

USE OF AN ELECTRON GUN FOR A CATHODE RAY TUBE

The invention relates to the use of an electron gun for cathode ray tubes of the type with focusing of the beam either by a magnetic lens or by an electrostatic lens having a high resolution and a high luminance according to the first part of Claim 1.

A use of an electron gun according to the first part of Claim 1 is known from US-A-4,009,410.

A cathode ray tube (CRT) is the unit constituted by an evacuated enclosure inside which is placed an electron gun producing a beam of electrons which bombard a luminescent screen.

The electron gun comprises a set of electrodes and possibly deflecting plates. The electron source is classically formed by a cathode with oxides of alkaline-earths heated by a filament. The thermionic emission of electrons is stimulated by an electric field created between the cathode and the accelerating electrode. A control electrode or Wehnelt cylinder, formed by a metal collar surrounding the cathode and presenting a small diameter orifice along the axis of the tube, makes it possible to modify the electric field and to control the intensity of the emitted electrons and hence the beam current and finally the brightness of the track on the screen.

With a view to limiting the divergence of the beam, an electron gun such as that represented in Figure 1 is classically used. This gun comprises an electron source electrode or emissive cathode 1, a Wehnelt cylinder or control electrode 2, an electrode of first acceleration or anode 3, and then an electrode 4 which may, depending on the case, be an electrode of final acceleration or a focusing electrode.

In operation, each electrode is subjected to a respective polarisation voltage V_1 , V_2 , V_3 , V_4 and possibly V_5 for the case in which there is both an electrode of final acceleration and a second focusing electrode.

Prefocusing of the electron beam is carried out in order to obtain a beam of small diameter over its whole length together with a small inclination of the rays with respect to the axis of the beam. This pre-
5 focusing is obtained through the effect of the pre-focusing lens which consists of the electrodes 3 and 4. A principal focusing lens is constituted, depending on the case, by a magnetic lens placed outside the neck of the tube or by an electrostatic lens formed for example
10 by the electrodes 4 and 5.

In operation, polarisation voltages V_3 and V_4 are applied in a voltage ratio V_4/V_3 which, depending on the type of gun, may be large (of the order of 15) or small (of the order of 5 to 8). Polarisation voltages V_5
15 and V_4 are applied, in operation, in a voltage ratio V_5/V_4 which is small (of the order of 4 to 6).

The anode electrode 3 comprises a plane surface or preferably a plane disc for entrance 13 pierced at its centre by a circular orifice 17. The first focusing
20 electrode 4 comprises a plane surface or preferably a plane disc for entrance 14 also pierced at its centre by a circular hole 18. The entrance discs 13 and 14 of the electrodes 3 and 4 are parallel to each other and orthogonal to the axis of the electron beam 21 passing
25 through their centre. The first focusing electrode 4 comprises a plane surface or preferably a plane disc for exit 15 and the second focusing electrode 5 a plane surface or preferably a plane disc for entrance 16. The two discs 15 and 16, each pierced by a circular orifice
30 19 and 20 at their centre, are parallel to each other and orthogonal to the axis of the electron beam 21 passing through their centre.

The prefocusing lens therefore consists of the parallel discs 13 and 14 of the electrodes 3 and 4 fitted
35 with their orifices. The second lens, or principal lens, consists of the parallel discs 15 and 16 of the electrodes 4 and 5 fitted with their orifices.

The voltage ratio V_5/V_4 may be small in comparison with the voltage ratio V_4/V_3 . However, because

of its geometrical constitution, the power of the said second lens is sufficient to provide the principal focusing. The entrance orifice 18 of the electrode 4 consists of a circular hole of small diameter. This hole produces a curvature of the field lines and a pinch in the beam in its plane. The second lens, or principal lens, forms on the screen the image of an object whose position and diameter vary little with the cathode output, thus ensuring a small variation of the size of the spot on the screen. The deflection of the electron beam is achieved through the intermediary of any standard deflecting system not represented in Figure 1. A control voltage V2 is applied to the Wehnelt cylinder. For a certain value of V2, the cathode current is reduced to zero. This value of V2 is called the cut-off voltage.

Another electron gun structure shown in a Patent US-A-4,009,410 might also be mentioned. In this other structure, a supplementary electrode is placed between an electrode of first acceleration and an electrode of final acceleration. In addition to a first "cross-over" formed between the Wehnelt cylinder and the electrode of first acceleration as represented in Figure 1, this supplementary electrode has the effect of making the electron beam converge very strongly onto its axis, to the point where a second "cross-over" is produced (the "cross-over" being the point on the axis at which the limits of the beam cross each other).

