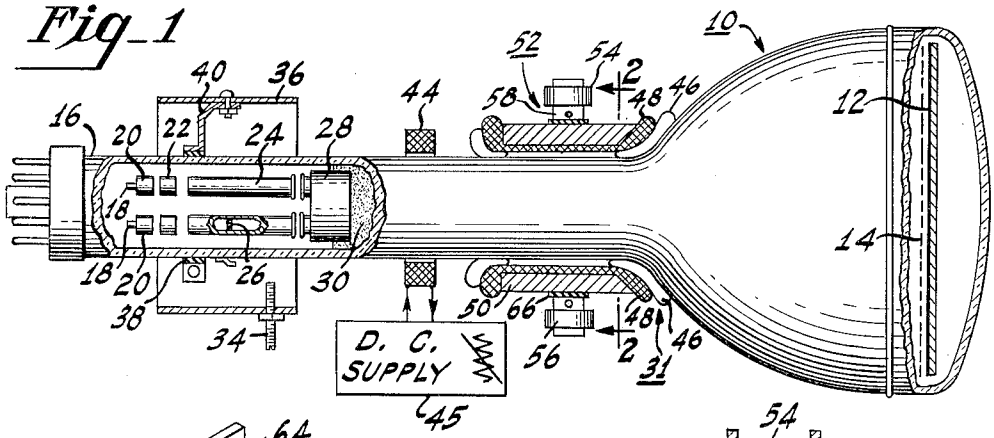
Sept. 6, 1955 B. R. CLAY 2,717,323

ELECTRON BEAM CENTERING APPARATUS

Filed March 23, 1954

Fig_1



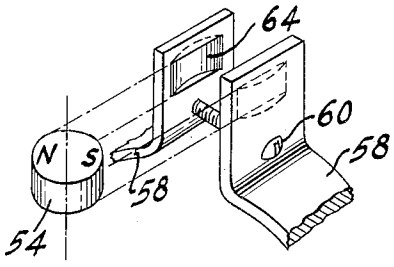


Fig_3

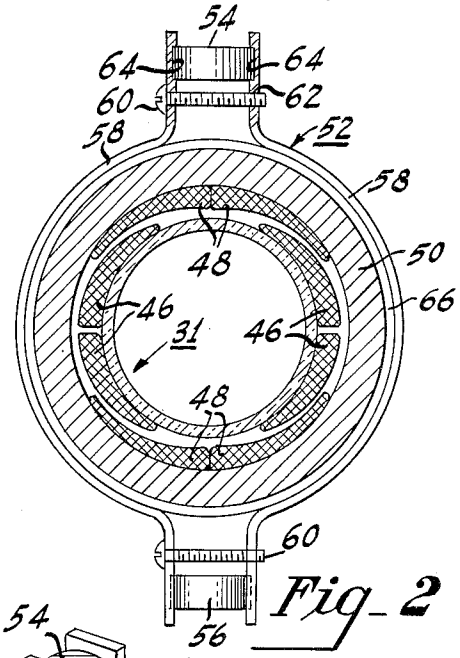


Fig_2

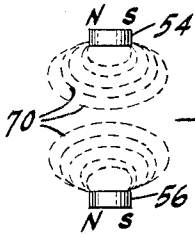


Fig_4

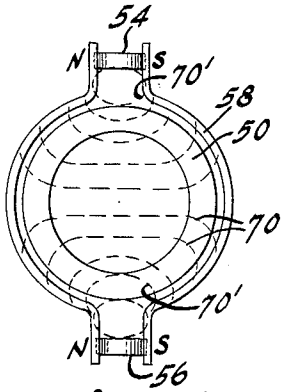


Fig_5

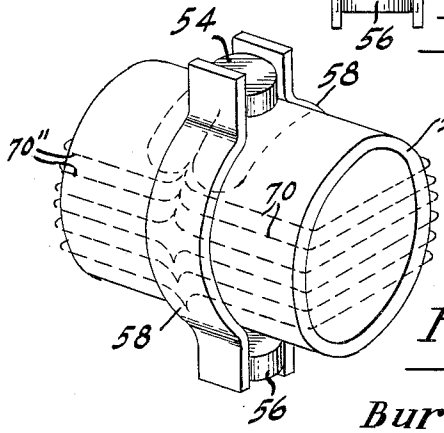


Fig_6

INVENTOR.
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2,717,323

ELECTRON BEAM CENTERING APPARATUS

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Application March 23, 1954, Serial No. 418,021

