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TO CORRECT ORTHOGONALITY ERRORS

3,497,744

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2 Sheets-Sheet 1

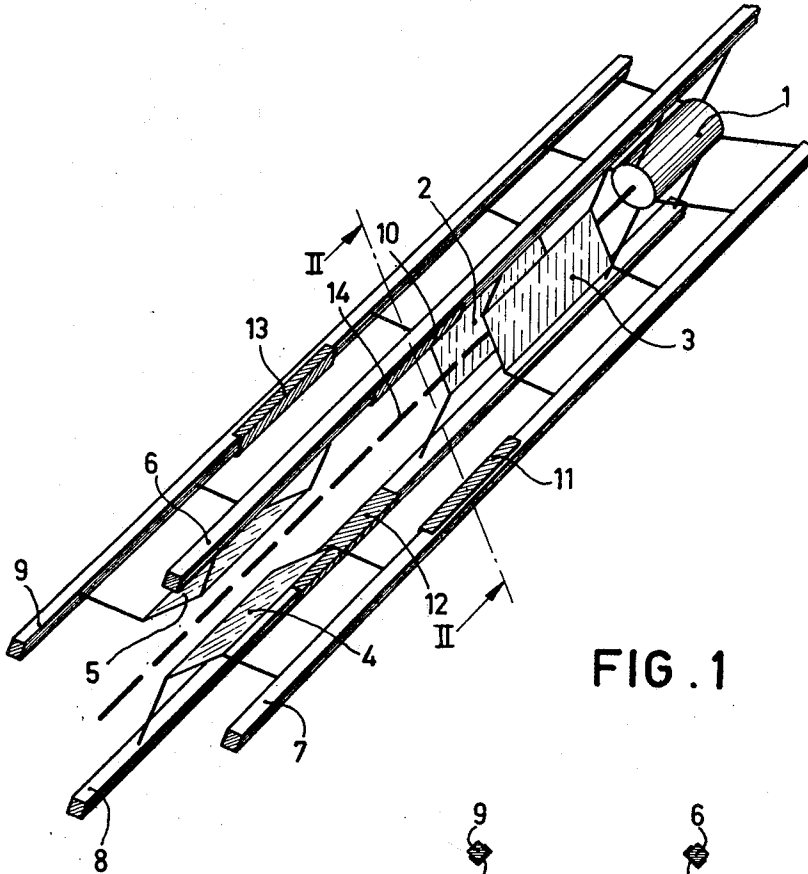


FIG. 1

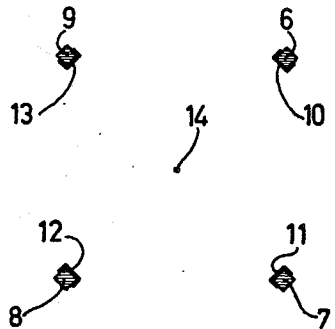


FIG. 2

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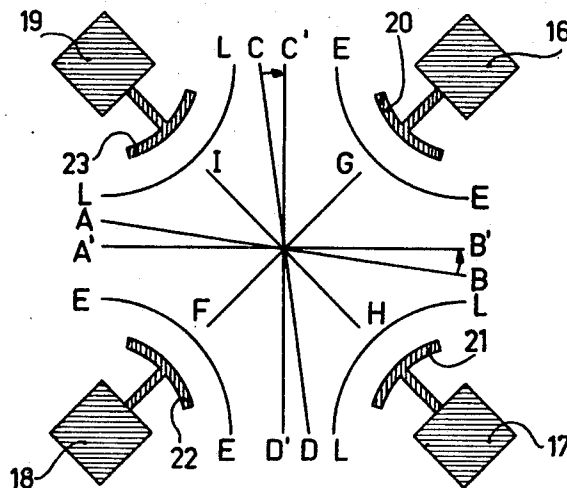


