United States Patent

[11] 3,619,687

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[21] Appl. No. 813,827
[22] Filed Apr. 7, 1969
[45] Patented Nov. 9, 1971
[73] Assignee Sony Corporation
Tokyo, Japan
[32] Priority Apr. 14, 1968
[33] Japan
[31] 43/24592

[54] **COLOR TV TUBE HAVING CURVED CONVERGENCE DEFLECTION PLATES**
4 Claims, 8 Drawing Figs.

[52] U.S. Cl. **313/78,** 313/80, 315/25
[51] Int. Cl. **H01j 29/72,** H01j 31/20
[50] Field of Search .... 313/70 C, 78, 80, 69 C, 75

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Primary Examiner—Robert Segal
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ABSTRACT: In a color picture tube of the single-gun, plural-beam type in which a central beam and two side beams originate in a common plane and are all made to pass through the center of an electron lens for focusing the beams on the color screen with the central beam emerging from the lens along the optical axis of the latter and the side beams emerging from the lens along paths that are oppositely divergent from the axis, the divergent side beams are acted upon by an electrostatic convergence deflecting device constituted by pairs of spaced plates arranged along the divergent paths and having voltages applied thereacross to produce electric fields by which the divergent side beams passing therethrough are deflected to converge at a common spot with the central beam on the apertured grill or mask associated fields the screen, and a main deflection yoke produces magnetic fields in the direction of the common plane of the beams and orthogonally thereto for causing the beams to scan the screen; the distances between the plates of each pair are varied in the direction perpendicular to the common plane in which the beams originate to correspondingly vary the strengths of the electric fields and thus correct distortions in the rasters of the side beams.

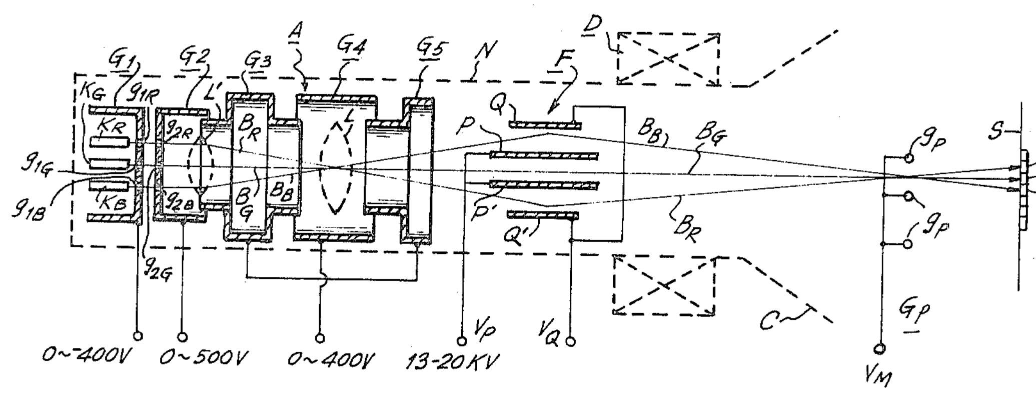
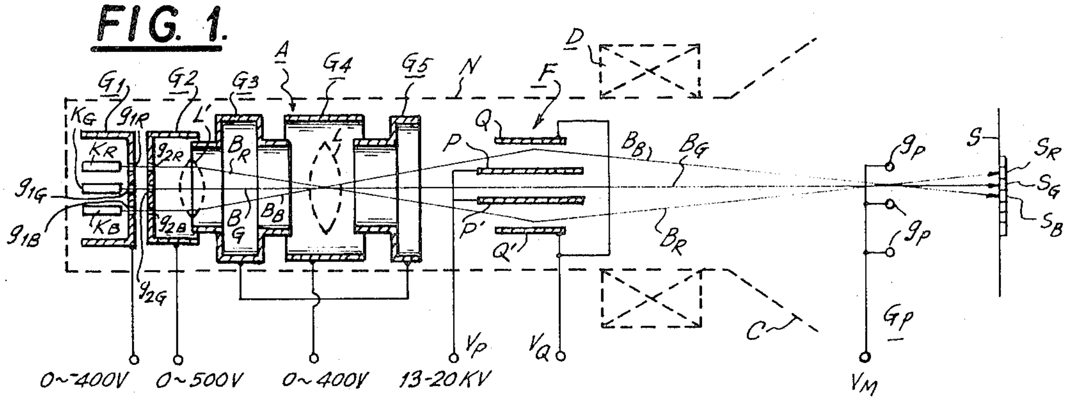


FIG. 1.