15 Claims. (Cl. 313—77)

The present invention relates to new and improved cathode ray image reproduction apparatus and, more particularly, to beam-centering 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-gun 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-gun 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 fine 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 a red, green and blue dot 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 a 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.

In an article entitled "Deflection and convergence in color kinescopes" by Albert W. Friend which appeared in the same issue of the Proceedings of the IRE cited supra, the deflection convergence problems associated with a color kinescope of the shadow mask type are described in detail. As pointed out therein, the color kinescope may contain a triangular array of three parallel electron guns which should project their beams symmetrically into a "convergence anode" cylinder. From this anode space the beams pass through a convergence lens formed by the opening of the end of the convergence anode cylinder and into the "final" or "accelerating" anode portion of the tube neck, which is provided with a conductive coating on its interior surface. A direct current potential of, for example, 10 kilovolts is applied across the convergence lens elements to cause the three beams to converge in the plane of the apertured shadow mask.

As will be appreciated, however, manufacturing tolerances render it difficult to produce three-gun assemblies in which the guns are precisely parallel to each other and to the central axis of the tube. Thus a uniform transverse magnetic field produced by some means may be applied to all the electron beams to shift the axis of the beams as desired. One such means is described and claimed in the copending U. S. application of A. W. Friend, Serial No. 202,185, filed December 22, 1950, for "Beam Alignment Devices." According to that application a "color purity coil" employing either a rotatable, yoke-like single pair of coils or two fixed pairs of coils arranged normally to each other, which coils are fed from an adjustable source of direct energy.

As set forth in the Friend article, moreover, the tolerances of manufacture of the aperture mask and dot screen assembly may make it desirable that the undeflected axis of the beam system approach the assembly at an angle which differs slightly from 90° in order to compensate for very slight transverse shifts of these elements. To adjust the approach angle of the beam system for color purity, the direct current in the transverse magnetic field of the color purity coil is adjusted to deflect the beams slightly. The beam axis must then be re-centered on the application of a transverse, uniform "centering field" in the deflection yoke region to achieve a slight angle of incidence of the central axis of the beams with the plane of the aperture mask. Heretofore, such centering has been satisfactorily accomplished through the application of an adjustable direct current component to the deflection yoke windings.

It is an object of the present invention, however, to provide novel and simplified means for performing the beam-centering function in a multiple-gun kinescope of the type in question.

A further object of the present invention is the provision of permanent-magnet means for affording beam centering in a kinescope of the type set forth.

While permanent magnet centering devices have long been known as adjuncts to single beam, monochrome kinescopes, the requirement of centering in a multi-beam kinescope so stringent as to render such prior art devices unsuitable for use. Briefly, in the latter case, the centering field must have a deflection center which is coincident with the "purity center" of the kinescope (i. e. that point which is coplanar with and equidistant from the three points which appear as the origin points for the several beams, insofar as the phosphor dots of the several colors are concerned), for otherwise an undesirable interaction with color purity results. In contradistinction therewith, the centering field in the case of a monochrome kinescope may be removed from the raster deflection field.

In general, the present invention provides a beam centering device which meets the rigid specifications described and which, by reason of its use of a permanent magnetic field, obviates the need for chokes, capacitors, potentiometers, direct current source and the other accoutrements of an electromagnetic centering arrangement. In accordance with a specific embodiment, there is provided a pair of cylindrical magnets and means for rotatably supporting the magnets on diametrically opposed sides of the cylindrical core which forms a conventional part of present day deflection yokes. The strength of the centering field is readily variable through the rotation of either of the magnets about its own longitudinal axis, while the field direction may be varied through rotation of the magnets about the longitudinal axis of the kinescope neck.

