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(54) DEFLECTION YOKE FOR USE WITH WIDE ANGLE DEFLECTION SYSTEM

(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 for use with a picture tube of a television receiver set and more particularly to deflection yoke for wide deflection angle picture tube in which vertical raster distortion is not produced.

It a conventional television receiver set, a raster is formed by an electron beam which is scanned on a face plate of the picture tube and the raster includes much distortion. For example, when a radius of curvature of the face plate is smaller than a deflection angle of a deflection yoke and a deflection magnetic field is uniform, the scanned raster has a pincushion distortion. A conventional deflection yoke having a pair of saddle-shaped horizontal deflection coils produces pincushion-shaped horizontal deflection field at an exit of the electron beam so that a vertical pincushion distortion of the raster is reduced. However, the saddle-shaped horizontal deflection coil has a circular transverse end conductor so that a current flowing in the end conductor also produces a magnetic field. Probably because of this magnetic field, the conventional deflection yoke cannot fully reduce the vertical pincushion distortion without wing-shaped secondary harmonics distortions of the vertical pincushion distortion still remaining at the left and right ends and the center of the raster. When the pincushion-shaped horizontal deflection field is intensified, the distortion at the center of the raster disappears but the distortion at the opposite ends of the raster further increases. Consequently, the prior art television receiver set is equipped with compensation circuits, or permanent magnets for compensating for the pincushion distortion or the secondary harmonics distortion.

It is an object of the present invention to provide a deflection yoke which does not produce a vertical pincushion distortion of a raster.

According to the present invention there is provided a deflection yoke for use with a picture tube of a television receiver set, such deflection yoke comprising a cylindrical core, a vertical deflection coil toroidally wound around said core, and a pair of saddle-type horizontal deflection coils disposed to extend through said core, said horizontal coils producing a pincushion shaped deflection field at the front end of the yoke, that is, the end of the yoke nearer the face plate of the picture tube in use of the yoke, due to a passage of a current through the horizontal coils so that vertical pincushion distortion of the image on the face plate is reduced in use of the picture tube with the yoke, the horizontal coils having, at the front and rear ends of the yoke, respective forward and rearward transverse end conductors which project in the radial direction from the core, the forward end conductors being so shaped that the distance between the center portion of said forward end conductors and the center axis of the deflection yoke is shorter than the distance between any portion other than said center portion of the forward end conductors and said center axis, whereby a secondary harmonics distortion of the vertical pincushion distortion is reduced in use of the yoke.

When a magnetic field produced by a current flowing in the end conductor is increased or decreased, or the shape of the magnetic field is changed, the secondary harmonics distortion may be reduced. In the present invention, the magnetic field produced by the end conductor is enhanced at an area through which the electron beam passes, and this magnetic field is positively

utilized.

When the center portion of the end conductor is shaped to be concave or linear or the entire end conductor is oval, the center portion of the end conductor is closer to the area through which the electron beam passes. Therefore, the distribution of magnetic field produced by the current flowing in the end conductor is changed to intensify the field at the electron beam passing area as compared with the magnetic field produced by the current flowing in the conventional circular end conductor. The magnetic field produced by the current flowing in the deformed end conductor has a field component which is normal to the face plate, which field component functions to suppress the vertical deflection of the horizontally deflected electron beam reduces and hence the distortion is reduced. Furthermore, the magnetic field produced by the end conductor is shaped as to be intensified at those locations where it strongly acts on the largely vertically deflected electron beam, that is, the electron beam which produces the distorted raster. beam, that is, the electron beam which produces the distorted raster.

According to another aspect of the invention there is provided a deflection yoke for use with a picture tube of a television receiver and including a pair of saddle-type horizontal deflection coils oppositely disposed to one another about a center axis of said yoke, each of said horizontal deflection coils having, at the front and rear ends of the yoke respectively, forward and rearward transverse end conductors which project in the radial direction from the core, said horizontal deflection coils being effective in use to produce a pincushion shaped deflection field at a front end of said yoke due to current flowing through said horizontal deflection coils thereby to reduce vertical pincushion distortion, each of the forward end conductors being so shaped that a center portion of said forward end conductor between extreme portions of said forward end conductor is closer to the center axis of said yoke than are the extreme portions of said deflection yoke so that the radial distance from the center axis to the center portions of said forward end conductors is less than that of the extreme portions of said forward end conductors.

