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PLURAL GUN CATHODE RAY TUBE

Filed April 16, 1956

2 Sheets-Sheet 1

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2 Sheets-Sheet 2

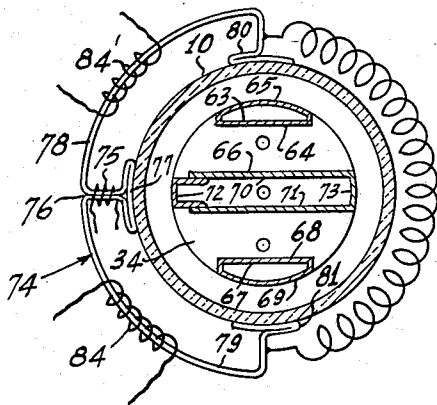


Fig. 3.

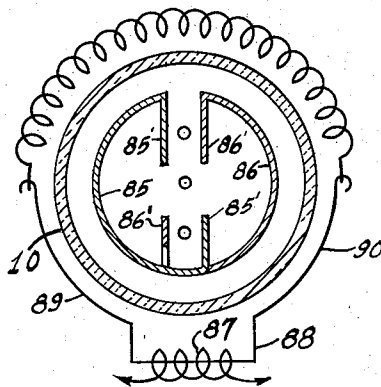


Fig. 4.

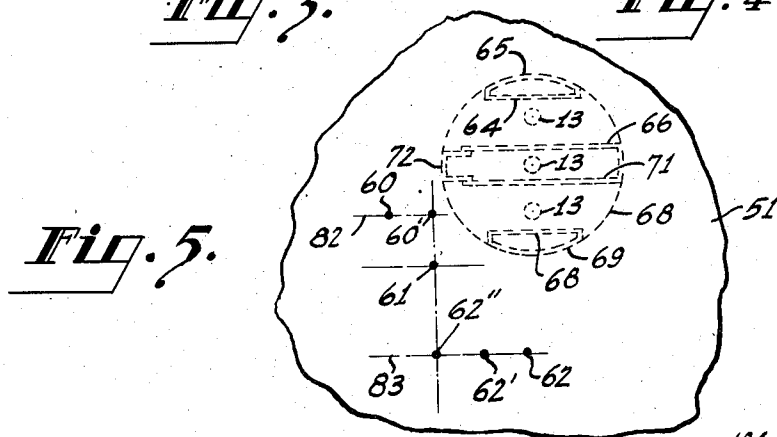


Fig. 5.

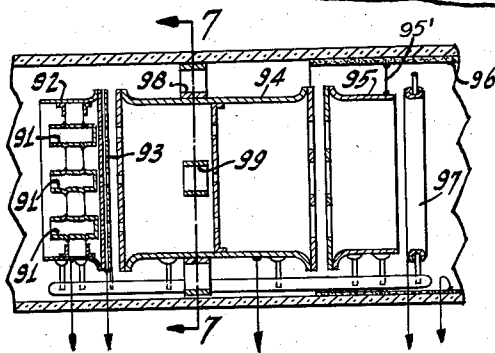


Fig. 6.

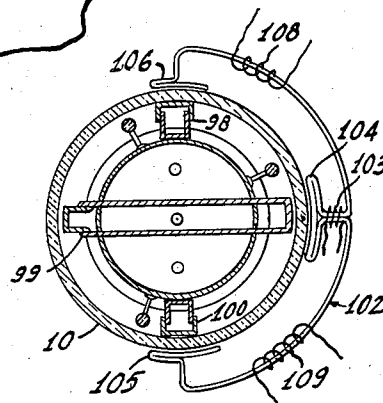


Fig. 7.

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1

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PLURAL GUN CATHODE RAY TUBE

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20 Claims. (Cl. 313—70)

This invention is directed to an electron gun structure utilized for forming a plurality of electron beams in a cathode ray tube and, particularly, in tubes utilizing plural electron beams which have a common deflection over the tube target.

