

May 4, 1954

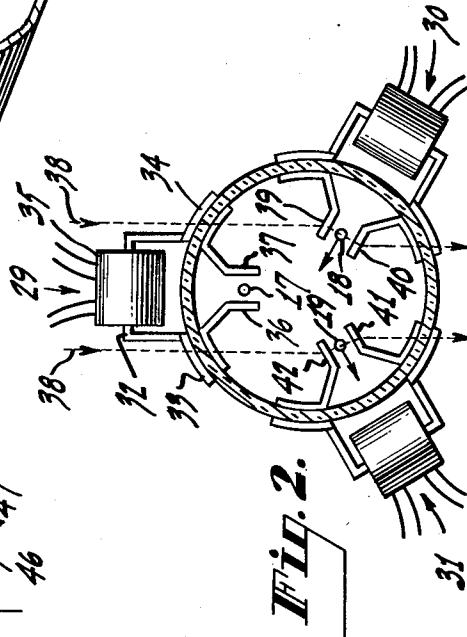
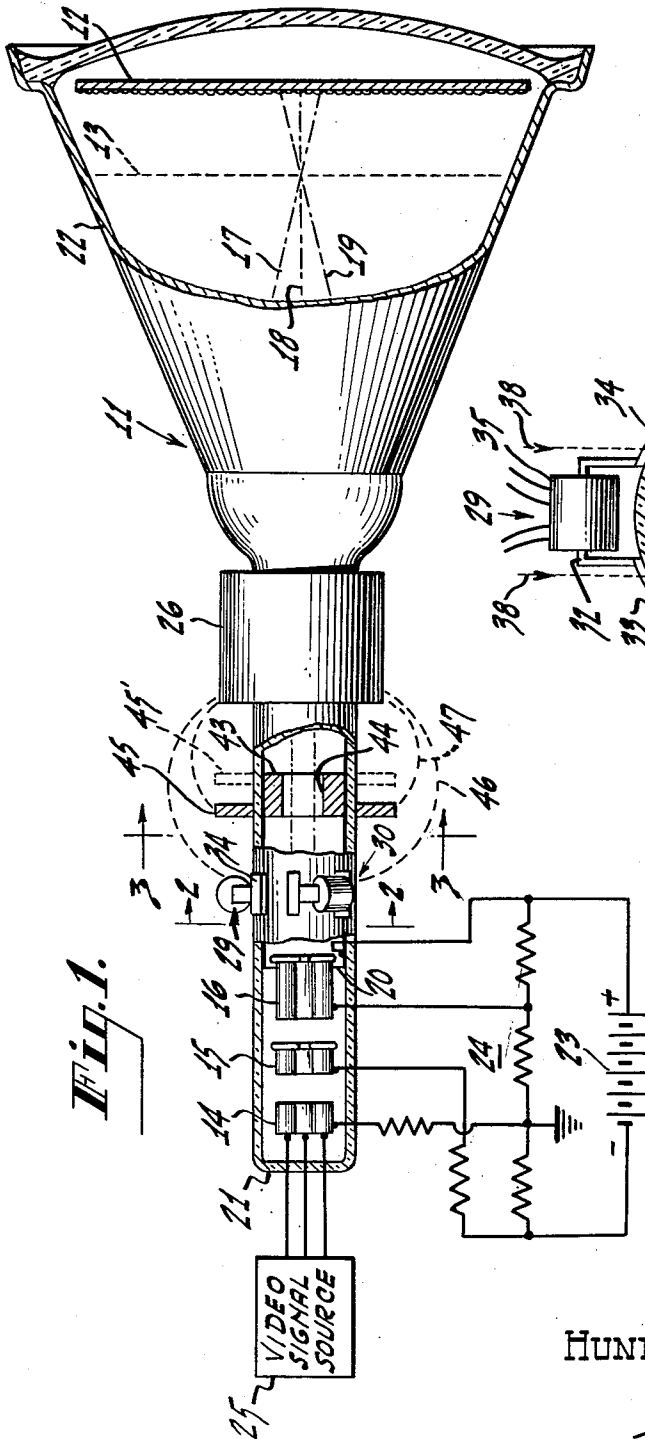
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2,677,779