The cut-off voltage of the electron beam depends on the dimensions of the elements constituting the gun, particularly on the distances between the electrodes cathode-Wehnelt cylinder and Wehnelt cylinder-anode, and on the diameters of the orifices of the entrance surface of each of these electrodes.

In practice, however, this cut-off voltage never has exactly the same value for each tube manufactured because of manufacturing tolerances. The scatter in this cut-off voltage that exists between various tubes of the same model makes it essential to carry out an adjustment. This adjustment may be

performed on the voltage V2 of the control electrode. In general, however, it is preferable to carry out this adjustment from the polarisation voltage V3 of the anode since it is easier to obtain a variable supply for the
5 anode polarisation voltage than for the voltage of the control electrode.

It is found that, in the case of electron guns for high-performance CRTs, the adjustment of the cut-off voltage by adjustment of the polarisation voltage of the
10 anode causes deteriorations either in the resolution or in the luminance, depending on whether the gun has a higher or lower cut-off voltage within the range of the adjustment. The scatter in the electro-optical characteristics from one tube to another, in the same manufactured batch, is then quite large, and may pose problems
15 for top-of-the-range equipment where performance must be very consistent.

The present invention enables these problems to be overcome by proposing the use of an electron gun in which a supplementary electrode is inserted between the
20 electrode of first acceleration or anode and the focusing electrode, this supplementary electrode having a fixed polarisation voltage whose value is situated in the range of adjustment of the anode polarisation voltage.

25 The present invention therefore has as its subject the use of an electron gun for cathode ray tubes comprising in succession an electron source electrode or cathode, a control electrode or Wehnelt cylinder, an electrode of first acceleration or anode placed at an
30 adjustable voltage and at least one focusing electrode or electrode of second acceleration, a supplementary electrode inserted between the electrode of first acceleration or anode and the focusing electrode; characterised in that the said supplementary electrode is placed at a
35 fixed polarisation voltage, the supplementary electrode constituting with the electrode of first acceleration a first low-power prefocusing lens and constituting with the focusing electrode a high-power prefocusing lens.

The invention will be more clearly understood

with the help of the following description presented as a non-limiting example and made with reference to the following figures, which represent:

- Figure 1, a diagram of an electron gun according to the previous art;

- Figure 2, a diagram of an electron gun according to the invention.

Figure 1 represents the diagram of an electron gun according to the previous art. This figure has already been described and more detail will not be given.

Figure 2 represents a partial diagram of an electron gun according to the invention. Only that part comprising the set of electrodes to which the invention refers has been represented, i.e. the electron source electrode, the control electrode, the electrode of first acceleration and the focusing electrode. These electrodes are placed in the evacuated enclosure 6. The electron gun comprises a succession of electrodes or [sic] the electrode 1 is an emissive cathode, the electrode 2 is a control electrode or Wehnelt cylinder, the electrode 3 is an electrode of first acceleration or anode, the electrode 30 is a focusing electrode, the electrode 4 is a focusing electrode also producing a second acceleration. The gun may also comprise another electrode in order to produce a third acceleration such as the electrode 5 represented in Figure 1 of the previous art. Each electrode is, in operation, subjected to a polarisation voltage V_1 , V_2 , V_3 , V_{30} , V_4 respectively.

According to the invention, the electrode 3 and the electrode 30 form a low-power prefocusing lens, while the electrode 30 and the electrode 4 form a high-power prefocusing lens. Prefocusing of the electron beam is achieved by means of the first prefocusing lens, formed by the electrodes 3 and 30, which has a weak action, and the second prefocusing lens formed by the electrodes 30 and 4.

In accordance with the invention, the supplementary electrode, which is constituted by the electrode 30, is placed between the anode 3 and the electrode 4,

10 this electrode 30 having a polarisation voltage V_{30} whose value lies in the range of adjustment of the anode polarisation voltage. The polarisation voltages applied during operation to the electrodes 3 and 30 are in a
5 small ratio V_{30}/V_3 , V_3 being substantially equal to V_{30} to within 30%. The polarisation voltages applied during operation to the electrodes 30 and 4 are in a large ratio V_4/V_{30} , greater than or equal to 10. The polarisation voltage V_3 of the anode electrode 3 is adjustable and may
10 be adjusted in order to obtain the desired electron cut-off voltage.