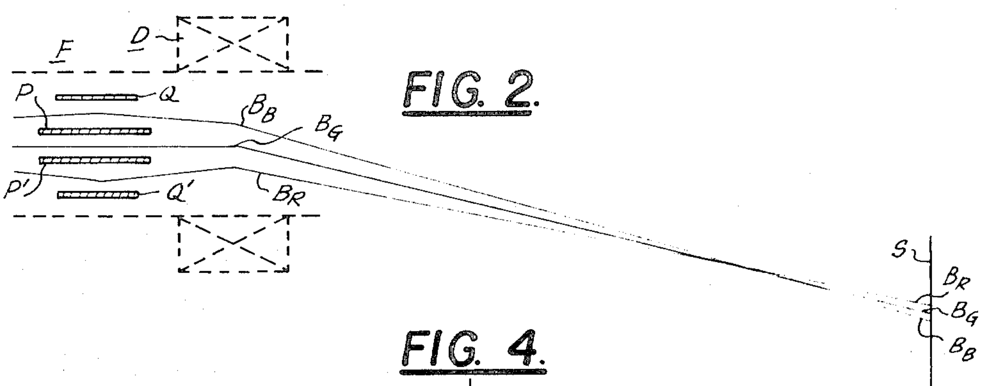


FIG. 2.

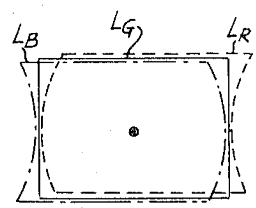
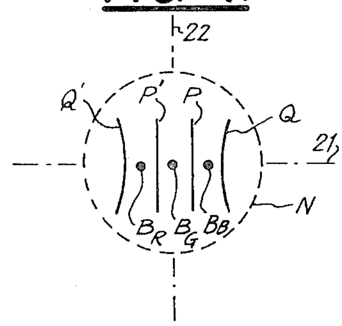


FIG. 3.

FIG. 4.



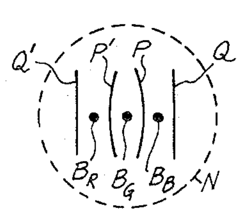


FIG. 5.

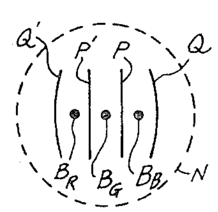


FIG. 6.

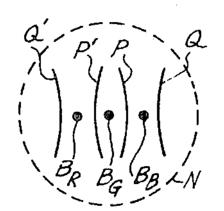


FIG. 7.

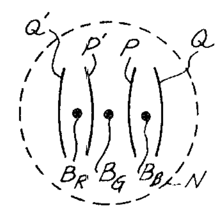


FIG. 8.

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COLOR TV TUBE HAVING CURVED CONVERGENCE DEFLECTION PLATES

This invention relates generally to color picture tubes of the single-gun, plural-beam type, and particularly to tubes of that type in which the plural beams are passed through the optical center of a common electron lens by which the beams are focused on the color phosphor screen.