TRICOLOR KINESCOPE MAGNETIC SHIELD

Filed May 22, 1953

2 Sheets-Sheet 1



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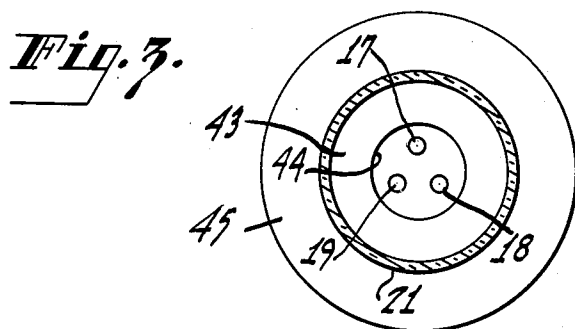
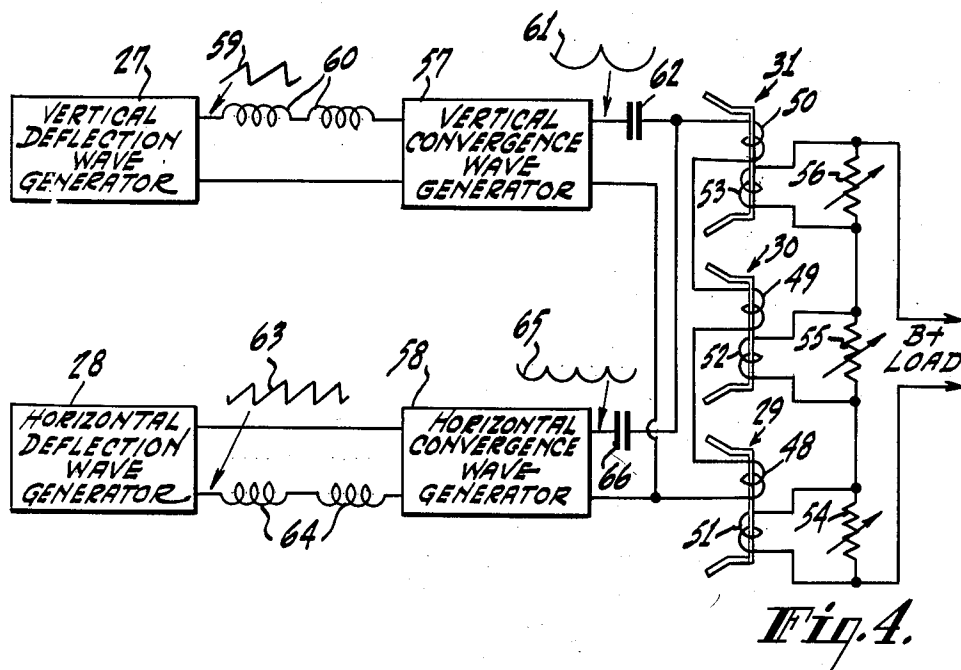
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UNITED STATES PATENT OFFICE

2,677,779

TRICOLOR KINESCOPE MAGNETIC SHIELD

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Application May 22, 1953, Serial No. 356,620

7 Claims. (Cl. 313—70)

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This invention relates to systems for controlling the electron beams of cathode ray tubes and particularly to systems in which a plurality of beams is deflected by a common deflection apparatus.

One type of cathode ray tube with which the present invention may be successfully employed is a color kinescope of the general type described in an article titled "A Three-Gun Shadow-Mask Color Kinescope," by H. B. Law published in the Proceedings of the I. R. E., vol. 39, No. 10, October 1951 at page 1186. Such a tube forms the subject matter of Patent No. 2,595,548, issued May 6, 1952, to Alfred C. Schroeder, and titled "Picture Reproducing Apparatus." Such a tube has a luminescent screen as part of a target electrode in which different phosphor areas produce differently colored light when excited by electron beam components impinging upon it from different angles, the angle of impingement determining the particular color of the light produced by the phosphor areas. The invention also pertains to a kinescope of the type described in another article titled "A One-Gun Shadow-Mask Color Kinescope," by R. R. Law, published in the Proceedings of the I. R. E., vol. 39, No. 10, October 1951 at page 1194. Such a tube is the subject matter of a copending U. S. patent application of Russel R. Law, Serial No. 165,552, filed June 1, 1950, and titled "Color Television."

