

Description

The present invention relates to color display systems including cathode-ray tubes having three beam electron guns, and particularly to such guns having means therein to compensate for astigmatism of a self-converging deflection yoke used with the tube in the system.

Such a system and gun as described in the first parts of the claims 1 and 4 is known from document GB-A 1 567 807, which will be discussed later.

Although present-day deflection yokes produce a self-convergence of the three beams in a cathode-ray tube, the price paid for such self-convergence is a deterioration of the individual electron beam spot shapes. The yoke magnetic field is astigmatic, and it both overfocuses the vertical-plane electron beam rays, leading to deflected spots with appreciable vertical flare, and underfocuses the horizontal rays, leading to slightly enlarged spot width (deflection defocusing). To compensate, it has been the practice to introduce an astigmatism into the beam-forming region of the electron gun to produce a defocusing of the vertical rays and an enhanced focusing of the horizontal rays. Such astigmatic beam-forming regions have been constructed by means of G1 control grids or G2 screen grids having slot-shaped apertures. These slot-shaped apertures produce non-axially-symmetric fields with quadrupolar components which act differently upon rays in the vertical and horizontal planes. Such slot-shaped apertures are shown in US-A 4 234 814. These constructions are static; the quadrupole field produces compensatory astigmatism even when the beams are undeflected and experiencing no yoke astigmatism.

To provide improved dynamic correction, US-A 4 319 163, introduces an extra upstream screen grid, G2a, with horizontally slotted apertures, and with a variable or modulated voltage applied to it. The downstream screen grid, G2b, has round apertures and is at a fixed voltage. The variable voltage on G2a varies the strength of the quadrupole field, so that the astigmatism produced is proportional to the scanned off-axis position.

Although effective, use of astigmatic beam-forming regions has several disadvantages. First, beam-forming regions have a high sensitivity to construction tolerances because of the small dimensions involved. Second, the effective length or thickness of the G2 grid must be changed from the optimum value it has in the absence of slotted apertures. Third, beam current may vary when a variable voltage is applied to a beam-forming region grid. Fourth, the effectiveness of the quadrupole field varies with the position of the beam cross-over and, thus, with the beam current. Therefore, it is desirable to develop astigmatism correction in an electron gun which is not subject to these disadvantages.

GB-A 1 567 807 describes a color display system including a cathode-ray tube having an electron gun for generating and directing three electron beams along paths towards a screen of the tube, the gun including electrodes comprising a beam-forming region and electrodes for forming a main focusing lens, and the system including a self-converging yoke that produces an astigmatic magnetic deflection field. A multipole lens being substantially a quadrupole lens is formed between the beam-forming region and the main focusing lens in each of the electron beam path. Each multipole lens is oriented to provide a correction to an associated electron beam to at least partially compensate for the effect of the astigmatic magnetic deflection field on the associated beam. An individual pair of focusing lens electrodes is associated to each beam. One of these electrodes has a fixed focus voltage applied. Two of the multipole lens electrodes which have the form of elongated flat plates, extend normal to the beam paths across cut-outs in the upstream focusing electrodes and have a dynamic voltage signal applied which is related to the deflection of the electron beams.

There is no teaching in the above document how to fabricate the structure comprising the plate-shaped multipole lens electrodes disposed above and below the cut-outs of the upstream focusing electrodes.

The present color display system includes an inline cathode-ray tube having an electron gun for generating and directing three inline electron beams along path towards a screen of the tube. The gun includes electrodes comprising a beam-forming region and electrodes for forming a main focusing lens, and the system includes a self-converging yoke that produces an astigmatic magnetic deflection field. The electrodes in the electron gun form a multipole lens between the beam-forming region and the main focusing lens in each of the electron beam path, wherein each multipole lens has substantially a quadrupole lens action and is oriented to provide a correction to an associated electron beam to at least partially compensate for the effect of the astigmatic magnetic deflection field on the associated beam. The electrodes for forming the multipole lens include a first multipole lens electrode and a second multipole lens electrode. The second multipole lens electrode is a portion of one of the electrodes for forming the main focusing lens. Means are provided for applying a fixed focus voltage to the second multipole lens electrode, and means for applying a dynamic voltage signal which is related to the deflection of the electron beams, to said first multipole lens electrode. Each multipole lens is located sufficiently close to the main focusing lens to cause the strength of the main focusing lens to vary as a function of voltage variation of the dynamic voltage signal.

In accordance with the present invention, each of said focusing lens and multipole lens electrodes is a single unitized structure having three inline apertures to permit passage of the three electron beams, and the first multipole lens electrode is located between the second multipole lens electrode and the beam forming region, adjacent to the second multipole lens electrode.

