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[54] **COLOR TUBE HAVING ASYMETRICAL
 ELECTROSTATIC CONVERGENCE CORRECTION
 SYSTEM**
4 Claims, 5 Drawing Figs.

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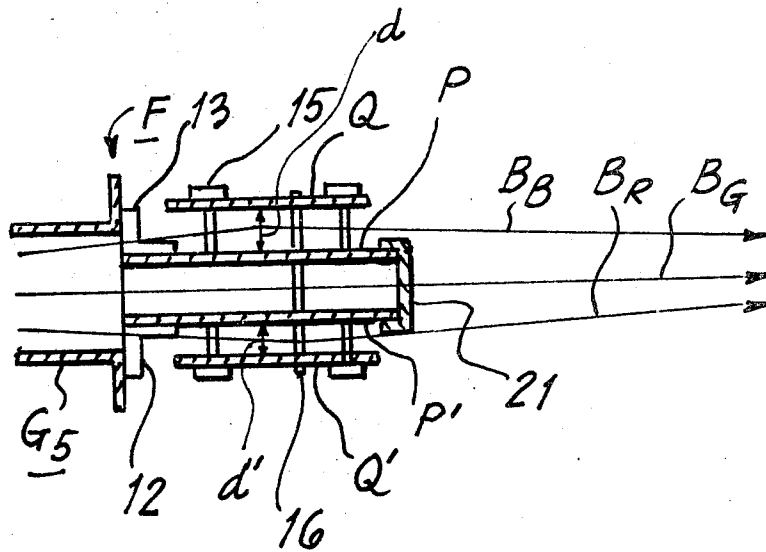
