

Aug. 23, 1960

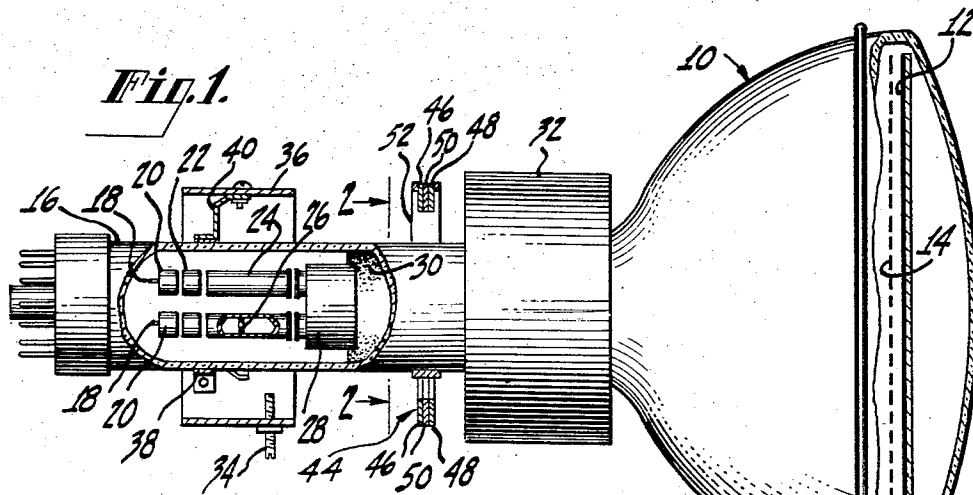
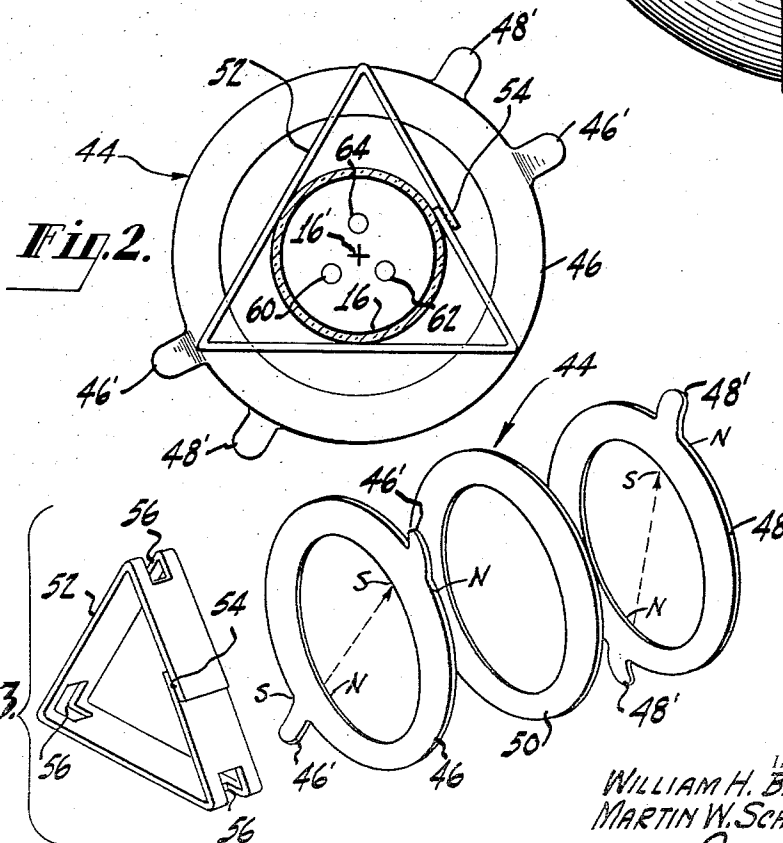
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2,950,407