Thus, the quadrupole lens is located between the beamforming region and the main focusing lens, but closer to the main focusing lens. The advantages of this location are:

- 1) a low sensitivity to construction tolerances,
- 2) the effective G2 length need not be changed from the optimum value,
- 3) the closeness of the quadrupole to the main focusing lens produces beam bundles which are closely circular in the main lens and less likely to be intercepted by the main focusing lens,
- 4) the beam current is not modulated by the variable quadrupole voltage,
- 5) the effective quadrupole lens strength is greater the closer the quadrupole lens is to the main lens, and
- 6) the quadrupole lens, being separate from the main focusing lens, does not adversely affect the main lens. The advantages of the new construction are:
 - 1) the quadrupole's transverse fields are produced directly and are stronger than the transverse fields which arise indirectly, as only an accompaniment to the differential penetration of G2b voltages into the slot of the G2a, in the prior tube of above-cited US-A 4 319 163;
 - 2) the absence of spherical aberration caused by the higher multipoles produced additionally by the slotted-aperture type of grid lens, and
 - 3) self-containment, making the construction independent of adjacent electrodes.

In the drawings:

FIGURE 1 is a plan view, partly in axial section, of a color display system embodying the invention.

FIGURE 2 is a partially cutaway axial section side view of the electron gun shown in dashed lines in FIGURE 1.

FIGURE 3 is an axial section view of the electron gun taken at line 3-3 of FIGURE 2.

FIGURE 4 is a plan view of the electron gun taken at line 4-4 of FIGURE 3.

FIGURE 5 is a plan view of the electron gun taken at line 5-5 of FIGURE 3.

FIGURES 6 and 7 are front and side views, respectively, of a set of quadrupole lens sector portions of the electron gun of FIGURE 2.

FIGURE 8 is an upper right quadrant view of the quadrupole lens sector portions of FIGURES 6 and 7, showing electrostatic potential lines.

FIGURE 9 is a three-dimensional perspective graph of three separate focus curves positioned relative to a cross plot of focus voltage versus bias voltage.

FIGURE 10 is a cross plot of focus voltage versus bias voltage, showing points of zero astigmatism at the center and the corner of a screen.

FIGURE 11 is a cross plot, similar to the cross plot of FIGURE 10, showing data collected from operating an actual electron gun.

FIGURE 1 shows a color display system 9 including a rectangular color picture tube 10 having a glass envelope 11 comprising a rectangular faceplate panel 12 and a tubular neck 14 connected by a rectangular funnel 15. The funnel 15 has an internal conductive coating (not shown) that extends from an anode button 16 to the neck 14. The panel 12 comprises a viewing faceplate 18 and a peripheral flange or sidewall 20 which is sealed to the funnel 15 by a glass frit 17. A three-color phosphor screen 22 is carried by the inner surface of the faceplate 18. The screen 22 preferably is a line screen with the phosphor lines arranged in triads, each triad including a phosphor line of each of the three colors. Alternatively, the screen can be a dot screen. A multi-apertured color selection electrode or shadow mask 24 is removably mounted, by conventional means, in predetermined spaced relation to the screen 22. An improved electron gun 26, shown schematically by dashed lines in FIGURE 1, is centrally mounted within the neck 14 to generate and direct three electron beams 28 along convergent paths through the mask 24 to the screen 22.

The tube of FIGURE 1 is designed to be used with an external magnetic deflection yoke, such as the yoke 30 shown in the neighborhood of the funnel-to-neck junction. When activated, the yoke 30 subjects the three beams 28 to magnetic fields which cause the beams to scan horizontally and vertically in a rectangular raster over the screen 22. The initial plane of deflection (at zero deflection) is at about the middle of the yoke 30. Because of fringe fields, the zone of deflection of the tube extends axially from the yoke 30 into the region of the gun 26. For simplicity, the actual curvatures of the deflected beam paths in the deflection zone are not shown in FIGURE 1. In the preferred embodiment, the yoke 30 produces a self-convergence of the centroids of the three electron beams at the tube mask. Such a yoke produces an astigmatic magnetic field which overfocuses the vertical-plane rays of the beams and underfocuses the horizontal-plane rays of the beams. Compensation for this astigmatism is provided in the improved electron gun 26.

FIGURE 1 also shows a portion of the electronics used for exciting the tube 10 and yoke 30. These electronics are described below following a description of the electron gun 26.

