

PATENT SPECIFICATION

(11)

1 591 392

1 591 392

(21) Application No. 35752/77

(22) Filed 25 Aug 1977

(31) Convention Application No. 51/100592

(32) Filed 25 Aug 1976 in

(33) Japan (JP)

(44) Complete Specification Published 24 Jun 1981

(51) INT. CL.³ H01J 29/46 29/51 29/76

(52) Index at Acceptance H1D 4A4 4A7 4B2 4B3A 4B3B
4B3Y 4B4 4C2B 4CY 4K4 4K7Y 4K8



(54) A DEFLECTION YOKE DEVICE IN AN IN-LINE PICTURE TUBE FOR USE IN COLOUR TELEVISION RECEIVER SETS

(71) We, HITACHI, LTD., a Japanese Body Corporate of 5-1, 1-chome, Marunouchi, chiyoda-ku, Tokyo, Japan 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 present invention relates to a colour picture tube having a deflection yoke device for deflecting electron beams and more particularly to such a tube of in-line gun type.

When a 90° in-line type color picture tube of a conventional type is combined with a deflection yoke device having a magnetic field distribution wherein, as shown in Figure 1, the vertical deflection magnetic field takes the form of a barrel and the horizontal deflection magnetic field is of a pincushion, it is possible to converge the side electron beams over the entire surface of the picture screen without using any convergence correcting circuit. In Figure 1, there are illustrated a left side electron beam (blue beam B) 1, a central electron beam (green beam G) 2 and a right side electron beam (red beam R) 3, as viewed from the phosphor screen of the color picture tube toward the electron gun assembly.

With the deflection magnetic field as shown in Figure 1, however, only the side electron beams 1 and 3 are converged while the central electron beam 2 is not converged with the side electron beams 1 and 3 so that an aberration is caused wherein the central electron beam 2 lands inside the side electron beams 1 and 3 converged with each other as shown in Figure 2. In Figure 2 numeral 4 represents a rectangular pattern by the central electron beam 2 and numeral 5 represents a rectangular pattern by the converged side electron beams 1 and 3. The deviation of the central electron beam 2 from the converged side electron beams 1 and 3 becomes greater toward the periphery of the picture screen. Such an aberration results from the fact that the central electron beam 2 has less deflection sensitivity to the magnetic field than that of the side electron beams 1 and 3 especially at the neck side portion of a deflection yoke mounted on a color picture tube. Namely, at the neck side portion of the deflection yoke, the central electron beam 2, the side

electron beams 1 and 3 are laterally or horizontally spaced from one another and the vertical and horizontal deflection magnetic fields act less intensely on the central electron beam 2 than on the side electron beams 1 and 3, resulting in the aberration as shown in Figure 2.

It is to be noted that the curvature of the deflection magnetic field increases with the distance from the central axis, i.e. Z-axis, of the tube with the result that a pincushion distortion is incurred by a deflection magnetic field near the funnel side portion of the deflection yoke mounted on the color picture tube, but that a vertical pincushion distortion will be corrected since the horizontal deflection magnetic field by the horizontal deflection coil takes the form of a pincushion at the funnel side portion of the horizontal deflection coil.

For use in 90° deflection in-line type color picture tubes, the present inventors have already devised a deflection yoke device capable of not only converging the side electron beams 1 and 3 but also being almost free from the vertical pincushion distortion by maintaining the horizontal magnetic field of horizontal deflection coil as a whole in a pincushion configuration to such an extent as to converge the side electron beams 1 and 3 and at the same time by varying the horizontal magnetic field distribution along the Z-axis (parallel to the travelling electron beams) in such a manner that the horizontal magnetic field is of sharp or strong pincushion at the funnel side portion of the horizontal deflection coil and is of weak pincushion at the neck side portion thereof. This is based on the fact that while the convergence characteristics in determined by the magnetic field distribution of the entire deflection yoke, picture distortions such as pincushion ones are created rather by the magnetic field at the funnel side portion than that at other portions.

