Nov. 21, 1967 R. F. DE BOTH 3,354,337

CONVERGENCE MAGNET POLE SHOES

Filed Feb. 28, 1966

FIG. 1

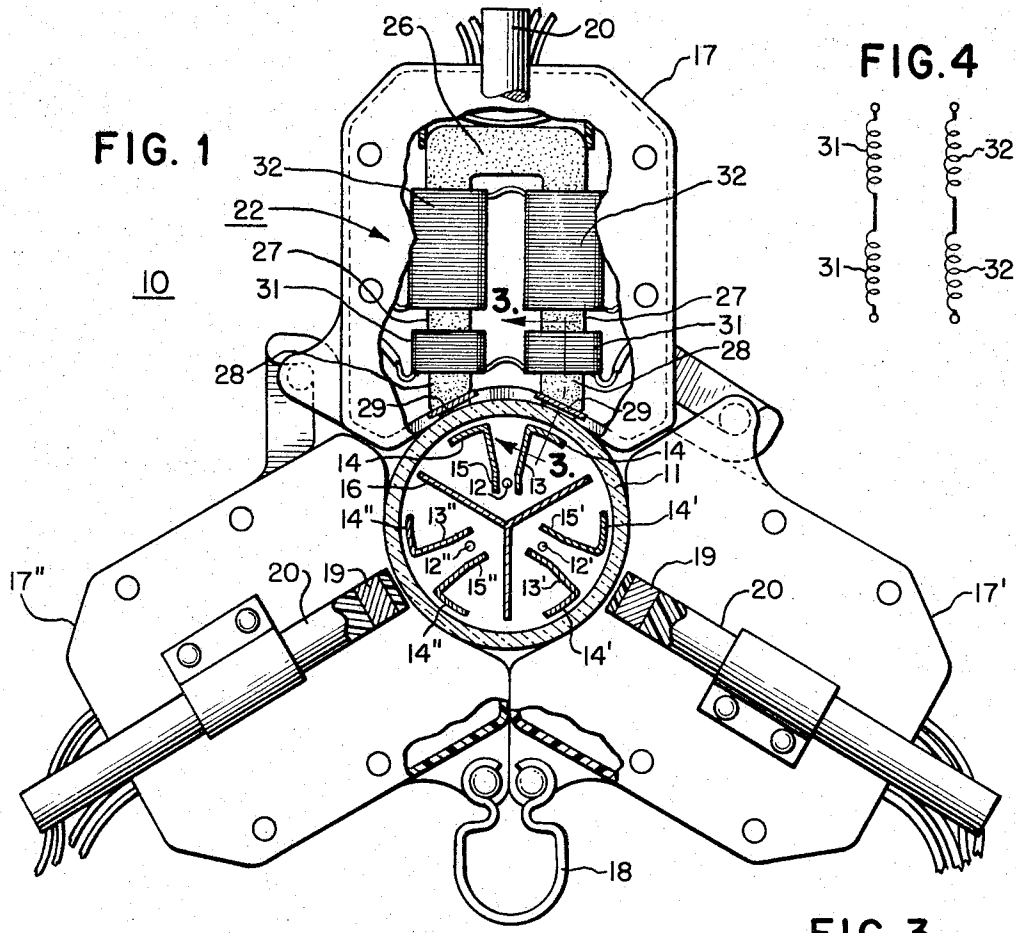


FIG. 4

FIG. 2

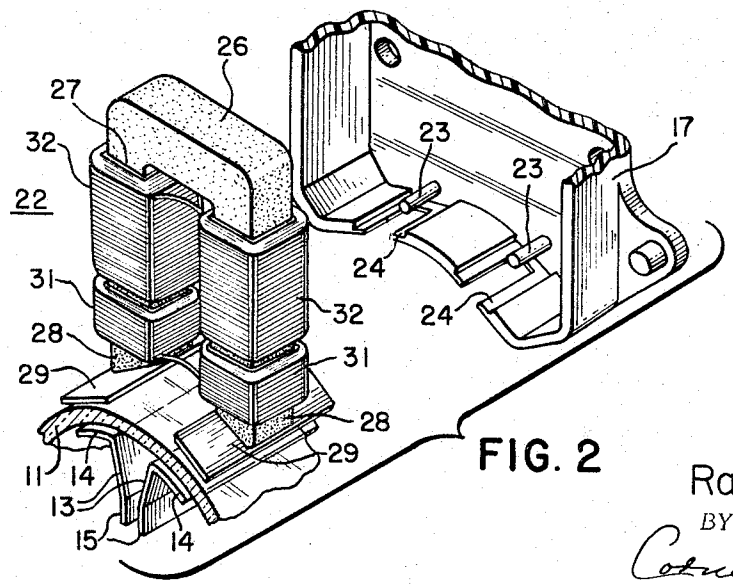


FIG. 3

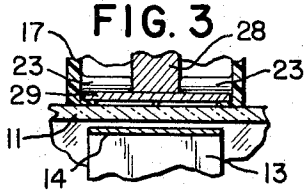


FIG. 3a

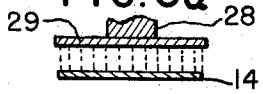
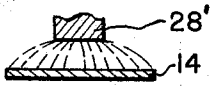


FIG. 3b



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CONVERGENCE MAGNET POLE SHOES

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The subject invention relates, in general, to color television but more particularly to electromagnetic convergence apparatus for use with tri-beam color reproducing cathode ray tubes.

A cathode ray tube of the type employed in conventional color television receivers comprises a delta array of electron guns which generate and direct a trio of electron beams towards the target structure of the tube. The target includes a luminescent screen comprising an ordered grouping of red, green and blue phosphor dots. These phosphor dots are arranged in a plurality of primary color triads, i.e., each triad is formed of a red, a green and a blue phosphor dot. Disposed adjacent the screen is a mask having a like plurality of apertures, one in registration with each color triad.

During scansion, the three beams must substantially converge at or near the plane of the aperture mask if proper color reproduction is to be achieved. When properly converged the three beams instantaneously illuminate only the phosphor dots included within a particular triad.

The geometry of a shadow-mask tube, however, is such that the three beams do not naturally converge at all points of the raster during scansion. Normally, static as well as dynamic convergence is required. To achieve such convergence it is known to subject the beams to auxiliary magnetic fields. Static convergence is conventionally accomplished by the use of permanent magnets which are adjustably supported about the neck of the tube. These magnets direct their flux toward magnetic circuits disposed within the neck section of the tube. One such circuit is provided for each beam and typically takes the form of a pair of elongated pole pieces which flank the path of its assigned electron beam and thereby direct the field of the magnet across the path of the beam.

