Aug. 12, 1958 R. H. HUGHES 2,847,598

ELECTRON GUN STRUCTURE FOR PLURAL BEAM TUBES

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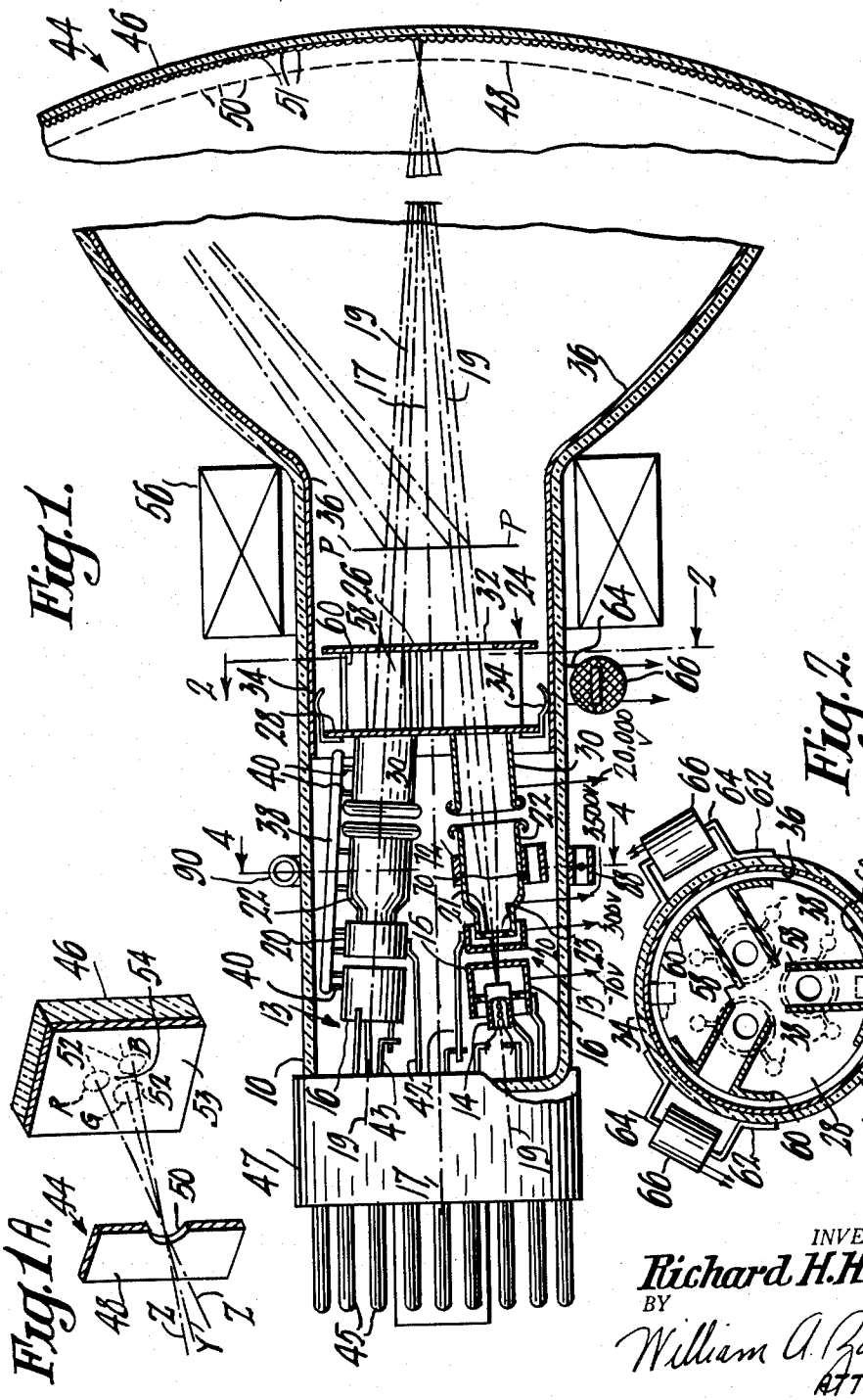


Fig. 1.



Fig. 1A.



Fig. 2.

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Fig. 4.