Plural electron beams have been used in cathode ray tubes for various purposes. One application of plural beams is in television picture tubes for color in which each beam forms a different colored fluorescent light on the phosphor screen and where each beam is modulated by color signals corresponding to the color of the light that the beam initiates. One type of color tube utilizes a masking electrode at the phosphor screen in combination with three electron beams. The electron beams are, respectively, modulated by color video signals corresponding to red, green and blue portions of the televised picture. The mask at the screen has a large number of small apertures therethrough. The phosphor screen is formed with a large number of phosphor dots on an adjacent surface of a supporting glass plate. The phosphor dots are arranged in groups of three in alignment with each aperture of the masking electrode. The dots of each group are of different phosphor material luminescing with either red, green and blue light when struck by the high energy electrons of the beams. The three beams of the tube approach the masking electrode and the phosphor screen at a small angle to the screen. The arrangement is such that the masking electrode masks each phosphor dot from all but one of the electron beams. Also, the phosphor dots are positioned so that each beam will strike only those phosphor dots formed of the same phosphor material.

The three electron beams of the tube described are swept or scanned over the phosphor screen by common deflecting fields. To provide this scansion, a conventional yoke is used having two pairs of coils, in which one pair of coils is mounted on the tube neck and aligned in a vertical plane with one coil above the other and diametrically on opposite sides of the tube neck. These vertically mounted coils are connected together in series to a source of variable current having a saw-tooth wave shape. The field produced by this pair of coils moves the electron beam from one side of the target to the other along horizontal lines. To move the beams from one line to the other and thus provide vertical deflection, a second pair of coils is mounted with one coil on opposite sides of the tube neck on a common horizontal axis. The second pair of coils is also connected in series to a source of saw-tooth variable currents to provide movement of the three beams from the top of the screen to the bottom.

These four deflection coils are formed into a common yoke structure which is mounted concentrically on the tube neck with the horizontal and vertical coils positioned horizontally and vertically, respectively. A beam passing along the yoke axis at equal distances from the two coils of each pair will pass through a uniform deflection field. However, beams which pass through the deflection yoke off the yoke axis will pass through deflection

2

fields which are slightly different than the same fields at the center of the yoke. This produces then a distortion of the convergence spot of the three beams. That is, if the three beams are first converged at the center of the phosphor screen, upon deflection from the center of the screen, the beams are differently affected by the deflection fields so that they lose convergence. Furthermore, since the radius of the screen plate is not the same as the locus of beam convergence as the beams are deflected away the screen center, the beams reaching the screen during scansion are not in convergence at the screen. This all produces what may be called, a deflection distortion, and it has been found necessary to provide convergence correction and control of the three beams so as to maintain their convergence at all times during the scanning of the three beams over the target. In tube types using a plurality of electron beams, misconvergence of the beams at the target also is obtained due to physical misalignment of gun parts. This misconvergence should also be corrected for optimum tube operation.

It is therefore an object of this invention to provide a novel means for maintaining convergence of a plurality of beams which are scanned over a target screen by a common deflection means.

It is another object of this invention to provide a novel means for obtaining the convergence of a plurality of beams directed onto a target electrode.

It is another object of the invention to provide convergence control for correcting the convergence of a plurality of beams in which misconvergence is introduced by any factor.

The invention resides in an electron gun structure for providing a plurality of electron beams along separate paths extending in substantially the same direction. Means are provided for bringing the several beams to a common point of convergence at a target electrode. Plate structures are incorporated in the electron gun structure to aid in establishing fields transverse to the beam paths. Controllable variations of the transverse fields provide convergence correction of the several beams. Such convergence correction is necessary due to misconvergence caused by structural misalignment of the several electron gun structures as well as misconvergence due to deflection distortion as the electron beams are scanned over the target. The correcting fields may be both static and dynamic to maintain constant beam convergence during tube operation.

Figure 1 is a transverse sectional view of a cathode ray tube utilizing electron gun structures in accordance with the invention;

Figure 2 is an enlarged sectional view of the target structure of the tube of Figure 1;

Figures 3 and 4 are transverse sectional views along lines 3—3 and 4—4 of Figure 1;

Figure 5 is a diagrammatic representation of the operation of the invention of Figure 1 at the target of the tube;

Figure 6 is a longitudinal sectional view of an electron gun structure different from that shown in Figure 1 and also utilizing the invention;

Figure 7 is a transverse sectional view along lines 7—7 of Figure 6.

