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(54) A DEFLECTION YOKE DEVICE 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 deflection yoke device for deflecting the electron beams in a color picture tube and more particularly to a deflection yoke device suitable for use in in-line type color picture tubes.

In the accompanying drawings:

Fig. 1 is a diagrammatic representation showing deflection magnetic fields of a conventional 90° deflection angle in-line type color picture tube;

Fig. 2 is a diagrammatic representation of a coma aberration due to the deflection magnetic fields of Fig. 1;

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

Fig. 5 is a schematic side view showing a pair of horizontal deflection coils of the deflection yoke device according to the invention;

Fig. 6 is a sectional view taken on line A-A' in Fig. 5;

Fig. 7 is a sectional view taken on line B-B' in Fig. 5;

Fig. 8 is a sectional view taken on line C-C' in Fig. 5;

Fig. 9 is a graphic representation of the magnetic field distribution and the intensity of the field along the Z-axis of a color picture tube obtainable from a deflection yoke device embodying the invention; and

Fig. 10 is a diagrammatic representation of rectangular patterns according to the invention.

When a 90° in-line type color picture tube of a conventional type is combined

with a deflection yoke device having magnetic field distributions wherein, as shown in Fig. 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 make convergence of the side electron beams over the entirety of the picture screen without using any vertical pincushion distortion correcting circuit. In Fig. 1, there are illustrated a left side electron beam (blue or B) 1, a central electron beam (green or G) 2 and a right side electron beam (red or R) 3 as viewing the electron gun assembly from the phosphor faceplate of color picture tube.

The same inventors as this invention have previously materialized a deflection yoke device capable of not only making the convergence of 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 to be a pincushion magnetic field to such an extent as necessary for the convergence of the side electron beams 1 and 3 and at the same time varying the horizontal magnetic field distribution along the Z-axis (parallel to the electron beams running direction) such that the horizontal magnetic field is of the intensified pincushion shaped field at the funnel side portion of the horizontal deflection coil whereas it is of a weakened pincushion shape at the neck side portion thereof. This is based on the fact that while the convergence characteristics are determined by the magnetic field distribution of the entirety of deflection yoke, distortions on the picture screen such as the pincushion distortion is created rather by the magnetic field at the funnel side portion.

In this manner, a deflection yoke device applicable to a 90° in-line type color picture tube has been obtained capable of 90

making a complete convergence of the side electron beams 1 and 3 and being devoid of 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 ensured the convergence of the side electron beams 1 and 3 over the entire picture screen as well as the elimination of vertical pincushion distortion since the pincushion distortion before correction is present to a great extent. In this connection, it should be understood that the dimension and the magnetic field distribution of a deflection yoke device that can make the convergence of the side electron beams 1 and 3 over the entirety of the picture screen as well as the elimination of the vertical pincushion distortion are determined dependent on the spacing between the electron guns, the deflection angle, the picture screen size of the color picture tube in question, but heretofore quantitative relations between these factors were not made clear.

It will be appreciated that the more the deflection magnetic field is spaced from the central axis of the color picture tube, the more is curved the deflection magnetic field with the result that a pincushion deformation is created by a deflection magnetic field at the funnel side portion of deflection yoke mounted on the color picture tube, but a vertical pincushion distortion will be corrected since the horizontal deflection magnetic field due to the horizontal deflection coil takes the form of a pincushion at the funnel side portion of the horizontal deflection coil.

But when a wide deflection angle color picture tube such as a 110° deflection type is combined with the deflection yoke device having the vertical barrel shaped deflection magnetic field and the horizontal deflection pincushion shaped magnetic field, there still remains the vertical pincushion distortion. Further, where a deflection yoke device having an intensified pincushion shaped field 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 on one hand but, on the other hand, excessive correction of the convergence is caused wherein the side electron beams 1 and 3 are prevented from being converged both vertically and horizontally.

With the deflection magnetic field as shown in Fig. 1, however, the convergence is effected only for the side electron beams 1 and 3 and the central electron beam 2 fails to converge with the side electron beams 1 and 3 so that a coma 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 Fig. 2, where numeral 4 represents a rectangular pattern of a scanned raster due to the central electron beam 2 and numeral 5 represents a rectangular pattern of a scanned raster due to the converged side electron beams 1 and 3. The displacement between the converged side electron beams 1 and 3 and the central electron beam 2 becomes greater toward the periphery of the picture screen. Such a coma 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 the deflection yoke mounted on the color picture tube. Namely, at the neck side portion of the deflection yoke, the central electron beam 2 and side electron beams 1 and 3 run in a laterally or horizontally spaced relationship and weakened vertical and horizontal deflection magnetic fields act on the central electron beam 2 as compared with the side electron beams 1 and 3, resulting in the coma aberration as shown in Fig. 2.

