

Description

The present invention relates to cathode ray tubes and color display systems including cathode-ray tubes. It is particularly applicable to cathode ray tubes having inline electron guns.

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. 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 a 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 U.S. Patent 4 234 814, issued to Chen et al. on November 18, 1980. These constructions are static; the quadrupole field produces the same compensatory astigmatism even when the beams are undeflected and experiencing no yoke astigmatism.

To provide improved correction, U.S. Patent 4 319 163, issued to Chen on March 9, 1982, introduced an extra upstream screen grid, G2a, with horizontally slotted apertures, and with a variable or modulated potential applied to it. The downstream screen grid, G2b, has round apertures and is at a fixed potential. 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 with a variable potential applied to a beam-forming region grid. Fourth, the effectiveness of the quadrupole field varies with the position of the beam cross-over and, therefore, with beam current.

European Patent Application EP-A 0 163 443 concerns a colour display system including a cathode-ray tube having a 3-beam, in-line electron gun and a self-convergent deflection yoke, and addresses the problem of vertical overfocusing. The solution disclosed is to insert three or five metal wafer electrodes between the two halves of the main focusing electrode. In the case of five electrodes, these are divided into two groups, each of which constitutes a lens element which 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. The combination of five electrodes forms a multipole lens and this combination includes a first electrode and a second electrode, the second electrode being connected to one of the electrodes for forming the main focusing lens and the first electrode being located between the second electrode and the beam forming region, and facing the second electrode.

British Patent Specification GB-A 1 567 807 discloses a cathode-ray tube having an electron gun in which one of the cylindrical electrodes forming the main focusing lens is modified by the provision of a pair of opposed apertures. A pair of additional electrodes are situated opposite to, i.e. facing, the respective apertures. The additional electrodes are at the same potential. Considering only one of the electron beams for simplicity, the pair of additional electrodes interacts with the modified cylindrical electrode to form a quadrupole lens which compensates for the astigmatism of a self convergent deflection coil. The main focusing lens is formed by the action of the unmodified (i.e. cylindrical) end portion of the cylindrical electrode and a further cylindrical electrode while the quadrupole lens is formed by the action of the apertured portion of the cylindrical electrode and the additional electrodes.

In one aspect, the present invention provides a color display system including a self-converging yoke that produces an astigmatic magnetic deflection field and a cathode-ray tube having an electron gun for generating and directing three 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 for forming a quadrupole lens between the beam-forming region and the main focusing lens in each of the electron beam paths, each quadrupole lens being 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, wherein said electrodes for forming a quadrupole lens include a first quadrupole lens electrode and a second quadrupole lens electrode, said second quadrupole lens electrode being mechanically and electrically connected to one of said electrodes for forming a main focusing lens, and said first quadrupole lens electrode being located between the second quadrupole lens electrode and the beam-forming region and facing the second quadrupole lens electrode and characterised in that first and second quadrupole lens electrodes each include a pair of opposed sector portions of a tubular member, the opposed sector portions of each of the first and second quadrupole lens electrodes being interdigitated with the opposed sector portions of the other.

In another aspect, the present invention provides a color cathode-ray tube having an electron gun for generating and directing three 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 for forming a quadrupole lens between the beam-forming region and the main focusing lens in each of the electron beam paths, wherein said electrodes for forming a quadrupole lens include a first quadrupole lens electrode and a second quadrupole lens electrode, said second quadrupole lens electrode being mechanically and electrically connected to one of said electrodes for forming a main focusing lens, and said first quadrupole lens electrode being located between the second quadrupole lens electrode and the beam-forming region and facing the second quadrupole lens electrode, characterised in that the first and second quadrupole lens electrodes each include a pair of opposed sector portions of a tubular member, the opposed sector portions of each of the first and second quadrupole lens electrodes being interdigitated with the opposed sector portions of the other.

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 broken-apart perspective view of quadrupole lens electrodes used in the electron gun.

FIGURES 5 and 6 are front and side views, respectively, of a first set of quadrupole lens electrodes.

FIGURE 7 is an upper right quadrant view of the quadrupole lens electrodes of FIGURES 5 and 6, showing electrostatic potential lines.

FIGURES 8 and 9 are front and side views, respectively, of another set of quadrupole lens electrodes.

FIGURE 10 is an upper right quadrant view of the quadrupole lens electrodes of FIGURES 8 and 9, showing electrostatic potential lines.

