

the axis of the colour picture tube. Another pair of pole piece segments having substantially the same configuration as the first-mentioned pole pieces are disposed above the electron guns on the opposite sides thereof in symmetrical relationship with one of the first-mentioned pole piece segments. With this construction, the vertical deflection field applied to the electron beams from the electron guns on both sides near the pole pieces can be decreased compared with the case wherein no pole piece is used, and the vertical deflection field applied to the electron beam from the central electron gun can be increased compared with the case wherein no pole piece used, thereby compensating for the difference in the vertical deflection sensitivity and eliminating the difference in the horizontal deflection sensitivity caused by the magnetic shield.

However, even with this improved construction, it is impossible sufficiently to compensate for the differences in the vertical and horizontal deflection sensitivities. Further, because the pole pieces positioned at the outer ends of the electron guns on both sides intercept the horizontal dynamic convergence field for the electron beams emitted by the electron guns on both sides, it is not only impossible to apply satisfactory convergence but also increases the electric power consumed by the external convergence circuit. Moreover, the construction of the fixtures for holding the pole pieces is complicated and bulky, thus requiring a large space.

Accordingly, it is an object of this invention to provide an improved in-line type colour picture tube in which the static and dynamic convergences can be provided in the same plane and the dynamic convergence can be adjusted readily.

Another object of this invention is to provide an improved in-line type colour picture tube including a convergence pole piece assembly capable of eliminating the compensation for the dynamic convergence for the vertical deflection and which permits use of current of a symmetrical waveform for the dynamic convergence in the horizontal direction for the electron beams from the electron guns on the opposite sides.

Still another object of this invention is to provide an in-line type colour picture tube provided with convergence pole pieces of the improved construction which do not intercept the fields of the static and dynamic convergences for the electron beams emanating from the electron guns on both sides.

Yet another object of this invention is to provide an in-line type colour picture tube having convergence pole pieces which are

simple in construction and can be readily mounted.

In accordance with this invention, there is provided an in-line type colour picture tube comprising three electron guns arranged on a straight line, and means for adjusting in substantially the same plane the dynamic convergence and the static convergence provided for concentrating three electron beams emitted by said three electron guns at a point on the fluorescent screen of said colour picture tube, wherein a pole piece assembly is disposed in said plane of convergence adjustment, said pole piece assembly including a first pair of spaced pole piece segments substantially symmetrically disposed with respect to a plane perpendicular to said straight line, which plane passes through the axis of a central electron gun, one of said first paired pole piece segments being disposed between the axes of the central electron gun and an outer electron gun, the other being disposed between the axes of the central electron gun and the other outer electron gun, individual segments of said first paired pole piece segments being disposed also symmetrically with respect to another plane passing through the axes of the three electron guns and spaced from each other by a smaller distance at their central portions than at their opposite ends far from said another plane, and a second pair of pole piece segments being disposed symmetrically with respect to said plane passing through the axes of three electron guns, individual segments of said paired pole piece segments being disposed also substantially symmetrically with respect to said plane perpendicular to said straight line and passing through the axis of the central electron gun, and having a web projecting toward said central electron gun substantially along the last mentioned plane.

Further features of the invention will be more fully understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a diagrammatic representation of a portion of an in-line type colour picture tube;

Fig. 2 is a diagram showing typical rasters where no pole piece is used;

Fig. 3 is a diagram showing typical rasters where the central electron gun is magnetically shielded;

Fig. 4 is a perspective view of one example of the pole pieces embodying the invention;

Fig. 5 is a cross-sectional view of the assembly of the pole pieces shown in Fig. 4;

Fig. 6 is a diagram to explain the operation of this invention;

Fig. 7 is a diagram showing the rasters appearing in the colour picture tube

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(54) COLOUR PICTURE TUBES CONTAINING AN IN-LINE TYPE ELECTRON GUN ASSEMBLY