Yet another aspect of the invention provides a deflection yoke for use with a picture tube of a television receiver set and comprising a cylindrical core, a vertical deflection coil means around said core, and saddle-type horizontal deflection coil means disposed to extend through said core, said horizontal deflection coil means including transverse conductor means on one end thereof near the face plate of said picture tube which project in the radial direction from the core, said transverse conductor means being so formed that the radial distance of a center portion thereof from the core axis is less than the distance of other portions of said transverse conductor means from the core axis so as to generate a compensating magnetic field for reducing a secondary harmonics distortion of the vertical pincushion distortion.

The present invention will become further apparent from the following description of the preferred embodiment of the invention when taken in conjunction with the accompanying drawings, in which:—

Fig. 1 is a perspective view of one embodiment of a deflection yoke of the present invention;

Fig. 2 shows distortion of a raster on a face plate;

Fig. 3 is a side elevation view of one embodiment of a horizontal deflection coil of the present invention;

Fig. 4 is a front view thereof;

Fig. 5 shows a front view of a horizontal deflection coil half in accordance with a second embodiment of the present invention; and

Fig. 6 is a front view of a horizontal deflection coil half in accordance with a third embodiment of the present invention.

The preferred embodiments of the invention will now be explained in detail. In Fig. 1, a deflection yoke 1 of the present invention comprises a horizontal deflection coil 2, a cylindrical core 3 of which the bore on the side of the face plate is larger than that on the side near the neck of the picture tube, a vertical deflection coil 4 wound in a toroidal pattern on the core 3, and a separator 5. The core 3 is of cylindrical or trumpet shape which two semi-cylindrical cores being coupled together by a core clamp 8. The horizontal deflection coil 2 comprises two saddle-shaped coils 2A and 2B each having a forward and a rearward transverse end conductor 6, 6′ which project in the radial direction from the core 3. The coils 2A and 2B are arranged to extend into the core 3. The separator 5 is disposed between the vertical deflection coil 4 and the horizontal deflection coil 2, and it maintains insulation between the vertical deflection coil 4 and the horizontal deflection coil 2. The deflection coil 2 of the deflection yoke 1 has a small width L and produces a pincushion-shaped deflection field at an exit of an electron beam. The pincushion-shaped deflection field is strongest when an angle θ is equal to 30°, where the angle θ is defined as an angle made by a line connecting the end of the horizontal deflection coil 2 and a center 0 and an X-axis. A conventional horizontal deflection coil 2 which produces the pincushion-shaped magnetic field has the angle θ which is approximately equal to 45°. The horizontal deflection coil 2 has a forward end

conductor 6 having its center portion 7 concaved. A secondary harmonics distortion of a raster 12 scanned on a face plate 13 of a picture tube 11 shown in Fig. 2 is eliminated by a magnetic field produced by the center portion 7 of the forward end conductor 6. In order for the distortion of the raster 12 to be eliminated, the raster 12 must be moved in the directions shown by arrows A_1, A_2, A_3 and A_4 while the center portion of the raster 12 should remain stationary. The function of the center portion 7 of the forward and conductor 6 is now explained. In order to facilitate the understanding of the present invention, a center axis of the deflection yoke 1 is defined as a Z-axis , and X-axis and Y-axis are defined as shown in Fig. 1. Similarly, the X-axis, Y-axis and Z-axis of the picture tube 11 are defined. The present invention is explained for a case where the electron beam is deflected to a first quadrant of X–Y plane of the picture tube 11.