Figure 1 discloses a cathode ray tube utilizing a plurality of electron gun structures 13 for providing a plurality of electron beams directed toward a common target electrode. The tube consists of an evacuated envelope having a neck portion 10 and a bulb portion 12 which may be of glass or metal or a combination of the two. The electron gun structures 13 are mounted within the neck portion 12 with their respective axes 13 in a common vertical plane as shown in Figure 1. Each electron gun 13 consists of a cathode electrode 14 mounted within a tubular control grid electrode 16. Each

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

Closely spaced from each control grid 15 of each gun, there is mounted a short cup-like accelerating electrode 20 having a centrally disposed aperture in the bottom wall 21 and aligned with the aperture in the control grid wall 15. Spaced along the axis 19 of each gun from the accelerating electrode 20 is a relatively long tubular accelerating electrode 22. The several electrodes 22 are mounted within a common support cylinder 24, which is closed at its end away from the cathode 14 with a wall portion 26. Formed through the wall 26 are a plurality of beam limiting apertures 28, with one aperture 28 aligned on each of the gun axes 19.

Spaced along the axes 19 from support cylinder 24 is a focusing electrode structure consisting of tubular members 30 and 32 fixed to apertured plate portions 34, 36, 38 and 40 in the order shown. Tubular structure 30 is closed at the cathode end thereof with an apertured plate 42 having apertures 44 therethrough, with one aperture 44 aligned on each gun axis 19. In a similar manner, plates 34, 36, 38 and 40 all have apertures therethrough with a single aperture aligned with each of the axes 19 so as to provide beam paths through the electrode structures along the respective gun axes 19.

To prevent beam bending by the electron lens between electrode plates 42 and 26, these plates are curved, as shown in Figure 1, to present surfaces substantially normal to the axis 19 where these axes pass through the plates. The space within the focusing electrode between plates 42 and 40 is substantially electrostatically field free, and it is not necessary to form plates 34, 36, 38 and 40 with surfaces normal to the beam paths along axes 19.

During tube operation, appropriate voltages are applied to the several electrodes and may be of the values shown in Figure 1. The thermionic emission from each cathode 14 of the several guns is accelerated along the respective gun axis 19 and formed into an electron beam by the several gun electrodes. The electrostatic lens formed between plates 26 and 42 along each axis 19 in each beam path, focuses each beam to a fine spot at the point of convergence of axes 19 at the target 45 of the tube.

Target 45 (Figures 1 and 2) 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, with each group consisting of three dots positioned in a vertical line arrangement parallel to the common plane of gun axes 19. 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 the center dot 52 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 2. Furthermore, each phosphor dot 52 is aligned with its corresponding aperture 50 in electrode 48 along the 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 the upper and lower guns 13 at a small angle to the axis 19 of the central gun 13 which is coincident with axis 17 of the tube envelope 10. Thus, the axes 19 of the three guns will converge to a common point at the target 45. Thus, 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 the outer guns 13 make with tube axis 17 is small and is determined by the dimensions of the tube. In tubes of the type described which have been successfully operated, this angle is in the order of $1^{\circ} 10'$.

The three beams are simultaneously scanned over the surface of the masking electrode 48 in a rectangular pattern 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 scanion of the three electron beams simultaneously over the surface of the masking electrode 48. The scanning coils of yoke 56 are conventional.

Screen 51 may also consist of parallel horizontal phosphor lines, and the accuracy of beam scanion may be controlled so that each beam follows a different line during horizontal scanion. Mask 48 may be omitted in this case. Also, with parallel horizontal phosphor lines, an apertured mask as shown in Figure 2 may be used or a parallel wire mask can be utilized where the wires run parallel to the phosphor lines and each line is shielded by the mask from all but one electron beam.