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

Figure 1 is a side elevation, 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 sectional view along line 2—2 of Figure 1;

Figure 3 is a fragmentary, isometric view of the apparatus of the invention; and

Figures 4, 5 and 6 illustrate flux patterns useful in the explanation of the operation of the invention.

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 cited. 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 anode cylinder **22** (having an apertured end plate at its target end) and a second or beam-focusing anode cylinder **24** which includes a limiting aperture disc **26**. The kinescope is also provided with a substantially cylindrical convergence anode **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 internal surfaces of the kinescope and which extends from the neck thereof in the vicinity of the convergence anode **28** along the flared portion to a region in the vicinity of the target structure.

Respective focusing lenses formed between the individual beam-focusing anodes **24** and the common convergence anode **28**, when all are suitably energized, function to effect the proper focusing of the individual electron beams so that they may have the proper individual scanning spot sizes in the target. A convergence lens formed between the convergence anode **28** and the beam-accelerating anode **30** functions to effect substantial convergence of the several electron beams in the plane of the aperture mask **14**. For a more detailed explanation of a multiple gun structure of the type illustrated reference is made to the copending U. S. application of Hannah C. Moodey, Serial No. 295,225, filed June 24, 1952, for "Multiple Beam Tube." In a conventional manner the kinescope **10** is further provided with a deflection yoke **31** seated on the tube neck as shown for effecting the desired raster scanning deflection of the beams in a manner to be described more fully hereinafter.

Also illustrated are means for effecting rotatable positioning of the electron beams in accordance with the invention described and claimed in copending U. S. application, Serial No. 385,748, filed October 13, 1953, by J. K. Kratz for "Beam Controlling Apparatus." 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**. As described in the cited Kratz application, 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 its associated electron beam in such manner as to effect what amounts to a rotational alignment or positioning of the beams in order that each such beam is initially directed toward its proper position at the shadow mask **14**.

As has also been stated, however, it is ordinarily necessary, in view of manufacturing tolerances, to provide color purification means for shifting the three beams as a group with respect to the tube axis, such shifting being in addition to the "alignment" function performed by the positioning magnets **34**. In the interest of completeness of disclosure, a color purity coil is indicated at **44**, the direct current energization therefore being provided by source **45**.

Referring more particularly to the raster deflection apparatus **31**, it will be seen that it includes the usual horizontal and vertical deflection coils **46** and **48**, respectively, arranged at right angles about the neck **16** of the kinescope in such manner as to effect anastigmatic deflection of the three beams when suitably energized with line and field frequency sawtooth currents. Surrounding the coils **46** and **48** is a conventional core or sleeve **50** of magnetic material such as a ferrite which provides a low reluctance return path for the deflection flux. Normally, as explained supra, centering of the electron beams is effected by means of a direct current component applied to the deflection coils for producing a static transverse magnetic field component of the desired strength and direction. In accordance with the present invention, however, the direct current centering apparatus is eliminated and its function is performed through the relatively simple and inexpensive permanent magnet assembly indicated in its entirety by reference numeral **52**.

The assembly **52** includes, as shown in Figure 1, a pair of cylindrical magnets **54** and **56** adjustably supported at diametrically opposite sides of the ferrite core **50** as by means of a pair of straps **58**, only one of which is apparent in that figure. Figure 2 illustrates the relationship of assembly **52** with respect to the yoke **31** and its core **50**. In Figure 2 it may be seen more clearly that the core **50** surrounds the horizontal and vertical deflection coils **46** and **48** in the usual manner. The straps **58**, which may be of soft iron, for example, are held in place around the core by means of non-magnetic bolts **60** which pass through tapped holes **62** and carry between themselves, adjacent their extremities, the cylindrical magnets **54** and **56**. Each of the magnets which, by way of illustration, may be formed of the well-known material Alnico is magnetized along its diameter and is rotatable about its longitudinal axis. The provision for such rotation of the magnets is apparent from the showings of Figures 2 and 3 wherein it may be noted that the magnets are held in recesses or seats **64** in the straps **58**. The recesses **64** are or may be curved arcuately to conform to the cylindrical magnets, whereby to serve as bearing surfaces therefor.

