

Description

The invention relates to a colour display device comprising a cathode ray tube comprising an evacuated envelope with a rear part and with a front part including a display screen, said rear part accommodating an electron gun system for producing three in-line electron beams, said electron gun system comprising a first focussing electrode remote from the display screen and a second focussing electrode facing the display screen, which focussing electrodes comprise means for counteracting deflection defocussing said display device further comprising means for applying a focussing voltage and a high voltage, respectively, to the first and second focussing electrodes.

Such a display tube is of a conventional type.

In a cathode ray tube it is often desired to focus an electron beam in, for example, 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 electron lenses in the tube. This is necessary, *inter alia*, in colour display tubes having three electron beams located in one plane and a self-convergent deflection coil. Such a deflection coil exerts a converging influence on the separate electron beams in a direction perpendicularly to the plane through the electron beams. The vertical overfocussing which thereby occurs cannot be sufficiently compensated with static means, notably in high resolution colour display tubes, owing to the ever stricter requirements imposed on the definition.

US Patent 4,366,419 describes a main lens construction for a non-integrated in-line colour gun accommodating a system of electrodes for (dynamically) counteracting deflection defocussing. However, this system cannot be used without any further measures in integrated guns.

It is an object of the present invention to correct the vertical overfocussing in a simple and effective manner in an integrated colour gun.

According to the invention a colour display tube of the type described in the opening paragraph is characterized in that the first focussing electrode comprises a front sub-electrode and a rear sub-electrode, the front sub-electrode facing the second focussing electrode, and an intermediate auxiliary electrode which is provided with apertures for passing the electron beams and which constitutes an astigmatic lens element, in that means are provided for applying a constant voltage to said auxiliary electrode, and correction means for applying a correction voltage V_C to at least the front one of the sub-electrodes (27, 28).

The invention is based on the recognition that correction of the vertical overfocussing is possible by using an extra electrode and only one correction

voltage.

The correction voltage may be a fixed (static) voltage. Its value may be such that an optimum spot shape is produced in the centre of the display screen. Alternatively, the value may be such that an optimum spot shape is produced in the corners. If a compromise is desired, a value between the two aforementioned values may be chosen. In addition the correction voltage may be set to eliminate small differences caused during the series production of the tubes.

Instead of a fixed voltage the correction voltage may be a dynamically varying voltage. It is then possible to optimise the spot shape in all areas of the display screen.

The (dynamically varying) correction voltage may be applied to the two, sub-electrodes. As the triode part of the gun is then influenced too, the amplitude of this correction voltage should be chosen to be relatively small (for example, 300 V). A varying voltage on the triode part results however in the beam aperture angle being modulated, what not always can be tolerated. An alternative is formed by only applying the (dynamically varying) correction voltage to the front sub-electrode (which forms part of the main lens). In that case a considerably higher amplitude (for example, 600 V) should be chosen as then the triode part is not influenced. In the latter case the sensitivity of the system is smaller. If the (dynamically varying) correction voltage is only applied to the front sub-electrode, it is practical to apply a same constant voltage to the rear sub-electrode and the auxiliary electrode. It is then particularly possible to have a fixed connection between the auxiliary electrode and the rear sub-electrode.

A suitable variation of the dynamically varying correction voltage is obtained if it comprises a parabolic component which is in synchronism with that deflection voltage which produces deflection in the direction in which the deflection unit has the largest astigmatism component. In practice this direction usually is the line deflection direction.

A further possibility is for the dynamically varying voltage to comprise a combination of parabolic components which are in synchronism with the line deflection and with the field deflection, respectively.

Some embodiments of the invention will now be described in greater detail by way of example with reference to a drawing in which.