- (71) We, HITACHI LIMITED, a corporation organised and existing under the laws of Japan, 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:—
- 10 This invention relates to a colour picture tube containing an in-line type electron gun assembly (hereinafter termed an in-line type colour picture tube), and more particularly to an improved construction of convergence pole pieces for effecting dynamic convergence by utilizing a magnetic deflection field at the rear end of a deflection yoke utilized to cause scanning of the electron beams.
- 20 In the in-line type colour picture tube wherein no field correction by pole pieces is provided, the rasters of the three electron beams do not generally coincide with each other in the vertical and horizontal peripheries of the fluorescent screen. More especially, the deflection sensitivity of the electron beam emitted by the central electron gun to the vertical deflection field is smaller than that of the electron beams emitted by the electron guns on both sides. Such a phenomenon is caused by the characteristic of the deflection yoke. Under these conditions, it is necessary to apply dynamic convergence by an external circuit, both in the horizontal and vertical directions.
- 30 In order to apply static convergence to an in-line type colour picture tube, it has been the practice to hold the electron beam emitted by the central electron gun stationary by means of a magnetic shield, and to shift the electron beams emitted by the side electron guns by means of the magnetic field generated by a magnet utilized for providing the static convergence, thereby causing the central electron beam to coincide with the electron beams emitted by the electron guns on both sides. In practice, however, as it is necessary to make as short as possible the total length of the colour picture tube, the field of the magnet for providing the static convergence and the deflection field at the rear end of the deflection yoke overlap with each other. For this reason, shielding of the electron beam of the central electron gun from the field for the static convergence also shields a portion of the vertical and horizontal deflection fields, with the result that the raster of the central electric field will be shifted toward the centre of the fluorescent screen. In other words, the deflection sensitivity of the electron beam from the central electron gun is decreased in the case wherein the electron beam is not magnetically shielded both in the horizontal and vertical directions. If the dynamic convergence were to be applied under these conditions it would be necessary to supply a current having an asymmetrical waveform with respect to the direction of the horizontal deflection of the electron beams emanating from the electron guns on both sides. Furthermore, it is necessary to provide a complicated dynamic convergence circuit which increases the deflection sensitivity of the electron beam from the central electron gun for the vertical deflection, or decreases the deflection sensitivity of the electron beams emanating from the electron guns on both sides.
- 40 To solve these problems the Applicant has proposed an improved construction according to which two arcuate pole piece segments with their opposite ends flared outwardly are provided at a position near the front end of three electron guns arranged in-line on the opposite sides of the central electron gun and in the substantially horizontal direction which is perpendicular to

embodying the invention; and

Fig. 8 is a diagrammatic representation to explain the operation of this invention.

Referring now to Fig. 1, which shows the construction of the deflector of an in-line type colour picture tube, electron beams B_G , B_B and B_R emanating from electron guns G_G , G_B and G_R , respectively, are corrected by a convergence adjusting member 1 and are then deflected by a deflection yoke 2 so as to scan the entire surface of a fluorescent screen (not shown) of the colour picture tube. It is to be understood that the convergence member 1 includes a dynamic convergence adjuster and a static convergence adjuster which are arranged in the same plane. Since the convergence adjusting member 1 and the deflection yoke 2 are located close to each other, the pole pieces (not shown) for field correction which are disposed in substantially the same plane as the convergence adjusting member 1 are subjected to the complicated action of the flux produced by the deflection yoke 2, and the fluxes for providing the dynamic and static convergences. Especially at the time of adjusting the static convergence, if one tries to make the electron beam B_B or B_G on one side coincident with the central electron beam B_R , the central electron beam B_R will be moved by the interference with the flux for effecting the static convergence, thus rendering the static convergence difficult to adjust.

Fig. 2 shows the mis-convergence of the electron beams B , G and R for respective colours at the periphery of the fluorescent screen where no pole piece for field correction is used, such mis-convergence being representative of the characteristic of the deflection yoke. As shown in this Figure, in the vertical direction the deflection of the red beam R is not sufficient, so that the red beam R is positioned on the inside of the screen with respect to the blue beam B and the green beam G . In the horizontal direction, the red beam R is positioned between the blue beam B and the green beam G . With the condition of the rasters of the electron beams as shown in Fig. 2, if a magnetic shield were provided, as shown by dotted lines in Fig. 3, for the purpose of avoiding the interference caused by the static convergence flux of the central electron gun G_R , the interferences caused by the electron guns G_B and G_G would be decreased, thus making the convergence easy to adjust. But as shown by the rasters on the fluorescent screen shown in Fig. 3, at the periphery of the screen, the raster of the red beam R will be shifted toward the centre of the screen, thus making it difficult to achieve convergence with other beams B and G .