Dynamic convergence is attained by resort to electromagnetic apparatus which also directs magnetic flux into the internal pole pieces. These electromagnets are energized by correction signals derived from the horizontal and vertical deflection circuits. The electromagnetic apparatus, as well as the permanent magnets are commonly mounted on a yoke which is adjustably positionable about the neck of the tube.

A typical prior art electromagnetic convergence device comprises a U-shaped core having a vertical and a horizontal convergence winding mounted in tandem on each leg of the core. The total flux realizable from such an electromagnetic core is determined by the core material, its dimensions, the windings and the input energy. The magnitude of flux transferable from such a core to an adjoining magnetic circuit, on the other hand, is determined principally by the reluctance encountered by the flux. This, in turn, is a function of the proximity of the magnetic circuits and their configurations.

In a cathode ray tube the proximity of the electromagnetic device to the internal pole pieces is established, of course, by the wall thickness of the tube neck and the housing which supports the device. The configuration of the internal magnetic circuit is dictated by electron gun considerations while the shape of the electromagnet core has been determined by space and economy factors. Space is conserved and some core and coil material economies are effected if the electromagnetic device is physically reduced in size. This expedient, however, undesirably increases the reluctance of the flux coupling path between the core and the internal pole pieces thereby taxing the correction signal source and, as a consequence, reducing the efficiency of the convergence system.

It is therefore a general object of the invention to provide an improved convergence apparatus for use with multi-beam color reproducing cathode ray tubes.

It is a specific object of the invention to provide a more efficient electromagnetic device for use in dynamic convergence apparatus.