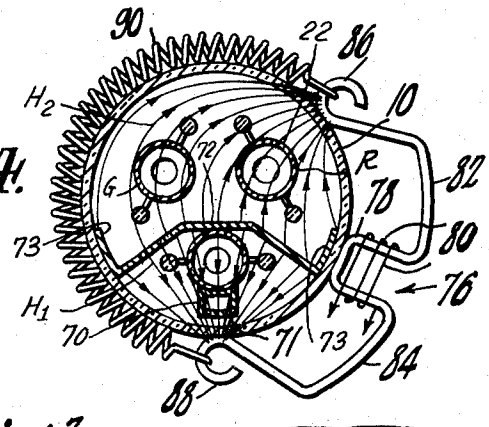



Fig. 3.

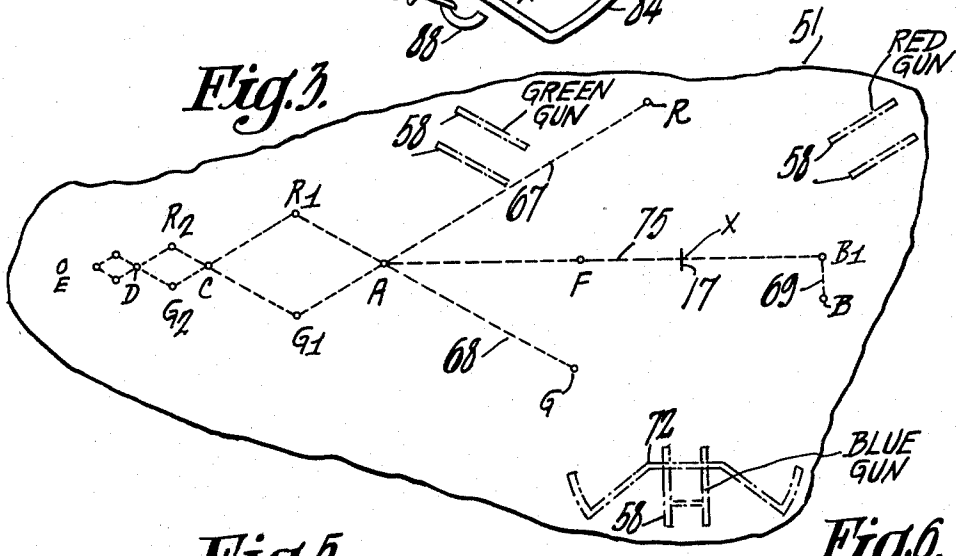



Fig. 5.

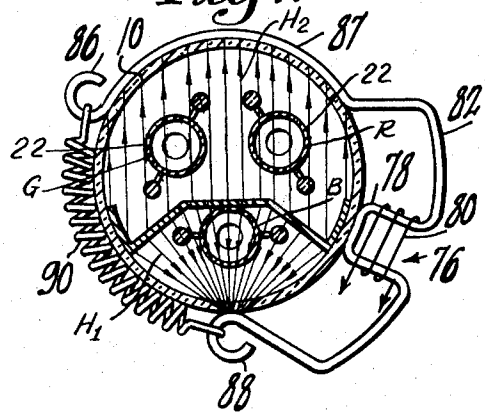
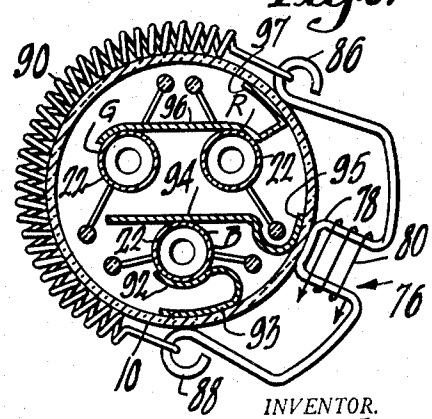



Fig. 6.




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# ELECTRON GUN STRUCTURE FOR PLURAL BEAM TUBES

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Application April 16, 1956, Serial No. 578,434

8 Claims. (Cl. 313—70)

The invention is directed to a cathode ray tube and specifically to means for correcting the convergence of a plurality of electron beams on the target of such a tube.

A cathode ray tube which utilizes a plurality of electron beams may be of the type designed so that the electron beams are converged to a single point on the target of the tube. Such a tube is utilized for color television. The beams are formed by electron gun structures and are directed by the mechanical alignment of the gun structures toward a common point at the tube target. However, it has not been feasible to provide the accuracy of mechanical alignment to the gun parts in order to obtain complete convergence of the three beams at the target. Such convergence is necessary in color television tubes in order to provide accurate registry of the portions of the picture produced on the tube screen. Devices have been utilized whereby the mechanical misalignment of the gun parts is corrected by dynamic and static fields to maintain beam convergence during the scansion of the beams over the target of the tube. Such solutions have proved adequate under most conditions. However, it has been found that due to the interaction of the correcting fields on the several electron beams, that complete convergence control of the several beams is difficult.