In this manner, a deflection yoke device applicable to a 90° in-line type color picture tube has been obtained which can completely converge the side electron beams 1 and 3 and be free from any vertical pincushion distortion on the picture screen. In a wide deflection angle color picture tube such as a 110° deflection type, for example, it was impossible to

obtain a deflection yoke device which both ensured the convergence of side electron beams 1 and 3 over the entire picture screen and caused no vertical pincushion distortion since the pincushion distortion before correction is considerable. In this connection, it should be understood that the dimensions and the magnetic field distribution of a deflection yoke device that can converge the side electron beams 1 and 3 over the entire picture screen and eliminate the vertical pincushion distortion, are determined depending on the spacing between electron guns, deflection angle, picture screen size of a color picture tube in question, but that the quantitative relations between these factors have not yet been made clear.

Accordingly, whenever a wide deflection angle color picture tube such as a 110° deflection type is combined with a deflection yoke device having a barrel shaped vertical deflection magnetic field and a pincushion shaped horizontal deflection magnetic field, there still remains a vertical pincushion distortion. Further, where a deflection yoke device having a magnetic field in the form of intensified pincushion at the funnel side portion of the horizontal deflection coil is applied to the wide deflection angle color picture tube, the vertical pincushion distortion may be corrected but an over-convergence is caused wherein the side electron beams 1 and 3 are prevented from converging both vertically and horizontally.

It is an object of the invention to provide in an in-line type color picture tube an improved deflection yoke device capable of reducing or eliminating the aforementioned drawbacks of the prior art device.

According to the invention there is provided an in-line gun type colour picture tube comprising magnetic field control elements disposed near the beam projecting openings of electron gun to weaken the horizontal deflection magnetic flux acting on the central beam as compared with that acting on the side beams in use of the picture tube, and having a deflection yoke device comprising a core, a pair of vertical deflection coils toroidally wound around said core, a pair of saddle shaped horizontal deflection coils, and permanent magnets provided at the funnel side portion of the deflection yoke device, said vertical deflection coils having a winding distribution for producing a barrel shaped magnetic field, and said horizontal deflection coils having a first winding distribution at the funnel side portion of said horizontal coils for producing an extremely intense pincushion shaped magnetic field and a second winding distribution at the neck side portion of said horizontal deflection coils for producing an intense barrel shaped magnetic field, whereby said pincushion shaped magnetic field corrects the vertical, pincushion distortion of the scanned raster in the corners of the picture screen, said permanent magnets correct the vertical pincushion distortion at the centre

portion of the upper and lower side of the picture screen and said intense barrel shaped magnetic field, which would in the absence of the magnetic field control elements cause the central beam to fall outside the converged side beams at the right and left side portions of the picture screen, prevents over-correction of the convergence of the side beams arising from the pincushion shaped magnetic field.

A further aspect of the invention provides an in-line gun type color picture tube comprising magnetic field control elements disposed near the beam projecting openings of electron guns to weaken the horizontal deflection magnetic flux acting on the central beam as compared with that acting on the side beams in use of the picture tube, and having a deflection yoke device comprising a core, a pair of vertical deflection coils toroidally wound around said core, a pair of saddle shaped horizontal deflection coils, and permanent magnets provided at the funnel side portion of the deflection yoke device, said vertical deflection coils having a winding distribution for producing a barrel shaped magnetic field, and said horizontal deflection coils having a first winding distribution at the funnel side portion of said horizontal coils and a second winding distribution at the neck said portion of said horizontal deflection coils, said first winding distribution having a coil winding centre of gravity at an angle from the horizontal sufficiently less than 30° to produce an extremely intense pincushion shaped magnetic field and said second winding distribution having a coil winding centre of gravity at an angle from the horizontal sufficiently more than 30° to produce an intense barrel shaped magnetic field, whereby said pincushion shaped magnetic field corrects the vertical pincushion distortion of the scanned raster in the corners of the picture screen, said permanent magnets correct the vertical pincushion distortion at the centre portion of the upper and lower side of the picture screen and said barrel shaped magnetic field, which would in the absence of the magnetic field control elements cause the central beam to fall outside the converged side beams at the right and left side portions of the picture screen, prevents over-correction of the convergence of the side beams arising from the pincushion shaped magnetic field.

