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2,816,244

ELECTRON BEAM CONTROLLING APPARATUS

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3 Sheets-Sheet 1

Fig. 1.

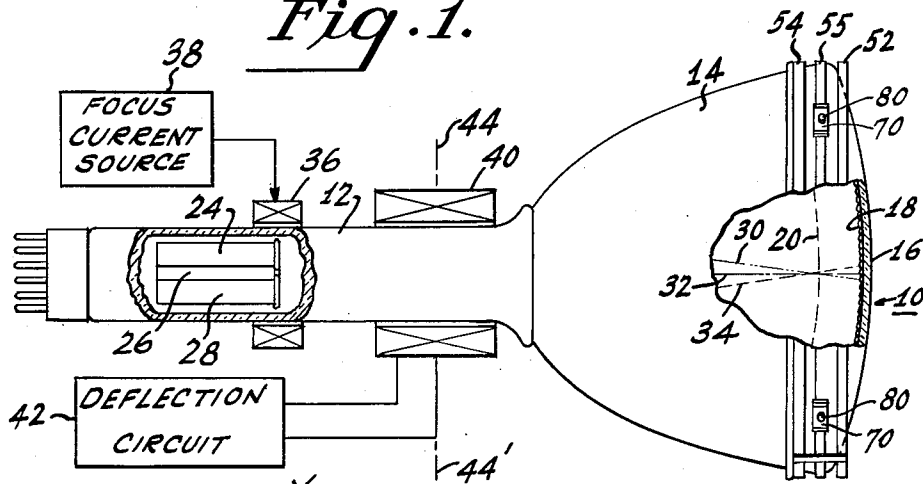


Fig. 2.

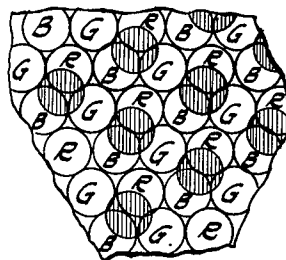
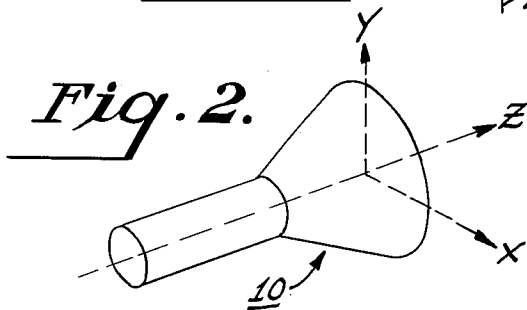


Fig. 3.

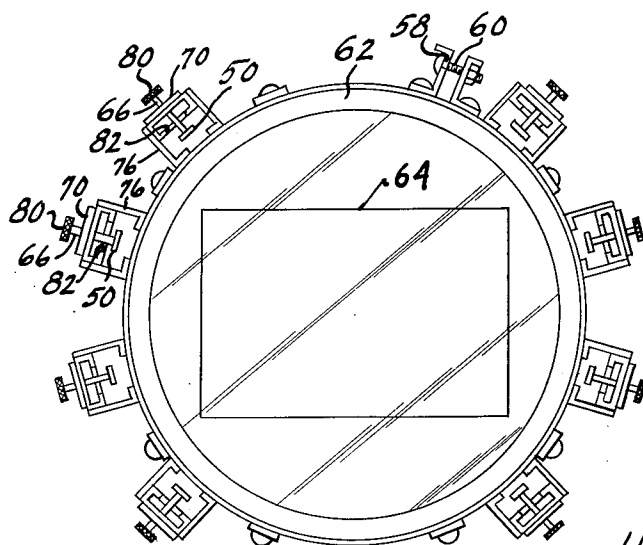


Fig. 4.