It is therefore an object of this invention to provide a novel means for obtaining convergence of a plurality of beams of a cathode ray tube at the tube target.

It is a further object of the invention to provide novel means for correcting the convergence of a plurality of electron beams of a cathode ray tube at the tube target.

It is another object of this invention to provide a magnetic field producing structure for providing convergence control of a plurality of beams of a cathode ray tube in a novel manner.

Figure 1 is a longitudinal sectional view of a cathode ray tube utilizing a plurality of beams in accordance with the invention;

Figure 1*a* is an enlarged sectional portion of the target surface of the tube of Figure 1;

Figure 2 is a sectional view of the device of Figure 1 along the lines 2—2;

Figure 3 is a diagrammatic sketch of the operation of the device of Figure 1 under certain conditions;

Figure 4 is a sectional view of the device of Figure 1 along the sectional lines 4—4;

Figures 5 and 6 are sectional views of modifications of the invention shown in Figure 1.

Figure 1 discloses a cathode ray tube having a plurality of electron beams and used as a picture viewing tube for color television. The tube consists of an evacuated envelope having a neck portion 10, for example, of glass, and a shell portion 12, which may be either conical or substantially the frustum of a pyramid, and which may be of metal or glass. Within the neck portion 10 of the envelope are a plurality of electron guns 13 each consisting of a cathode electrode 14 mounted within a tubular



control grid electrode 16. Each control grid 16 is closed at one end by a wall 15 having a single aperture at its center. The adjacent end of each cathode tube 14 is closed by a solid wall portion and is coated on its outer surface, facing electrode wall 15, with electron emitting material, such as a mixture of barium and strontium oxides, to provide a source of electron emission.

Closely spaced from the control grid 16 of each electron gun and along a common gun axis 19, there is mounted a short tubular or cup-like accelerating electrode 20 having a centrally disposed aperture in the bottom wall 21 of the cup in line with the aperture in the control grid wall 15. Spaced along the axis 19 of each gun from accelerating electrode 20 is a relatively long tubular accelerating electrode 22, closed at its end facing accelerating electrode 20 by a centrally apertured wall portion 23, whose aperture is aligned with the apertures in electrode portions 21 and 15. Spaced from the other end of electrode 22 of each gun 13 is a common focusing electrode 24, having a plate portion 26 at the far end and having mounted in an oppositely disposed plate portion 28 a plurality of short tubular members 30. One of the tubular members 30 is aligned on the common axis 19 of each electron gun with the other gun electrodes 16, 20 and 22 respectively. Through plate 26 of focusing electrode 24, there is formed an aperture 32 on the axis of each gun in alignment respectively with the apertures of electrode portions 15, 21 and 23. Electrode 24 is electrically connected by spring fingers or spacers 34 to a conductive wall coating 36, which extends over the inner surface of the tubular envelope neck portion 10 from a point adjacent focusing electrode 24 into the conical envelope portion 12.

The several electrodes described are mounted within the neck portion 10 by rigidly fastening them together by means of a plurality of studs 40 each having one end welded to the electrode and the other end sealed into a glass rod 38. A lead wire 42 extends from each electrode respectively, to supporting base wires 43 sealed through the end wall 39 of the tubular envelope neck portion 10. The base wires 43 are conductively fixed to base pins 45 extending through a base 43 to make electrical contact to external sources of potential. By lead wires 42 and the spring spacing fingers 34, the electron guns are rigidly supported within the envelope neck portion 10.

In Figure 1, voltages are indicated as those which can be applied to the respective gun electrodes. These voltages are those which have been successfully used in tubes of the type described and need not be limiting.

During the operation of the several electron guns, potentials are applied to several gun electrodes in the amounts indicated. The electron emission from each cathode 14 is formed by the electrostatic fields respectively between electrode portions 15, 21 and 23 into an electron beam directed through the apertured portions of the gun electrodes. The difference of potential between electrode 22 and the corresponding electrode portion 30 provides a principal focusing lens field in the path of each electron beam, whereby the electrons of each beam are converged to a small focused spot at a target electrode 44 mounted in the large shell portion 12 of the envelope.

