

SPECIFICATION

Cathode-ray tube

- 5 The invention relates to a cathode-ray tube.
 Generally a cathode-ray tube comprises in
 an evacuated glass envelope an electron gun
 to generate an electron beam and a target for
 receiving the electron beam, which electron
 10 gun consists at least of a cathode which is
 centred substantially around an axis and the
 emissive surface of which is substantially nor-
 mal to said axis, a first grid and a second
 grid, the first grid in cooperation with the
 15 cathode and the second grid constituting non-
 rotationally symmetrical electron lenses.
 Such a cathode-ray tube may be used for
 displaying television pictures or may be used
 in an oscilloscope. In that case the target is a
 20 display screen having a phosphor layer or a
 pattern of phosphors luminescing in different
 colours. Such a cathode-ray tube may also be
 used for recording television pictures. In that
 case the target usually is a photoconductive
 25 layer. In all applications a spot is desired
 having certain dimensions and without a haze
 surrounding the spot.
 A cathode-ray tube is disclosed in British
 Patent Specification No. 1,177,319. In the
 30 first grid of the electron gun of the cathode-
 ray tube described in the abovementioned
 specification an angular or elliptical aperture is
 provided which in cooperation with the cath-
 ode and the second grid constitutes non-
 35 rotationally symmetrical electron lenses to
 compensate for the astigmatism which has
 arisen from a quadrupole lens for deflection
 amplification. Such an elongate aperture,
 however, does not result in strong focusing of
 40 the electron beam in two mutually perpendi-
 cular directions.
 It is therefore an object of the invention to
 provide a cathode-ray tube in which a strong
 focusing by means of the first grid in two
 45 mutually perpendicular directions is possible.
 Another object of the invention is to provide a
 cathode-ray tube in which the spot has a good
 quality, that is, has the desired shape and is
 substantially not surrounded by a haze.
 50 According to the present invention there is
 provided a cathode-ray tube comprising in an
 evacuated glass envelope an electron gun to
 generate an electron beam, which electron
 gun consists at least of a cathode which is
 55 centred substantially around an axis and has
 an emissive surface which is substantially nor-
 mal to said axis, a first grid and a second
 grid, wherein the first grid in cooperation with
 the cathode constitutes a first multipole elec-
 60 tron lens in which the quadrupole lens compo-
 nent predominates, and in cooperation with
 the second grid constitutes a second multipole
 electron lens in which the quadrupole lens
 component predominates, said latter quadru-
 65 pole lens component being rotated 90° with

respect to the quadrupole lens component of
 the first multipole electron lens.

- The first and second multipole electron
 lenses can be obtained in a large number of
 70 manners. In a first embodiment the two mul-
 tipole electron lenses are formed in that the
 aperture in the first grid has an elongate
 cross-section both on the side of the cathode
 and on the side of the second grid and the
 75 long axis of the elongate cross-section on the
 side of the cathode is normal to the long axis
 of the elongate cross-section on the side of
 the second grid. By providing an elongate
 aperture in an electrode, which electrode is in
 80 an accelerating electric field, a multipole lens
 is formed which mainly is a quadrupole lens
 that is a lens in which the quadrupole compo-
 nent is the strongest. By providing such a first
 grid two multipole electron lenses having their
 85 quadrupole components rotated 90° with re-
 spect to each other and situated immediately
 behind each other are obtained. The depth
 and the dimensions of the parts of the aper-
 ture in the first grid, the distances to the
 90 cathode and the second grid and the poten-
 tials on the electrodes determine the strength
 of said quadrupole lenses. It will be apparent
 that many desired shapes can be obtained
 which shapes are necessary for many types of
 95 pick-up and display tubes by variations in the
 dimensions and depth of the parts of the
 aperture.

- In colour display tubes in general three
 electron guns situated beside each other or
 100 arranged in a triangular arrangement are
 used. These electron guns may have one or
 more electrodes in common. A gun having a
 common electrode is disclosed, for example,
 in United States Patent Specification
 105 3,772,554. The invention described herein-
 after may also be used in such a gun system.
 Moreover, in colour display tubes deflection
 defocusing often occurs. This is an astigmatic
 influence on the beam as a result of the
 110 deflection field. The deflection defocusing re-
 sults in a serious spot deformation at the edge
 of the display screen. The astigmatic influence
 is mainly caused by a quadrupole field gener-
 ated by the deflection coils. Together with the
 115 two quadrupoles in the first grid a combina-
 tion is formed of three quadrupole fields after
 each other with which a considerable compen-
 sation of the deflection defocusing is possible.

