

Dec. 5, 1967

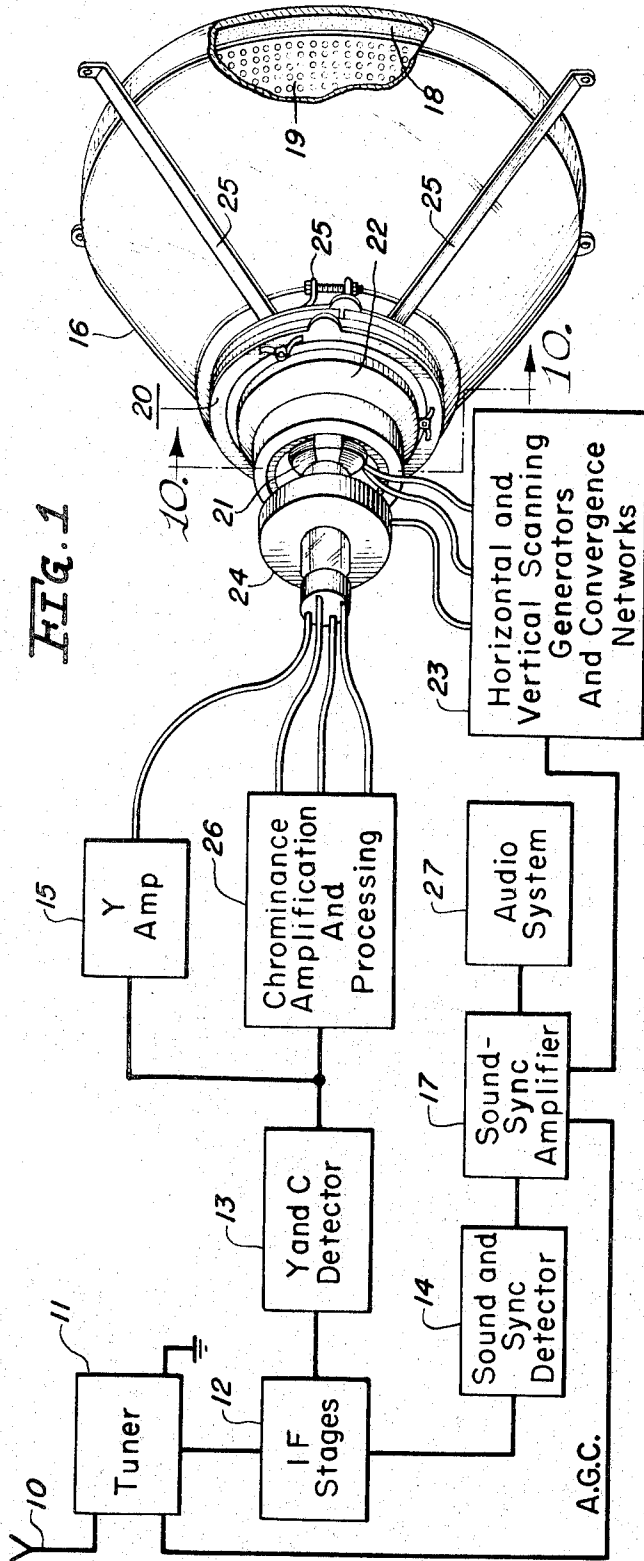
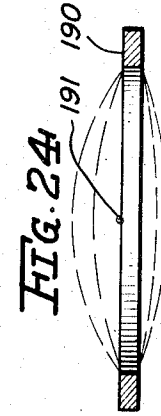
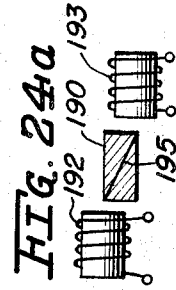
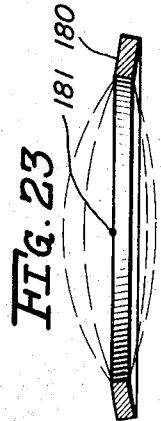
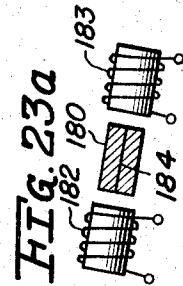
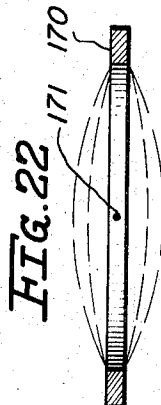
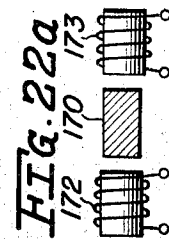
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3,356,879

BEAM POSITIONING DEVICE FOR VARYING THE EFFECTIVE ORIGIN
OF CATHODE-RAY TUBE ELECTRON BEAM

Filed Aug. 14, 1963

6 Sheets-Sheet 1



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6 Sheets-Sheet 2

FIG. 2a

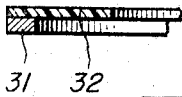


FIG. 2

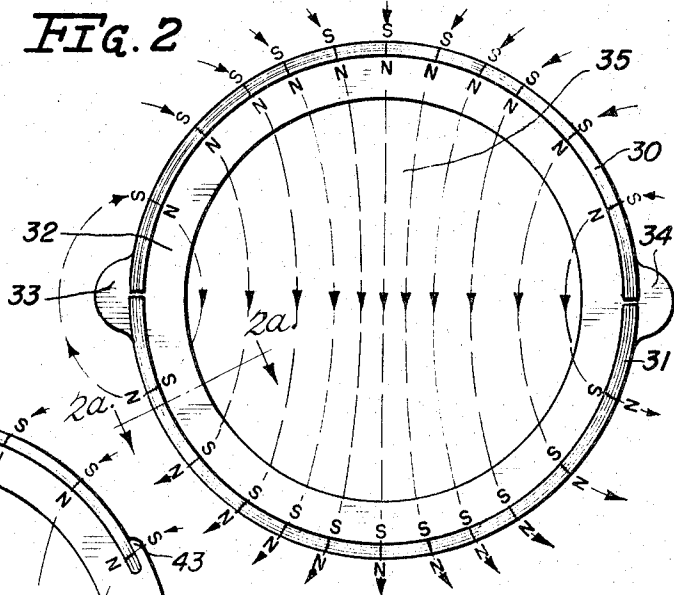


FIG. 3a



FIG. 3

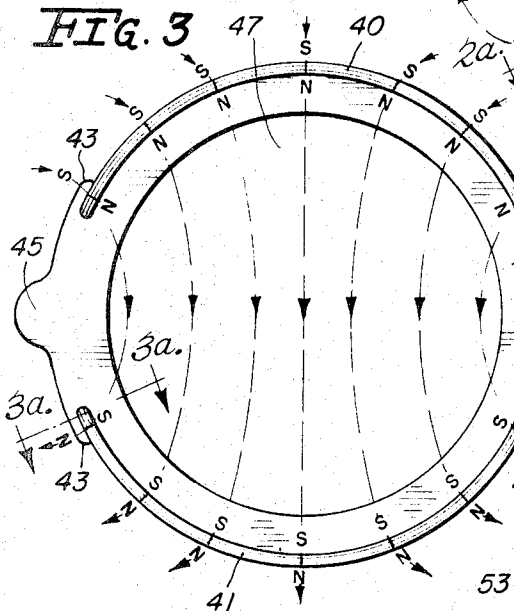


FIG. 4

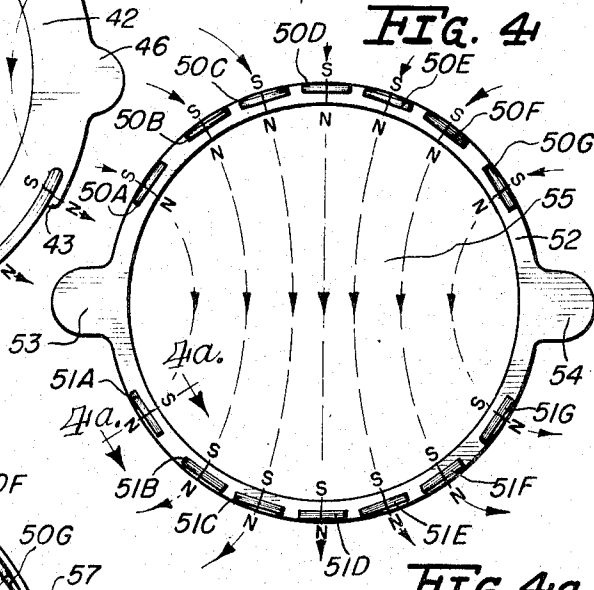


FIG. 5

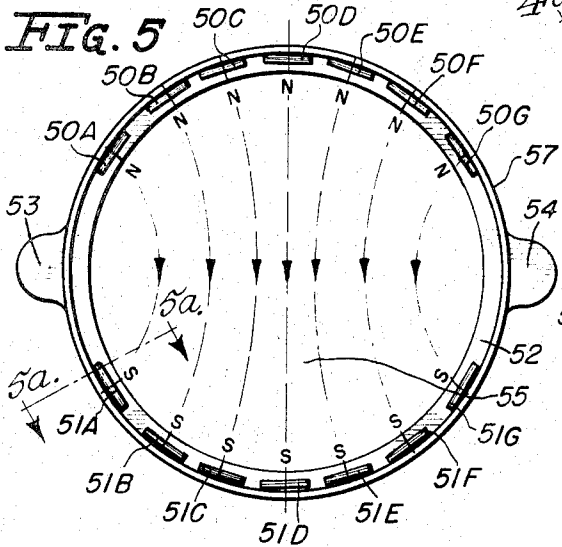


FIG. 5a

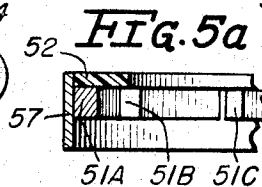
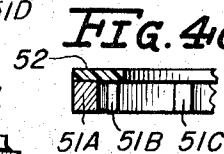