FIG. 3

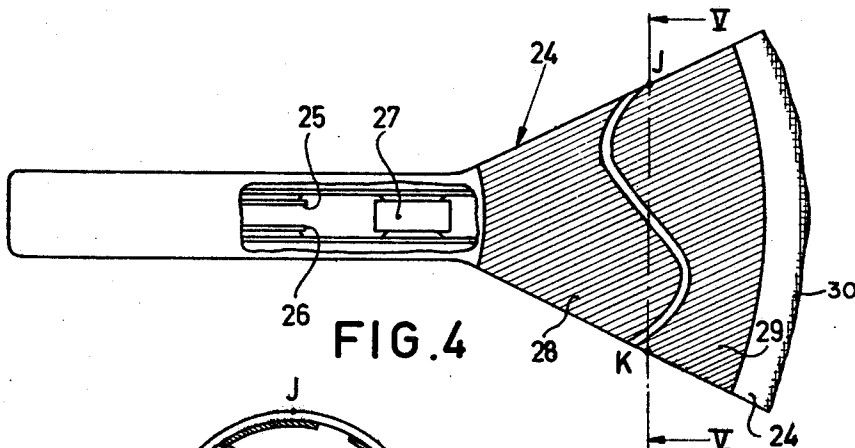


FIG. 4

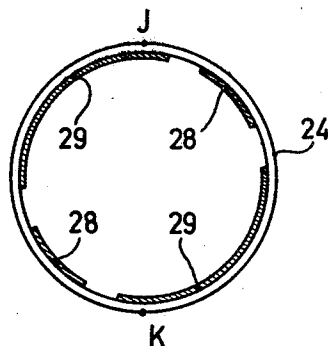


FIG. 5

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CATHODE-RAY TUBE USING A QUADRUPOLEAR ELECTROSTATIC LENS TO CORRECT ORTHOGONALITY ERRORS

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6 Claims

ABSTRACT OF THE DISCLOSURE

A cathode-ray tube employing an electrostatic quadrupolar field the two planes of symmetry of which pass through the axis of the electron gun and form angles of 45° with the two directions of deflection to correct deviations in orthogonality produced by the main deflection electrode systems.

This invention relates to an arrangement including a cathode-ray tube comprising an electron gun for producing an electron beam, and a screen struck by the electron beam, deflection means for deflecting the electron beam between the electron gun and the screen in two substantially perpendicular directions, and means for correcting deviations in orthogonality of the two directions of deflection.

In various kinds of cathode-ray tubes, for example display tubes and oscillograph tubes, it is undesirable that deviations occur in the orthogonality of two directions of deflection. This is especially true for oscillograph tubes because these are used as measuring devices in which the distances between the luminescent dots of the fluorescence screen struck by the electron beam and two orthogonal axes on this screen are used as a measuring result and hence must correspond to the actual deflection.

Known means for correcting orthogonality errors in arrangements including a cathode-ray tube provided with electrostatic means of deflection are pairs of rod-shaped auxiliary electrodes which are controlled, linearly or not, by the electrostatic means of deflection. However, orthogonality errors owing to mechanical tolerances of the deflection means cannot thus be corrected in a simple manner.

A known means for correcting deviations in orthogonality in a device including a cathode-ray tube provided with a magnetic means of deflection comprises auxiliary magnets which produce a rotating field, for example a magnetic quadrupolar field. In connection with the size of these auxiliary magnets they require a rather large space. If the auxiliary magnet system is designed as an electromagnetic system, there is the additional disadvantage that energy must be supplied to the system in order to energize the deflection coils.

An object of the invention is to provide an arrangement including means for correcting deviations in orthogonality of two directions of deflection in a cathode-ray tube which has advantages over known arrangements as regards operation, usability, construction and adjustment.

According to the invention, in an arrangement including a cathode-ray tube comprising an electron gun for producing an electron beam, and a screen struck by the electron beam, deflection means for deflecting the electron beam between the electron gun and the screen in two substantially perpendicular directions, and means for correcting deviations in orthogonality of the two directions of deflection, these means for correcting deviations

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in orthogonality of the two directions of deflection produce an electrostatic quadrupolar field the two planes of symmetry of which pass through the axis of the electron gun and form angles of substantially 45° with the two directions of deflection.

The use of a quadrupolar field, the two planes of symmetry of which pass through the axis of the electron gun and form angles of substantially 45° with the directions of deflection in the cathode-ray tube, permits elimination of orthogonality errors caused by mechanical tolerances in the arrangement of the deflection means and by deviations in the post-acceleration field.