When a current flows in the horizontal deflection coil 2 as shown by an arrow B in Fig. 3, a current flowing in the forward end conductor 6 on the side of the face plate produces a magnetic field 21 which has a minus Z-direction field component $-H_z$ in on area in the forward end conductor 6 and a minus Y-direction field component $-H_y$ in front of the forward end conductor 6. Since the center portion 7 of the forward end conductor 6 is concave, the magnetic field 21 having the field component $-H_z$ is produced closer to the center axis 0, as shown in Fig. 4, than the magnetic field produced by the conventional circular end conductor so that the magnetic field is enhanced at the electron beam passing area. Since the electron beam deflected in the first quadrant has the Z-axis component as well as the plus X velocity component, the electron beam is effected by a force in the direction shown by an arrow D, by the field component $-H_z$. Although the electron beam is also effected by such a force in the conventional deflection coil, the force in use of the present invention is stronger because the horizontal deflection coil 2 of the present invention has the enhanced field component $-H_z$. Since the electron beam is effected by the force in the direction of the arrow D, the raster 12 shown in Fig. 2 is moved in the direction of the arrow A_1.

In the horizontal deflection coil 2 of the present invention, the magnetic field produced in front of the forward end conductor 6 also serves to move the raster 12 in the directions A_1, A_2, A_3 and A_4. In the conventional horizontal deflection coil, since the end conductor thereof is circular, the magnetic field produced in front of the end conductor by the current flowing in the end conductor is of pincushion shape and has the minus X-direction field component $-H_x$ in the first quadrant. Accordingly, the electron beam having the plus Z-direction velocity component is effected by the Y-direction force by the $-H_x$ field component so that the raster 12 shown in Fig. 2 is deflected in the Y-axis direction. On the other hand, in the horizontal deflection coil 2 of the present invention, since the magnetic field produced in front of the forward end conductor 6 by the current flowing in the forward end conductor 6 is somewhat of barrel shape, the field component $-H_x$ is smaller than that in the convention horizontal deflection yoke and hence the electron beam is less effected by the Y-direction force. Accordingly, the raster 12 is moved in the direction of A_1.

The same is equally applicable to the other quadrants than the first quadrant and the raster 12 is moved in the directions of A_1, A_2, A_3 and A_4, respectively. As a result, the distortion of the raster 12 is reduced.

Fig. 5 shows a second embodiment of the horizontal deflection coil of the deflection yoke of the present invention. A horizontal deflection coil 2C has a forward end conductor 6A having its center portion 7A shaped to be linear. In the horizontal deflection coil 2C, when a current shown by an arrow C flows in the forward end conductor 6A, the center portion 7A of the forward end conductor 6A can produce, at the electron beam passing area, a magnetic field having a stronger field component $-H_z$ than the conventional circular end conductor. Although the effect of the magnetic field produced by the center portion 7A of the forward end conductor 6A is smaller than the effect in the first embodiment, the horizontal deflection coil 2C of the present embodiment can be used when the distortion of the raster 12 shown in Fig. 2 is small.

Fig. 6 shows a third embodiment of the horizontal deflection coil of the deflection yoke of the present invention. A horizontal deflection coil 2D is generally oval in its entire shape, and a distance l_1 between a center portion 7B of a forward end conductor 6B and the center axis 0 is shorter than a distance l_2 in other area. In the horizontal deflection coil 2D, when a current as shown by an arrow C flows in the forward end conductor 6B, the center portion 7B of the forward end conductor 6B can produce, at the electron beam passing area, a magnetic field having a stronger field component $-H_z$ than the conventional circular forward end conductor. The effect of the magnetic field produced by the center portion 7B of the forward end conductor 6B is smaller than that in the second embodiment, but the horizontal deflection coil 2D can be used when the distortion of the raster 12 in Fig. 2 is small.

As described hereinabove, when the deflection yoke of the present invention is used, no vertical raster distortion is produced. Consequently, the present deflection

yoke is suitable for use with a 110° wide deflection angle television receiver set. The television receiver circuit does no longer require a pincushion distortion compensation circuit or a secondary harmonics distortion compensation circuit. Furthermore, since only the shape of the horizontal deflection coil is changed, the present deflection yoke is not expensive.