FIG. 4a



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FIG. 6a

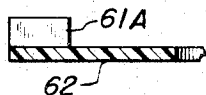


FIG. 6

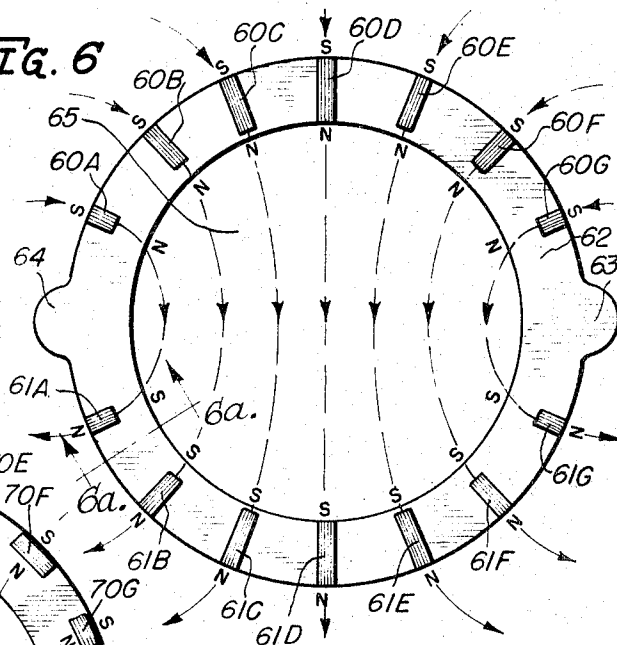


FIG. 8a

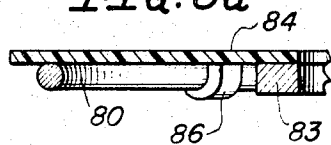


FIG. 7

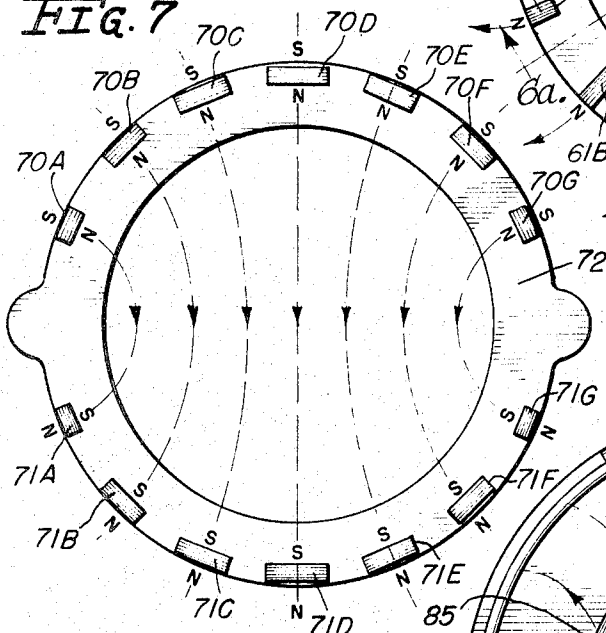


FIG. 8

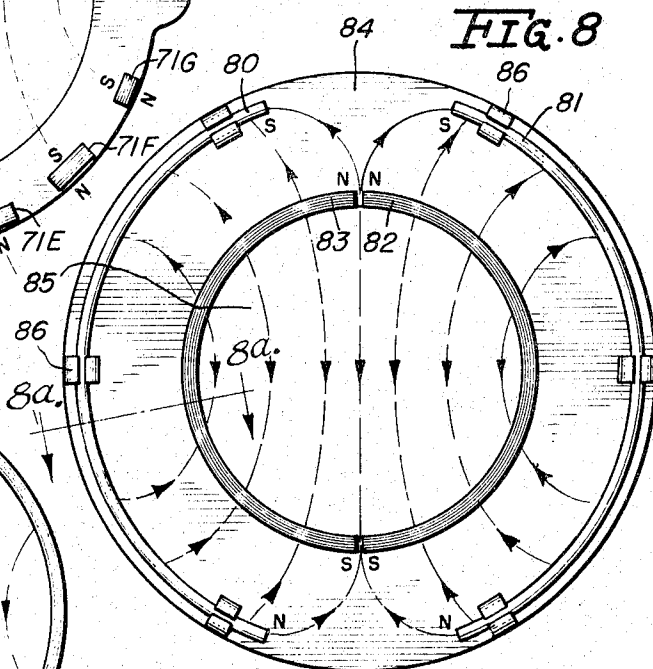
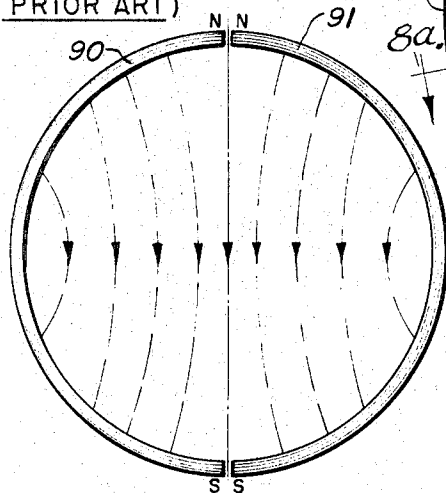


FIG. 9
(PRIOR ART)



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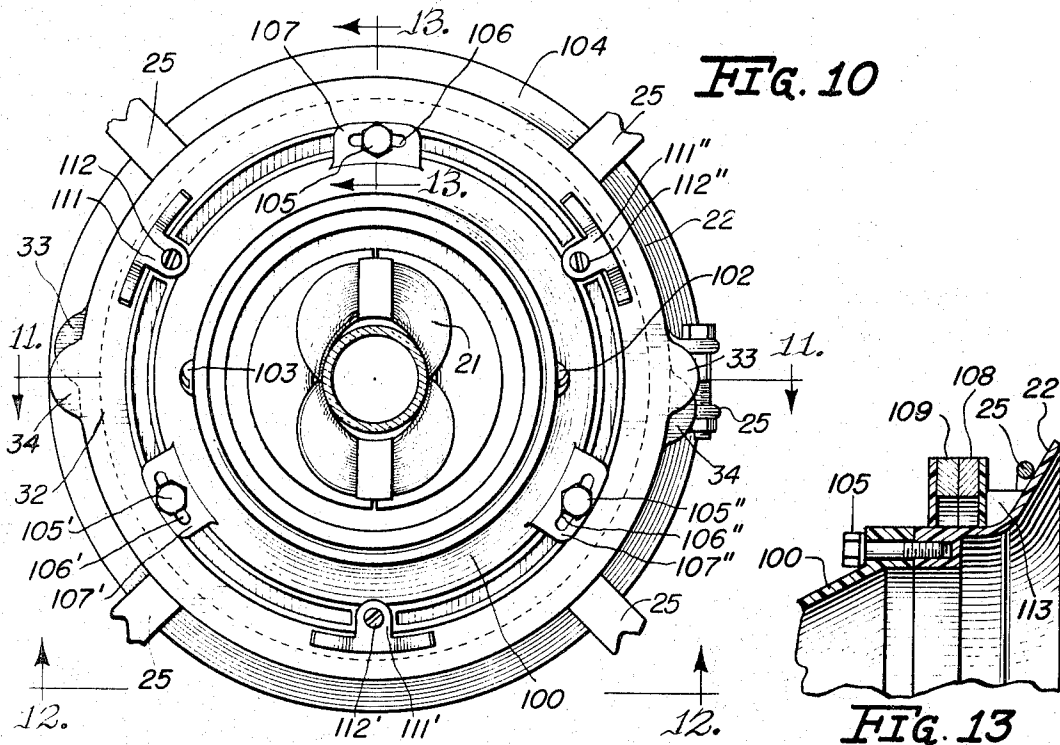
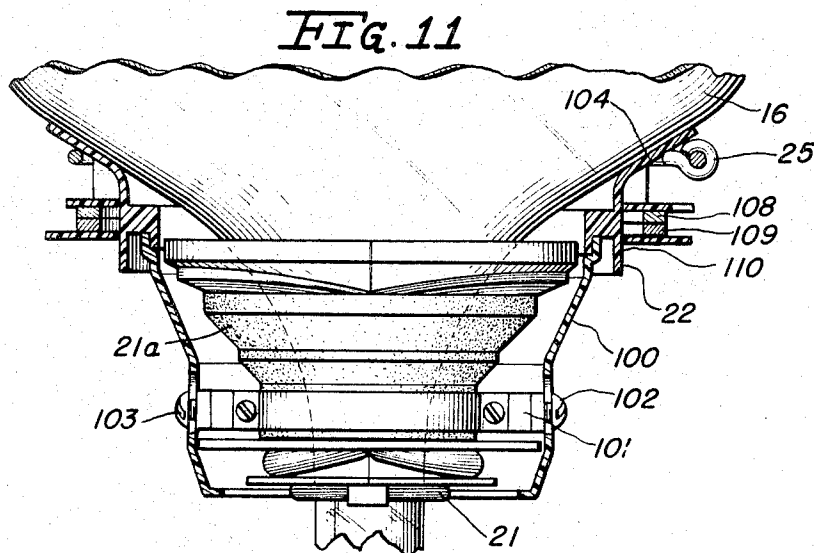
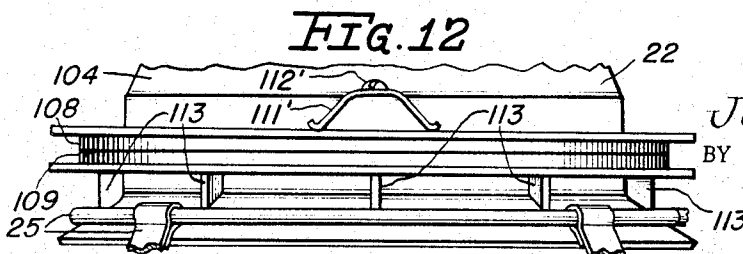
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6 Sheets-Sheet 4