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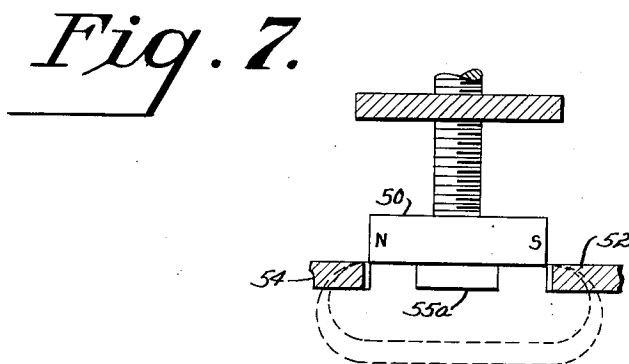
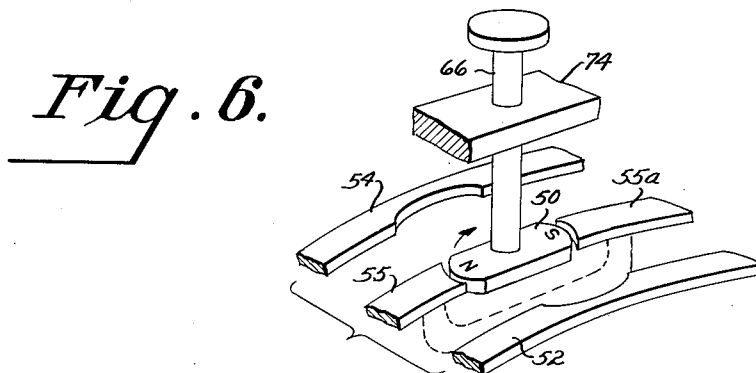
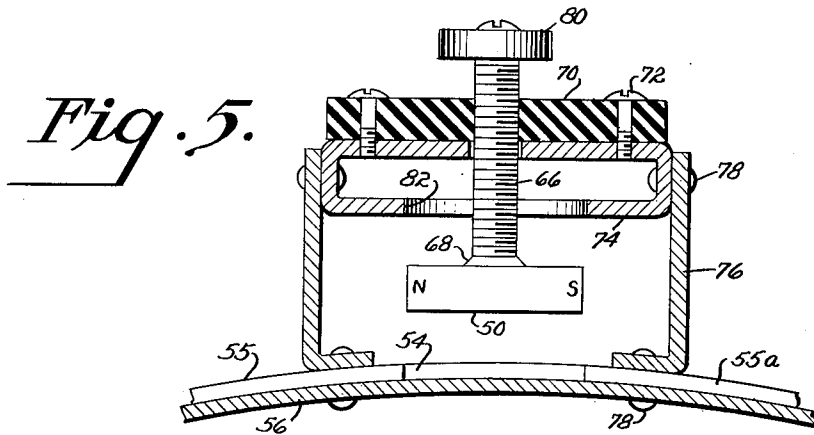
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3 Sheets-Sheet 2



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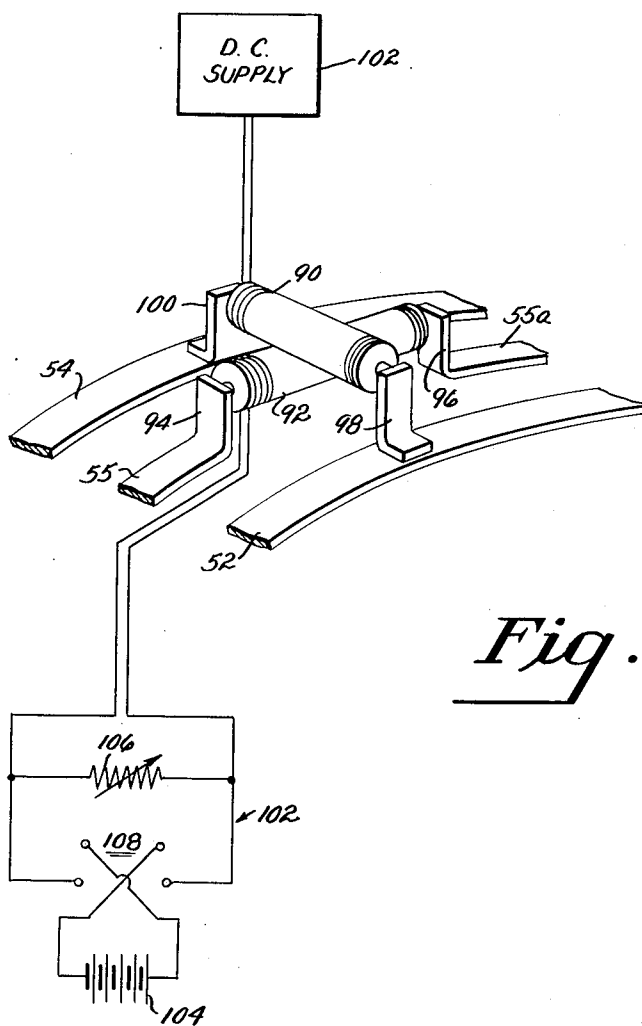
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ELECTRON BEAM CONTROLLING APPARATUS