Figure 1 is a longitudinal section of a colour display tube according to the invention;

Figure 2 is a longitudinal section of an electron gun system including an auxiliary electrode as used in the colour display tube of Figure 1;

Figure 3 is an elevational view of the auxiliary electrode of the electron gun system of Figure 2;

Figure 4 illustrates the relation between the anode voltage V_a at G_4 and the voltage V_{G3} at G_3 at a fixed voltage V_{AST} at the auxiliary electrode in the case of the gun of Figure 2;

Figure 5 shows an example of a dynamically varying voltage at G_3 ;

Figure 6a is a longitudinal section of a first alternative embodiment of the electron gun system of Figure 2;

Figure 6b is a longitudinal section of a second alternative embodiment of the electron gun system of Figure 2, and

Figure 7 illustrates the relation between the anode voltage V_a at G_4 and the voltage V_{G3} at G_3 at a fixed voltage V_{AST} at the auxiliary electrode in the case of the gun of Fig. 6a.

Figure 1 shows a colour display tube of the "in-line" type in a longitudinal section. In a glass envelope 1, which is composed of a display window 2, a cone 3 and a neck 4, this neck accommodates an integrated electron gun system 5 which generates three electron beams 6, 7 and 8 whose axes are located in the plane of the drawing. The axis of the central electron beam 7 initially coincides with the tube axis 9. The inside of the display window 2 is provided with a large number of triplets of phosphor elements. The elements may consist of lines or dots. Each triplet comprises an element consisting of a blue luminescing phosphor, an element consisting of a green luminescing phosphor and an element consisting of a red luminescing phosphor. All triplets combined constitute the display screen 10. Positioned in front of the display screen is the shadow mask 11 in which a large number of elongated apertures 12 is provided through which the electron beams 6, 7 and 8 pass, each impinging only on phosphor elements of one colour. The three co-planar electron beams are deflected by the system of deflection coils 13.

Fig. 2 is a longitudinal section of the electron gun system as used in the colour display tube according to Figure 1. The electron gun system comprises a common cup-shaped electrode 20, in which three cathodes 21, 22 and 23 are secured, and one common plate-shaped screen grid 24. The three electron beams whose axes are located in one plane are focussed with the aid of the focussing electrodes 25 (G_3) and 26 (G_4) which are common for the three electron beams. Electrode 25 consists of two cup-shaped parts 27 and 28 whose open ends face each other. The main lens,

which is thus constituted by a first focussing electrode G_3 and a second focussing electrode or anode G_4 , may be of a conventional type or of, for example, the polygon type. The latter type is described in EP-A-134,059 (PHN 10 752).

In this embodiment an extra auxiliary electrode G_{AST} , which constitutes an astigmatic element, is provided in an insulated manner as a flat plate having elongated apertures at some distance from the main lens, approximately halfway G_3 . The apertures may have any shape which leads to the production of a quadripolar field, for example, a rectangular shape (as is shown in Fig. 3), an oval shape or a diamond shape. The potential of the auxiliary electrode is chosen to be approximately equal to that of G_3 (the use of an auxiliary electrode in G_4 is less practical because then there are two electrodes in the tube having a very high, slightly different voltage).

As there is no need of any area-dependent dynamic focussing in a self-convergent system in the horizontal direction, the total focussing action in the horizontal direction of the astigmatic element and the main lens combined should remain constant, independent of the influence on focussing for the vertical direction, which influence is brought about by the correction voltage.

This means that in Figure 2 the correction voltage V_c should not be applied to the astigmatic element G_{AST} because focussing in the horizontal and vertical directions would then be influenced in opposite ways. If on the other hand the correction voltage V_c is applied to the focussing electrode G_3 , both the strength of the main lens and the strength of the quadripolar field constituted by the astigmatic element within G_3 are simultaneously influenced. It is then found to be possible to dimension the axial position, the strength and the direction of this quadripolar field in such a manner that the total focussing does not change in the horizontal direction because the actions of the main lens and the quadripole eliminate each other. Both actions amplify each other in the vertical direction. This situation is illustrated by means of a measurement as is shown in Fig. 4. The anode voltage V_a at G_4 is plotted against that at G_3 at a fixed voltage at G_{AST} and on the condition that the spot remains focussed in the horizontal and vertical directions, respectively. It is found that $V_a(\text{hor.})$ is substantially independent of V_{G3} in the case of a correct dimensioning. Since the total vertical lens strength must become weaker towards the corner of the picture, the polarity of the dynamic signal at G_3 must be such in the case of dynamic correction that the voltage increases upon deflection. The dynamic signal may be, for example, parabolic and in synchronism with the line deflection (see Fig. 5).