One embodiment of this invention will now be described with reference to Figs. 4 and 5. The pole piece assembly of this invention for correcting the magnetic field comprises a first pair of pole piece segments 3 and a second pair of pole piece segments 6. Each pole piece segment 3 is concave and includes a central flat portion 3a and inclined portions 3b on both sides thereof. Each pole piece segment 6 comprises an arcuate portion 6a and a flat web 6b extending in the diametrical direction from the centre of the arcuate portion 6a. The pole piece segments 3 and 6 are made of a material of high permeability, for example permalloy, for providing magnetic paths of low reluctance. Accordingly, it is necessary to form the portions 3a and 3b and 6a and 6b as integral structures, not including any air gap or region of high reluctance at the interface between these parts.

As shown in Fig. 5, two pole piece segments 3 are disposed symmetrically with their back surfaces opposed to each other and are secured to the inside of a cylindrical cage 5 by means of supporting members 4. The supporting members 4 and the cylindrical cage 5 are made of a material which transmits magnetic flux, non-magnetic stainless steel for example. The pole piece segments 6 are disposed between the spaced pair of segments 3 with their arcuate portions 6a secured to the inside of the cylindrical cage 5. The pairs of segments 3 and 6 are combined to form an assembly wherein a line inter-connecting the webs 6b of the segments 6 intersects at right angles with a line interconnecting the centres of the segments 3. Since the pole piece assembly is disposed on the convergence adjusting surface of the colour picture tube such that the pair of segments 3 coincides with the direction of the vertical deflection, the central electron beam R will pass through the centre of the space bounded by the segments 3 and 6, whereas the electron beams B and G will pass through the spaces defined by the left and right segments 3 and the cylindrical cage 5.

When the pole piece assembly described above is disposed in the magnetic deflection field, a distribution of the magnetic flux as shown in Fig. 6 is obtained. More particularly, the pole piece segments 3 function to gather the vertical deflection flux VH at the centre to increase the vertical deflection sensitivity of the central electron beam, that is the red beam R . This is due to the fact that a magnetic path having a small reluctance is formed between the opposed flat portions 3a of the pair of segments 3, thereby concentrating the uniformly distributed vertical deflection flux VH . On the other hand, since the uniformly distributed horizontal deflection flux H_R passes through

the webs 6b of the pair of segments 6, it is slightly concentrated thereby, making uniform the flux acting upon the central electron beam, that is the red beam R, and the flux acting upon the electron beams on both sides, that is the blue and green beams B and G. As a result, the condition of deflection of three electron beams in the horizontal direction will be substantially the same as that of the case wherein no pole piece is provided.

Consequently, it will be understood that by using the pole piece segments of this invention, it is possible to obtain rasters as shown in Fig. 7 instead of those shown in Figs. 2 and 3. Fig. 7 shows the condition wherein the left and right hand rasters are maintained unchanged but the rasters R along the upper and lower edges are made to coincide with the rasters B and G on the same sides. As it is possible to obtain rasters as shown in Fig. 7, in the in-line type colour picture tube embodying the invention it is not necessary to provide vertical dynamic convergence. Moreover, it is possible to provide horizontal dynamic convergence for the blue and green beams with respect to the red beam R by using a current having symmetrical waveform.

Two pairs of pole piece segments 3 and 6 provide the function of the magnetic shield which prevents the flux of an external adjusting member (not shown) from interfering with the central electron beam (red beam R). This function will be described with reference to Fig. 8.

Fig. 8 shows the relationship between the static and dynamic convergences and the pole piece sections embodying the invention, in which the left-hand side a shows the function of the dynamic convergence, whereas the right-hand side b that of the static convergence. As shown, the static convergence is provided by rotating the magnets M_1 , M_2 , M_3 and M_4 to adjust the polarity and intensity of the flux SH flowing through E-shaped magnetic cores of the convergence adjusting member 1, so as statically to make the outside beams (green and blue beams B_G and B_B) coincident with the central beam B_R .

The dynamic convergence is provided by passing a current having a parabolic waveform through a coil 8 of the convergence adjusting member 1 from an external source E.C.S., to form the dynamic convergence flux D_H which shifts the blue and green electron beams B_B and B_G to coincide with the central red beam B_R . In this manner, as the external fluxes D_H and S_H do not interfere with the central beam B_R to any appreciable extent, it is possible to readily adjust the convergence. In addition, since the convergence field for the electron beams on both sides is not shielded, the

power required for the dynamic convergence may be small. It is necessary to vary the size and configuration of the two pairs of pole piece segments 3 and 6 in accordance with the flux distribution of the external convergence field and the flux distribution of the deflection yoke.

The correction of convergence provided by this invention is most suitable for convergence of the simple type tube, such as those utilizing a saddle type deflection yoke or of the wide angle (110°) deflection type.