The details of the electron gun 26 are shown in FIGURES 2 and 3. The gun 26 comprises three spaced inline cathodes 34 (one for each beam, only one being shown), a control grid electrode 36 (G1), a screen

grid electrode 38 (G2), an accelerating electrode 40 (G3), a first quadrupole electrode 42 (G4), a combined second quadrupole electrode and first main focusing lens electrode 44 (G5), and a second main focusing lens electrode 46 (G6), spaced in the order named. Each of the G1 through G6 electrodes has three inline apertures located therein to permit passage of three electron beams. The electrostatic main focusing lens in the gun 26 is formed by the facing portions of the G5 electrode 44 and the G6 electrode 46. The G3 electrode 40 is formed with three cup-shaped elements 48, 50 and 52. The open ends of two of these elements, 48 and 50, are attached to each other, and the apertured closed end of the third element 52 is attached to the apertured closed end of the second element 50. Although the G3 electrode 40 is shown as a three-piece structure, it could be fabricated from any number of elements to attain the same or any other desired length.

The first quadrupole electrode 42 comprises a plate 54 having three inline apertures 56 therein and casted extrusions extending therefrom in alignment with the apertures 56. Each extrusion includes two sector portions 62. As shown in FIGURE 4, the two sector portions 62 are located opposite each other, and each sector portion 62 encompasses approximately 85 degrees of the circumference of a cylinder.

The G5 electrode 44 and the G6 electrode 46 are similar in construction in that they have facing ends that include peripheral rims 86 and 88, respectively, and apertured portions set back in large recesses 78 and 80, respectively, from the rims. The rims 86 and 88 are the closest portions of the two electrodes 44 and 46 to each other and have the predominant effect on forming the main focusing lens.

The G5 electrode 44 includes three inline apertures 82, each aperture having extrusions that extend toward the G4 electrode 42. The extrusions of each aperture 82 are formed in two sector portions 72. As shown in FIGURE 5, the two sector portions 72 are located opposite each other, and each sector portion 72 encompasses approximately 85 degrees of the cylinder circumference. The positions of the sector portions 72 are rotated 90° from the positions of the sector portions 62 of the G4 electrode 42 and the four sector portions are assembled in non-touching, interdigitated fashion. Although the sector portions 62 and 72 are shown with square corners, their corners may be rounded.

All of the electrodes of the gun 26 are either directly or indirectly connected to two insulative support rods 90. The rods 90 may extend to and support the G1 electrode 36 and the G2 electrode 38, or these two electrodes may be attached to the G3 electrode 40 by some other insulative means. In a preferred embodiment, the support rods are of glass, which has been heated and pressed onto claws extending from the electrodes, to embed the claws in the rods.

FIGURES 6 and 7 show the sector portions 62 and 72 of equal dimensions, being curved on the same radius "a" and having an overlap length "t". A voltage $V_4 = V_{o4} + V_{m4}$ is applied to the sector portions 62, and a voltage $V_5 = V_{o5}$ is applied to the sector portions 72. Subscript "o" indicates a D.C. voltage, and subscript "m" indicates a modulated voltage. This structure produces a quadrupolar potential, at positions x, y,

$$\phi = (V_4 + V_5)/2 + (V_4 - V_5)(x^2 - y^2)/2a^2 + \dots,$$

and a transverse field,

$$E_x = -(\Delta V/a^2)x = (-x/y)E_y,$$

where

$$\Delta V = V_4 - V_5.$$

This field deflects an incoming ray through an angle,

$$\theta = LE_x/2V_o,$$

where the effective length of the interaction region is

$$L = 0.4a + t,$$

and where the mean potential is

$$V_o = (V_4 + V_5)/2.$$

Thus, the paraxial focal length of this quadrupole lens is

$$f_x = x/\theta = [2a^2/(0.4a + t)](V_o/\Delta V) = -f_y.$$

An additional degree of control is obtainable by using a different lens radius, a , and/or length, l , for the quadrupoles around the two outer beams, as compared to the radius and/or length for the quadrupole around the center beam.

The electrostatic potential lines established by the equal sector portions 62 and 72 are shown in FIGURE 8 for one quadrant. Nominal voltages of 1.0 and -1.0 are shown applied to the sector portions 72 and 62, respectively. The electrostatic field forms a quadrupole lens which has a net effect on an electron beam of compressing it in one direction and expanding it in an orthogonal direction.

The electron gun 26 includes a dynamic quadrupole lens which is located differently and constructed differently than quadrupole lenses used in prior electron guns. The new quadrupole lens includes curved plates having surfaces that lie parallel to the electron beam paths and form electrostatic field lines that are normal to the beam paths.