This coma aberration is not fully compensated by the deflection yoke alone; however, this is not important as the coma aberration can usually be compensated by the provision of a piece of magnetic material, known as a field controller, at the peripheral of the electron gun. In the case of the coma aberration as shown in Fig. 2, by the action of the piece of magnetic material the magnetic field at the peripheral of the central beam 2 is strengthened, and the magnetic fields at the peripheral of the side beams 1 and 3 are weakened in order to produce consistency between the central beam 2 and side beams 1 and 3. Therefore, it is an important characteristic for a deflection yoke which is required to deflect at a wide angle to compensate the pincushion distortion without causing a deterioration of the convergence of the side beams 1 and 3.

An object of the invention is to provide an improved deflection yoke device capable of eliminating the aforementioned drawbacks of the prior art device.

According to one aspect of the present invention there is provided a deflection yoke device comprising a core, a pair of vertical deflection coils toroidally wound around said core and a pair of saddle shaped horizontal deflection coils, in continuation with an in-line type color picture tube which produces a plurality of coplanar in-line beams; said vertical deflection coils having a winding distribution for producing a barrel shaped magnetic field distribution and said horizontal deflection coils having a first winding distribution, at the funnel side portion of said horizontal

coils, for producing an intensified pincushion shaped magnetic field distribution and a second winding distribution, at the neck side portion of said horizontal deflection coils, for producing a barrel shaped magnetic field distribution, whereby said intensified pincushion shaped magnetic field distribution corrects the vertical pincushion distortion of a scanned raster and said barrel shaped magnetic field distribution prevents over-correction of the convergence of the side beams arising from the intensified pincushion magnetic field.

According to another aspect of the present invention there is provided a deflection yoke device comprising a core, a pair of vertical deflection coils toroidally wound around said core and a pair of saddle shaped horizontal deflection coils, in combination with an in-line type color picture tube which produces a plurality of coplanar in-line beams; said vertical deflection coils having a winding distribution for producing a barrel shaped magnetic field distribution, and said horizontal deflection coils having a first winding distribution at the funnel side portion and a second winding distribution at the neck side, said first winding distribution having a coil winding width angle less than 30° to produce an intensified pincushion magnetic flux and said second winding distribution having a coil winding width angle more than 30° to produce barrel magnetic flux, whereby said intensified pincushion shaped magnetic field distribution corrects the vertical pincushion distortion of a scanned raster and said barrel shaped magnetic field distribution, prevents over-correction of the convergence of the side beams arising from the intensified pincushion magnetic field.

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

In a deflection yoke used for a picture tube having a larger deflection angle, this barrel shaped magnetic field is more distorted or swollen.

The wide deflection angle color picture tube such as 110° deflection type suffers from accelerated pincushion distortions and accordingly, in order to eliminate the vertical pincushion distortion correcting circuit, the horizontal deflection magnetic field is designed to have a more curved or intensified pincushion shape magnetic field as compared with a 90° deflection type.

More particularly, the horizontal deflection magnetic field near the funnel side portion of the horizontal deflection coil is made more pincushion-like as shown in Fig. 3 whereby effectively to correct the vertical pincushion distortion. As compared with the intensified pincushion shape magnetic field shown in Fig. 3, a pincushion shaped magnetic field of the 90° deflection type would be less sharply curved. On the other hand, the pincushion shape magnetic field intensified near the funnel side portion of the horizontal deflection coil would cause an excessive correction for the convergence between the side electron beams 1 and 3. Therefore, in order to cancel 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 Fig. 4.

The provision of the horizontal magnetic field of the horizontal deflection coil including the intensified pincushion magnetic field at the funnel side portion and the barrel shaped magnetic field at the neck side portion permits, even in case of the wide deflection angle color picture tube such as 110° deflection type, the elimination of the need for the vertical pincushion distortion correcting circuit while allowing the convergence of the side electron beams 1 and 3.

A deflection yoke device of the present invention is constructed as will be detailed hereunder and comprises a core, a vertical deflection coil having a pair of toroidal coils wound around the core and a pair of horizontal deflection coils in the form of a saddle, but the vertical deflection coil is wound and formed in the same manner as a conventional one and produces a barrel shaped magnetic field distribution. Such a vertical deflection coil as mentioned just above is combined with the horizontal deflection coil having a construction as described in detail hereinafter for the specific purposes of the present invention as mentioned hereinbefore.