Target electrode 44 consists of a glass support plate 46 and a metallic masking electrode 48 closely spaced from the surface of plate 46 facing the electron guns. Support plate 46 may be the end wall or face plate of bulb 12 or an additional plate supported within bulb 12. Masking electrode 48 is a thin copper-nickel sheet having a large number of small apertures 50. Fixed to the adjacent surface of the glass plate 46 is a luminescent screen 51 consisting of groups of phosphor dots 52

(Figure 1*a*), with each group consisting of three dots positioned in a triangular arrangement about a center point. The positioning of each group of phosphor dots is such that the center of each aperture **50**, in the masking electrode **48**, will be aligned with center point **54** of the corresponding group of phosphor dots.

The phosphor dots **52** of each group are formed of phosphor material fluorescing with a different colored light when struck by the high energy electrons from guns **13**. The dots of each group have a red, green or blue fluorescence under electron bombardment, as indicated respectively by R, G, and B in Figure 1*a*. Furthermore, the positioning of the phosphor dots is that in which each dot is aligned with its corresponding aperture **50** in electrode **48** along a different directional line X, Y or Z, respectively. The fluorescent screen may be covered with a thin film **53** of reflective metal to intensify the luminescence of the phosphor by reflecting light from the phosphor screen through plate **46** toward the observer.

The three electron beams leaving the electron guns **13** are caused to converge by mounting each gun **13** at a small angle to envelope axis **17** so that the axes **19** of the three guns will converge to a common point at the masking electrode **48**. Each beam, normally following the axis **19** of its gun, will approach the masking electrode **48** at a small angle of incidence and from one of the different directions X, Y or Z. Electrons from each beam passing through the apertures **50** of electrode **48** along one of the paths extending in the directions X, Y or Z, will strike one phosphor dot in each group of dots. The arrangement is such that the electrons from each gun can strike only those phosphor dots **52** luminescing with a single color of light. The angle which each gun makes with tube axis **17** is small and is determined by the dimensions of the tube. In tubes of the type described, having a tube length of around 25 inches, this angle is in the order 1° 1′. Figure 1 exaggerates the angle between the guns and axis **17**, for purpose of illustration.

The three beams are simultaneously scanned over the surface of the masking electrode **48** by conventional scanning means indicated as a neck yoke **56**, which consists of two pairs of deflecting coils, with the coils of each pair mounted on opposite sides of the envelope neck **10**. Each pair of deflecting coils of yoke **56** is connected in series to sources of saw-tooth currents for providing line and frame scansion of the three electron beams simultaneously over the surface of the masking electrode **48**. The scanning coils of yoke **56** are of known design and do not constitute a part of this invention and need not be further described. The scansion of electron beams may be in any desired manner but for color television viewing is normally a rectangular raster.

The three beams which have been converged at a common point on axis **17** at the target **44**, will lose convergence when they are simultaneously scanned over the target between the point of beam convergence on masking screen **48** will vary with the deflection of the beams during scanning. Also, because of the complexity of using three beams, the convergence of any two beams is different from the convergence of any other two of the three beams during beam scansion. To maintain convergence of the three beams at the target at all times during scansion, a correcting dynamic magnetic field is established respectively in the path of each beam and the strength and direction of each field is varied in synchronism with the deflection of the beam.

The dynamic converging field is provided by pairs of pole pieces with one pair mounted on opposite sides of each of the electron beam paths. As shown specifically in Figures 1 and 2, each pair of pole pieces include parallel plate portions **58** extending substantially toward the axis **17** of the envelope neck **10** and on opposite sides of each electron beam. The plates **58** are fixed between electrode plate portions **26** and **28** of focusing electrode **24**. The pole pieces **58** have arcuate portions **60** extending along the inner wall portions of the tubular neck **10** and as shown in Figure 3. Each pair of arcuate pole pieces portions **60** are matched with armature portions **62** forming a part of an armature **64** of an electromagnet **66** mounted on the outer wall portion of the tubular neck **10** and overlying the pair of pole pieces **60**.

The passage of current through magnet coils **66** will cause deflection of the corresponding electron beam in a plane parallel to the plate portions **58**. The direction of current flow through coils **66** will determine the polarity of opposite pole plates **58** and will thus impart to the respective electron beam a directional component of travel toward or away from the tube axis **17**. A varying current synchronized with and related to the amount of scanning deflection of the beams is applied to each coil **66** to maintain common convergence of the three beams at all times at the target during beam scansion.