Referring back to FIGURE 1, there is shown a portion of the electronics 100 that may operate the system as a television receiver or as a computer monitor. The electronics 100 is responsive to broadcast signals received via an antenna 102, and to direct red, green and blue (RGB) video signals via input terminals 104. The broadcast signal is applied to tuner and intermediate frequency (IF) circuitry 106, the output of which is applied to a video detector 108. The output of the video detector 108 is a composite video signal that is applied to a synchronizing signal (sync) separator 110 and to a chrominance and luminance signal processor 112. The sync separator 110 generates horizontal and vertical synchronizing pulses that are, respectively, applied to horizontal and vertical deflection circuits 114 and 116. The horizontal deflection circuit 114 produces a horizontal deflection current in a horizontal deflection winding of the yoke 30, while the vertical deflection circuit 116 produces a vertical deflection current in a vertical deflection winding of the yoke 30.

In addition to receiving the composite video signal from the video detector 108, the chrominance and luminance signal processing circuit 112 alternatively may receive individual red, green and blue video signals from a computer, via the terminals 104. Synchronizing pulses may be supplied to the sync separator 110 via a separate conductor or, as shown in FIGURE 1, by a conductor from the green video signal input. The output of the chrominance and luminance processing circuitry 112 comprises the red, green and blue color drive signals, that are applied to the electron gun 26 of the cathode ray tube 10 via conductors RD, GD and BD, respectively.

Power for the system is provided by a voltage supply 118, which is connected to an AC voltage source. The voltage supply 118 produces a regulated DC voltage level $+V_1$ that may, illustratively, be used to power the horizontal deflection circuit 114. The voltage supply 118 also produces DC voltage $+V_2$ that may be used to power the various circuits of the electronics, such as the vertical deflection circuit 116. The voltage supply further produces a high voltage V_u that is applied to the upper terminal or anode button 16.

Circuits and components for the tuner 106, video detector 108, sync separator 110, processor 112, horizontal deflection circuit 114, vertical deflection circuit 116 and voltage supply 118 are well known in the art and therefore not specifically described herein.

In addition to the elements noted above, the electronics 100 includes a dynamic waveform generator 120. The waveform generator 120 provides the dynamically varied voltage V_m to the sector portions 62 of the electron gun 26.

The generator 120 receives the horizontal and vertical scan signals from the horizontal deflection circuit 114 and the vertical deflection circuit 116, respectively. The circuitry for the waveform generator 120 may be that known from, for example: US-A 4 214 188; US-A 4 258 298; and US-A 4 316 128.

The required dynamic voltage signal is at a maximum when the electron beam is deflected to screen corner and is zero when the beam is at screen center. As the beam is scanned along each raster line, the dynamic voltage signal is varied from high to low to high in a form that may be parabolic. This parabolic signal at line rate may be modulated by another parabolic signal that is at frame rate. The particular signal utilized depends upon the design of the yoke that is used.

Principles Of Operation

If, at a given position on the screen, the spot height (Y) and width (X) are measured as a function of the focus voltage, V_5 , with the bias ΔV ($\Delta V = V_4 - V_5$) between V_5 and the quadrupole voltage, V_4 , held constant, then the Y -versus- V_5 and X -versus- V_5 focus curves each exhibit a minimum, as is shown in FIGURE 9. The difference between the V_5 value for the X -minimum and that for the Y -minimum is the astigmatism voltage at that bias value. Alternatively, the astigmatism can be measured from "cross plots", such as that shown in FIGURE 9. Such plots are obtained when the focus voltage V_5 is set to some value, and the bias ΔV is changed by changing the quadrupole voltage, V_4 . The two values of V_4 are noted at which the spot height and the width are each a minimum. The procedure is repeated for a range of V_5 values.

When cross plots are measured for spots at both the screen center and corner, the result is generally as shown in FIGURE 10, where the approximation is made that both of the X -lines (dashed) have slopes of the same magnitude as do both of the Y -lines (solid). Zero astigmatism, though not necessarily a round

spot, is obtained at points P and P' where the X-lines and Y-lines cross. At zero bias, the screen center spot height generally focuses at a lower G5 voltage than does the spot width; the difference in V_5 values is the gun astigmatism, A, associated with the unmodified gun. At zero bias, the screen corner spot height focuses at a much higher V_5 value, because the main-lens focusing must be weakened to compensate for the focusing of the vertical rays induced by the horizontal-deflection pincushion field of the self-convergent yoke. Compensation is made for the small horizontal defocusing induced by the pincushion field by a small reduction in G5 voltage, usually 50-to-100 volts. The following ignores this small reduction and takes the two dashed X-lines for the center and corner as being coincident. The difference, A', in focus voltage for the horizontal and vertical dimensions of the corner spots is the yoke astigmatism and is read from the cross plot at ΔV_{ctr} where the bias compensates for the gun astigmatism.