The correct polarity of the quadripolar field can

be achieved by choosing vertical slots in Figure 2 in the astigmatic element G_{ast} . The correct strength can be achieved by the shape of the slots and the thickness of the plate constituting the astigmatic element, together with the axial position, because the quadripolar lens strength must be in the correct ratio to the focal distance. When, for example, G_{ast} is too close to the main lens and/or when the configuration of the apertures is chosen to be incorrect, it is found that V_a (hor.), for example, is no longer independent of V_{G3} .

A side effect of applying a correction voltage to the entire $G3$ is that also the strength of the pre-focussing lens varies. This can be prevented by applying the correction voltage only to part 28 of $G3$ (the part of $G3$ forming part of the main lens). Part 27 of $G3$ (the part of $G3$ between the triode and G_{ast}) may then be at a fixed voltage, together with G_{ast} . A combination of axial position and dimensioning of G_{ast} can then also be found, whilst the horizontal focussing is not influenced by variations of the voltage at part 28 of $G3$. This embodiment is shown in Fig. 6a in which the same reference numerals as those in Figure 2 have been used for the same components.

In order to achieve the optimum effect, the auxiliary electrode G_{ast} is located closer to the main lens than in this case than in the case shown in Figure 2.

Figure 7 shows a measurement which is characteristic of the embodiment of Fig. 6a and is analogous to the measurement whose results are shown in Fig. 4.

Fig. 6b shows an embodiment which is a variant of the embodiment shown in Fig. 6a. The auxiliary electrode G_{ast} has a fixed connection with the sub-electrode 27 in this case.

Experiments have shown that the above described embodiments yield eminent results. The spot is focussed to an optimum extent both horizontally and vertically in all areas on the screen in the case of correct dynamic operation.

Fig. 2 shows the following details. The invention is, however, not limited to the embodiment of Figure 2. Electrode 26 has one cup-shaped part 29 and a centring bush 30 whose bottom has apertures 31 through which the electron beams pass. Electrode 25 has an outer edge 32 extending to electrode 26 and electrode 26 has an outer edge 33 extending to electrode 25. Apertures 38, 39 and 40 are provided in the recessed part 34 which extends perpendicularly to the axes of the electron beams 6, 7 and 8. Apertures 42, 43 and 44 are provided in the recessed part 41 which extends substantially perpendicularly to the axis of the central electron beam. The recessed parts 34 and 41 form one assembly with parts 28 and 29, respectively.

Dependent on the gun design, the electron beams for the convergence may be bent towards each other, either in the focussing lens or in the lens field between electrodes 24 and 27.

Claims

1. A colour display device comprising a cathode ray tube comprising an evacuated envelope (1) with a rear part and with a front part including a display screen (10), said rear part accommodating an electron gun system (5) for producing three in-line electron beams (6, 7, 8), said electron gun system (5) comprising a first focussing electrode (25) remote from the display screen (10) and a second focussing electrode (26) facing the display screen, which focussing electrodes comprise means for counteracting deflection defocussing said display device further comprising means for applying a focussing voltage and a high voltage, respectively, to the first and second focussing electrodes (25, 26), characterized in that the first focussing electrode (25) comprises a front sub-electrode (28) and a rear sub-electrode (27), the front sub-electrode (28) facing the second focussing electrode (26), and an intermediate auxiliary electrode (G_{ast}) which is provided with apertures for passing the electron beams and which constitutes an astigmatic lens element, in that means are provided for applying a constant voltage to said auxiliary electrode (G_{ast}), and correction means for applying a correction voltage V_c to at least the front one (28) of the sub-electrodes (27, 28).
2. A colour display device as claimed in Claim 1, characterized in that the correction voltage (V_c) is a fixed voltage.
3. A colour display device as claimed in Claim 1, characterized in that the correction voltage (V_c) is a dynamically varying voltage.
4. A colour display device as claimed in Claim 3, characterized in that the dynamically varying voltage comprises a parabolic component which is in synchronism with the line deflection voltage.
5. A colour display device as claimed in Claim 3, characterized in that the dynamically varying voltage comprises a combination of parabolic components which are in synchronism with the line deflection and with the field deflection, respectively.
6. A colour display device as claimed in Claim 1,



