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(54) **Color cathode-ray tube having a three-lens electron gun.**

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Description

The invention relates to a color cathode-ray tube having an electron gun with three electron lenses, and, more particularly, to a three-lens electron gun capable of providing asymmetrically-shaped electron beams of substantially constant current density.

FIGURE 1 shows a conventional 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 16. The panel 12 comprises a viewing faceplate 18 and a peripheral flange or sidewall 20 which is sealed to the funnel 16 by a frit seal 21. A mosaic three-color phosphor screen 22 is located on the inner surface of the faceplate 18. The screen preferably is a line screen with the phosphor lines extending substantially perpendicular to the high frequency raster line scan of the tube (normal to the plane of the FIGURE 1). Alternatively, the screen could 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 inline 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 initially coplanar beam paths through the mask 24 and toward the screen 22. One type of electron gun that is conventional is a four grid bi-potential electron gun such as that shown in FIGURE 2 and described in U. S. Patent No. 4,620,133, issued to Morrell et al. on October 28, 1986.

The tube of FIGURE 1 is designed to be used with an external magnetic deflection yoke, such as yoke 30 located in the region 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 shown by the line P-P in FIGURE 1 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 deflected beam paths in the deflection zone is not shown in FIGURE 1. The yoke 30 provides an inhomogeneous magnetic field that has a strong pincushion-like vertical deflection magnetic field and a strong barrel-like horizontal deflection magnetic field, to converge the electron beams at the peripheral part of the screen 22. When the electron beams pass through such an inhomogeneous magnetic field, the beams are subject to distortions and defocusing. As a result, at the peripheral portions of the screen 22, the shape of the electron beam spot is greatly distored. FIGURE 3 represents an electron beam spot for a single beam which is circular at the center of the screen and undergoes various types of distortions at the periphery of the screen 22. As shown in FIGURE 3, the beam spot becomes horizontally elongated when deflected along the horizontal axis. The beam spot at the four corners of the screen comprises a combination of horizontally elongated portions and vertically elongated portion that form elliptically-shaped spots with halo-shaped elongations thereabout. The resolution is degraded as the electron beam is deflected, and the non-uniform focusing, which cannot be neglected, presents a problem which must be addressed.

The above-cited U.S. Patent 4,620,133 addresses the beam focus problem by providing an improved color imaging display system that includes a deflection yoke and an electron gun that has both an improved beam forming region, comprising a first grid, G1, a second grid, G2, a third grid, G3, and an improved main focusing lens, G3-G4, which works in conjunction with the deflection yoke and the beam forming region to provide an improved beam spot at the screen 22. FIGURE 4a herein shows an electron beam current density contour, at the center of the screen 22, for an electron beam produced by the beam forming region and the main lens of the electron gun shown in FIGURE 2. The beam current of the electron gun is 4 milliamperes. The electron beam current density contour of Fig. 4a comprises a relatively large center portion, having a substantially constant beam current of about 50% of the average beam current, and peripheral portions, where the beam current drops to about 5% of the average beam current and finally to about 1% of the average beam current. The beam is elliptically-shaped along the vertical axis to reduce the overfocusing action of the yoke when the beam is deflected. FIGURE 4b shows the beam current density contour within the main lens, L2, that is between the G3 and G4 electrodes of Fig. 2. The electron beam at this location is horizontally elongated; however, the 50% beam current density portion is contained within the small elliptical center section of the beam which is circumscribed by the larger elliptical portions which represent the 5% and 1% beam current density profiles. FIGURE 4c shows the electron beam current density contour of the electron beam deflected into the upper right hand corner of the screen. Some haloing occurs above and below the central portion of the beam. FIGURE 5 depicts the paths of the electrons emerging from the beam forming region of the electron gun of FIGURE 2 for various beam currents. In FIGURE 5a, the beam current is adjusted to 4 milliamperes, and a crossover point occurs at about 2.8 to 2.9 mm (110 to 115 mils) from the cathode located at the origin. At a distance of about 5.2 mm (200 mils) from the origin, the electrons are concentrated in the center portion of the beam. This distribution of electrons produces the current density contour, at the screen, shown in FIGURE 4a. The effect of the beam current on the location of the crossover point and on the beam current density contour is shown in

Figures 5b and 5c. In FIGURE 5b, when the beam current is decreased to 0.8 millampere, the crossover point is shifted to a location about 1.14 mm (45 mils) from the cathode. It is apparent that the divergence angle of the electron beam is somewhat less at an operating current of 0.8 milliampere than at an operating current of 4.0 milliamperes (FIGURE 5a). In FIGURE 5c, at a beam current of 0.2 milliampere, the crossover point is located less than about 0.6 mm (25 mils) from the cathode, and the beam is virtually a laminar beam.

U.S. Patent 4,641,058, issued to Koshigoe et al. on Feb. 3, 1987, also discloses a four-grid bi-potential electron gun in which a prefocus astigmatic lens is formed between the second and third grids and a main astigmatic focus lens is formed between the third and fourth grids. The advantage of that two-lens structure over prior bi-potential structures is that, unlike various types of prior bi-potential electron guns, such as that shown in FIGURE 2, which provide an astigmatic shape to the electron beam by means of the first grid, Koshigoe et al. have utilized the second and/or third grids as the first astigmatic lens. The latter structure allegedly permits the astigmatic electron beam formed by the first astigmatic lens to be compensated for in the main astigmatic focus lens, to provide a substantially circular-shaped beam spot on a phosphor screen of a cathode ray tube. The structure described in the Koshigoe et al. patent is also applied to a composite lens type electron gun having six grids and three separate electron lenses, such as that shown in FIGURE 6. In the six grid structure of Koshigoe et al., the first (prefocus) lens, L1, is formed between the second and third grids; the third, fourth, and fifth grids constitute a sub-lens, L2; and the fifth and sixth grids constitute a main lens, L3. In this latter embodiment, the first (prefocus) lens serves as the first astigmatic lens, and the main lens serves as the second astigmatic lens. The allegation is that the deflected beam spot in this electron gun is superior to that obtained in prior art electron guns. However, in such an electron gun structure, the location of the crossover point is dependent upon the beam current of the electron gun. While the first asymmetric lens, L1, is formed in the region between the second and third grid electrodes, G2 and G3, respectively, the crossover point may occur either before or after lens L1, depending upon the electron beam current. At a high beam current of about 4 milliamperes (mA), the crossover point occurs after the lens L1, closer to the G3 electrode. Thus, the asymmetric effect of lens L1 is a function of beam current. It is therefore desirable to provide an electron lens which is insensitive to the beam current; i.e., the asymmetric lens should be located beyond the crossover point, regardless of the operating beam current of the electron gun. Additionally, it is desirable to have a gun structure which provides beams of substantially constant current density, in both the horizontal and vertical directions, in the main lens.

The documents PATENT ABSTRACTS OF JAPAN, Vol. 3, No.141 (E 153) 21 November 1979, page 151 E.153; and JP-A-54120581, disclose an in-line electron gun for a colour cathode-ray tube for generating and directing three in-line electron beams along initially co-planar axes on paths towards a screen, including a plurality of spaced electrodes (15-20) which provide a first lens (15,16,17), a second lens (17,18,19) and a third lens (19,20) for focusing said electron beams, said first lens including a beam-forming region for providing beams to said second lens; said second lens being used as an Einzel lens for refracting electron beams, emerging off said axes from said first lens, towards said axes, and asymmetric beam-focusing means for providing beams to said third lens and said third lens for providing beams which agree in terms of shape to said screen.

The above arrangement is intended primarily for providing beam spots with a circular cross-section, but the construction produced very high spherical aberration. Accordingly, a plate (18) is provided in the second lens with apertures for compensating for the spherical aberration.

In Toshiba Review No.121, May-June 1979, S. Takenaka el al: "New Hi-Fi Focus Electron Gun for Color Cathode-Ray Tube", pages 30-35, there is an explanation of a focusing lens system for an electron gun including a beam shaping or pre-focus lens, a main lens and a sub-lens intermediate the pre-focus lens and the main lens for reducing the angular cross-section of the electron beam from the pre-focus lens.

EP-A-104674 discloses a lens system for an electron gun comprising two lenses, namely a beam shaping lens (20,21,24) and main lens (25,26,37). In this arrangement an aperture insert (30) is inserted in the main lens to provide a correction for manufacturing tolerances in the basic lens system.

US-A-2884559 discloses a lens system for an electron gun comprising two lenses, namely a beam shaping lens (13), and a main Einzel lens (25-28), wherein the inner two lens plates of the Einzel lens are provided with horizontal and vertical elliptically shaped apertures and are connected to receive the deflection voltages applied to the deflection plates in order to provide dynamic compensation to the shape of the beam spot.

EP-A-0231964 discloses a lens system for an electron gun which has essentially two lenses, namely a beam shaping lens (20,24,27) and a main focusing lens (28,29). There is in addition inserted an auxiliary electrode (G_{ast}) which is not a further lens, but which is connected to a dynamically varying voltage, which is in synchronism with the line deflection for providing a compensation or trimming effect to the shape of the electron beams.

Patent Abstracts of Japan, Vol. 10, No 244 (E-430) [2300], 22 August 1986; & JP-A-61074246, disclose a three lens system for an electron gun wherein the centre lens, which may be regarded as an adaptation of the simple Einzel lens has an extra centre plate (9) with rectangular apertures for the three electron beams to provide compensation for defects in the shape of the beam; there is no asymmetric beam formation.

The present invention provides in one aspect a colour cathode-ray tube, including an envelope having therein an inline electron gun for generating and directing three inline electron beams along initially coplanar axes on paths towards a screen on an interior portion of said envelope, said gun including a plurality of spaced electrodes which provide a first lens, a second lens and a third lens for focusing said electron beams, said first lens including a beam-forming region for providing substantially symmetrical beams to said second lens; said first lens comprising a first electrode, a second electrode and a first portion of a third electrode, said second lens comprising a second portion of said third electrode, a fourth electrode and a first portion of a fifth electrode, and said third lens comprising a second portion of said fifth electrode and a sixth electrode, said second electrode and said fourth electrode being interconnected, and said third electrode and said first portion of said fifth electrode being interconnected, said electrodes having suitable operating voltages applied thereto, said second lens including beam refraction means for refracting said electron beams, emerging off said axes from said first lens, toward said axes, and asymmetric beam-forming means comprising said fourth electrode for providing horizontally elongated asymmetrically-shaped beams to said third lens said fourth electrode including three horizontally elongated openings therein for producing said horizontally elongated, asymmetrically-shaped beams, and said third lens being a low-aberration main focusing lens for providing vertically elongated, asymmetrically-shaped beams of substantially constant current density to said screen, said asymmetric main focusing lens being formed by facing surfaces of the second portion of said fifth electrode and said sixth electrode each of which includes a recess formed at the respective outer edge extending to said second portion of said fifth electrode and said sixth electrode, respectively, each recess having a greater horizontal than vertical dimension, and three set-back apertures in the bottom of the respective recess, each single aperture being surrounded by a single extrusion.

In another aspect, the invention provides a colour cathode-ray tube, including an envelope having therein an inline electron gun for generating and directing three inline electron beams along initially coplanar axes on paths toward a screen on an interior portion of said envelope, said gun including a plurality of spaced electrodes which provide a first lens, a second lens and a third lens for focusing said electron beams, said first lens including a beam-forming region for providing substantially symmetrical beams to said second lens; said first lens comprising a first electrode, a second electrode and a first portion of a third electrode, said second lens comprising a second portion of said third electrode, a fourth electrode and a first portion of a fifth electrode, and said third lens comprising a second portion of said fifth electrode and a sixth electrode, said third electrode and said first portion of said fifth electrode being interconnected, and said fourth electrode and said sixth electrode being interconnected, said electrodes having suitable operating voltages applied thereto, said second lens including beam refraction means for refracting said electron beams emerging off said axes from said first lens, toward said axes, and asymmetric beam-forming means comprising said fourth electrode for providing horizontally elongated, asymmetrically-shaped beams to said third lens, said fourth electrode including three vertically elongated openings therein for producing said horizontally elongated, asymmetrically-shaped beams, and said third lens being a low-aberration main focusing lens for providing vertically elongated, asymmetrically-shaped beams of substantially constant density to said screen, said asymmetric main focusing lens being formed by facing surfaces of the second portion of said fifth electrode and said sixth electrode each of which includes a recess formed at the respective outer edge extending to said second portion of said fifth electrode and said sixth electrode, respectively, each recess having a greater horizontal than vertical dimension, and three set-back aperture in the bottom of the respective recess, each single aperture being surrounded by a single extrusion.