It is also an object of the invention to obtain a more efficient convergence apparatus in an economical fashion.

In accordance with the invention an electromagnetic device for use with convergence apparatus employed with a multi-beam cathode ray tube having a pole piece pair associated with at least one of the beams and comprising outwardly directed pole faces, comprises a core of magnetic material having a pair of spaced apart legs. A convergence winding is supported upon the core. Additionally, the device comprises a pair of flux permeable pole shoes having respective areas greater than the area of a core leg extremity. Means are included for supporting the pole shoes adjacent the extremities of the core legs and mounting means are provided for mounting the core and the pole shoes upon the neck of the cathode ray tube with the pole shoes confronting the pole piece faces.

The features of this invention which are believed to be novel are set forth with particularity in the appended claims. The invention, together with further objects and advantages thereof, may best be understood, however, by reference to the following description taken in conjunction with the accompanying drawings, in the several figures of which like reference numerals identify like elements, and in which:

FIGURE 1 is an elevational view, partly in section, of the inventive convergence apparatus positioned about the neck of a tri-beam cathode ray tube;

FIGURE 2 is an exploded view, partly in section, of a portion of the convergence apparatus shown in FIGURE 1;

FIGURE 3 is a cross-sectional view taken along line 3—3 of FIGURE 1;

FIGURE 3*a* is a schematic representation of the magnectic field distribution across that portion of the convergence apparatus shown in FIGURE 3;

FIGURE 3*b* is a schematic representation of the magnetic field distribution in a prior art convergence apparatus; and

FIGURE 4 is a schematic diagram depicting the electrical circuitry of the convergence coils shown in FIGURES 1 and 2.

A convergence apparatus **10** embodying the invention is depicted in FIGURE 1. As there shown, the convergence apparatus is mounted upon the neck **11** of a tri-beam cathode ray tube of the type generally employed in color television receivers. In color reproducing tubes of this type, the longitudinal axis of neck **11** is coincident with the geometric axis of the tube itself. A trio of electron guns (not shown) is symmetrically disposed above this axis and develops the electron beams **12**, **12′** and **12″**. Supported within the neck portion of the tube and extending radially from the tube axis are pairs of elongated metallic pole pieces **13**, **13′** and **13″**. These pole pieces, which are spaced about the tube axis on 120° centers, present outer faces **14**, **14′**, **14″** to electromagnetic devices which are housed within convergence apparatus **10** and which will be more fully described below. The inner extremities **15**, **15′**, **15″** of these pole pieces, on the other hand, confront the paths of

respective electron beams 12, 12' and 12'' for substantially the entire lengths of the pole pieces. A Y-shaped magnetic shield 16 is interposed between the internal pole pieces to prevent interaction of the magnetic field developed across them.

It is appreciated, of course, that a delta gun array is not employed in all multi-beam color reproducing cathode ray tubes. One alternative construction, for example, contemplates an in-line or planar gun array. In such a construction a pole piece pair for the centrally disposed beam may be unnecessary.

Convergence apparatus 10 is of an interlocking tripartite construction comprising three substantially identical equally spaced units or lobes 17, 17', 17''. As best seen in FIGURE 1, each of the lobes includes an arcuate wall section having a curvature conforming to the wall of tube neck 11. A U-shaped spring 18 secures convergence apparatus 10 at a desired location upon neck 11, that is, with each of lobes 17, 17', 17'' positioned over an assigned one of pole pairs 13, 13', 13'', respectively.

Individually associated with each of lobes 17, 17', 17'' are static convergence magnets 19 (only two shown) which are mounted in holders 20 adjustably supported upon outside walls of the lobes. With this arrangement the flux fields of magnets 19 are presented to the outer faces 14, 14', 14'' of the internal pole pieces.

Each of lobes 17, 17', 17'' houses identical structure for dynamically converging its assigned beam; therefore, discussion will be confined to a consideration of lobe 17, the internal structure of which is detailed for this purpose. Accordingly, and as is apparent from a consideration of FIGURES 1–3, lobe 17 is formed of a pair of matching half-shells which enclose an electromagnetic convergence device 22. Each half-shell comprises pedestals 23 and a pair of pockets 24, which are formed in the arcuate wall section 25 of the shell, for supporting and positioning device 22.

