of the tube. Since cylindrical member 26 may be rotated about and moved longitudinally along neck 10, the magnetic fields of magnets 27 and 28 may be adjusted until the desired deflection of the electron beam through aperture 24 is obtained.

In a constructed embodiment of the invention the following dimensions were used to provide a gun that operated with a high degree of efficiency to provide an ion-free electron beam. These dimensions are listed herein merely by way of an illustrative example:

Diameter of anode 21, .520 inch O. D.
 Diameter of aperture 24, .120 inch
 Spacing between electrodes 18, 21, 0.079 inch
 Diameter of electrode 18, .520 inch O. D.
 Rolled edge, .665 inch
 Diameter of aperture 20, .075 inch
 Spacing between electrodes 14, 18, 0.030 inch
 Diameter of electrode 14, .520 inch O. D.
 Diameter of aperture 16, .040 inch
 Potential of anode 21, 11,000 volts
 Potential of electrode 18, 250 volts
 Potential of electrode 14, -45 volts
 Potential of cathode 17, 0 volt
 Off-set between anode 21 and electrodes 14, 18, 0.079 inch.

The embodiment of the invention shown in Figure 2 is essentially similar to that of Figure 1 except that in Figure 2 the electrodes 14, 18 and anode 21 are tilted so that they lie on respective parallel axes displaced one from the other by a preselected amount and inclined to the longitudinal axis of the tube by a preselected angle. With

this arrangement the compensating magnet 28 may be dispensed with. The angle of tilt is so chosen that the direction of electron beam as compensated by single permanent magnet 27 emerges from aperture 24 on the longitudinal axis of the cathode-ray tube. In a constructed embodiment using the previously listed dimensions highly satisfactory results were derived when the angle of tilt was made substantially six degrees.

It is to be clearly understood that the present invention is not limited to cathode-ray tubes including three tubular electrodes. For example, the electrode 18 may be dispensed with when so desired and the tube constructed to utilize only electrodes 14, 21 displaced relative to each other in the manner described.

This invention provides, therefore, an improved trap type of electron-gun structure for use in cathode-ray tubes. The improved electron gun has been found to operate in a highly satisfactory manner to prevent negative ions in the tube from reaching and contaminating the fluorescent screen. As shown in the drawing, the improved gun is composed of symmetrical standard components that may be conveniently and economically assembled by known standard fabrication processes. There are no requirements in the gun structure of the present invention for components of irregular shapes or sizes or for peculiarly positioned apertures.

While particular embodiments of the invention have been shown and described, modifications may be made and it is intended in the appended claims to cover all such modifications as may fall within the true spirit and scope of the invention.

We claim:

1. An electron-gun structure for an ion-trap type of cathode-ray tube comprising: a first tubular electrode having an apertured transverse wall and having a right-angle end portion; a cathode for emitting electrons; a second tubular electrode having a right-angle end portion adjacent to and facing said end portion of said first electrode and aligned with said cathode along a common axis offset with respect to the axis of said first electrode by a distance small compared with the diameter of said first electrode; a centrally apertured transverse wall included in said second electrode through which a mixed beam of ions and electrons emerges along said common axis; and terminal connections extending to said electrodes to establish a difference of potential therebetween and create a transverse electric field at said offset end portions of said electrodes for directing said mixed beam into said first electrode along a path that is divergent in the direction of the offset of said second electrode.

2. An electron-gun structure for an ion-trap type of cathode-ray tube comprising: a first tubular electrode having an apertured transverse wall and having a right-angle end portion; a cathode for emitting electrons; a second tubular electrode having a right-angle end portion adjacent to and facing said end portion of said first electrode and aligned with said cathode along a common axis which is parallel but offset with respect to the axis of said first electrode by a distance small compared with the diameter of said first electrode; a centrally apertured transverse wall included in said second electrode through which a mixed beam of ions and electrons emerges along said common axis; and terminal connections extending to said electrodes to establish a difference of potential therebetween and create a transverse electric field at said offset end portions of said

electrodes for directing said mixed beam into said first electrode along a path that is divergent in the direction of the offset of said second electrode.