The operation of an electrostatic quadrupolar field the two planes of symmetry of which pass through the axis of the electron gun and form angles of substantially 45° with the directions of deflection in the cathode-ray tube is of such a nature as to cause a rotation of the direction in which the electrons have been deflected. If the quadrupolar field is situated behind both deflection means then both directions of deflection will be rotated. Both directions of deflection are rotated in an opposite sense so that the angle between the directions varies. If the quadrupolar field is, however, situated behind only one of the deflection means then only the associated direction of deflection is rotated. In this case also the angle between both directions of deflection is varied. In either case the rotation is effected wholly independently of the deflection means and its magnitude depends on the strength of the quadrupolar field.

The invention is not restricted to arrangements including specific kinds of deflection means, but relates to arrangements including electrostatic means of deflection as well as to arrangements including magnetic means of deflection, while it is also applicable to arrangements including a combination of both kinds of deflection means.

The construction of means producing an electrostatic quadrupolar field the two planes of symmetry of which pass through the axis of the electron gun and form angles of substantially 45° with the directions of deflection in the cathode-ray tube is considerably simpler than the construction of means for producing a magnetic quadrupolar field.

The arrangement described above can be manufactured with fairly wide mechanical tolerances in the arrangement of the deflection means. A correct adjustment of the arrangement can afterwards be obtained in a simple manner by adapting the polarity and the strength of the quadrupolar field.

An electrostatic quadrupolar field the two planes of symmetry of which pass through the axis of the electron gun and form angles of substantially 45° with the directions of deflection can be produced in a cathode-ray tube in various manners.

Cathode-ray tubes include in certain cases four rods of insulating material to which components of the electron gun are fixed, the rods being situated so that in any cross-section perpendicular to the axis of the electron gun they have a substantially equal distance from this axis and that the planes passing through two diametrically opposite rods pass through the axis of the electron gun and form angles of substantially 45° with the directions of deflection. In such tubes it is a simple matter to fix electrodes to these rods in order to produce a quadrupolar field as referred to.

The invention relates particularly to a cathode-ray tube in which the said rods in the cathode-ray tube are locally provided with an electrically conductive coating, for example, "Aquadag."

In cathode-ray tubes in which an electron beam is deflected in two substantially perpendicular directions, the inner wall of the tube between the deflection means and

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the screen is often provided in part with an electrically conductive coating to obtain a field-free space.

The invention relates more particularly to a cathode-ray tube in which the axis of the electron gun substantially coincides with the axis of the tube and in which the inner wall of the tube between the deflection means and the screen is provided in part with such a coating. This cathode-ray tube is characterized in that this coating consists of two portions separated from each other so that over a portion of the axis of the tube the cross-sections perpendicular to this axis comprise two diametrically opposite sectional figures of each of these two portions which are situated symmetrically relative to the lines forming angles of substantially 45° with the directions of deflection.

When this tube is in use the two portions of this coating have a potential difference. Between the deflection means and the screen there arises then in succession a substantially field-free space as a result of the influence of the first portion of the coating, an electrostatic quadrupolar field the two planes of symmetry of which pass through the axis of the tube and form angles of substantially 45° with the directions of deflection as a result of the influence of both portions of the coating, and again a substantially field-free space as a result of the influence of the second portion of the coating.

This tube affords the advantage that with the aid of a simple means, namely the electrically conductive coating of the inner wall of the tube, both field-free spaces and a quadrupolar field can be produced. Furthermore, this tube need not have a greater length than that of a tube without means for correcting deviations in orthogonality of two directions of deflection. Another advantage is that the means of producing the quadrupolar field is situated behind both deflection means, so that the strength of the quadrupolar field required for a proper correction of deviations in orthogonality is approximately half the strength of the quadrupolar field which would be required for this purpose in a cathode-ray tube in which the quadrupolar field is produced between the deflection means if this would show similar deviations in orthogonality.

Preferably the two portions of the inner wall coating of the tube between the deflection means and the screen are applied as closely as possible to the deflection means. The rotation of the directions of the deflection as a result of the quadrupolar field is then as exact as possible because the distance between the electrons and the axis of the tube in the area of the quadrupolar field is in that case smaller than when the quadrupolar field would be situated more closely to the screen whereas the electrostatic field most approximates to its idealized form in the vicinity of the axis.