As is common practice, the pair of horizontal deflecting coils are mounted vertically one above the other within yoke 56 and diametrically opposite each other on either side of the neck 10 of the tube. The vertical deflection coils are mounted in a horizontal line also on diametrically opposite sides of the neck 10 and within yoke 56. The three electron beams of the guns 13 are thus symmetrically positioned within the yoke 56 with respect to this horizontal and vertical coil arrangement. As the three beams are moved by the scanning fields over the target 45, the convergence of the three beams at the target is destroyed as they are moved radially away from the center of the screen 45. This misconception is due to the distortion provided by the deflecting fields as the beams are moved from the central portion of the field into fringe areas. Furthermore, the geometry of the several beam paths is changed as the beams are swept from the center of the screen to the edges. Although the beams may be in convergence at the center of the screen the surface of glass plate 46 and mask 48 do not conform with the locus of beam convergence as the beams are scanned over target 45. However, with the gun arrangement, shown in Figure 1, in which the beams are symmetrical with respect to the horizontal and vertical yoke windings, the deflection distortion which occurs is in a symmetrical pattern over the entire raster, providing that the yoke 56 is reasonably centered with respect to axis of symmetry of the three beams. For example, the deflection distortion as noticed around the edges of the raster on target 45 takes a pattern in which all three beam spots form substantially a straight line, but are rotated from their original vertical gun positions.

Another cause of misconvergence of the three beams at the target 45 is due to the misalignment of gun parts within each of the three guns 13, so that the electron beams formed at the several guns do not land at the theoretical center of the target nor at any point of convergence. This misconvergence is mechanical and is due to the accuracy with which the gun structure, shown in Figure 1, is assembled. However, even with the most accurately assembled guns, it has proved difficult to provide convergence of the three beams at the center of the target without correcting means.

In accordance with the invention then, there is provided means for controlling the convergence of the beams not only at the center of the target when they are not being scanned by the deflection coils of yoke 56, but also during the scansion of the three beams over the target area.

Figure 5 shows a schematic representation of a central portion of the phosphor screen 51 looking through the screen toward guns 13. The three guns 13 are shown in phantom to represent the relative position of the guns with screen 51. Due to mechanical misalignment of the guns 13 it may be assumed that the respective beams from the three beams land at spots 60, 61 and 62, for example, in which spot 61 represents the point where the beam of the center gun 13 lands on the target. It is desirable first to provide convergence of the beams at the center. To obtain this, in accordance with the invention, the two beams of the outermost guns 13 are given both a radial correction and a tangential correction in order to bring them into convergence with the beam of the center gun 13. The radial and tangential corrections are represented by displacements given to the beams of the outermost guns both in a radial and in a tangential direction about the beam of the center gun 13.

To provide tangential motion of the beams of the outermost guns, in accordance with the invention, pole pieces or plate structures 64, 66 and 68 are mounted between the electrode plates 34 and 36 of the focusing electrode. As shown in Figures 1 and 3, plate 64 constitutes a flat portion 63 and an arcuate portion 65 mounted adjacent to the glass wall 10 of the envelope neck. In like manner, plate structure 68 constitutes a flat plate portion 67 and an arcuate plate portion 69. Plate 66 constitutes two longitudinal wall portions 70 and 71 extending parallel to the flat plate portions 63 and 67, respectively. Plate structure 66 is closed at the ends by arcuate walls 72 and 73 positioned adjacent to the tubular envelope neck portion 10. Thus, the two beams of the outermost guns 13 pass between the plate structures 64 and 66 and 66 and 68, respectively, while the beam of the center gun 13 passes through the hollow enclosure of plate structure 66.

The plate structures 64, 66 and 68 are of high permeable metal so as to constitute pole pieces between which the magnetic fields are easily formed. An external magnet structure 74 is used to provide the tangential correction fields for the beams of the outermost guns 13. The external magnet consists of a magnet coil 75 wrapped around an armature portion 76 having a pole piece 77 extending arcuately around the portion of the glass neck 10 of the tube adjacent to the arcuate portion 72 of the pole plate structure 66. The other pole of armature 76 consists of two portions 78 and 79 which extend respectively in opposite directions around envelope 10 and end respectively in arcuate portions 80 and 81. End portion 80 is adjacent to the arcuate plate 65 of the pole piece 64 while the end portion 81 is positioned adjacent the arcuate plate 69 of pole piece 68.

A direct current flowing through coil 75 will provide a polarity in pole 77 opposite to the polarity in pole end pieces 80 and 81. A magnetic flux path then is established externally of armature 76, from pole portion 80 to pole piece 64 across the space between pole pieces 64 and 66 and back to the external magnet pole piece 77.