In single-gun, plural-beam color picture tubes of the described type, for example, as specifically disclosed in the copending U.S. application Ser. No. 697,414, filed Jan. 12, 1968 and having a common assignee herewith, three laterally spaced electron beams are emitted by a beam generating or cathode assembly and directed in a common substantially horizontal plane with the central beam coinciding with the optical axis of the single-electron focusing lens and the two outer or side beams being converged to cross the central beam at the optical center of the lens and thus emerge from the latter along paths that are divergent from the optical axis. Arranged along such divergent paths are respective pairs of convergence deflecting plates constituting a convergence deflecting device and having voltages applied thereacross to produce electric fields which laterally deflect the divergent beams in a substantially horizontal plane for causing all beams to converge at a common spot on the apertured beam-selecting grill or shadow mask associated with the color screen. Further, arranged between the convergence deflecting device and the screen is a main deflection yoke which, in response to its reception of horizontal and vertical sweep signals, produces horizontal and vertical magnetic deflection fields acting on all of the beams to cause the latter to scan the color screen in predetermined rasters. Since the beams are horizontally spaced and nonparallel during their passage through the horizontal deflection field, the distances that the side beams travel through such field will be respectively greater and less than the distance that the central beam travels through the field when the beams are deflected toward one side or the other side of the screen. If the horizontal deflection field has a uniform flux density thereacross, the side beam traveling therethrough for the greater distance will be deflected to a greater extent than the side beam traveling the shorter distance through the field and misconvergence of the beams will result. Even if the horizontal deflection field is given a nonuniform flux density thereacross, misconvergence of the beams can be thereby avoided only when the beams are deflected toward one side or the other of the screen midway between the top and bottom of the screen, that is, when the common plane of the beams passing through the horizontal deflection field is directed horizontally, that is, substantially perpendicular to the vertical lines of magnetic flux of the horizontal deflection field. However, when the common plane of the beams passing through the horizontal deflection field is substantially inclined from the horizontal, that is, when the vertical deflection field deflects the beams to cooperate with the horizontal deflection field in directing the beams toward an upper and lower corner of the screen, the difference between the distances traveled by the side beams through the horizontal deflection field is further increased and hence may not be compensated by the nonuniform flux density established across the horizontal deflection field. Thus, the rasters of the side beams may have shapes that are oppositely distorted with respect to the shape of the raster of the central beam.

Accordingly, it is an object of this invention to provide a single-gun, plural-beam color picture tube in which the rasters of the several beams are free of distortion with respect to each other.

Another object is to provide a single-gun, plural-beam color picture tube in which distortions of the rasters of the several beams are avoided by a particular construction of the convergence deflecting device.

In accordance with an aspect of the invention, the described distortions of the rasters of the side beams with respect to the raster of the central beam are avoided by suitably varying, in the direction perpendicular to the common plane in which the beams originate, the distances between the paired plates of the convergence deflecting device, whereby to correspondingly vary the strengths of the electric fields between such plates by which the side beams are convergently deflected.

The above, and other objects, features and advantages of this invention, will be apparent in the following detailed description of illustrative embodiments which is to be read in connection with the accompanying drawing, wherein:

FIG. 1 is a schematic sectional view in a horizontal plane passing through the axis of a single-gun, plural-beam color picture tube of the type to which this invention is preferably applied;

FIG. 2 is a diagrammatic view to which reference is hereinafter made in explaining the invention;

FIG. 3 is a diagrammatic view showing the possible relative distortions of the rasters of the several beams, as seen from the viewer's side of the tube screen, and which are to be avoided by this invention;

FIG. 4 is a diagrammatic, transverse sectional view through the convergence deflecting device of a color picture tube according to a first embodiment of this invention; and

FIGS. 5–8 are views similar to FIG. 4, but showing other embodiments of the invention.