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3 Sheets-Sheet 3



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ELECTRON BEAM CONTROLLING APPARATUS

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8 Claims. (Cl. 313—77)

The present invention relates to new and improved apparatus for use in controlling electrons in cathode ray tubes of the type employed as color television image reproducing devices. Specifically, the invention relates to such apparatus which is adapted for use in conjunction with cathode ray tubes having a plane of deflection at which electrons are subjected to a scanning movement in their travel toward a screen unit of the type comprising a so-called mosaic screen and one or more adjacent grills or masks through which electrons pass in different angular directions to preselected elemental areas of the mosaic.

While the present invention will be described herein as it may be applied to a cathode ray tube of the dot-screen variety disclosed in an article by H. B. Law, "A Three-Gun Shadow-Mask Color Kinescope" (October 1951 issue of Proceedings of the IRE), its applicability is not limited, since the invention may also be employed with other types of cathode ray tubes wherein the angle of approach of an electron beam toward a mosaic screen determines its point of contact with the screen.

As described in the cited Law article, the particular screen area which is illuminated at any given instant in a cathode ray tube of the type in question is a function of the precise angle at which the electron beam approaches the color screen. When such tubes are manufactured in accordance with present-day mass production methods, it is not always possible to maintain the necessary accuracy in the assembly of the grill or mask and the phosphor screen. By virtue of such difficulties, many cathode ray tubes which are otherwise satisfactory in structure must be rejected because of "color dilution." One particular form of color dilution which is encountered in color kinescopes is that which results from misalignment of the shadow mask or grill about its longitudinal axis with respect to the phosphor screen, this form of color dilution being termed "tangential" or "rotational" color dilution. Another form of color dilution is that which results from radial misalignment of shadow mask or grill and screen such that the electrons strike a point on the screen radially displaced from their desired point of impingement and which may be termed "radial" color dilution.

Still another source of difficulty in the operation of color kinescopes of the type under consideration is that which is brought about by stray magnetic fields such, for example, as the earth's magnetic field and which may be "tangential" and/or "radial" in nature.

It is, therefore, a primary object of the present invention to provide new and improved apparatus for preventing color dilution of the type stemming from rotational and/or radial misalignment of the tube parts and/or from magnetic fields.

Insofar as the correction for color dilution resulting from rotational misalignment in the screen unit of a color kinescope is concerned, one satisfactory proposal made heretofore is that which provides an electromagnetic coil of suitable internal diameter for permitting its lo-

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cation around and in general alignment with the screen unit of a cathode ray tube. Passage through the coil of a suitable direct current produces a magnetic field in the vicinity of the screen unit for correction of tangential mislocation of an electron beam with respect to the mosaic phosphor screen.

It has been determined, however, that certain manufacturing misalignment errors and those attributable to stray fields affect beam positioning differently in different quadrants of the scanned raster, so that a single coil may be incapable of effecting rotational correction in such a case. That is to say, different corners of the raster may require different correctional treatment. Hence it is an object herein to provide correctional apparatus as described, which apparatus is capable of selective correction at different raster locations.

The matter of minimizing or eliminating color dilution which may be brought about by ambient magnetic fields has also been treated by the provision of a shield of magnetic material surrounding the electron beam path within the kinescope between substantially its plane of deflection and screen unit. The present applicant has found that, while such a shield of magnetic material is effective in protecting electrons within the tube against magnetic field components in a plane transverse of the longitudinal axis of the cathode ray tube, magnetic field components parallel to such longitudinal axes are free to enter the electron beam path and to produce undesirable rotation of the electrons therein.