- By using a cathode-ray tube made in accor-
 120 dance with the invention it is possible to
 influence the electron beam in such manner
 that a very good quality of the spot is ob-
 tained, which is expressed *inter alia* in a spot
 on the display screen substantially without a
 125 haze surrounding the spot and with the de-
 sired shape.

- It is possible to provide the two elongate
 mutually perpendicular parts of the aperture in
 the first grid by means of known methods, for
 130 example, etching and spark erosion. It is

alternatively possible to provide elongate recesses in the material and to connect them together, for example, by drilling.

Another embodiment of the first grid consists of two at least partly plate-shaped parts which are secured together and are electrically connected together and are provided with mutually perpendicular elongate apertures.

A third embodiment of the first grid consists of three at least partly plate-shaped parts which are secured together and are electrically connected together, of which the plate-shaped parts situated on the cathode side and on the side of the second grid are provided with mutually perpendicular elongate apertures and the intermediate part is provided with an aperture having a smallest dimension which exceeds the largest dimension of the elongate apertures.

A fourth embodiment of the first grid consists of an at least partly plate-shaped part in which on the two sides mutually perpendicularly extending grooves are provided, said grooves being so deep that at the area of the crossing of the grooves an aperture is formed. The grooves may be V or U-shaped.

A fifth very simple embodiment is that in which the first grid has a part extending at right angles to the axis which part has a coaxial aperture therein and at least one diametrically extending pleat. Since the pleat, viewed from one side, is convex and is concave from the other side, the system of two quadrupole lenses rotated 90° with respect to each other is obtained in cooperation with the cathode and the second grid.

A sixth very simple embodiment in which a stronger system of lenses than in the preceding embodiment is obtained can be manufactured by providing a part of the first grid with two diametrically extending pleats of which one is concave and the other is convex, said pleats extending in mutually perpendicular directions.

It will be obvious that the two mutually perpendicular parts of the aperture in the first grid can be obtained in many other manners or combinations of the methods described.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which

Figure 1 is a sectional view of a cathode-ray tube in accordance with the invention,

Figure 2 is a perspective view of a triple electron gun for a cathode-ray tube in accordance with the invention,

Figure 3 is a sectional view of one of the three guns shown in Fig. 2.

Figures 4 and 5 are sectional views on the lines IV-IV and V-V of Fig. 3,

Figures 6 to 12 and Figures 15 and 16 are a number of sectional views of different embodiments of a first grid, more particularly Figs. 7 and 8, are views on the lines VII-VII and VIII-VIII of Fig. 6 and Fig. 10 is a view

on the line X-X of Fig. 9.

Figures 13 and 14 illustrate the focusing influences of the first grid in a cathode-ray tube made in accordance with the invention, and

Figures 17 and 18 show a spot with and without a haze, respectively.

Fig. 1 is a diagrammatic sectional view of a cathode-ray tube in accordance with the invention, in this case a colour display tube of the in-line type. In a glass envelope 1 which is composed of a display window 2, a funnel-shaped part 3 and a neck 4, three electron guns 5, 6 and 7 are provided in said neck and generate the electron beams 8, 9 and 10, respectively. The axis of the electron guns are situated in one plane, the plane of the drawing. The axis of the central electron gun 6 coincides substantially with the tube axis 11. The three electron guns debouch into a sleeve 16 which is situated coaxially in the neck 4.

The display window 2 is provided on its inside with a large number of triplets of phosphor lines. Each triplet comprises a line consisting of a green-luminescing phosphor, a line consisting of a blue-luminescing phosphor and a line consisting of a red-luminescing phosphor. All triplets together constitute the display screen 12. The phosphor lines are normal to the plane of the drawing. In front of the display screen a shadow mask 13 is positioned in which a very large number of elongate apertures 14 are provided through which the electron beams 8, 9 and 10 pass. The electron beams are deflected in the horizontal direction (in the plane of the drawing) and in the vertical direction (normal thereto) by the system 15 of deflection coils. The three electron guns are assembled so that their axes enclose a small angle with each other. As a result of this the electron guns pass through the apertures 14 at said angle, the so-called colour selection angle, and each impinge only on phosphor lines of one colour.