3. An electron-gun structure for an ion-trap type of cathode-ray tube comprising: a first tubular electrode disposed on the longitudinal axis of said tube, having a centrally apertured transverse wall and having a right-angle end portion; a cathode for emitting electrons; a second tubular electrode having a right-angle end portion adjacent to and facing said end portion of said first electrode and aligned with said cathode along a common axis which is parallel but offset with respect to the axis of said first electrode by a distance small compared with the diameter of said first electrode; a centrally apertured transverse wall included in said second electrode through which a mixed beam of ions and electrons emerges along said common axis; and terminal connections extending to said electrodes to establish a difference of potential therebetween and create a transverse electric field at said offset end portions of said electrodes for directing said mixed beam into said first electrode along a path that is divergent in the direction of the offset of said second electrode.

4. An electron-gun structure for an ion-trap type of cathode-ray tube comprising: a first tubular electrode having a right-angle end portion and having an apertured transverse wall with the aperture thereof disposed across the longitudinal axis of said tube; a cathode for emitting electrons; a second tubular electrode having a right-angle end portion adjacent to and facing said end portion of said first electrode and aligned with said cathode along a common axis offset with respect to the axis of said first electrode by a distance small compared with the diameter of said first electrode; a centrally apertured transverse wall included in said second electrode through which a mixed beam of ions and electrons emerges along said common axis; and terminal connections extending to said electrodes to establish a difference of potential therebetween and create a transverse electric field at said offset end portions of said electrodes for directing said mixed beam into said first electrode along a path that is divergent in the direction of the offset of said second electrode.

5. An electron-gun structure for an ion-trap type of cathode-ray tube comprising: a first tubular electrode having a right-angle end portion and having an apertured transverse wall disposed adjacent the opposite end of said electrode with the aperture thereof across the longitudinal axis of said tube; a cathode for emitting electrons; a second tubular electrode having a right-angle end portion adjacent to and facing said right-angle end portion of said first electrode and aligned with said cathode along a common axis offset with respect to the axis of said first electrode by a distance small compared with the diameter of said first electrode; a centrally apertured transverse wall included in said second electrode through which a mixed beam of ions and electrons emerges along said common axis; and terminal connections extending to said electrodes to establish a difference of potential therebetween and create a transverse electric field at said offset end portions of said electrodes for directing said mixed beam into said first electrode along a path that is divergent in the direction of the offset of said second electrode.

6. An electron-gun structure for an ion-trap type of cathode-ray tube comprising: a first tu-

bular electrode having an open right-angle end portion and having an apertured transverse wall disposed adjacent the opposite end of said electrode with the aperture thereof across the longitudinal axis of said tube; a cathode for emitting electrons; a second tubular electrode having an open right-angle end portion adjacent to and facing said right-angle end portion of said first electrode and aligned with said cathode along a common axis offset with respect to the axis of said first electrode by a distance small compared with the diameter of said first electrode; a centrally apertured transverse wall included in said second electrode near the end thereof adjacent said cathode through which a mixed beam of ions and electrons emerges along said common axis; and terminal connections extending to said electrodes to establish a difference of potential therebetween and create a transverse electric field at said offset end portions of said electrodes for directing said mixed beam into said first electrode along a path that is divergent in the direction of the offset of said second electrode.

7. An electron gun structure for an ion-trap type of cathode-ray tube comprising: a tubular anode electrode having an open right-angle end portion and having an apertured transverse wall disposed adjacent the opposite end of said anode with the aperture thereof across the longitudinal axis of the tube; a cathode having an electron emitting surface; a first tubular control electrode surrounding said cathode and having a centrally apertured transverse wall adjacent said emitting surface of said cathode; a second tubular electrode, having an open right-angle end portion adjacent to and facing said right-angle portion of said anode, aligned with said cathode and said first control electrode along a common axis which is parallel but offset with respect to the axis of said anode by a distance small compared to the diameter of said anode; a centrally apertured transverse wall included in said second electrode near the end thereof adjacent said first electrode so that a mixed beam of ions and electrons originating at said cathode travels along said common axis and through said apertured walls of said first and second electrodes; and terminal connections extending to said anode and to said second electrode to establish a difference of potential therebetween and create a transverse electric field at said offset end portions of said anode and said second electrode for directing said mixed beam into said anode along a path that is divergent in the direction of the offset of said second electrode.

WILLIS E. PHILLIPS.

CONSTANTIN S. SZEGHO.

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