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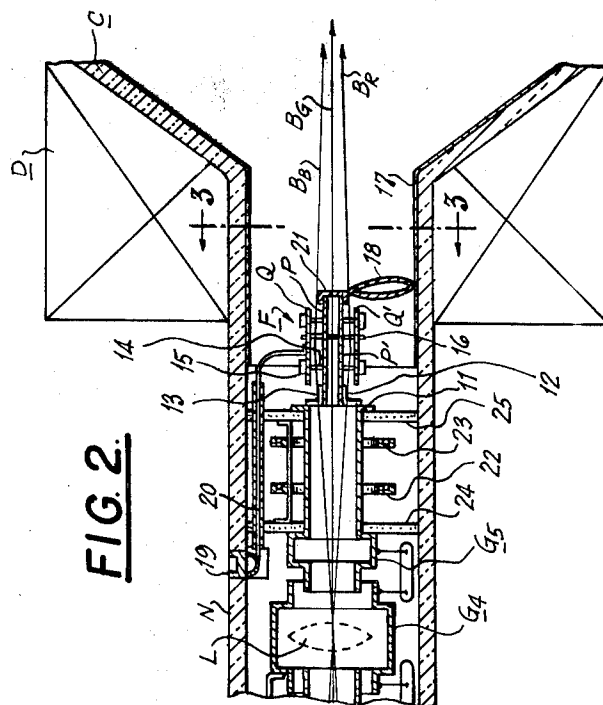
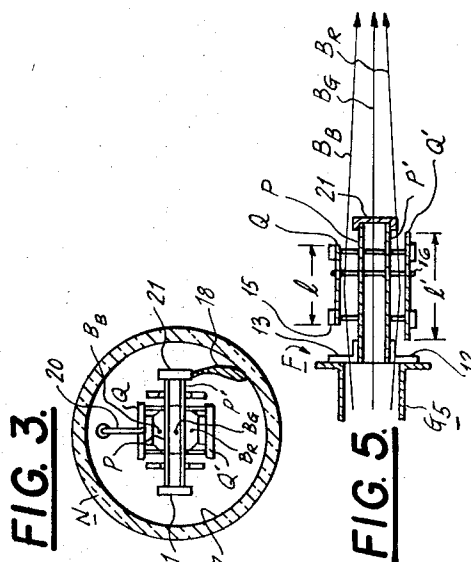
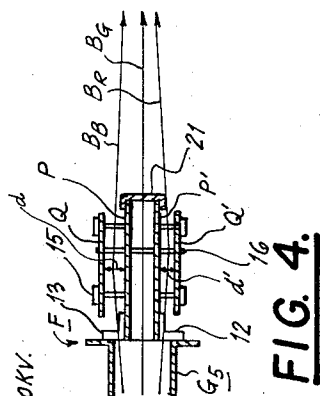
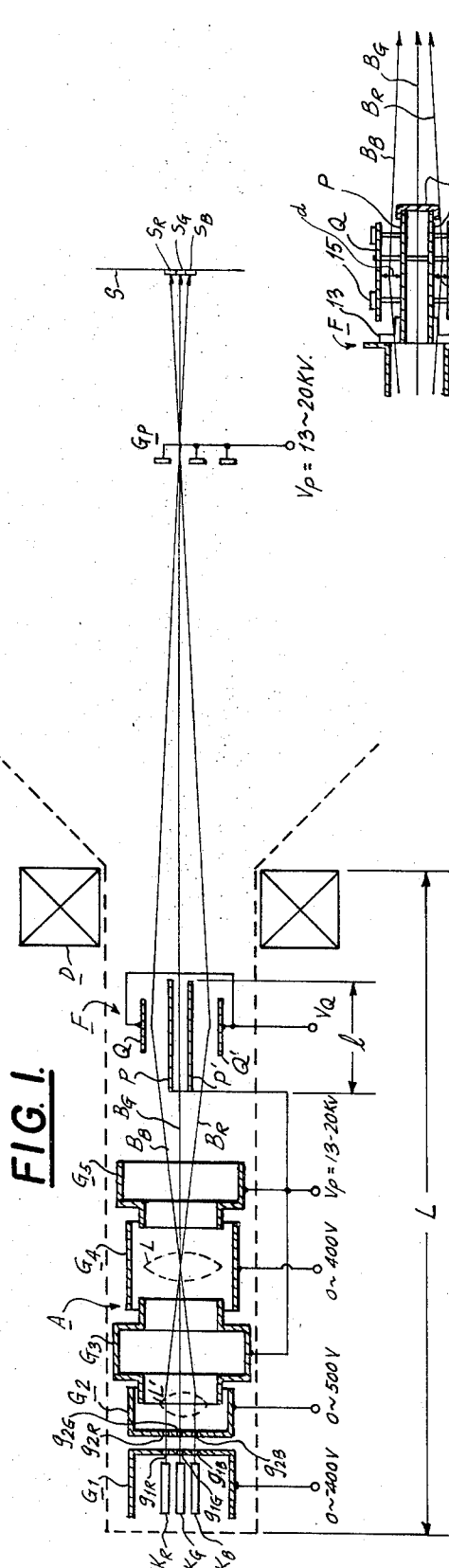
[50] Field of Search **313/70 (C),**
78, 80, 69 (C), 79

