

PATENT SPECIFICATION

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(54) ELECTRON GUN WITH MEANS FOR EXPANDING THE FOCUSsing LENS FIELD

(71) We, RCA CORPORATION, a Corporation organized under the laws of the State of Delaware, United States of America, of 30 Rockefeller Plaza, City and State of New York, 10020, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to an electron gun for producing and directing at least one, and preferably a plurality of, electron beams, and is directed to the means for focussing the beam or beams on a target.

In a conventional color television picture tube having a multiple-beam electron gun, each electron beam passes through a separate electron lens which focusses the beam to a point on the target screen. The lens is essentially an electrostatic field which directs the individual rays of the beam toward a common point as they pass through the field. This field is normally established between two spaced electrodes positioned transverse to the beam path, the electrodes having a series of apertures through which the beam passes. The characteristics of the lens may be altered by changing the electrostatic field, usually by varying the voltage between the electrodes, the size of the apertures, the separation distance of the electrodes, or a combination thereof.

In some cases, in order to reduce spherical aberration, it is desirable to have a long focal length lens. Since the voltages of the lens electrodes are limited to values which do not cause arcing at the picture tube base, the focal length is lengthened by increasing aperture size and/or electrode spacing. However, if the spacing between the electrodes becomes too large (in excess of about 1.5 mm), the focussing field becomes susceptible to interference from other electrostatic fields within the electron gun. Conversely, each focussing field

created by a large spacing also interferes with adjacent electrostatic focussing fields. Ideally therefore, the lens should have a relatively large diameter aperture (about 8 mm) and small electrode spacing (about 1.5 mm).

The physical design of the electron gun, however, places several restraints on this configuration. For example, in the in-line electron gun shown in United States Patent 3,772,554, issued 12 November 1973, to Hughes, the three electron beams are very close, and the lens characteristics are adjusted only by varying the spacing of the electrodes since the aperture size is already maximized. To duplicate the characteristics of the ideal large aperture lens, the electrode spacing must be made several times the tolerable maximum of 1.5 mm.

In accordance with the invention an electron gun structure for producing and directing at least one electron beam along a beam path, comprises a plurality of electrodes including a cathode, a first focussing electrode, and a second focussing electrode spaced successively along said beam path; a plurality of spaced electrode plates positioned between said first focussing electrode and said second focussing electrode for simulating a larger-aperture focussing lens in said beam path, each of said plates having an aperture there-through in alignment with said beam path; support means supporting said plates; and resistive means connected at one end to said first focussing electrode, at a second end to said second focussing electrode, and at spaced points between said ends to said spaced electrode plates, said resistive means being disposed on said support means.

In the accompanying drawings:

Figure 1 is a side view of an electron gun embodying the invention;

Figure 2 is a top view of the gun of Figure 1; and

Figure 3 is a sectional view taken on line 3—3 of Figure 1.

The embodiment of the invention shown

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in Figures 1 to 3 depicts an in-line electron gun for a color television picture tube (not otherwise shown); however, the invention may be used with any geometrical gun configuration employing a wide-gap electron lens.

Referring to the Figures, an electron gun 10 comprises two parallel glass support rods 28 between which various gun elements are mounted. At one end of the rods 28 are mounted several support straps 14 on which three cathodes 12 are fastened. Mounted in order after the support straps 14 are a control grid electrode 16, a screen grid electrode 18, a first accelerating and focussing electrode 24, and a second accelerating and focussing electrode 26. The three cathodes project electron beams along three coplanar beam paths 30. The control grid electrode 16 and screen grid electrode 18 are closely spaced flat metal elements containing three apertures such as 17 and 19 respectively, which are aligned with a different beam path 30, as shown in Figure 3. The first accelerating and focussing electrode 24 is closely spaced from the screen grid electrode 18 and comprises two rectangular shaped cups 20 and 22 joined at their open ends. The closed ends of cups 20 and 22 each have three apertures which also are aligned with a different beam path 30. The apertures 21 in first cup 20 are larger than those in screen grid electrode 18, and the apertures 32, 34 and 36 in second cup 22 are slightly larger than those in first cup 20.

Spaced from the first such electrode 24 is the second accelerating and focussing electrode 26 comprising a rectangular cup having a base 27. The base 27 faces electrode 24 and has three apertures 38, 39 and 40, preferably slightly larger than the apertures of second cup 22. Middle aperture 39 in base 27 is aligned with middle aperture 34 in second cup 22. The two outer apertures 38 and 40 in base 27 are slightly offset outwardly with respect to the outer apertures 32 and 36, respectively, in second cup 22. A shield cup 42 with a base 43 is attached to electrode 26 such that the base 43 covers the open end of electrode 26. The shield cup 42 has three apertures 41 through its base 43, each aligned with one of the beam paths 30. The shield cup 42 also has three bulb spacers 44 attached to and extending from its open end.