In the assembly of the apparatus of the present invention, the straps **58** are placed on opposite sides of the yoke **31** at substantially the mid point of the core **50**. With the bolts **60** holding the straps together, it is a simple matter to place the magnets in their seats **64**, whereupon the bolts may be tightened to pull the straps closer together so that the magnets are held in place. In conventional yokes, the core may ordinarily comprise a plurality of arcuate segments held together and in place as by means of a clamp or strap indicated generally at **66** in Figure 2. Thus the magnet-holding straps may be spaced from the core **50**. In a practical structure it was found that the straps **58** were actually spaced from the core by ¼ inch of insulating material such as a plastic track. Such spacing is, moreover, necessary for proper operation of the centering apparatus, as will appear from the following portions of the specification. Finally, with respect to the elements of the assembly the bolts **60** which serve to hold the straps **58** together are of a nonmagnetic material such as brass or the like, for otherwise they would effectively short-circuit the flux line of the magnets.

In order that the significance of the various components described thus far may be appreciated, the requirements for satisfactory beam centering in a multibeam tube of the type in question should be understood. It is, as should be apparent, necessary that the magnetic field produced by the centering magnets have a resultant vector located in a plane perpendicular to the axes of the beams. Secondly, the centering field must be uniform to a degree sufficient to preclude undesirable scanning nonlinearity or raster distortion. The third requirement, and

one which is peculiar to the color kinescope use, is that the effective deflection plane of the centering apparatus be coincident with the plane of color centers (as mentioned supra and as explained in an article by Van Ormer and Ballard entitled "Effects of screen tolerances on operating characteristics of aperture-mask tri-color kinescopes," which appeared in the same issue of the Proceedings of the IRE cited above). That is to say, the center of deflection of the centering field must lie in the color centers plane. Another specification to be met is that the direction of the centering field be rotatable through 360°. Finally, the strength or magnitude of the centering field should be variable from zero to a maximum. As will be apparent to those skilled in the art from the following description of the operation of the present invention, the present structure satisfies all of the above-enumerated requirements.

The illustration of Figure 4 provides a somewhat idealized flux pattern such as would result from the use of the magnets **54** and **56** by themselves (i. e. without the iron straps and core). With the magnets **54** and **56** polarized as shown, the flux pattern produced in a plane would be made up of the curved lines **70**, thus affording a pincushioned field which would bring about undesirable scanning, nonlinearity and raster distortion.

Figure 5, on the other hand, is a diagrammatic, front elevational showing of the effect of the iron straps **58** and magnetic core **50** when combined with the magnets **54** and **56**. As will be noted, the iron straps **50** serve pole pieces for the magnets, so that the lines of flux **70** effectively originate from the straps, insofar as the useful field is concerned. Moreover, and as illustrated, the net effect of the straps and core is that of rendering the flux lines **70** straighter than their curved form of Figure 4. Such straightening of the flux lines is necessary in order that the field which acts upon the electron beams is uniform. The above recited facts may be better understood from an appreciation of the fact that the core **50** serves as a shunt or shield for the undesirable, curved flux lines such as those indicated at **70'** in Figure 5.