The present invention as claimed provides an improvement in color picture tubes which include an electron gun for generating and directing three electron beams, a centre beam and two side beams, along initially coplanar paths towards the screen of the tube. The gun includes a plurality of spaced electrodes which provide a first lens including a beam forming region for providing substantially symmetrical beams to a second lens. The second lens includes beam refraction means for refracting the electron beams, emerging off the axis from the first lens, toward the axis, and asymmetric beam-focusing means for providing asymmetrically shaped beams to a third lens. The third lens is a low aberration main focusing lens for providing an asymmetrically shaped beam of substantially constant current density to the screen.

In the drawings:

FIGURE 1 is a plan view, partially in axially section, of a conventional color cathode-ray tube.

FIGURE 2 is a schematic sectional view showing an overall construction of a conventional bi-potential four-grid electron gun.

FIGURE 3 is a representation showing the shapes of electron beam spots on the screen of a conventional color cathode-ray tube.

FIGURE 4a shows the electron beam current density contour at the center of the screen, for the conventional electron gun of FIGURE 2; FIGURE 4b shows the electron beam current density contour within the main lens; and FIGURE 4c shows the current density contour for the electron beam deflected to the upper right hand corner of FIGURE 3.

FIGURE 5a shows the electron beam ray diagram for the beam forming region of the conventional electron gun of FIGURE 2, operating at a beam current of 4.0 milliamperes; FIGURE 5b shows that same conventional electron gun operating at a beam current of 0.8 milliampere; and FIGURE 5c shows that same conventional electron gun operating at a beam current of 0.2 milliampere.

FIGURE 6 is a schematic sectional view showing a six grid electron gun operating with the second and fourth grids at a first potential and the third and fifth grids at a second potential.

FIGURES 7 and 8 are axial top and side views, respectively, of an electron gun according to the present invention.

FIGURES 9, 10 and 11 are sectional views of the electron gun shown in Figure 7, taken along lines 9-9, 10-10 and 11-11, respectively.

FIGURE 12 shows the electron beam ray diagram for the beam forming region of the present electron gun.

FIGURE 13 shows the electron beam current density contour from the beam forming region (first lens) of the present electron gun.

FIGURE 14 shows the electron beam current density contour within the main lens produced by the second lens of the present electron gun, connected as shown in Figure 6.

FIGURES 15a, 15b and 15c show the beam current density contour of the present electron gun, connected as shown in FIGURE 6, at the center of the screen, deflected to the upper right corner of the screen, and at the same deflected location on the screen but with a dynamic correction voltage applied to one electrode of the main (third) lens.

FIGURE 16 is a schematic sectional view showing a second embodiment of a six grid electron gun, operating with the third and fifth grids at a second potential and the fourth and sixth grids at a third potential.

FIGURE 17 shows the electron beam current density contour within the main lens produced by the second embodiment of the present electron gun, connected as shown in FIGURE 16.

FIGURE 18 shows the electron beam current density contour at the center of the screen for the second embodiment of the present electron gun, connected as shown in FIGURE 16.

Referring to FIGURES 7 and 8, an electron gun 40 according to the present invention is shown as comprising three equally spaced coplanar cathodes 42 (one for each beam), a control grid 44 (G1), a screen grid 46 (G2), a third electrode 48 (G3), a fourth electrode 50 (G4), a fifth electrode 52 (G5), the G5 electrode including a spatially separated portion G5′ identified as element 54, and a sixth electrode 56 (G6). The electrodes are spaced in the order named from the cathodes and are attached to a pair of support rods (not shown).

The cathodes 42, the G1 electrode 44, the G2 electrode 46 and a portion of the G3 electrode 48 facing the G2 electrode 46 comprise a beam forming region of the electron gun 40. Another portion of the G3 electrode 48, the G4 electrode 50 and the G5 electrode 52 comprise a first asymmetric lens. The portion 54 of the G5′ electrode and the G6 electrode 56 comprise a main focusing (or second asymmetric) lens.

Each cathode 42 comprises a cathode sleeve 58 closed at its forward end by a cap 60 having an end coating 62 of an electron emissive material thereon, as is known in the art. Each cathode 42 is indirectly heated by a heater coil (not shown) positioned within the sleeve 58.

The G1 and G2 electrodes, 44 and 46, are two closely spaced substantially flat plates each having three pairs of inline apertures 64 and 66, respectively, therethrough. The apertures 64 and 66 are centered with the cathode coating 62, to initiate three equally-spaced coplanar electron beams 28 (as shown in Figure 1) directed towards the screen 22. Preferably, the initial electron beam paths are substantially parallel, with the middle path coinciding with the central axis A-A of the electron gun.

The G3 electrode 48 includes a substantially flat outer plate portion 68 having three inline apertures 70 therethrough, which are aligned with the apertures 66 and 64 in the G2 and G1 electrodes 46 and 44, respectively. The G3 electrode 48 also includes a pair of cup-shaped first and second portions 72 and 74, respectively, which are joined together at their open ends. The first portion 72 has three inline apertures 76 formed through the bottom of the cup, which are aligned with the apertures 70 in the plate 68. The second portion 74 of the G3 electrode has three apertures 78 formed through its bottom, which are aligned with the apertures 76 in the first portion 72. Extrusions 79 surround the apertures 78. Alternatively, the plate portions 68 with its inline apertures 70 may be formed as an integral part of the first portion 72.

The G4 electrode 50 comprises a substantially flat plate having three inline apertures 80 formed therethrough, which are aligned with the apertures 78 in the G3 electrode.

The G5 electrode 52 is a deep-drawn cup-shaped member having three apertures 82, surrounded by extrusions 83, formed in the bottom end thereof. A substantially flat plate member 84 having three apertures 86, aligned with the apertures 82, is attached to and closes the open end of the G5 electrode 52. A first plate portion 88, having a plurality of openings 90 therein, is attached to the opposite surface of the plate member 84.

The G5′ electrode 54 comprises a deep-drawn cup-shaped member having a recess 92, formed in the bottom end with three inline apertures 94 formed in the bottom surface thereof. Extrusions 95 surround the apertures 94. The opposite open end of the G5′ electrode 54 is closed by a second plate portion 96 having three openings 98 formed therethrough, which are aligned with and cooperate with the openings 90 in the first plate portion 88 in a manner described below.

The G6 electrode 56 is a cup-shaped deep-drawn member having a large opening 100 at one end, through which all three electron beams pass, and an open end, which is attached to and closed by a plate member 102 that has three apertures 104 therethrough which are aligned with the apertures 94 in the G5′ electrode 54. Extrusions 105 surround the apertures 104.

The shape of the recess 92 in the G5′ electrode 54 is shown in FIGURE 9. The recess 92 has a uniform vertical width at each of the electron beam paths, with rounded ends. Such a shape has been referred to as the "racetrack" shape.

The shape of the large aperture 100 in the G6 electrode 56 is shown in FIGURE 10. The aperture 100 is vertically higher at the side electron beam paths than it is at the center beam path. Such a shape has been referred to as the "dogbone" or "barbell" shape.

The first plate portion 88 of the G5 electrode 52 is spatially separated from, and faces the second plate portion 96 of the G5′ electrode 54. The apertures 90 in the first plate portion 88 of the G5 electrode 52 have extrusions, extending from the plate portion, that have been divided into two segments 106 and 108 for each aperture. The apertures 98 in the second plate portion 96 of the G5′ electrode 54 also have extrusions, extending from the plate portion 96, that have been divided into two segments 110 and 112 for each aperture. As shown in FIGURE 11, the segments 106 and 108 are interleaved with the segments 110 and 112. These segments are used to create quadrupole lenses in the paths of each electron beam when different potentials are applied to the G5 and G5′ electrodes 52 and 54, respectively. By proper application of a dynamic voltage differential to either the G5 electrode 52 or the G5′ electrode 54, it is possible to use the quadrupole lenses established by the segments 106, 108, 110 and 112 to provide an astigmatic correction to the electron beams, to compensate for astigmatisms occurring in either the electron gun or in the deflection yoke.

Specific dimensions of a computer-modeled electron gun for a first preferred embodiment are presented in TABLE I.

TABLE I

	Inches	mm
K-G1 spacing	0.003	0.08
Thickness of G1 electrode 44	0.0025	0.06
Thickness of G2 electrode 46	0.024	0.61
G1 and G2 aperture diameter	0.025	0.64
G1 to G2 spacing	0.010	0.25
G2 to G3 spacing	0.030	0.76
Thickness of G3 plate portion 68	0.010	0.25
G3 aperture diameter	0.040	1.02
Length of G3 electrode	0.200	5.08
Thickness of G4 electrode 50	0.035	0.89
G4 electrode aperture size	0.166H x 0.160V	4.22H x 4.06V
G3 to G4 spacing	0.050	1.27
Overall length of G5 and G5' electrodes 52 and 54	0.890	22.61
G4 to G5 spacing	0.050	1.27
Spacing between plate portions 88 and 96	0.040	1.02
Length of recess 92	0.715	18.16
Vertical height of recess 92	0.315	8.00
Depth of recess 92	0.115	2.92
Length of G6 electrode	0.130	3.30
G5 to G6 spacing	0.050	1.27
Diameter of apertures 78, 82, 90 94, 98 and 104	0.160	4.06
Center-to-center aperture spacing	0.200	5.08

Length of aperture 100	0.698	17.73
Vertical height of aperture 100 at center beam	0.267	6.78
Vertical height of aperture 100 at outer beams	0.280	7.11
Depth of aperture 100	0.115	2.92
Length of G3 extrusions 79	0.035	0.89
Length of G5 extrusions 83	0.029	0.74
Length of G5' extrusions 95	0.034	0.86
Length of G6 extrusions 105	0.045	1.14

In the embodiment presented in TABLE I, the electron gun is electrically connected as shown in FIGURE 6. Typically, the cathode operates at about 150V, the G1 electrode is at ground potential, the G2 and G4 electrodes are electrically interconnected and operate within the range of about 300V to 1000V, the G3 and G5 electrodes also are electrically interconnected and operate at about 7kV, and the G6 electrode operates at an anode potential of about 25 kV.

While the electrical parameters of the preferred embodiment are similar to those described in U.S. Patent No. 4,641,058, cited above, the structural differences in the present electron gun provide superior performance.

In the present electron gun 40, the first lens, L1, (FIGURE 6) provides a symmetrically-shaped high quality electron beam into the second lens, L2. The beam has a large divergence angle of about 120 milliradians and an electron distribution as shown by the ray diagram in FIGURE 12. The crossover for the electron beam, operating at about 4 mA, occurs at a distance of about 2.3mm (0.090 inch) from the cathode. The corresponding beam current density contour of one of the beams is shown in FIGURE 13. It can be seen that the present beam forming region does not introduce any appreciable asymmetry into the electron beam.