It is necessary for the satisfactory operation of such kinescopes to effect substantial convergence of the different electron beam components at all points of the raster scanned thereby in the plane of the target electrode. In general, this convergence may be effected by means of apparatus such as that disclosed in an article titled "Deflection and Convergence in Color Kinescopes" by A. W. Friend, published in the Proceedings of the I. R. E., vol. 39, No. 10, October 1951 at page 1249. One such system in accordance with the disclosure of this article forms the subject matter of a copending application of Albert F. Friend, Serial No. 164,444 filed May 26, 1950, and titled "Electron Beam Controlling System." Such beam convergence apparatus includes an electron-optical system by which to control the beam convergence angles. The electron-optical system is variably energized as a function of the radial angle of beam deflection.

Another type of apparatus for controlling the convergence of a plurality of electron beam components in a predetermined plane and with which the present invention is more particularly concerned comprises, in general, a means for pro-

ducing a plurality of electron beam components which traverse predeflection paths that are spaced respectively about the longitudinal axis of the tube, and individual electromagnetic means located respectively adjacent to the pre-deflection beam paths and of such a character to be energizable directly from the beam deflection circuits in a manner to effect the desired beam convergence. In this manner, the beam convergence angle may be varied in a manner suitable to maintain the desired beam convergence in the predetermined plane at all points in the scanned raster.

More particularly, it will be understood that the term "beam components" as used in this specification and in the appended claims denotes either a plurality of individual electron beams emanating, respectively, from a plurality of electron guns or from a single electron gun provided with suitable electron-optical, or other apparatus, for forming three individual beams and, in addition, those components of a single electron beam to which is imparted a spinning motion so as to trace a substantially conic locus at different positions thereof. Accordingly, the apparatus by which a plurality of such electron beam components is produced may include on the one hand, three electron guns or, on the other hand, a single electron gun, together with the auxiliary apparatus by which the spinning motion is imparted to the beam.

The particular beam convergence electromagnetic apparatus to which this invention pertains includes for each beam component a pair of pole pieces located internally of the kinescope envelope. It has been found that magnetic flux leaking from the deflection yoke traverses the various pairs of pole pieces differently, thereby tending to cause a misconvergence of the beam components.

It, therefore, is an object of the present invention to prevent leakage flux from a raster-scanning deflection yoke from affecting individual beam-convergence electromagnets in a manner to cause misconvergence of a plurality of beam components.

Another object of the invention is to magnetically shield a plurality of individual beam-convergence electromagnets located in a pre-deflection region of a plurality of beam components from a raster-scanning deflection yoke.

In accordance with this invention, multi-beam cathode ray tube apparatus, having a plurality of beam convergence electromagnets located in a pre-deflection region of the beams, is provided

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with a magnetic shield located between the beam deflection apparatus and the beam convergence apparatus to exclude from the latter leakage flux from the former.

The novel features that are considered characteristic of this invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, as well as additional objects and advantages thereof, will best be understood from the following description when read in conjunction with the accompanying drawings.

In the drawings:

Figure 1 is a view showing the general arrangement of image-reproducing apparatus embodying one form of an electron beam convergence system in accordance with this invention;

Figure 2 is a transverse cross-sectional view taken generally on the line 2—2 of Figure 1 and showing the arrangement of the beam convergence electromagnets;

Figure 3 is another transverse cross-sectional view taken generally along the line 3—3 of Figure 1 and showing a form of magnetic shielding apparatus in accordance with the invention; and,

Figure 4 is a schematic circuit diagram of an arrangement in accordance with the invention for energizing the electromagnetic beam convergence apparatus.

Reference first will be made to Figure 1 for a general description of an illustrative embodiment of electron beam convergence system in accordance with the present invention. The system includes a tri-color kinescope 11 which may be of the same general type as that disclosed in the H. B. Law paper previously referred to. It will be understood, however, that the kinescope, alternatively, may be of other types such as that shown in the R. R. Law paper. In either case, however, the kinescope preferably has a substantially flat luminescent screen 12 provided with a multiplicity of small phosphor areas arranged in groups and capable respectively of producing light of the different primary colors in which the image is to be reproduced when excited by an electron beam. In back of and spaced from the screen 12 there is an apertured masking electrode 13 having an aperture for and in alignment with each group of phosphor areas of the screen 12.

