Nov. 4, 1958 A. M. MORRELL 2,859,365

ELECTRON BEAM CONTROLLING APPARATUS

Filed Sept. 14, 1954 2 Sheets-Sheet 1

Fig. 1.

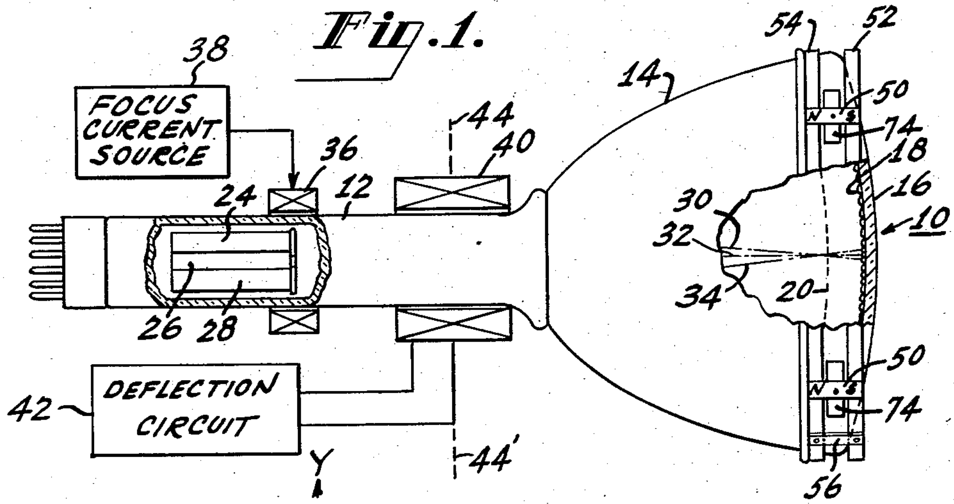
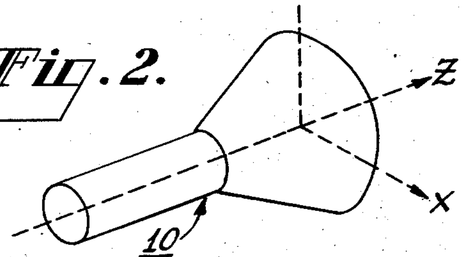


Fig. 2.



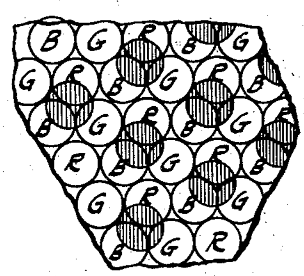
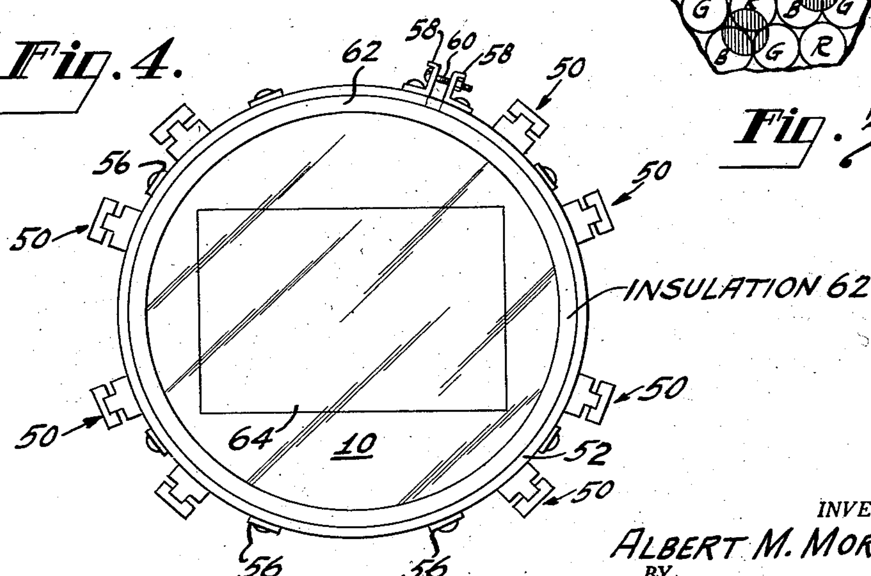


Fig. 3.