It is another object of the present invention to provide novel and improved neutralizing apparatus for substantially precluding interference with electron beam paths within a cathode ray tube image device from magnetic field components including those components parallel to the longitudinal axis of the tube and components transverse of the axis.

In general, the present invention provides means for subjecting the electron beams, in the space between the tube's shadow mask and target screen to substantially constant direct current magnetic fields of such intensity, polarity and orientation as to direct said electrons to their normal or intended points of impact on the screen, regardless of the section of the screen in which the beams may be operating. In accordance with a specific illustrative embodiment of the present invention, such direct current, magnetic field producing means may comprise a plurality of permanent magnets having north and south poles and disposed around the screen unit of the cathode ray tube, each of the magnets being in association with magnetic pole forming means comprising a pair of rings of iron or the like, spaced from each other axially of the tube and continuous in the region of the magnet, and a third ring disposed between and parallel to but spaced from the first two rings and discontinuous in the region of the magnet. Thus, rotation of each magnet about its axis (i. e., about an axis radial of the tube) affords selection of axial or transverse magnetic fields, the degree of activity of which is extended over a substantial angle by the pole-forming rings. Further in accordance with the illustrative form of the invention employing permanent magnets, each magnet may be provided with a magnetic shunt, the permanent magnet and its shunt being mounted for relative movement in such manner that the strength as well as the direction of the magnetic fields may be suitably adjusted.

In accordance with another illustrative form of the invention, electromagnets are associated with pole forming rings as described, each of the electromagnets having a north and a south pole with two such magnets, perpendicular to each other, associated with the rings at the location of discontinuity of the center ring. Means may be provided for applying to each of the electromagnets a

direct current which is adjustable as to magnitude and reversible in polarity.

Thus, and as will be more fully appreciated hereinafter, the permanent magnets and their pole pieces may be selectively oriented and, in the case of the electromagnets, the currents so adjusted to produce reversible axial or transverse magnetic fields. Such fields may serve to correct either rotational or radial misalignment of the parts of the tube or to neutralize undesired stray fields.

Additional objects and advantages of the present invention will become apparent to those skilled in the art from a study of the following detailed description of the accompanying drawing, in which:

Fig. 1 is a side elevational view, partially in section, of a three-gun tri-color kinescope of conventional construction which is provided, in accordance with one form of the invention, with novel electron beam path-controlling apparatus;

Fig. 2 is a diagrammatic illustration of a cathode ray tube oriented with respect to certain axes to be described;

Fig. 3 is a fragmentary front view, greatly enlarged, of the screen of the tube of Fig. 1;

Fig. 4 is a front view of the apparatus of Fig. 1;

Fig. 5 is a vertical sectional view of one of the permanent magnet arrangements of Figures 1 and 4;

Figs. 6 and 7 illustrate magnetic fields produced in different selected positions of one of the magnets of Fig. 5; and

Fig. 8 is illustrative of another form of the invention.

Referring to Fig. 1 of the drawing, the color kinescope 10 shown therein comprises an evacuated envelope having a cylindrical neck portion 12 of glass, for example, which terminates in a flared "cone" portion 14 whose larger end is closed by a glass face plate 16 through which is visible the phosphor screen 18 of the target structure of the tube which further includes a shadow mask or aperture mask electrode 20. The tube as described thus far may be of the type disclosed in the above-cited Law article in which the phosphor screen 18 is of the well-known dot screen variety. As shown in the drawing, the phosphor screen is deposited directly upon the rear surface of the face plate 16 and the mask 20 is curved concentrically with the curvature of the face plate. Specifically, the screen 18 is provided on its rear surface with a multiplicity of groups of red, blue and green phosphor dots, the dots of each group being arranged at the apices of an equilateral triangle. The mask element 20 of the screen unit comprises a thin metal plate containing a multiplicity of apertures arranged in the same triangular pattern as the trios of phosphor dots such that there is one mask aperture for each trio of phosphor dots. The aperture mask 20 is supported in spaced relationship with respect to the screen 18 by suitable means (not shown).