In the particular tube illustrated, the kinescope also has a plurality of electron guns, equal in number to the number of primary colors in which the image is to be reproduced. Each of these guns may be conventional, consisting of a cathode, a control grid and a focussing electrode. Since the three-guns are identical, the different parts thereof will be referred to collectively as the cathodes 14, the control grids 15, and the focussing electrodes 16. The three electron guns produce schematically represented beams 17, 18 and 19 by which to energize respectively, the blue, red and green phosphor areas of the screen 12. When these electron beams are properly converged in the plane of the masking electrode 13 they pass through the apertures thereof from different directions and impinge upon different phosphor areas of the various groups so as to produce blue, red and green light. It is to be noted that the size of the phosphor areas, the angles between the beams and the spacing of the mask 13 from the screen 12 as compared with the length of the tube are exaggerated for

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better illustration of the operation of the kinescope.

The electron-optical apparatus of the kinescope 11 also includes a beam-accelerating electrode consisting, in the present instance, of a conductive wall coating 20 formed on the inner surface of the tubular glass neck 21 of the kinescope extending from the region adjacent to the outer end of the focussing electrodes 16 to the conical section 22 of the tube which in this case is metallic. Suitable electrical connection (not shown) is made at the junction of the wall coating with the metal cone 22. Preferably, the target electrode structure, including the masking electrode 13 and the luminescent screen 12 which for this purpose may be metallized, is electrically connected to the metal cone 22 by suitable means (not shown). Metallization of a luminescent screen of the character described may be effected in the manner disclosed in a paper by D. W. Epstein and L. Pensak titled "Improved Cathode Ray Tubes with Metal-Backed Luminescent Screens" published in the RCA Review, vol. VII, March 1946 at pages 5-10.

The described electrode structure of the kinescope may be energized in a conventional manner such as that illustrated. The source of energy is represented by a battery 23 across the terminals of which there is connected a voltage divider 24. The cathodes 14 are connected to the grounded point of the voltage divider and the control grids 15 are connected to a point which is somewhat negative relative to ground. Similarly, the focussing electrodes 16 are connected to a point on the voltage divider which may conventionally be at a potential of approximately 3000 volts positive relative to the grounded cathodes. Also the beam-accelerating anode, including the wall coating 20 and metal cone 22, is connected to the voltage divider 24 at a point which may conventionally be approximately 18,000 volts positive relative to the grounded cathodes.

The electron beams 17, 18 and 19 are modulated suitably in intensity under the control of color-representative video signals derived from a source 25. It will be understood that the video signal source is represented herein entirely diagrammatically since it does not form an essential part of the present invention. The signal source 25 usually will be part of a signal receiver and may be understood to include a signal detector, or equivalent device, together with one or more stages of video signal amplification. Alternatively, the video signal source may be a color television camera in the event that the kinescope 11 is employed as a monitor, for example. Also, it will be understood that the illustrated connection of the video signal source 25 to the electron guns of the kinescope 11 is merely diagrammatic and accordingly these connections may or may not be made directly to the cathodes 14. Instead, it will be understood, that they may be made to the grids 15 or, in accordance with modes of operation of color image-reproducing apparatus, the video signal source may be connected both to the cathodes and to the control grids of the electron guns.

Also associated with the color kinescope 11 is a deflection yoke 26 which may be entirely conventional including two pairs of suitably placed coils electrically connected together in such a manner that, when properly energized, electromagnetic fields are produced, whereby to effect both horizontal and vertical angular deflections of the electron beams so as to scan the usual

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rectangular raster. Energization of the deflection coils comprising the yoke 26 may be effected by conventional vertical and horizontal deflection wave generators 27 and 28, respectively (see Figure 4). Such apparatus will be understood to function suitably to produce substantially sawtooth energy at both horizontal and vertical deflection frequencies so that the fields produced by the yoke 26 are varied in a substantially sawtooth manner.