Referring to the drawings in detail, and initially to FIG. 1 thereof, it will be seen that a single-gun, plural-beam color picture tube of the type to which this invention may be applied comprises a glass envelope (indicated in broken lines) having a neck N and cone C extending from the neck to a color screen S provided with the usual arrays of color phosphors S_R, S_G and S_B and with an apertured beam selecting grill or shadow mask G_P. Disposed within neck N is an electron gun A having cathodes K_R, K_G and K_B, each of which is constituted by a beam-generating source with the respective beam-generating surfaces hereof disposed as shown in a plane which is substantially perpendicular to the axis of the electron gun A. In the embodiment shown, the beam-generating surfaces are arranged in a straight line so that the respective beams B_R, B_G and B_B emitted therefrom are directed in a substantially horizontal plane containing the axis of the gun, with the central beam B_G being coincident with such axis. A first grid G_1 is spaced from the beam-generating surfaces of cathodes K_R, K_G and K_B and has apertures g_{1R}, g_{1G} and g_{1B} formed therein in alignment with the respective cathode beam-generating surfaces. A common grid G_2 is spaced from the first grid G_1 and has apertures g_{2R}, g_{2G} and g_{2B} formed therein in alignment with the respective apertures of the first grid G_1. Successively arranged in the axial direction away from the common grid G_2 are open-ended, tubular grids or electrodes G_3, G_4 and G_5, respectively with cathodes K_R, K_G and K_B, grids G_1 and G_2, and electrodes G_3, G_4 and G_5 being suitably maintained in the depicted, assembled positions thereof.

For operation of the electron gun A of FIG. 1, appropriate voltages are applied to the grids G_1 and G_2 and to the electrodes G_3, G_4 and G_5. Thus, for example, a voltage of 0 to minus 400 v. is applied to the grid G_1, a voltage of 0 to 500 v. is applied to the grid G_2 ₁, a voltage of 13 to 20k.v. is applied to the electrodes G_3 and G_5, and a voltage of 0 to 400 v. is applied to the electrode G_4, with all of these voltages being based upon the cathode voltage as reference. As a result, the voltage distributions between the respective electrodes and cathodes, and the respective lengths and diameters thereof, may be substantially identical with those of a unipotential-single beam-type electron gun which is constituted by a single cathode and first and second, single-apertured grids.

With the applied voltage distribution as described hereinabove an electron lens field will be established between grid G_2 and the electrode G_3 to form an auxiliary lens L′ as indicated in dashed lines, and an electron lens field will be established around the axis of electrode G_4, by the electrodes G_3, G_4 and G_5, to form a main lens L, again as indicated in dashed lines. In a typical use of electron gun A, bias voltages of 100 v., 0 v., 300 v. 20 k.v., 200 v. and 20 v. may be applied respectively to the cathodes K_R, K_G and K_B, the first and second grids G_1 and G_2 and the electrodes G_3, G_4 and G_5.

Further included in the electron gun A of FIG. 1 are electron beam convergence deflecting means F which comprise inner shielding plates P and P' disposed in the depicted spaced, relationship at opposite sides of the gun axis, and axially extending, deflector plates Q and Q' which are disposed, as shown, in outwardly spaced, opposed relationship to shielding plates P and P', respectively. Although depicted as substantially straight, it is to be understood that the deflector plates Q and Q' may, alternatively, be somewhat curved or outwardly bowed, as is well known in the art.

The shielding plates P and P' are equally charged and disposed so that the central electron beam B_G will pass substantially undeflected therebetween, while the deflector plates Q and Q' have negative charges with respect to the plates P and P' so that electron beams B_B and B_R will be convergently deflected as shown by the respective passages thereof between the plates P and Q and the plates P' and Q'. More specifically, a voltage V_P which is equal to the voltage applied to the electrode G_5, may be applied to both shielding plates P and P', and a voltage V_Q, which is some 200 to 300 v. lower than the voltage V_P, is applied to the plates Q and Q' to result in the plates P and P' being at the same potential, and in the application of deflecting voltage difference or convergence deflecting voltages V_C between the plates P' and Q' and the plates P and Q and it is, of course, this convergence deflecting voltage V_C which will impart the requisite convergent deflection to the electron beams B_B and B_R.