ELECTRIC BEAM CONTROLLING APPARATUS

Filed Dec. 21, 1956

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

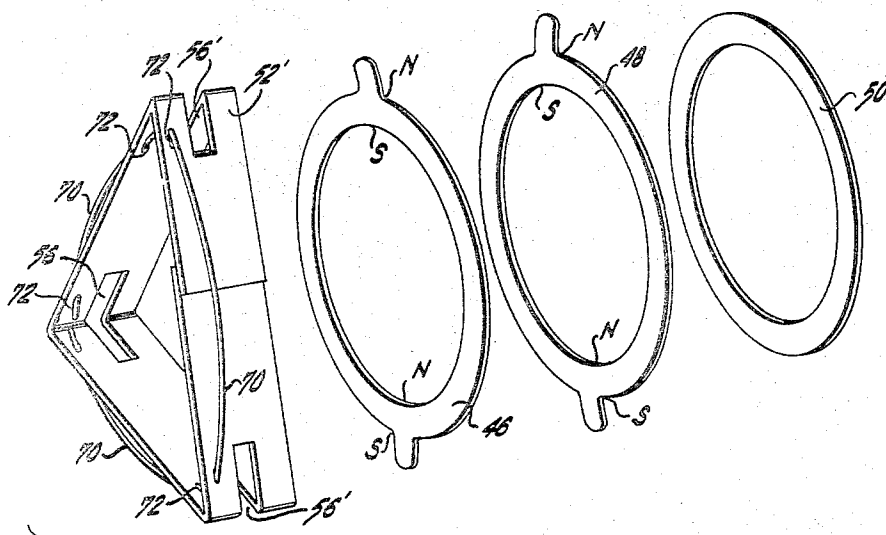


Fig. 4.

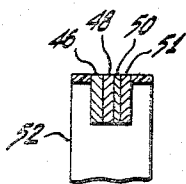


Fig. 5.

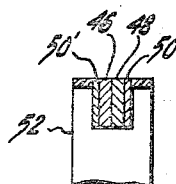


Fig. 6.

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ELECTRIC BEAM CONTROLLING APPARATUS

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15 Claims. (Cl. 313—70)

This application is a continuation-in-part of application Serial No. 405,175, filed January 20, 1954, now forfeited.

The present invention relates to new and improved cathode ray image reproduction apparatus and, more particularly, although not necessarily exclusively, to beam controlling apparatus for use with multiple gun kinescopes of the variety employed in color television receivers.

While the invention will be described herein in connection with a three-beam color kinescope of the shadow mask type, such as is described in an article entitled "A Three-Gun Shadow-Mask Color Kinescope" by H. B. Law in the Proceedings of the IRE, October 1951, its applicability to other types of image reproducers should be borne in mind.

In the three-beam shadow-mask color kinescope described in the cited article, three electron beams are employed, one for each selected component color. The beams strike a phosphor screen composed of a regular array of red, green and blue light emitting phosphor dots. Between the electron gun position and the phosphor screen there is placed a thin perforated metal sheet which masks the electron beams. The phosphor screen is made up of closely spaced trios of phosphor dots on a glass plate, each trio consisting of red, green and blue luminescing dots, with the centers of the dots lying at the corners of an equilateral triangle. The trios themselves lie at the corners of a still larger equilateral triangle. Associated with each of the phosphor trios is a hole or aperture in the shadow mask, such holes also being located at the corners of an equilateral triangle. The three beams, located 120° apart about the longitudinal axis of the tube are converged to a point on the mask by an electron lens system. The electron beam which is to contribute the red portions of the picture is prevented by the mask from striking those areas on the screen containing blue and green light-emitting phosphors. Similarly, the green and blue beams are permitted to strike only the green and blue phosphor dots, respectively.