In a similar manner, the flux extends from pole portion 81 through the internal pole piece 68 across the space between the internal pole pieces 68 and 66 and back to the external pole 77. This flux provides a magnetic field then between plates 64 and 66 and 68 and 66. The magnetic fields are in opposite directions and will thus move the two beams of the outermost guns passing through these fields in opposite directions and normal to the field lines extending between the plates 64, 66 and 68. In this manner then, these correcting fields will move the beams of the outermost electron guns 13 along horizontal paths in opposite directions as viewed in Figure 5.

Thus, the beam spots 60 and 62 may be moved along the respective horizontal paths 82 and 83 to move beam 60 to a point 60' on a vertical line with spot 61 and to simultaneously move beam spot 62 an equal distance in the opposite direction to spot 62'. However, to get spot 62 in the same vertical line as spot 61 and 60' it is necessary to add a further correcting displacement to spot 62. This is provided by an additional coil winding 84 wound around the armature pole portion 79 so as to provide in the path of the beam forming spot 62 an additional tangential displacement to move the spot from 62' to 62'' on the vertical line with spot 61. The corrections described above and relative to Figure 5 are for extreme conditions of mechanical misalignment. Normally, however, a single direct current through coil 75 is sufficient to move spots 60 and 62 into substantially vertical alignment with spot 61.

To converge spots 60' and 62'' with spot 61, it is necessary to provide a radial displacement of the beams of the outermost guns. This is provided by internal pole piece structures 85 and 86 (Figure 4) which are mounted between the focusing electrode plates 38 and 40, as shown in Figure 1. Plates 85 and 86 constitute arcuate plate structures which are mounted adjacent to the wall of tubular neck portion 10. Plate 85 terminates in end portions 85' and plate 86 terminates in end portions 86' positioned parallel to end portions 85'. The end portions 85' are disposed on opposite sides of the common plane of guns 13, also end portions 86' are similarly placed. The arrangement is such, that, as shown in Figure 4, the beams of the outermost guns 13 pass through oppositely disposed pairs of end portions 85' and 86', respectively. Externally of the tube is mounted a magnet structure consisting of a coil 87 and an armature 88 extending there-through. One end 89 of armature 88 is an arcuate structure extending along the outer surface of tubular neck 10 and adjacent to the arcuate portion of internal plate structure 85. The other end 90 of armature 88 is an arcuate plate extending also around the exterior surface of tube neck 10 and adjacent to the arcuate internal plate structure 86. A direct current passed through coil 87 will establish two magnetic fields between the opposed pole pieces 85' and 86', respectively. These two fields have their directions opposite to each other and will provide displacement of the outermost beams, respectively in directions along a vertical path passing through the beam of the center gun 13. Thus, to move the spots 60' and 62'' into convergence with spot 61 an appropriate direct current passed through coil 87 will move the spots 60' and 62'' simultaneously toward each other and until they converge with the spot 61.

The structures 85 and 86 shown in Figure 4 for correcting radial displacement of the three beams constitute a single means for providing the same correction displacement for the two outermost beams. If separate control of the radial displacement of each of the outermost beams is desired, two external coil structures 87 may be utilized, in which each pair of the opposite internal pole pieces 85 and 86' are controlled by a separate coil. This type of control is set forth in the copending application of Albert M. Morrell, Serial No. 364,041, filed June 25, 1953, now Patent No. 2,752,520, granted June 26, 1956.

In the structure of Figure 3, a second coil 84' may be

formed on pole piece portion 78 and the coils 84 and 84' may be used for providing static tangential control of the outermost electron beams of guns 13. With this arrangement then, the coil 75 can be utilized with a dynamically variable current which is modulated in synchronism with the deflection fields of yoke 56, to provide constant convergence of the three beams during their scansion over the phosphor screen. It is also recognized that the static correction provided by the coils 84 and 84' may also be provided by permanent magnets mounted on the pole portions 79 and 78, respectively. Also in Figure 4 the radial convergence deflection of the two outermost beams may be provided by an adjustable permanent magnet substituted for coil 87.