In operation, the electron beams B_R, B_G and B_B which emanate from the beam generating surfaces of the cathodes K_R, K_G and K_B will pass through the respective grid apertures g_{1R}, g_{1G} and g_{1B}, to be intensity modulated with what may be termed the "red," "green," and "blue," intensity modulation signals applied between the said cathodes and the first grid G_1. The electron beams will then pass through the common auxiliary lens L' to cross each other at the center of the main lens L. Thereafter, the central electron beams B_G will pass substantially undeflected between shielding plates P and P' since the later are at the same potential. Passage of the electron beam B_B between the plates P' and Q' and of the electron beam B_R between the plates P and Q will, however, result in the convergent deflections thereof as a result of the convergence deflecting voltage V_Q applied therebetween, the system of FIG 1 is so arranged that the electron beams B_B, B_G and B_R will desirably converge or cross each other at a common spot centered in an aperture of the beam-selecting grill or mask G_P so as to diverge therefrom to strike the respective color phosphors of a corresponding array thereof on screen S. More specifically it may be noted that the color phosphor screen S is composed of a large plurality of sets or arrays of vertically extending "red," "green" and "blue" phosphor stripes or dots S_R, $S_G$and S_B with each of the arrays or sets of color phosphors forming a color picture element. Thus, it will be understood that the common spot of beam convergence corresponds to one of the thusly formed color picture elements.

The voltage V_P may also be applied to the lens electrodes G_3 and G_5 and to the screen S as an anode voltage as well as to the aperture grill G_P. Electron beam scanning of the face of the color phosphor screen is effected in conventional manner, for example, main deflection yoke means indicated in broken lines at D and which receives horizontal and vertical sweep signals to produce horizontal and vertical deflection fields by which the beams are made to scan the screen for providing a color picture thereon. Since, with this arrangement, the respective electron beams are each passed, for focusing, through the center of the main lens L of the electron gun A, the beam spots formed by impingement of the beams on the color phosphor screen S will be substantially free from the effects of coma and/or astigmatism of the same main lens, whereby improved color picture resolution will be provided.

In the color picture tube as illustrated on FIG. 1, plates P and P' and plates Q and Q' are shown flat and parallel with each other so that the electric fields between plates P and Q and plates P' and Q' are substantially uniform thereacross,

that is, in the direction perpendicular to the common horizontal plane of beams B_B, B_G and B_B. Thus, as the beams are vertically deflected by the vertical deflection field of yoke D so as to be directed at the upper or lower portions of screen S and such vertical deflection field vertically displaces the beams within convergence deflecting device F, the deflecting effects on beams B_B and B_R of the fields between plates P and Q and plates P' and Q', respectively, are substantially unchanged. However, as shown on FIG. 2, when the horizontal deflection field of yoke D deflects the beams toward the left of the screen as seen from the viewer's side of the latter, that is, downwardly as viewed on FIG. 2, the side beams B_B and B_R travel distances through such horizontal deflection field that are respectively greater than and smaller than the distance that the central beam B_G travels through the horizontal deflection field. Conversely, when the horizontal deflection field of yoke D deflects the beams toward the right side of the screen as viewed from the viewer's side, the distances traveled by the beams B_B and B_R through the horizontal deflection field are respectively smaller than and greater than the distance that the central beam B_G travels through such field. By reason of the foregoing difference between the distances that the beams travel through the horizontal deflection field when deflected by the latter toward one side or the other of the screen S, the raster of beam B_B and the raster of beam B_R would be displaced toward the left and toward the right, respectively, from the raster of the beam B_G, as seen from the viewer's side of the screen. If the horizontal deflection field of yoke D is given a nonuniform flux density thereacross, for example, a greater flux density at the sides than at the middle of the field, the described relative displacements of the rasters can be compensated for so long as the common plane of the beam is substantially horizontal, that is, so long as the beams are directed at the screen substantially midway between the top and bottom of the screen. However, when the horizontal deflection field of yoke D directs the beams toward one side or the other of the screen at a time when the vertical deflection field of yoke D deflects the beams vertically so that the common plane of the beams is substantially inclined from the horizontal to direct the beams toward a corner of the screen, the differences between the distances traveled by the beams through the horizontal deflection are further increased, as compared with the differences in the distances traveled through the field when the common plane of the beam is horizontal, so that even the mentioned nonuniform flux density across the horizontal deflection field of yoke D would be ineffective to avoid distortions of the rasters of beams B_B and B_R relative to the raster of beam B_G.