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ABSTRACT: In a single-gun, plural-beam color picture tube in which two beams emerge from a focusing lens along paths that diverge from a central beam emerging along the optical axis of the lens by which all of the beams are focused on the color screen, and the divergent beams are deflected to converge with the central beam by passage through respective electrical fields established between first spaced plates, at opposite sides of the central beam path, and second plates spaced outwardly from the first plates; such plates are disposed closely adjacent to the main deflection yoke by which the beams are made to scan the screen so that the length of the tube can be minimized, and the misconvergence of the beams that may result from the magnetic field produced between the first plates by reason of a current flow induced in the first plates by flux change of the magnetic field of the main deflection yoke is corrected by providing the second plates with different dimensional relationships to the first plates, for example, different distances from the first plates or different distances along the first plates, so that the deflecting effects of the electrical fields are correspondingly different.





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COLOR TUBE HAVING ASYMETRICAL ELECTROSTATIC CONVERGENCE CORRECTION SYSTEM

This invention relates generally to plural-beam color picture tubes, 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 so as to eliminate coma and spherical aberration by reason of the lens.

In plural-beam color picture tubes of the described type, for example, in the single-gun tube as specifically disclosed in the copending U.S. application Ser. No. 697,414, filed Jan. 12, 1968 now U.S. Pat. No. 3,448,316 and having a common assignee herewith, three laterally spaced electron beams are emitted or originated by a beam generating or cathode assembly and directed in a common substantially horizontal or vertical plane with the central beam coinciding with the optical axis of the single electron focusing lens and the two outer 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 between the focusing lens and the color screen is an electrostatic convergence deflecting means by which the beams divergent from the optical axis are deflected substantially in the plane of origination thereof for causing all of the beams to converge at a common location on a beam-selecting means, such as an aperture grill, and to pass therethrough for impingement on respective color phosphors of a color screen. Further, between the focusing lens and the beam-selecting means, the beams are acted upon by the magnetic fields resulting from the application of horizontal and vertical sweep signals to a main deflection yoke, whereby the beams are made to scan the screen in the desired raster. The convergence deflecting means of the foregoing color picture tube conveniently comprises a first pair of interconnected, spaced plates between which the central beam is passed, and a second pair of plates spaced outwardly from the first plates so that the divergent beams are passed between the first and second plates to be deflected for convergence by electrical fields provided therebetween when one voltage is applied to both first plates and a different voltage is applied to both second plates.

If the above convergence deflecting plates are to be remote from the magnetic fields of the main deflection yoke, the length of the neck of the tube envelope is undesirably increased and requires a corresponding increase in the depth of the television receiver cabinet to accommodate the tube. On the other hand, if the neck portion of the tube is shortened, which requires that the convergence deflection plates extend closely adjacent to the main deflection yoke, a magnetic field of the latter induces a current flow in the closed path constituted by the interconnected first plates between which the central beam is passed, and such current flow produces a magnetic field that deflects the central beam away from accurate convergence with the other two beams.

Accordingly, it is an object of this invention to provide a plural-beam color picture tube of the described type in which the convergence deflection plates are closely adjacent to, or even axially overlapped with respect to the main deflection yoke so as to minimize the necessary length of the neck portion of the tube envelope, and further in which any misconvergence that would result from the proximity of the convergence deflection plates to the main deflection yoke is avoided.

In accordance with an aspect of this invention, the misconvergence that would result from the proximity of the convergence deflection plates to the main deflection yoke is compensated for by providing the second or outer convergence deflection plates with different dimensional relationships to the respective first convergence deflection plates so that the electrical fields established between the first and second plates exert unequal deflecting effects on the beams passing therethrough. The different dimensional relationships mentioned above may involve different spacings between the first and second plates for deflecting one of the divergent beams

and between the first and second plates for deflecting the other divergent beam, so that the flux densities are different in the electric fields traversed by the two divergent beams. Alternatively, or in combination with the foregoing, the different dimensional relationship may be provided by giving the second plates different dimensions in the direction along the respective first plates so that the two divergent beams pass for different distances through the respective electric fields.

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

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 fragmentary sectional view taken in the same plane as FIG. 1, and which shows the structural arrangement of a portion of such tube in order to reduce the length of the neck portion of the tube envelope;

FIG. 3 is a transverse sectional view taken along the line 3-3 on FIG. 2; and

FIGS. 4 and 5 are fragmentary sectional views showing the arrangements of the convergence deflection plates in a tube as shown on FIGS. 2 and 3 in order to avoid misconvergence in accordance with two respective embodiments of this 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 10 of the type to which this invention may be applied comprises a glass envelope (not shown) having a neck and a cone 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 the neck is a single 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 thereof disposed as shown in a plane which is substantially perpendicular to the axis of the electron gun. 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 or other common 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 maintained in the depicted, assembled positions thereof, by suitable, nonillustrated support means of an insulating material.

For operation of the electron gun 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 , a voltage of 13 to 20 kv. 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 a 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 focusing 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 kv., 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 of FIG. 1 are electron beam convergence deflecting means F which comprise a first pair of shielding plates P and P' disposed in the depicted spaced, relationship at opposite sides of the gun axis, and a second pair of 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_C will pass substantially undeflected between the shielding plates P and P' , while the deflector plates Q and Q' have negative charges with respect to the plates P and P' so that respective electron beams B_R and B_G 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 , may be applied to the respective deflector plates Q and Q' to result in the respective shielding plates P and P' being at the same potential, and to result in the application of a deflecting voltage difference or convergence deflecting voltages between plates P' and Q' and plates P and Q and it is, of course, this convergence deflecting voltage V_C which will produce electric fields to impart the requisite convergent deflection to electron beams B_R and B_G .