Figure 6 shows a modification of an inline gun utilizing the invention. The gun structure of Figure 6 utilizes, however, a plurality of parallel cathode electrodes 91 mounted in a common control grid structure 92, common accelerating electrodes 93, 94 and 95 the last of which is conductively connected at 95' to the neck wall coating 96, and a decelerating electrode 97 which provides a converging lens between it and accelerating electrodes 95 and 96. The convergence of the three beams from cathode 91 is provided by this lens field, which may be varied by changing the relative potentials of the several electrodes forming this field. A tangential control of the beam convergence is provided by the internal pole pieces 98, 99 and 100. As shown in Figures 6 and 7, the arrangement of this pole structure is similar to that in the gun of Figure 1. A magnet structure 102 similar to that shown in Figure 3 is used externally of the tube neck 10 to provide the tangential convergence fields on the outermost electron beams. Magnet structure 102 consists of a magnet coil 103, a single pole piece 104, and a second pole piece having one portion 105 and a second portion 106 positioned oppositely to internal pole pieces 98 and 100, respectively. As shown in Figure 7, the single pole piece 104 is positioned opposite one end of the internal pole structure 99. The operation of the external magnet structure 102 and the internal pole piece structure is similar to that described above relative to the structure of Figure 3.

The beam convergence correction structures, described above, for providing both tangential and radial correction of the outermost beams of the gun structure utilize a single coil external magnet device for providing tangential correction of the outermost electron beams, as shown in the structures of Figure 3 and Figure 7. A similar single coil external magnet may also be provided to correct for radial misconvergence of the three beams, and as shown in Figure 4. The advantage of using a single coil external magnet structure arranged as described above is in the economy of control structure, since a single coil magnet device provides convergence control of a plurality of beams simultaneously without the necessity of a plurality of coils and separate armatures and controls. It is obvious, if other additional magnet structures are desired, they also can be added to the arrangements shown and described above for coils 84 and 84'.

In a similar manner, the structure of Figure 7 may utilize additional coils 108 and 109 to provide independent static tangential control of each of the outermost electron beams, while coil 103 can be utilized for the dynamic convergence control during beam scanning.

The use of three beams in a common plane as set forth in the structures above is advantageous when used with the conventional type scanning structure of vertical and horizontal deflecting coil systems. The tangential correction pole structure shown in Figures 3 and 7 provides an adequate magnetic shield of the center electron beam by the box-like pole structure 56 in Figure 3, and 99 in Figure 7. Thus, the radial fields set up between the internal pole pieces are shielded from the center electron beam.

What is claimed is:

1. An electron discharge device comprising an envelope, electron gun means within said envelope for producing separate electron beams along respective paths having the same general direction, means for forming in the path of each beam a pair of beam bending fields with the fields of each of said pair of fields having directions transverse to each other, said means including a first pair of plate structures positioned within said envelope on opposite sides of a first one of said beam paths, a second pair of plate structures within said envelope on opposite sides of a second one of said beam paths, and a separate plate structure within said envelope and extending between said first and second beam paths, and means for scanning said beams in a raster.

2. An electron discharge device comprising an envelope, electron gun means within said envelope for producing separate electron beams along respective paths, means for forming in the path of each of said electron beams a pair of beam-bending fields with the fields of each of said pair of fields having directions transverse to each other, said means including a first pair of plate structures positioned within said envelope on opposite sides of a first one of said beam paths, a second pair of plate structures within said envelope on opposite sides of a second one of said beam paths, a separate plate structure within said envelope and extending between said first and second beam paths, magnet means mounted externally of said envelope for providing said pair of transverse beam bending fields in each of said beam paths, and means for scanning said beams in a raster.

3. An electron discharge device comprising an envelope, electron gun means within said envelope for producing separate electron beams along respective spaced paths having a common direction, means for forming in the path of each of said beams a field transverse to said beam direction, said means including a magnetically permeable metal plate structure mounted within said envelope between one of said spaced beam paths and another of said beam paths and a magnet including a pair of pole structures positioned with one of said pole structures closely spaced from one end of said plate structure and the other of said pole structures closely spaced from said one of beam paths on the side of said one beam path opposite to said metal plate structure whereby the flux of said magnet may extend across said one beam path and said other beam path in opposite directions.

4. An electron discharge device comprising an envelope, electron gun means within said envelope for producing separate electron beams along respective spaced paths having the same general direction, means for forming in the path of each of said beams a field transverse to said beam direction, said means including a magnetically permeable metal plate structure mounted within said envelope between one of said spaced beam paths and another of said beam paths, a magnet including a plurality of pole structures positioned with one of said pole structures closely spaced from one end of said plate structure and another of said pole structures having one portion closely spaced from and on the side of said one beam path opposite to said metal plate structure and a second portion of said another pole structure closely spaced from and on the side of said other beam path opposite to said metal plate structure, whereby the flux of said magnet may extend across said one beam path and said other beam path in opposite directions.