FIGURE 11 is a top view, partially in section, of an other electron gun.

FIGURE 12 is a front view of the quadrupole lens electrodes of the other electron gun, taken at line 12-12 of FIGURE 11.

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 multiapertured color selection electrode or shadow mask 24 is removably mounted, by conventional means, in predetermined spaced relation to the screen 22. An electron gun 26, shown schematically by dotted 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 curvature of the deflection beam paths in the deflection zone is not shown in FIGURE 1. In the preferred embodiment, the yoke 30 produces a self-convergence of the three electron beams at the tube screen. Such a yoke forms 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 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.

The details of the electron gun 26 are shown in FIGURES 2, 3 and 4. 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 flat plate 54 having three inline apertures 56 therein and castled cylinders 58 extending therefrom in alignment with the apertures 56. Each cylinder 58 includes a cylindrical portion 60 in contact with the plate 54 and two sector portions 62 extending from the

cylindrical portion 60. The two sector portions 62 are located opposite each other, and each sector portion 62 encompasses approximately 85 degrees of the cylinder circumference.

The portion of the G5 electrode 44 that comprises the second quadrupole lens electrode includes a flat plate 64 having three inline apertures 66 therein and castled cylinders 68 extending therefrom in alignment with the apertures 66. Each cylinder 68 includes a cylindrical portion 70 in contact with the plate 64 and two sector portions 72 extending from the cylindrical portion 70. The two sector portions 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, and the sector portions are assembled in non-touching, interdigitated fashion. Although the sector portions 62 and 72 are shown with square corners, such corners may be rounded.

The portion of the G5 electrode 44 that comprises the first main focusing electrode includes a somewhat cup-shaped element 74 which has its open end closed by the plate 64. The G6 electrode 46 is similar in shape to the element 74, but has its open end closed by an apertured shield cup 76. The facing apertured closed ends of the G5 electrode 44 and the G6 electrode 46 have large recesses 78 and 80, respectively, therein. The recesses 78 and 80 set back a portion of the closed end of the G5 electrode 44 that contains three inline apertures 82 from the portion of the closed end of the G6 electrode 46 that contains three inline apertures 84. The remaining portions of the closed ends of the G5 electrode 44 and the G6 electrode 46 form rims 86 and 88, respectively, that extend peripherally around the recesses 78 and 80. The rims 86 and 88 are the closest portions of the two electrodes 44 and 46 to each other.

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 5 and 6 show the sector portions 62 and 72 of the cylinders 58 and 68, respectively. The four sector portions are of equal dimensions, being curved on a radius "a" and having an overlapped length "t". A voltage $V_4 = V_{o4} + V_{m4}$ is applied to the sector portions 62, and a voltage $V_5 = V_{o5} + V_{m5}$ 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,

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

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,

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

where the effective length of the interaction region is

$$L = .4a + t,$$

and where the mean potential is

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

Thus, the paraxial focal length of this quadrupole lens is

$$f_x = x/\theta = [2a^2/(.4a + t)](V_o/\Delta V) = -f_y.$$

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

The electrostatic potential lines established by the equal sector portions 62 and 72 are shown in FIGURE 7 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.

Although the above-described embodiment has been shown having equal quadrant and circular sector

portions, noncircular and/or unequal sector portions also can be used to attain other order multipoles. An example is shown in FIGURES 8 and 9. In this example, two sector portions 62' encompass each approximately 145 degrees of the circumference, and two smaller sector portions 72' encompass each approximately 25 degrees of the circumference. The electrostatic field lines formed by these sector portions 62' and 72', with nominal voltages applied, are shown in FIGURE 10. The net effect of this electrostatic field is to compress an electron beam more in one direction than to expand it in an orthogonal direction.

Although the above-described embodiments have been shown with castled interdigitated cylinders used to form a multipole lens, other construction techniques also may be used. FIGURES 11 and 12 show another electron gun embodiment. In this embodiment, a main lens focus electrode 130, having extrusions at its apertures, is sectioned by cutting out four pieces 132, 134, 136 and 138 from a closed end of the electrode. The sectioning is done through the apertures, as shown in FIGURE 12, dividing each extrusion into four segments of a cylinder. These four sectioned pieces are then attached back to the main portion of the electrode 130 with an insulative ceramic cement 140 and are electrically interconnected to each other by a fine wire 142. The remaining parts of the electron gun that form the main focusing lens are a buffer plate 144 and a final electrode 146. The buffer plate 144 isolates the main lens from the quadrupole lens, both electrically and physically.

