Jan. 15, 1952 C. S. SZEGHO 2,582,402

ION TRAP TYPE ELECTRON GUN

Filed Sept. 29, 1950

Fig. 1

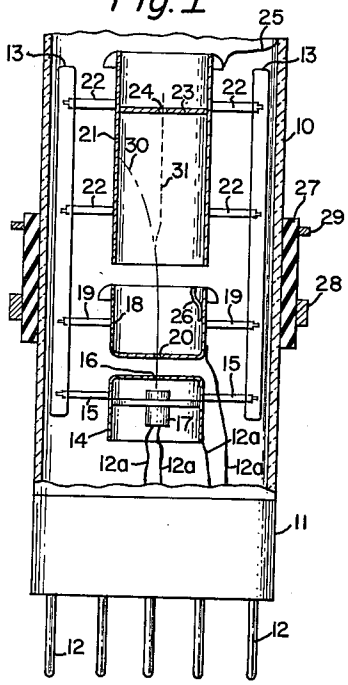


Fig. 2

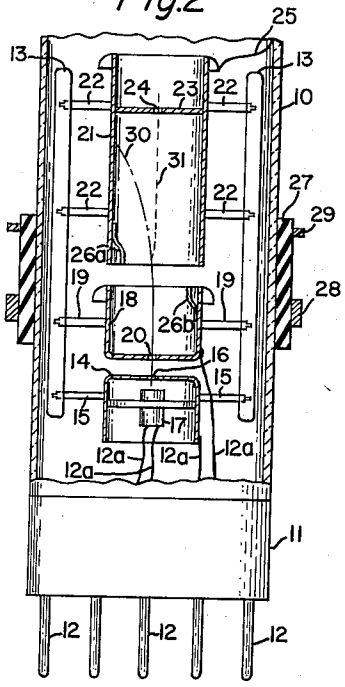
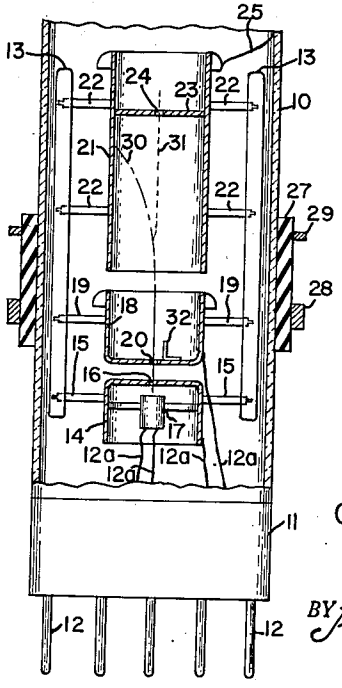


Fig. 3



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Patented Jan. 15, 1952

2,582,402

UNITED STATES PATENT OFFICE

2,582,402

ION TRAP TYPE ELECTRON GUN

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Application September 29, 1950, Serial No. 187,432

7 Claims. (Cl. 313—85)

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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 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 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 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 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 made the commercial use of such arrangements infeasible. Yet other arrangements require peculiar configurations of certain components of the gun which renders the construction and assemblage thereof unduly costly and complicated.

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It is an object of the present invention to provide an improved ion-trap of electron gun structure which utilizes standard symmetrical component parts well-known to the art, which overcomes the aforementioned disadvantages of the prior 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:

Figures 1–3 show various embodiments of the invention.

Referring now to Figure 1, a section of the neck portion 10 of a cathode-ray tube is illustrated in which the electron gun of the present invention may be mounted. Neck 10 may have the customary base 11 affixed thereto to accommodate a plurality of pins 12 extending therethrough and electrically connected to various elements of the electron gun by way of terminal connections 12*a* to establish these elements at desired operating potentials. The electron gun includes a tubular control electrode or first grid 14 supported from tube base 11 in any convenient manner and carrying radially extending lugs 15 which are suitably secured to a plurality of longitudinally disposed support rods 13. The control electrode has a centrally located aperture 16 in its upper surface through which the cathode-ray beam passes. A usual cathode structure 17 is mounted 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 tubular electrode or second grid 18 is secured to and supported by rods 13 by means of lugs 19 and is positioned in coaxial alignment with the first grid 14. Electrode 18 has a central aperture 20 in its lower transverse surface which is aligned with aperture 16. A tubular anode electrode 21 is supported in coaxial alignment with electrode 18 by means of lugs 22 which likewise are attached to rods 13. Electrode 21 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 op-

erating potential by means of a terminal connection 25 which leads, in well-known manner, to the internal conductive surface of the tube (not shown).