Fig. 2 is a perspective view of the three electron guns 5, 6 and 7. The electrodes of said three-fold electron gun system are positioned with respect to each other by means of the metal strips 17 which are sealed in the glass assembly rods 18. Each gun comprises a cathode (not visible), a first grid 21, a second grid 22 and grids 23 and 24.

Fig. 3 is a sectional view of one of the guns shown in Fig. 2. In the first grid 21 a rapidly heating cathode 19 is provided. A coiled coil heating filament 28 is situated in the cathode shaft 29 which, opposite to the aperture 34, is provided with an emissive surface consisting of a barium-strontium oxide layer. The cathode shaft is secured to the support cylinder 33 by means of three thin metal strips 30, which support cylinder is positioned in the first grid 21 by means of glass 31 provided in a metal ring 72. The support rods 32 for connecting the filament in the cathode are also sealed in the glass 31.

The first grid 21 comprises an aperture 34 which is provided in the electrode by an etching process.

Fig. 4 is a sectional view of Fig. 3 viewed against the surface 36 of the first grid. The aperture 34 has an elongate cross-section in that an elongate cavity 37 has been etched in the material of the electrode.

Fig. 5 is a sectional view of Fig. 3 viewed against the surface 35 of the first grid. The aperture 34 also has an elongate cross-section. The long axis of this part of the aperture, however, is normal to the long axis of the elongate aperture in the surface 36. This part of the aperture has also been obtained by etching an elongate cavity 37 in the material of the first grid. The cavities have been etched to such a depth that aperture 34 is obtained. It will be obvious that, if one cavity is made deeper, the other one may be less deep. Herewith the strength ratio of the two quadrupoles can be varied and be adapted to the remainder of the system of lenses.

As compared with the known first grid having the elongate aperture, the first grid described herein uses a smaller region of the emissive cathode surface which is approximately equal to the occupied region in a first grid having a circular aperture, while nevertheless the favourable focusing properties of the elongate aperture are maintained.

Fig. 6 shows one of the possibilities in which a first grid as used in the cathode-ray tube made in accordance with the invention can be obtained in a simple manner. In this case the first grid consists of a plate-shaped part 38 having a rectangular aperture 39, as is also shown in Fig. 7, and of a plate-shaped part 40 which is placed against it and has a likewise rectangular aperture 42, as is also shown in Fig. 8. The longitudinal directions of the apertures 41 and 39 are normal to each other and thus constitute the first grid as is used in the cathode-ray tube made in accordance with the invention.

Fig. 9 shows another possibility in which a first grid as used in a cathode-ray tube made in accordance with the invention can be manufactured. In this case also the first grid comprises two plate-shaped parts 42 and 46 having therein two mutually perpendicular elongate apertures 43 and 47. Between the two plate-shaped parts 42 and 46 a plate 44 is positioned having an aperture 45 which has a diameter exceeding the larger dimension of the elongate apertures.

Fig. 10 is a sectional view of Fig. 9 viewed against the part 46 and aperture 47.

Fig. 11 is a perspective view of another possibility of manufacturing the first grid. Two mutually perpendicular V or U-shaped grooves 49 and 50 are milled in a metal plate 48 and are so deep that aperture 51 is obtained.

Fig. 12 is also a perspective view of a first grid for a cathode-ray tube made in accordance

with the invention. It comprises a plate 52 having a circular aperture 53. This plate comprises two parallel metal strips 54, 55 and 56, 57 on opposite sides. The strips 54 and 55 extend at right angles to the strips 56 and 57. The quadrupole lens action of the first grid obtained in this manner is less strong than the quadrupole action of the first grid shown in Fig. 9 in comparable operating conditions.

Fig. 13 shows in the half of a cross-section in the Y-Z plane the potential field and the electron paths of the electrons leaving the cathode without initial speed in a cathode-ray tube made in accordance with the invention. This is in a plane through the tube axis (Z-direction) and the longitudinal direction of a first part of an aperture (Y-direction) in the first grid.