The electron gun 26 includes a dynamic quadrupole lens which is located differently and constructed differently than prior uses of quadrupole lenses in 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. The quadrupole lens is located between the beam-forming 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 focus 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 in the prior tube of above-cited U.S. Patent 4 319 163, as only an accompaniment to the differential penetration of G2b voltages into the slot of the G2a, 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.

Referring back to FIGURE 1, there is shown a portion of the electronics 100 that may operate the system as a television receiver and 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 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, association with the green video signal. 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 ultor 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, are not specifically described herein.

In addition to the foregoing elements, the electronics 100 includes either one or two dynamic circuits and a focus voltage waveform generator 122, with or without a spot shape waveform generator 120. The spot shape waveform generator 120 provides the dynamically varied voltage V_{m4} to the sector portions 62 of the electron gun 26. The focus voltage waveform generator 122 is similar in design to the generator

120, but provides a dynamically varied focus voltage V_{ms} to the electrodes 42 and 44. Use of these two generators permits optimization of both electron beam spot focus and spot shape at any point on the tube screen.

Both of the generators 120 and 122 receive the horizontal and vertical scan signals from the horizontal deflection circuit 114 and the vertical deflection circuit 116, respectively. The circuitry for the wave-form generators 120 and 122 can be that as is known in the art. Examples of such known circuits may be found in: U.S. Patent 4 214 188, issued to Bafaro et al. on July 22, 1980; U.S. Patent 4 258 298, issued to Hilburn et al. on March 24, 1981; and U.S. Patent 4 316 128, issued to Shiratsuchi on February 16, 1982.

Tables I and II below give experimental results of the center and corner beam spot sizes for an electron gun, such as gun 26, in a 26V110* color picture tube with a 25KV ultor voltage applied and a beam current of 2.0mA. Table I presents the voltages applied to the first quadrupole electrode 42, V_{G4} , the combined second quadrupole electrode and first main focusing electrode 44, V_{G5} , the voltage difference between these electrodes, ΔV , and the horizontal H and vertical V spot sizes, in mils (and equivalent millimeters), at the center and corner of the screen when no bias is applied.

Table I

	V_{G5}	V_{G4}	ΔV	HXV mm	(mils)
Center	6550	6550	0	1.80 x 3.35	(71 x 132)
Corner	6550	6550	0	3.73 x 2.18	(147 x 86)

Table II presents similar information, but for the situation where a bias is applied.

Table II

	V_{G5}	V_{G4}	ΔV	HXV mm	(mils)
Center	6000	5800	-200	1.55 x 1.93	(61 x 76)
Corner	6750	7000	+250	2.31 x 1.30	(91 x 51)

As can be seen by comparing the tables above, considerable reduction in the vertical dimension of the electron beam spot is achieved by proper application of voltages to the quadrupole structure.

Claims

1. A color display system including a self-converging yoke (30) that produces an astigmatic magnetic deflection field and a cathode-ray tube (10) having an electron gun (26) for generating and directing three electron beams along paths toward a screen (22) of said tube, said gun including electrodes (34, 36, 38, 40) comprising a beam-forming region, electrodes (44, 46) for forming a main focusing lens, and electrodes for forming a quadrupole lens between the beam-forming region and the main focusing lens in each of the electron beam paths, each quadrupole lens being oriented to provide a correction 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, wherein said electrodes for forming a quadrupole lens include a first quadrupole lens electrode (42) and a second quadrupole lens electrode (44), said second quadrupole lens electrode being mechanically and electrically connected to one of said electrodes (44) for forming a main focusing lens, and said first quadrupole lens electrode being located between the second quadrupole lens electrode and the beam-forming region and facing the second quadrupole lens electrode and characterised in that first and second quadrupole lens electrodes (42, 44) each include a pair of opposed sector portions (62, 72; 62', 72') of a tubular member (60, 70), the opposed sector portions of each of the first and second quadrupole lens electrodes being interdigitated with the opposed sector portions of the other.