In accordance with one embodiment of the invention a wire or conductive strip 26 is supported by and electrically connected to the inner peripheral surface of electrode 18 and projects toward anode electrode 21 so as to be exposed to at least a portion of the latter electrode across the axis of the cathode-ray tube. A potential difference is established between electrodes 18 and 21 through the terminal connections and sets up an electro-static accelerating field therebetween. The presence of conductive strip 26 established at the potential of electrode 18 distorts this electro-static field and establishes a component thereof between the strip and anode electrode 21 which is transverse to the common axis of the electrodes. A tubular member 27 is mounted on the external surface of neck 10 and supports a pair of spaced permanent magnetic rings 28, 29. 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 to establish an electro-static accelerating field therebetween. Cathode 17 emits electrons which may be formed into a mixed beam of ions and electrons by suitable external magnetic focusing means (not shown), the mixed beam passing along the common axis of electrodes 14, 18 through aperture 20 in tubular electrode 18. The transverse component of the electro-static field between electrodes 18, 21 produced by strip 26 tends to cause the mixed beam to enter the anode electrode along a path 30 directed away from aperture 24 in the transverse wall 23 and towards the internal peripheral surface of the anode. Under these conditions, neither the electrons nor ions are directed to aperture 24 in transverse wall 23.

The permanent magnet ring 28 is oriented to produce a magnetic field within neck 10 to direct solely the electrons of the mixed beam to the common axis of the electrodes and through aperture 24 to the fluorescent screen (not shown) along a path indicated by broken construction line 31. It is preferable in this type of construction to include a second magnetic ring 29 oriented to produce a magnetic field in the opposite sense to the field of magnet 28 to compensate for any over shooting effect of the field of magnet 27 and to insure that the electron beam emerging from aperture 24 is directed along the common axis of the electrodes. Since tubular member 27 may be rotated about and moved longitudinally along neck 10, the fields of magnets 28 and 29 may be adjusted until the desired deflection of the electron beam through aperture 24 is obtained.

It is apparent that similar results may be obtained when the conductive strip 26 is supported by and electrically connected to anode electrode 21 instead of electrode 18 as in the illustrated embodiment in Figure 1.

The embodiment of Figure 2 differs from the embodiment of Figure 1 only in that a pair of conductive strips 26*a* and 26*b* are utilized to establish the transverse component of the electro-static field, these strips being connected to and supported by anode electrode 21 and electrode 18 respectively.

In accordance with the preferred embodiment of the invention, illustrated in Figure 3, a relatively small deflection electrode 32 is secured to the inside surface of the end-wall portion of electrode 18 and exposed to a portion of electrode 21 across the common axis of the electrodes. Electrode 32 is in the form of an L-shaped plate and is mounted in close proximity to aperture 20. It has been found that the transverse component of the electro-static field between electrode 18 and electrode 21 set up by plate 32 has sufficient strength to deflect away from aperture 24, the mixed beam of ions and electrons emerging from aperture 20. Moreover, the strength of this transverse component of the electro-static field is not excessive and allows for convenient deflection by magnets 28, 29 of the electron beam, so that it is directed along path 31 towards aperture 24.

The invention provides, therefore, an improved ion-trap type of electron-gun structure for use in cathode-ray tubes, which operates to prevent ions from reaching and contaminating the fluorescent screen thereof. As shown in the drawing, the improved gun is composed of standard symmetrical components that may be conveniently and economically assembled by any well-known fabrication process; ion trapping being accomplished by the simple expedient of securing a small conductive strip to at least one of the electrodes. There are no requirements in the gun structure of the present invention for components of irregular shapes and sizes, or for eccentrically 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.

I claim:

1. An electron-gun structure for an ion-trap type of cathode-ray tube comprising: a cathode for emitting electrons; a first tubular electrode supported in substantially coaxial alignment with said cathode through which a mixed beam of ions and electrons passes along the common axis of said cathode and said electrode; a second tubular electrode, having an apertured transverse wall, supported in substantial coaxial alignment with said cathode and first tubular electrode and spaced therefrom along said common axis; at least one conductive strip supported within said cathode-ray tube, displaced from said common axis, and exposed to at least a portion of one of said electrodes across said common axis; and terminal connections extending to said electrodes and to said strip for establishing a difference of potential between said electrodes and between said strip and said one of said electrodes, to produce an electro-static accelerating field between said electrodes with a component transverse to said common axis, whereby said mixed beam enters said second electrode along a path directed away from said aperture in said transverse wall.