WHAT WE CLAIM IS:—

1. A deflection yoke for use with a picture tube of a television receiver set, such deflection yoke comprising a cylindrical core, a vertical deflection coil toroidally wound around said core, and a pair of saddle-type horizontal deflection coils disposed to extend through said core, said horizontal coils producing a pincushion shaped deflection field at the front end of the yoke, that is, the end of the yoke nearer the face plate of the picture tube in use of the yoke, due to passage of a current through the horizontal coils so that vertical pincushion distortion of the image on the face plate is reduced in use of the picture tube with the yoke, the horizontal coils having, at the front and rear ends of the yoke, respective forward and rearward transverse end conductors which project in the radial direction from the core, the forward end conductors being so shaped that the distance between the center portion of said forward end conductors and the center axis of the deflection yoke is shorter than the distance between any portion other than said center portion of the forward end conductors and said center axis, whereby a secondary harmonics distortion of the vertical pincushion distortion is reduced in use of the yoke.

2. A deflection yoke according to claim 1, wherein the inner surface of said forward end conductor of said horizontal deflection coil is oval in shape.

3. A deflection yoke according to claim 1, wherein a center portion of the inner surface of the forward end conductor of each said horizontal deflection coil is linear.

4. A deflection yoke according to claim 1, wherein a center portion of the inner surface of the forward end conductor of each said horizontal deflection coil is convex towards the center axis of said yoke.

5. A deflection yoke according to claim 1, wherein a center portion of the outer surface of the forward end conductor of each said horizontal deflection coil is concave.

6. A deflection yoke for use with a picture tube of a television receiver and including a pair of saddle-type horizontal deflection coils oppositely disposed to one another about a center axis of said yoke, each of said horizontal deflection coils having, at the front and rear ends of the yoke respectively, forward and rearward transverse end conductors which project in the radial direction from the core, said horizontal deflection coils being effective in use to produce a pincushion shaped deflection field at a front end of said yoke due to current flowing through said horizontal deflection coils thereby to reduce vertical pincushion distortion, each of the forward end conductors being so shaped that a center portion of said forward end conductor between extreme portions of said forward end conductor is closer to the center axis of said yoke than are the extreme portions of said deflection yoke so that the radial distance from the center axis to the center portions of said forward end conductors is less than that of the extreme portions of said forward end conductors.

7. A deflection yoke according to claim 6, wherein the mid-portion of each forward end conductor of said horizontal deflection coils is linear.

8. A deflection yoke according to claim 6, wherein an outer periphery of the mid-portion of each forward end conductor of said horizontal deflection coils is formed to be radially concaved.

9. A deflection yoke for use with a picture tube of a television receiver set and comprising a cylindrical core, a vertical deflection coil means around said core, and saddle-type horizontal deflection coil means disposed to extend through said core, said horizontal deflection coil means including transverse conductor means on one end thereof near the face plate of said picture tube which project in the radial direction from the core, said transverse conductor means being so formed that the radial distance of a center portion thereof from the core axis is less than the distance of other portions of said transverse conductor means from the core axis so as to generate a compensating magnetic field for reducing a secondary harmonics distortion of the vertical pincushion distortion.

10. A deflection yoke according to claim 9, wherein said transverse conductor means has an inner surface, the distance from the center axis of the deflection yoke to the center portion of the inner surface being less than the distance from the center axis to other portions of the inner surface of said transverse conductor means.

11. A deflection yoke according to claim 9, wherein said transverse conductor means has an inner surface which is oval in shape.

12. A deflection yoke according to claim 9, wherein said transverse conductor means has an inner surface with a center portion which is linear.

13. A deflection yoke according to claim 9, wherein said transverse conductor means has an outer surface with a center portion which is concave.

14. A deflection yoke according to claim

yoke is suitable for use with a 110° wide deflection angle television receiver set. The television receiver circuit does no longer require a pincushion distortion compensation circuit or a secondary harmonics distortion compensation circuit. Furthermore, since only the shape of the horizontal deflection coil is changed, the present deflection yoke is not expensive.