However, prior to tube operation it is necessary to statically bring all three beams to convergence at the target so that beam convergence may be maintained when the tube is put into operation.

Figure 3 shows a portion of the center of the luminescent screen **51** where tube axis **17** intercepts the screen. If the three beams are accurately positioned symmetrically about axis **17**, and with no scanning deflection fields acting on the beams, electron beam portions passing through an aperture **50** at the center of mask **48**, theoretically should strike the single spot on screen **51** where tubular axis **17** strikes the screen. However, due to inherent misalignment of gun parts, or to non-uniformity of fields, through which the beams pass, or both, one or more of the beams may be displaced from spot **17**, and will strike in spots R, G and B, for example.

Figure 3 shows in phantom plates **58** of the three electron guns **13**, to roughly indicate their relative positions. The spots B, R and G are rotationally displaced from their respective guns, since the beams in passing through their guns to screen **51** tend to spiral in the same rotational direction about the axix **17**. The spiral occurs mostly in the misaligned focus lens. To bring the three spots B, R and G into convergence, a static magnetic correcting field is established between the pairs of converging plates **58** of each gun. This may be done by passing a direct current through each coil **66**, which will move the respective electron beam in a plane parallel to its convergence correcting plates **58** as described above for the dynamic operation of coil **66**. For example (referring to Figure 3), a direct current passed through coil **66** of the red gun will move the red beam spot from point R along a path **67** parallel to the plates **58** of the red gun. Similarly, applying a direct current to the coil **66** of the green gun provides a magnetic field which will move the green electron beam from the spot G along a path **68** parallel to plates **58** of the green gun and which intersects the path of the red beam at A. The amount and direction of the displacement of the red and green beams along their respective paths **67** and **68** on screen **51** is easily controlled by the strength and direction of the direct current applied to the respective coils **66** of the red and green guns. In this manner the red and green beams are brought to convergence on screen **51** at spot A.

A similar direct current correcting field passed through coil **66** of the blue gun will move the blue beam along a path **69** on screen **51** which is parallel to the plates **58** of the blue gun. However, to bring the blue beam into convergence with the red and green beams at point A or any other point on screen **51**, it has been found necessary to use correcting plates which provide a lateral displacement of the blue beam at right angles to its correction path provided by the convergence plates **58** of the blue gun.

This lateral correction control of the blue beam is provided by a magnetic field established between a pair of pole pieces **70** and **72** fixed to the blue gun on opposite sides of the accelerating electrode **22**. As shown

in Figures 1 and 4, pole piece **70** is a short tubular box-like pole piece having an arcuate surface **71** adjacent to the glass wall neck **10**. Pole piece **72**, however, consists of a flat plate structure having a central portion fixed by welding, for example, to electrode **22** and a pair of end portions bent around electrode **22** and extending toward the wall of the glass tubular neck portion **10**. The ends **73** of plate **72** are arcuately shaped to fit closely against the cylindrical neck wall **10**, as shown specifically in Figure 4.

Normally an electromagnet (not shown) is fixed to the outer surface of neck portion **10** to provide a magnetic field between the pole pieces **70** and **72**. This field is normal to the magnetic field provided by plates **58** fixed to the blue gun. Figure 3 schematically shows the relationship of the pole pieces **70** and **72** relative to the beam convergence pole pieces **58** of the blue gun. A direct current through the coil of the electromagnet will move the blue beam in a plane normal to the path the beam is moved by the field established between pole piece **58** of the blue gun. The strength and polarity of current in the electromagnet control the direction and distance the beam is moved in this lateral direction. In this manner, the blue beam has two possible corrections normal to each other so that at screen **51**, the beam spot $B_1$ may be moved to any point in the neighborhood of the screen center **17**.