Fig. 4.



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ELECTRON BEAM CONTROLLING APPARATUS

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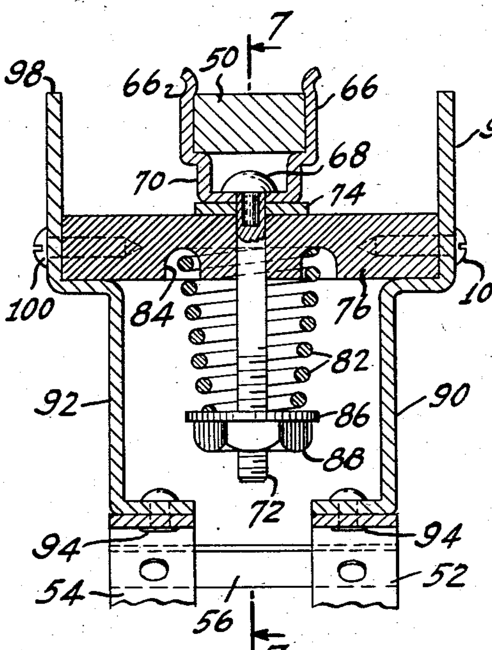


Fig. 6.

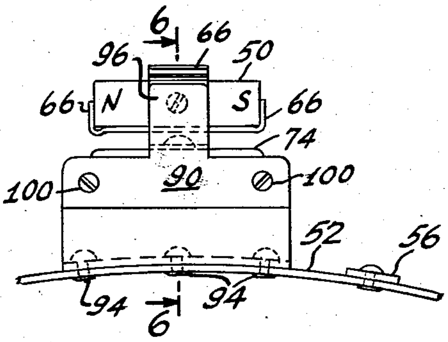
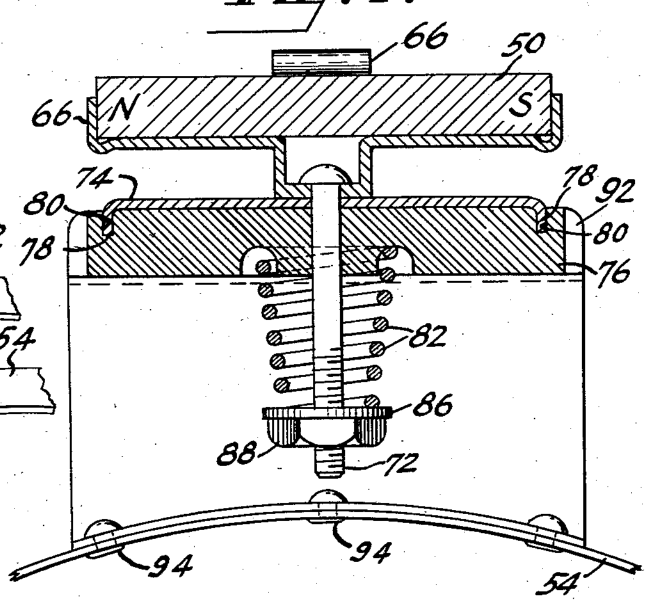


Fig. 5.

Fig. 7.



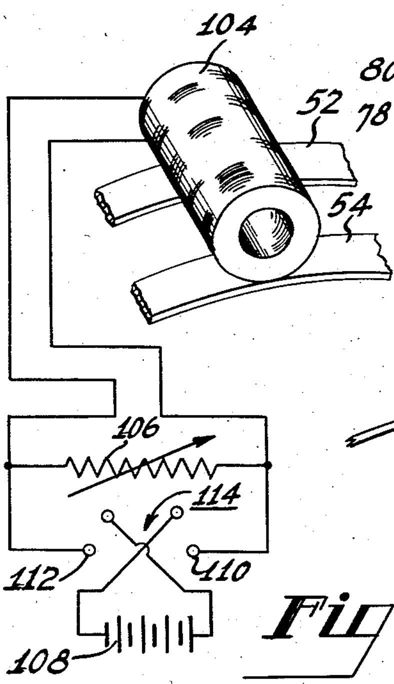


Fig. 8.