Convergence device 22 comprises a U-shaped core 26 of magnetic material having a pair of spaced apart legs 27. Core 26 is preferably constituted of a high permeability material such as ferrite although other high permeability materials are also suitable. The free extremities 28 of legs 27 are inserted in wall pockets 24 and centrally positioned within lobe 17 by virtue of the support afforded by pedestals 23. Extremities 28 of the core legs are canted to accommodate the curvature of tube neck 11 and, as apparent in FIGURE 2, have cross-sectional areas substantially smaller than the areas of adjacent pole faces 14.

Device 22 further comprises a pair of permeable pole shoes 29 having respective areas approximately the same as the areas of pole faces 14. More particularly, pole shoes 29 comprise strips of magnetic material which are supported in an abutting relation with core leg extremities 28 and in a parallel spaced relation to pole faces 14 by wall pockets 24, see FIGURE 3. Thus supported pole shoes 29 overlap core leg extremities 28 in two directions, in fact, it is preferred that the pole shoes be geometrically centered with respect to the core legs. In this fashion, and as schematically illustrated in FIGURE 3*a*, a uniform non-magnetic air gap is established between the external magnetic circuit, i.e., the pole shoes 29 of device 22, and faces 14 of pole piece 13. Preferably, pole shoes 29 are formed of thin rectangular strips of transformer lamination stock which is grain oriented in the direction of the longest dimension of the strip, that is, along its length.

A horizontal convergence winding 31 and a vertical convergence winding 32 are mounted in a tandem arrangement on each of core legs 27. As schematically shown in FIGURE 4, the end turns of each horizontal convergence winding 31 are serially connected in a flux-aiding relation. In like fashion, the end turns of each vertical convergence winding are serially connected in a flux-aiding relation. The free ends of windings 31 and 32 are returned, respectively, to horizontal and vertical deflection circuits, not shown, for energization.

In operation, convergence apparatus 10 is mounted upon the neck of the picture tube and positioned so that electromagnets 22 and magnets 19 are in juxtaposition with assigned ones of internal pole pieces 13, 13', 13''. As already indicated, each of the electron beams passes between the confronting inner extremities of an assigned pair of pole pieces. The magnetic field extending across the ends of each pair of pole pieces is substantially perpendicular to the trajectory of the beam thus producing a lateral deflection of the beam which is proportional to the strength of the impressed field. By controlling the strength of these magnetic fields, beam trajectories are altered so that the beams converge at a given point on the tube screen.

In the absence of a control signal to the dynamic convergence windings 31, 32, the flux passing through the internal pole pieces is determined by magnets 19. The strength of these fields is determined by the orientation and the proximity of the magnet to the outer faces 14, 14', 14'' of the internal pole pieces. Accordingly, to achieve static convergence of the three beams, magnets 19 are adjusted until the desired degree of convergence is attained.

Dynamic convergence of the electron beams, on the other hand, is accomplished by electromagnets 22. More particularly, horizontal and vertical convergence windings 31, 32 are energized by control signals derived from the deflection system, which signals vary as functions of the horizontal and vertical scanning signals, respectively. These control signals develop time-varying magnetic flux fields within core 26. Again, confining attention specifically to the apparatus associated with lobe 17, the magnetic field developed in core 26 is directed via pole shoes 29 into the outer faces 14 of pole pieces 13. As schematically depicted in FIGURE 3*a*, the magnetic flux generated by device 22 is uniformly distributed across the air gap between pole shoe 29 and outer face 14 of the internal pole piece. As a result of such distribution, the reluctance of this air gap is reduced over that which would be presented to the core in the absence of the pole shoes. This obtains because the reluctance of the air gap is inversely proportional to the confronting areas of the internal pole pieces and the external magnetic structure which, in this instance, constitutes pole shoes 29.

In the absence of a pole shoe 29, and as illustrated in FIGURE 3*b*, a non-uniform flux field is developed between the extremity of a core leg 28' and the face 14 of the internal pole piece. These magnetic structures, that is, core leg 28' and pole face 14, present a higher reluctance to the magnetic field, for the reason above given, and, as a result, adversely affect the sensitivity of the dynamic convergence circuits. In other words, to achieve identical displacements of an electron beam, the magnetic structure of FIGURE 3*b* requires a greater driving power than the structure of FIGURE 3*a*.