The beam convergence system, in accordance with the present invention, also includes a plurality of electromagnetic field producing elements such as the magnets 29 and 30 mounted around the neck 21 of the color kinescope adjacent to the predeflection paths of the electron beam components. It is to be understood that the precise location of these magnets is not necessarily indicated in this figure. Instead, as will appear in greater detail from a subsequent portion of the specification, it is to be understood that each of these magnets is located relative to one of the electron beam components so as to influence its associated beam component to the substantial exclusion of the others. Furthermore, it is to be understood that these magnets are of a character which, when suitably energized, produce respective fields which are transverse to the associated beam paths.

Each of these convergence electromagnets includes a pair of spaced pole pieces and at least one energizing winding. Preferably two windings are provided for each of the electromagnets for separate energization. These features will be described subsequently in greater detail.

Before describing the details of the convergence system with which the present invention is related, a brief description will be given of the general manner in which the apparatus functions to produce the desired results. The convergence magnets such as 29 and 30 are energized by substantially unidirectional energy so as to effect an initial convergence of the electron beam components substantially in the plane of the apertured masking electrode 13. In order to do this, the unidirectional energization of these magnets is effected in such a way that the magnets may be individually energized in different magnitudes. In effecting this initial beam convergence, it is to be understood that the beams may be in any desired one of their different deflected positions. For example, they may be initially converged at the center of the raster to be scanned. Alternatively they may be initially converged at one corner of the raster.

The convergence magnets such as 29 and 30 also are dynamically energized by the control wave energy derived from a suitable generator (not shown in Figure 1) so as to effect a variation in the magnitude of the transverse fields produced respectively thereby. These field strength variations are in accordance with a predetermined function of the beam deflection. Variations in the strength of the fields produced by the convergence magnets such as 29 and 30 effect corresponding variations in the paths of the electron beam components relative to the longitudinal axis of the tube. Hence, suitable variations are made in the convergence angles between the various beam components so as to produce the desired convergence of the beam components substantially in the plane of the masking electrode 13.

For a further description of this type of beam convergence apparatus, reference now will be made to Figure 2 of the drawings. This figure

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shows more clearly the relative positions of the convergence magnets, such as 29 and 30 and, additionally, 31, relative to one another and to the electron beams with which they are respectively associated. Inasmuch as all of these magnets are substantially the same, only one of them will be described in detail. The convergence magnet 29, which is associated with the blue electron beam 17, is provided with a core having a body portion 32 and two external pole pieces 33 and 34. These pole pieces are mounted so as to be in close association with the tube neck 21. Also, as indicated in Figure 1, the pole pieces extend for some distance longitudinally of the tube substantially as indicated. The magnet also is provided with an energizing coil structure 35 mounted upon the body portion 32. The energizing coil 35 preferably is provided with two windings, one for static energization and the other for dynamic energization in a manner to be described subsequently. The convergence magnet 29 produces a field which, in the vicinity of the electron beam 17, is substantially transverse to the axis of the kinescope. By means of such a field, the electron beam 17 may be moved toward or away from the longitudinal tube axis. The direction and magnitude of such a beam movement is controlled by the energization of the magnet by means including the coil 35.

In Figure 2, it also is illustrated that for each of the magnets there are provided on the inside of the tube neck 21 extended pole pieces so as to increase the effectiveness of these magnets. The magnet 29, for example, is provided with a pair of inwardly extending pole pieces 36 and 37, associated respectively with the external pole pieces 33 and 34. By such means, it is seen that the reluctance of the magnetic circuit is considerably decreased, and also the flux distribution of the field produced between the internal pole pieces 36 and 37 is considerably improved.