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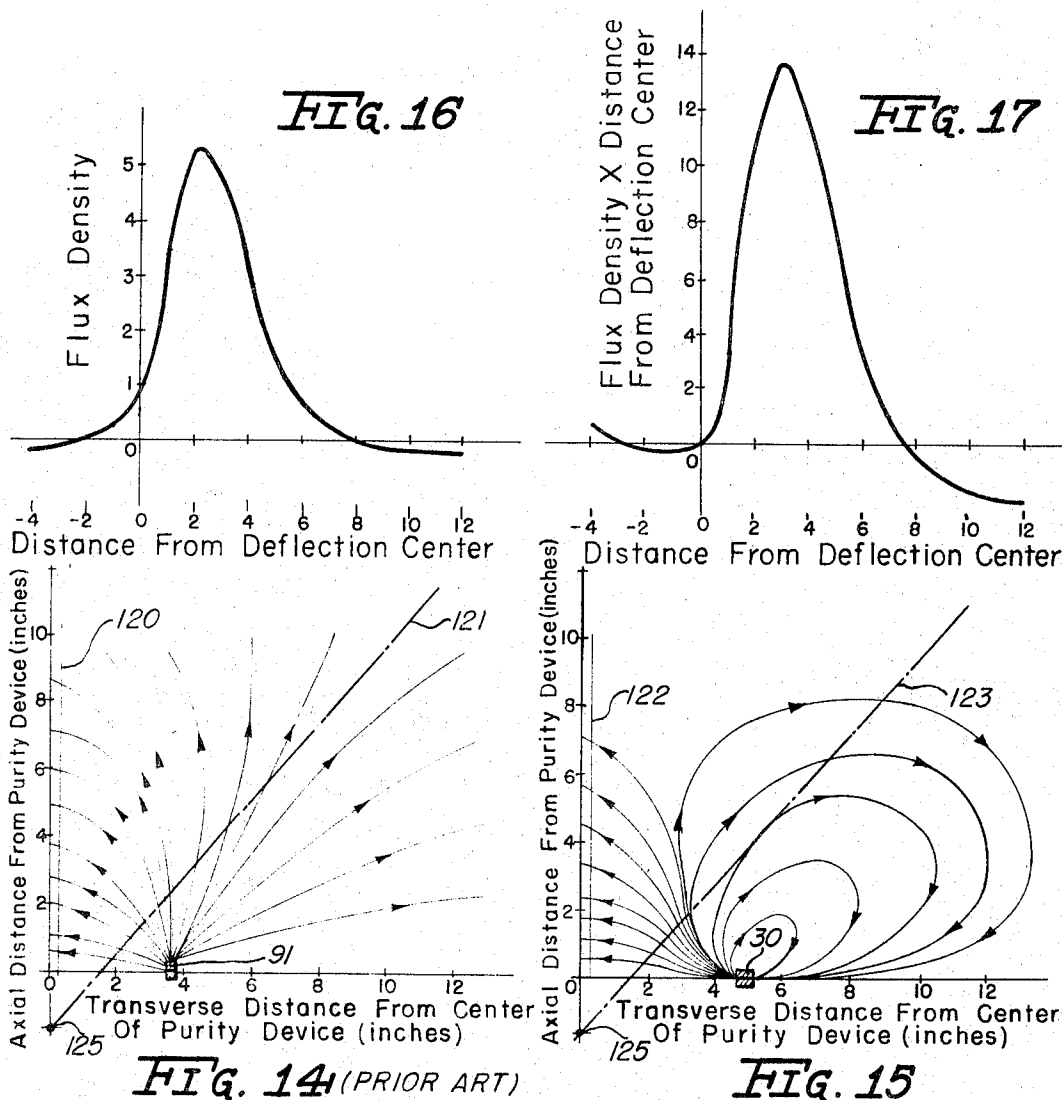
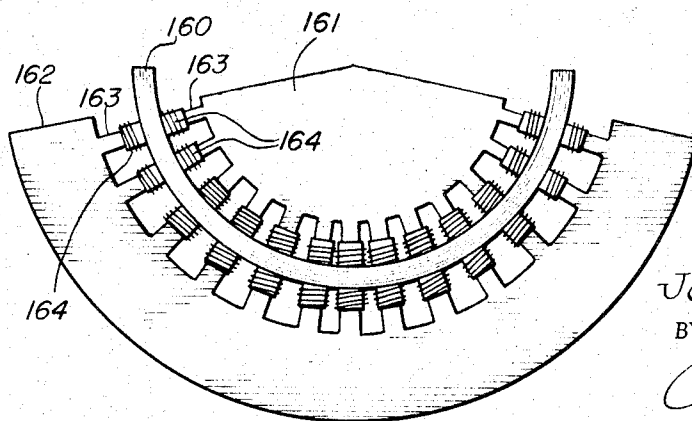
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6 Sheets-Sheet 5



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BEAM POSITIONING DEVICE FOR VARYING THE EFFECTIVE ORIGIN
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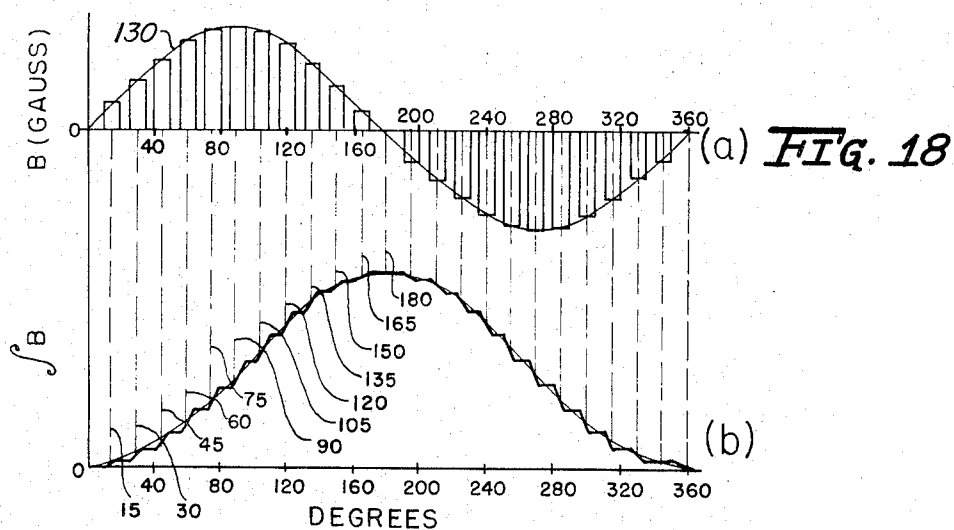


FIG. 19

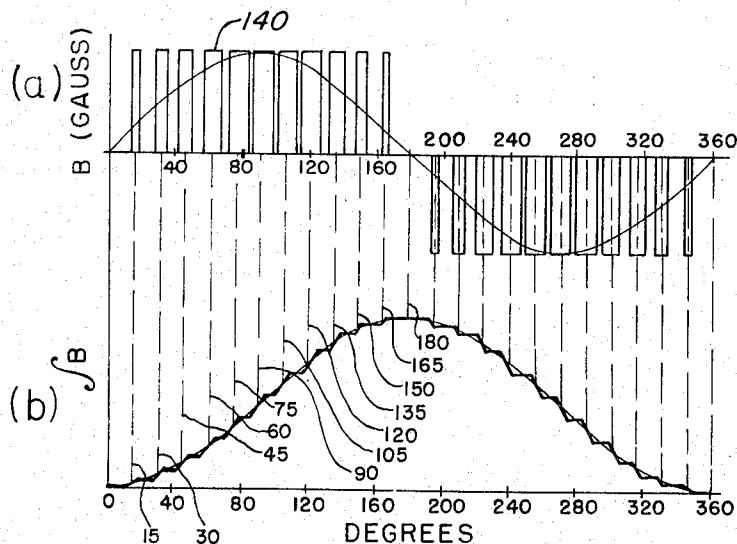
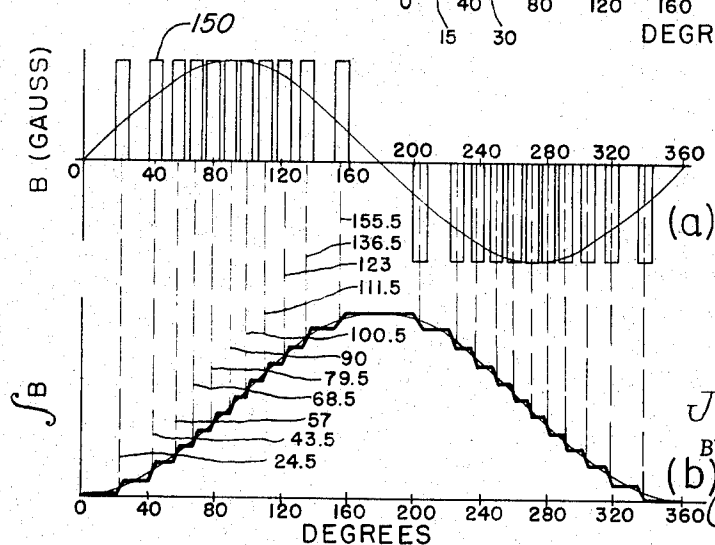


FIG. 20

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BEAM POSITIONING DEVICE FOR VARYING THE EFFECTIVE ORIGIN OF CATHODE-RAY TUBE ELECTRON BEAM

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Filed Aug. 14, 1963, Ser. No. 302,017

11 Claims. (Cl. 313-76)

This invention generally relates to cathode-ray tube beam controlling devices and particularly, although not exclusively, to beam positioning devices for use with a multi-beam color cathode-ray tube of the type employed in color television receivers and the like.