The present invention will be further apparent when one reads the following description given by way of example with reference to the accompanying drawings, in which,

Figure 1 is a diagrammatic representation of deflection magnetic fields of a conventional 90° deflected in-line type color picture tube;

Figure 2 is a diagrammatic representation of an aberration due to the deflection magnetic fields of Figure 1;

Figures 3 and 4 show magnetic field distributions useful to explain a deflection yoke device according to the present invention;

Figure 5 is a perspective view of a deflection yoke device according to the present invention and

Figure 6 is a schematic side view of a horizontal deflection coil of the deflection yoke device shown in Figure 5;

Figure 7 is a sectional view taken on line A-A' in Figure 6;

Figure 8 is a sectional view taken on line B-B' in Figure 6;

Figure 9 is a sectional view taken on line C-C' in Figure 6;

Figure 10 is a graphic representation of magnetic field distribution along the Z-axis of a color picture tube, developed by the horizontal deflection coil of a deflection yoke device embodying the invention;

Figure 11 is a diagrammatic representation of rectangular patterns according to the deflection yoke device embodying the invention;

Figure 12 is a perspective view of one example of magnetic field control element used for a color picture tube combined with a deflecting yoke device according to this invention;

Figure 13 is a plan view of Figure 12;

Figure 14 is a graph showing the relation between horizontal position and intensity of the horizontal deflection magnetic field of the magnetic field control element shown in Figure 12;

Figure 15 is a graph showing the relation between horizontal position and intensity of the vertical deflection magnetic field of the magnetic field control element shown in Figure 12;

Figure 16 shows a rectangular pattern generated by the combination of the deflecting yoke device according to this invention with a color picture tube having a magnetic field control element; and

Figure 17 schematically shows the auxiliary magnetic field generated by the permanent magnets.

Through various experiments directed to reduce vertical pincushion distortions in a self-convergence manner in a wide deflection angle color picture tube combined with a deflection yoke device, the inventors of the present invention have found that it is necessary not only to make the horizontal deflection magnetic field at the funnel side portion of the horizontal deflection coil a pincushion shaped magnetic field of an extremely high intensity but also to make the horizontal deflection magnetic field at the neck side portion a barrel shaped magnetic field of a high intensity, in case of the wide deflection angle color picture tube, differing from the deflection yoke which has been conventionally available. The shape of this barrel shaped magnetic field needs to be varied depending on the spaces between the electron guns, the deflection angle and the picture screen size.

A wide deflection angle color picture tube such as 110° deflection type suffers from

exaggerated pincushion distortions and accordingly, the horizontal deflection magnetic field to be used must be designed to be a more curved or intensified pincushion shaped magnetic field as compared with a 90° deflection type.

The extremely intensified pincushion magnetic field sufficiently compensates the pincushion distortion at the four corners of the picture screen. In wide deflection angle color picture tubes, however, the pincushion distortion appeared at the upper and lower central portions of the picture screen is not sufficiently corrected, because the horizontal deflection magnetic field at the centre portion of the upper and lower sides of the deflection yoke device is not so intensified even in the case where the pincushion magnetic field is extremely intensified. With the deflection yoke device of the present invention the remaining distortion of raster at the central portion of the upper and lower sides of the picture screen is eliminated by at least two permanent magnets disposed at the upper and lower sides of the deflection yoke device.

Namely, the horizontal deflection magnetic field near the funnel side portion of the horizontal deflection coil is made more pincushion-like thereby effectively to correct the vertical pincushion distortion at the corners of the picture screen. And vertical pincushion distortion at the centre portion of the upper and lower sides of the picture screen is corrected by the permanent magnets. The pincushion-magnetic field intensified near the funnel side portion of horizontal deflection coil will cause an excessive correction for the convergence of the side electron beams 1 and 3. Therefore, in order to prevent the excessive correction and to obtain a normal correction, the horizontal deflection magnetic field near the neck side portion of the horizontal deflection coil is made, in contrast to the pincushion type, a barrel type as shown in Figure 4.

Thus, the horizontal magnetic field of the horizontal deflection coil having an extremely intensified pincushion configuration at the funnel side portion and an intensified barrel configuration at the neck side portion ensures, even in case of the wide deflection angle color picture tube such as 110° deflection type, the convergence of the side electron beams 1 and 3.