Assuming that the raster of central beam B_G has a rectangular shape, as indicated at L_G on FIG. 3, the raster L_B of beam B_B, as seen from the viewer's side of the screen, is distorted in the sense that its sides are convex toward the right, while the raster L_R of beam B_R is oppositely distorted, that is, its sides are convex toward the left.

In accordance with the present invention, such distortions of the rasters of side beams B_B and B_R relative to the raster of central beam B_G are avoided by suitably varying, in the direction perpendicular to the common plane in which the beams originate, for example, in the vertical direction for tube of FIG. 1, the distances by which plates P and Q and plates P' and Q' are spaced from each other. For example, in the embodiment shown by FIG. 4, plates P and P' are made flat or planar while plates Q and Q' are outwardly concave in the vertical direction or the direction across the plates, whereby the distances between plates P and Q and between plates P' and Q' are relatively small at the horizontal plane 21 containing the tube axis and such distances between the plates increase progressively in the direction of vertical plane 22 upwardly and downwardly from horizontal plane 21 in which the beams all originate.

Since convergence deflecting device F is disposed adjacent the main deflecting yoke D (FIG. 1), it will be apparent that the vertical deflection field of yoke D will extend into device F, and thereby influence the vertical positions of the beams

B_B, B_G and B_R in passing through device F. Thus, when the vertical and horizontal deflection fields of yoke D are effective to direct the beam toward a corner of the screen, the vertical deflection field of yoke D will vertically displace beams B_R, B_G and B_B either upwardly or downwardly from plane 21 within convergence deflection device F. By reason of the increased distance between plates P and Q and plates P' and Q' at such displaced positions of beams B_B and B_R, the parts of the electric fields then acting on such beams will be of relatively reduced intensity thereby to similarly reduce the convergent deflections imparted to beams B_B and B_R. Thus, for example, when the beams are horizontally and vertically deflected by yoke D so as to be directed at the upper or lower left-hand corner of the screen, as seen from the viewer's side thereof. The leftward deflection of beam B_B by the field between plates P and Q will be reduced and the rightward deflection of beam B_R by the field between plates P' and Q' will be similarly reduced, whereby to bring the left-hand sides of the rasters L_B and L_R, as seen on FIG. 3, into agreement with the left-hand side of the raster L_G. Similarly, when the beams are horizontally and Vertically deflected by yoke D so as to be directed at the upper or lower right-hand corner of the screen as viewed on FIG. 3, the leftward and rightward deflections of beams B_B, and B_R, respectively, by the fields between plates P and Q and plates p' and Q' will be reduced whereby to bring the right-hand sides of raster L_B and $L_R$into agreement with the right-hand side of raster L_G. Thus, distortions of the rasters L_B and L_R relative to the raster L_G can be effectively avoided by suitably selecting the position of convergence deflecting device F relative to yoke D and the shapes of plates Q and Q'.

As shown on FIGS. 5 and 7, the effect described above may also be achieved by providing flat or planar outer plates Q and Q' and outwardly convex inner plates P and P' (FIG. 5), or by providing outer plates Q and Q' that are inwardly convex and inner plates P and P' that are outwardly convex (FIG. 7). In each of these modifications, the distances between plates P and Q and between P' and Q' vary from a minimum at the horizontal plane passing through the tube axis to maximums at the upper and lower portions of the plates to conversely vary the strengths of the electrical fields between plates P and Q and plates P' and Q'. Since plates P and P' are at equal potential there is no electric field established therebetween, and thus the varying distance between plates P and P' in FIGS. 5 and 7 does not affect beam B_G as the latter is vertically deflected.