be achieved by choosing vertical slots in Figure 2 in the astigmatic element G_{ast} . The correct strength can be achieved by the shape of the slots and the thickness of the plate constituting the astigmatic element, together with the axial position, because the quadrupolar lens strength must be in the correct ratio to the focal distance. When, for example, G_{AST} is too close to the main lens and/or when the configuration of the apertures is chosen to be incorrect, it is found that V_a (hor.), for example, is no longer independent of V_{G3} .

A side effect of applying a correction voltage to the entire $G3$ is that also the strength of the pre-focussing lens varies. This can be prevented by applying the correction voltage only to part 28 of $G3$ (the part of $G3$ forming part of the main lens). Part 27 of $G3$ (the part of $G3$ between the triode and G_{ast}) may then be at a fixed voltage, together with G_{ast} . A combination of axial position and dimensioning of G_{ast} can then also be found, whilst the horizontal focussing is not influenced by variations of the voltage at part 28 of $G3$. This embodiment is shown in Fig. 6a in which the same reference numerals as those in Figure 2 have been used for the same components.

In order to achieve the optimum effect, the auxiliary electrode G_{ast} is located closer to the main lens than in this case than in the case shown in Figure 2.

Figure 7 shows a measurement which is characteristic of the embodiment of Fig. 6a and is analogous to the measurement whose results are shown in Fig. 4.

Fig. 6b shows an embodiment which is a variant of the embodiment shown in Fig. 6a. The auxiliary electrode G_{AST} has a fixed connection with the sub-electrode 27 in this case.

Experiments have shown that the above described embodiments yield eminent results. The spot is focussed to an optimum extent both horizontally and vertically in all areas on the screen in the case of correct dynamic operation.

Fig. 2 shows the following details. The invention is, however, not limited to the embodiment of Figure 2. Electrode 26 has one cup-shaped part 29 and a centring bush 30 whose bottom has apertures 31 through which the electron beams pass. Electrode 25 has an outer edge 32 extending to electrode 26 and electrode 26 has an outer edge 33 extending to electrode 25. Apertures 38, 39 and 40 are provided in the recessed part 34 which extends perpendicularly to the axes of the electron beams 6, 7 and 8. Apertures 42, 43 and 44 are provided in the recessed part 41 which extends substantially perpendicularly to the axis of the central electron beam. The recessed parts 34 and 41 form one assembly with parts 28 and 29, respectively.

Dependent on the gun design, the electron beams for the convergence may be bent towards each other, either in the focussing lens or in the lens field between electrodes 24 and 27.

Claims

1. A colour display device comprising a cathode ray tube comprising an evacuated envelope (1) with a rear part and with a front part including a display screen (10), said rear part accommodating an electron gun system (5) for producing three in-line electron beams (6, 7, 8), said electron gun system (5) comprising a first focussing electrode (25) remote from the display screen (10) and a second focussing electrode (26) facing the display screen, which focussing electrodes comprise means for counteracting deflection defocussing said display device further comprising means for applying a focussing voltage and a high voltage, respectively, to the first and second focussing electrodes (25, 26), characterized in that the first focussing electrode (25) comprises a front sub-electrode (28) and a rear sub-electrode (27), the front sub-electrode (28) facing the second focussing electrode (26), and an intermediate auxiliary electrode (G_{AST}) which is provided with apertures for passing the electron beams and which constitutes an astigmatic lens element, in that means are provided for applying a constant voltage to said auxiliary electrode (G_{AST}), and correction means for applying a correction voltage V_C to at least the front one (28) of the sub-electrodes (27, 28).
2. A colour display device as claimed in Claim 1, characterized in that the correction voltage (V_C) is a fixed voltage.
3. A colour display device as claimed in Claim 1, characterized in that the correction voltage (V_C) is a dynamically varying voltage.
4. A colour display device as claimed in Claim 3, characterized in that the dynamically varying voltage comprises a parabolic component which is in synchronism with the line deflection voltage.
5. A colour display device as claimed in Claim 3, characterized in that the dynamically varying voltage comprises a combination of parabolic components which are in synchronism with the line deflection and with the field deflection, respectively.
6. A colour display device as claimed in Claim 1,