Figure 5 shows an example of a deflection yoke device giving such a magnetic field distribution as described above and the pattern generated by the deflection yoke device of Figure 5, but without the provision of correcting, permanent magnets 14, is as shown in Figure 11. Such a deflection yoke without permanent magnets is described in detail in the specification of British Patent Application No. 14935/77. (Serial No. 1577147).

The present invention provides the permanent magnets 14 on the funnel side portion of the deflection yoke.

12

The present invention will be detailed with the aid of the attached drawings hereunder. As shown in Figure 5, the deflection yoke device comprises a core, a vertical deflection coil 12 having a toroidal coil wound around a core 11, a horizontal deflection coil 6 in the form of a saddle and permanent magnets 14 attached on to the funnel side portion of a mold frame 13 for separately supporting the vertical and horizontal deflection coils 12 and 6. The vertical deflection coil is wound and formed in the same manner as a conventional one and produces a barrel type magnetic field distribution.

Figure 6 is a side view of a horizontal deflection coil 6 of the deflection yoke device, which comprises a pair of horizontal coils 7 and 7' formed in a saddle configuration. The horizontal deflection coils 7 and 7' produce, along the Z-axis, an intense barrel shaped magnetic field localized at the neck side portion and an extremely intense pincushion shaped magnetic field localized at the funnel side portion as shown at curve 9 in Figure 10. The curve 8 in Figure 10 illustrates the intensity of the magnetic field while the curve 9, as indicated illustrates the shape of the magnetic field.

Figures 7, 8 and 9 show the conductor distributions of the horizontal deflection coils 7 and 7' shown in Figure 6 at cross sections along lines A-A', B-B' and C-C'. The horizontal deflection coils 7 and 7' of Figure 5 each have, at a cross-section on line A-A' shown in Figure 7, a winding conductor distribution which has a coil winding width angle θ_1 ranging from 7.5° to 80° and the center of gravity A at 44°; at a cross-section on line B-B' shown in Figure 8, a winding conductor distribution which has a coil winding width angle θ_2 ranging from 5.5° to 50° and the center of gravity B at 28°; and at a cross-section on line C-C' shown in Figure 9, a winding conductor distribution which has a coil winding width angle θ_3 ranging from 0.5° to 20° and the center of gravity C at 10°.

The most important factor of the winding conductor distributions of the horizontal deflection coils 7 and 7' is the angular position of the center of gravity and depending on this angular position, the magnetic field distribution is determined as either a pincushion type or a barrel type. Namely, with an angle for the center of gravity of 30°, a substantially uniform magnetic field is produced; with this angle being smaller, a pincushion shaped magnetic field is generated; and with this angle being larger, a barrel shaped magnetic field is created.

Thus, the horizontal deflection coils 7 and 7' produce an intense barrel shaped magnetic fields at the neck side portion corresponding to the A-A' section in Figure 7 at which the center of gravity A of the winding conductor distribution coincides with 44 degrees, an approximately uniform magnetic field at the central portion around B-B' section in Figure 8 at which the centre of gravity B of winding conductor distribution coincides with 28 degrees,

and an extremely intense pincushion shaped magnetic field at the funnel side portion corresponding to the C-C' section in Figure 9 at which the centre of gravity C of winding conductor distribution coincides with 10 degrees. The magnetic field distribution along the Z-axis in this state is shown in Figure 10.

As has been described, since, in the deflection yoke device the vertical deflection coil produces a barrel shaped magnetic field, and the winding conductor distribution of the horizontal deflection coil is so designed as to generate along the Z-axis, an intense barrel shaped magnetic field at the neck side portion and an extremely intense pincushion shaped magnetic field at the funnel side portion and the permanent magnets are provided on the upper and lower portion of the mould frame, the deflection yoke device combined with the wide deflection angle color picture tube such as 110° deflection type permits a pattern wherein the convergence of the side electron beams 1 and 3 is ensured and the vertical pincushion distortion is eliminated. This combination can dispense with the provision of a vertical pincushion distortion correcting circuit.