With beam convergence apparatus of this general character, it may be seen from a further consideration of Figure 2 that such apparatus is adversely affected by leakage flux from the deflection yoke. Leakage deflection flux of a character to deflect the electron beam components 17, 18 and 19 to the left as viewed in the drawing is indicated by the broken lines 38. With respect to the internal pole pieces 36 and 37 associated with the electromagnet 29, no adverse effects of the leakage deflection flux are produced. However, it is seen that the leakage deflection flux 38 passes between the internal pole pieces 39 and 40 of the electromagnet 30 substantially at right angles to these pole pieces since this is the path of lowest reluctance. Similarly, the leakage deflection flux 38 passes between the internal pole pieces 41 and 42 of the electromagnet 31 at right angles to these pole pieces. As a result, it may be seen that when the beams are being deflected to the left, the red beam 18 will be moved to a higher position than it would have in the absence of the leakage flux from the deflection yoke, as indicated by the arrow. Similarly, the green beam 19 will have a lower than normal position when beam deflection is toward the left. Conversely, when beam deflection by the yoke is toward the right, as viewed in Figure 2, the leakage flux 38 will be in the opposite direction, thereby tending to move the red beam downwardly and the green beam upwardly. Consequently, there is effected a misconvergence of the electron beam components as a result of the leakage flux from the de-

deflection yoke traversing the internal pole pieces of certain of the convergence electromagnets.

In accordance with the present invention, there is provided means for preventing the leakage flux from the deflection yoke from adversely affecting the individual beam convergence electromagnets in the manner described. By referring again to Figure 1 and also to Figure 3 of the drawings, this apparatus comprises a magnetic shield located between the deflection yoke 26 and the convergence electromagnets, such as 29 and 30. In the illustrative form of the magnetic shield, it comprises a disk-like shielding member 43 of magnetic material mounted internally of the cathode ray tube. Preferably, the internal shielding member 43 has an outside diameter which enables it to fit snugly on the inside of the substantially cylindrical tube neck 21. It also is provided with a centrally located aperture 44 so as to enable the passage of the electron beams. It is to be noted that the internal shielding member 43 has a substantial thickness in the direction longitudinally of the tube axis. The magnetic shield also includes at least one other disk-like shielding member 45 of magnetic material located externally of the tube and in substantial alignment with the internal shielding member 43. The external shielding member has a centrally located aperture of proper diameter to enable it to be suitably mounted in close proximity to the outside of the tube neck 21. The outside diameter of the external shielding member 45 is made sufficient to effect the desired shielding. It is to be noted that the external shielding member 45 has a thickness longitudinally of the tube axis which is considerably less than that of the internal shielding member 43. The thickness of the external member should be sufficient to provide the necessary mechanical strength. Also, it may be arranged so as to enable a sliding adjustment thereof for varying the effectiveness of the shield. The external shielding member 45 is shown in solid lines in one extreme position at the back end of the internal member 43 and by dotted lines in a forward limiting position. Also, in accordance with the invention, the magnetic shield may include a plurality of external members such as 45 and 45'.

The leakage flux from the deflection yoke 26, in the absence of the magnetic shield, is indicated as following generally the path 46. It is seen that this path links the electromagnetic convergence apparatus and produce the deleterious results previously described. By means of the magnetic shunt, the leakage flux may be confined substantially to the path indicated by the broken line 47. In this case, it is seen that the magnetic shield effectively shunts the leakage flux into a path which is harmless so far as the beam convergence apparatus is concerned.

Reference now will be made to Figure 4 of the drawings for a general description of an illustrative manner in which the beam convergence apparatus may be energized. The energizing coils of the convergence magnets 29, 30 and 31 include dynamic windings 48, 49 and 50 respectively. These convergence magnets also include static windings 51, 52 and 53 respectively. The energizing circuit for the static convergence windings 51, 52 and 53 includes a series circuit of resistors 54, 55 and 56 connected between the positive terminal of a power supply and its load. Preferably, these resistors are adjustable so as to enable the individual control of the energizing

current for the associated static windings of the convergence magnets 29, 30 and 31, respectively.

The dynamic windings 48, 49 and 50 of the convergence magnets 29, 30 and 31, respectively, are connected in series with one another and to vertical and horizontal convergence wave generators 57 and 58, respectively. These convergence wave generators may be of the general type disclosed in the I. R. E. Friend paper or any other suitable forms. In general, the substantially sawtooth wave energy 59 of field frequency which is derived from a conventional vertical deflection wave generator 27 for energization of the vertical deflection yoke coils 69 is converted by means of the vertical convergence wave generator 57 into a substantially parabolic wave 61. This parabolic wave energy is coupled by a capacitor 62 to the series connection of the dynamic windings of the convergence electromagnets. In a substantially similar manner, the line frequency sawtooth wave energy 63 derived from the horizontal deflection wave generator 28 for the energization of the horizontal deflection yoke windings 64 is converted by the horizontal convergence wave generator 58 to a substantially parabolic wave 65 for impression by means including a coupling capacitor 66 upon the dynamic windings of the beam convergence electromagnets 29, 30 and 31. By such means, it is seen that the convergence magnets are energized dynamically as functions of both vertical and horizontal beam deflection angles so as to effect substantial convergence of the electron beam components in the plane of the target electrode structure at all points in the scanned raster.