The fabrication of the phosphor screen of the three beam shadow mask tube includes the coating of a glass plate used as the screen support with a film of photosensitive phosphor material. The apertured mask is mounted adjacent to the coated plate in the same position that it will occupy in the completed tube. The photosensitive film is exposed through the mask to a point light source placed at a point simulating a color center of the completed tube. The color centers of a three beam tube are those three points within the tube from which the three electron beams, at any one time, appear to emanate, after the beams have been deflected by the scanning yoke. After exposure, the unexposed portions of the phosphor film are removed and a second photosensitive phosphor film is applied to the glass plate surface and the plate again exposed to the point light source placed at a second color center. Again the unexposed phosphor film areas are removed from the glass plate and a third film is applied to the plate and exposed from the third color cen-

ter. Again after removing the unexposed portion of the third film, there remains on the glass plate three dot patterns, each of a different light emitting phosphor material.

The electron gun assembly and the phosphor screen are fabricated independently and only in the final assembly of the color tube parts within the envelope are they brought into an operative relationship. Since the screen was formed from accurately determined simulated color centers, it is necessary in the operation of the completed tube to insure that the three electron beams of the gun assembly will have color centers coinciding with the simulated centers used to form the phosphor screen. Because of the manufacturing tolerances obtained by mass production techniques in fabricating the electron gun, it has been found necessary to provide corrective means to insure that the color centers of the electron beams of each tube will substantially coincide with the simulated color centers used to form the screen of the tube. Such corrective means have been found necessary in most cases to provide color purity of the picture formed on the tube screen during tube operation.

In some tubes used for color television or for other purposes, only a single beam may be used. The operation of such tubes may require that the beam be sequentially deflected off the gun axis in different directions to effectively produce three beam portions approaching the tube target from off-axis positions to which the beam was deflected. For color television it is again important that the beam portions pass through their proper color centers.

It is therefore an object of the present invention, to provide new and simplified means for providing color purity in a cathode ray tube used for viewing a color image.

A further object of the present invention is the provision of means for affording color purification in a color cathode ray tube in a novel and simple manner.

It is another object of this invention to provide color purity in a plural beam cathode ray tube by novel means for correctly positioning the color centers of the beams.

The present invention is a device for obtaining color purity in a plural beam color tube. The device includes three metal rings, each of which is rotatable about the axis of the cathode ray tube. Two of the rings are magnets and the third ring is a washer of high permeability material. The assembled rings are supported coaxially on the axis of the neck. The relative positions of the magnet rings determine the direction and value of the resulting magnetic flux, which is used to position the several beams of the tube so that they pass through the proper color centers in the deflection region of the tube.

Additional objects and advantages of the present invention will become apparent from a study of the following detailed description of the accompanying drawings, in which:

Figure 1 is an elevational view, partially in section, of a tri-gun shadow mask color kinescope in association with apparatus embodying the principles of the present invention;

Figure 2 is a vertical sectional view along line 2—2 of Figure 1, with parts removed in the interest of simplicity;

Figure 3 is an exploded view of one form of the invention, and

Figure 4 is an exploded view of another form of the invention;

Figures 5 and 6 are partial sectional views of alternative arrangements of the structures of Figures 1—3.

Referring to the drawing, there is illustrated in Figure 1 a tricolor kinescope 10 of the type described in the above mentioned Law article, which kinescope includes

a phosphor screen 12 and a shadow mask 14, both of which are described in detail in the article. Three electron guns are located within the neck portion 16 of the kinescope and are arranged at the apices of an equilateral triangle. In the drawing, only two of the three guns are shown, but it will be understood that each of the guns includes an indirectly heated cathode 18 enclosed within a cylinder 20 (closed at the target end by an apertured disc) which cylinder serves as the control grid. Each gun further includes an accelerating cylinder 22, having an apertured end plate at its target end and a second or beam focusing accelerating cylinder 24, which includes a limiting aperture disc 26. The kinescope is also provided with a substantially cylindrical accelerating convergence electrode 28, which is common to and surrounds the paths of all three guns. Another important part of the electron system of the kinescope is the final or beam-accelerating electrode 30, which is illustrated herein as a conductive wall coating, formed on the inner surface of the kinescope and which extends from the neck thereof in the vicinity of the convergence electrode 28 along the flared bulb envelope portion to a region in the vicinity of the target structure.