With this control, the blue beam is moved to the point A, at which the red and green beams have previously been converged. However, it has been found that in applying a lateral correction field between plates **70** and **72** of the blue gun, fringe fields of the electromagnet extend into the beam paths of the red and green guns respectively so that when the blue gun is moved from B or $B_1$ to A, for example, the lateral correction fields of the blue gun will also move the red beam to a new point $R_1$ and the green beam to a new point $G_1$. Additional convergence correction current is passed through the respective coils **66** of the red and green guns to bring the beams back to convergence at a new point C. This then necessitates an additional increase in the lateral correcting field between plates **70** and **72** of the blue gun to move the blue beam laterally again from point A to the new point of convergence C. The increase in the lateral correction field of the blue gun again moves the red beam to new point $R_2$ and the green beam to a new point $G_2$. Additional convergence correction applied to the red and green gun respectively bring the red and green beams to a third point of convergence D. Again the blue beam is moved from convergence point C to D by adding a correction to the lateral field between plates **70** and **72** of the blue gun. However, each application of the lateral correcting field to the blue gun provides less displacement of the red and green beams so that eventually, a point is reached at E where the three beams are substantially in convergence. It has been found that this procedure for correcting the convergence of the beams is not entirely satisfactory since the convergence correcting procedure described above displaces the three beams to a final point E, which is considerably removed from the theoretical convergence point X on the axis **17** of the tube. Additional means can be used to bring the common convergence point E of the three beams back to the point X but this necessitates an additional field producing means. Furthermore, the excessive corrections provided to the three beams increased the distortion of each beam spot on the phosphor screen **51**. Excessive lateral correction of the blue beam also prevents the beam from passing through the center of the beam focusing field between electrodes **22** and **30** of the blue gun. This increases the aberration effects of the focusing lens on the beam and distorts the spot of the blue beam on the target. It has been found desirable in the commercial production of these tubes to accept for sale only those tubes in which it is necessary to move the blue beam from $B_1$ to E one half inch or less. This places a great demand on the mechanical alignment of the guns **13**.

In accordance with my invention, a lateral correction magnet **76** is positioned relative to the three electron guns **13** so as to provide oppositely directed lateral correcting fields in the green and red guns relative to the correcting field of the blue gun (Figure 4). External magnet **76** consists of a center pole piece **78** about which a magnet coil **80** is wound. The other pole piece of the magnet consists of two legs **82** and **84** which are doubled back to contact the neck of the tube at end portions **86** and **88** respectively. The end portions are shaped with a hook structure to which a retaining spring **90** is attached for clamping the magnet **76** to the outer surface of the tubular neck portion **10**.

In accordance with the invention, the pole piece **78** is positioned adjacent to the arcuate end piece **73** of the internal pole piece **72**. Furthermore, the external pole pieces **82** and **84** are proportioned so that the pole piece end **88** is adjacent to the internal pole piece **70**, while the external pole piece end **86** is adjacent to the red gun electrode **22**, as shown in Figure 4. This arrangement provides a lateral correction field between plates **70** and **72**, which is normal to the convergence correction field provided by plates **58** of the blue gun. Furthermore, there is provided in the red and green guns, shown in Figure 4, lateral convergence fields which although not directly normal to the convergence fields provided by plates **58** of the respective guns, do provide correcting fields at a substantial angle to the convergence correcting fields of plates **58** of the respective guns. Furthermore, because of the arrangement of external pole pieces **78**, **86** and **88**, the lateral correcting field $H_1$ between plates **70** and **72** of the blue gun is substantially in an opposite direction from the lateral correcting fields $H_2$ in the red and green guns formed between the external pole piece **86** and the internal pole piece **72**. Figure 4 shows the flux lines $H_1$ and $H_2$. If external pole piece **78** is north and end pieces **86** and **88** are south, then the field direction $H_1$ is from pole piece **88** to plate **72** diametrically across the blue gun, and the field direction $H_2$ is from pole piece **86** to plate **72** across the red and green guns, as shown by the flux arrows in Figure 4. Thus the field has substantially an opposite direction across the blue gun as across the red and green guns. A current flow through coil **80** will establish flux in a manner shown in Figure 4 to provide lateral displacement of the several electron beams normal to the field lines. The blue beam will be displaced in a direction substantially opposite to that of the red and green beams although not in parallel planes. However, the lateral displacement in each gun is substantially different from the convergence correction provided by plates **58** of each gun. With such an arrangement of pole pieces and correction magnet, as shown in Figure 4, convergence of the three beams may be accomplished with much less correction and subsequent distortion of beam spot and beam focus.