As has been described in detail, when the pole piece segments of this invention are used, even in the in-line type colour picture tube in which the dynamic and static convergences are provided in the same plane, a pair of pole piece segments 3 acts to increase the deflection of the central beam (red beam B_R) in the vertical direction and the other pair of the pole piece segments 6 functions to cause the horizontal deflection flux to act uniformly upon respective electron beams. Moreover as it is possible to prevent the fluxes of the dynamic and static convergences from interfering with the central electron beam, it is possible readily to adjust the convergence of the colour picture tube.

Thus, the invention provides an improved colour picture tube in which adjustment of the convergence can be readily made in a short time by an unskilled person.

WHAT WE CLAIM IS:

1. An in-line type colour picture tube comprising three electron guns arranged on a straight line, and means for adjusting in substantially the same plane the dynamic convergence and the static convergence provided for concentrating three electron beams emitted by said three electron guns at a point on the fluorescent screen of said colour picture tube, wherein a pole piece assembly is disposed in said plane of convergence adjustment, said pole piece assembly including a first pair of spaced pole piece segments substantially symmetrically disposed with respect to a plane perpendicular to said straight line, which plane passes through the axis of a central electron gun, one of said first paired pole piece segments being disposed between the axes of the central electron gun and an outer electron gun, the other being disposed between the axes of the central electron gun and the other outer electron gun, individual segments of said first paired pole piece segments being disposed also symmetrically with respect to another plane passing through the axes of the three electron guns and spaced from each other by a smaller distance at their central portions than at their opposite ends far from said another plane, and a second pair of pole piece segments being disposed symmetrically



the webs 6b of the pair of segments 6, it is slightly concentrated thereby, making uniform the flux acting upon the central electron beam, that is the red beam R, and the flux acting upon the electron beams on both sides, that is the blue and green beams B and G. As a result, the condition of deflection of three electron beams in the horizontal direction will be substantially the same as that of the case wherein no pole piece is provided.

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The correction of convergence provided by this invention is most suitable for convergence of the simple type tube, such as those utilizing a saddle type deflection yoke or of the wide angle (110°) deflection type.

As has been described in detail, when the pole piece segments of this invention are used, even in the in-line type colour picture tube in which the dynamic and static convergences are provided in the same plane, a pair of pole piece segments 3 acts to increase the deflection of the central beam (red beam B_R) in the vertical direction and the other pair of the pole piece segments 6 functions to cause the horizontal deflection flux to act uniformly upon respective electron beams. Moreover as it is possible to prevent the fluxes of the dynamic and static convergences from interfering with the central electron beam, it is possible readily to adjust the convergence of the colour picture tube.

Thus, the invention provides an improved colour picture tube in which adjustment of the convergence can be readily made in a short time by an unskilled person.

WHAT WE CLAIM IS:

1. An in-line type colour picture tube comprising three electron guns arranged on a straight line, and means for adjusting in substantially the same plane the dynamic convergence and the static convergence provided for concentrating three electron beams emitted by said three electron guns at a point on the fluorescent screen of said colour picture tube, wherein a pole piece assembly is disposed in said plane of convergence adjustment, said pole piece assembly including a first pair of spaced pole piece segments substantially symmetrically disposed with respect to a plane perpendicular to said straight line, which plane passes through the axis of a central electron gun, one of said first paired pole piece segments being disposed between the axes of the central electron gun and an outer electron gun, the other being disposed between the axes of the central electron gun and the other outer electron gun, individual segments of said first paired pole piece segments being disposed also symmetrically with respect to another plane passing through the axes of the three electron guns and spaced from each other by a smaller distance at their central portions than at their opposite ends far from said another plane, and a second pair of pole piece segments being disposed symmetrically



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with respect to said plane passing through the axes of three electron guns, individual segments of said paired pole piece segments being disposed also substantially symmetrically with respect to said plane perpendicular to said straight line and passing through the axis of the central electron gun, and having a web projecting toward said central electron gun substantially along the last mentioned plane.

2. The colour picture tube according to claim 1, wherein said two pairs of pole piece segments and said webs are made of

a material of high permeability and mounted in a cylindrical cage made of a non-magnetic material.

3. An in-line colour picture tube substantially as hereinbefore described with reference to Figs. 4 to 8 of the accompanying drawings.

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MICHAEL BURNSIDE & PARTNERS,

Chartered Patent Agents,

Hancock House,

87 Vincent Square,

London SW1P 2PH.

Agents for the Applicants.