It, therefore, is seen from the foregoing description of an illustrative embodiment of the present invention that the leakage flux from a raster-scanning deflection yoke is prevented from reaching the region in which individual electromagnets are employed to effect static as well as dynamic convergence of a plurality of electron beam components in the plane of a target electrode. The magnetic shield, in accordance with the invention and by means of which the leakage flux is shunted away from the convergence apparatus, comprises in one form a plurality of disk-like members of magnetic material, one of which is located inside of the cathode ray tube and another of which is located outside of the tube. It will be appreciated that, in some cases, satisfactory shielding may be effected by use of only one of such members located either internally or externally of the cathode ray tube. Also, it is to be noted that the shielding apparatus may be of a fixed or adjustable type as desired.

The nature of the invention, having been set forth in the foregoing description of an illustrative embodiment thereof, its scope is pointed out in the appended claims.

What is claimed is:

1. In a cathode ray tube image-reproducing system wherein a plurality of electron beam components, which traverse pre-deflection paths that are spaced respectively about the longitudinal axis of the tube, are angularly deflected both horizontally and vertically by electromagnetic beam deflection apparatus to scan a raster in a predetermined plane, electron beam convergence apparatus comprising, a plurality of electromagnets respectively mounted adjacent to said pre-deflection beam paths and energizable to produce respective fields transverse to said beam paths, each of said electromagnets having a core includ-

ing a body portion located externally of said tube and a pair of pole pieces located internally of said tube and respectively extending from points adjacent to opposite ends of said body portion into the region of said associated beam component, and a magnetic shield located between said deflection apparatus and said convergence electromagnets to exclude deflection flux from said electromagnets.

2. Electron beam convergence apparatus as defined in claim 1 wherein, said magnetic shield comprises a disk-like member located internally of said cathode ray tube.

3. Electron beam convergence apparatus as defined in claim 1 wherein, said magnetic shield comprises a disk-like member located externally of said cathode ray tube.

4. Electron beam convergence apparatus as defined in claim 1 wherein, said magnetic shield comprises a plurality of disk-like members, one of said members being located internally of said cathode ray tube, and another of said members being located externally of said cathode ray tube.

5. Electron beam convergence apparatus as defined in claim 4 wherein, said internal and external disk-like members are relatively movable longitudinally of said cathode ray tube axis.

6. Electron beam convergence apparatus as defined in claim 5 wherein, said internal disk-like member has a greater dimension longitudinally of said cathode ray tube axis than the corresponding dimension of said external disk-like member.

7. In a cathode ray tube image reproducing system wherein, a plurality of electron beam components, which traverse pre-deflection paths that are spaced respectively about the longitudinal

axis of the tube, are angularly deflected both horizontally and vertically by electromagnetic beam deflection apparatus to scan a raster in a predetermined plane, and wherein a plurality of electromagnets each having pole pieces located internally of said tube respectively adjacent to said pre-deflection beam paths and energizable to produce respective fields transverse to said beam paths by which to effect dynamic electron beam convergence, a magnetic shield located between said deflection apparatus and said convergence electromagnets to exclude deflection flux from said electromagnets and comprising, a disk-like member of magnetic material mounted internally of said tube and having a central aperture for the passage of said electron beam components, and a second disk-like member of magnetic material mounted externally of said tube in alignment with said internally mounted disk-like member and having a central aperture of suitable dimensions to accommodate said cathode ray tube envelope, said internally mounted member having a greater thickness longitudinally of said tube axis than the corresponding thickness of said externally mounted disk-like member, and said externally mounted member being adjustably positionable longitudinally of said tube axis to vary the effectiveness of said magnetic shield.

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