Since the actual flux pattern produced by the apparatus is three-dimensional in nature, the isometric view of Figure 5 best illustrates the path of the flux lines produced by magnets **54** and **56**. Assuming, therefore, in the showing of Figure 6 that the magnets **54** and **56** are polarized in the same manner as that set forth with respect to Figures 4 and 5, it will be seen that flux lines **70** originating at the north pole of magnet **54** travel through a portion of the strap **58** and then emerge therefrom along lines substantially parallel to the surface of the core **50** until they reach the front end of the core, from which point they travel along a path substantially perpendicular to the last-mentioned path across the front of the core, after which the flux lines return to the other strap **58** to complete the magnetic circuit. The action described with respect to the flux lines which cross the front end of core **50** is also true in the case of the flux lines designated **70''** which leave the strap **58** and travel rearwardly whereby to cross the rear end of the core. It should, therefore, be apparent that the magnets **54** and **56** in conjunction with the straps **58** and core **50**, produce two discrete magnetic fields, namely, those at the front and rear ends of the core. Hence, as the beams enter the yoke assembly **31** they are initially deflected in a predetermined amount and direction by the field at the rear or entrance end of the yoke. After having been subjected to the scanning deflection action of the yoke, the beams are again acted upon by the centering apparatus through the agency of the transverse field existing at the exit end of the yoke. It is the net or resultant effect of the two discrete fields which determines the exact amount and direction of deflection produced by the centering apparatus.

By suitably selecting the axial position of the magnet assembly with respect to the core **50**, it is possible to provide the two discrete fields such that their net effect upon the beams is as desired. Since the beams are more easily deflected at the entrance end of the yoke than at the exit end, it has been found that the permanent magnet assembly should be located slightly forward of the mid point of the core, for equal centering fields to be present at the two ends thereof.

The direction of the centering field in accordance with the present invention may be rotated or varied by rotating the magnets and their straps about the axes of the core, while the magnitude or strength of the field may be varied by rotating one of the permanent magnets **54** and **56** about its own axes. Thus, for example, when the magnets are disposed with corresponding poles in contact with the same iron strap the strength of the centering field is maximum. Conversely when one of the magnets is rotated 180° from that position, the field strength is substantially zero, since the flux lines of the magnets are effectively short circuited or confined to the iron straps. Hence, it will be noted that, in addition to the fact that the permanent magnet assembly must be located at the yoke region in order to meet the third requirement listed above, the necessary function of the core in linearizing the flux lines also dictates that the permanent magnet assembly be in magnetic association with the core.

While the invention has been described in accordance with a specific embodiment it should be borne in mind that certain changes and substitutions may be made without departing from its scope. For example, although the strap **58** has been described as made of soft iron any other material having low residual magnetism characteristics may be used. Examples of such material are silicon steel, mumetal and the like. Additionally, while the spacing element **66** between the core **50** and straps **58** has been described as a plastic track, it should be understood that any other material offering a high impedance to the flux lines may be employed. It is, however, essential that the straps **58** be separated magnetically from the core, for otherwise the flux lines would be short circuited by the core.

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

1. Beam centering apparatus for use in conjunction with a multi-beam kinescope of the type having a target, means for directing a plurality of electron beams toward such target and an electromagnetic deflection yoke for causing such beams to scan a raster, said centering apparatus comprising: a pair of permanent magnets; and means for supporting said magnets on diametrically opposed sides of such yoke in such manner that said magnets are rotatable about such yoke, said magnet supporting means having means permitting rotation of at least one of said magnets about an axis perpendicular to such beams.

2. Beam centering apparatus for use in conjunction with a multi-beam kinescope of the type having a target, means for directing a plurality of electron beams toward such target and an electromagnetic deflection yoke for causing such beams to scan a raster, said centering apparatus comprising: a pair of diametrically magnetized, cylindrical permanent magnets; and means for supporting said magnets on diametrically opposed sides of such yoke in such manner that said magnets are rotatable about such yoke, said magnet supporting means having means permitting rotation of at least one of said magnets about an axis perpendicular to such beams.

3. Beam centering apparatus for use in conjunction with a multi-beam kinescope of the type having a target, means for directing a plurality of electron beams toward such target and an electromagnetic deflection yoke for causing such beams to scan a raster, said centering apparatus comprising: a pair of permanent magnets; and magnetic strap means for supporting said magnets on diametrically opposed sides of such yoke in such manner that said magnets are rotatable about such yoke, said magnet support-

ing means having means permitting rotation of at least one of said magnets about an axis perpendicular to such beams.