The cylindrical neck portion 12 of the kinescope 10 houses three electron guns 24, 26 and 28, each of which produces an electron beam intended for bombardment of a particular screen color. The guns 24, 26 and 28 may be arranged at the apices of an equilateral triangle as shown in the Law article or in any other suitable manner such, for example, as an "in-line" arrangement. The electron beams produced by the guns are indicated diagrammatically by the dotted lines 30, 32 and 34 and are focused in a conventional manner by suitable means indicated as an electro-magnetic focus coil 36 energized by currents from a source 38, whereby to provide fine spots at the target screen. The electron beams are subjected to the action of substantially perpendicular magnetic fields for the scanning, in horizontal and vertical directions, of a conventional rectangular raster at the screen unit. Such scanning fields are produced by means of a deflection yoke 40 which may comprise a pair of normally arranged deflection windings disposed about the neck of the kinescope and energized by suitable saw-

tooth currents of television line and field frequencies from the deflection circuits 42. As indicated by the dotted line 44-44', the plane of deflection for the three beams 30, 32 and 34 extends transversely through the deflection yoke 40.

In subsequent portions of the instant specification, reference will be made to the "X," "Y" and "Z" axes of the kinescope 10. In order to facilitate an understanding of such designations, Fig. 2 illustrates, in simplified form, the kinescope 10 oriented about its several axes "X," "Y" and "Z." It will be seen from Fig. 2 that the "Z"-axis coincides with the longitudinal axis of the tube, while the "X" and "Y"-axes are normal to each other and to the "Z"-axis.

As has been stated generally supra, one object of the present invention is that of eliminating the so-called "tangential" color dilution which results from a situation tantamount to that which exists when the shadow mask of a screen unit is rotationally displaced with respect to the phosphor screen (about their common axis). Fig. 3 illustrates a front view of such a screen unit, showing a typical case of "tangential" dilution. It will be understood that the three beams 30, 32 and 34 are intended to converge at the shadow mask 20 and diverge therefrom so that the red beam 30 strikes the red-designated phosphor "R" and the other beams 32 and 34 strike the green and blue-designated phosphors "G" and "B," respectively, which phosphor dots are arranged, as explained, at the apices of an equilateral triangle. Assuming that there is some rotational mislocation of the shadow mask 20 and screen 18 or that there exists a magnetic field in the path of the beams between the shadow mask and phosphor screen unit such that components of the magnetic field are parallel to the "Z" axis of the tube, color dilution of the tangential type will result. Thus, referring to Fig. 3 wherein it is assumed, for purposes of simplicity of description, that only the red beam 30 is "on" and that only the red screen dots "R" are intended to be struck by electrons, the tangential color dilution is manifest at peripheral regions of the screen such that the red beam spots are not centered exactly on the red phosphor dots. Rather, the red beam spots are tangent to or overlap and, hence, illuminate peripheral portions of the adjacent blue and green phosphor dots, thus diluting the red light and preventing it from appearing with its proper degree of saturation.

While not illustrated in the drawing, it will be understood that "radial" color dilution, such as may result from a radial misalignment between the shadow mask 20 and screen 18, would be manifested by the beam spot's being shifted laterally (i. e., horizontally or vertically) from its desired point of impingement, and that the beam spot intended for illumination of a red phosphor dot might instead land on an adjacent blue or green dot.

The present invention eliminates or, at least, substantially minimizes both forms of color dilution through the agency of means for subjecting the several electron beams to the action of substantially constant (i. e., D. C.) magnetic fields (axial or transverse, for tangential or radial errors, respectively), in their travel between the shadow mask and the phosphor screen 18. The intensity and polarity of the field are chosen so as to divert the electrons from their predetermined angularly related paths to other angular directions as required to direct them to their intended points of impact upon the phosphor screen 18.

Figure 1 illustrates means, in accordance with a specific form of the invention, for providing the requisite axial or transverse magnetic field, such means comprising a plurality of permanent magnets 50 disposed around the screen unit of the tube 10, as illustrated in Figure 4. Interposed between the magnets 50 and the cathode ray tube are the outer pole-forming rings 52 and 54, of iron or the like, and the sectionalized inner pole-forming ring

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55. The pole rings 52, 54 and 55 may be held in place with respect to the tube and with respect to each other by means of a strip 56 of brass, aluminum, or other non-magnetic material, the rings being riveted or otherwise secured to the strap. For ease of mounting the assembly, the strap is split and its loose ends are provided with apertures 58 through which a brass bolt 60 is passed for securing the assembly.