With the bias voltage defined as $\Delta V = V_4 - V_5$ and the changes in the G4 and G5 voltages between their corner and center-screen values defined as $\delta(V_4) = V_{4cnr} - V_{4ctr}$ and $\delta(V_5) = V_{5cnr} - V_{5ctr}$, then the slope, S_X , of the X-line, such as in FIGURE 10, is expressible as:

$$S_X = \frac{V_{5cnr} - V_{5ctr}}{\Delta V_{cnr} - \Delta V_{ctr}} = \frac{\delta(V_5)}{\delta(V_4) - \delta(V_5)}$$

whence

$$\frac{\delta(V_5)}{\delta(V_4)} = \frac{S_X}{1 + S_X} \quad (1)$$

Furthermore, with the slope of the Y-line denoted by S_Y , FIGURE 10 also leads to the following expression for the yoke astigmatism:

$$A' = (S_X - S_Y)[\delta(V_4) - \delta(V_5)].$$

Thus, by Equation (1),

$$\delta(V_4) = \left(\frac{1 + S_X}{S_X - S_Y} \right) A'$$

(2)

$$\delta(V_5) = \left(\frac{S_X}{S_X - S_Y} \right) A'$$

The interdigitated quadrupole can be designed to operate with a positive slope for the X-lines (and, therefore, a negative slope for the Y-lines). For positive S_X the north-south (i.e., vertical direction) digits are on the G4, and the east-west (i.e., horizontal direction) digits are on the G5. Then, raising $\Delta V = V_4 - V_5$ makes the north-south digits more positive than the east-west and so overfocuses the rays in the horizontal plane. Restoring horizontal focus then calls for a weakening of the main lens and, therefore, a raising of the G5 voltage.

In addition to being able to control the signs of the slopes S_X and S_Y through the orientation of the quadrupole digits, one can control the magnitudes of the slopes through the choice of constructional dimensions. If, for the moment, any electrostatic coupling between the G4 electrode and the main-lens is neglected, then the magnitudes of S_X and S_Y in a cross plot are equal and given by the equation:

$$|S_X(0)| = |S_Y(0)| \approx (f-g) \left(\frac{4}{8} + \frac{\ln \sigma}{\ln \sigma} \right) \left[\frac{0.6}{a} \left(0.36 + \frac{t}{a} \right) \right], \quad (3)$$

where $t/a > 0.30$. For $t/a < 0.30$, the last factor in Equation (3) is replaced by

$$\left[\frac{1.4}{a} \left(-\frac{t}{a} \right) \right] \quad (3)$$

because of changes in fringe field. Here $\sigma = V_6/V_5$ is the ratio of ulitor-to-focus voltage, f is the main-lens focal length, g is the separation between the centers of the quadrupole lens and main lens, t is the overlap of the quadrupole digits, and a is the quadrupole aperture radius.

In practice, however, there is always some electrostatic coupling between the two lenses. Thus, for example, raising the voltage of a north-south G4 raises the effective G5 voltage at the main lens. This will weaken the main-lens focusing and so augment the quadrupole's vertical defocusing, while counteracting the quadrupole's horizontal focusing. The result is a cross plot in which the Y-lines are steeper by a certain amount than in the absence of coupling, and in which the X-lines are less steep by the same amount. This can be expressed in terms of an empirical coupling factor, α , defined by

$$V_5 \text{ (effective)} = V_5 + \alpha(V_4 - V_5) \quad (4)$$

$$= V_5 + \alpha \Delta V,$$

where $0 \leq \alpha < 1$. The slopes in Equation (2) are thus rewritten as:

$$S_X = S_X(0) - \alpha$$

$$S_Y = S_Y(0) - \alpha$$

(5)

$$S_Y(0) = -S_X(0),$$

where $S_X(0)$ is the X-line slope in the absence of coupling, and is given by Equation (3). Equations (2), (3) and (5) are used in the following design of an electron gun for single-waveform operation.

A static focus voltage, $\delta(V_5) = 0$, is obtained, as shown by Equation 2, if $S_X = S_X(0) - \alpha = 0$. The accompanying swing in quadrupole voltage is $\delta(V_4) = A'/2\alpha$ and is smaller the larger the coupling factor. A large coupling factor is obtained with small lens separation; the X-line slope is positive when the north-south digits are on the G4 electrode; and the slope magnitude, $S_X(0)$, is adjusted to equal α by choice of dimensions.