characterized in that the correction means apply a correction voltage (V_C) to both sub-electrodes (27, 28).

7. A colour display device as claimed in Claim 1, characterized in that the correction means apply a correction voltage (V_C) to only the front sub-electrode (28).
8. A colour display device as claimed in Claim 7, characterized in that the correction means apply the same constant voltage to the rear sub-electrode (27) and the auxiliary electrode (G_{AST}).
9. A colour display device as claimed in Claim 8, characterized in that the auxiliary electrode (G_{AST}) has a fixed connection with the rear sub-electrode (27).

Revendications

1. Dispositif de reproduction d'images en couleur comportant un tube à rayons cathodiques comportant une enveloppe mise sous vide (1) munie d'une partie arrière et d'une partie avant comprenant un écran (10), un système de canon à électrons (5) étant disposé dans ladite partie arrière pour produire trois faisceaux à électrons en ligne (6, 7, 8), ledit système de canon à électrons (5) comportant une première électrode de focalisation (25) éloignée de l'écran (10) et une deuxième électrode de focalisation (26) située vis-à-vis de l'écran, ces électrodes de focalisation comportant des moyens pour contrecarrer la défocalisation par déviation, ledit dispositif de reproduction d'images comportant en outre des moyens pour appliquer respectivement une tension de focalisation et une tension élevée aux première et deuxième électrodes de focalisation (25, 26), caractérisé en ce que la première électrode de focalisation (25) comporte une sous-électrode avant (28) et une sous-électrode arrière (27), la sous-électrode avant (28) étant située vis-à-vis de la deuxième électrode de focalisation (26), et une électrode auxiliaire intermédiaire (G_{AST}) pourvue d'ouvertures pour le passage des faisceaux à électrons et constituant un élément de lentille astigmatique, en ce que des moyens sont prévus pour appliquer une tension constante à ladite électrode auxiliaire (G_{AST}), ainsi que des moyens de correction pour appliquer une tension de correction V_C au moins à celle (28) des sous-électrodes (27, 28) qui est située à l'avant.

2. Dispositif de reproduction d'images en couleur

selon la revendication 1, caractérisé en ce que la tension de correction (V_C) est une tension fixe.

3. Dispositif de reproduction d'images en couleur selon la revendication 1, caractérisé en ce que la tension de correction (V_C) est une tension à variation dynamique.
4. Dispositif de reproduction d'images en couleur selon la revendication 3, caractérisé en ce que la tension à variation dynamique comporte une composante parabolique qui est en synchronisme avec la tension de déviation de ligne.
5. Dispositif de reproduction d'images en couleur selon la revendication 3, caractérisé en ce que la tension à variation dynamique comporte une combinaison de composantes paraboliques qui sont respectivement en synchronisme avec la déviation de ligne et avec la déviation de trame.
6. Dispositif de reproduction d'images en couleur selon la revendication 1, caractérisé en ce que les moyens de correction appliquent une tension de correction (V_C) aux deux sous-électrodes (27, 28).
7. Dispositif de reproduction d'images en couleur selon la revendication 1, caractérisé en ce que les moyens de correction appliquent une tension de correction (V_C) à la sous-électrode avant (28) seulement.
8. Dispositif de reproduction d'images en couleur selon la revendication 7, caractérisé en ce que les moyens de correction appliquent la même tension constante à la sous-électrode arrière (27) et à l'électrode auxiliaire (G_{AST}).
9. Dispositif de reproduction d'images en couleur selon la revendication 8, caractérisé en ce que l'électrode auxiliaire (G_{AST}) présente une liaison fixe avec la sous-électrode arrière (27).