Six metal plates 46 are mounted on the glass support rods 28 between the first accelerating and focussing electrode 24 and the second accelerating and focussing electrode 26 such that the spacing between each pair of plates does not exceed 1.5 mm. Each plate 46 includes three apertures 48 approximately equal in size to the apertures 32, 34 and 36 in the second cup 22. Each

aperture 48 is aligned with a separate beam path 30. A resistor 50 is mounted on one of the glass support rods 28, adjacent to the plates 46. Resistor 50 is a thin cermet film 49 deposited on a substrate 51, which is bonded to the support rod. For operation within the picture tube, the resistor 50 has a very small temperature coefficient of resistivity and is able to withstand the high voltage (approximately 32,000 volts) typically applied to the second accelerating and focussing electrode 26. One end of the resistor 50 is electrically connected to the first accelerating and focussing electrode 24 by means of a first conductor 54. The other end of the resistor 50 is electrically connected to the second accelerating and focussing electrode 26 by means of a second conductor 56. Each plate 46 successively spaced from electrode 24 is electrically connected, by means of electrical taps 52, to one of six points on resistor 50 of successively greater resistance with respect to the one end thereof.

After the electron gun 10 is assembled inside the tube, the bulb spacers 44 contact the inside surface of the tube to establish electrical contact between that surface and electrode 26. During gun operation, a first voltage of about 4,000 volts (relative to control grid electrode 16) is applied to the first accelerating and focussing electrode 24, and a second voltage in the range of 25,000 to 32,000 volts is applied to the inside surface of the tube. The second voltage is effectively applied to the second accelerating and focussing electrode 26, creating a voltage difference between electrodes 24 and 26. This voltage difference is distributed to each plate 46 by means of resistor 50, the two conductors 54 and 56, and taps 52, so that each plate 46 spaced successively from electrode 24 is at a higher voltage than the previous plate. The distribution of the voltages is such that each plate 46 is maintained at approximately the same potential as that of an equipotential line at the same location in an electrostatic field established by a large aperture electron lens.

There are two basic arrangements for establishing the electrostatic field between the first and second accelerating and focussing electrodes 24 and 26. One arrangement forms a uniform electrostatic field by applying a voltage to each plate 46 which is proportional to the spacing of that plate from the two electrodes 24 and 26; i.e., the taps 52 are spaced on resistor 50 proportionally to the plate spacing. The uniform field with equally-spaced equipotential lines closely approximates the electrostatic field in a large aperture lens. However, in the large aperture lens the field is not exactly uniform; the equipotential

lines near the beam path are closer to one another near the center of the lens gap than elsewhere between the electrodes 24 and 26. The other basic arrangement more accurately duplicates this nonuniform field by applying the voltages disproportionately to the plate spacing. This is accomplished by evenly spacing the plates 46 or the resistor taps 52 while unevenly spacing the taps or plates, respectively. The plates 46 are thereby maintained at voltages equivalent to the potentials at their position in the electrostatic field of a large aperture lens.

The novel electron gun 10 has a focussing lens with the same or closely similar properties as a large aperture electron focussing lens. The plates 46 stabilize the electrostatic field, permitting a large focussing gap while minimizing external interference. This large focussing gap increases the focal length of the lens, which reduces the lens aberration. By placing the resistor 50 within the tube and electrically connecting the resistor to the first and second accelerating and focussing electrodes 24 and 26, any need for additional high voltage leads extending through the tube envelope is eliminated. This also eliminates lead insulation problems which exist in small neck diameter cathode ray tubes where the leads are closely spaced to one another.

WHAT WE CLAIM IS:—

1. An electron gun structure for producing and directing at least one electron beam along a beam path, comprising a plurality of electrodes including a cathode, a first focussing electrode, and a second focussing electrode spaced successively along said beam path; a plurality of spaced electrode

plates positioned between said first focussing electrode and said second focussing electrode for simulating a larger-aperture focussing lens in said beam path, each of said plates having an aperture therethrough in alignment with said beam path; support means supporting said plates; and resistive means connected at one end to said first focussing electrode, at a second end to said second focussing electrode, and at spaced points between said ends to said spaced electrode plates, said resistive means being disposed on said support means.

2. An electron gun structure according to claim 1, wherein said plates are connected to said resistive means such that the resistance between said plates is proportional to their spacing.

3. An electron gun structure according to claim 1 or 2, wherein said electrodes include a plurality of cathodes for producing a like plurality of electron beams directed along respective beam paths, and each of said plates has a like plurality of apertures therethrough, each aperture in any plate being aligned with a different one of said paths.

4. An electron gun structure according to any preceding claim wherein said resistive means comprises a thin cermet film.

5. An electron gun structure substantially as hereinbefore described with reference to the accompanying drawings.

6. A color television picture tube having a multiple beam electron gun structure according to any preceding claim.

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