An interdigitated quadrupole was incorporated into a 26V110° tube having an electron gun as shown in FIGURE 2. The separation, g , between midplanes of the quadrupole lens and the main lens was 4.09mm (0.161"). The lengths of the G4 and G5 sector portions 62 and 72, respectively, were such that the overlap length, t , was 0.178mm (0.007").

The measured cross plots at the screen center and corner are shown in FIGURE 11. The table shows that the G5 voltage at the center and corner zero-astigmatism operating points is constant to better than 1.5% of its value. The accompanying swing in G4 voltage is $\delta(V_4) = 1880V$.

The coupling factor and the X-line slope for zero coupling can be estimated from the measured slopes of the X and Y lines at screen center, shown in FIGURE 11. Thus, inserting $S_X = 0.18$ and $S_Y = -0.97$ into Equation (5) results in $\alpha = 0.40$ and $S_X(0) = 0.58$. The value of α also may be inferred as follows: the measured swing in G4 voltage, $\delta(V_4) = 1880V$, should be equal to $A'/2\alpha$. Thus, if the measured value of $A' = 8230-6580 = 1650$ (at the bias $\Delta V = -600$ which removes the main-lens astigmatism) is read from FIGURE 11, then $\alpha = 1650/2 \times 1880 = 0.44$. This agrees with the previous estimate.

The value of the X-line slope for zero coupling inferred from FIGURE 11, $S_X(0)$ is 0.58. The value of $S_X(0)$ also may be inferred as follows: insertion of the values

$f = 19.05\text{mm}$ (0.750"), $g = 4.09\text{mm}$ (0.161"),

$\sigma = 25,000/6600 = 3.79$, $a = 2.03\text{mm}$ (0.080"), and

$t = 0.178\text{mm}$ (0.007") into Equation (3) yields a calculated value of $S_X(0) = 0.52$.



Claims

1. A color display system including an inline cathode-ray tube having an electron gun for generating and directing three inline electron beams along paths toward a screen of said tube, said gun including electrodes comprising a beam forming region and electrodes for forming a main focusing lens, and said system including a self-converging yoke that produces an astigmatic magnetic deflection field; said electrodes (4, 44) in said electron gun (26) forming a multipole lens between the beam-forming region and the main focusing lens in each of the electron beam paths, wherein each multipole lens has substantially a quadrupole lens action and is oriented to provide a correction to an associated electron beam (28) to at least partially compensate for the effect of the astigmatic magnetic deflection field on the associated beam, and wherein said electrodes for forming a multipole lens include a first multipole lens electrode (42) and a second multipole lens electrode (44), said second multipole lens electrode (44) being a portion of one of said electrodes (44, 46) for forming a main focusing lens, means for applying a fixed focus voltage (V_{fs}) to said second multipole lens electrode, means (120) for applying a dynamic voltage signal (V_{md}) to said first multipole lens electrode, said dynamic voltage signal being related to deflection of the electron beams and each multipole lens being located sufficiently close to the main focusing lens to cause the strength of the main focusing lens to vary as a function of voltage variation of said dynamic voltage signal, characterized in that each of said focusing lens and multipole lens electrodes (42, 44, 46) is a single unitized structure having three inline apertures to permit passage of the three electron beams (28), and said first multipole lens electrode (42) is located between the second multipole lens electrode (44) and the beam forming region, adjacent to the second multipole lens electrode (44).

2. The system as defined in claim 1, characterized in that the strength of said main focusing lens is decreased with an increase in voltage of said dynamic voltage signal (V_{md}).

3. The system as defined in claim 1, characterized in that said multipole lens is formed by facing interdigitated portions (62, 72) of said first and second multipole lens electrodes (42, 44).

4. An inline cathode-ray tube having an electron gun for generating and directing three inline electron beams along paths toward a screen of said tube, said gun including electrodes comprising a beam-forming region, electrodes for forming a main focusing lens, and electrodes (42, 44) for forming a multipole lens having substantially a quadrupole lens action between the beam-forming region and the main focusing lens in each of the electron beam paths, wherein said electrodes for forming a multipole lens include a first multipole lens electrode (42) and a second multipole lens electrode (44), said second multipole lens electrode (44) being a portion of one of said electrodes (44, 46) for forming said main focusing lens, each multipole lens being located sufficiently close to the main focusing lens to cause the strength of the main focusing lens to vary in relation to the strength of said multipole lens, characterized in that each of said focusing lens and multipole lens electrodes (42, 44, 46) is a single unitized structure having three inline apertures to permit passage of the three electron beams (28), and said first multipole lens electrode (42) is located between the second multipole lens electrode (44) and the beam-forming region, adjacent to the second multipole lens electrode (44).