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 respective electron beams will then pass through the common auxiliary lens L' to cross each other at the center of the main lens L and to emerge from the latter with beams B_R and B_G diverging from beam B_C . Thereafter, the central electron beam B_C will pass substantially undeflected between shielding plates P and P' since the latter 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 applied therebetween, and the system of FIG. 1 is intended to be so arranged that electron beams B_R , B_G and B_B will desirably converge or cross each other at a common spot centered in an aperture of the beam-selecting grill G_P and then 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. It will be understood that the common spot of beam convergence corresponds to one of the thusly formed color picture elements.

Electron beam scanning of the face of the color phosphor screen is effected by horizontal and vertical deflection yoke means indicated in broken lines at D and which receives horizontal and vertical sweep signals whereby a color picture will be provided on the color screen. Since, with this arrangement, the electron beams are each passed, for focusing, through the center of the main lens L of 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 main lens, whereby improved color picture resolution will be provided.

As shown on FIGS. 2 and 3, the plates P and P' , in a structural embodiment of the tube schematically illustrated on FIG. 1, may be supported, at the sides of their ends closest to electrode G_5 , by angle members 12 and 13 secured to a flange 11 at the adjacent end of a tubular extension of electrode G_5 which is, in turn, supported within tube neck N by insulating discs 24 and 25 having getter rings 22 and 23 suitably mounted therebetween. The forward ends of plates P and P' are joined, at the sides of the latter, by bracing members 21 extending therebetween. The voltage V_P is applied to plates P and P' through a contact spring 18 extending from one of the bracing members 21 into engagement with a conductive coating 17 which is applied to the inner surface of the cone portion C of the tube envelope and extends into the adjacent neck portion thereof. The voltage V_P is applied to coating 17 by way of an anode button (not shown) provided in cone portion C , and is applied to electrode G_5 from plates P and P' by way of angle members 12 and 13. From electrode G_5 , the voltage V_P may be applied to electrode G_3 by way of a suitable conductor (not shown). The voltage V_P may also be applied to aperture grill G_P as an anode voltage, by way of coating 17.

Posts or pins 14 extend outwardly from plates P and P' and, at their outer ends, carry glass beads 15 by which plates Q and Q' are supported while being insulated with respect to plates P and P' . The voltage V_Q is applied to plate Q by a conducting lead 20 extending from a button 19 in neck N and the voltage V_Q is applied to plate Q' by way of a conducting lead 16 extending between plates Q and Q' and being spaced from plates P and P' .

In order to reduce the necessary length of neck N of the tube envelope, the convergence deflecting means F is located closely adjacent to the main deflection yoke D , and may even axially overlap the location of the latter as shown on FIG. 2. However, when convergence deflecting means F is thus located, it is disposed within the magnetic field with vertical lines of flux produced by main deflecting yoke D for causing the beams to horizontally scan the color screen. Since plate P , bracing members 21, plate P' , angle members 12, 13 and electrode G_5 form a closed loop, the magnetic flux changes in such magnetic field of yoke D induces a current to flow in the closed loop, and the induced current, in turn, produces a magnetic field between plates P and P' that acts on the central beam B_C in the direction opposed to the horizontal scanning movement of the beams. Since the other beams B_R and B_G are not acted upon by the magnetic field between plates P and P' resulting from the induced current, at any instant during each horizontal scan the point at which beam B_C reaches the aperture grill G_P will lag behind the point on the latter at which beams B_R and B_G converge, whereby misconvergence results.

In accordance with this invention, such misconvergence is avoided or corrected by providing the convergence deflecting plates Q and Q' with different dimensional relationships to the respective shielding plates P and P' so that the electrical fields between plates P and Q and between plates P' and Q' , respectively, will have different deflecting effects on beams B_R and B_G , respectively, and thus cause such beams to reach the aperture grill at the same point as beam B_C notwithstanding the fact that beams B_R and B_G are not subjected, during horizontal scanning, to the magnetic field acting on central beam B_C between plates P and P' .