WHAT WE CLAIM IS:—

1. A deflection yoke for use with a picture tube of a television receiver set, such deflection yoke comprising a cylindrical core, a vertical deflection coil toroidally wound around said core, and a pair of saddle-type horizontal deflection coils disposed to extend through said core, said horizontal coils producing a pincushion shaped deflection field at the front end of the yoke, that is, the end of the yoke nearer the face plate of the picture tube in use of the yoke, due to passage of a current through the horizontal coils so that vertical pincushion distortion of the image on the face plate is reduced in use of the picture tube with the yoke, the horizontal coils having, at the front and rear ends of the yoke, respective forward and rearward transverse end conductors which project in the radial direction from the core, the forward end conductors being so shaped that the distance between the center portion of said forward end conductors and the center axis of the deflection yoke is shorter than the distance between any portion other than said center portion of the forward end conductors and said center axis, whereby a secondary harmonics distortion of the vertical pincushion distortion is reduced in use of the yoke.

2. A deflection yoke according to claim 1, wherein the inner surface of said forward end conductor of said horizontal deflection coil is oval in shape.

3. A deflection yoke according to claim 1, wherein a center portion of the inner surface of the forward end conductor of each said horizontal deflection coil is linear.

4. A deflection yoke according to claim 1, wherein a center portion of the inner surface of the forward end conductor of each said horizontal deflection coil is convex towards the center axis of said yoke.

5. A deflection yoke according to claim 1, wherein a center portion of the outer surface of the forward end conductor of each said horizontal deflection coil is concave.

6. A deflection yoke for use with a picture tube of a television receiver and including a pair of saddle-type horizontal deflection coils oppositely disposed to one another about a center axis of said yoke, each of said horizontal deflection coils having, at the front and rear ends of the yoke respectively, forward and rearward transverse end conductors which project in the radial direction from the core, said horizontal deflection coils being effective in use to produce a pincushion shaped deflection field at a front end of said yoke due to current flowing through said horizontal deflection coils thereby to reduce vertical pincushion distortion, each of the forward end conductors being so shaped that a center portion of said forward end conductor between extreme portions of said forward end conductor is closer to the center axis of said yoke than are the extreme portions of said deflection yoke so that the radial distance from the center axis to the center portions of said forward end conductors is less than that of the extreme portions of said forward end conductors.

7. A deflection yoke according to claim 6, wherein the mid-portion of each forward end conductor of said horizontal deflection coils is linear.

8. A deflection yoke according to claim 6, wherein an outer periphery of the mid-portion of each forward end conductor of said horizontal deflection coils is formed to be radially concaved.

9. A deflection yoke for use with a picture tube of a television receiver set and comprising a cylindrical core, a vertical deflection coil means around said core, and saddle-type horizontal deflection coil means disposed to extend through said core, said horizontal deflection coil means including transverse conductor means on one end thereof near the face plate of said picture tube which project in the radial direction from the core, said transverse conductor means being so formed that the radial distance of a center portion thereof from the core axis is less than the distance of other portions of said transverse conductor means from the core axis so as to generate a compensating magnetic field for reducing a secondary harmonics distortion of the vertical pincushion distortion.

10. A deflection yoke according to claim 9, wherein said transverse conductor means has an inner surface, the distance from the center axis of the deflection yoke to the center portion of the inner surface being less than the distance from the center axis to other portions of the inner surface of said transverse conductor means.

11. A deflection yoke according to claim 9, wherein said transverse conductor means has an inner surface which is oval in shape.

12. A deflection yoke according to claim 9, wherein said transverse conductor means has an inner surface with a center portion which is linear.

13. A deflection yoke according to claim 9, wherein said transverse conductor means has an outer surface with a center portion which is concave.

14. A deflection yoke according to claim

10, wherein said horizontal deflection coil means comprises a apir of saddle-type horizontal deflection coils with the center portion of the transverse conductor means of each coil being concave.

15. A deflection yoke for a television picture tube constructed and arranged to operate substantially as hereinbefore described with reference to and as shown by the accompanying drawings.

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