However, although provision of the permanent magnets and of the horizontal deflection magnetic field consisting of an extremely intense pincushion shaped magnetic field at the funnel side portion and an intense barrel shaped magnetic field at the neck side portion ensures, when used in the wide deflection angle color picture tube, the elimination of the vertical pincushion distortion correcting circuit as mentioned above and the convergence of side electron beams 1 and 3, the overall misconvergence in this case is different from that shown in Figure 2; the central electron beam 2 lands outside the side electron beams 1 and 3 as shown in Figure 11. In Figure 11 showing rectangular patterns produced by the deflecting yoke device numeral 41 designates a rectangular pattern produced by the central electron beam 2 and 42 a rectangular pattern by the converged side electron beams 1, 3. The reason why the rectangular pattern 41 falls outside the rectangular pattern 42, at the sides, and inside at the top and bottom, will be described again. Namely, this is due to the fact that the horizontal deflection magnetic field, taking the form of the barrel at the neck side portion, has the highest intensity at the central portion of picture screen and decreases in its intensity toward the periphery (in the horizontal direction) of the picture screen so that the central electron beam 2 is deflected much more than the side electron beams 1, 3.

In such a case, the side beams are converged and no vertical pincushion distortion takes place, but the central beam falls inside the side beams near the vertical extreme portions of the picture screen and outside the side beams near the horizontal extreme portions of the picture screen, the side beams and the central beam not

converging together.

In use of the yoke device with 110° in-line type color picture tube such deviations of the central beam from the side beams near the extreme portions are corrected by magnetic field control elements provided near the electron beam projecting openings of the electron guns of a color picture tubes.

Figure 12 is a perspective view, as viewed from front and left above, of magnetic field control elements provided for a color picture tube, and Figure 13 is a plan view of Figure 12.

As shown in Figure 12, magnetic field control elements 21 and 22 made of magnetic material have a symmetric configuration and are disposed symmetrically with respect to a central beam 2. The magnetic field control element 21 consists of three thin magnetic material plates. First and second magnetic plates 23 and 24 are disposed to sandwich a side beam 1 vertically, and they are long horizontally and short vertically. A third magnetic plate 25 which is long vertically and short back and forth is disposed to separate the side beam 1 from the central beam 2. The first and second magnetic plates 23 and 24 are connected with the third magnetic plate 25 at the upper and lower portions thereof, respectively. On the other hand, the magnetic field control element 22 consists of a first, a second and a third magnetic material plates 26, 27 and 28 which are correspondingly symmetrical with the first, second and third magnetic plates 23, 24 and 25. The magnetic field control elements 21 and 22 are secured to a non-magnetic body. In Figure 13 arrows 1', 2' and 3' show directions in which beams 1, 2 and 3 travel, and the magnetic field control elements are illustrated as being secured to a shield cap of the non-magnetic material a portion of which is designated to 29.

As regards the horizontal deflection magnetic field, a portion of magnetic flux which would affect the central beam 2 in the absence of the vertically long magnetic plates 25 and 28, passes through the magnetic plates 25 and 28 of high permeability, that is, the magnetic flux which would affect the central beam 2 is confined in the magnetic plates 23 and 28 and reduced thereby so that the horizontal deflection magnetic field acting on the central beam 2 is weakened. The horizontal deflection magnetic flux affecting the side beams 1 and 2 remains substantially unchanged because the side beams 1 and 2 are spaced apart from the magnetic plates 25 and 28. Further, since the magnetic plates 23, 24, 26 and 27 are short vertically and long horizontally, the presence or absence of these magnetic plates has little influence upon the horizontal deflection magnetic flux affecting the side beams 1 and 3. Accordingly, the magnetic fluid control elements 21 and 23 reduces the horizontal deflection magnetic flux acting on the central beam 2, thereby weakening the horizontal deflection

magnetic field acting on the central beam 2 relative to the horizontal deflection magnetic fields acting on the side beams 1 and 3. As a result, the horizontal aberration as shown in Figure 11 can be corrected.