With reference to Figure 3, convergence of the three beams may now be accomplished by first utilizing the convergence correcting plates **58** of each gun, and in the manner described above. This correction brings the red and green beams to convergence at point A, and moves the blue beam to $B_1$. Applying a direct current to coil **80** of the lateral correction magnet **76** moves the blue beam along the path **75** toward the axis **17**, while the lateral fields in the red and green gun being in an opposite direction will move the red and green beams from point A in a direction toward the center point X. By providing additional convergence correction to the red and green beams through their respective plates **58**, the spot A of the red and green beam convergence can be moved along the path **75** until it meets the spot of the blue beam moving along the path in the opposite direction. Such a point in which the three beams can be converged may be a point F which is considerably nearer

the point X, at the center of the screen, than the point E of beam convergence previously established. By thus applying a lateral correction field to the red and green beams, which is in an opposite direction to that of the blue lateral correcting field, the convergence spot of the three beams can be brought very closely to the theoretical center of convergence X. This then permits greater tolerance of mechanical misalignment of the three electron guns with a resulting lower cost of manufacturing. Furthermore, the use of the lateral correction fields of the structure of Figure 4 does not necessitate more than a small application of an additional correction to center the three beams once they have been converged and thus, introduces less distortion of the beams.

Figures 5 and 6 show alternate designs of the lateral correction means of the type shown in Figure 4. In Figure 5, for example, the external pole piece 82 of magnet 76 is formed with an arcuate structure 87 which partially encloses the red and green guns so that the lateral correction field $H_2$ passing through these guns are symmetrical with respect to each other and to the field $H_1$ of the blue gun. In Figure 5, it may also be noted, that the internal pole piece 70 of Figure 4 has been omitted as this is not entirely necessary for tube operation. The magnetic field $H_2$ between pole pieces 87 and 72 is substantially opposite in direction to the field $H_1$ between pole pieces 88 and 72, as shown by the flux arrows in Figure 5. Thus, the lateral correcting field causes a lateral displacement of the blue electron beam substantially opposite in direction to the lateral displacement of the red and green electron beams.

Figure 6 shows a different design of internal pole pieces so as to provide lateral correction fields in the red and green guns which are substantially normal to the convergence correcting fields provided by plates 58 of the respective guns. This structure includes internal pole pieces 92 and 94 fixed to the blue gun electrode 22 and a common pole piece 96 fixed to both the red and green gun electrodes 22. The pole pieces 92, 94 and 96 all have arcuate end structures 93, 95 and 97 respectively, which are positioned adjacent to the inner surface of the glass tubular neck portion 10. The external magnet 76 is positioned with its pole piece 78 adjacent to the arcuate end portion 95 of the internal pole piece end 94 and with the external pole piece end 88 adjacent to the arcuate end 93 of the internal pole piece 92, while the external pole piece end 86 is positioned adjacent to the arcuate end 97 of the internal pole piece 96. Current passing through coil 80 thus provides a magnetic flux between pole pieces 92 and 94 which is in an opposite direction to the flux between pole pieces 96 and 94. The lateral displacement of the blue electron beam in this modification is in a plane parallel to that of the red and green beams.

The relative strength of the lateral correcting flux in the red and green guns may be adjusted to any desired value relative to the strength of the lateral correcting flux in the blue gun. For example, in referring to Figure 4 these relative flux strengths may be adjusted to move the blue beam along the path 75 toward point A a distance twice as far as the red and green beams are moved along the same path in the opposite direction; or the flux strengths within the respective guns may be adjusted so that the lateral movement of the blue beam is equal to the lateral movement of the red and green beam. This is a matter of preference and expediency, as well as modifications in the design of the pole piece structures of the magnet 76.

What is claimed is:

1. An electron discharge device comprising an envelope, an electron gun structure within said envelope for producing separate electron beams along three paths not in a common plane and extending in the same general direction, a magnetically permeable plate structure mounted within said envelope and extending between one of said three electron beam paths and the other two of said beam paths, a magnet including two pole structures mounted with one of said pole structures closely spaced from one end of said plate structure and the other of said pole structures having one portion thereof closely spaced from and on the side of said one electron beam path opposite to said permeable plate and another portion of said other pole structure closely spaced from and on the side of said other two beam paths opposite to said permeable plate.

2. An electron discharge device comprising an envelope having a tubular portion, an electron gun structure within said envelope tubular portion for producing separate electron beams along three paths not in a common plane and extending in the same general direction as the axis of said tubular portion, a magnetically permeable plate structure mounted within said tubular envelope portion and extending between one of said three electron beam paths and the other two of said beam paths, said plate structure having an end portion terminating adjacent to the inner surface of said tubular envelope portion, a magnet including two pole pieces mounted with one of said pole pieces closely spaced from said end portion of said plate structure and the other of said magnet pole pieces having one portion thereof closely spaced from and on the side of said one electron beam path opposite to said permeable plate, and another portion of said other pole piece closely spaced from and on the side of said other two beam paths which is opposite to said permeable plate.