2. A color cathode-ray tube (10) having an electron gun (26) for generating and directing three electron beams along paths toward a screen (22) of said tube, said gun including electrodes (34, 36, 38, 40) comprising a beam-forming region electrodes (44, 46) for forming a main focusing lens, and electrodes for forming a quadrupole lens between the beam-forming region and the main focusing lens in each of the electron beam paths, wherein said electrodes for forming a quadrupole lens include a first quadrupole lens electrode (42) and a second quadrupole lens electrode (44), said second quadrupole lens electrode being mechanically and electrically connected to one of said electrodes (44) for forming a main focusing



120, but provides a dynamically varied focus voltage V_{ms} to the electrodes 42 and 44. Use of these two generators permits optimization of both electron beam spot focus and spot shape at any point on the tube screen.

Both of the generators 120 and 122 receive the horizontal and vertical scan signals from the horizontal deflection circuit 114 and the vertical deflection circuit 116, respectively. The circuitry for the waveform generators 120 and 122 can be that as is known in the art. Examples of such known circuits may be found in: U.S. Patent 4 214 188, issued to Bafaro et al. on July 22, 1980; U.S. Patent 4 258 298, issued to Hilburn et al. on March 24, 1981; and U.S. Patent 4 316 128, issued to Shiratsuchi on February 16, 1982.

Tables I and II below give experimental results of the center and corner beam spot sizes for an electron gun, such as gun 26, in a 26V110⁺ color picture tube with a 25KV ultor voltage applied and a beam current of 2.0mA. Table I presents the voltages applied to the first quadrupole electrode 42, V_{G4} , the combined second quadrupole electrode and first main focusing electrode 44, V_{G5} , the voltage difference between these electrodes, ΔV , and the horizontal H and vertical V spot sizes, in mils (and equivalent millimeters), at the center and corner of the screen when no bias is applied.

Table I

	V_{G5}	V_{G4}	ΔV	HXV mm	(mils)
Center	6550	6550	0	1.80 x 3.35	(71 x 132)
Corner	6550	6550	0	3.73 x 2.18	(147 x 86)

Table II presents similar information, but for the situation where a bias is applied.

Table II

	V_{G5}	V_{G4}	ΔV	HXV mm	(mils)
Center	6000	5800	-200	1.55 x 1.93	(61 x 76)
Corner	6750	7000	+250	2.31 x 1.30	(91 x 51)

As can be seen by comparing the tables above, considerable reduction in the vertical dimension of the electron beam spot is achieved by proper application of voltages to the quadrupole structure.

Claims

1. A color display system including a self-converging yoke (30) that produces an astigmatic magnetic deflection field and a cathode-ray tube (10) having an electron gun (26) for generating and directing three electron beams along paths toward a screen (22) of said tube, said gun including electrodes (34, 36, 38, 40) comprising a beam-forming region, electrodes (44, 46) for forming a main focusing lens, and electrodes for forming a quadrupole lens between the beam-forming region and the main focusing lens in each of the electron beam paths, each quadrupole lens being oriented to provide a correction 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, wherein said electrodes for forming a quadrupole lens include a first quadrupole lens electrode (42) and a second quadrupole lens electrode (44), said second quadrupole lens electrode being mechanically and electrically connected to one of said electrodes (44) for forming a main focusing lens, and said first quadrupole lens electrode being located between the second quadrupole lens electrode and the beam-forming region and facing the second quadrupole lens electrode and characterised in that first and second quadrupole lens electrodes (42, 44) each include a pair of opposed sector portions (62, 72; 62', 72') of a tubular member (60, 70), the opposed sector portions of each of the first and second quadrupole lens electrodes being interdigitated with the opposed sector portions of the other.

2. A color cathode-ray tube (10) having an electron gun (26) for generating and directing three electron beams along paths toward a screen (22) of said tube, said gun including electrodes (34, 36, 38, 40) comprising a beam-forming region electrodes (44, 46) for forming a main focusing lens, and electrodes for forming a quadrupole lens between the beam-forming region and the main focusing lens in each of the electron beam paths, wherein said electrodes for forming a quadrupole lens include a first quadrupole lens electrode (42) and a second quadrupole lens electrode (44), said second quadrupole lens electrode being mechanically and electrically connected to one of said electrodes (44) for forming a main focusing



lens, and said first quadrupole lens electrode being located between the second quadrupole lens electrode and the beam-forming region and facing the second quadrupole lens electrode, characterised in that the first and second quadrupole lens electrodes (42, 44) each include a pair of opposed sector portions (62, 72; 62', 72') of a tubular member (60, 70), the opposed sector portions of each of the first and second quadrupole lens electrodes being interdigitated with the opposed sector portions of the other.