5. The cathode-ray tube as defined in claim 4, characterized in that said multipole lens is formed by facing interdigitated portions (62, 72) of said first and second multipole lens electrodes (42, 44).

Patentansprüche

1. Farbdisplayeinrichtung mit einer Inline-Kathodenstrahlröhre, die ein Elektronenstrahlerzeugungssystem zum Erzeugen und Richten von drei Inline-Elektronenstrahlen längs Strahlwegen auf einen Schirm der Röhre enthält, welches Elektroden, die einen Strahlformungsbereich umfassen und Elektroden zur Bildung einer Hauptfokussierlinse enthält, ferner mit einem selbstkonvergierenden Ablenkjoch, welches ein astigmatisches magnetisches Ablenkkfeld erzeugt, wobei die Elektroden (4, 44) im Strahlerzeugungssystem (26) in jedem der Strahlwege zwischen dem Strahlformungsbereich und der Hauptfokussierungslinse eine Multipollinse bilden, die in wesentlichen eine Quadrupollinsenwirkung aufweist und so orientiert ist, daß sie für einen zugeordneten Elektronenstrahl (28) eine Korrektur ergibt, die den Einfluß des astigmatischen magnetischen Ablenkkfeldes auf den zugehörigen Strahl zumindest teilweise kompensiert, und wobei die Elektroden zur Bildung der Multipollinse eine erste Multipollinsenelektrode (42) und eine zweite Multipollinsenelektrode (44) enthalten, von denen die zweite Multipollinsenelektrode (44) ein Teil einer der Elektroden (44, 46) zum Bilden der Hauptfokussierungslinse ist, mit einer Anordnung zum Anlegen einer festen Fokussierspannung (V_{fs}) an die zweite Multipollinsenelektrode, mit einer Anordnung (120) zum Anlegen eines dynamischen Spannungssignales (V_{md}) an die erste Multipollinsenelektrode, welches in Beziehung zur Ablenkung der Elektronenstrahlen steht, wobei jede Multipollinse genügend nahe bei der Hauptfokussierungslinse angeordnet ist, um eine Änderung der Stärke der Hauptfokussierungslinse als Funktion einer Spannungsänderung des dynamischen Spannungssignales zu bewirken, dadurch gekennzeichnet, daß die Fokussierungslinsen- und Multipollinsenelektroden (42, 44, 46) jeweils eine einzige, einheitliche Struktur mit drei Inline-Öffnungen, die das Hindurchtreten der drei Elektronenstrahlen (28) gestatten, sind und daß die erste Multipollinsenelektrode (42) zwischen



der zweiten Multipollinsenelektrode (44) und dem Strahlformungsbereich bei der zweiten Multipollinsenelektrode (44) liegt.

2. Einrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Stärke der Hauptfokussierungslinse mit zunehmender Spannung des dynamischen Spannungssignales (V_{m4}) abnimmt.

3. Einrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Multipollinse durch einander gegenüberstehende, ineinandergreifende Teile (62, 72) der ersten und der zweiten Multipollinsenelektrode (42, 44) gebildet ist.

4. Inline-Kathodenstrahlröhre mit einem Strahlerzeugungssystem zum Erzeugen und Richten von drei Inline-Elektronenstrahlen längs Strahlwegen auf einen Schirm der Röhre, welches Elektroden, die einen Strahlformungsbereich umfassen, Elektroden zum Bilden einer Hauptfokussierungslinse, und Elektroden (42, 44) zum Bilden einer Multipollinse, welche im wesentlichen eine Quadrupollinsenwirkung hat, zwischen dem Strahlformungsbereich und der Hauptfokussierungslinse in jedem der Elektronenstrahlwege enthält, wobei die Elektroden zur Bildung der Multipollinse eine erste Multipollinsenelektrode (42) und eine zweite Multipollinsenelektrode (44) umfassen und die zweite Multipollinsenelektrode (44) ein Teil einer der Elektroden (44, 46) zur Bildung der Hauptfokussierungslinse ist, wobei jede Multipollinse genügend nahe an der Hauptfokussierungslinse angeordnet ist, um eine Änderung der Stärke der Hauptfokussierungslinse in Abhängigkeit von der Stärke der Multipollinse zu verursachen, dadurch gekennzeichnet, daß die Fokussierungslinsen- und Multipollinsen-Elektroden (42, 44, 46) jeweils eine einzige, einheitliche Struktur mit drei Inline-Öffnungen, die das Hindurchtreten der drei Elektronenstrahlen (28) gestatten, sind und daß die erste Multipollinsenelektrode (42) zwischen der zweiten Multipollinsenelektrode (44) und dem Strahlformungsbereich bei der zweiten Multipollinsenelektrode (44) angeordnet ist.