3. An electron discharge device comprising an envelope, a plurality of electron guns within said envelope for producing separate electron beams along a plurality of paths extending in the same general direction, a magnetically permeable plate structure fixed and extending between one of said guns and the remainder of said guns, said plate structure having an end portion terminating adjacent to said envelope wall, a magnet including two pole pieces mounted externally of said envelope with one of said pole pieces closely spaced from said end portion of said plate structure and the other of said pole pieces having one portion thereof closely spaced from and on the side of said one electron gun opposite to said permeable plate and another portion of said pole piece closely spaced from and on the side of said remainder of said electron guns which is opposite to said permeable plate, whereby the direction of the flux of said magnet in said one electron gun is substantially opposite to its direction in said remainder of said electron guns.

4. An electron discharge device comprising an envelope, an electron gun structure within said envelope for producing separate electron beams along three paths not in a common plane and extending in the same general direction, a magnetically permeable plate structure mounted within said envelope and extending between one of said three electron beam paths and the other two of said beam paths, a magnet including two pole pieces mounted with one of said pole pieces closely spaced from one edge of said plate structure and the other of said pole pieces having one portion thereof closely spaced from and on the side of said one electron beam path opposite to said permeable plate and another portion closely spaced from and partially surrounding said other two beam paths on the side of said other two beam paths opposite to said permeable plate.

5. An electron discharge device comprising an envelope, an electron gun structure within said envelope for producing separate electron beams along three paths not in a common plane and extending in the same general direction, a first magnetically permeable plate structure mounted within said envelope and extending between one of said three electron beam paths and the other two of said beam paths, a second magnetically permeable plate structure mounted within said envelope on the side of said other two electron beam paths which is opposite from said first plate structure, a magnet including two

pole pieces mounted with one of said pole pieces closely spaced from one edge of said first plate structure and the other of said pole pieces having one portion thereof closely spaced from and on the side of said one electron beam path opposite to said first permeable plate structure and another portion of said other pole piece closely spaced from said second plate structure.

6. An electron discharge device comprising an envelope, three electron guns within said envelope for producing separate electron beams along paths extending in the same general direction, a first magnetically permeable plate structure fixed to one of said electron guns, said first plate structure extending between said one electron gun and the other two of said electron guns, said plate structure having an end portion terminating adjacent to said envelope wall, a second magnetically permeable plate structure joining said other two electron guns on the side of said two guns which is opposite from said first plate structure, a magnet including two pole pieces mounted externally of said envelope with one of said pole pieces closely spaced from said end portion of said first plate structure and the other of said pole pieces having one portion thereof closely spaced from and on the side of said one electron gun opposite to said first permeable plate structure and another portion of said pole piece closely spaced from said second plate structure, whereby the direction of the flux of said magnet in said one electron gun is substantially opposite to its direction in said other two electron guns.

7. An electron discharge device comprising an envelope, electron gun means within said envelope for producing three separate electron beams along paths not in a single plane symmetrically arranged about an axis, magnet means mounted adjacent to said gun structure and having a plurality of pole structures adapted to be of different polarities and through which the flux lines of the field of said magnet means may enter and leave, one of said pole structures mounted on a line from said axis and passing between two of said beam paths and another of said pole structures having portions thereof mounted adjacent to said two beam paths, one of said pole structure portions positioned on a line from said axis passing through one of said two electron beam paths and another of said pole structure portions positioned on a line passing from said axis through the other of said two electron beam paths, the polarities of said one pole structure and said another pole structure portions being different.



8. An electron discharge device comprising an envelope, three electron guns symmetrically arranged about an axis in different planes and within said envelope for producing separate electron beams along paths having a common direction, magnet means having a plurality of pole portions adapted to be of different polarities and through which flux lines of the field of said magnet means may enter and leave, one of said pole structures mounted on a line from said axis and passing between two of said electron guns, and another pole structure having portions thereof mounted adjacent to said two electron guns, one of said pole structure portions positioned on a line from said axis passing through one of said two electron guns and another of said pole structure portions positioned on a line passing from said axis through the other of said two electron guns, the polarities of said one pole structure and said another pole structure being different.

**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 2,752,520 | Morrell | June 26, 1956 |
| 2,769,110 | Obert | Oct. 30, 1956 |