In a conventional color cathode-ray tube, the screen is formed of a plurality of groups or triads of phosphor dots symmetrically spaced or interspersed about the screen. Each triad comprises three phosphor dots which individually produce one of the primary colors red, blue and green when excited by an electron beam. Customarily, three electron beams, one for each of the three primary colors, are produced by individual electron guns. An apertured barrier is placed adjacent to the screen and the beams are caused to approach the barrier or aperture mask at different angles so that each beam, as it scans the screen area, excites only those dots of a selected primary color.

When manufacturing the cathode-ray tube, the screen is constructed separately from the electron gun assembly. Only in the final assembly of the color tube is the electron gun assembly positioned within the tube envelope in predetermined spatial relation to the screen. To insure that the gun is properly positioned with respect to the screen so that the electron beams impinge upon only their associated phosphor dots, the guns must be indexed within the tube neck with extreme accuracy during assembly of the tube or, alternatively, the tube must be provided with an auxiliary adjustment device so that the effective points of origin of the beams may be varied. Due to the extremely critical manufacturing tolerances which must be maintained, it has been found impractical to provide mechanical adjustments within the tube for accurately positioning the electron guns after completion of the tube assembly. Consequently auxiliary externally mounted magnetic devices, conventionally known as purity devices, are employed to provide a static adjustment of the effective points of origin of the electron beams by subjecting them to a uniform static deflection field to compensate for minor mechanical misalignment between the gun assembly and the aperture mask, so that each beam only has access to the phosphor dots of its associated primary color.

Conventionally, these purity devices are positioned on the tube neck adjacent the electron gun assembly. With the purity device in this position, the beams pass through the same region of the magnetic field produced by the purity device regardless of which area of the screen they may be subsequently directed to by the deflection yoke, and the attainment of uniform purity compensation throughout the scanning raster is therefore not difficult. With cathode-ray tubes having wider deflection angles and shorter, smaller diameter tube necks, however, there is insufficient room on the neck for a purity device in addition to the required deflection and convergence yokes. It has also been found that purity adjustment by a device located on the neck sometimes causes the beams to strike the flared portion of the neck after deflection by the yoke, resulting in neck-shadow or cutting off of a marginal portion of the reproduced image when large amounts of purity correction are required. Moreover, a purity de-

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vice on the neck of the tube must be located close to the convergence pole pieces, and stray magnetic fields from the purity device often cause undesirable interaction with the convergence adjustment, making the alignment procedure unduly difficult. Consequently, attempts have been made to devise purity devices for positioning between the deflection yoke and the tube screen. With a post-deflection purity device, however, the three beams are subjected to the magnetic scanning deflection field prior to correction by the static purity deflection field and pass through different regions of the purity field at different scanning angles depending upon which area of the screen they have been directed to by the scanning deflection field. Accordingly, it is not possible to provide the necessary purity adjustment with simple magnetic devices of the type used in the neck-mounted constructions, and the lack of a satisfactory post-deflection purity device has been a major deterrent to the commercial introduction of short-necked, wide deflection angle round or rectangular color television picture tubes.

It is, therefore, a primary object of this invention to provide a new and improved electron beam positioning device for a cathode-ray tube.

It is also an object of this invention to provide a new and improved purity device for use with a multi-beam color picture tube of the type employed in color television receivers and the like.

It is another object of this invention to provide a post-deflection purity device which provides a color purity correction at least comparably effective as that achieved with neck-mounted devices.

It is a still further object of this invention to provide such a post-deflection purity device which is simple to construct and easy to adjust.

In accordance with the invention, a beam positioning device for varying the effective point of origin of an electron beam of a cathode-ray tube which is deflected from a predetermined center of deflection across the viewing screen of the tube comprises a support member at least partially encompassing the axis of symmetry of the tube at a location intermediate the center of deflection and the screen. The beam positioning device further comprises means on the support member for developing an auxiliary deflection field of predetermined configuration within the tube between the center of deflection and the screen, with the integral of the curve of the field strength component transverse to the beam path in a predetermined sense times its distance from the deflection center as a function of the distance from the deflection center being substantially the same along all beam paths.

As another feature of the invention, the beam positioning device comprises a support member at least partially encompassing the axis of symmetry of the tube at a location intermediate the center of deflection and the screen, and permanent magnet means on the support member for establishing trajectories for the beam with points of inflection farther from the center of deflection for smaller scanning angles than for larger scanning angles of the beam.

As still another feature of the invention, a beam positioning device for varying the effective point of origin of an electron beam of a cathode-ray tube comprises ring magnet means having a central opening and a plurality of magnetic pole pairs circumferentially spaced about the opening and oriented to establish a predetermined flux pattern including flux components from one pole of any selected pole pair to the opposite pole of the selected pole pair as well as other flux components from the one pole across the central opening to the opposite pole of another pole pair.

The features of this invention which are belived to be novel are set forth with particularity in the appended claims. The invention, together with further objects and advantages thereof, may best be understood, however, by reference to the following description taken in conjunction with the accompanying drawings, in the several figures of which like reference numerals identify like elements, and in which:

FIGURE 1 is a combined block diagram and perspective view of a color television receiver embodying a preferred form of the invention;

FIGURE 2 is an elevational view of one of the purity rings used in the receiver of FIGURE 1 and constructed in accordance with the present invention, with a schematic representation of the magnetic field pattern in the plane of the ring;

FIGURE 2a is a cross-sectional view taken along line 2a-2a of FIGURE 2;

FIGURE 3 is an elevational view, similar to that of FIGURE 2, of an alternative purity ring construction embodying the invention;

FIGURE 3a is a cross-sectional view taken along line 3a-3a of FIGURE 3;

FIGURE 5 is an elevational view, similar to that of FIGURE 2, of another alternative purity ring construction embodying the invention;

FIGURE 4a is a cross-sectional view taken along line 4a-4a of FIGURE 4;

FIGURE 5 is an elevational view, similar to that of FIGURE 2, of another alternative purity ring construction embodying the invention;

FIGURE 5a is a cross-sectional view taken along line 5a-5a of FIGURE 5;

FIGURE 6 is an elevational view, similar to that of FIGURE 2, of still another purity ring construction embodying the invention;

FIGURE 6a is a cross-sectional view taken along line 6a-6a of FIGURE 6;

FIGURE 7 is an elevational view, similar to that of FIGURE 2, of another purity ring construction embodying the invention;

FIGURE 8 is an elevational view, similar to that of FIGURE 2, of still another purity ring construction embodying the invention;

FIGURE 8a is a cross-sectional view taken along line 8a-8a of FIGURE 8;

FIGURE 9 is an elevational view, similar to that of FIGURE 2, of an unsuccessful purity ring construction attempted by the prior art, and is included for comparison purposes to facilitate a better understanding of the present invention;

FIGURE 10 is a partial cross-sectional view taken along line 10-10 of FIGURE 1;

FIGURE 11 is a fragmentary cross-sectional view taken along line 11-11 of FIGURE 10;

FIGURE 12 is a fragmentary side view taken along line 12-12 of FIGURE 10;

FIGURE 13 is a fragmentary cross-sectional view taken along line 13-13 of FIGURE 10;

FIGURE 14 is a graphical representation of a flux pattern illustrative of a portion of the flux field produced by the prior art device of FIGURE 9;

FIGURE 15 is a graphical representation of a flux pattern illustrative of a similar portion of the flux field produced by the embodiment of FIGURE 2;

FIGURES 16 and 17 are graphical illustrations of certain characteristics of the magnetic flux fields produced by the embodiment of FIGURE 2;

FIGURES 18-20 are graphical illustrations depicting the manner in which the devices of FIGURES 2-8 may be constructed to develop a desired flux pattern;

FIGURE 21 is a plan view of apparatus which may be employed in manufacturing the embodiment shown in FIGURE 2;

FIGURE 22 is a simplified cross-sectional view of the

purity ring magnet of FIGURE 2 with a schematic representation of its associated magnetic field;

FIGURE 22a is a schematic representation, partly in cross-section, of apparatus useful in manufacturing the device of FIGURE 22;

FIGURE 23 is a simplified cross-sectional view, similar to that of FIGURE 22, of a modified purity ring embodying another feature of the invention;

FIGURE 23a is a schematic representation, similar to that of FIGURE 22a, of apparatus useful in manufacturing the device of FIGURE 23;

FIGURE 24 is a simplified cross-sectional view, similar to those of FIGURES 22 and 23, of a preferred embodiment of the invention; and

FIGURE 24a is a schematic representation, similar to those of FIGURES 22a and 23a, of apparatus which may be used in manufacturing the device of FIGURE 24.

In the color television receiver shown in FIGURE 1, composite color television signals received by an antenna 10 are applied to the input circuit of a tuner 11. Tuner 11 comprises one or more stages of radio-frequency amplification and a converter or first detector. Intermediate-frequency composite color television signals developed by tuner 11 are applied to an intermediate-frequency (IF) amplifier 12 of any desired number of stages. The amplified intermediate-frequency signal from IF amplifier 12 is concurrently applied to a pair of detectors 13 and 14, one for deriving a sound signal component and the other for deriving the brightness (Y) and chrominance (C) signal components. The sound detector of 14 is preferably used to derive scanning synchronization (sync) information as is conventional; however, it is known that either detector may be utilized to obtain the required scanning synchronization information.

The detected brightness signal, commonly designated as a Y signal, is applied from detector 13 to a Y amplifier 15 of any desired number of stages. The amplified brightness signal is impressed upon the cathode of each of the three electron guns of a conventional three-beam tricolor cathode-ray tube 16 including a tricolor mosaic phosphor screen 18 and an associated metallic aperture mask 19. Tube 16 may take the form of either a round, as illustrated, or rectangular cathode-ray tube.