Respective electron lenses formed between the individual beam-focusing electrodes 24 and the common convergence electrode 28, when all are suitably energized, function to effect independent focusing of the individual electron beams so that they may have minimum spot sizes at the target. An electron lens formed between the convergence electrode 28 and the beam-accelerating electrode 30 functions to effect substantial convergence of the several electron beams in the plane of the aperture mask 14. In a conventional manner, the kinescope 10 is further provided with a deflection yoke 32 seated on the tube neck, as shown, for effecting the desired raster scanning deflection of the beams and which may comprise the usual arrangement of horizontal and vertical deflection windings assembled so that the yoke is substantially anastigmatic.

Also illustrated in the interest of completeness of description are means for effecting rotatable positioning of the electron beams. Briefly, such means, known as "beam alignment" or "beam positioning" apparatus comprises three permanent magnets such as the one shown at 34. Each of the magnets 34 is or may be in the form of a magnetized threaded bolt, held in spaced relationship (120° apart about the longitudinal axis of the tube), as by means of a cylindrical member 36 secured rigidly to the tube neck through the agency of a clamp member 38 and struts 40. The cylindrical member 36 may be formed of high permeability material in order that it may serve additionally as shielding means. Thus, it will be understood that each of the magnets 34 may be adjustably positioned with respect to a different one of the electron beams in such manner as to effect what amounts to a rotational alignment or radial positioning of the beam, in order that the beam is initially directed toward its proper position at the shadow mask 14.

The electron gun structure of the color tube may consist of several electron guns or a single common gun structure for producing three electron beams angularly spaced 120° about the axis of the tube neck.

The phosphor screen 12 of the shadow-mask color tube is normally fabricated by coating a glass plate 13 with a photosensitive phosphor film. The glass plate may be a separate plate mounted within the tube envelope, or may be the face plate of tube envelope. The apertured mask 14 is mounted in a predetermined spaced relationship to the glass plate. The photosensitive phosphor film is exposed to a point light source positioned so that light passing through the apertured mask will strike the photo-sensitive film in areas to which the electron beams will be directed in the finished tube. The positioning of the light source is, thus, critical and is at points spaced from the mask corresponding to the three color centers

of the tube. These color centers are those three virtual points, within the tube neck, each one determined, with respect to a different beam, by the intersection of the projection of the beam path before deflection by yoke 32 and the projection of the beam path after deflection. Thus, the three color centers are within the tube neck portion enclosed by the deflection yoke. Because the alignment of the tube gun structure with the tube neck provides three beams angularly spaced about the tube axis, the three color centers also have the same angular spacing.

The phosphor screen is fabricated by placing the exposing light source at a first point, corresponding to a first color center, to expose the phosphor screen through the apertured mask in dot areas to be struck by one of the electron beams in the finished tube. The unexposed phosphor film is removed and a second photosensitive film of a different color luminescent phosphor is coated over the glass plate. The light source is moved to a second point corresponding to a second color center and the phosphor film exposed to form a second set of exposed dot areas. The process is repeated for a third color luminescent phosphor film to form a third dot configuration with the exposing light source placed at a third simulated color center.

In this manner, the phosphor screen is fabricated by exposure from simulated color centers. However, manufacturing tolerances render it difficult to produce electron gun structures whose color centers in the finished tubes will accurately coincide with the simulated centers used to form the respective screens. This results in the electron beam of a particular tube following paths different from those of the light used to produce the phosphor dot patterns of the screen. The beams, then, will strike phosphor areas other than those for which they are intended and will produce color dilution. It is necessary, in tubes of this type, to provide corrective means to ensure that the electron beams of each tube will have color centers substantially coinciding with the simulated centers used to form the screen of the tube, in order to provide "color purity" of the picture.