15 The anode electrode 3 comprises a plane surface which is preferably a plane entrance disc 13 pierced at its centre by a circular orifice 17. This electrode comprises a rear surface 21 which is completely open and which is opposite the front surface 31 of the electrode 30. The electrode 30 comprises a rear surface constituted by a plane disc 32 pierced by a circular orifice 33. The electrode 4 comprises a front surface 40 opposite the rear surface 32, pierced with orifices 41. The
20 front and rear surfaces of each of the electrodes are parallel to each other and orthogonal to the axis XX' of the electron beam 7.

25 Thus in accordance with the invention, the addition of the electrode 30 with fixed polarisation opposite the electrode 4 and the choice of polarisations so that the ratio between these polarisation voltages is large, enables a powerful lens to be obtained, which ensures focusing of the electron beam, the beam having a
30 small diameter over the whole of its length at the output from the electrostatic lens 30-4.

35 The addition of the electrode 30 also makes it possible to be able to adjust the polarisation voltage of the anode in order to regulate the cut-off voltage of the electron beam without at the same time altering the characteristics of the beam, these alterations being reflected in the previous art either by a poor output or by a poor resolution. The lenses formed by the electrodes 3 and 30 and by the electrodes 30 and 4 have a

large diameter, and thus ensure a prefocusing of the beam without contributing spherical aberration to the screen, and thus make it possible to have good resolution and good luminance.

- 5 According to a preferred embodiment, the diameters of the orifices of the electrodes 2 and 3 are of the same order of magnitude as in a classical gun. The diameter of the openings 21 and 31 is of the same order of magnitude as the outer diameter of the electrodes which are of cylindrical shape. The diameter of the orifices 33 and 41 are of the same order of magnitude and may be chosen between 2 and 6 mm. The distance between the surfaces 32 and 40 of the electrodes 30 and 4 is of the order of 0.2 to 1 mm. The distance between the point A of the pinch region situated in the space between the electrodes 2 and 3 and the disc 32 of the electrode 30 lies between 5 and 10 mm.
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CLAIMS

1. Use of an electron gun for cathode ray tubes comprising in succession an electron source electrode or cathode (1), a control electrode or Wehnelt cylinder (2),
5 an electrode of first acceleration or anode (3) placed at an adjustable voltage and at least one focusing electrode or electrode of second acceleration (4), a supplementary electrode (30) inserted between the electrode of first acceleration or anode (3) and the focusing electrode or
10 electrode of second acceleration (4), characterised in that the said supplementary electrode (30) is placed at a fixed polarisation voltage (V30), this supplementary electrode constituting with the electrode (3) of first acceleration a first low-power prefocusing lens and
15 constituting with the focusing electrode (4) a high-power prefocusing lens.

2. Use of an electron gun for cathode ray tubes according to Claim 1, characterised in that the polarisation voltage (V30) at which the supplementary electrode is
20 placed is some ten times lower than the polarisation voltage of the focusing electrode (4) and is substantially equal, to within 30%, to the polarisation voltage at which the electrode of first acceleration (3) is placed.

25 3. Use of an electron gun for cathode ray tubes according to Claim 1 or 2, in which the control electrode (2) and the electrode of first acceleration (3) are constituted by cylindrical members comprising a surface opposite to each other having a circular orifice with a
30 predetermined diameter whose centres are positioned on the same axis XX', characterised in that the supplementary electrode (30) and the electrode of second acceleration (4) are constituted by cylindrical members each comprising a plane surface (32, 40) opposite to each
35 other having an orifice (33, 41) with a small diameter constituting the high-power lens, the supplementary



electrode (30) and the electrode of first acceleration (3) comprising an opening (21, 31) opposite to each other and constituting the low-power lens, the openings and orifices having centres positioned on the axis XX'; the
5 polarisation voltage V3 of the electrode of first acceleration (3) being equal to the polarisation voltage (V30) of the supplementary electrode, plus or minus 30% of this value, and the ratio (V4/V30) between the polarisation
10 voltage V4 of the electrode of second acceleration (4) and the supplementary electrode being greater than 10.

4. Use of an electron gun according to Claim 2 or 3, in which a pinch region in the beam is produced between the plane surfaces of the control electrode (2) and the
15 electrode of first acceleration (3), characterised in that the distance between the central point (A) of this pinch region and the high-power lens constituted by the supplementary electrode (30) and the electrode of second
acceleration (4) is of the order of 5 to 10 mm.

5. Use of an electron gun according to Claim 3,
20 characterised in that the diameter of the openings (21, 31) opposite to the electrode of first acceleration (3) and to the supplementary electrode (30) is of the order of the diameter of these electrodes.