As shown in section in Fig. 5, a horizontal deflection coil 6 of the deflection yoke device according to the invention comprises a pair of horizontal coils 7 and 7' formed into the saddle configuration. The horizontal deflection coils 7 and 7' 130

produce, along the Z-axis, a barrel shaped magnetic field localized at the neck side portion and an intensified pincushion shape magnetic field localized at the funnel side portion as shown at curve 9 in Fig. 9. The curve 8 in Fig. 9 shows the intensity of the magnetic field while, in contrast, the curve 9 shows the form of the magnetic field. The intensity of the magnetic field is proportional to the current flowing in the coil and the current can be selected to cause deflection of the beam by the necessary amount. The form of the magnetic field is not substantially changed by changes in the current and thus the intensity of the field is not important with respect to compensation of the pincushion distortion and the convergence of the side beams. Curve 9 illustrates below the horizontal ordinate axis the shape of the barrel shaped magnetic field and above the ordinate axis the shape of the pincushion shaped magnetic field. Thus for different positions along the horizontal ordinate axis the degree of curvature of one or the other of the barrel shaped or pincushion shaped magnetic fields will be greater or lesser depending upon the distance of the curve 9 at locations corresponding with those positions away from the horizontal ordinate axis.

The horizontal deflection coils 7 and 7' have different winding distributions as shown in section in Figs. 6, 7 and 8. More particularly, the horizontal deflection coils 7 and 7' of Fig. 5 each have, at a cross-section on line A-A' shown in Fig. 6, a winding distribution which has a coil winding width angle Θ_1 subtending (80-7.5) degrees and a center of gravity A at 44 degrees; at a cross-section on line B-B' shown in Fig. 7, a winding distribution which has a coil winding width angle Θ_2 subtending (50-5.5) degrees and a center of gravity B at 28 degrees; and at a cross-section on line C-C' shown in Fig. 8, a winding distribution which has a coil winding width angle Θ_3 subtending (20-0.5) degrees and a center of gravity C at 10 degrees.

The most important factor of the winding distribution of the horizontal deflection coils 7 and 7' is an angle subtending for the center of gravity and depending on this angle, the magnetic field distribution is determined as having either a pincushion shape or a barrel shape. That is to say, with an angle for the center of gravity of 30 degrees, a substantially uniform magnetic field is produced; with an angle of less than 30 degrees, a pincushion shaped magnetic field is produced; and with an angle of more than 30 degrees, a barrel shaped magnetic field is produced.

Thus, the horizontal deflection coils 7

and 7' produces the barrel shaped magnetic fields at the neck side portion corresponding to A-A' section of Fig. 6 at which the center of gravity A of the winding distribution coincides at 44 degrees, a uniform magnetic field manifesting the absence of the barrel shaped, and pincushion shaped magnetic fields at the central portion corresponding to B-B' section of Fig. 7 at which the center of gravity B of winding distribution coincides at 28 degrees, and the intensified pincushion shaped magnetic field at the funnel side portion corresponding to C-C' section of Fig. 8 at which the center of gravity C of winding distribution coincides at 10 degrees. The magnetic field distribution of a variety of these types of the fields along the Z-axis is shown by the curve 9 in Fig. 9.

As has been described, since, in the deflection yoke device according to this invention, the winding distribution of the pair of vertical deflection coils is of a barrel shaped magnetic field, and the winding distribution of the horizontal deflection coils along the Z-axis, is of a barrel shaped magnetic field at the neck side portion and of an intensified pincushion shaped magnetic field at the funnel side portion, 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, while dispensing with the vertical pincushion distortion correcting circuit.

In this manner, the horizontal deflection magnetic field which includes the intensified pincushion shaped magnetic field at the funnel side portion and the barrel shaped magnetic field ensures, even when applied to the wide deflection angle color picture tube, the elimination of the vertical pincushion distortion correcting circuit as mentioned above as well as the convergence of the side electron beams 1 and 3, thus giving rise to a coma aberration different from that of Fig. 2 such that the central electron beam 2 lands outside the side electron beams 1 and 3 as shown in Fig. 10. In Fig. 10 showing rectangular patterns according to the present invention, numeral 41 designates a rectangular pattern due to the central electron beam 2 and 42 a rectangular pattern due to the converged side electron beams 1 and 3. To repeat, the rectangular pattern 41 indicative of the central electron beam 2 is present outside the rectangular pattern 42 indicative of the side electron beams 1 and 3 due to the fact that the horizontal deflection magnetic field taking the form of the barrel at the neck side portion has the greatest intensity at the central portion of the deflection yoke and is

decreased in its intensity toward the periphery (in the horizontal direction) of the deflection yoke screen so that the central electron beam 2 is deflected much more than the side electron beams 1 and 3.