In accordance with the invention, there is provided means for shifting the three beams, of the tube of Figure 1, as a group with respect to the tube axis. Such shifting is in addition to the "alignment" function performed by the positioning magnets 34. In accordance with a specific embodiment of the present invention such shifting or "color purification" is accomplished through the agency of the apparatus indicated generally by reference numeral 44. As shown in Figure 1, the color purity apparatus 44 comprises a pair of "ring" or annular permanent magnet elements or members 46 and 48 and an annular shunting element or washer member 50 of material, which has high permeability at low flux densities, but, which saturates rapidly for greater flux densities. The two ring magnet elements 46 and 48 and shunting member 50 are of equal inner diameter and are supported coaxially with respect to the neck of the kinescope 10 by means of a non-magnetic holder 52. Shunting member 50 is thinner than magnet elements 46 and 48.

Insofar as the specific material of which the washer member 50 is formed is concerned, the specifications set forth above therefor describe the particular properties. One well-known material which may be employed is that manufactured and sold by the Allegheny Ludlum Steel Corporation under the registered trademark "Mumetal", which comprises a nickel-copper-iron alloy having high permeability at low flux densities. A typical composition of Mumetal is 77.2 percent nickel, 4.8 percent copper, 1.5 percent chromium and the balance iron. Each of the ring magnets 46 and 47 is provided with radial extensions or tabs 46' and 48', respectively, for ease of manipulation. Moreover, the tabs 46' and 48' may be bent out of the planes of the magnets themselves in order to facilitate grasping of the tabs. The magnets

are, perhaps, better seen in the view of Figure 2 in their relationship to both the cathode ray tube neck 16 and the holder 52.

The holder 52 comprises a strip of insulating material such as "nylon" formed into an equilateral triangle with its overlapping ends heat-sealed as at 54. Each apex of the triangular "nylon" holder is provided with a slot, as shown in Figure 3, which slots are indicated at 56. The depth of the slots 56 is so chosen that the ring magnet elements 46 and 48 and the Mumetal shunting washer member 50 are held within the slots coaxially with the center of the triangle. The width of each of the slots 56 should be no greater than is necessary to accommodate the ring magnets and washer with a slightly frictional fit. The internal dimensions of the triangular member 52 should be such that the holder fits snugly about the kinescope neck 16. Since the nylon material is somewhat flexible, the holder may be slightly smaller than the tube neck so that its sides bow to accommodate the tube, whereby a tight fit is afforded. By virtue of the triangular shape of the holder 52, the magnetic holder is "self-centering" with respect to the neck 15 of the kinescope 10. That is to say, since the holder contacts the tube neck at three equally spaced points, the ring magnets and washer may be automatically centered about the longitudinal axis 16' of the tube (represented by the cross mark in Figure 2). With the nylon holder 52, no metal contacts the tube neck. This eliminates possible scratching of the glass neck. Also, the nylon holder provides a better bearing surface against the glass.

Each of the ring magnets 46 and 48 is magnetized along a diameter, as shown for example, by the north and south pole designations "N" and "S" and the arrows, shown in Figure 3. Thus, it will be understood that, when the tabs of the two magnets 46 and 48 are together with the magnetic fields in alignment, the combined magnetic field across the diameters of the two magnets is at its maximum value. When one of the magnets is rotated 180° about an axis normal to its plane, the resultant magnetic field will be at its minimum value.