The invention will now be described with reference to the accompanying drawing, in which:

FIG. 1 shows a portion of the internal structure of a cathode-ray tube for use in an arrangement according to the invention;

FIG. 2 is a cross-sectional view of a cathode-ray tube structure as shown in FIG. 1;

FIG. 3 is an analogous cross-sectional view of another cathode-ray tube and shows in addition the orientation of a quadrupolar field produced therein relative to the directions of deflection;

FIG. 4 shows a third embodiment of the cathode-ray tube;

FIG. 5 is a cross-sectional view of the cathode-ray tube shown in FIG. 4.

The components of a cathode-ray tube shown in FIG. 1, for use in an arrangement according to the invention are located within an evacuated envelope, not shown. The figure shows an electron gun 1 for producing a beam of electrons, a deflection means including two deflection plates 2 and 3 for deflecting the electrons in a first direction and a deflection means including two

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deflection plates 4 and 5 for deflecting the electrons in a second direction substantially perpendicular to the first direction. After having passed the deflection means, the electron beam finally reaches a screen, not shown. The deflection means are fixed to four substantially parallel insulating rods 6, 7, 8 and 9. The plane through 6 and 8 and the plane through 7 and 9 intersect each other in the axis 14 of the electron gun and form angles of substantially 45° with the directions of deflection. These rods are locally provided with electrically conductive coatings 10, 11, 12 and 13 between the two deflection means. The electrical supply lines to the electron gun, to the deflection plates 2, 3, 4 and 5 and to the conductive coatings 10, 11, 12 and 13 of which 10 is connected to 12 and 11 to 13 are not shown. If 10 and 12 have a voltage applied thereto relative to the average potential which would prevail in the field between the electrodes 10, 11, 12 and 13 if these electrodes were not connected to an external voltage source, and 11 and 13 had an equally high voltage of the reverse sign applied thereto relative to the same reference potential, then an electrostatic quadrupolar field would be generated by 10, 11, 12 and 13 of which the two planes of symmetry pass through the axis 14 of the electron gun 1 and form angles of substantially 45° with the directions of deflection. This quadrupolar field rotates the direction of deflection caused by the deflection plates 2 and 3 through an angle which depends on the velocity of the electron beam and the strength of the quadrupolar field, but does not depend on the magnitude of the deflection voltage between 2 and 3.

A cross-section perpendicular to the axis 14 of the electron gun of this cathode-ray tube at the area of the electrically conductive coatings is shown in FIGURE 2. This figure only shows the internal part of the tube, namely the insulating rods 6, 7, 8 and 9 which have substantially equal distances from the axis 14 of the electron gun and the conductive coatings 10, 11, 12 and 13.

FIGURE 3 shows an analogous cross-section of another cathode-ray tube. This tube also contains similarly four rods 16, 17, 18 and 19. Four cylindrical electrodes 20, 21, 22 and 23 are fixed to these rods between the deflection means and the screen. Furthermore the lines AB and CD in this figure indicate the directions of deflection such as may appear on the screen, for example, if no correction is used, the deviation in orthogonality having been strongly exaggerated for the sake of clarity. This figure also shows the equipotential lines EE and LL which indicate the quadrupolar field which is produced when the electrode 20 and the associated electrode 22 is given a positive voltage relative to the average potential which would prevail in the field between the electrodes 20, 21, 22 and 23 if these electrodes were not connected to an external voltage source, and if the electrode 21 and the associated electrode 23 were given an equally high negative voltage relative to the same reference potential. The planes of symmetry of the quadrupolar field indicated by the lines FG and HI form angles of substantially 45° with the directions of deflection AB and CD. The quadrupolar field rotates the directions AB and CD to A'B' and C'D'. By adjusting the magnitude of the voltages on the electrodes 20, 21, 22 and 23 A'B' and C'D' are made to form an angle of 90° with each other.