Figure 14 shows one example of the relation between horizontal position and intensity of the horizontal deflection magnetic field. In the figure, the abscissa represents the variation in position in the horizontal direction, that is perpendicular to the Z-axis, within a space 30° . Figure 13, in which the magnetic plates 25 and 28 are contained. Positions 1'', 2'' and 3'' correspond to the centers of the beam projecting openings 31, 32 and 33. If the horizontal deflection magnetic field is uniform as designated at 34 in the absence of the magnetic field control elements 21 and 22, the presence of the magnetic field control elements 21 and 22 creates a horizontal deflection magnetic field intensity distribution as designated at 35 wherein the intensity of the magnetic field at the position 2'' is weakened in comparison with the intensities of magnetic field at the positions 1'' and 3''. As will be seen from Figure 14, the horizontal deflection magnetic fields near the side beam projecting openings 31 and 33 are weakened because the portions of the horizontal deflection magnetic flux passing through the pair magnetic plates 23 and 24 and the other paired magnetic plates 26 and 28, respectively, are confined in the magnetic plates 25 and 28. In this case, the magnetic plates 23, 24, 26 and 27 which are short vertically will have little influence upon the horizontal deflection magnetic field.

Next, as regards the vertical deflection magnetic field, the vertical deflection magnetic flux which would pass near the side beam projecting openings 31 and 33 in the absence of the magnetic plates 23, 24, 26 and 27, mostly passes through the magnetic plates 23, 24, 26 and 27 of high permeability so that the vertical deflection magnetic fields near the openings 31 and 33 are weakened as compared with the case where the magnetic plates 23, 24, 26 and 27 are not provided. In addition, since the vertical deflection magnetic flux once absorbed by the magnetic plates 26 and 28 leave the magnetic plates 26 and 28 near the central beam projecting opening 32 and is again confined in the magnetic plates 23 and 24, the vertical deflection magnetic field near the central beam projecting opening 32 is intensified as compared with the case where the magnetic plates 23, 24, 26 and 27 are not provided.

Accordingly, the magnetic plates 23, 24, 26 and 27 serve to weaken the vertical deflection degree of the side beams 1 and 3 but intensity the vertical deflection degree of the central beam 2, thereby correcting the vertical aberration of the pattern as shown in Figure 11.

Figure 15 shows one example of the relation between horizontal position and intensity of the vertical deflection magnetic field. In the

figure, the abscissa represents the variation in position in the horizontal direction, that is perpendicular to the Z-axis, within a space in which the magnetic plates 23, 24, 26 and 27 are contained.

The vertical deflection magnetic flux which would be uniform as designated at 37 in the absence of the magnetic plates 23, 24, 26 and 27 is absorbed by the magnetic plates 23, 24, 26 and 27 and then leave them so that the intensity of magnetic field changes as designated at a curve 38. The intensity of magnetic field is weakened near the side beam projecting openings 31 and 33 where the vertical deflection magnetic flux is absorbed but intensified near the central beam projecting opening 32 where the vertical deflection magnetic flux is emitted.

It is noted that the magnetic plates 25 and 28 which are thin horizontally have little influence on the vertical deflection magnetic field.

With the combination of the deflection yoke device having such a horizontal deflection coil as shown in Figure 6 (without the permanent magnets) with a wide deflection angle color picture tube, having such magnetic field control elements as described above, the central beam and the side beams can be caused correctly to converge vertically and horizontally as shown in Figure 16. The distortions, however, still remain as shown in Figure 16 wherein a pincushion distortion is observed in the rectangular pattern. The curved distortions at the upper and lower central portions of the picture screen in Figure 16 cannot be corrected by changing the shapes of the horizontal deflection coils, such distortions are corrected by the provision of the permanent magnets top and bottom.

As shown in Figure 5, at the upper and the lower portions of the funnel side portion of the mold frame 13 for separately supporting the vertical and horizontal deflection coils 12 and 6 are provided permanent magnets 14 for generating an auxiliary deflecting magnetic field 141 as shown in Figure 17 so that the curved distortions shown in Figure 16 are corrected to generate an exactly rectangular pattern. The permanent magnets 14 may be disposed on any member if it is located at the funnel side end of the deflection yoke device. The magnetic flux generated by the permanent magnets 14 mainly deflects the electron beams vertically and the problem of beam landing seems to cause no difficulty in a color picture tube having a stripe type phosphor screen. In practice, however, the flux generated by the magnets 14 curves at the extreme ends as shown in Figure 17 so that the beams are deflected horizontally to some extent. Accordingly, the beam landing is slightly affected and the degree of affecting the beam landing determines the upper limit of the degree of correcting the curved distortions by the permanent magnets 14.