There have been previous proposals for permanent magnet centering devices, such as have been suggested for use with single beam kinescopes, which bear a general resemblance to the ring magnets forming a part of the present invention. These devices include only a pair of magnet rings, magnetized across their diameters. Such prior art devices act upon a single beam, the cross-sectional diameter which may be of the order of 100 mils. When the two magnets of these prior devices are rotated so as to oppose each other, the magnet flux field at their centers is sufficiently zero so that the beam is unaffected. However, the flux field, as measured from the center radially outwardly to the rings, has a gradually increasing, finite value. Such a "zero" field is not sufficient for use in the present type of arrangement, wherein three beams are spaced a substantial distance from the central axis of the tube, such that the beams are for example, located perhaps 1/2" from each other. This latter arrangement is illustrated in Figure 2, wherein the beams produced by the electron guns of kinescope 10 are shown at 60, 62 and 64. Moreover, it has been found that such a gradually increasing field, supplied by these prior art structures, is not sufficiently uniform for all points on concentric circles about the tube axis. Thus, each of the three beams of the color tube would be subjected to a magnetic field different from that acting upon each of the other beams. With such a magnetic environment, undesirable mispositioning and distortion of the beams are necessary results which are obviated by means of the present invention.

More specifically, in accordance with the invention the Mumetal washer 50, having a high permeability at low flux densities, serves as a shunt or short circuit for the weak field which is present when the two ring magnets 46 and 48 are diametrically opposed. That is to say,

the flux lines, which are present, travel short-circuit-wise through the washer and are prevented from passing through the neck of the kinescope, where their influence is undesired. Since the Mumetal washer saturates readily, the stronger magnetic fields, which are produced when the magnets are not opposed are permitted to pass through the tube to effect the color purification desired.

The magnetic field required for beam correction by the magnets 46 and 48 is relatively small. The maximum field at the center of the two magnet rings is in the order of 9 gauss. When the rings 46 and 48 are turned so that their fields mutually buck-out, or oppose each other, the minimum field at the center of the rings is in the order of 0.1 gauss. Since this is a very weak field, its action on the electron beams is effectively zero. Without the shunting ring 50, however, it would be quite impossible to obtain as low a field as 0.1 gauss within the magnet rings.

What has been described above are magnet rings, which are being used successfully in accordance with the invention, with color tubes of the type described. Each alone produces a field across its center in the order of 4 to 5 gauss. Each magnet of the assembly 44 is magnetized uniformly. It has been found desirable that the magnet rings 46 and 48 be of the same shape and size so that the fields of the magnets will more effectively buck-out when the magnets are turned to oppose each other. High quality metal is preferred, since non-uniformity in the metal of the magnet results in non-uniformity of the field of the magnet and thus, hinders the bucking-out of one field by the other. The magnets 46 and 48 are thus matched as closely as possible. Differences caused by mismatching of a pair of magnets due to production tolerances are compensated for by the shunt washer 50, when the magnets are positioned in the range of adjustment for a minimum field. The magnet rings are easily magnetized in a manner similar to that used for magnetizing speaker magnets. The procedure is that of placing the rings in a high density unidirectional magnetic field, until the desired magnetism is established across each ring.

The size of the magnets, as well as of the shunt washer ring 50 is not critical. However, dimensions are minimized to provide a device of lowest cost which will provide the desired results. It is preferable that the shunt ring be of a material which will saturate above low field strengths. The washer 50 of "mu-metal" is thick enough to function as a magnetic shunt element yet thin enough to saturate in the desired manner. The magnets are designed to provide the desired range of field strengths across their diameters. Stronger magnets can be used, but this would require a thicker shunt ring with a resulting increase in cost of materials. The magnets 46 and 48 may be made of appropriate magnetic material. However, it has been found that spring steel has proved to be a less expensive material, and is sufficient for the purpose described.

It is possible that other shapes of the rings 46, 48 and 50 may be used. For example, washer 50 could consist of a tubular ring encircling tubular magnets 46 and 48. This, however, would be a more expensive design.