A side view of a part of an embodiment of a cathode-ray tube in which the axis of the electron gun coincides with the axis of the tube and in which the means for correcting deviations in orthogonality of the two directions of deflection comprises a conductive coating on the inner wall of the tube is shown in FIGURE 4. The wall 24 of the tube is partly broken up so that the deflection means are visible. The plates 25 and 26 form a deflection means for deflecting the electrons in a first direction. A second deflection means for deflecting the electrons in a second direction substantially perpendicular to the first direction also comprises

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two plates of which 27 only is visible. Between the deflection means and the screen 30 which is situated at the right of the figure, the wall 24 of the tube in the direct vicinity of the deflection means is provided with an electrically conductive coating comprising two portions 28 and 29 which are separated from each other so that over a portion of the axis of the tube the cross-sections perpendicular to this axis comprise two identical, diametrically opposite sectional figures of each of these two portions which are situated symmetrically relative to the lines forming angles of substantially 45° with the directions of deflection. Such a cross-section is the section perpendicular to the axis of the tube which is indicated by the line JK. This is shown in FIGURE 5 and illustrates two identical, diametrically opposite sectional figures of 28 which are situated symmetrically relative to the lines forming angles of substantially 45° with the directions of deflection. This figure also shows two identical diametrically opposite sectional figures of 29 which are situated symmetrically relative to the same lines. The figure makes it clear that the coatings 28 and 29 form a configuration of electrodes which produce a quadrupolar field at a potential difference between 28 and 29, the two planes of symmetry of the quadrupolar field passing through the axis of the tube and forming angles of substantially 45° with the directions of deflection, namely the direction JK and the direction perpendicular to this direction and perpendicular to the axis of the tube.

While the invention has been described with reference to particular embodiments and applications thereof, other modifications will be readily apparent to those skilled in this art without departing from the spirit and scope of the invention which is defined in the appended claims.

What is claimed is:

1. In combination:

a cathode-ray tube comprising an electron gun for producing an electron beam, and a screen struck by the electron beam;

deflection means for deflecting the electron beam between the electron gun and the screen in two substantially perpendicular directions; and

correction means for correcting deviations in orthogonality of the two directions of deflection, said correction means comprising elements for producing an electrostatic quadrupolar field the two planes of symmetry of which pass through the axis of the electron gun and form angles of substantially 45° with the two directions of deflection.

2. A combination as claimed in claim 1 in which the cathode-ray tube includes four rods of insulating material to which components of the electron gun are fixed, the rods being situated so that in any cross-section perpendicular to the axis of the electron gun they have a substantially equal distance from this axis and that the planes passing through two diametrically opposite rods pass through the axis of the electron gun and form angles of substantially 45° with the two directions of deflection, and in which the said elements are constituted by electrically conductive coatings locally applied to said rods.

3. A combination as claimed in claim 1 in which the axis of the electron gun substantially coincides with the

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axis of the tube and in which the inner wall of the tube between the deflection means and the screen is provided in part with an electrically conductive coating, the said elements being constituted by said coating, said coating consisting of two portions which are separated from each other so that over a part of the axis of the tube the cross-sections perpendicular to this axis comprise a sectional figure of each of said two portions, each of said sectional figures consisting of two diametrically opposite parts, which are situated symmetrically relative to each of the lines forming angles of substantially 45° with the directions of deflection.

4. A cathode-ray tube comprising an electron gun for producing an electron beam, a screen in the path of the electron beam, electrostatic deflection means for deflecting the electron beam between the electron gun and the screen in two substantially perpendicular directions and correction means for correcting deviations in orthogonality of the two directions of deflection, said correction means comprising elements for producing an electrostatic quadrupolar field the two planes of symmetry of which pass through the axis of the electron gun and form angles of substantially 45° with the two directions of deflection.

5. A cathode-ray tube as claimed in claim 4, including four rods of insulating material to which components of the electron gun are fixed, the rods being situated so that in any cross-section perpendicular to the axis of the electron gun they have a substantially equal distance from this axis and that the planes passing through two diametrically opposite rods pass through the axis of the electron gun and form angles of substantially 45° with the two directions of deflection, the said elements being constituted by electrically conductive coatings locally applied to said rods.

6. A cathode-ray tube as claimed in claim 4 in which the axis of the electron gun substantially coincides with the axis of the tube and in which the inner wall of the tube between the deflection means and the screen is provided in part with an electrically conductive coating, the said elements being constituted by said coating, said coating consisting of two portions which are separated from each other so that over a part of the axis of the tube the cross-sections perpendicular to this axis comprise a sectional figure of each of said two portions, each of said sectional figures consisting of two diametrically opposite parts, which are situated symmetrically relative to each of the lines forming angles of substantially 45° with the directions of deflection.

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U.S. Cl. X.R.

313—83; 315—31