4. Beam centering apparatus for use in conjunction with a multi-beam kinescope of the type having a target, means for directing a plurality of electron beams toward such target and an electromagnetic deflection yoke for causing such beams to scan a raster, said centering apparatus comprising: a pair of diametrically magnetized, cylindrical permanent magnets; and magnetic strap means for supporting said magnets on diametrically opposed sides of such yoke in such manner that said magnets are rotatable about such yoke, said magnet supporting means having means permitting rotation of at least one of said magnets about an axis perpendicular to such beams.

5. Beam centering apparatus for use in conjunction with a kinescope of the type having a target, means for directing an electron beam toward said target and electromagnetic yoke means including a magnetic core sleeve for causing such beam to scan transversely of such target, said centering apparatus comprising: a pair of permanent magnets; and means for supporting said magnets on diametrically opposite sides of such core sleeve but in a plane intermediate the ends of such sleeve, said supporting means being rotatable about such core.

6. Beam centering apparatus for use in conjunction with a kinescope of the type having a target, means for directing an electron beam toward such target and electromagnetic yoke means including a magnetic core sleeve for causing such beam to scan transversely of such target, said centering apparatus comprising: a pair of permanent magnets; and magnetic holder means for supporting said magnets on diametrically opposite sides of such core sleeve but in a plane intermediate the ends of such sleeve, said supporting means being spaced from and rotatable about such core.

7. The invention as defined by claim 5 wherein said permanent magnets are cylindrical and magnetized diametrically, said supporting means including means permitting rotation of at least one of said magnets about its central axis.

8. Beam centering apparatus for use in conjunction with a kinescope of the type having a target, means for directing an electron beam toward said target and electromagnetic yoke means including a magnetic core sleeve for causing such beam to scan transversely of such target, said centering apparatus comprising: a pair of permanent magnets; and magnetic holder means for supporting said magnets on diametrically opposite sides of such core sleeve but in a plane intermediate the ends of such sleeve, said holder serving as a pole extension for said magnets whereby flux lines from said magnets follow paths lying partially in planes at the ends of said core.

9. Beam centering apparatus for use in conjunction with a cathode ray tube of the type having a target, means for directing an electron beam along a path toward such target, and electromagnetic yoke means including a core of magnetic material surrounding such path for deflecting such beam transversely of such target, said centering apparatus comprising: a pair of permanent magnets; magnetic strap means for supporting said magnets on diametrically opposed sides of such core and spaced therefrom, said strap means and said magnets forming a continuous loop of magnetic material around such core and intermediate the ends of such core, whereby flux from each of such magnets is caused to travel along paths which traverse the regions at the ends of such core.

10. The invention as defined by claim 9 wherein said magnet supporting strap means include means permitting rotation of at least one of said magnets through at least 180° about an axis perpendicular to such electron beam path.

11. The invention as defined by claim 9, wherein said magnet supporting means are capable of rotation as a unit about such core.

12. The invention as defined by claim 10 wherein said strap means are capable of rotation as a unit about such core.

13. The invention as defined by claim 10 including magnetic insulating means for spacing said magnetic strap means from such core.

14. Beam centering apparatus which comprises: a pair of cylindrical permanent magnets, each magnetized along its diameter, a pair of non-linear straps of magnetic material, each strap having a seat portion at each of its ends for engaging a portion of one of said magnets; and means for holding said straps and magnets together in such manner that said magnets are held coaxially at opposite ends of said straps and such that each magnet is rotatable about its own axis in said seat portions, said straps being disposed with their non-linear portions defining an opening for accommodating a cathode ray tube neck and deflection yoke.

15. Beam centering apparatus for associating with a cathode ray tube deflection yoke, which centering apparatus comprises: a pair of cylindrical permanent magnets, each magnetized along its diameter; a symmetrical pair of straps of magnetic material, each strap having straight end portions and a bowed intermediate portion; a magnet receiving seat in each end portion of each strap, said seats being disposed on that side of each strap remote from the outer region of its bow; and means for securing said strap in fixed relationship whereby said magnets are held in said straps a fixed distance from each other and in such manner that said bowed portions extend outwardly from a line joining said magnets.

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