The shape of magnets 46 and 48, as shown in Figure 3, need not be limiting. However, the design of the magnets, as shown, appears to provide the optimum effects desired. The magnets 46 and 48 may be segments of rings mounted in an insulating holder. The arcuate or ring-shape of magnets 46 and 48 and shunting ring 50 appear to be an optimum configuration. The arcuate ring shape provides greater uniformity of the magnetic field and is easily duplicated from magnet to magnet in production, which results in optimum bucking effects between opposed magnets. Furthermore, the arcuate shape provides a consistently good centering of

the magnetic field relative to the tube axis and the electron beam paths:

Figure 4 shows a slight modification of the design of Figure 3. Figure 4 is an exploded view of the magnet assembly and shows the shunting ring 50 on one side of the magnet rings 46 and 48. It was found, in accordance with the invention that ring 50 need not be sandwiched between the magnet rings 46 and 48, but can be positioned on either side of the magnet rings to provide the desired shunting effect. The assembly shown in Figure 4 includes a nylon triangular support structure 52' having supporting notches 56' corresponding to notches 56 of the structure of Figure 3. Fastened along each side of the triangular support rod 52' is a spring wire 70, which is threaded through apertures 72 at the corners of the triangular support. Wires 70 add a certain resilience to the nylon support and help to hold it securely to the round neck of the tube, when the magnet assembly is placed in position.

Figures 5 and 6 are partial sectional views of the centering magnet assembly, showing alternative arrangements of the magnet rings and shunting washer. Figure 5 shows washer 50 on one side of the two magnet rings 46 and 48 which are positioned next to each other. This is the same arrangement shown in Figure 4. If desirable a non-magnetic ring 51 such as brass, fiberboard or the like may be assembled on support 52 with rings 46, 48 and 50, to add lateral support to the thin washer 50. Figure 6 shows an arrangement of two shunting washers 50 and 50', one on either side of the two adjacent magnet rings 46 and 48 for the purpose of producing a more symmetrical field produced by the structure of Figure 4. This arrangement is feasible, if the two washers 50 and 50' will both saturate at the low field density present when magnets 46 and 48 are aiding each other. It is also possible to use a third shunt washer between magnets 46 and 48 in the arrangement of Figure 6. Again all the shunt washers should saturate at the low flux density in accordance with the invention.

While the invention has been described in accordance with a specific embodiment in which the high permeability washer is formed of "Mumetal" it should be understood that any other material having the described properties may be employed. Additionally, any other non-magnetic material having the requisite mechanical strength and flexibility may be substituted for the "nylon" described above as the material of which the triangular holder 52 is fashioned.

The position of the novel beam alignment device 44 on the tube neck need not be limited to the position shown in Figure 1. On some successfully operated tubes the assembly 44 is positioned adjacent to the focus lens between electrodes 26 and 28. However, the device can be used anywhere on the tube from the gun cathode position to the apertured mask 14, to provide color purity.

The use of the alignment device 44 has been described specifically with respect to a three beam tube. However, some color television picture tubes utilize a single beam gun. The single beam is sequentially directed along a plurality of beam paths which approach the target of the tube from different directions. A tube of this type is disclosed in U.S. Patent 2,581,487 to D. A. Jenny. In single beam multi-path tubes, alignment of the beam at the color centers is also important. The above described alignment device 44 can also be used with single beam tubes of this type in the manner described.

We claim:

1. Electron beam controlling apparatus comprising a pair of annular permanent magnets magnetized along their diameters; means for supporting said magnets coaxially with and for rotation about the neck of a cathode ray tube; and an annular member disposed between

said magnets; said annular member being of high permeability at low flux densities.

2. The invention as defined by claim 1 wherein said annular member comprises an iron alloy washer.

3. Electron beam controlling apparatus comprising a pair of annular permanent magnets, each magnetized along its diameter; a washer of high permeability; and means for supporting said magnets and washer coaxially with and for rotation about the neck of a cathode ray tube, said means comprising a triangular member of non-magnetic material whose internal dimensions are sufficient to accommodate tightly the neck of a cathode ray tube, said triangular member having means on its apices for holding said magnets in axial alignment with each other.