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2,859,365

Patented Nov. 4, 1958

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2,859,365

ELECTRON BEAM CONTROLLING APPARATUS

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Application September 14, 1954, Serial No. 455,996

4 Claims. (Cl. 313—77)

This 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 invention is described herein as 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 so 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.

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.

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 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 forms the subject matter of the co-pending application S. N. 364,070, filed June 25, 1953, now abandoned and which provides an electromagnetic coil of suitable internal diameter for permitting its location 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

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certain manufacturing misalignment errors and those attributable to stray fields affect beam positioning differently in different marginal regions of the scanned raster, so that a single correctional field may be incapable of effecting rotational correction in such a case. That is to say, different corners of the raster, for example, may require different correctional treatment.

Hence it is an object herein to provide improved 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. It has been 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 axis 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 parallel to the longitudinal axis of the tube.

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 embodiment of the present invention, such direct current, magnetic field producing means may comprise a plurality of permanent magnets disposed around the screen unit of the cathode ray tube, each of the magnets being in association with magnetic pole forming means and being provided with a magnetic shunt piece, the permanent magnet and its shunt being mounted for relative movement in such manner that the strength and direction of the magnetic fields produced by the magnets may be suitably adjusted.

In accordance with another form of the invention, there is provided a plurality of electro-magnetic coils disposed around the screen region of the cathode ray tube, with separate means associated with each of the coils for applying direct current thereto in a manner which is adjustable as to field strength and direction. The coils are so oriented with respect to pole forming means surrounding the screen unit that the active flux produced by the coils is generally parallel to the longitudinal axis of the tube.

In both of the foregoing forms of the invention, and as will be more fully appreciated hereinafter, the magnets, whether of the electromagnetic or permanent magnetic type, and their pole pieces, are oriented to produce axial fields. Such adjustable axial fields may serve to correct for either rotational misalignment of the parts of the tube or to neutralize undesired stray fields which are axial of the tube.

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 an enlarged detail view of a portion of the apparatus of Figures 1 and 4;

Fig. 6 is a sectional view taken along line 6—6 of Figure 5;

Fig. 7 is a sectional view, with certain parts omitted, taken along line 7—7 of Figure 6; and

Fig. 8 is an isometric view 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. Superficially, 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 electromagnetic 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 sawtooth 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, a primary 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. 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 the 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. The present invention eliminates or, at least, substantially minimizes such color dilution through the agency of means for subjecting the several electron beams to the action of substantially constant (i. e., D. C.) axial magnetic fields, 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 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 some of the iron rings 52 and 54 which serve as magnetic pole forming means. The pole rings 52 and 54 are held in spaced relationship by means of spacers 56 of brass or other non-magnetic material, the spacers being riveted or otherwise secured to the rings. For ease of mounting the assembly, the rings are split and their loose ends are provided with brackets 58 of brass or other non-magnetic material. A brass bolt 60 is passed through holes in the brackets 58 for securing the assembly.

As shown further in Figure 4, the rings are not mounted directly on the tube 10 but are, rather, 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 Figures 5, 6 and 7, there is shown here in enlarged fashion one of the permanent magnets of Figures 1 and 4. The permanent magnet 50 is a bar magnet having north and south poles designated "N" and "S" and is held by a clamp 66 formed of suitable non-magnetic spring material such as Phosphor bronze. A rivet 68 passed through an aperture 70 in the bottom of the clamp 66 is secured to one end of a threaded bolt 72.