The sound and sync signals from sound detector 14 are amplified in a sound-sync amplifier 17 of one or more stages which includes a synchronizing-signal separator. The amplified and separated sync signal is then applied to the horizontal and vertical scanning generators and convergence networks schematically indicated as a unit 23. Horizontal and vertical scanning generator and convergence circuits 23 include a line frequency oscillator and its associated phase detector and frequency control stages to provide automatic control of the horizontal scanning oscillator frequency. It further includes a field scanning generator with one or more stages of amplification. These generators are coupled to representative line-frequency and field-frequency magnetic deflection elements of a conventional scanning yoke 21 which encompasses the neck of cathode-ray tube 16. Also included in horizontal and vertical generators and convergence networks 23 are circuits which develop appropriate horizontal and vertical convergence signals which are applied to convergence yoke 24 also mounted on the neck of tricolor tube 16.

In accordance with the invention, a post-deflection purity device 20 is positioned on a support member 22 between deflection yoke 21 and screen 18. As will be discussed in detail subsequently, the purity device 20 is located adjacent the deflection yoke 21 in order that the static purity field produced by device 20 influence the landing positions of the beams immediately after they have left the deflection field. The support member 22 is appropriately retained about the axis of symmetry of the tube by a strap and ring assembly 25 which is anchored

to the cabinet escutcheon or other supporting member (not shown).

An automatic gain potential is also developed in the synchronizing-signal separator of the sound-sync amplifier 17 for application to tuner 11 and/or IF amplifier 12 as is well understood in the art. Intercarrier sound signals derived from the output circuits of sound-sync amplifier 17 are applied to an audio system 27 which comprises a limiter, a discriminator, an audio amplifier of any desired number of stages, and a loudspeaker or other sound-reproducing device.

Detected video signals from Y-C detector 13 are applied to suitable chrominance amplification and processing circuits 26. As is typical, these circuits include one or more stages of chrominance amplification, a color burst amplifier and separator, a color reference oscillator with an associated automatic frequency control circuit, a color killer, and a pair of synchronous demodulators for developing three color difference signals R-Y, G-Y and B-Y corresponding to the chrominance information associated with the three primary colors red, green and blue. The color signals developed by circuits 26 are applied respectively to the control grids of the three electron guns of tube 16. If desired, chrominance amplification and processing circuits 26 may also comprise appropriate chrominance control circuits and, of course, appropriate controls for adjusting hue and saturation of the reproduced image.

With the exception of the purity device 20 and its associated support member 22, the color television receiver may be of any conventional construction. The operation of such a receiver is well understood in the art and will not be discussed here.

The purity device 20 of FIGURE 1 is composed of two closely juxtaposed and individually rotatable magnetic rings, of which one is shown in FIGURES 2 and 2a. The semi-circular complementary ferromagnetic bars 30 and 31, preferably of ferrite, are mounted as by gluing or press-fitting in appropriately located recesses (not shown), adjacent the circumference of a plastic magnet retaining disc 32 of circular configuration having a large central opening 35. Ring retaining member 32 is provided with two diametrically opposed tabs 33, 34 which may be used to rotate the ring about the support member 22 of FIGURE 1. The ferromagnetic ring segments 30, 31 are each permanently magnetized with a plurality of radially oriented magnetic pole pairs to produce a magnetic flux field across the central opening 35 of magnet retaining member 32, and the upper ring segment 30 is polarized oppositely from lower ring segment 31 so that the north poles of upper segment 30 face the south poles of lower segment 31 across central opening 35. Magnetic flux passes from the north pole of each pole pair on upper segment 30 across opening 35 to the south pole of the corresponding pole pair on lower segment 31, as schematically illustrated in FIGURE 2. The magnetic field thus produced in the plane of the ring is essentially linear across the diameter of the ring between the centrally located pole pairs on ferromagnetic ring segments 30, 31 and becomes progressively more curved as the lateral displacement from the central axis of symmetry increases. In the embodiment illustrated in FIGURE 2, each ring segment 30, 31 is provided with eleven pole pairs, although a greater or lesser number may be provided if desired. The magnetic pole pairs are of substantially equal saturation or strength and equal width, but the circumferential spacing between adjacent pole pairs varies about the ferromagnetic ring sections 30, 31 in accordance with a predetermined non-linear function as will be explained subsequently.

In the embodiment of FIGURES 3 and 3a, two resilient ferromagnetic bars 40, 41 which are constructed of powdered ferrite bound with natural latex or similar material are curved about and captivated by a magnet retaining ring 42 constructed of plastic or other non-magnetic

material and provided with finger portions 43 which retain the bars 40, 41 in place. A central opening 47 is provided in the ring. Also provided on the magnet retaining ring 42 are a pair of tab portions 45, 46 which facilitate rotation of the ring assembly about the support member 22 of FIGURE 1. The bars 40, 41 each have a plurality of radially oriented magnetic pole pairs equally spaced along the bar, and opposite poles of correspondingly located pole pairs face each other across central opening 47. The magnetic pole pairs are of substantially equal width but of different strengths or saturations, with the strongest located at the center of each bar. The strengths of the pole pairs differ in accordance with a predetermined non-linear function of their displacement from the central axis of symmetry, as will be described, with each pole pair slightly weaker than the adjacent pole pair toward the center. The weakest pole pairs are at the end of the bars. In this embodiment, each ring segment 40, 41 is illustrated as being provided with seven pole pairs, although more or less may be employed, and the flux pattern created in the plane of the ring across central opening 47 has a configuration generally similar to that of the purity ring of FIGURE 2. With the purity ring assembly of FIGURE 3, the resilient ferromagnetic bars 40, 41 may be magnetized when they are straight and then curved about and captivated by the retaining ring 42 prior to mounting on support member 22.

In the embodiment of FIGURES 4 and 4a, a plurality of individual magnet bars 50A-G, 51A-G, of permanently magnetized ferrite or the like, are glued or press-fitted to a magnet retaining ring 52 of non-magnetic material. The bars 50A-G are positioned about the upper segment of ring 52 while bars 51A-G are correspondingly positioned about the lower segment. The ring 52 is provided with a central opening 55 and also with tab members 53, 54 which facilitate rotation of ring 52 about support member 22 when the ring is mounted thereon. The bar magnets 50A-G, 51A-G, are longitudinally disposed about the circumference of the ring and are magnetized transversely so that their magnetic axes are radially oriented, with opposite poles of correspondingly located pole pairs facing each other across opening 55. The individual magnets 50, 51 are dimensionally identical and of equal magnetic strength or saturation, but the spacing between adjacent magnets differs in accordance with a predetermined non-linear function of circumferential location, as will be described in detail. The field configuration across the central opening 55 in the plane of the ring is generally similar to those provided with the rings of FIGURES 2 and 3.

The embodiment of FIGURES 5 and 5a is similar to the ring of FIGURE 4 with the exception that an unmagnetized band 57 of soft iron or other ferromagnetic material is positioned about the circumference of the ring and circumscribes the magnet bars 50, 51 to provide a magnetic return path for reducing the amount of stray flux in the areas external to the ring.

The purity ring of FIGURES 6 and 6a includes individual ferrite bar magnets 60A-G, 61A-G glued or otherwise affixed to a retaining ring 62 constructed of non-magnetic material and having a large central opening 65. The ring 62 has tab portions 63, 64 to facilitate rotation of the retaining ring 62 about the support member 22. The bar magnets 60A-G, 61A-G are equally spaced about the respective upper and lower portions of the circumference of retaining ring 62. The magnets are of equal width and are positioned so that the longitudinal axis of each magnet is radially oriented, with opposite poles of correspondingly located pole pairs facing each other across opening 65 as in the preceding embodiments. In constructing this embodiment, the ferrite bars of which magnets 60A-G, 61A-G are constructed are fabricated with different length dimensions, in accordance with a predetermined non-linear function of their ultimate positions on the retaining ring 62, but are premagnetized with

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equal polarizing fields so that, as mounted, they are of different magnetic strengths with the strongest magnets 60D, 61D diametrically opposed at the centers and the weakest magnets located at the end of the upper and lower portions of retaining ring 62. The resultant flux pattern produced across central opening 65 by the device of FIGURE 6 is generally similar to those flux patterns produced by the previously described rings.

The embodiment of FIGURE 7 is similar to that of FIGURE 4 except that the desired flux pattern to be discussed subsequently, is obtained by the use of premagnetized ferrite bars 70A-G, 71A-G of different lengths, providing radially oriented pole pairs of different widths, equally spaced along the circumference of retaining ring 72.

The embodiment of FIGURES 8 and 8a comprises four ferromagnetic ring sections 80, 81, 82, 83 secured to a magnet retaining ring 84 constructed of non-magnetic material and provided with a central opening 85. The ring sections 80 and 81 are positioned near the outer circumference of ring retaining member 84 while ring sections 82, 83 are positioned on member 84 at the inner circumference of retaining ring 82 adjacent central opening 85. Each of the ring sections 80-83 is premagnetized so that its respective ends are of opposite magnetic polarity. Magnets 80-83 may be formed of preshaped ferrite material or of a resilient ferrite-containing composition such as that employed in the embodiment of FIGURE 3 which is curved after polarization and captivated by retaining clamps 86. The inner and outer magnet rings are of unequal strength and, preferably, the inner magnets 82, 83 are stronger. The ring sections are positioned with the north poles of the outer ring sections 80 and 81 at the bottom of retaining member 84 and the north poles of inner ring sections 82 and 83 at the top; in other words, the magnetic axes of the outer ring sections are oppositely oriented from those of the inner sections. The flux produced by ring sections 80-83 passes across the central opening 85 of ring 84 in a pattern similar to that developed by the previously described purity rings. The provision of radially spaced circumferentially polarized ring sections in this manner produces the effect of an infinite plurality of circumferentially spaced radially oriented pole pairs each having one pole on an inner ring section and an opposite pole on an adjacent outer ring section. With the illustrated construction these equivalent pole pairs are not exactly radially oriented, but it has been found that a slight departure from radial orientation of the pole pairs does not cause any substantial adverse effect upon the resulting flux pattern nor any degradation in the adequacy of purity correction which may be achieved.