5. An electron discharge device comprising an envelope, an electron gun structure within said envelope for producing three separate electron beams along respective paths 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 end of said plate structure and the other of said pole pieces having one portion thereof closely spaced from and on the side of a first one of said other two beam paths opposite to said permeable plate and another portion of said other pole piece closely spaced from and on the side of the second one of said other two beam paths opposite to said permeable plate.

6. 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 respective paths 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 pole pieces having one portion thereof closely spaced from and on the side of a first one of said other two beam paths opposite to said permeable plate and another portion of said other pole piece closely spaced from and on the side of the second one of said other two beam paths which is opposite to said permeable plate.

7. 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 respective paths extending in the same general direction as the axis of said tubular portion, a magnetically permeable tubular plate structure enclosing a portion of one of said beam paths and having plate portions extending between said one beam path and the other two of said electron beam paths, said tubular plate structure having a side wall 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 side wall portion of said plate structure and the other of said pole pieces having one portion thereof closely spaced from and on the side of a first one of said other two beam paths which is opposite to said tubular plate structure and another portion of said other pole piece closely spaced from and on the side of the second one of said other two beam paths which is opposite to said tubular plate, whereby the flux of said magnet may extend across said other two beam paths in opposite directions.

8. An electron discharge device comprising an envelope, electron gun means within said envelope for producing separate electron beams along respective spaced paths having the same general direction, a first means for forming in the path of each beam a first beam deflection field having a direction transverse to said beam path, a second means for forming in the path of each of said beams a second field transverse to said beam direction and the directions of said respective first fields, said second means including a magnetically permeable metal plate structure mounted within said envelope between one of said spaced beam paths and another of said beam paths, a magnet including a plurality of pole structures positioned with one of said pole structures closely spaced from one end of said plate structure and another of said pole structures having one portion closely spaced from and on the side of said one beam path opposite to said metal plate structure and a second portion of said another pole structure closely spaced from and on the side of said other beam path opposite to said metal plate structure, whereby the flux of said magnet may extend across said one beam path and said other beam path in opposite directions.

9. An electron discharge device comprising an envelope, electron gun means mounted within said envelope for producing separate electron beams along three respective paths extending in the same general direction as the axis of said tubular envelope portion, a first magnetic means for forming in the paths of two of said three beam paths a first beam deflection field having a direction transverse to said beam paths respectively, said first magnetic means including a magnetically permeable plate structure mounted on opposite sides of said two beam paths, a second magnetic means for forming in the path of each of said beams a second field transverse to said beam direction and the direction of said respective first field, said second magnetic means including a magnetically permeable metal plate structure mounted within said envelope between the third one of said spaced beam paths and said two of said beam paths, a magnet including a plurality of pole structures positioned with one of said pole structures closely spaced from an end portion of said metal plate structure and another of said pole structures having one portion thereof closely spaced from one of said two beam paths on the side thereof opposite to said metal plate structure and a second portion of said another pole structure closely spaced from the other of said two beam paths on the side thereof opposite to said metal plate structure, whereby the flux of said magnet may extend across said two beam paths in opposite directions.

10. An electron discharge device comprising an envelope, electron gun means mounted within said envelope for producing separate electron beams along three paths extending in the same general direction as the axis of said tubular envelope portion, a first magnetic means for forming in the paths of two of said three beam paths a first beam deflection field having a direction transverse to said beam paths respectively, said first magnetic means including a pair of magnetically permeable plate structures each having a different end portion thereof positioned adjacent to each one of said two beam paths, a magnet having two pole structures positioned with one of said pole structures adjacent to one of said pair of plate structures and the other of said pole structures adjacent to the other of said pair of plate structures, a second magnetic means for forming in said two beam paths a second magnetic field transverse to said beam direction and to the direction of said first beam deflection field, said magnetic second means including magnetically permeable plate structures mounted between said two electron beam paths and the third of said beam paths.

