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(54) CATHODE-RAY TUBE

(71) We, N.V. PHILIPS' GLOEILAMPENFABRIEKEN, a limited liability Company, organised and established under the laws of the Kingdom of the Netherlands, of Emmasingel 29, Eindhoven, the Netherlands, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a cathode-ray tube and to an apparatus having such a cathode-ray tube.

In a cathode-ray tube it is often desired to focus an electron beam, for example, in the horizontal direction more strongly than in the vertical direction. This may be necessary, for example, to compensate for astigmatism of the deflection coil or of other electron lenses in the tube. This is necessary *inter alia* in colour display tubes having three electron beams in one plane and a so-called parastigmatic self-converging deflection coil. In a direction normal to the plane through the electron beams, such a deflection coil exerts a converging influence on the individual electron beams. The resulting vertical overfocusing cannot be compensated for by controlling the strength of the usual focusing lens dynamically as a function of the deflection, as is done in colour display tubes having the three electron beams in delta configuration and a non-astigmatic deflection coil, because in that case horizontal underfocusing would occur.

British Patent Specification 889,005 discloses a quadrupole lens which consists of two coaxial cylindrical electrodes of which the innermost is provided with apertures through which the electrical field between the two cylinders can penetrate into the space in the innermost cylinder. As a result of this, an astigmatic so-called quadrupole field is formed in the innermost cylinder and converges the electron beam in one direction and diverges it in the direction at right anges thereto.

British Patent Specification 574,056 discloses a focusing lens in which as a result of the design of the edge of one of the two cylindrical electrodes, an axial non-rotationally symmetrical field is obtained which converges the electron beam in one direction more strongly than in the direction at right angles thereto.

According to the present invention there is provided a cathode-ray tube having an electron gun comprising a main focusing lens having two cylindrical electrodes arranged axially one behind the other, the cylindrical wall of one of the electrodes at its end facing the other electrode having diametrically opposed apertures or recesses adjacent to said end, additional electrode means being provided opposite to said apertures or recesses, at the exterior of said one electrode.

In a cathode-ray tube made in accordance with the invention, a variation in the strength of an astigmatic component of the lens also influences the rotationally symmetrical major field of the lens. This has for its result that, for example, an increase of the horizontal focusing by the astigmatic component of the lens field is compensated for by a decrease of the strength of the rotationally symmetrical component of the lens field, whereas the corresponding decrease of the vertical focusing by the astigmatic component of the lens field is just intensified by the decrease of the strength of the rotationally symmetrical component of the lens field.

The main focusing lens of a cathode ray tube in accordance with the present invention is suitable to focus three electron beams in one plane.

Such a focusing lens is furthermore suitable for use in a cathode ray tube for displaying coloured pictures which comprises three such electron lenses the axes of which are situated beside each other in a flat plane. In an embodiment of the cathode ray tube made in accordance with the present invention the said additional electrode means are common to the three electron lenses and are formed by two plates which

are arranged on either side of the electrodes parallel to the said flat plane.

An apparatus including a cathode-ray tube in which the three main focusing lenses are accelerating lenses and in which the opposed apertures or recesses are provided in the one of the two cylindrical electrodes of each of the three lenses held in use at the lower potential, and means for applying a potential to the additional electrode means, which potential is controlled so that it is substantially equal to that of the electrodes held at the lower potential when the electron beams are not deflected electron beams but increases with increasing deflection of the electron beams.

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

Fig. 1 shows a cathode-ray tube for displaying coloured pictures having a main focusing lens in the form of an astigmatic electron lens,

Fig. 2 shows a combination of three astigmatic electron lenses,

Fig. 3 is a side elevation of the lenses shown in Fig. 2, and

Fig. 4 is a sectional view at right angles to the axes of the electron beams of the lenses shown in Fig. 2.

The display tube for colour television shown in Fig. 1 comprises in a glass envelope 1 a combination of three electron guns 2 for generationg electron beams 3, 4 and 5, a colour selection electrode 6 having a large number of apertures 7, and a display screen 8. The tube furthermore has a set of deflection coils 9 for deflecting the electron beams 3, 4 and 5 over the display screen 8. The three electron beams 3, 4 and 5 are generated by the electron guns 2 in such manner that their axes are situated in one plane, the plane of the drawing of Fig. 1. The deflection coils 9 are manufactured so that the three electron beams 3, 4 and 5 remain coincident on the display screen 8 even when the beams are deflected. Such a so-called parastigmatic, self-converging deflection coils, in combination with three electron beams in one plane, are known from the prior art and need not be described in detail.