As shown further in Figure 4, the rings are not necessarily mounted directly on the tube 10 but may, rather, be separated therefrom by a cylinder 62 of plastic material or the like. The cylinder 62 may, for example, form a part of the conventional "mask" usually associated with television receiver kinescopes. While eight of the permanent magnets 50 are shown in Figure 4, that is, two for each corner of the raster 64 scanned by the tube, it will be understood that fewer or more magnets may be employed, depending upon the extent of correction control desired.

Referring now to Figs. 5 and 6, there is shown in enlarged fashion one of the permanent magnets of Figs. 1 and 4. The permanent magnet 50 is illustrated as a bar magnet having north and south poles designated "N" and "S." The magnet is supported in a suspended fashion with respect to the pole rings 52, 54 and 55 in the following manner:

A threaded bolt 66 which is secured to the magnet 50 centrally of its opposite ends as by means of a solder joint 68 is threaded through a block of plastic 70 or other suitable insulating material to the underneath surface of which there is secured, as by means of screws 72 a soft iron keeper or shunt 74. Brackets 76 of brass or other non-magnetic material are secured to the strip 56 and to the keeper 74, as by means of rivets 78, the brackets being of sufficient length as to maintain the keeper 74 spaced from the pole-forming rings. Secured to the end of the bolt 66 remote from the magnet 50 is a knob 80 which may be provided for ease of manual rotation of the bolt.

The keeper 74 may, as shown, take the form of a generally tubular member having an opening 82 in its bottom wall of sufficient size to accommodate the magnet 50. As the bolt 66 is threaded through the block 70, the magnet 50 will be rotated about the axis of the bolt and will also be moved toward and away from the rings comprising the pole pieces. In its extreme retracted position, the magnet 50 is entirely within the confines of the keeper 74, so that the keeper may serve as a shunt or short-circuit path for flux from the magnet, thereby preventing the flux from passing to the pole-forming rings 52, 54 and 55.

As has been stated, the outer pole-forming rings 52 and 54 are continuous in the region of the magnet 50, although each of the rings 52 and 54 may, if desired, be rendered discontinuous between successive magnet locations. The inner ring 55, however, is discontinuous in the region of the magnet and its sections 55 and 55a may be separated by an air gap equal in length to the length of the magnet 50, so that the magnet may fit lengthwise between the sections 55 and 55a.

Since all of the magnets are identical to each other, only one of them has been described in detail. From the foregoing, however, it should be understood that each magnet 50 acts in co-operation with the outer pole-forming rings 52 and 54 and with pole segments 55 and 55a which are located between the outer rings but parallel thereto. Moreover, each magnet 50 may be rotated about the axis of its bolt 66 so that it may be perpendicular to the rings 52 and 54 or parallel to the rings to form a continuation of the ring segments 55 and 55a. While the drawing illustrates four such magnet-operating locations on each side of the raster, it should be understood that the number may be increased or decreased as necessary.

It is further to be noted that when the magnet 50 is

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oriented with its north and south poles aligned as shown in Fig. 6 along a line parallel to the segments 55 and 55a, those segments will serve, respectively, as north and south pole-forming pieces, while the rings 52 and 54 will receive substantially none of the flux produced by the magnet. The flux lines from the magnet 50 in the position assumed will be, as shown in Figure 6, generally transverse of the tube so as to produce radial deflection of electrons in the field. Conversely, when the magnet is rotated through 90° so that its poles are on a line perpendicular to the rings 52 and 54 (as in Fig. 7), the ring 54 will serve as a north pole-forming ring and the ring 52 will serve as a south pole-forming ring, whereby the flux lines produced will be axial of the tube and capable of producing tangential movement of electrons within the region of their activity.