5. Kathodenstrahlröhre nach Anspruch 4, dadurch gekennzeichnet, daß Multipollinse durch einander gegenüberliegende, ineinandergreifende Teile (62, 72) der ersten und der zweiten Multipollinsenelektrode (42, 44) gebildet ist.

Revendications

1. Un système de visualisation en couleurs comprenant un tube à rayons cathodiques en ligne ayant un canon à électrons pour produire et diriger trois faisceaux d'électrons en ligne le long de trajets vers un écran dudit tube; ledit canon comprenant une région de formation de faisceaux et des électrodes pour former une lentille de focalisation principale, et ledit système comprenant un bloc autoconvergent qui produit un champ de déviation magnétique astigmatique; lesdites électrodes (4, 44) dans le canon à électrons (26) formant une lentille multipôles entre la région de formation de faisceaux et la lentille de focalisation principale dans chacun des trajets de faisceaux d'électrons, où chaque lentille multipôles a sensiblement une action de lentille quadripolaire et est orientée pour produire une correction à un faisceau d'électrons associé (28) pour au moins partiellement compenser l'effet du champ de déviation magnétique astigmatique au faisceau associé, et où lesdites électrodes formant une lentille multipôles comprennent une première électrode de lentille multipôles (42) et une seconde électrode de lentille multipôles (44), la seconde électrode de lentille multipôles (44) étant une portion de l'une desdites électrodes (44, 46) formant une lentille de focalisation principale, un moyen pour appliquer une tension de focalisation fixe (V_{0s}) à la seconde électrode de lentille multipôles, un moyen (120) pour appliquer un signal de tension dynamique (V_{m4}) à la première électrode de lentille multipôles, ledit signal de tension dynamique étant en rapport avec la déviation des faisceaux d'électrons et chaque lentille multipôles étant située suffisamment proche de la lentille de focalisation principale pour amener la force de la lentille de focalisation principale à varier comme une fonction de variation de tension dudit signal de tension dynamique, caractérisé en ce que chacune des électrodes de lentille de focalisation et de lentille multipôles (42, 44, 46) est une structure unitaire unique ayant trois ouvertures en ligne pour permettre le passage des trois faisceaux d'électrons (28), et la première électrode de lentille multipôles (42) est située entre la seconde électrode de lentille multipôles (44) et la région de formation de faisceaux, adjacente à la seconde électrode de lentille multipôles (44).

2. Le système selon la revendication 1, caractérisé en ce que la force de la lentille de focalisation principale précitée est diminuée par une augmentation en tension du signal de tension dynamique précité (V_{m4}).

3. Le système selon la revendication 1, caractérisé en ce que la lentille multipôles précitée est formée par des portions imbriquées se faisant face (62, 72) des première et seconde électrodes de lentille multipôles précitées (42, 44).

4. Un tube à rayons cathodiques en ligne ayant un canon à électrons pour produire et diriger trois faisceaux d'électrons en ligne le long de trajets vers un écran dudit tube, ledit canon comprenant des électrodes comprenant une région de formation de faisceaux, des électrodes pour former une lentille de focalisation principale, et des électrodes (42, 44) pour former une lentille multipôles ayant sensiblement une action de lentille quadripolaire entre la région de formation de faisceaux et la lentille de focalisation principale dans chacun des trajets de faisceaux d'électrons, où lesdites électrodes formant une lentille



5 multipôles comprennent une première électrode de lentille multipôles (42) et une seconde électrode de lentille multipôles (44), la seconde électrode de lentille multipôles (44) étant une portion de l'une desdites électrodes (44, 46) formant la lentille de focalisation principale, chaque lentille multipôles étant située suffisamment proche de la lentille de focalisation principale pour amener la force de la lentille de focalisation principale à varier en relation avec la force de la lentille multipôles, caractérisé en ce que

10 chacune des électrodes de lentille de focalisation et de lentille multipôles (42, 44, 46) est une structure unitaire unique ayant trois ouvertures en ligne pour permettre le passage des trois faisceaux d'électrons (28), et la première électrode de lentille multipôles (42) est située entre la seconde électrode de lentille multipôles (44) et la région de formation de faisceaux, adjacente à la seconde électrode de lentille multipôles (44).

5. Le tube à rayons cathodiques selon la revendication 4, caractérisé en ce que la lentille multipôles précitée est formée par des portions imbriquées se faisant face, (62, 72) des première et seconde électrodes de lentille multipôles (42, 44).

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