With the deflection yoke device of the invention including the horizontal deflection coil of Fig. 5 with the winding distributions shown in Figs. 6, 7 and 8 mounted on a 22-inch 110° deflection in-line type color picture tube (spacing between electron guns being 6.6 m/m, 560 ALB 22 type, manufactured by Hitachi, Ltd.), the amount of the vertical pincushion shaped distortion was within 1% at the uppermost and lowermost sides of the picture screen, the side electron beams were completely converged with each other at the right and left sides of the picture screen, and the central electron beam was present 2 m/m outside the converged side electron beams.

Additionally, it is possible to converge the three electron beams at the right and left sides of the picture screen by changing the configuration of the coma aberration correcting magnetic material pieces (field controller) which are mounted to the electron guns.

As has been described in the foregoing, the novel deflection yoke device with the magnetic field distribution which has not been realized heretofore may be combined with the wide deflection angle in-line type color picture tube to permit the elimination of the very expensive correcting circuit for making the convergence of the side electron beams over the entire picture screen and the vertical pincushion distortion correcting circuit, thereby greatly contributing to reduction in the cost of color picture tubes. Further, the deflection yoke device of the invention dispenses with these correcting circuits which inherently suffer unstable performance due to the number of portions to be adjusted and lack of reliability due to the number of circuit elements and is highly stable and reliable.

WHAT WE CLAIM IS:

1. A deflection yoke device comprising a core, a pair of vertical deflection coils toroidally wound around said core and a pair of saddle shaped horizontal deflection coils, in combination with an in-line type color picture tube which produces a plurality of coplanar in-line beams: said

vertical deflection coils having a winding distribution for producing a barrel shaped magnetic field distribution and said horizontal deflection coils having a first winding distribution, at the funnel side portion of said horizontal coils, for producing an intensified pincushion shaped magnetic field distribution and a second winding distribution, at the neck side portion of said horizontal deflection coils, for producing a barrel shaped magnetic field distribution, whereby said intensified pincushion shaped magnetic field distribution corrects the vertical pincushion distortion of a scanned raster and said barrel shaped magnetic field distribution prevents over-correction of the convergence of the side beams arising from the intensified pincushion magnetic field.

2. A deflection yoke device comprising a core, a pair of vertical deflection coils toroidally wound around said core and a pair of saddle shaped horizontal deflection coils, in combination with an in-line type color picture tube which produces a plurality of coplanar in-line beams; said vertical deflection coils having a winding distribution for producing a barrel shaped magnetic field distribution, and said horizontal deflection coils having a first winding distribution at the funnel side portion and a second winding distribution at the neck side, said first winding distribution having a coil winding width angle less than 30° to produce an intensified pincushion magnetic flux and said second winding distribution having a coil winding width angle more than 30° to produce barrel magnetic flux, whereby said intensified pincushion shaped magnetic field distribution corrects the vertical pincushion distortion of a scanned raster and said barrel shaped magnetic field distribution prevents over-correction of the convergence of the side beams arising from the intensified pincushion magnetic field.

3. A deflection yoke device substantially as hereinbefore described with reference to and as shown by Figures 3 to 10 of the accompanying drawings.

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decreased in its intensity toward the periphery (in the horizontal direction) of the deflection yoke screen so that the central electron beam 2 is deflected much more than the side electron beams 1 and 3.

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vertical deflection coils having a winding distribution for producing a barrel shaped magnetic field distribution and said horizontal deflection coils having a first winding distribution, at the funnel side portion of said horizontal coils, for producing an intensified pincushion shaped magnetic field distribution and a second winding distribution, at the neck side portion of said horizontal deflection coils, for producing a barrel shaped magnetic field distribution, whereby said intensified pincushion shaped magnetic field distribution corrects the vertical pincushion distortion of a scanned raster and said barrel shaped magnetic field distribution prevents over-correction of the convergence of the side beams arising from the intensified pincushion magnetic field.

2. A deflection yoke device comprising a core, a pair of vertical deflection coils toroidally wound around said core and a pair of saddle shaped horizontal deflection coils, in combination with an in-line type color picture tube which produces a plurality of coplanar in-line beams; said vertical deflection coils having a winding distribution for producing a barrel shaped magnetic field distribution, and said horizontal deflection coils having a first winding distribution at the funnel side portion and a second winding distribution at the neck side, said first winding distribution having a coil winding width angle less than 30° to produce an intensified pincushion magnetic flux and said second winding distribution having a coil winding width angle more than 30° to produce barrel magnetic flux, whereby said intensified pincushion shaped magnetic field distribution corrects the vertical pincushion distortion of a scanned raster and said barrel shaped magnetic field distribution prevents over-correction of the convergence of the side beams arising from the intensified pincushion magnetic field.

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