In Fig. 14 this is done analogously in the X-Y plane. This is a plane through the tube axis (Z-direction) and the longitudinal direction of the second part of the aperture (X-direction) in the first grid, which longitudinal direction is at right angles to the longitudinal direction of the first part of the aperture. The electrons leave the cathode surface 57 and pass through the first grid 58 and the subsequent second grid 59 according to the paths 60 shown. In this case the cathode potential is 30V, the first grid 58 has a potential of 0V and the second grid 59 has a potential of 771 V. The potentials in the potential field are denoted in Volts for the potential lines 61. The distances in the X, Y and Z-directions are denoted in mm. The electron paths and field lines after the second grid 59 are also indicated.

By varying the depth 62 and 63 of the parts of the apertures in the first grid, another focusing is obtained and cross-overs 64 are formed in quite different places.

Fig. 15 shows a very simple embodiment of a part of a first grid which can be used in the cathode-ray tube made in accordance with the invention. The first grid in this case comprises a plate-shaped part 65 which extends at right angles to the axis and in which a central aperture 66 for passing the electron beam is provided. As a result of the diametrically extending pleat 67 a double quadrupole lens is obtained. Since the pleat is convex on one side and is concave on the other side, two quadrupole lenses rotated 90° with respect to each other are obtained. In this case the depth of the pleat was 0.2 mm and its width was approximately equal to the diameter of the aperture. The depth may be varied in accordance with the desired lens action.

Fig. 16 shows a second very simple embodiment. The first grid in this case comprises a plate-shaped part 68 which extends at right angles to the tube axis and in which a central aperture 69 for passing the electron beam is provided. As a result of the two diametrically

extending pleats 70 and 71 a double quadrupole lens is also obtained. Since the lens actions of the two pleats amplify each other, two quadrupole lenses which are rotated with respect to each other are also formed and the strength of which is larger than the lens strength of the lenses shown in Fig. 15. The depth of the pleats 70 and 71 need not be equal. The shape of the apertures 69 and 66 may also be varied so as to influence the shape of the beam.

Fig. 17 shows a spot 73 of an electron beam on a display screen, which electron beam has been generated an electron gun without having a first grid capable of providing a double quadrupole lens. The spot is surrounded by a haze 74, a region having a low but interfering light intensity.

Fig. 18 shows a spot 75 of an electron beam generated in a cathode-ray tube made in accordance with the invention has been used. The haze 76 is negligible and hardly annoying.

25 CLAIMS

1. A cathode-ray tube comprising in an evacuated glass envelope an electron gun to generate an electron beam, which electron gun consists at least of a cathode which is centred substantially around an axis and has an emissive surface which is substantially normal to said axis, a first grid and a second grid, wherein the first grid in cooperation with the cathode constitutes a first multipole electron lens in which the quadrupole lens component predominates, and in cooperation with the second grid constitutes a second multipole electron lens in which the quadrupole lens component predominates, said latter quadrupole lens component being rotated 90° with respect to the quadrupole lens component of the first multipole electron lens.

2. A cathode-ray tube as claimed in Claim 1, wherein the first and second multipole lenses are formed by the first grid having an aperture which is elongate both on the side of the cathode and on the side of the second grid the long axis of the elongate cross-section on the side of the cathode extending substantially normal to the long axis of the elongate cross-section on the side of the second grid.

3. A cathode-ray tube as claimed in Claim 2, wherein the first grid comprises two at least partly plate-shaped parts which are secured against each other and are electrically connected together, each part having an elongate aperture which extends substantially at right angles to the other.

4. A cathode-ray tube as claimed in Claim 2, wherein the first grid comprises three at least partly plate-shaped parts which are secured together and are electrically connected together and of which the plate-shaped parts situated on the side of the cathode and on the side of the second grid are provided with

elongate apertures which extend substantially at right angles to each other and the intermediately located part is provided with an aperture having a smallest dimension which exceeds the largest dimension of the elongate apertures.

5. A cathode-ray tube as claimed in Claim 2, wherein the first grid comprises an at least partly plate-shaped part having a groove provided in each side, which grooves extend mutually at right angles, said grooves being so deep that at the area where the grooves cross each other a through aperture is formed.