In the present electron gun 40,the second lens, L2, comprising the G4 electrode 50 and the adjacent portions of the G3 electrode 48 and the G5 electrode 52, constitutes an asymmetric lens which provides a horizontally-elongated electron beam which, within the third or main focus lens, L3, has the beam spot contour shown in FIGURE 14. The substantially rectangular shape of the electron beam is produced by the rectangular apertures 80 formed through the G4 electrode 50. Since the Vertical dimensions of the apertures 80 are less than the horizontal dimensions, and the adjacent G3 and G5 electrodes operate at a potential greater than the potential on the G4 electrode, there is stronger vertical focusing of the beams prior to entering the main lens, L3. The G5′ electrode 54 is adapted to have a dynamic differential focus voltage applied thereto. That voltage ranges from the potential on the G5 electrode 52, with no deflection, to a voltage more positive than the voltage on the G5 electrode, but less positive than the voltage applied to the G4 electrode 50 and the G6 electrode 56, at maximum deflection. In the event that a slight misalignment of about 0.025 mm (0.001 inch) occurs in the apertures 64, 66 and 70 of the beam-forming region, the potential on the G4 electrode 50 (and on the interconnected G2 electrode 46) refracts the electrons of the electron beams emerging off-axes from the beam-forming region toward the axes.

The main focus lens, L3, formed between the G5′ electrode 54 and the G6 electrode 56 also is a low aberration, asymmetric lens, which provides a vertically-elongated, or asymmetrically-shaped, electron beam spot at the center of the screen. The resultant beam spot, shown in FIGURE 15a, has a substantially gaussian current density contour. As shown in FIGURE 15b, deflection of the beam to the upper right corner of the screen causes substantial elongation of the central 50% region of the beam, with enlarged regions or halos of lower intensity surrounding the central region.

By applying to the G5′ electrode 54 a dynamic differential focus voltage that ranges from the potential on G5, with no deflection, to about 1000 volts more positive than the voltage applied to the G5 electrode 52, at maximum deflection, the deflected electron beam current density contour can be improved as shown in FIGURE 15c.

A second embodiment of the computer modeled electron gun 40 shown in FIGURES 7 and 8 is presented in TABLE II. The beam-forming region of the electron gun of the second embodiment is identical to the beam-forming region of the first embodiment, and like numbers are used to designate like tube elements throughout the electron gun.

TABLE II

	Inches	mm
K-G1 spacing	0.003	0.08
Thickness of G4 electrode 50	0.030	0.76
G4 electrode aperture size	0.160H x 0.168V	4.06H x 4.27V
G3 to G4 spacing	0.050	1.27
Overall length of G5 and G5' electrodes 52 and 54	0.890	22.61
G4 to G5 spacing	0.050	1.27
Spacing between the plate portions 88 and 96	0.040	1.02
Length of recess 92	0.715	18.16
Vertical height of recess 92	0.315	8.00
Depth of recess 92	0.115	2.92
Length of G6 electrode	0.130	3.30
G5 to G6 spacing	0.050	1.27
Diameter of apertures 78, 82, 90 94, 98 and 104	0.160	4.06
Center-to-center aperture spacing	0.200	5.08
Length of aperture 100	0.693	17.60
Vertical height of aperture 100 at center beam	0.260	6.60
Vertical height of aperture 100 at outer beams	0.270	6.86
Depth of aperture 100	0.115	2.92
Length of G3 extrusions 79	0.035	0.89
Length of G5 extrusions 83	0.029	0.74
Length of G5' extrusions 95	0.034	0.86
Length of G6 extrusions 105	0.045	1.14

In the embodiment presented in TABLE II, the electron gun 40 is electrically connected as shown in FIGURE 16. Typically, the cathode operates at about 150V, the G1 electrode at ground potential, and the G2 electrode at about 400V. The G3 electrode is electrically interconnected to the G5 electrode and operates at about 7 kV, and the G4 electrode is electrically interconnected to the G6 electrode which operates at an anode potential of about 25 kV.

In the present electron gun, the first lens, L1, (FIGURE 16) provides a symmetrically-shaped high quality electron beam into the second lens, L2. Since the beam-forming region of the second embodiment is identical to that of the first embodiment, FIGURES 12 and 13 also show, respectively, the electron distribution and beam current density contour for one of the electron beams therefrom.

In the second embodiment, the second electron lens, L2, comprising the G4 electrode 50 and the adjacent portions of the G3 electrode 48 and the G5 electrode 52, constitutes an asymmetric lens which provides a horizontally-elongated, elliptically-shaped electron beam which, within the third or main focus lens, L3, has the beam current density contour shown in FIGURE 17. The elliptical shape of the beam is produced by the interaction of the rectangular apertures 80 in the G4 electrode 50 and voltage gradients in the second lens, L2. FIGURE 18 shows the resultant beam current density contour of an electron beam at the center of the screen. Since the horizontal dimension of the apertures 80 in the second embodiment is less than the vertical dimension, and the adjacent G3 and G5 electrodes operate at a potential less than the potential on the G4 electrode, weaker horizontal focusing of the beams occurs prior to entering the main lens, L3.

Despite the differences in structure and operating voltages between the first and second embodiments of the electron gun 40 presented in TABLES I and II, the beam contours shown in FIGURES 15a and 18 are similar and demonstrate that acceptable performance can be achieved utilizing either embodiment. The electrical configuration shown in FIGURE 6 is preferred, because the anode potential is not introduced into the lower voltage region of the electron gun.

A primary advantage of the embodiments presented in TABLES I and II over prior six-electrode electron guns, such as that described in U.S. Pat. 4,641,058, is that the initial asymmetric lens, L2, is located beyond the electron beam crossover point. Accordingly, the asymmetric effect of lens, L2, on the beam spot size and current density contour on the screen is relatively independent of the beam current. Additionally, the present structures provide beams of substantially constant current density, in both the horizontal and vertical directions, in the main lens.

The embodiments described herein are exemplary of the invention and are not meant to be limiting. For example, the rectangular apertures of the second embodiment of the G4 electrode 50 can be replaced with apertures of other suitable geometric shapes, to provide an asymmetric second lens. Additionally, the focus voltage on the G3 and G5 electrodes can be selected to vary the strength of the electron lenses in the electron gun.

Claims

1. A color cathode-ray tube, including an envelope having therein an inline electron gun for generating and directing three inline electron beams along initially coplanar axes on paths towards a screen on an interior portion of said envelope, said gun including a plurality of spaced electrodes which provide a first lens, a second lens and a third lens for focusing said electron beams, said first lens including a beam-forming region for providing substantially symmetrical beams to said second lens;

   said first lens (L1) comprising a first electrode (44), a second electrode (46) and a first portion of a third electrode (48), said second lens (L2) comprising a second portion of said third electrode, a fourth electrode (50) and a first portion (52) of a fifth electrode, and said third lens (L3) comprising a second portion (54) of said fifth electrode and a sixth electrode (56), said second electrode (46) and said fourth electrode (50) being interconnected, and said third electrode (48) and said first portion (52) of said fifth electrode being interconnected, said electrodes having suitable operating voltages applied thereto,

   said second lens (L2) including beam refraction means (48-52) for refracting said electron beams (28), emerging off said axes from said first lens (L1), toward said axes, and asymmetric beam-forming means comprising said fourth electrode (50) for providing horizontally elongated, asymmetrically-shaped beams to said third lens (L3), said fourth electrode including three horizontally elongated openings (80) therein for producing said horizontally elongated, asymmetrically-shaped beams, and

   said third lens (L3) being a low-aberration main focusing lens for providing vertically elongated, asymmetrically-shaped beams of substantially constant current density to said screen (22), said asymmetric main focusing lens being formed by facing surfaces of the second portion (54) of said fifth electrode and said sixth electrode (56) each of which includes a recess (92, 100) formed at the respective outer edge extending to said second portion (54) of said fifth electrode and said sixth electrode (56), respectively, each recess having a greater horizontal than vertical dimension, and three set-back apertures (94,104) in the bottom of the respective recess (92,100), each single aperture (94,104) being surrounded by a single extrusion (95, 105).

2. The tube as described in claim 1, characterized in that said second electrode (46) and said fourth elec-

trode (50) is adapted to operate at a first potential, said third electrode (48) and said first portion (52) of said fifth electrode is adapted to operate at a second potential which is more positive than said first potential, and said sixth electrode (56) is adapted to operate at a third potential which is more positive than said first and said second potentials.

3. The tube as described in claim 2, characterized in that said second portion (54) of said fifth electrode is spatially separated from said first portion (52) of said fifth electrode and is adapted to have a dynamic potential applied thereto, said dynamic potential ranging from said second potential to a fourth potential greater than said potential but substantially less than said third potential.

4. A color cathode-ray tube, including an envelope having therein an inline electron gun for generating and directing three inline electron beams along initially coplanar axes on paths towards a screen on an interior portion of said envelope, said gun including a plurality of spaced electrodes which provide a first lens, a second lens and a third lens for focusing said electron beams, said first lens including a beam-forming region for providing substantially symmetrical beams to said second lens;

said first lens (L1) comprising a first electrode (44), a second electrode (46) and a first portion of a third electrode (48), said second lens (L2) comprising a second portion of said third electrode, a fourth electrode (50) and a first portion (52) of a fifth electrode, and said third lens (L3) comprising a second portion (54) of said fifth electrode and a sixth electrode (56), said third electrode (48) and said first portion (52) of said fifth electrode being interconnected, and said fourth electrode (50) and said sixth electrode (56) being interconnected, said electrodes having suitable operating voltages applied thereto,

said second lens (L2) including beam refraction means (48-52) for refracting said electron beams (28), emerging off said axes from said first lens (L1), toward said axes, and asymmetric beam-forming means comprising said fourth electrode (50) for providing horizontally elongated, asymmetrically-shaped beams to said third lens (L3), said fourth electrode including three vertically elongated openings (80) therein for producing said horizontally elongated, asymmetrically-shaped beams, and

said third lens (L3) being a low-aberration main focusing lens for providing vertically elongated, asymmetrically-shaped beams of substantially constant density to said screen (22), said asymmetric main focusing lens being formed by facing surfaces of the second portion (54) of said fifth electrode and said sixth electrode (56) each of which includes a recess (92, 100) formed at the respective outer edge extending to said second portion (54) of said fifth electrode and said sixth electrode (56), respectively, each recess having a greater horizontal than vertical dimension, and three set-back apertures (94,104) in the bottom of the respective recess (92,100), each single aperture (94,104) being surrounded by a single extrusion (95,105).

5. The tube as described in claim 4, characterized in that said second electrode (46) is adapted to operate at a first potential, said third electrode and said first portion (52) of said fifth electrode are adapted to operate at a second potential which is more positive than said first potential, and said fourth electrode (50) and said sixth (56) are adapted to operate at a third potential which is more positive than said first and second potentials.

6. The tube as described in claim 5, characterized in that said second portion (54) of said fifth electrode is spatially separated from said first portion (52) of said fifth electrode and is adapted to have a dynamic potential applied thereto, said dynamic potential ranging from said second potential to a fourth potential, which is more positive than said second potential but less positive than said third potential.

7. A color cathode-ray tube, including an envelope having therein an inline electron gun for generating and directing three inline electron beams along initially coplanar axes on paths towards a screen on an interior portion of said envelope, said gun including a plurality of spaced electrodes which provide a first lens, a second lens and a third lens for focusing said electron beams, said first lens including a beam-forming region for providing substantially symmetrical beams to said second lens;

said first lens (L1) comprising a first electrode (44), a second electrode (46) and a first portion of a third electrode (48), said second lens (L2) comprising a second portion of said third electrode, a fourth electrode (50) and a first portion (52) of a fifth electrode, and said third lens (L3) comprising a second portion (54) of said fifth electrode and a sixth electrode (56), said second electrode (46) and said fourth electrode (50) being interconnected, and said third electrode (48) and said first portion (52) of said fifth electrode being interconnected, whereby in use suitable operating voltages are applied to said electrodes,

said second lens (L2) including beam refraction means (48-52) for refracting said electron beams

(28), emerging off said axes from said first lens (L1), toward said axes, and asymmetric beam-forming means comprising said fourth electrode (50) for providing horizontally elongated, asymmetrically-shaped beams to said third lens (L3), said fourth electrode including three horizontally elongated openings (80) therein for producing said horizontally elongated, asymmetrically-shaped beams, and

said third lens (L3) being a low-aberration main focusing lens for providing vertically elongated, asymmetrically-shaped beams of substantially constant current density to said screen (22), said asymmetric main focusing lens being formed by facing surfaces of the second portion (54) of said fifth electrode and said sixth electrode (56) each of which includes a recess (92,100) formed at the respective outer edge extending to said second portion (54) of said fifth electrode and said sixth electrode (56), respectively, each recess having a greater horizontal than vertical dimension, and three set-back apertures (94,104) in the bottom of the respective recess (92,100), each single aperture (94,104) being surrounded by a single extrusion (95,105).