The bolt 72 passes through a shunt piece 74 of soft iron or other magnetic material which is supported by a block 76 of Lucite or other plastic composition, as indicated in Figure 7. Specifically, the shunt piece 74 is provided at each end with a detent or struck-down portion 78, the detent being held in depressions 80 in the top surface of the block 76. A coil compression spring 82 which may be conical, as shown, surrounds the bolt 72 and bears against a continuous groove 84 in the under-surface of the block 76. The end of the spring 82 remote from the block, bears against a washer 86 which is held on the bolt by means of a nut 88.

The block 76 is supported, with respect to the soft iron rings 52 and 54, by means of soft iron brackets 90 and 92. The brackets 90 and 92 are secured, respectively, to the rings 52 and 54 by means of rivets 94 and the block 76 is secured to upwardly-extending portions 96 and 98 of the brackets by screws 100.

From the foregoing, it will be understood that the magnet 50 carried by the clamp 66, may be rotated about the axis of the bolt 72. When the magnet 50 is oriented as shown in Figure 1 (i. e., parallel to the longitudinal axis of the tube 10 or at right angles to the position shown in Figures 4 through 7), the north and south poles of the magnet will be spaced a very short distance from the upwardly-extending portions of the brackets 96 and 98, so that the path of the magnetic flux produced by the magnet 50 may be traced through the apparatus as follows:

Assuming that the magnet is oriented with its north pole adjacent the member 98 and its south pole adjacent the member 96, flux will pass through the member 98 and its lower portion 92 to the pole ring 54. The pole ring 54 serves to spread the flux over an appreciable angle of the tube, and the flux passes from the ring 54 to the ring 52, from which it travels through the bracket 90 and its upwardly-extending portion 96 to the south pole of the magnet. It should be born in mind that the pole forming rings 52 and 54 serve, in addition to their function of enlarging the sector of activity of each of the magnets 50, to render the active magnetic field in the region of the screen unit of the tube more uniformly axial with respect to the tube.

In the operation of the apparatus of Figures 1 through 7 and assuming that rotational or tangential color dilution exists in the corners of the raster 64 as illustrated by the showing of Figure 3, which color dilution is most prominent in the marginal regions of the raster, each of the magnets 50 may be rotated about its bolt 72 so that it is perpendicular to its shunt piece 74. In this position the magnetic fields produced will be maximum. Normally, if it is found that color dilution in a particular section of the raster is increased rather than decreased with the magnets adjacent that section polarized in a given direction, that fact indicates that the magnetic field operating upon the raster there is of the wrong polarity. The magnet in question may then be rotated through 180° until the proper magnitude of magnetic field of the required polarization is provided. Assuming further that no color dilution is present in one of the sections of the raster, so that no correction is required there, the permanent magnets nearest that section may be effectively immobilized by rotating them until they are parallel to their magnetic shunt pieces 74.

The foregoing description of the operation of the present invention as thus far illustrated is applicable to the correction of color dilution of the tangential type, regardless of whether such color dilution is caused by rotational misalignment of the shadow mask and phosphor screen, or whether the error may be traced to ambient magnetic fields having components parallel to the longitudinal axis of the tube.

Whereas the foregoing aspect of the invention has been described in accordance with a specific embodiment in which the pole forming rings are split in the interest of facilitating mounting thereof on the cathode ray tube, it will be understood that the rings may be continuous, if desired. Moreover, while specific magnetic materials have been set forth by way of example for the rings and their extensions 90 and 92, it is to be understood that other materials offering the necessary magnetic properties may be substituted. Corresponding substitutions of materials may also be made for the spacers 56, bracket 66 and the other non-magnetic elements of the apparatus.