2. An electron-gun structure for an ion-trap type of cathode-ray tube comprising: a cathode for emitting electrons; a first tubular electrode supported in substantially coaxial alignment with said cathode through which a mixed beam of ions and electrons passes along the common axis of said cathode and said electrode; a second tubular electrode, having an apertured transverse wall, supported in substantial coaxial alignment with said cathode and first tubular electrode and spaced therefrom along said common axis; at

least one conductive strip displaced from said common axis, supported by and electrically connected to at least one of said electrodes, and exposed to at least a portion of the other of said electrodes across said common axis; and terminal connections extending to said electrodes for establishing a difference of potential therebetween to produce an electro-static accelerating field between said electrodes with a component transverse to said common axis, whereby said mixed beam enters said second electrode along a path directed away from said aperture in said transverse wall.

3. An electron-gun structure for an ion-trap type of cathode-ray tube comprising: a cathode for emitting electrons; a first tubular electrode supported in substantially coaxial alignment with said cathode through which a mixed beam of ions and electrons passes along the common axis of said cathode and said electrode; a second tubular electrode, having an apertured transverse wall, supported in substantial coaxial alignment with said cathode and first tubular electrode and spaced therefrom along said common axis; a conductive strip displaced from said common axis, supported by and electrically connected to one of said electrodes, and exposed to at least a portion of the other of said electrodes across said common axis; and terminal connections extending to said electrodes for establishing a difference of potential therebetween, to produce an electrostatic accelerating field between said electrodes with a component transverse to said common axis, whereby said mixed beam enters said second electrode along a path directed away from said aperture in said transverse wall.

4. An electron-gun structure for an ion-trap type of cathode-ray tube comprising: a cathode for emitting electrons; a first tubular electrode supported in substantially coaxial alignment with said cathode through which a mixed beam of ions and electrons passes along the common axis of said cathode and said electrode; a second tubular electrode, having an apertured transverse wall, supported in substantial coaxial alignment with said cathode and first tubular electrode and spaced therefrom along said common axis; a conductive strip displaced from said common axis, supported by and electrically connected to the internal surface of one of said electrodes, projecting towards the other of said electrodes, and exposed to a portion of said other electrode across said common axis; and terminal connections extending to said electrodes for establishing a difference of potential therebetween, to produce an electrostatic accelerating field between said electrodes with a component transverse to said common axis, whereby said mixed beam enters said second electrode along a path directed away from said aperture in said transverse wall.

5. An electron-gun structure for an ion-trap type of cathode-ray tube comprising: a cathode for emitting electrons; a first tubular electrode supported in substantially coaxial alignment with said cathode through which a mixed beam of ions and electrons passes along the common axis of said cathode and said electrode; a second tubular electrode, having an apertured transverse wall, supported in substantial coaxial alignment with said cathode and first tubular electrode and spaced therefrom along said common axis; a conductive strip displaced from said common axis, supported by and electrically connected to the internal surface of said first electrode, projecting towards said second electrode, and exposed to a portion of said second electrode across said common axis; and terminal connections extending to said electrodes for establishing a difference of potential therebetween, to produce an electrostatic accelerating field between said electrodes whereby said mixed beam enters said second electrode along a path directed away from said aperture in said transverse wall.

6. An electron-gun structure for an ion-trap type of cathode-ray tube comprising: a cathode for emitting electrons; a first tubular electrode supported in substantially coaxial alignment with said cathode through which a mixed beam of ions and electrons passes along the common axis of said cathode and said electrode; a second tubular electrode, having an apertured transverse wall, supported in substantial coaxial alignment with said cathode and first tubular electrode and spaced therefrom along said common axis; a first conductive strip, displaced from said common axis, supported by and electrically connected to the internal peripheral surface of said first electrode; a second conductive strip oppositely displaced from said common axis relative to said first strip, supported by and electrically connected to the internal peripheral surface of said second electrode, and exposed to said first strip; and terminal connections extending to said electrodes for establishing a difference of potential therebetween, to produce an electrostatic accelerating field between said electrodes with a component transverse to said common axis, whereby said mixed beam enters said second electrode along a path directed away from said aperture in said transverse wall.

7. An electron-gun structure for an ion trap type of cathode-ray tube comprising: a cathode for emitting electrons; a first tubular electrode supported in substantially coaxial alignment with said cathode and having an apertured transverse wall through which a mixed beam of ions and electrons passes along the common axis of said cathode and said electrode; a second tubular electrode, having a centrally apertured transverse wall, supported in substantially coaxial alignment with said cathode and first tubular electrode and spaced therefrom along said common axis; a conductive plate supported by and electrically connected to the aforesaid transverse wall of one of said electrodes adjacent the aperture therein, projecting toward the other of said electrodes and exposed to a portion of said other electrode across said common axis; and terminal connections extending to said electrodes for establishing a difference of potential therebetween, to produce an electrostatic accelerating field between said electrodes with a component transverse to said common axis, whereby said mixed beam enters said second electrode along a path directed away from the central aperture in said transverse wall thereof.

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