11. An electron discharge device comprising an envelope, electron gun means mounted within said envelope for producing separate electron beams along three respective paths extending in the same general direction as the axis of said tubular envelope portion, a magnetic means for forming in the paths of two of said three beam paths a beam deflection field having a direction transverse to said beam paths respectively, said magnetic means including a pair of magnetically permeable plate structures each having a different end portion thereof positioned adjacent to each one of said two beam paths, one of said different end portions of one of said pair of plate structures being on an opposite side of each one of said two beam paths from one of said different end portions of the other of said pair of plate structures.

12. An electron discharge device comprising an envelope, electron gun means mounted within said envelope for producing separate electron beams along three paths extending in the same general direction as the axis of said tubular envelope portion, a first magnetic means for forming in the paths of two of said three beam paths a first beam deflection field having a direction transverse to said beam paths respectively, said first magnetic means including a pair of magnetically permeable plate structures each having a different end portion thereof positioned adjacent to each one of said two beam paths, one

of said different end portions of one of said pair of plate structures being on an opposite side of each one of said two beam paths from one of said different end portions of the other of said pair of plate structures, a second magnetic means for forming in said two beam paths a second magnetic field transverse to said beam direction and to the direction of said first beam deflection field, said second means including a magnetically permeable plate structure mounted between said two electron beam paths and the third of said beam paths.

13. An electron discharge device comprising an envelope, an electron gun structure within said envelope for producing separate electron beams along respective paths symmetrically arranged about an axis, magnet means 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 on lines respectively from said axis and passing through said two beam paths, the polarities of said one pole structure and said another pole structure portions being different.

14. An electron discharge device comprising an envelope, an electron gun structure within said envelope for producing separate electron beams along respective paths symmetrically arranged about an axis, a plurality of magnets mounted adjacent to said gun structure, said magnets having a plurality of pole structures adapted to be of different polarities and through which the flux lines of the field of said magnets 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.

15. An electron discharge device comprising an envelope, a plurality of electron guns symmetrically arranged about an axis, within said envelope for producing separate electron beams along respective paths having a common direction, magnet means 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 electron guns and another of said pole structures having portions thereof mounted adjacent to said two electron guns on lines from said axis passing respectively through said two electron guns, the polarities of said one pole structure and said another pole structure portions being different.

16. An electron discharge device comprising an envelope, a plurality of electron guns symmetrically arranged about an axis within said envelope for producing separate electron beams along respective paths having a common direction, magnet means having a plurality of pole structures 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 portions being different.

17. An electron discharge device comprising means for forming at least two electron beams along respective paths having the same general direction, a single magnet means for producing a magnetic field across each beam path, said magnet means having pole structures of one polarity positioned adjacent to said beam paths and a pole structure of opposite polarity positioned between said beam paths, whereby said magnetic field across one of said two beam paths has a different direction than said magnetic field across the other of said two beam paths.

18. An electron discharge device comprising means for forming at least two electron beams along respective paths having the same general direction, a single magnet means for producing a magnetic field across each beam path, said magnet means having pole structures of one polarity positioned adjacent to said beam paths and a pole structure of the other polarity positioned between said beam paths, and a plurality of magnetically permeable elements mounted adjacent to said beam paths and having portions thereof closely spaced from said pole structures, whereby said magnetic field across one of said two beam paths has a different direction than said magnetic field across the other of said two beam paths.

19. An electron discharge device comprising means for forming at least two electron beams along respective paths having the same general direction, a single magnet means for producing a magnetic field across each beam path, said magnet means having pole structures of one polarity positioned adjacent to said beam paths and a pole structure of the other polarity positioned between said beam paths, and a plurality of pairs of magnetically permeable elements positioned with each one of said two electron beams passing between a different pair of said permeable elements, said permeable elements having portions thereof closely spaced from said magnet means pole structures, whereby said magnetic field across one of said two beam paths has a different direction than said magnetic field across the other of said two beam paths.

20. A magnet structure for use with a plural electron beam device, said magnet structure comprising an armature having a first pole piece for positioning substantially between two of said plural beams and a second pole piece including two portions adapted to be positioned respectively adjacent to said two beams, and a magnet positioned between said first and second pole pieces for providing said first pole piece with one polarity and said second pole piece portions with the other polarity whereby a magnetic field will extend in different directions across said two beam paths.

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