Patentansprüche

1. Farbwiedergabeanordnung mit einer Elektronenstrahlröhre mit einem evakuierten Außenkolben (1), mit einem hinteren Teil und mit einem vorderen Teil mit einem Wiedergabschirm (10), wobei in dem genannten hinteren Teil ein Elektronenstrahlerzeugungssystem (5) angeordnet ist zum Erzeugen von drei mit ihren Achsen in einer Ebene liegenden Elektronenstrahlen (6, 7, 8), wobei dieses Elektronenstrahlerzeugungssystem (5) eine in einem Ab-



- stand von dem Wiedergabeschirm (10) vorgesehene erste Fokussierungselektrode (25) sowie eine näher bei dem Wiedergabeschirm (10) vorgesehene zweite Fokussierungselektrode (26) aufweist, wobei diese Fokussierungselektroden Mittel zum Entgegenwirken der Ablenkdefokussierung aufweisen, wobei die genannte Wiedergabeordnung weiterhin Mittel aufweist zum Zuführen einer Fokussierungsspannung und einer Hochspannung zu der ersten bzw. zweiten Fokussierungselektrode (25,26), dadurch gekennzeichnet, daß die erste Fokussierungselektrode (25) eine vordere Unterelektrode (28) und eine hintere Unterelektrode (27) aufweist, wobei die vordere Unterelektrode (28) an die zweite Fokussierungselektrode grenzt, sowie eine zwischenliegende Hilfselektrode (G_{AST}), die mit Öffnungen für den Durchgang der Elektronenstrahlen versehen ist und ein astigmatisches Linsenelement bildet, daß Mittel vorgesehen sind zum Zuführen einer konstanten Spannung zu der genannten Hilfselektrode (G_{AST}), sowie Korrekturmittel zum Zuführen einer Korrekturspannung V_C zu wenigstens der vorderen (28) der Hilfselektroden (27,28).
2. Farbwiedergabeordnung nach Anspruch 1, dadurch gekennzeichnet, daß die Korrekturspannung (V_C) eine feste Spannung ist.
 3. Farbwiedergabeordnung nach Anspruch 1, dadurch gekennzeichnet, daß die Korrekturspannung (V_C) eine sich dynamisch ändernde Spannung ist.
 4. Farbwiedergabeordnung nach Anspruch 3, dadurch gekennzeichnet, daß die sich dynamisch ändernde Spannung eine parabelförmige Komponente enthält, die zu der Horizontalablenkspannung synchron ist.
 5. Farbwiedergabeordnung nach Anspruch 3, dadurch gekennzeichnet, daß die sich dynamisch ändernde Spannung eine Kombination parabelförmiger Komponenten enthält, die mit der horizontalen Ablenkung bzw. der vertikalen Ablenkung synchron sind.
 6. Farbwiedergabeordnung nach Anspruch 1, dadurch gekennzeichnet, daß die Korrekturmittel den beiden Unterelektroden (27,28) eine Korrekturspannung (V_C) zuführen.
 7. Farbwiedergabeordnung nach Anspruch 1, dadurch gekennzeichnet, daß die Korrekturmittel nur der vorderen Unterelektrode (28) eine Korrekturspannung (V_C) zuführen.
 8. Farbwiedergabeordnung nach Anspruch 7, dadurch gekennzeichnet, daß die Korrekturmittel der hinteren Unterelektrode (27) und der Hilfselektrode (G_{AST}) dieselbe konstante Spannung zuführen.
 9. Farbwiedergabeordnung nach Anspruch 8, dadurch gekennzeichnet, daß die Hilfselektrode (G_{AST}) mit der hinteren Unterelektrode (27) fest verbunden ist.