8. A color cathode-ray tube, including an envelope having therein an inline electron gun for generating and directing three inline electron beams along initially coplanar axes on paths towards a screen on an interior portion of said envelope, said gun including a plurality of spaced electrodes which provide a first lens, a second and a third lens for focusing said electron beams, said first lens including a beam-forming region for providing substantially symmetrical beams to said second lens;

said first lens (L1) comprising a first electrode (44), a second electrode (46) and a first portion of a third electrode (48), said second lens (L2) comprising a second portion of said third electrode, a fourth electrode (50) and a first portion (52) of a fifth electrode, and said third lens (L3) comprising a second portion (54) of said fifth electrode and a sixth electrode (56), said third electrode (48) and said first portion (52) of said fifth electrode being interconnected, and said fourth electrode (50) and said sixth electrode (56) being interconnected, whereby in use suitable operating voltages are applied to said electrodes,

said second lens (L2) including beam refraction means (48-52) for refracting said electron beams (28), emerging off said axes from said first lens (L1), toward said axes, and asymmetric beam-forming means comprising said fourth electrode (50) for providing horizontally elongated, asymmetrically-shaped beams to said third lens (L3), said fourth electrode including three vertically elongated openings (80) therein for producing said horizontally elongated, asymmetrically-shaped beams, and

said third lens (L3) being a low-aberration main focusing lens for providing vertically elongated, asymmetrically-shaped beams of substantially constant density to said screen (22), said asymmetric main focusing lens being formed by facing surfaces of the second portion (54) of said fifth electrode and said sixth electrode (56) each of which includes a recess (92,100) formed at the respective outer edge extending to said second portion (54) of said fifth electrode and said sixth electrode (56), respectively, each recess having a greater horizontal then vertical dimension, and three set-back apertures (94,104) in the bottom of the respective recess (92,100), each single aperture (94,104) being surrounded by a single extrusion (95,105).

Patentansprüche

1. Farbkathodenstrahlröhre mit einer Hülle, in der eine Inline-Elektronenkanone angeordnet ist, um drei in Reihe liegende Elektronenstrahlen zu erzeugen und entlang zunächst koplanarer Achsen auf Wegen auf einen Schirm auf einem inneren Teil der Hülle zu richten, wobei die Kanone eine Vielzahl von einen Abstand voneinander aufweisenden Elektroden enthält, die eine erste Linse, eine zweite Linse und eine dritte Linse zur Fokussierung der Elektronenstrahlen bilden, wobei die erste Linse einen strahlformenden Bereich enthält, um im wesentlichen symmetrische Strahlen der zweiten Linse zuzuführen;

wobei die erste Linse (L1) eine erste Elektrode (44), eine zweite Elektrode (46) und einen ersten Teil einer dritten Elektrode (48) umfaßt, wobei die zweite Linse (L2) einen zweiten Teil der dritten Elektrode, eine vierte Elektrode (50) und einen ersten Teil (52) einer fünften Elektrode umfaßt, und wobei die dritte Linse (L3) einen zweiten Teil (54) der fünften Elektrode und eine sechste Elektrode (56) umfaßt, wobei die zweite Elektrode (46) und die vierte Elektrode (50) miteinander verbunden sind, und wobei die dritte Elektrode (48) mit dem ersten Teil (52) der fünften Elektrode verbunden ist, und wobei den Elektroden geeignete Betriebsspannungen zugeführt werden,

wobei die zweite Linse L2 Strahlbrechungsmittel (48 - 52) zur Brechung der Elektronenstrahlen (28), die aus den Achsen von der ersten Linde (L1) austreten, zu den Achsen enthält, und wobei asymmetrische strahlformende Mittel vorgesehen sind, die die vierte Elektrode umfassen, um der dritten Linse (L3) horizintal gestreckte, asymmetrisch geformte Strahlen zuzuführen, wobei die vierte Elektrode drei horizontal gestreckte Öffnungen (80) aufweist, um die horizontal gestreckten, asymmetrisch geformten Strahlen zu erzeugen, und

wobei die dritte Linse (L3) eine Haupt-Fokussierungslinse mit geringer Aberration ist, um dem Schirm (22) vertikal gestreckte asymmetrisch geformte Strahlen mit weitgehend konstanter Stromdichte zuzuführen, wobei die asymmetrische Haupt-Fokussierungslinse durch einander zugekehrte Flächen des zweiten Teils der fünften Elektrode und der sechsten Elektrode (56) gebildet wird, von denen jede eine Ausnehmung (92, 100) enthält, die an dem entsprechenden äußeren Rand gebildet ist, der sich zu dem zweiten Teil (54) der fünften Elektrode bzw. zur sechsten Elektrode (56) erstreckt, wobei jede Ausnehmung eine größere horizontale als vertikale Abmessung hat, und wobei drei zurückgesetzte Öffnungen (94, 104) im Boden der entsprechenden Ausnehmung (92, 110) angeordnet sind, von denen jede einzelne Öffnung (94, 104) von einem einzelnen Kragen (95, 105) umgeben ist.

2. Röhre nach Anspruch 1, dadurch gekennzeichnet, daß die zweite Elektrode (46) und die vierte Elektrode (50) so eingerichtet sind, daß sie mit einem ersten Potential arbeiten, daß die dritte Elektrode (48) und der erste Teil (52) der fünften Elektrode so eingerichtet sind, daß sie mit einem zweiten Potential arbeiten, das positiver als das erste Potential ist, und daß die sechste Elektrode (56) so eingerichtet ist, daß sie mit einem dritten Potential arbeitet, das positiver ist als das erste und zweite Potential.

3. Röhre nach Anspruch 2, dadurch gekennzeichnet, daß der zweite Teil (54) der fünften Elektrode räumlich von dem ersten Teil (52) der fünften Elektrode getrennt ist und so eingerichtet ist, daß ihm ein dynamisches Potential zugeführt wird, wobei das dynamische Potential von dem zweiten Potential bis zu einem vierten Potential reicht, das größer-als das genannte Potential aber wesentlich kleiner als das dritte Potential ist.

4. Farbkathodenstrahlröhre mit einer Hülle, in der eine Inline-Elektronenkanone angeordnet ist, um drei in Reihe liegende Elektronenstrahlen entlang zunächst koplanarer Achsen auf Wegen auf einen Schirm auf einem inneren Teil der Hülle zu richten, wobei die Kanone eine Vielzahl von einen Abstand voneinander aufweisenden Elektroden enthält, die eine erste Linse, eine zweite Linse und eine dritte Linse zur Fokussierung der Elektronenstrahlen bilden, wobei die erste Linse einen strahlformenden Bereich enthält, um im wesentlichen symmetrische Strahlen zu der zweiten Linse zu liefern;

wobei die erste Linse (L1) eine erste Elektrode (44), eine zweite Elektrode (46) und einen ersten Teil einer dritten Elektrode (48) umfaßt, wobei die zweite Linse (L2) einen zweiten Teil der dritten Elektrode, eine vierte Elektrode (50) und einen ersten Teil (52) einer fünften Elektrode umfaßt, und wobei die dritte Linse (L3) einen zweiten Teil (54) der fünften Elektrode und eine sechste Elektrode (56) umfaßt, wobei die dritte Elektrode (48) und der erste Teil (52) der fünften Elektrode miteinander verbunden sind, und wobei die vierte Elektrode (50) und die sechste Elektrode miteinander verbunden sind, und wobei den Elektroden geeignete Betriebsspannungen zugeführt werden,

wobei die zweite Linse (L2) Strahlbrechungsmittel (48 - 52) zur Brechung der Elektronenstrahlen (28), die aus den Achsen von der ersten Linse (L1) austreten, zu den Achsen enthält, und wobei asymmetrische strahlformende Mittel vorgesehen sind, die die vierte Elektrode (50) umfassen, um der dritten Linse (L3) horizontal gestreckte asymmetrisch geformte Strahlen zuzuführen, wobei die vierte Elektrode drei vertikal gestreckte Öffnungen (80) enthält, um die horizontal gestreckten asymmetrisch geformten Strahlen zu erzeugen, und

wobei die dritte Linse (L3) eine Haupt-Fokussierungslinse mit geringer Aberration ist, um dem Schirm (22) vertikal gestreckte, asymmetrisch geformte Strahlen mit weitgehend konstanter Stromdichte zuzuführen, wobei die asymmetrische Haupt-Fokussierungslinse durch einander zugekehrte Flächen des zweiten Teils (54) der fünften Elektrode und der sechsten Elektrode (56) gebildet wird, von denen jede eine Ausnehmung (92, 100) enthält, die an dem entsprechenden äußeren Rand gebildet ist, der sich zu dem zweiten Teil (54) der fünften Elektrode bzw. zur sechsten Elektrode (56) erstreckt, wobei jede Ausnehmung eine größere horizontale als vertikale Abmessung hat, und wobei drei zurückgesetzte Öffnungen (94, 104) im Boden der entsprechenden Ausnehmung (92, 100) angeordnet sind, von denen jede einzelne Öffnung (94, 104) von einem einzelnen Kragen (95, 105) umgeben ist.

5. Röhre nach Anspruch 4, dadurch gekennzeichnet, daß die zweite Elektrode (46) so eingerichtet ist, daß sie mit einem ersten Potential arbeitet, daß die dritte Elektrode und der erste Teil (52) der fünften Elektrode so eingerichtet sind, daß sie mit einem zweiten Potential arbeiten, das positiver als das erste Potential ist, und daß die vierte Elektrode (50) und die sechste Elektrode so eingerichtet sind, daß sie mit einem dritten Potential arbeiten, das positiver als das erste und zweite Potential ist.

6. Röhre nach Anspruch 5, dadurch gekennzeichnet, daß der zweite Teil (54) der fünften Elektrode räumlich von dem ersten Teil (52) der fünften Elektrode getrennt und so eingerichtet ist, daß ihm ein dynamisches Potential zugeführt wird, wobei das dynamische Potential von dem zweiten Potential bis zu einem vierten Potential reicht, das positiver als das zweite Potential aber weniger positiv als das dritte Potential ist.