The suitable amount of the correction of

the distortions by the permanent magnets 14 proved to be at most 2 mm for a 22-inch color picture tube having a deflection angle of 110° . The value of 2 mm is about 1.3% of the height, i.e. vertical size, of the picture screen. The amount of the correction by the permanent magnets 14 depends on the size of the phosphor screen of the picture tube to be used, but the distortions shown in Figure 16, generated in the color picture tube having such a deflection coils as shown in Figure 6 and magnetic field control elements, can be optionally corrected when the distortions are within half the width, i.e. horizontal size, of the phosphor screen and within $0.5 \sim 1.5\%$ of the height, i.e. vertical size, of the phosphor screen.

WHAT WE CLAIM IS:—

1. An in-line gun type color picture tube comprising magnetic field control elements disposed near the beam projecting openings of electron guns to weaken the horizontal deflection magnetic flux acting on the central beam as compared with that acting on the side beams in use of the picture tube, and having a deflection yoke device comprising a core, a pair of vertical deflection coils toroidally wound around said core, a pair of saddle shaped horizontal deflection coils, and permanent magnets provided at the funnel side portion of the deflection yoke device, said vertical deflection coils having a winding distribution for producing a barrel shaped magnetic field, and said horizontal deflection coils having a first winding distribution at the funnel side portion of said horizontal coils for producing an extremely intense pincushion shaped magnetic field and a second winding distribution at the neck side portion of said horizontal deflection coils for producing an intense barrel shaped magnetic field, whereby said pincushion shaped magnetic field corrects the vertical, pincushion distortion of the scanned raster in the corners of the picture screen, said permanent magnets correct the vertical pincushion distortion at the centre portion of the upper and lower side of the picture screen and said intense barrel shaped magnetic field, which would in the absence of the magnetic field control elements cause the central beam to fall outside the converged side beams at the right and left side portions of the picture screen, prevents over-correction of the convergence of the side beams arising from the pincushion shaped magnetic field.

2. An in-line gun type color picture tube comprising magnetic field control elements disposed near the beam projecting openings of electron guns to weaken the horizontal deflection magnetic flux acting on the central beam as compared with the acting on the side beams in use of the picture tube, and having a deflection yoke device comprising a core, a pair of vertical deflection coils toroidally wound around said core, a pair of saddle shaped horizontal deflection coils, and permanent magnets



figure, the abscissa represents the variation in position in the horizontal direction, that is perpendicular to the Z-axis, within a space in which the magnetic plates 23, 24, 26 and 27 are contained.

The vertical deflection magnetic flux which would be uniform as designated at 37 in the absence of the magnetic plates 23, 24, 26 and 27 is absorbed by the magnetic plates 23, 24, 26 and 27 and then leave them so that the intensity of magnetic field changes as designated at a curve 38. The intensity of magnetic field is weakened near the side beam projecting openings 31 and 33 where the vertical deflection magnetic flux is absorbed but intensified near the central beam projecting opening 32 where the vertical deflection magnetic flux is emitted.

It is noted that the magnetic plates 25 and 28 which are thin horizontally have little influence on the vertical deflection magnetic field.

With the combination of the deflection yoke device having such a horizontal deflection coil as shown in Figure 6 (without the permanent magnets) with a wide deflection angle color picture tube, having such magnetic field control elements as described above, the central beam and the side beams can be caused correctly to converge vertically and horizontally as shown in Figure 16. The distortions, however, still remain as shown in Figure 16 wherein a pincushion distortion is observed in the rectangular pattern. The curved distortions at the upper and lower central portions of the picture screen in Figure 16 cannot be corrected by changing the shapes of the horizontal deflection coils. such distortions are corrected by the provision of the permanent magnets top and bottom.

As shown in Figure 5, at the upper and the lower portions of the funnel side portion of the mold frame 13 for separately supporting the vertical and horizontal deflection coils 12 and 6 are provided permanent magnets 14 for generating an auxiliary deflecting magnetic field 141 as shown in Figure 17 so that the curved distortions shown in Figure 16 are corrected to generate an exactly rectangular pattern. The permanent magnets 14 may be disposed on any member if it is located at the funnel side end of the deflection yoke device. The magnetic flux generated by the permanent magnets 14 mainly deflects the electron beams vertically and the problem of beam landing seems to cause no difficulty in a color picture tube having a stripe type phosphor screen. In practice, however, the flux generated by the magnets 14 curves at the extreme ends as shown in Figure 17 so that the beams are deflected horizontally to some extent. Accordingly, the beam landing is slightly affected and the degree of affecting the beam landing determines the upper limit of the degree of correcting the curved distortions by the permanent magnets 14.