Figure 8 is illustrative of a second form of the invention; namely, that employing electromagnetic means in place of the permanent magnets heretofore described. In Figure 8, an electromagnetic coil 104 which is generally of cylindrical form is mounted on the pole forming rings 52 and 54 so that the rings lie adjacent the opposite magnetic poles of the coil. The coil 104 is supplied with direct current energy from a variable source illustrated, by way of example, as comprising a rheostat 106 across which is connected a battery 108 whose terminals may be connected in either of two directions to the ends 110 and 112 of the rheostat. Such reversible connections are made through the agency of a reversing switch 114. In an arrangement employing the electromagnetic form of the invention shown in Figure 8, a plurality of electromagnets 104 will be provided, each of the coils being supplied with reversible and variable direct current from a separate source. The electromagnetic assembly is mounted around the screen region of a cathode ray tube such as the tube 10 of Figure 1 and is effective in correcting color purity in the following manner. Assuming that there exists a condition of color dilution of the tangential type, as by reason of rotational misalignment of the tube elements or by reason of stray magnetic fields having axial components, each of the coils 104 is connected to its energy source. If it is found upon closing of the direct current paths through the coils and their energy sources that color dilution is increased rather than decreased, the reversing switches should be moved to their opposite positions and the rheostats adjusted to provide the proper magnitude of current through the coils for effecting rotational movement of the beams with respect to the phosphor screen. By virtue of the pole rings 52 and 54, the magnetic field of each of the coils 104 is spread over a substantially greater angle than that which would be affected in the absence of the rings, so that the number of coils required is thereby substantially reduced. Moreover, the rings 52 and 54 serve to insure that the magnetic fields of the coils are substantially parallel to the longitudinal axis of the cathode ray tube about which they are located.

From the foregoing, it will be understood that the present invention provides means comprising a plurality of magnets disposed around the screen unit of a tri-color kinescope, which magnets are adapted to be active in the marginal regions of the raster scanned on the screen and for the purpose of substantially eliminating tangential color dilution error. The pole forming means provided by the invention served to improve the shapes of the magnetic fields and to extend the activity of each magnet over a wider range than is otherwise possible. In the case of permanent magnet arrangement, adjustability of the strength of the magnetic fields is afforded through the agency of the shunt pieces, while the strength of the electromagnetic fields is adjustable in the manner shown.

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

1. The combination with a color image-reproducing cathode ray tube having a longitudinal axis and a plane of deflection at which electrons are subjected to a scanning deflection in their transit in angularly related paths to a mosaic screen of the type comprising areas of respectively different color characteristics, of a plurality of magnets mounted adjacent to and disposed around said screen, each of said magnets being adapted to provide a magnetic field whose flux lines are generally parallel to

such longitudinal axis of said tube, and pole-forming means located between said magnets and said tube.

2. The combination with a color image-reproducing cathode ray tube having a longitudinal axis and a plane of deflection at which electrons are subjected to a scanning deflection in their transit in angularly related paths to a mosaic screen of the type comprising areas of respectively different color characteristics, of a plurality of permanent magnets arranged around such paths and located in the vicinity of said screen and magnetic pole-forming means located between said magnets and said tube for causing said magnets to produce magnetic fields whose lines of flux are generally parallel to said longitudinal axis.

3. An adjunct for a color image-reproducing cathode ray tube of the type including a plane of deflection at which electrons are subjected to a scanning deflection in their transit toward a mosaic screen made up of a plurality of areas of respectively different color characteristics, said adjunct comprising: a plurality of magnets, means for supporting said magnets in ring-like array such that said magnets may be disposed around and adjacent to such screen and magnetic pole-forming means within said ring-like array for causing said magnets to produce magnetic fields whose lines of flux are in the axial direction of such tube.

4. The combination with a color image-reproducing cathode ray tube having a longitudinal axis and a plane of deflection at which electrons are subjected to a scanning deflection in their transit in angularly related paths to a mosaic screen of the type made up of areas of respectively different color characteristics, of a magnet having north and south poles, a pair of elongated magnetic pole members disposed adjacent said screen and spaced from each other axially of said tube, and means for supporting said magnet with respect to said pole members such that said members may serve as north and south magnetic poles for flux from said magnet, thereby spreading such flux through a greater angle in a plane perpendicular to such longitudinal axis than would be the case in the absence of said pole members.

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