7. Farbkathodenstrahlröhre mit einer Hülle, in der eine Inline-Elektronenkanone angeordnet ist, um drei in Reihe liegende Elektronenstrahlen zu erzeugen und entlang zunächst koplanarer Achsen auf Wegen auf einen Schirm auf einem inneren Teil der Hülle zu richten, wobei die Kanone eine Vielzahl von einen Abstand voneinander aufweisenden Elektroden enthält, die eine erste Linse, eine zweite Linse und eine dritte Linse zur Fokussierung der Elektronenstrahlen bilden, wobei die erste Linse einen strahlformenden Bereich enthält, um im wesentlichen symmetrische Strahlen zu der zweiten Linse zu liefern;

wobei die erste Linse (L1) eine erste Elektrode (44), eine zweite Elektrode (46) und einen ersten Teil einer dritten Elektrode (48) umfaßt, wobei die zweite Linse (L2) einen zweiten Teil der dritten Elektrode, eine vierte Elektrode (50) und einen ersten Teil (52) einer fünften Elektrode umfaßt, und wobei die dritte Linse (L3) einen zweiten Teil (54) der fünften Elektrode und eine sechste Elektrode (56) umfaßt, wobei die zweite Elektrode (46) und die vierte Elektrode (50) miteinander verbunden sind, und wobei die dritte Elektrode (48) und der erste Teil (52) der fünften Elektrode miteinander verbunden sind, wobei den Elektroden im Gebrauch geeignete Betriebsspannungen zugeführt werden,

wobei die zweite Linse (L2) Strahlbrechungsmittel (48 - 52) zur Brechung der Elektronenstrahlen (28), die aus den Achsen von der ersten Linse (L1) austreten, zu den Achsen enthält, und wobei asymmetrische strahlformende Mittel vorgesehen-sind, die die vierte Elektrode (50) umfassen, um horizontal gestreckte, asymmetrisch geformte Strahlen der dritten Linse (L3) zuzuführen, wobei die vierte Elektrode drei horizontal gestreckte Öffnungen (80) enthält, um die horizontal gestreckten asymmetrisch geformten Strahlen zu bilden, und

wobei die dritte Linse (L3) eine Haupt-Fokussierungslinse mit geringer Aberration zur Lieferung vertikal gestreckter asymmetrich geformter Strahlen mit im wesentlichen konstanter Stromdichte zu dem Schirm (22) ist, wobei die asymmetrische Haupt-Fokussierungslinse durch einander zugekehrte Flächen des zweiten Teils (54) der fünften Elektrode und der sechsten Elektrode (56) gebildet wird, von denen jede eine Ausnehmung (92, 100) an dem entsprechenden äußeren Rand aufweist, der sich zu dem zweiten Teil (54) der fünften Elektrode und der sechsten Elektrode (56) erstreckt, wobei jede Ausnehmung eine größere horizontale als vertikale Abmessung hat, und wobei drei zurückgesetzte Öffnungen (94, 104) im Boden der entsprechenden Ausnehmungen (92, 100) vorgesehen sind, die jeweils von einem einzelnen Kragen (95, 105) umgeben sind.

8. Farbkathodenstrahlröhre mit einer Hülle, in der eine Inline-Elektronenkanone angeordnet ist, um drei in Reihe liegende Elektrodenstrahlen zu erzeugen und entlang zunächst koplanarer Achsen auf Wegen auf einen Schirm auf einem inneren Teil der Hülle zu richten, wobei die Kanone eine Vielzahl von einen Abstand voneinander aufweisenden Elektroden enthält, die eine erste Linse, eine zweite Linse und eine dritte Linse zur Fokussierung der Elektronenstrahlen bilden, wobei die erste Linse einen strahlformenden Bereich enthält, um im wesentlichen symmetrische Strahlen zu der zweiten Linse zu liefern,

wobei die erste Linse (L1) eine erste Elektrode (44), eine zweite Elektrode (46) und einen ersten Teil einer dritten Elektrode (48) umfaßt, wobei die zweite Linse (L2), einen zweiten Teil der dritten Elektrode, eine vierte Elektrode und einen ersten Teil (52) einer fünften Elektrode umfaßt, und wobei die dritte Linse (L3) einen zweiten Teil (54) der fünften Elektrode und eine sechste Elektrode (56) umfaßt, wobei die dritte Elektrode (48) un der erste Teil (52) der fünften Elektrode miteinander verbunden sind, und wobei die vierte Elektrode (50) und die sechste Elektrode (56) miteinander verbunden sind, und wobei im Betrieb den Elektroden geeignete Betriebsspannungen zugeführt werden,

wobei die zweite Linse (L2) Strahlbrechungsmittel (48 - 52) zur Brechung der Elektronenstrahlen (28), die aus den Achsen von der ersten Linse (L1) austreten, zu den Achsen enthält, und wobei asymmetrische strahlformende Mittel vorgesehen sind, die die vierte Elektrode (50) umfassen, um der dritten Linse (L3) horizontal gestreckte, asymmetrisch geformte Strahlen zuzuführen, wobei die vierte Elektrode drei vertikal gestreckte Öffnungen (80) aufweist, um die horizontal gestreckten asymmetrisch geformten Strahlen zu erzeugen, und

wobei die dritte Linse (L3) eine Haupt-Fokussierungslinse mit geringer Aberration ist, um dem Schirm (22) vertikal gestreckte asymmetrisch geformte Strahlen mit weitgehend konstanter Stromdichte zuzuführen, wobei die asymmetrische Haupt-Fokussierungslinse durch einander zugekehrte Flächen des zweiten Teils (54) der fünften Elektrode und der sechsten Elektrode (56) gebildet wird, von denen jede eine Ausnehmung (92, 100) enthält, die an dem entsprechenden äußeren Rand gebildet ist, der sich zu dem zweiten Teil (54) der fünften Elektrode und der sechsten Elektrode (56) erstreckt, wobei jede Ausnehmung eine größere horizontale als vertikale Abmessung hat, und wobei drei zurückgesetzte Öffnungen (94, 104) im Boden der entsprechenden Ausnehmung (92, 100) angeordnet sind, von denen jede einzelne Öffnung (94, 104) von einem einzelnen Kragen (95, 105) umgeben ist.

Revendications

1. Tube couleur à rayons cathodiques, comprenant une enceinte comportant un canon à électrons en ligne pour générer et orienter trois faisceaux d'électrons en ligne le long d'axes initialement coplanaires sur des trajectoires dirigées vers un écran situé sur une partie intérieure de ladite enceinte, ledit canon à électrons comportant une pluralité d'électrodes espacées qui fournissent une première lentille, une seconde lentille et une troisième lentille pour focaliser lesdits faisceaux d'électrons , ladite première lentille comprenant une zone de formation de faisceaux pour fournir des faisceaux sensiblement symétriques à ladite seconde lentille ;

   ladite première lentille (L1) comprenant une première électrode (44), une seconde électrode (46) et une première partie d'une troisième électrode (48), ladite seconde lentille (L2) comprenant une seconde partie de ladite troisième électrode, une quatrième électrode (50) et une première partie (52) d'une cinquième électrode et ladite troisième lentille (L3) comprenant une seconde partie (54) de ladite cinquième électrode et une sixième électrode (56), ladite seconde électrode (46) et ladite quatrième électrode (50) étant interconnectées, et ladite troisième électrode (48) et ladite première partie (52) de ladite cinquième électrode étant interconnectées, étant appliquées auxdites électrodes des tensions de fonctionnement convenables,

   ladite seconde lentille (L2) comprenant des moyens de réfraction de faisceaux (48-52) pour réfracter lesdits faisceaux d'électrons émergeant, hors desdits axes, de ladite première lentille (L1) vers lesdits axes, et des moyens de formation de faisceaux asymétriques comprenant ladite quatrième électrode (50) pour fournir des faisceaux configurés de façon asymétrique, allongés horizontalement, à ladite troisième lentille (L3), ladite quatrième électrode comportant trois ouvertures allongées horizontalement (80) pour produire lesdits faisceaux configurés de façon asymétrique, allongés horizontalement, et

   ladite troisième lentille (L3) étant une lentille de focalisation principale de faible aberration destinée à fournir des faisceaux configurés de façon asymétrique, verticalement allongés, d'une densité de courant sensiblement constante audit écran (22), ladite lentille de focalisation principale asymétrique étant formée des surfaces opposées de la seconde partie (54) de ladite cinquième électrode et de ladite sixième électrode (56), chacune comportant un évidement (92, 100) formé au niveau du bord extérieur respectif s'étendant vers ladite seconde partie (54) de ladite cinquième électrode et ladite sixième électrode (56), respectivement , chaque évidement ayant une dimension horizontale plus grande que la dimension verticale et trois ouvertures en recul (94, 104) situées au fond de l'évidement respectif (92, 100) , chaque ouverture particulière (94, 104) étant entourée d'un rebord unique (95, 105).

2. Tube selon la revendication 1, caractérisé en ce que ladite seconde électrode (46) et ladite quatrième électrode (50) sont adaptées pour fonctionner à un premier potentiel, ladite troisième électrode (48) et ladite première partie (52) de ladite cinquième électrode sont adaptées pour fonctionner à un second potentiel qui est plus positif que ledit premier potentiel, et ladite sixième électrode (56) est adaptée pour fonctionner à un troisième potentiel qui est plus positif que lesdits premier et second potentiels.

3. Tube selon la revendication 2, caractérisé en ce que ladite seconde partie (54) de ladite cinquième électrode est séparée spatialement de ladite première partie (52) de ladite cinquième électrode et est adaptée pour que lui soit appliqué un potentiel dynamique se situant dans la gamme allant dudit second potentiel au quatrième potentiel plus grand que ledit potentiel mais sensiblement plus petit que ledit troisième potentiel.

4. Tube couleur à rayons cathodiques, comprenant une enceinte comportant un canon à électrons en ligne pour générer et orienter trois faisceaux d'électrons en ligne le long d'axes initialement coplanaires sur des trajectoires orientées vers un écran situé sur une partie intérieure de ladite enceinte, ledit canon comprenant une pluralité d'électrodes espacées qui fournissent une première lentille, une seconde lentille et une troisième lentille pour focaliser lesdits faisceaux d'électrons, ladite première lentille comprenant une zone de formation de faisceaux destinée à fournir des faisceaux sensiblement symétriques à ladite seconde lentille ;

ladite première lentille (L1) comprenant une première électrode (44), une seconde électrode (46) et une première partie d'une troisième électrode (48), ladite seconde lentille (L2) comprenant une seconde partie de ladite troisième électrode, une quatrième électrode (50) et une première partie (52) d'une cinquième électrode et ladite troisième lentille (L3) comprenant une seconde partie (54) de ladite cinquième électrode et d'une sixième électrode (56), ladite troisième électrode (48) et ladite première partie (52) de ladite cinquième électrode étant interconnectées et ladite quatrième électrode (50) et ladite sixième électrode (56) étant interconnectées, des tensions de fonctionnement convenables étant appliquées auxdites électrodes,

ladite seconde lentille (L2) comprenant des moyens de réfraction de faisceaux (48-52) pour réfracter lesdits faisceaux d'électrons (28), émergeant, hors desdits axes, de ladite première lentille (L1) vers lesdits axes, et des moyens de formation de faisceaux asymétriques comprenant ladite quatrième électrode (50) destinée à fournir des faisceaux configurés de façon asymétrique, allongés horizontalement à la troisième lentille (L3), ladite quatrième électrode présentant trois ouvertures allongées verticalement (80) pour produire lesdits faisceaux configurés de façon asymétrique, allongés horizontalement, et

ladite troisième lentille (L3) étant une lentille de focalisation principale de faible aberration destinée à fournir des faisceaux configurés de façon asymétrique, allongés verticalement d'une densité sensiblement constante audit écran (22), ladite lentille de focalisation principale asymétrique étant formée par les surfaces opposées de la seconde partie (54) de ladite cinquième électrode et de ladite sixième électrode (56), dont chacune comporte un évidement (92, 100) formé au niveau du bord extérieur respectif, s'étendant vers ladite seconde partie (54) de ladite cinquième électrode et ladite sixième électrode (56), respectivement, chaque évidement ayant une dimension horizontale plus grande que la dimension verticale, et trois ouvertures en recul (94, 104) , chaque ouverture particulière (94, 104) étant entourée d'un rebord unique (95, 105).

5. Tube selon la revendication 4, caractérisé en ce que ladite seconde électrode (46) est adaptée pour fonctionner à un premier potentiel, ladite troisième électrode et ladite première partie (52) de ladite cinquième électrode sont adaptées pour fonctionner à un second potentiel qui est plus positif que ledit premier potentiel et ladite quatrième électrode (50) et ladite sixième (56) sont adaptées pour fonctionner à un troisième potentiel qui est plus positif que lesdits premier et second potentiels.

6. Tube selon la revendication 5, caractérisé en ce que ladite seconde partie (54) de ladite cinquième électrode est séparée spatialement de ladite première partie (52) de ladite cinquième électrode et est adaptée pour que lui soit appliqué un potentiel dynamique, ledit potentiel dynamique se situant dans l'intervalle allant dudit second potentiel à un quatrième potentiel lequel est plus positif que ledit second potentiel mais moins positif que ledit troisième potentiel.