As shown on FIG. 4, the different dimensional relationships of plates Q and Q' with respect to plates P and P' may refer to the distances by which plates Q and Q' are spaced from plates P and P' , respectively. Thus, on FIG. 4, the distance d between plates P and Q is larger than the distance d' between plates P' and Q' , from which it follows that the flux density or intensity of the electrical field between plates P' and Q' , and hence the deflecting force acting on beam B_R , will be greater than the flux density or intensity of the electrical field between plates P and Q , and hence the deflecting force acting on beam B_G .

Thus, the convergence deflection of beam B_R will be greater than the convergence deflection of beam B_B to cause beams B_R and B_B to converge at a common point with beam B_G at the aperture grill.

As shown on FIG. 5, the mentioned different dimensional relationships of plates Q and Q' with respect to plates P and P' may alternatively refer to the distances along plates P and P' that the plates Q and Q' respectively extend. Thus, on FIG. 5, the plate Q is shown to have a length l in the direction of the tube axis that is smaller than the length l' of the plate Q' in the same direction. In view of the foregoing, beam B_B will traverse a distance in passing through the electric field between plates P and Q that is greater than the distance traversed by beam B_R in passing through the electric field between plates P' and Q'. Thus, once again the convergence deflection of beam B_R will be greater than the convergence deflection of beam B_B so as to restore proper convergence of the three beams B_R , B_G and B_B at a common point on the aperture grill.

It is also apparent that the measures according to this invention for correcting the described misconvergence as shown on FIGS. 4 and 5 can be combined, that is, for example, the plate Q may be spaced further from the plate P than the distance of plate Q' from plate P' and the length of plate Q may be made shorter than the length of plate Q'.

Although illustrative embodiments of the invention have been described in detail herein with reference to the drawings, 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.

I claim:

1. A plural beam color picture tube comprising a color screen having arrays of color phosphors and beam selecting means with apertures corresponding to said arrays, beam-generating means for directing a plurality of electron beams toward said color screen for impingement on respective phosphors of each array through the corresponding aperture, lens means for focusing said electron beams on said color screen and having an optical center through which all of said beams are passed with one of said beams passing through said lens means along the optical axis of the latter and two of said beams being angled with respect to said optical axis to emerge from said lens means along paths divergent to said axis, elec-

tron beam convergence deflecting means interposed between said lens means and said beam selecting means for deflecting said two beams emerging along said divergent paths so as to achieve convergence of all of said beams at an aperture of said beam-selecting means, and magnetic yoke means also interposed between said lens means and said beam-selecting means to produce a magnetic field by which said beams are simultaneously deflected to scan said screen; said convergence deflecting means including first interconnected plates which are spaced apart for the passage of said one beam therebetween, second plates spaced outwardly from said first plates so that each of said two beams passes between a first plate and a second plate and means to apply one voltage to said first plates and a different voltage to said second plates so that the voltage difference between said first plates and said second plates produces electrical fields therebetween for effecting said convergence, said convergence deflecting means being disposed closely adjacent to said magnetic yoke means so as to reduce the necessary length of the tube and as a result of which said magnetic field of the yoke means induces a current flow through said interconnected first plates producing a magnetic field between said first plates which acts on said one beam to cause misconvergence of the beams, and said misconvergence being corrected by providing one of said second plates with different dimensional relationships to its corresponding first plate than the other of said second plates has to its corresponding first plate so that said electrical fields exert unequal deflecting effects on said two beams in coaction with the field of said magnetic yoke means for restoring the convergence thereof with said one beam.

2. A plural-beam color picture tube according to claim 1, in which said second plates are spaced from the respective first plates by different distances so that the flux densities of said electrical fields are different.

3. A plural-beam color picture tube according to claim 1, in which said second plates extend for different distances along the respective first plates in the direction of said beams therebetween so that said two beams pass for different distances through the respective electrical fields.

4. A plural-beam color picture tube according to claim 1, in which said convergence deflecting means and said magnetic yoke means overlap in the direction of the axis of the tube.

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