6. A cathode-ray tube as claimed in Claim 1, wherein the first grid has a part which extends substantially at right angles to the axis, which part has co-axial aperture therein and a diametrically extending pleat.

7. A cathode-ray tube as claimed in Claim 1, wherein the first grid has a part extending at right angles to the axis, which part has co-axial aperture therein and two mutually perpendicular diametrically extending pleats, one of which is concave and the other of which is convex.

8. A cathode-ray tube substantially as hereinbefore described with reference to and as shown in Figs. 1 to 5, of the accompanying drawings.

9. A cathode-ray tube, as claimed in Claim 8 modified substantially as hereinbefore described with reference to Figs. 6 to 8, Figs. 9 and 10, Fig. 11, Fig. 12, Fig. 15 or Fig. 16 of the accompanying drawings.

10. A video display apparatus comprising a cathode-ray tube as claimed in any one of claims 1 to 9.



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extending pleats 70 and 71 a double quadrupole lens is also obtained. Since the lens actions of the two pleats amplify each other, two quadrupole lenses which are rotated with respect to each other are also formed and the strength of which is larger than the lens strength of the lenses shown in Fig. 15. The depth of the pleats 70 and 71 need not be equal. The shape of the apertures 69 and 66 may also be varied so as to influence the shape of the beam.

Fig. 17 shows a spot 73 of an electron beam on a display screen, which electron beam has been generated an electron gun without having a first grid capable of providing a double quadrupole lens. The spot is surrounded by a haze 74, a region having a low but interfering light intensity.

Fig. 18 shows a spot 75 of an electron beam generated in a cathode-ray tube made in accordance with the invention has been used. The haze 76 is negligible and hardly annoying.

25 CLAIMS

1. A cathode-ray tube comprising in an evacuated glass envelope an electron gun to generate an electron beam, which electron gun consists at least of a cathode which is centred substantially around an axis and has an emissive surface which is substantially normal to said axis, a first grid and a second grid, wherein the first grid in cooperation with the cathode constitutes a first multipole electron lens in which the quadrupole lens component predominates, and in cooperation with the second grid constitutes a second multipole electron lens in which the quadrupole lens component predominates, said latter quadrupole lens component being rotated 90° with respect to the quadrupole lens component of the first multipole electron lens.

2. A cathode-ray tube as claimed in Claim 1, wherein the first and second multipole lenses are formed by the first grid having an aperture which is elongate both on the side of the cathode and on the side of the second grid the long axis of the elongate cross-section on the side of the cathode extending substantially normal to the long axis of the elongate cross-section on the side of the second grid.

3. A cathode-ray tube as claimed in Claim 2, wherein the first grid comprises two at least partly plate-shaped parts which are secured against each other and are electrically connected together, each part having an elongate aperture which extends substantially at right angles to the other.

4. A cathode-ray tube as claimed in Claim 2, wherein the first grid comprises three at least partly plate-shaped parts which are secured together and are electrically connected together and of which the plate-shaped parts situated on the side of the cathode and on the side of the second grid are provided with

elongate apertures which extend substantially at right angles to each other and the intermediately located part is provided with an aperture having a smallest dimension which exceeds the largest dimension of the elongate apertures.

5. A cathode-ray tube as claimed in Claim 2, wherein the first grid comprises an at least partly plate-shaped part having a groove provided in each side, which grooves extend mutually at right angles, said grooves being so deep that at the area where the grooves cross each other a through aperture is formed.

6. A cathode-ray tube as claimed in Claim 1, wherein the first grid has a part which extends substantially at right angles to the axis, which part has co-axial aperture therein and a diametrically extending pleat.

7. A cathode-ray tube as claimed in Claim 1, wherein the first grid has a part extending at right angles to the axis, which part has co-axial aperture therein and two mutually perpendicular diametrically extending pleats, one of which is concave and the other of which is convex.

8. A cathode-ray tube substantially as hereinbefore described with reference to and as shown in Figs. 1 to 5, of the accompanying drawings.

9. A cathode-ray tube, as claimed in Claim 8 modified substantially as hereinbefore described with reference to Figs. 6 to 8, Figs. 9 and 10, Fig. 11, Fig. 12, Fig. 15 or Fig. 16 of the accompanying drawings.

10. A video display apparatus comprising a cathode-ray tube as claimed in any one of claims 1 to 9.