4. Apparatus for controlling the axial positioning of an electron beam within a cathode ray tube, which comprises: a pair of annular magnets, each permanently magnetized along its diameter; an annular washer of high permeability material disposed between said magnets, said washer and said magnets having substantially equal internal diameters greater than the external diameter of the neck of such cathode ray tube; and means including a holder for maintaining said magnets and said washer in axial alignment with each other and coaxially with such tube.

5. The invention as defined by claim 4 wherein said washer of high permeability is readily saturated by a relatively strong magnetic field.

6. In combination with a cathode ray color image reproducing tube having a neck portion, a target area and means within said neck portion for directing a plurality of electron beams along spaced paths toward said target, beam controlling apparatus for adjustably positioning said beams with respect to the axis of said tube, which comprises: a pair of annular magnets, each permanently magnetized along its diameter; an annular washer having high permeability to relatively low flux densities, said washer being disposed coaxially with and between said magnets; and means for supporting said washer and magnets around and coaxially with said tube neck and for permitting relative rotation of said magnets.

7. The invention as defined by claim 6 wherein said washer is formed of an iron alloy containing nickel, copper and chromium.

8. In combination with a cathode ray color image reproducing tube having a neck portion, a target area, means within said neck portion for directing a plurality of electron beams along spaced paths toward said target and beam alignment means for providing each such beam with a predetermined location relative to another of such beams, electron beam controlling apparatus disposed between said beam alignment means and said target area for adjustably positioning said beams with respect to the axis of said tube, which comprises: a pair of annular permanent magnets, each magnetized along its diameter; means for supporting said magnets coaxially with and for rotation about the axis of said tube; and an annular washer member disposed between and substantially coaxially with said magnets, said washer being of material having high permeability at low flux densities whereby to provide a zero field strength within said tube when said magnets are arranged with their opposite poles in substantial juxtaposition.

9. A magnet device for a cathode ray tube, said magnet device comprising a plurality of annular elements, means coaxially mounting said elements adjacent to each other, at least two of said annular elements including a magnet, another one of said annular elements being of material having a high magnetic permeability at low magnetic flux densities.

10. A magnet device for a cathode ray tube, said magnet device comprising a plurality of annular elements, means coaxially mounting said elements adjacent to each other, at least two of said annular elements being dia-

metrically magnetized to provide a magnetic field across each of said two annular elements, another one of said annular elements being of material having a high magnetic permeability at low magnetic flux densities.

11. A magnet device for a cathode ray tube, said magnet device comprising a plurality of rings, means coaxially mounting said rings adjacent to each other, at least two of said rings having magnetized portions positioned to provide a magnetic flux diametrically across each of said two rings, another one of said rings being of material having high magnetic permeability at low magnetic flux densities.

12. A magnet device for a cathode ray tube, said magnet device comprising a plurality of rings, a mount structure supporting said rings in contact with each other and for rotational movement about a common axis through the center of said rings, at least two of said rings being magnetized along their respective diameters, a magnetically permeable element mounted adjacent to said rings, said permeable element being of a material having the property of high magnetic permeability at low magnetic flux densities, said permeable element being formed of material which saturates rapidly at greater flux densities.

13. Electron beam controlling apparatus comprising a pair of annular permanent magnets magnetized along their diameters, means supporting said magnets for rotation about a common axis through their centers, and an annular member coaxially mounted in contact with one of said annular magnets, said annular member being of

material having high permeability at low flux densities.

14. A color purity magnet device for use with a plural beam cathode ray tube, said magnet device comprising a pair of annular permanent magnets, means mounting said magnets adjacent to each other on a common axis, and a shunting element of a material having high magnetic permeability at low flux densities supported by said mounting means adjacent to said magnets.

15. An electron discharge device comprising a tubular envelope portion, an electron gun structure within said envelope for providing a plurality of beams spaced from the axis of said envelope portion, a pair of permanent magnets magnetized along their diameters, means supporting said magnets on said tubular envelope portion for a rotation about said axis, and an annular member coaxially mounted with said magnets, said annular member being of material having high permeability at low flux densities.

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