7. Tube couleur à rayons cathodiques comprenant une enceinte comportant un canon à électrons en ligne pour générer et orienter trois faisceaux d'électrons en ligne le long d'axes initialement coplanaires sur des trajectoires dirigées vers un écran situé sur une partie intérieure de ladite enceinte , ledit canon comprenant une pluralité d'électrodes espacées qui fournissent une première lentille , une seconde lentille et une troisième lentille destinées à focaliser lesdits faisceaux d'électrons , ladite première lentille comprenant une zone de formation de faisceaux destinée à fournir des faisceaux sensiblement symétriques à ladite seconde lentille ;

ladite première lentille (L1) comprenant une première électrode (44), une seconde électrode (46) et une première partie d'une troisième électrode (48) , ladite seconde lentille (L2) comprenant une seconde partie de ladite troisième électrode , une quatrième électrode (50) et une première partie (52) d'une cinquième électrode et ladite troisième lentille (L3) comprenant une seconde partie (54) de ladite cinquième électrode et une sixième électrode (56), ladite seconde électrode (46) et ladite quatrième électrode (50) étant interconnectées et ladite troisième électrode (48) et ladite première partie (52) de ladite cinquième électrode étant interconnectées, de façon qu'en fonctionnement, des tensions de fonctionnement adéquates soient appliquées auxdites électrodes,

ladite seconde lentille (L2) comprenant des moyens de réfraction de faisceau (48-52) pour réfracter lesdits faisceaux d'électrons (28), émergeant, hord desdits axes, de ladite première lentille (L1) vers lesdits axes et des moyens de formation de faisceaux asymétriques comprenant ladite quatrième électrode (50) destinée à fournir des faisceaux configurés de façon asymétrique, horizontalement allongés à ladite troisième lentille (L3), ladite quatrième électrode comprenant trois ouvertures allongées horizontalement (80) pour produire lesdits faisceaux configurés de façon asymétrique, allongés horizontalement, et

ladite troisième lentille (L3) étant une lentille de focalisation principale de faible aberration destinée à fournir des faisceaux configurés de façon asymétrique, allongés verticalement, d'une densité de courant sensiblement constante audit écran (22), ladite lentille de focalisation principale asymétrique étant formée par les surfaces opposées de la seconde partie (54) de ladite cinquième électrode et de ladite sixième électrode (56) dont chacune comporte un évidement (92, 100) formé au niveau du bord extérieur respectif s'étendant vers ladite seconde partie (54) de ladite cinquième électrode et ladite sixième électrode (56), respectivement, chaque évidement ayant une dimension horizontale plus grande que la dimension verticale et trois ouvertures en recul (94-104) au fond de l'évidement respectif (92-100), chaque ouverture particulière (94-104) étant entourée d'un rebord unique (95, 105).

8. Tube couleur à rayons cathodiques, comprenant une enceinte comportant un canon en ligne pour générer et orienter trois faisceaux d'électrons en ligne le long d'axes initialement coplanaires sur des trajectoires dirigées vers un écran situé sur une partie intérieure de ladite enceinte, ledit canon comprenant une pluralité d'électrodes espacées qui fournissent une première lentille, une seconde et une troisième lentilles pour focaliser lesdits faisceaux d'électrons, ladite première lentille comprenant une zone de formation de faisceaux pour fournir des faisceaux sensiblement symétriques à ladite seconde lentille ;

ladite première lentille (L1) comprenant une première électrode (44), une seconde électrode (46) et une première partie d'une troisième électrode (48), ladite seconde lentille (L2) comprenant une seconde partie de ladite troisième électrode , une quatrième électrode (50) et une première partie (52) d'une cinquième électrode et ladite troisième lentille (L3) comprenant une seconde partie (54) de ladite cinquième électrode et une sixième électrode (56), ladite troisième électrode (48) et ladite première partie (52) de ladite cinquième électrode étant interconnectées et ladite quatrième électrode (50) et ladite sixième électrode (56) étant interconnectées, de sorte que lors de l'utilisation , des tensions de fonctionnement adéquates soient appliquées auxdites électrodes,

ladite seconde lentille (L2) comprenant des moyens de réfraction de faisceaux (48-52) pour réfracter lesdits faisceaux d'électrons (28), émergeant, hors desdits axes, de ladite première lentille (L1) vers lesdits axes, et des moyens de formation de faisceaux asymétriques comprenant ladite quatrième électrode (50) pour fournir des faisceaux configurés de façon asymétrique, allongés horizontalement, à ladite troisième lentille (L3), ladite quatrième électrode comprenant trois ouvertures allongées verticalement (80) pour produire lesdits faisceaux configurés de façon asymétrique, allongés horizontalement, et

ladite troisième lentille (L3) étant une lentille de focalisation principale de faible aberration pour fournir des faisceaux configurés de façon asymétrique, allongés verticalement, de densité de courant sensiblement constante audit écran (22), ladite lentille de focalisation principale asymétrique étant formée de surfaces opposées de la seconde partie (54) de ladite cinquième électrode et de ladite sixième électrode (56), dont chacune comporte un évidement (92, 100) formé au niveau du bord extérieur respectif s'étendant vers ladite seconde partie (54) de ladite cinquième électrode et ladite sixième électrode (56), respectivement,chaque évidement ayant une dimension horizontale plus grande que la dimension verticale et trois ouvertures en recul (94,104) situées au fond de l'évidement respectif (92,100) , chaque ouverture particulière (94,104) étant entourée d'un seul rebord (95, 105).

Fig. 1
PRIOR ART

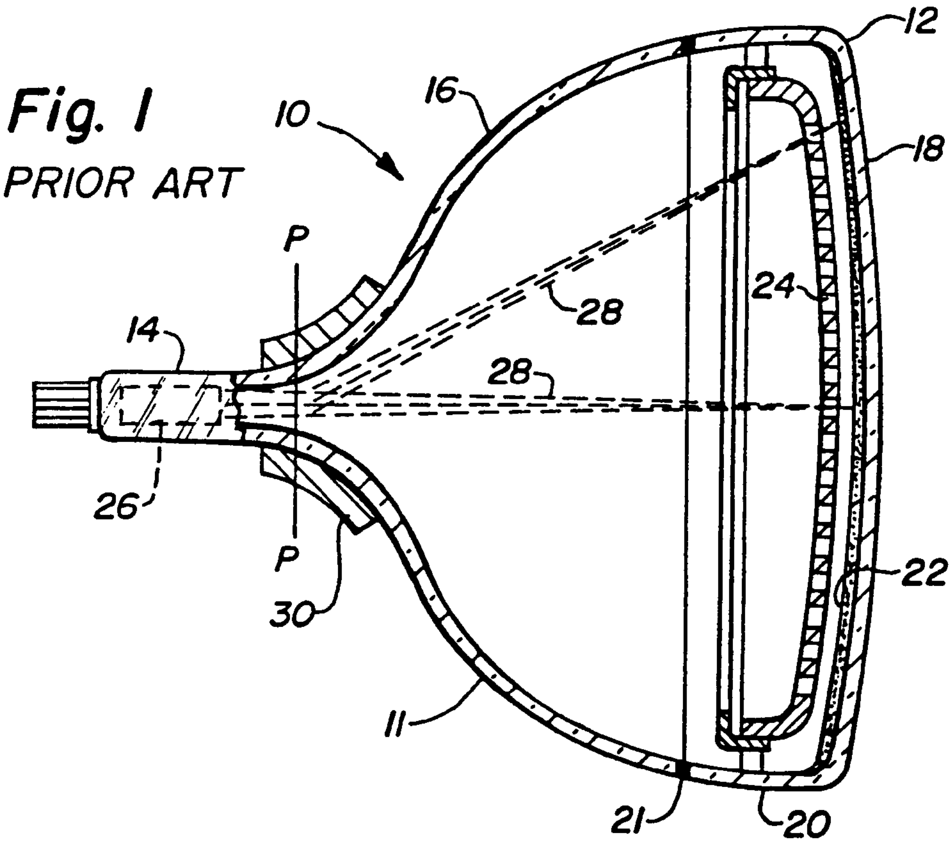
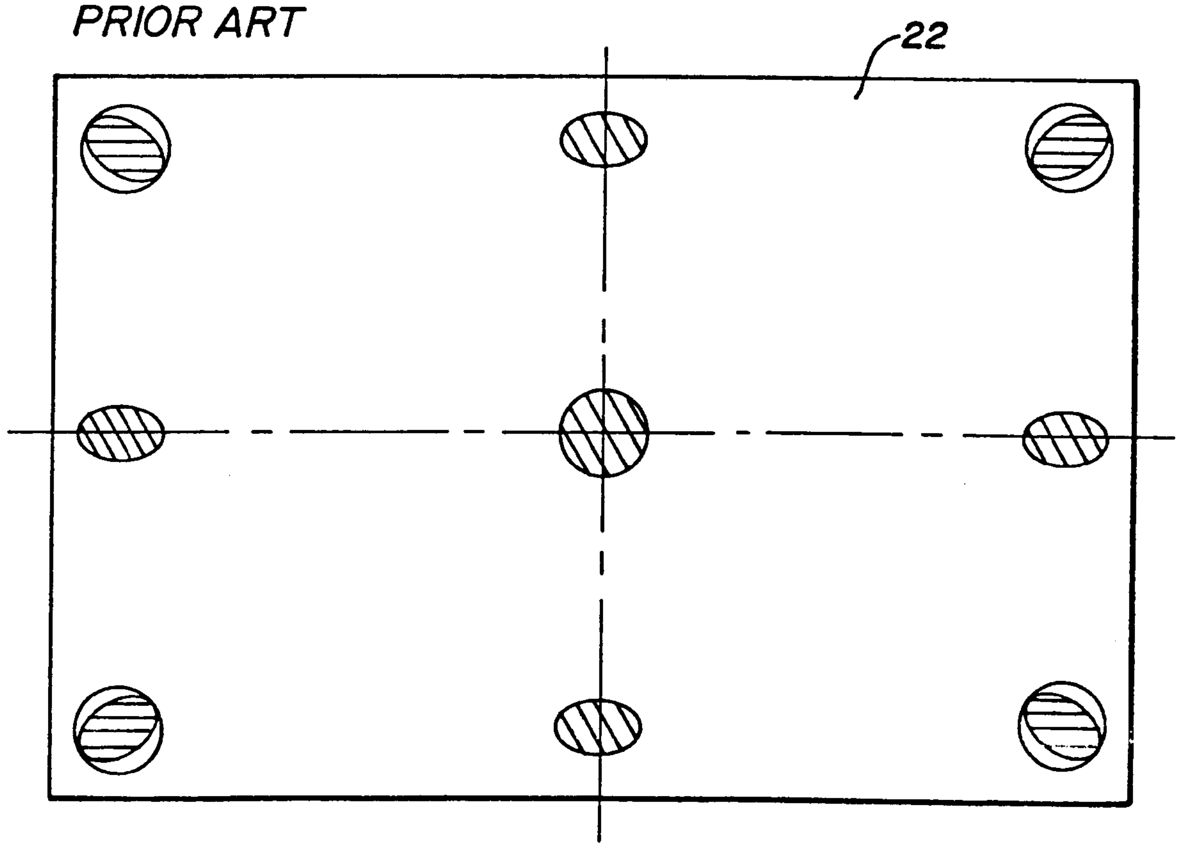