As previously discussed in conjunction with FIGURE 1, the purity device 20 comprises two closely juxtaposed and individually rotationally adjustable purity rings which may take the form of any of the devices described in FIGURES 2-8. The support member 22 for supporting the purity rings which make up device 20 is shown in FIGURES 10-13. Rings of the type shown in FIGURE 2, for example, are mounted on the supporting member 22 about the electromagnetic deflection yoke 21. The support member is constructed of any suitable plastic material or the like and includes provision for retaining the purity rings at a location close to the deflection yoke 21 on the side thereof closer to the phosphor screen 18. Support member 22 is constructed of two pieces, one of which is generally bell-shaped while the other is substantially ring-like and abuts the cone portion of tube 16. The bell-shaped portion 100 encompasses the deflection yoke 21 and its associated yoke core 21a and is provided with an internal circular mounting strap 101 which is suitably affixed to the bell housing 100 by screws 102 and 103. The strap 101 is clamped on the core 21a and positions and secures yoke 21 in position about the neck of tube 16. The bell-shaped housing 100 is affixed to the ring collar 104 by three screws 105-105'' which pass through corre-

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sponding slots 106-106'' in three tab portions 107-107'' of the bell portion 100. These screws firmly hold the bell portion 100 and yoke 21 to the ring member 104 while the slots 106-106'' provide a degree of rotational adjustability to member 100 and, consequently, yoke 21. As previously explained, housing 100 is suitably supported about the tube by strap and ring assembly 25.

The purity rings 108 and 109, each of which may be constructed in the manner shown and described in connection with any of the embodiments of FIGURES 2-8, are positioned on a collar 110 of ring portion 104 and retained by three spring members 111-111'' which are symmetrically disposed about the support member 22. Screws 112-112'' firmly hold the springs 111-111'' to the ring collar 104 of support member 22. These springs urge the purity rings 108 and 109 toward a plurality of stop abutments 113 which are spaced about the ring collar 104 of support member 22. With this arrangement, the rings 108 and 109 are captivated between springs 111-111'' and stop abutments 113, and each may be independently rotated about the collar 110 to any desired position on the support member with respect to the neck of tube 16.

To facilitate an explanation of the manner in which the post-deflection purity devices of the present invention effect the required purity correction, it may be helpful to consider the operational shortcomings of a prior art construction, shown in FIGURE 9, which has been employed in unsuccessful attempts to achieve post-deflection purity compensation. The device of FIGURE 9, which in effect constitutes an enlarged version of a conventional neck-mounted purity device adapted for post-deflection mounting, comprises a pair of semi-circular longitudinally polarized ferrite ring sections 90 and 91, supported with their like magnetic poles in close juxtaposition. As may be seen from an inspection of FIGURE 9, the flux pattern in the plane of the ring with such a construction corresponds substantially to that produced by the purity devices of the present invention. However, because the purity device is positioned beyond the center of deflection, so that the electron beams enter the purity deflection field at different locations and at different scanning angles, consideration must be given to the field distribution in the region between the purity device and the phosphor screen 18. This field distribution is graphically represented in FIGURE 14, in which a quarter-section of the resulting flux pattern between the purity device and the phosphor screen is depicted on a coordinate plot in which the distance from the plane of the purity device is represented along the ordinate and the transverse distance from the center of the purity device is plotted as the abscissa. The flux field here depicted lies in a plane normal to the plane of the purity rings and is symmetrical so that the entire flux pattern in this plane includes appropriate mirror images of the illustrated quarter-section. The scanning deflection centers for the three electron beams are laterally displaced from the tube axis in a common transverse plane 125 below the plane of the purity device. With this type of graphical representation, the purity deflection fields encountered by any of the three electron beams in travelling from the purity device towards the phosphor screen may be visualized by projecting a straight line from the effective origin of the beam at the center of deflection plane 125 upwardly at the scanning angle under consideration. Consideration of such beam paths 120, 121, at scanning angles of 0° and 45° respectively, which constitute the limiting scanning conditions in a 90-degree deflection tube, will suffice to demonstrate the full range of conditions encountered throughout the picture scan.

With the field produced by the device of FIGURE 9 as illustrated in FIGURE 14, all the effective purity deflection field components normal to either of the beam paths 120, 121 or any path therebetween are of uniform sense or in the same direction, i.e., the flux components transverse to beam paths 120 and 121 are always directed to

the left of the beam path. Therefore, the auxiliary purity deflection is in a common direction at all scanning angles. Moreover, due to parallax considerations and because the flux density encountered by any electron beam at a given distance from the center of deflection is greater at higher than at lower scanning angles, due to the closer proximity of the beam path to the purity magnets, the lateral displacement in landing position effected by the purity magnets is greater at the edges of the screen than at the center. This condition, which is inherent with a post-deflection purity device of the type shown in FIGURE 9, is directly contrary to that achieved by neck-mounted purity devices on the gun side of the deflection center, and accordingly it has been found impossible to achieve a satisfactory purity adjustment with conventional constructions such as that shown in FIGURE 9.

FIGURE 15 illustrates a similar plot of the magnetic field pattern produced when two rings of the type shown in FIGURE 2 are employed in accordance with the present invention. Similar fields are produced by the embodiments of FIGURES 3-8. Again only a quarter-section of the flux pattern is shown for the reasons explained in conjunction with FIGURE 14. The lateral or transverse distance from the center of the rings is plotted on the abscissa while the distance from the plane of the rings to the screen along the axis of symmetry of the tube is plotted on the ordinate. A beam path parallel to the axis of symmetry of the tube is designated as path 122 while a path which is 45 degrees to the axis of symmetry to the tube is designated as path 123. The field of FIGURE 15 is created by the plurality of magnetic poles of the rings of FIGURES 2-8 which are circumferentially spaced about the central opening of the rings and oriented to establish a predetermined flux pattern including flux components from the north pole of a selected pole pair to the south pole of such selected pole pair, as well as other flux components from the same north pole across the central opening to the south pole of another pole pair. A beam traveling along path 122 initially passes through a flux field having effective transverse deflection components normal to the beam in a predetermined sense (i.e., to the left of beam path 122) and, as it nears the screen, which is conventionally at a distance of about 11½ inches from the plane of the purity device and is therefore off the scale of the drawing, may encounter a field having effective transverse deflection components of the opposite sense. The reversal in sense of the effective transverse deflection components of the purity correction field encountered by the beam causes a corresponding reversal in the direction of auxiliary beam deflection, leading to a beam trajectory which is characterized by a reverse bend or point of inflection at the point where the purity field reversal takes place. A beam traveling down path 123 encounters similar field conditions, but the reversal in sense of the effective transverse deflection components is encountered a shorter distance down the path. Thus, the magnet pole pairs of the devices of FIGURES 2-8 constitute permanent magnet means on support member 22 for developing a magnetic flux field having deflection components transverse to the path of the beam, effective to establish trajectories for the beam with points of inflection farther from the center of deflection of the yoke for smaller scanning angles than for larger scanning angles of the beam.

While the reversal in direction or sense of the effective flux components normal to the beam path affects the landing position of the beam on the screen, the strengths of the normal field components at various points along any given beam path also are of importance. The graph of FIGURE 16 is a plot of the flux density in arbitrary units as a function of the distance from the deflection center of the deflection yoke 21, for a beam traveling down the maximum scanning angle path 123 in the flux field of FIGURE 15. The flux density encountered by the beam rises from a negative value as it approaches its center of

deflection, where the flux density from the purity device is slightly positive, to a maximum positive value approximately 2½ inches along the beam path which is just within the central opening of the purity rings. The flux density then decreases to a point approximately 8 inches along the beam path where the flux becomes negative again. The positive and negative values of flux density on the graph of FIGURE 16 correspond to effective transverse deflection components of opposite senses.

While both the magnitudes and directions of the effective transverse deflection components encountered by the beam influence its landing position, the point along the beam path at which the respective component is encountered is also of importance. More specifically, the purity shift attributable to an individual flux component is equal to the product of its strength, in an algebraic sense, multiplied by its distance from the yoke deflection center measured along the beam path. The combined effect of these factors on the beam at any given point is graphically illustrated for the maximum scanning angle represented by beam path 123 in the graph of FIGURE 17. The distance from the deflection center of yoke 21 is plotted on the abscissa while the product of the flux density times the distance from the deflection center of the yoke is plotted on the ordinate. The curve of FIGURE 17 is generally similar in character to that of FIGURE 16, except that the negative or reverse-sense flux components are weighted to reflect their relatively greater efficacy due to their closer proximity to the aperture mask 19; the effect of a given lateral displacement of the beam on its landing position on the screen is inversely proportional to the distance from the mask at which such displacement is introduced. Because the effect of the negative flux components is multiplied by their distance from the center of deflection, their effect on the landing position of the beam is substantial; indeed, a phase reversal in the effective transverse deflection components, has been found essential to the achievement at least at intermediate and large scanning angles, of a post-deflection purity correction equivalent to that obtained with neck-mounted devices.

Curves similar to that of FIGURE 17 may be plotted for other scanning angles. Paths nearer the axis of the tube show smaller positive excursions but their negative excursions are also smaller and do not occur as close to the deflection center, so that the difference between the area under the positive excursions and that under the final negative portion, i.e., the net positive area under the curve, is substantially constant and independent of the scanning angle. In other words, the total area under a curve plotting flux density times distance from the deflection center as a function of the distance from the deflection center is substantially the same for any beam path. Accordingly, the magnetic pole pairs of a post-deflection purity device embodying the invention constitute permanent magnet means on support member 22 for developing an auxiliary deflection field of predetermined configuration within tube 16 between the center of deflection of yoke 21 and the screen of the tube with the integral of the curve of the field strength component normal or transverse to the beam path in a predetermined sense times its distance from the deflection center along the beam path as a function of the distance from the deflection center being substantially the same along all beam paths. While FIGURES 15-17 represent a flux pattern and graphs produced by the device of FIGURE 2, similar considerations apply and comparable results are achieved with any of the devices of FIGURES 3-8.