The suitable amount of the correction of

the distortions by the permanent magnets 14 proved to be at most 2 mm for a 22-inch color picture tube having a deflection angle of 110° . The value of 2 mm is about 1.3% of the height, i.e. vertical size, of the picture screen. The amount of the correction by the permanent magnets 14 depends on the size of the phosphor screen of the picture tube to be used, but the distortions shown in Figure 16, generated in the color picture tube having such a deflection coils as shown in Figure 6 and magnetic field control elements, can be optionally corrected when the distortions are within half the width, i.e. horizontal size, of the phosphor screen and within 0.5 ~ 1.5% of the height, i.e. vertical size, of the phosphor screen.

WHAT WE CLAIM IS:-

1. An in-line gun type color picture tube comprising magnetic field control elements disposed near the beam projecting openings of electron guns to weaken the horizontal deflection magnetic flux acting on the central beam as compared with that acting on the side beams in use of the picture tube, and having a deflection yoke device comprising a core, a pair of vertical deflection coils toroidally wound around said core, a pair of saddle shaped horizontal deflection coils, and permanent magnets provided at the funnel side portion of the deflection yoke device, said vertical deflection coils having a winding distribution for producing a barrel shaped magnetic field, and said horizontal deflection coils having a first winding distribution at the funnel side portion of said horizontal coils for producing an extremely intense pincushion shaped magnetic field and a second winding distribution at the neck side portion of said horizontal deflection coils for producing an intense barrel shaped magnetic field, whereby said pincushion shaped magnetic field corrects the vertical, pincushion distortion of the scanned raster in the corners of the picture screen, said permanent magnets correct the vertical pincushion distortion at the centre portion of the upper and lower side of the picture screen and said intense barrel shaped magnetic field, which would in the absence of the magnetic field control elements cause the central beam to fall outside the converged side beams at the right and left side portions of the picture screen, prevents over-correction of the convergence of the side beams arising from the pincushion shaped magnetic field.

2. An in-line gun type color picture tube comprising magnetic field control elements disposed near the beam projecting openings of electron guns to weaken the horizontal deflection magnetic flux acting on the central beam as compared with the acting on the side beams in use of the picture tube, and having a deflection yoke device comprising a core, a pair of vertical deflection coils toroidally wound around said core, a pair of saddle shaped horizontal deflection coils, and permanent magnets



16

7

1 591 392

7

provided at the funnel side portion of the deflection yoke device, said vertical deflection coils having a winding distribution for producing a barrel shaped magnetic field, and said horizontal deflection coils having a first winding distribution at the funnel side portion of said horizontal coils and a second winding distribution at the neck side portion of said horizontal deflection coils, said first winding distribution having a coil winding centre of gravity at an angle from the horizontal sufficiently less than 30° to produce an extremely intense pincushion shaped magnetic field and said second winding distribution having a coil winding centre of gravity at an angle from the horizontal sufficiently more than 30° to produce an intense barrel shaped magnetic field, whereby said pincushion shaped magnetic field corrects the vertical pincushion distortion of the scanned raster in the corners of the picture screen, said permanent magnets correct the vertical pincushion distortion at the centre portion of the upper and lower side of the picture screen and said barrel shaped magnetic field,

which would in the absence of the magnetic field control elements cause the central beam to fall outside the converged side beams at the right and left side portions of the picture screen, prevents over-correction of the convergence of the side beam arising from the pincushion shaped magnetic field.

3. A picture tube as claimed in Claim 1, wherein said permanent magnets are provided on a mold frame for separately supporting said horizontal and vertical deflection coils.

4. A color picture tube having a deflection yoke constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated in Figures 5 and 17 of the accompanying drawings.

J.A. KEMP & CO.
Chartered Patent Agents
14 South Square
Gray's Inn
London
WC1R 5EU