Fig. 3
PRIOR ART



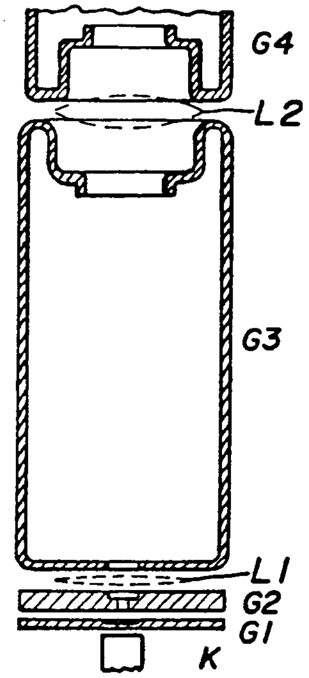


Fig. 2

PRIOR ART

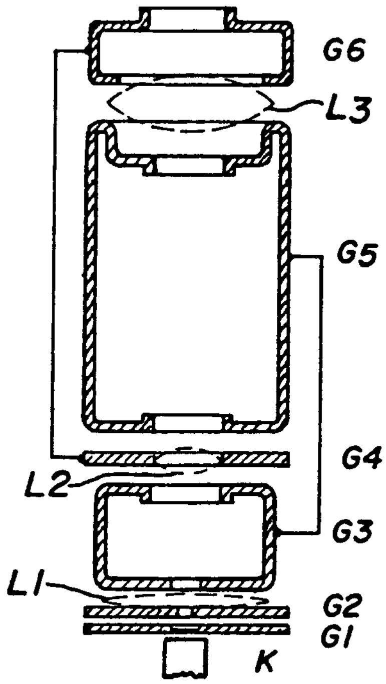


Fig. 16

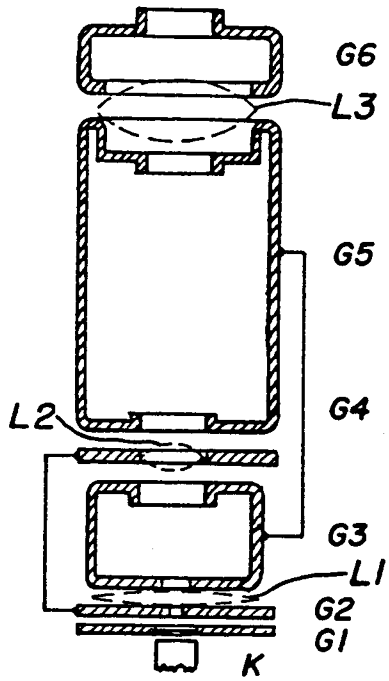


Fig. 6

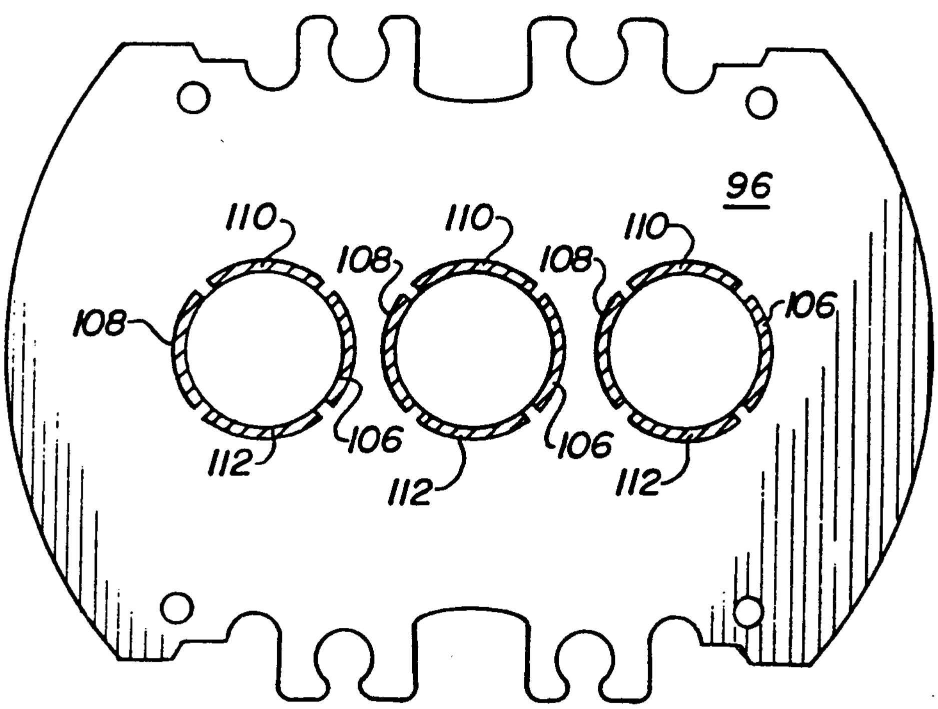


Fig. 11

Fig. 5a

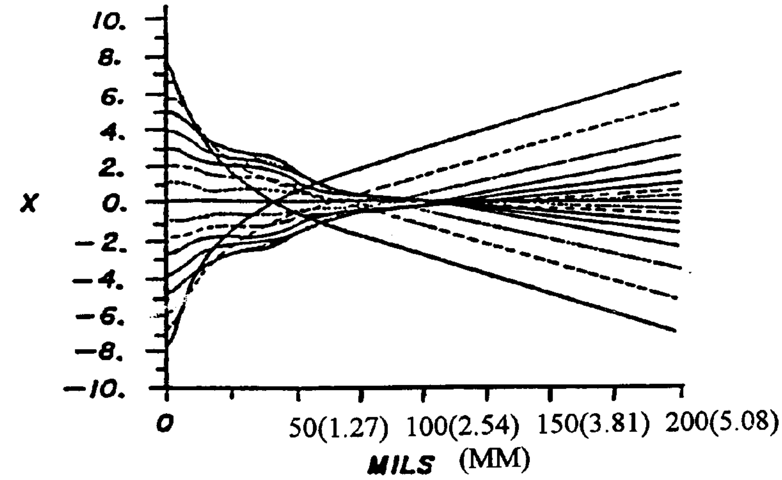


Fig. 4a

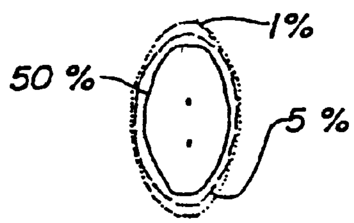


Fig. 5b

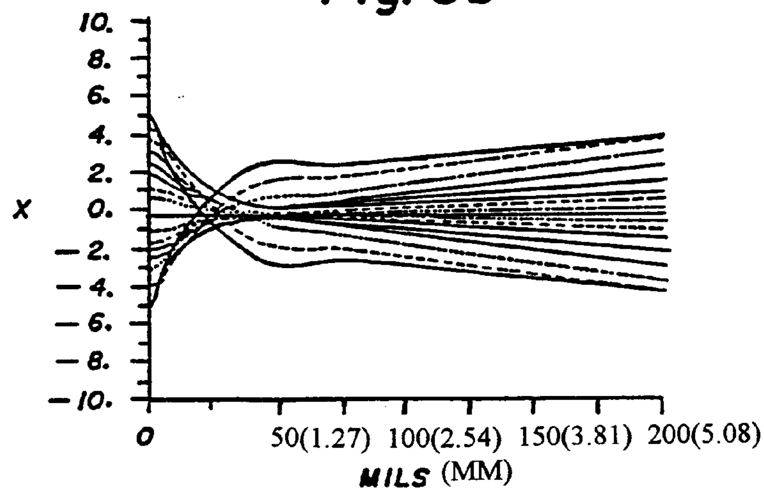


Fig. 4b

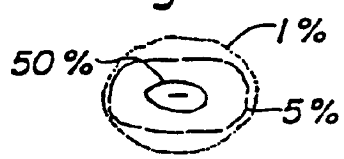


Fig. 4c

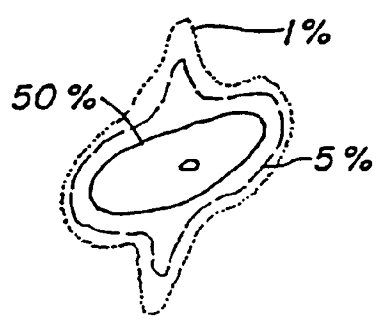
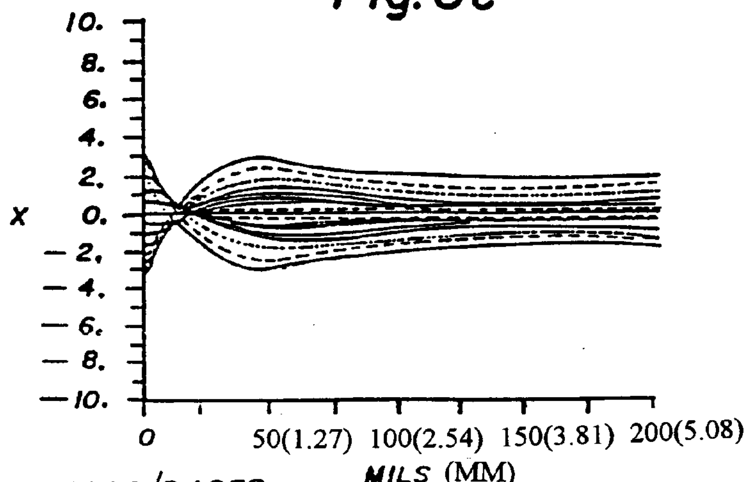


Fig. 5c



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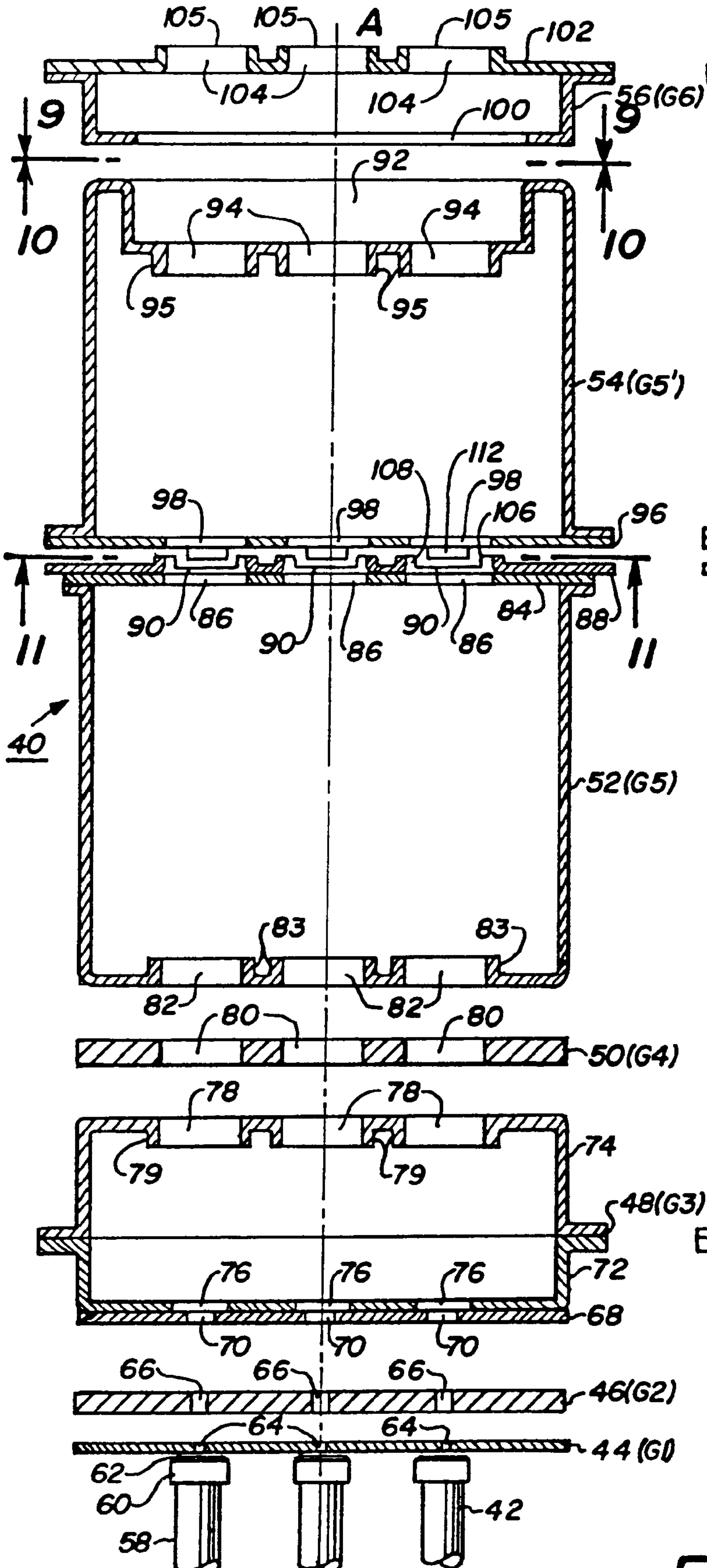
105
105
A
105
102
104
104
100
56(G6)
9
9
92
94
94
10
10
95
95
54(G5')
108
112
98
98
98
106
96
90
86
90
86
90
86
84
88
11
11
40
52(G5)
83
83
82
82
80
80
50(G4)
78
78
79
79
74
48(G3)
76
76
76
72
68
70
70
70
66
66
66
46(G2)
64
64
44 (G1)
62
60
58
42
A