A side phenomenon of such deflection coils is that they also exert an undesired converging influence on the electron beams in a direction normal to the plane through the three beams. Since the plane through the three beams generally is horizontal there is thus vertical overfocusing. Of course, the vertical overfocusing is zero when the electron beams are not deflected and increases with the deflection. This undesired vertical overfocusing can be compensated for by means of a dynamically controlled astigmatic lens as a quadrupole lens the strength of which and hence the diverging effect in the vertical direction increases with increasing deflection. In the known constructions of such lenses, however, the convering effect in the horizontal direction also increases with increasing deflection so that a horizontal overfocusing occurs. In a cathode ray tube made in accordance with the present invention a main focusing lens is provided which avoids this horizontal overfocusing. In a main focusing lens using one lens the vertical overfocusing is compensated for while the horizontal focusing remains substantially unvaried. It is to be noted that the horizontal overfocusing could also be avoided with a rotationally symmetrical focusing lens and a quadrupole lens which are each individually controlled. However, such an obvious solution is structurally more complicated and requires more space so that the length of the electron gun would increase.

Fig. 2 shows the main focusing lenses of the electron guns 2 individually. The focusing lenses each comprise two cylindrical electrodes namely 10 and 11, 12 and 13, and 14 and 15, respectively. The electrodes 10, 12 and 14 have diametrically oppositely located apertures 16 and 17, 18 and 19, and 20 and 21, respectively. An electrode 22 is situated opposite to the apertures 17, 19 and 21. An electrode 23 is situated opposite to the apertures 16, 18 and 20. The apertures 16 to 21 are situated so close to the gaps between the electrodes 10, 12 and 14 on the one hand and 11, 13 and 15 on the other hand, that the potential of the electrodes 22 and 23 can influence the electrical field in said gaps *via* the apertures 16 to 21. As a result of this not only are quadrupole lenses formed in the electrodes 10, 12 and 14, but also the strength of the focusing lenses is influenced.

In the embodiment shown in Fig. 2 the electrodes 10, 12 and 14 are at a lower potential than the electrodes 11, 13 and 15. So the focusing lenses are accelerating lenses. By causing the potential of the electrodes 22 and 23 to increase from a value substantially equal to the potential of the electrodes 10, 12 and 14 to values between the potential of the electrodes 10, 12 and 14 and the potential of the electrodes 11, 13 and 15, a quadrupole lens having an increasing strength which in the vertical direction exerts a diverging effect and in the horizontal direction exerts a converging effect is formed in the electrodes 10, 12 and 14, while in addition the strength of the focusing lenses is reduced. These two effects together give a decrease of the vertical focusing and a constant horizontal focusing. The time-dependent potential of the electrodes 22 and 23 is chosen to be so

that the decrease of the vertical focusing compensates for the vertical over-focusing of the deflection coils 9. In principle, the potential at the electrodes 22 and 23 should be quadratically dependent on the deflection.

For further explanation, Fig. 3 is a side elevation and Fig. 4 a sectional view of the electron lenses. The inside diameter of the electrodes 10 to 15 is 7·6 mm. The distance between the electrodes 22 and 23 is 9·5 mm. The axial length of the gap between the electrodes 10 and 11, 12 and 13, and 14 and 15, respectively, is 1·0 mm. The axial length of the apertures 16 to 21 is 3·0 mm. The dimension of the apertures 16 to 21 in a plane at right angles to the axis is 90° (angle 24 in Fig. 14). The distance from the centre of the apertures 16 to 21 to the centre of the focusing slot (distance 25 in Fig. 3) is 4·5 mm. The potential of the electrodes 10, 12 and 14 is 4·3 kV. The potential of the electrodes 11, 13 and 15 is 25 kV (measured with respect to the cathodes of the electron guns). The potential of the electrodes 22 and 23 is 4·3 kV when the electron beams 3, 4 and 5 are not deflected and increases to 4·5 kV with a deflection angle of 55° of the electron beams 3, 4 and 5. The further construction of the electron guns 2 is conventional and need thus not be described in detail.

The potential at the electrodes 22 and 23 is generated by superimposing a parabolic alternating voltage dependent on the deflection and having an average value of zero V on a voltage which is equal to the voltage at the electrodes 10, 12 and 14. As a result of this, the voltage at the electrodes 22 and 23 increases quadratically with increasing deflection from 4·3 kV to 4·5 kV, no separate direct voltage component need be generated for the voltage at the electrodes 22 and 23, and the variable component of the voltage at the electrodes 22 and 23 can be generated with a simple alternating current circuit.