In the operation of the apparatus described, it may be assumed for purposes of illustration that tangential color dilution exists in one or more of the corners of the raster as illustrated by the showing of Figure 3. In such event, one or more of the magnets 50 in that region may be rotated so that it is positioned as shown in Fig. 7. The resultant field may be varied in strength by moving the magnet toward its associated shunt or keeper 74. If it is found that color dilution is increased rather than decreased with the magnet adjacent a given region polarized in a given direction, that fact indicates that the magnetic field operating there is of the wrong polarity. The magnet in question may then be rotated through 180° to provide the proper polarization. Assuming further that no color dilution is present in a given section of the raster so that no correction is required there, the permanent magnet nearest that section may be effectively immobilized by retraction within its keeper 74.

In a similar manner radial color dilution in a given region of the raster may be corrected by rotating the magnet adjacent to that section so that it is polarized as shown in Fig. 6. The resultant flux lines, the strength of which may be varied by movement of the magnet toward its keeper, will produce radial deflection of the electron beams. The direction of deflection (i. e., toward or away from the center of the raster) will be a function of the polarization of the magnet, as will be understood.

It should additionally be noted that two or more adjacent magnets may be caused to aid each other for the correction of either tangential or radial error by polarizing the magnets in the same sense. Conversely, where opposite types of error exist in regions next to each other, the magnets respectively next to those regions may be oriented for the necessary kind of correction and without deleteriously affecting each other.

Since the specific materials of which the magnets and pole pieces are formed do not constitute a part of the present invention, it is sufficient to note that the magnets may be of any suitable material such as Alnico and the pole-forming rings and segments may be of soft iron. Except for the keeper 74 which should be of a suitable magnetic material, the other elements of the structure are to be formed of non-magnetic materials.

Figure 8 illustrates another form of the invention and, specifically, an embodiment employing electromagnets rather than permanent magnets. In Fig. 8 there are shown the outer pole-forming rings 52 and 54 and the inner pole-forming segments 55 and 55a, just as was shown in the preceding figures. In place of a permanent magnet, however, this form of the invention provides a pair of electromagnets 90 and 92 arranged at right angles to each other. Each of the magnets 90 and 92 may comprise a core of iron, for example, on which a conductor is wound, so that when a direct current is passed through the conductor, one end of the core will serve as a north magnetic pole and the opposite end as a south pole. The ends of the segments 55 and 55a are

or may be upwardly turned as at 94 and 96, respectively, to be in physical proximity with the north and south poles of the electromagnet 92. Soft iron angle pieces 98 and 100 may be secured to the rings 52 and 54 to form a low reluctance magnetic path between the ends of the magnet 90 and the rings 52 and 54, respectively. Each electromagnet, 90 and 92, is provided with a source of reversible and adjustable direct current 102, one of which is illustrated schematically as including a potential source 104 across which there is adapted to be connected a potentiometer 106, as through the agency of a reversing switch 108. In order to produce an axial magnetic field for the correction of tangential error, the magnet 92 may be immobilized by open circuiting its energy source and the electromagnet 90 may be provided with direct current of suitable polarity and magnitude, so that the pole rings 52 and 54 will serve to pass flux lines axially of the tube. For the correction of radial error, the magnet 90 is immobilized and the magnet 92 suitably energized.

From the foregoing it will be recognized that the present invention provides simple but effective arrangements for selective correction of either tangential or radial mis-positioning of electrons with respect to a target. Such selective action stems from the fact that there is provided in conjunction with a pair of outer, continuous pole rings, inner pole segments, so that a given magnet may cause axially separated rings to act as opposite magnetic poles (for tangential error correction) or may cause radially separated pole segments to act as opposite magnetic poles, depending upon the orientation of the magnet as explained. While the permanent and electromagnetic forms of apparatus have been shown as capable of producing axial or transverse fields, depending upon magnet orientation, it will be understood that it is also possible to produce a composite field having both axial and transverse components by orienting the permanent magnet to positions intermediate the two described positions or, in the electromagnetic arrangement, by energizing both electromagnets in suitable amounts.