Fig. 7

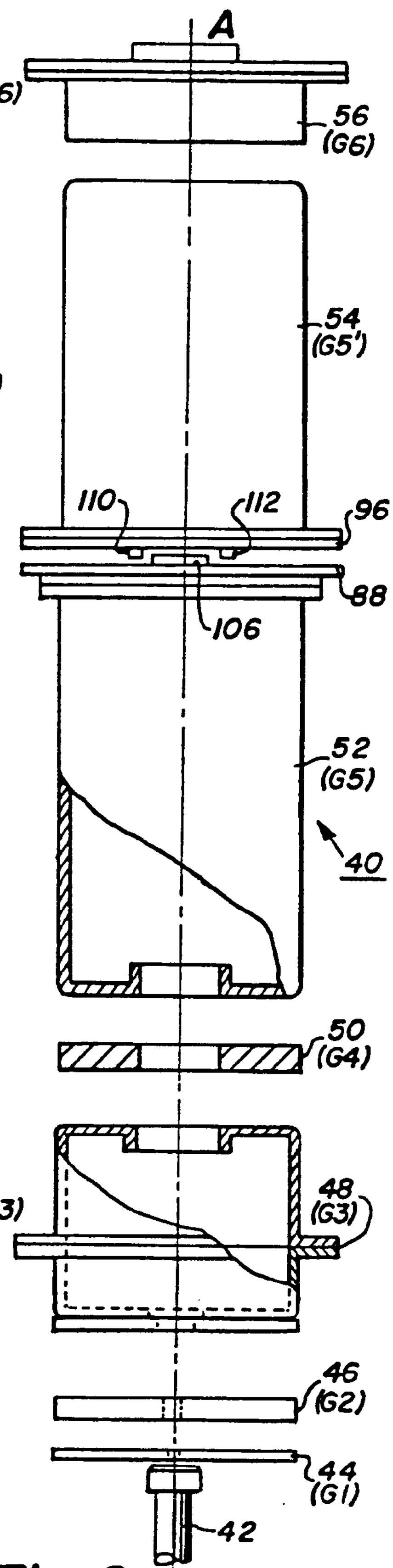
A
56
(G6)
54
(G5')
110
112
96
88
106
52
(G5)
40
50
(G4)
48
(G3)
46
(G2)
44
(G1)
42
A

Fig. 8

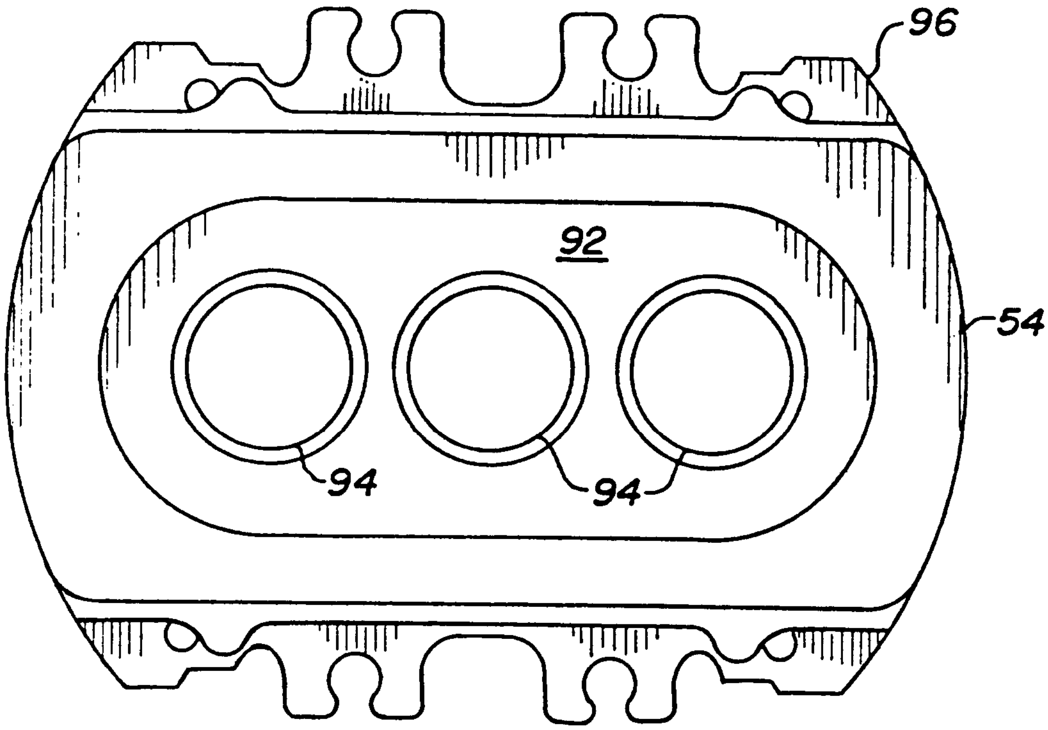

Fig. 9

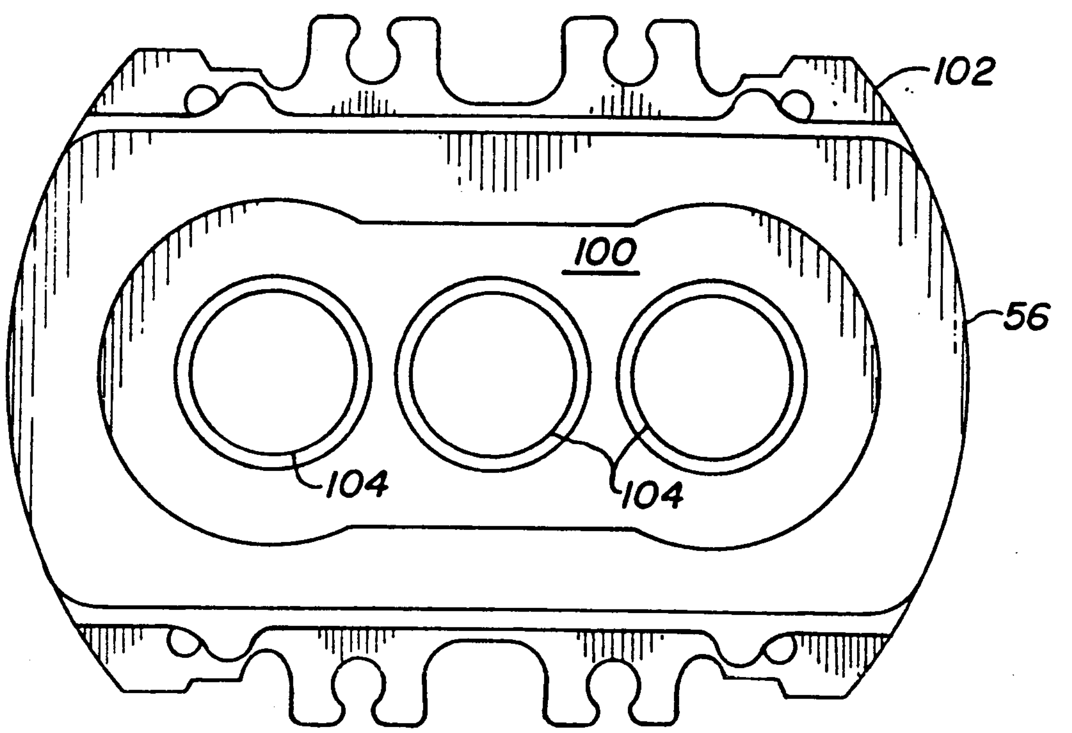

Fig. 10

Fig. 12

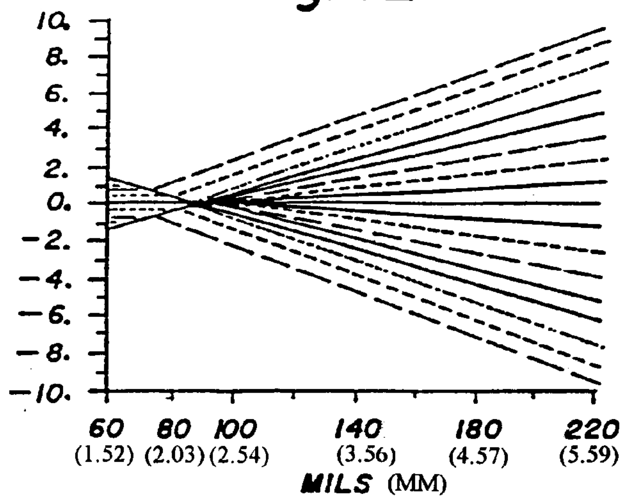

Fig. 13

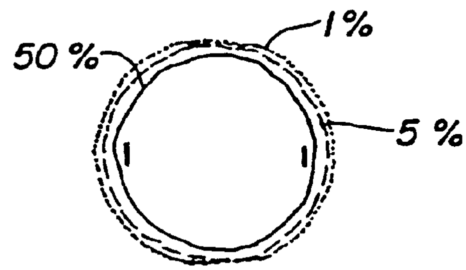

Fig. 14

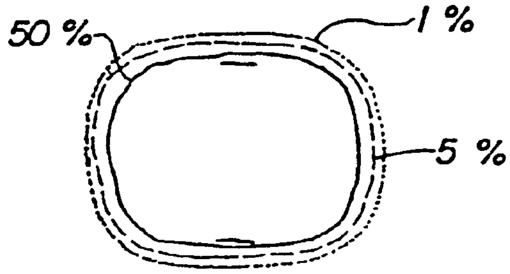

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Fig. 15a

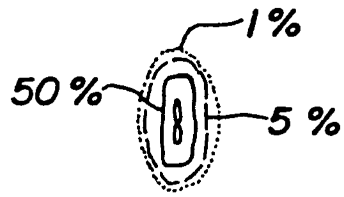

Fig. 15b

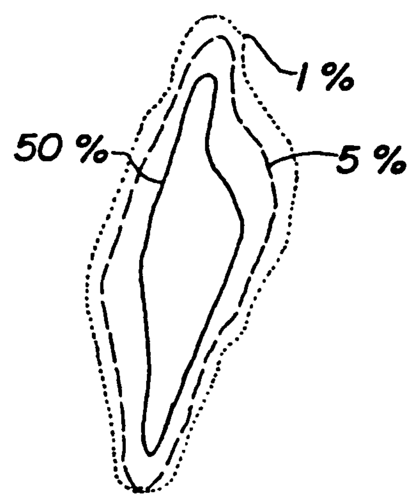

Fig. 15c

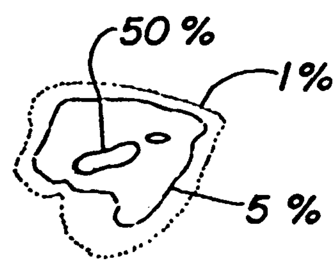

Fig. 17

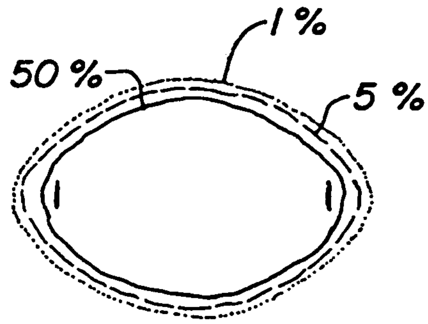

Fig. 18