WHAT WE CLAIM IS:—

1. A cathode-ray tube having an electron gun comprising a main focusing lens having two cylindrical electrodes arranged axially one behind the other, the cylindrical wall of one of the electrodes at its end facing the other electrode having diametrically opposed apertures or recesses adjacent to said end, additional electrode means being provided opposite to said apertures or recesses, at the exterior of said one electrode.

2. A cathode-ray tube as claimed in Claim 1, further comprising means to generate three electron beams in one plane which beams are focused by the main focusing lens.

3. A cathode-ray tube as claimed in Claim 1, for displaying coloured pictures and comprising three main focusing lenses the axes of which are situated in one plane and of which corresponding electrodes carry the same potential, wherein the said additional electrode means are common to the three focusing lenses.

4. A cathode-ray tube as claimed in Claim 3, wherein the said additional electrode means are formed by two plates which are arranged on either side of the electrodes parallel to the said plane.

5. Apparatus including a cathode ray tube as claimed in Claim 3 or 4 in which the three main focusing lenses are accelerating lenses and in which the opposed apertures or recesses are provided in one of the two cylindrical electrodes of each of the three lenses held in use at the lower potential, and means for applying a potential to the additional electrode means, which potential is so controlled that it is substantially equal to that of the electrodes held at the lower potential when the electron beams are not deflected but increases with increasing deflection of the electron beams.

6. A cathode-ray tube substantially as hereinbefore described with reference to and as shown in Figures 2 to 4 of the accompanying drawings

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2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

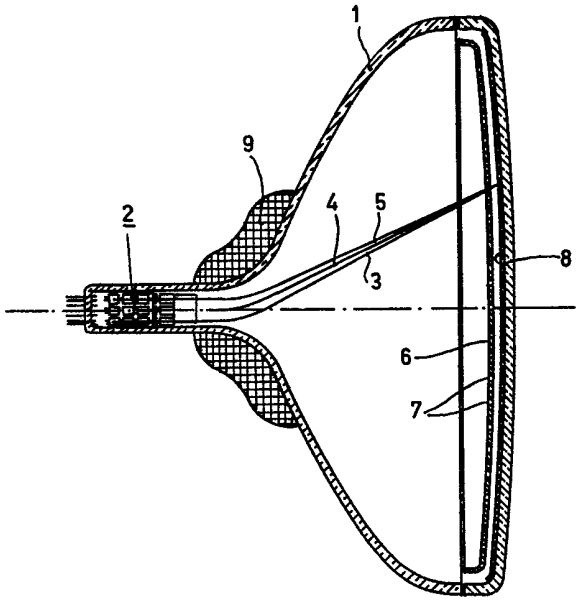

Fig.1

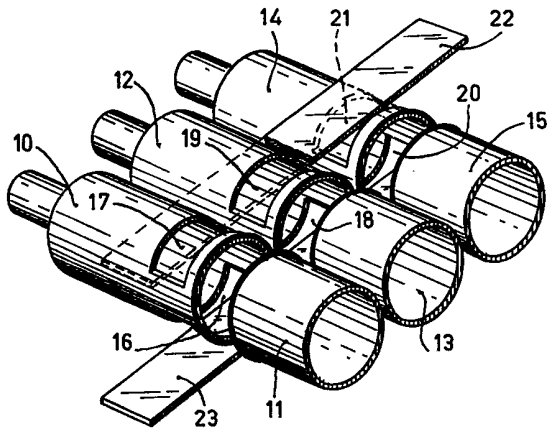

Fig. 2

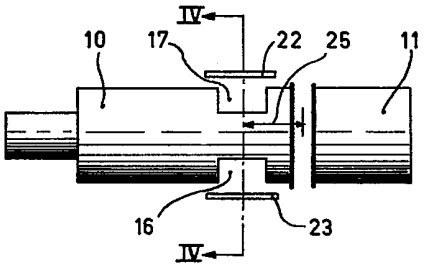

Fig. 3

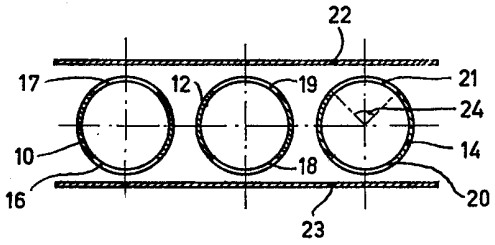

Fig. 4