3. A color display system according to claim 1 or a color cathode-ray tube according to claim 2, wherein said tubular member (60, 70) has the shape of a circular cylinder.

4. A color display system or a color cathode-ray tube according to claim 3, in which each sector portion (62, 72) encompasses approximately 85 degrees angle of a cylinder (60, 70) circumference.

5. A color display system or a color cathode-ray tube according to claim 3, in which the sector portions (62') on one electrode forming a particular quadrupole lens encompass a greater angle of a cylinder than do the sector portions (72') on the other electrode forming the particular quadrupole lens.

6. A color display system or a color cathode-ray tube according to claim 5, in which the sector portions (62') on one electrode each encompass approximately 145 degrees angle of a cylinder, and the sector portions (72') on the other electrode encompass approximately 25 degrees angle of a cylinder.

7. A color display system or a color cathode-ray tube according to any one of the preceding claims, which comprises means (120) for applying a dynamic signal (V_{m4}) to at least one (42) of said first and second quadrupole lens electrodes (42, 44), said dynamic signal being related to deflection of the electron beams (28).

8. A color display system or a color cathode-ray tube according to claim 7, which comprises means (122) for applying a second dynamic signal (V_{m5}) to at least the other (44) of said first and second quadrupole lens electrodes (42, 44), said second dynamic signal being related to deflection of the electron beams (28).

9. A color display system or a color cathode-ray tube according to any one of the preceding claims, in which said quadrupole lens is located closer to said main focusing lens than to said beam forming region.

Patentansprüche

1. Farbbildwiedergabesystem mit einem selbstkonvergierenden Joch (30), das ein astigmatisches Ablenkmagnetfeld erzeugt, und einer Kathodenstrahlröhre (10), die ein Elektronenstrahlsystem (26) aufweist, um drei Elektronenstrahlen zu erzeugen und entlang zugeordneter Wege auf einen Schirm (22) der Röhre zu richten, wobei das Strahlsystem einen strahlformenden Bereich umfassende Elektroden (34, 36, 38, 40), Elektroden (44, 46) zur Bildung einer Hauptfokussierungslinse und Elektroden zur Bildung einer Quadrupollinse zwischen dem strahlformenden Bereich und der Hauptfokussierungslinse in jedem der Elektronenstrahlwege enthält, mit einer derartigen Orientierung einer jeden Quadrupollinse, daß eine Korrektur für einen zugeordneten Elektronenstrahl (28) bewirkt wird, um zumindest teilweise den Einfluß des astigmatischen Ablenkmagnetfeldes auf den zugeordneten Strahl zu kompensieren, wobei die besagten Elektroden zur Bildung einer Quadrupollinse eine erste Quadrupollinsen-Elektrode (42) und eine zweite Quadrupollinsen-Elektrode (44) enthalten, die zweite Quadrupollinsen-Elektrode mechanisch und elektrisch mit einer der besagten Elektroden (44) zur Bildung einer Hauptfokussierungslinse verbunden ist und die erste Quadrupollinsen-Elektrode zwischen der zweiten Quadrupollinsen-Elektrode und dem strahlformenden Bereich liegt und der zweiten Quadrupollinsen-Elektrode zugewandt ist, dadurch gekennzeichnet, daß die erste und die zweite Quadrupollinsen-Elektrode (42, 44) jeweils ein Paar gegenüberliegender Sektorteile (62, 72; 62', 72') eines rohrförmigen Gliedes (60, 70) enthalten und die gegenüberliegenden Sektorteile einer jeden der ersten und zweiten Quadrupollinsen-Elektroden mit den gegenüberliegenden Sektorteilen der jeweils anderen ineinandergreifen.