Moreover, by employing strips of permeable material having a grain structure oriented in the direction of the longest dimension for shoes 29, the reluctance to the magnetic flux of device 22 is further reduced since the grain structure of such a shoe more expeditiously distributes the flux along the length of the shoe and therefore across the entire length of air gap between the shoe and outer pole face 14. This uniform flux distribution is further enhanced by abutting the pole shoe against the extremity of the core leg and by centering the shoe relative to the core leg.

Merely by way of illustration and in no sense by way of limitation, pole shoes constructed of transformer lamination stock M6X AAS and grain oriented in the longest dimension of the shoe have been successfully employed in an operative embodiment of the convergence apparatus shown in FIGURES 1–3. M6X is an American Iron and Steel Institute specification for a particular type of grain

oriented steel. The designation AAS stands for "Annealed After Stamping" and simply means that the steel is annealed after a forming or stamping operation in order to counter any stresses in the material due to such operation.

While the pole shoes are disclosed as substantially rectangular in cross section this construction is not imperative but was employed in the operative embodiment since it is a feasible configuration for magnetically cooperating with the internal pole pieces. It is more important that the area and configuration of the pole shoe be such as to confront substantially the entire face of the internal pole piece.

Insofar as multi-beam cathode ray tubes having gun arrays other than a delta configuration are concerned, it is recognized that such tubes may require different convergence apparatus arrangements. For example, apparatus having two rather than three convergence units may be indicated and even a different type convergence winding may be more suitable for a particular type tube. In any event, the disclosed magnetic core and pole shoe arrangement finds particular utility in convergence apparatus for use with any multi-beam cathode ray tube having one or more pairs of internal beam displacing pole pieces.

In summary, the objectives of the invention are achieved for multi-beam tubes of the type herein considered by virtue of the fact that the disclosed electromagnet construction permits a magnetic convergence field to be developed uniformly across the entire gap extending between the external magnetic circuit and the internal pole pieces thereby significantly increasing the sensitivity of the convergence system.

While a particular embodiment of the present invention has been shown and described, it is apparent that changes and modifications may be made therein without departing from the invention in its broader aspects. The aim of the appended claims, therefore, is to cover all such changes and modifications as fall within the true spirit and scope of the invention.

I claim:

1. In a convergence apparatus for use with a multi-beam cothode ray tube having a pole piece pair associated with at least one of the electron beams and comprising outwardly directed pole faces, an electromagnetic device for selectively positioning one of said beams comprising:

a core of magnetic material having a pair of spaced apart legs and supporting a convergence winding;

a pair of permeable pole shoes having respective areas greater than the area of a core leg extremity;

means for supporting said pole shoes adjacent the extremities of said core legs;

and means for mounting said core and said pole shoes upon the neck of said cathode ray tube with said pole shoes confronting said pole piece faces.

2. An electromagnetic beam positioning device of the type defined in claim 1, in which said pole shoes are supported in an abutting relation to the extremities of said core legs.

3. An electromagnetic beam positioning device of the type defined in claim 1, in which said pole shoes are mounted in parallel spaced relation to said pole faces.

4. An electromagnetic beam positioning device of the type defined in claim 1, in which said pole shoes comprise thin planar rectangular strips of magnetic material.

5. An electromagnetic beam positioning device of the type defined in claim 4, in which said pole strips overlap said core leg extremities in at least two directions.

6. An electromagnetic beam positioning device of the type defined in claim 4, in which said pole strips are supported geometrically centered relative to said core leg extremities.

7. An electromagnetic beam positioning device of the type defined in claim 4, in which said pole shoe material is grain oriented parallel to the longest dimension of said strip.

8. An electromagnetic beam positioning device of the type defined in claim 1, in which the respective areas of said pole shoes approximate the areas of said pole faces.

References Cited

UNITED STATES PATENTS

2,459,732	1/1949	Bradley	313—77
3,138,730	6/1964	Heuer et al.	313—77

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