Of course, in the foregoing, it has been assumed that the distortions of rasters L_B and L_R relative to raster L_G that are to be corrected are those shown on FIG. 3. However, a situation may arise, for example, by reason of a particular configuration of the horizontal deflection field produced by yoke D, in which the raster of beam B_B has the shape indicated at L_R on FIG. 3 while the raster of beam B_R has the shape indicated at L_B. In the latter case, the plates P and Q and the plates P' and Q' are shaped so that the distances therebetween are maximum at the horizontal plane containing the axis of the tube and decrease progressively therefrom in the vertical direction, that is, in the direction perpendicular to the common plane in which the beams originate. In achieving such variations in the distances between the plates, plates P and P' may be flat or planar and plates Q and Q' may be outwardly convex (FIG. 6), or plates P and P' may be inwardly convex and plates Q AND Q' may be outwardly convex (FIG. 8).

Further, in each of the above-described embodiments of this invention, the convergence deflection device F consists of only a single pair of plates P and Q or P' and Q' acting on each of the beams B_B and B_R to deflect the respective beam in the direction for convergence with the central beam B_G. However, the invention can also be applied to color picture tubes, for example, as disclosed in the copending U.S. application Ser. No. 718,738, filed Apr. 4, 1968, and having a common assignee herewith, in which the beams following paths diverging from the tube axis upon emerging from the focusing lens are each successively acted upon by two pairs of deflecting plates, with the first pair of plates establishing an electric field therebetween by which the respective beam is further diverged from the tube axis and the second pair of plates establishing a field therebetween by which the beam is deflected in the direction for converging with the other beams. The foregoing arrangement makes it possible to increase the angles of incidence of the side beams B_B and B_R at the the beam-selecting apertured grill or mask G_P, whereby to permit a decrease in the distance of the latter from screen S for facilitating the accurate locating and mounting of the grill or mask G_P relative to the screen S. Where each of the side beams B_B and B_R is successively acted upon by two pairs of deflecting plates, as aforesaid, one or the other of such pairs of plates, and preferably the pair of plates closest to the location of the main deflection yoke, is provided with a distance between the plates that varies in the direction perpendicular to the common plane in which the beams originate so as to avoid distortion of the raster of the respective beam in accordance with this invention.

Having described various embodiment of this invention, it is to be understood that the invention is not limited to those precise embodiments, and that various changes and modifications may be effected therein by one skilled in the art without departing from the scope or spirit of the invention.

We claim:

1. A single-gun, plural-beam color picture tube comprising a color screen, beam-generating means directing a central electron beam and two side beams in a common horizontal plane toward said screen electron lens means defining a focusing field having a center through which the beams pass and by which the bundle of electrons in each of the beams are focused on said color screen with the central beam emerging from said lens along the optical axis of the latter and said two side beams emerging from said lens along paths that are oppositely divergent from said central beam, electrostatic convergence deflecting means a pair of horizontally spaced plates arranged along each of said divergent paths, said spaced plates of each pair being disposed at the inside and outside, respectively, of the side beam in the related divergent path and having voltages applied thereacross to produce an electric field by which the respective side beam passing therethrough is deflected horizontally to converge at a common spot with said central beam and the other of said side beams, and a main deflection yoke producing magnetic fields by which said beams are deflected horizontally and vertically, respectively, for causing the beams to scan said screen; said convergence deflecting means being located within the field produced by said yoke to deflect said beams vertically so that said beams are deflected vertically within said convergence deflecting means, and the horizontal distance between said plates of each of said pairs varying progressively in the vertical direction from a minimum at said common horizontal plane to maximums at the opposed edges of the plates remote from said common plane, so as to correspondingly vary the strength of the respective electric field for changing the rasters of said side beams with respect to the raster of said central beam.

2. A single-gun, plural-beam color picture tube according to claim 1, in which the inner plate of each of said pairs which is closest to said central beam is flat and the other plate of the respective pair is convex at the side thereof facing toward said inner plate.

3. A single-gun, plural-beam color picture tube according to claim 1, in which the inner plate of each of said pairs which is closest to said central beam is convex at the side thereof facing toward the other plate of the respective pair, and said other plate is flat.

4. A single-gun, plural-beam color picture tube according to claim 1, in which the plates of each of said pairs are convex at the sides thereof facing toward each other.

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