Reference is made to the earlier filed, co-pending application of the present inventor, Serial No. 455,941, filed September 14, 1954, showing a pair of axially spaced, continuous pole rings for the correction of tangential error through the production of axial magnetic fields. The present invention will be understood as constituting an improvement thereover, by reason of its ability to produce both axial and transverse magnetic fields.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. An adjunct for a cathode-ray tube of the type including a plane of deflection at which electrons are subjected to a scanning deflection in their transit along the axis of such tube toward a mosaic screen made up of a plurality of respectively different elemental areas, said adjunct comprising: a pair of outer pole-forming members of magnetic material adapted to be arranged in the region of such screen and spaced from each other axially of such tube; a pair of inner pole-forming segments of magnetic material located between and spaced from but parallel to the members of said first pair, said inner segments being separated to form an air gap; and magnet means located in the region of said air gap for energizing either the pole-forming members of said first pair as opposite magnetic poles or the segments of said second pair as opposite magnetic poles.

2. The invention as defined by claim 1, said magnet means comprising a permanent magnet having north and south poles and movable with respect to said pole members and segments.

3. The invention as defined by claim 2 including a shunt member of magnetic material; and means supporting said shunt member and said magnet for relative

movement in such manner as to adjust the strength of the effective field produced by said magnet.

4. The invention as defined by claim 1, said magnet means comprising a permanent magnet having north and south poles and means supporting said magnet for rotation about an axis normal to a line drawn through a line joining such poles and normal to said pole-forming members and segments.

5. An adjunct for a cathode-ray tube of the type including a plane of deflection at which electrons are subjected to a scanning deflection in their transit along the axis of such tube toward a mosaic screen made up of a plurality of respectively different elemental areas, said adjunct comprising: a first pair of outer pole-forming members of magnetic material adapted to be arranged in the region of such screen and spaced from each other axially of such tube; a plurality of inner pole-forming segments of magnetic material located between and spaced from but parallel to said outer pole members, successive ones of said segments being separated from each other by an air gap; and magnet means operative in the air gap region between successive ones of said segments for energizing either the outer pole-forming members as opposite magnetic poles or successive ones of said segments as opposite magnetic poles.

6. An adjunct for a cathode-ray tube of the type including a plane of deflection at which electrons are subjected to a scanning deflection in their transit along the axis of such tube toward a mosaic screen made up of a plurality of respectively different elemental areas, said adjunct comprising: a first pair of outer pole-forming members of magnetic material adapted to be arranged in the region of such screen and spaced from each other axially of such tube; a plurality of inner pole-forming segments of magnetic material located between and spaced from but parallel to said outer pole members, successive ones of said segments being separated from each other by an air gap; and a plurality of permanent magnets, one of said magnets being located and operative in the region of each such air gap; and means supporting each of said magnets for movement with respect to said pole-members and segments in such manner that each of said magnets is capable of movement between positions of parallelism with and perpendicularity to said pole-forming segments.

7. In combination with a cathode ray tube of the type having a plane of deflection at which electrons are subjected to a scanning deflection in their transit along the axis of said tube toward a mosaic screen made up of a plurality of respectively different elemental areas, a pair of outer pole-forming members of magnetic material adapted to be arranged in the region of such screen and spaced from each other axially of such tube; a pair of inner pole-forming segments of magnetic material located between and spaced from but parallel to the members of said first pair, said inner segments being separated to form an air gap; and magnet means located in the region of said air gap for energizing either the pole-forming members of said first pair as opposite magnetic poles or the segments of said second pair as opposite magnetic poles.

8. In combination with a color image reproducing cathode ray tube of the type having a plane of deflection at which electrons are subjected to a scanning deflection in their transit along the axis of said tube toward a mosaic screen made up of a plurality of respectively different elemental areas, a first pair of outer pole-forming members of magnetic material adapted to be arranged in the region of such screen and spaced from each other axially of such tube; a plurality of inner pole-forming segments of magnetic material located between and spaced from but parallel to said outer pole members, successive ones of said segments being separated from each other by an air gap; and a plurality of permanent magnets, one of said magnets being located and operative in the region of

each such air gap; and means supporting each of said magnets for movement with respect to said pole-members and segments in such manner that each of said magnets is capable of movement between positions of parallelism with and perpendicularity to said pole-forming segments. 5

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