2. Farb-Kathodenstrahlröhre (10) mit einem Elektronenstrahlsystem (26), um drei Elektronenstrahlen zu erzeugen und entlang zugeordneter Wege auf einen Schirm (22) der Röhre zu richten, wobei das Strahlsystem einen strahlformenden Bereich umfassende Elektroden (34, 36, 38, 40), Elektroden (44, 46) zur Bildung einer Hauptfokussierungslinse und Elektroden zur Bildung einer Quadrupollinse zwischen dem strahlformenden Bereich und der Hauptfokussierungslinse in jedem der Elektronenstrahlwege enthält, wobei die besagten Elektroden zur Bildung einer Quadrupollinse eine erste Quadrupollinsen-Elektrode (42) und eine zweite Quadrupollinsen-Elektrode (44) enthalten, die zweite Quadrupollinsen-Elektrode mechanisch und elektrisch mit einer der besagten Elektroden (44) zur Bildung einer Hauptfokussierungslinse verbunden ist und die erste Quadrupollinsen-Elektrode zwischen der zweiten Quadrupollinsen-Elektrode und dem strahlformenden Bereich liegt und der zweiten Quadrupollinsen-Elektrode zugewandt ist, dadurch gekennzeichnet, daß die erste und die zweite Quadrupollinsen-Elektrode (42, 44) jeweils ein Paar gegenüberliegender Sektorteile (62, 72; 62', 72') eines rohrförmigen Gliedes (60, 70) enthalten und die gegenüberliegenden Sektorteile einer jeden der ersten und zweiten Quadrupollinsen-Elektroden mit den gegenüberliegenden Sektorteilen der anderen ineinandergreifen.

3. Farbbildwiedergabesystem nach Anspruch 1 oder Farbbildkathodenstrahlröhre nach Anspruch 2, worin das rohrförmige Glied (60, 70) die Gestalt eines Kreiszylinders hat.

4. Farbbildwiedergabesystem oder Farb-Kathodenstrahlröhre nach Anspruch 3, worin jeder Sektorteil (62, 72) ungefähr 85 Winkelgrade eines Umfangs eines Zylinders (60, 70) umfaßt.



5. Farbbildwiedergabesystem oder Farb-Kathodenstrahlröhre nach Anspruch 3, worin die Sektorteile (62') an einer Elektrode, die eine Quadrupollinse bildet, einen größeren Winkel eines Zylinders umfassen als die Sektorteile (72') an der anderen Elektrode, welche dieselbe Quadrupollinse bildet.

6. Farbbildwiedergabesystem oder Farb-Kathodenstrahlröhre nach Anspruch 5, worin die Sektorteile (62') an einer Elektrode jeweils ungefähr 145 Winkelgrade eines Zylinders umfassen und die Sektorteile (72') an der anderen Elektrode ungefähr 25 Winkelgrade eines Zylinders umfassen.

7. Farbbildwiedergabesystem oder Farb-Kathodenstrahlröhre nach einem der vorhergehenden Ansprüche mit einer Einrichtung (120) zum Anlegen eines dynamischen Signals (Vm4) an mindestens eine (42) der ersten und zweiten Quadrupollinsen-Elektroden (42, 44), wobei dieses dynamische Signal mit der Ablenkung der Elektronenstrahlen (28) in Beziehung steht.

8. Farbbildwiedergabesystem oder Farb-Kathodenstrahlröhre nach Anspruch 7 mit einer Einrichtung (142) zum Anlegen eines zweiten dynamischen Signals (Vm5) an mindestens die andere (44) der ersten und zweiten Quadrupollinsen-Elektroden (42, 44), wobei das zweite dynamische Signal mit der Ablenkung der Elektronenstrahlen (28) in Beziehung steht.

9. Farbbildwiedergabesystem oder Farb-Kathodenstrahlröhre nach einem der vorhergehenden Ansprüche, worin die Quadrupollinse näher an der besagten Hauptfokussierungslinse als am besagten strahlformenden Bereich liegt.

Revendications

1. Un système de visualisation en couleurs comprenant un bloc auto-convergent (30) qui produit un champ de déviation magnétique astigmatique et un tube à rayons cathodiques (10) ayant un canon à électrons (26) pour produire et diriger trois faisceaux d'électrons le long du trajet vers un écran (22) dudit tube, ledit canon comprenant des électrodes (34, 36, 38, 40) comprenant une région de formation d'un faisceau, des électrodes (44, 46) pour former une lentille de focalisation principale, et des électrodes pour former une lentille à quatre pôles entre la région de formation du faisceau et la lentille de focalisation principale dans chacun des trajets du faisceau d'électrons, chaque lentille à quatre pôles étant orientée pour produire une correction à un faisceau d'électrons associé (28) pour au moins compenser partiellement l'effet du champ de déviation magnétique astigmatique sur le faisceau associé, où lesdites électrodes pour former une lentille à quatre pôles comprennent une première électrode de lentille à quatre pôles (42) et une seconde électrode de lentille à quatre pôles (44), ladite seconde électrode de lentille à quatre pôles étant mécaniquement et électriquement reliée à l'une desdites électrodes (44) pour former une lentille de focalisation principale, et ladite première électrode de lentille à quatre pôles étant située entre la seconde électrode de lentille à quatre pôles et la région de formation du faisceau et faisant face à la seconde électrode de lentille à quatre pôles et caractérisé en ce que les première et seconde électrodes de lentille à quatre pôles (42, 44) comprennent chacune une paire de portions de secteurs opposées (62, 72; 62', 72') d'un élément tubulaire (60, 70), les portions de secteurs opposées des première et seconde électrodes de lentille à quatre pôles étant entrelacées avec les portions de secteurs opposées de l'autre.