The field plots of FIGURES 14 and 15 are somewhat idealized because, under actual operating conditions, the presence of the yoke with its ferromagnetic core in close proximity to the purity device introduces certain distortions in the purity field configuration, particularly in the lower two quadrants. However, the field patterns are plotted in FIGURES 14 and 15 with sufficient accuracy to

provide a correct qualitative understanding of the conditions from the plane of the purity device forward towards the screen, and the curves of FIGURES 16 and 17 are plotted from data taken with the yoke in place.

As previously mentioned, two identical and individually rotationally adjustable rings are preferably employed on the support member 22 to achieve the desired purity effect. One ring alone may be employed to produce purity shift; however, only the direction of the flux field can be varied by rotating a single ring on the support member 22. The provision of two closely adjacent independently rotatable rings of identical construction permits adjustment of the field intensity for a given-field configuration. In post-deflection purity devices constructed in accordance with the invention, the circumferential field strength distribution around each of the rings corresponds to a predetermined non-linear function. Specifically, in each of the embodiments of FIGURES 2-8, the effective field strengths of the magnetic pole pairs varies sinusoidally as a function of circumferential displacement. When the two rings are rotationally positioned so that their magnetic fields are additive, the resultant magnetic field is twice as strong as that achieved with one ring. When one ring is rotated 180 degrees with respect to the other, there is no resultant magnetic field. With intermediate rotational adjustments, the resultant magnetic field is of a correspondingly intermediate magnitude, and the field configuration remains unchanged because the sum of two sinusoidal functions is a third sinusoidal function, the resultant magnetic field in any case is also sinusoidal for all relative orientations of one ring with respect to the other. Consequently, the use of two rings allows adjustability of the magnitude of the flux field as well as its orientation.

The required sinusoidal variation of field strength as a function of circumferential displacement can be achieved by employing non-uniform pole pair spacings, strengths, or widths. As shown in FIGURE 18(a), the specific field strengths of the magnetic pole pairs required to obtain the desired sinusoidal field strength distribution by employing a plurality of permanent magnets 130 of equal width but of different saturations or strengths may be determined by reading directly from a sinusoidal plot of flux density β as a function of angular orientation in degrees. The graphical illustration of FIGURE 18 is that used in determining the field strengths required in embodiments such as those of FIGURES 3 and 6, and as an illustrative example, twenty-two pole pairs at intervals of 15 degrees are represented in the figure although a greater or lesser number of pole pairs may be provided.

FIGURE 18(b) is a graphical representation of the integral of the curve of FIGURE 18(a) and is useful in determining the necessary pole pair characteristics when different spacings or widths are employed. In the integral curve of FIGURE 18(b), flux density at any location is represented by the slope of the curve rather than its magnitude, and each pole pair contributes an incremental slope to the integral curve as may be readily appreciated from the drawing. Thus, to design an embodiment of the invention such as that of FIGURE 7, comprising equally spaced pole pairs of equal strengths but different widths, the cosinusoidal integral curve is subdivided into a number of incremental component slopes corresponding to the desired number of pole pairs and disposed with equal center-to-center spacings, as for example at 15 degree intervals as shown in FIGURE 19(b), and projection upwards establishes the required widths of equal strength pole pairs 140 to achieve the desired sinusoidal flux density distribution represented by curve 19(a). Similarly, to design an embodiment such as that of FIGURE 2, comprising differently spaced pole pairs of equal strengths and widths, the integral curve of FIGURE 20(b) is subdivided into incremental subportions of equal slopes and widths, which subportions are projected upwards to determine the required spacings of pole pairs 150 for the sinusoidal flux

density distribution represented by the curve of FIGURE 20(a).

While the number of pole pairs employed is not critical in any embodiment of the invention, it may readily be appreciated from a consideration of FIGURES 18-20 that the larger the number of pole pairs employed, the closer the approach to sinusoidal flux density distribution.

Of course, the strengths, widths and spacings may all be varied from pole pair to pole pair, and the cosinusoidal integral curve may be subdivided into any number of incremental slopes to arrive at a construction even more closely approximating the desired sinusoidal flux distribution.

The device of FIGURE 21 may be employed to magnetize a ferromagnetic ring section 160 for use in a purity device embodying the invention. The fixture comprises two core pieces 161, 162 having a plurality of oppositely disposed pole members 163 appropriately spaced to receive the ring section 160. Each pole member of core 163 has a coil 164 wound on it which, when properly energized with electric current (D.C.), creates a magnetic field resulting in a magnetic pole pair on the ring section 160 between each pair of core poles 163, and the strength of each pole pair thus produced in ring section 160 is determined by the magnitude of the energizing current. The fixture of FIGURE 21 is constructed to polarize ring section 160 with differently spaced pole pairs of equal strengths and widths in the central region, with narrower, more widely spaced pole pairs at each end. The magnetizing fixture of this type can simultaneously produce any required number and distribution of pole pairs.

As shown in FIGURE 22, with each of the previously described purity devices, the magnetic center of each ring 170 is at a point 171 at the center of the central opening in the plane of the ring. The apparatus magnetizing the ring 170 is schematically represented in FIGURE 22a, where two similarly shaped electromagnets 172, 173 when properly energized, cause a magnetic pole pair to be formed on the ring 170.

When two contiguous purity rings of this type are employed, as described above, there is a small but definite displacement between their magnetic centers owing to the finite thickness of the rings. This results in one ring being slightly more effective than the other as its magnetic center is farther along the beam path than the other, and although satisfactory purity correction can be achieved, eliminating or compensating for this displacement between magnetic centers makes it possible for the purity device to be adjusted for full cancellation of the purity field components from the two rings, as may be required with some picture tubes. Compensation may be achieved by making the purity ring closer to the screen weaker than the other ring, the relative strengths being proportioned to balance or offset the displacement between magnetic centers. Since compensation in this manner introduces production complications, in that two different rings must be manufactured and the rings must be assembled in proper sequence, a more effective solution is to twist the rings slightly so that the magnetic center of the ring is spaced outwardly from the center plane of the ring. Such a configuration is shown in FIGURE 23. A twisted ring 180 develops an asymmetrical flux field, and the amount of twist is selected to displace the magnetic center 181 from the center plane of the ring to the center plane of the two-ring assembled purity device; in practice, a twist of approximately one and one-half degrees has been found to produce the desired result. The apparatus for magnetizing the ring 180 is schematically represented in FIGURE 23a and comprises two electromagnets 182, 183 which are tilted to produce a magnetic axis 184 on the ring which is symmetrical within the ring core but canted with respect to the plane of the ring. Two such twisted rings 180 are placed back to back to form a purity device 20. With

such a construction, the magnetic centers of the two rings are coincident and, consequently, purity rings of unequal strengths need not be manufactured as both rings affect the electron beams equally because they act on the beam path at the same point.

A further improvement is shown in FIGURE 24, where a flat ring 190 which is operationally equivalent to the twisted ring of FIGURE 23 is shown. The magnet pole pairs of ring 190 are preferably radially oriented and circumferentially spaced about the central opening of the ring in the manner previously explained, but the magnetic axis of each pole pair is canted with respect to the plane of the ring for developing an asymmetrical flux field across the opening. FIGURE 24a discloses simplified apparatus for producing a ring of the desired magnetic configuration. Electromagnets 192, 193 are positioned to produce a magnetic pole pair having its magnetic axis 195 canted with respect to the core of ring 190, so that the magnetic center 191 of the ring is displaced to one side as in the embodiment of FIGURE 23. The ring of FIGURE 24 produces an asymmetrical field about the center plane of the ring while the ring is essentially flat, thereby facilitating both production of the ring and mounting on a magnet retaining ring of the type previously described. When two rings of the type shown in FIGURE 24 are mounted on appropriate magnet retaining rings, which in turn are mounted on support member 22, the structure is identical to that shown in FIGURES 10-13. One purity ring serves as first ring magnet means concentrically mounted about the axis of symmetry of the tube 16 on the support member 22 having a plurality of magnetic pole pairs radially oriented and circumferentially spaced about the central opening of the ring magnet means, each pole pair having its magnetic axis canted with respect to the plane of the ring magnet means for developing a flux field having its magnetic center on the axis of symmetry axially displaced from the center plane of the ring magnet means. The other purity ring serves as second ring magnet means also concentrically mounted about the axis of symmetry on the support member 22 and rotatable with respect to the first ring magnet also having a central opening and a plurality of magnetic pole pairs radially oriented and circumferentially spaced about said opening, each pole pair having its magnetic axis canted with respect to the plane of the second ring magnet means for developing a flux field having its magnetic center on the axis of symmetry axially displaced from the center plane of the second ring magnet means. The two-ring assembly constitutes means for varying the landing positions of the beams less at the edges than at the center of the screen.

With the constructions of FIGURES 23 and 24, the lateral displacement of the magnetic centers of the rings may be readily controlled by varying the amount of twist of the ring cores or the amount of canting of the polarizing fields with respect to the cores. If desired, a greater lateral displacement may be provided to assure coincidence of the magnetic centers even when a spacer of magnetic insulating material is interposed between the rings, as may be desired in some applications to provide for smoother adjustability of the rings.

While the beam positioning device described is used as a purity device in conjunction with color cathode-ray tubes, it is understood that devices embodying the invention may be used for positioning an electron beam in any cathode-ray tube employing one or more electron beams, as for example in permanent-magnet centering devices. Furthermore, the supporting structure 22 which supports the purity device 20 may be of any configuration which allows individual rotational adjustability of the rings about the tube neck.