2. Un tube à rayons cathodiques couleur (10) ayant un canon à électrons (26) pour produire et diriger trois faisceaux d'électrons le long de trajets vers un écran (22) dudit tube, ledit canon comprenant des électrodes (34, 36, 38, 40) comprenant des électrodes à région de formation de faisceau (44, 46) pour former une lentille de focalisation principale, et des électrodes pour former une lentille à quatre pôles entre la région de formation de faisceau et la lentille de focalisation principale dans chacun des trajets de faisceaux d'électrons, où lesdites électrodes pour former une lentille à quatre pôles comprennent une première électrode de lentille à quatre pôles (42) et une seconde électrode de lentille à quatre pôles (44), ladite seconde électrode de lentille à quatre pôles étant mécaniquement et électriquement reliée à l'une desdites électrodes (44) pour former une lentille de focalisation principale, et la première électrode de lentille à quatre pôles étant située entre la seconde électrode de lentille à quatre pôles et la région de formation de faisceau et faisant face à la seconde électrode de lentille à quatre pôles, caractérisé en ce que les première et seconde électrodes de lentille à quatre pôles (42, 44) comprennent chacune une paire de portions de secteurs opposées (62, 72; 62', 72') d'un élément tubulaire (60, 70), les portions de secteurs opposées de chacune des première et seconde électrodes de lentille à quatre pôles étant entrelacées avec les portions de secteur opposées de l'autre.

3. Un système de visualisation en couleurs selon la revendication 1 ou un tube à rayons cathodiques couleur selon la revendication 2, où l'élément tubulaire précité (60, 70) a la forme d'un cylindre circulaire.

4. Un système de visualisation en couleurs ou un tube à rayons cathodiques couleur selon la revendication 3, dans lequel chaque portion de secteur (62, 72) entoure approximativement 85 degrés d'angle d'une circonférence d'un cylindre (60, 70).

5. Un système de visualisation en couleurs ou un tube à rayons cathodiques couleur selon la revendication 3, dans lequel les portions de secteurs (62') sur une électrode formant une lentille à quatre pôles particulière entourent un angle plus grand d'un cylindre que les portions de secteurs (72') sur l'autre électrode formant la lentille à quatre pôles particulière.

6. Un système de visualisation en couleurs ou un tube à rayons cathodiques couleur selon la revendication 5, dans lequel les portions de secteurs (62') sur une électrode entourent chacune approximative-



ment 145 degrés d'angle d'un cylindre, et les portions de secteurs (72') sur l'autre électrode entourent approximativement 25 degrés d'angle d'un cylindre.

5 7. Un système de visualisation en couleurs ou un tube à rayons cathodiques couleur selon l'une des revendications précédentes, qui comprend un moyen (120) pour appliquer un signal dynamique (Vm4) à au moins l'une (42) des première et seconde électrodes de lentille à quatre pôles précitées (42, 44), ledit signal dynamique étant en rapport avec la déviation des faisceaux d'électrons (28).

10 8. Un système de visualisation en couleurs ou un tube à rayons cathodiques couleur selon la revendication 7, qui comprend un moyen (122) pour appliquer un second signal dynamique (Vm5) à au moins l'autre (44) des première et seconde électrodes de lentille à quatre pôles précitées (42, 44), le second signal dynamique précité étant en rapport avec la déviation des faisceaux d'électrons (28).

9. Un système de visualisation en couleurs ou un tube à rayons cathodiques couleur selon l'une des revendications précédentes, dans lequel la lentille à quatre pôles précitée est située plus près de la lentille de focalisation principale précitée que la région précitée de formation de faisceau.

15

20

25

30

35

40

45

50

55

60

65