Thus the invention provides a new and improved beam positioning device for a cathode-ray tube. In its preferred application, the invention provides a novel, sim-

ple and inexpensive post-deflection purity device for a color television picture tube which affords purity correction at least comparable to that achieved with neck-mounted devices, thus overcoming a major deterrent to the development and commercial introduction of wide-angle round- and rectangular-screen color television picture tubes.

While particular embodiments of the present invention have been shown and described, it is apparent that changes and modifications may be made therein without departing from the invention in its broader aspects. The aim of the appended claims, therefore, is to cover all such changes and modifications as fall within the true spirit and scope of the invention.

I claim:

1. A beam positioning device for varying the effective point of origin of an electron beam of a cathode-ray tube, said device comprising ring magnet means having a central opening and a plurality of magnetic pole pairs of equal strengths and different widths equally circumferentially spaced about at least a portion of said opening and radially oriented to establish a predetermined flux pattern including flux components from one pole of a selected pole pair to the opposite pole of said selected pole pair as well as other flux components from said one pole across said central opening to a pole of another pole pair.

2. A beam positioning device for varying the effective point of origin of an electron beam of a cathode-ray tube, said device comprising ring magnet means having a central opening and a plurality of magnetic pole pairs of different strengths and equal widths equally circumferentially spaced about at least a portion of said opening and radially oriented to establish a predetermined flux pattern including flux components from one pole of a selected pole pair to the opposite pole of said selected pole pair as well as other flux components from said one pole across said central opening to a pole of another pole pair.

3. A beam positioning device for varying the effective point of origin of an electron beam of a cathode-ray tube, said device comprising ring magnet means having a central opening and a plurality of magnetic pole pairs radially oriented and circumferentially spaced about said opening each having its magnetic axis canted with respect to the plane of said ring magnet means for developing an asymmetrical flux field across said opening.

4. A beam positioning device for varying the effective point of origin of an electron beam of a cathode-ray tube which is deflected from a predetermined center of deflection across the screen of said tube, said device comprising:

a support member at least partially encompassing the axis of symmetry of said tube at a location intermediate said center of deflection and said screen;

first ring magnet means mounted on said support member and having a central opening and a plurality of magnetic pole pairs circumferentially spaced about said opening for developing a flux field having a predetermined magnitude;

and second ring magnet means rotationally mounted with respect to said first ring magnet means on said support member having a central opening and a plurality of magnetic pole pairs circumferentially spaced about said opening for developing a flux field having a magnitude less than said predetermined magnitude.

5. A beam positioning device for varying the effective point of origin of an electron beam of a cathode-ray tube which is deflected from a predetermined center of deflection across the screen of said tube, said device comprising:

a support member at least partially encompassing the axis of symmetry of said tube at a location intermediate said center of deflection and said screen;

first ring magnet means mounted on said support member and having a central opening and a plurality of magnetic pole pairs circumferentially spaced about said opening, each pole pair having its magnetic axis canted with respect to the plane of said ring magnet means for developing a flux field having its magnetic center axially displaced from the center plane of said first ring magnet means;

and second ring magnet means rotationally mounted with respect to said first ring magnet means on said support member and having a central opening and a plurality of magnetic pole pairs circumferentially spaced about said opening, each pole pair having its magnetic axis canted with respect to the plane of said second ring magnet means for developing a flux field having its magnetic center axially displaced from the center plane of said second ring magnet means; said first and second ring magnet means being juxtaposed with their magnetic centers in substantial coincidence.

6. A beam positioning device for varying the effective point of origin of an electron beam of a cathode-ray tube which is deflected from a predetermined center of deflection across the screen of said tube, said device comprising:

a support member at least partially encompassing the axis of symmetry of said tube at a location intermediate said center of deflection and said screen;

first ring magnet means concentrically mounted about said axis of symmetry on said support member and having a central opening and a plurality of magnetic pole pairs radially oriented and circumferentially spaced about said opening, each pole pair having its magnetic axis canted with respect to the plane of said ring magnet means for developing a flux field having its magnetic center on said axis of symmetry axially displaced from the center plane of said first ring magnet means;

and second ring magnet means also concentrically mounted about said axis of symmetry on said support member and rotatable with respect to said first ring magnet means having a central opening and a plurality of magnetic pole pairs radially oriented and circumferentially spaced about said opening, each pole pair having its magnetic axis canted with respect to the plane of said second ring magnet means for developing a flux field having its magnetic center on said axis of symmetry axially displaced from the center plane of said second ring magnet means and coincident with the magnetic center of said first ring magnet means.

7. A post-deflection purity device for varying the effective points of origin of the electron beams of a color cathode-ray tube which are deflected from a predetermined deflection center plane across the viewing screen of said tube by an electromagnetic deflection yoke, said device comprising:

a support member positioned on said tube and at least partially encompassing the axis of symmetry of said tube at a location intermediate said center of deflection and said screen;

first ring magnet means concentrically mounted about said axis of symmetry on said support member and having a central opening and a plurality of magnetic pole pairs of substantially equal strength and differently spaced at least partially about said opening, each pole pair having its magnetic axis canted with respect to the plane of said ring magnet means for developing a flux pattern including flux components from one pole of the pole pair to the opposite pole of the pole pair as well as other flux components from said one pole across said central opening to a pole of another pole pair with the magnetic center of the flux pattern of said first ring magnet means

on said axis of symmetry axially displaced from the center plane of said first magnet means;

and second ring magnet means also concentrically mounted about said axis of symmetry on said support member and rotatable with respect to said first ring magnet means, and having a central opening and a plurality of magnetic pole pairs of substantially equal strength and differently spaced at least partially about its said central opening, each pole pair having its magnetic axis canted with respect to the plane of said second magnet means for developing a flux pattern including flux components from one pole of the pole pair to the opposite pole of the pole pair as well as other flux components from said one pole across said central opening of said second ring magnet means to a pole of another pole pair with the magnetic center of the flux pattern of said second ring magnet means on said axis of symmetry axially displaced from the center plane of said second ring magnet means and coincident with the magnetic center of said first ring magnet means; said first and second ring magnet means constituting means for varying the landing positions of said electron beams less at the edges than at the center of said screen.

8. A beam positioning device for varying the effective point of origin of a cathode ray tube electron beam which is deflected from a predetermined center of deflection across the viewing screen of said tube, said device comprising:

a support member at least partially encompassing the axis of symmetry of said tube at a location intermediate said center of deflection and said screen;

and means on said support member for developing within said tube between said center of deflection and said screen an auxiliary beam deflection field of predetermined configuration comprising flux density components uniformly directed transverse to the path of said beam from said center of deflection to said viewing screen for influencing the beam's landing position in a predetermined sense upon that portion of said screen swept during small scanning angles of said beam, and further comprising oppositely directed transverse flux density components at an intermediate location between said center of deflection and said viewing screen for influencing the beam's landing position in a predetermined different sense upon that portion of said screen swept during large scanning angles of said beam, to establish trajectories for said beam with points of inflection farther from said center of deflection for smaller scanning angles than for larger scanning angles of said beam.

9. A purity device for varying the effective points of origin of the electron beams of a multi-beam cathode ray tube which are deflected from a predetermined center of deflection across the viewing screen of said tube by an electromagnetic deflection yoke, said device comprising:

a support member positioned on said tube and at least partially encompassing the axis of symmetry of said tube at a location intermediate said center of deflection and said screen;

and ring-like permanent magnet means on said support member in proximity to said yoke for developing within said tube between said center of deflection and said screen a deflection field of predetermined configuration comprising flux density components uniformly directed transverse to the paths of said beams from said center of deflection to said viewing screen for influencing the beams' landing positions in a predetermined sense upon that portion of said screen swept during small scanning angles of said beams, and further comprising oppositely directed transverse flux density components at an intermediate location between said center of deflection and said viewing screen for influencing the beams' landing positions in a predetermined different sense upon

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that portion of said screen swept during large scanning angles of said beams, so as to vary the landing positions of said beams less at all peripheral portions than at the center of said screen.

10. A beam positioning device for varying the effective point of origin of a cathode ray tube electron beam which is deflected from a predetermined center of deflection across the viewing screen of said tube by an electromagnetic deflection yoke, said device comprising:

a support member at least partially encompassing the axis of symmetry of said tube at a location intermediate said center of deflection and said screen;

and permanent magnet means on said support member for developing within said tube between said center of deflection and said screen a magnetic flux field of predetermined configuration comprising flux density components uniformly directed transverse to the path of said beam from said center of deflection to said viewing screen for influencing the beam's landing position in a predetermined sense upon that portion of said screen swept during small scanning angles of said beam, and further comprising oppositely directed transverse flux density components at an intermediate location between said center of deflection and said viewing screen for influencing the beam's landing position in a predetermined different sense upon that portion of said screen swept during large scanning angles of said beam, to establish trajectories for said beam with points of inflection farther from said center of deflection for smaller scanning angles than for larger scanning angles of said beam.

11. A beam positioning device for varying the effective point of origin of a cathode ray tube electron beam which is deflected from a predetermined center of deflection across the viewing screen of said tube by an electromagnetic deflection yoke, said device comprising:

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a support member at least partially encompassing the axis of symmetry of said tube at a location intermediate said center of deflection and said screen; and permanent magnet means on said support member for developing within said tube between said center of deflection and said screen a flux field of predetermined configuration comprising flux density components uniformly directed transverse to the path of said beam from said center of deflection to said viewing screen for influencing the beam's landing position in a predetermined sense upon that portion of said screen swept during small scanning angles of said beam, and further comprising oppositely directed transverse flux density components at an intermediate location between said center of deflection and said viewing screen for influencing the beam's landing position in a predetermined different sense upon that portion of said screen swept during large scanning angles of said beam, said transverse flux density components affecting the beam trajectories after passing said deflection center farther along the beam path from said center of deflection for smaller scanning angles than for larger scanning angles.

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