

[54] **CONVERGENCE MEANS FOR INLINE-TYPE CATHODE RAY TUBE**

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abandoned.

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[51] Int. Cl. **H01f 1/00**

[58] Field of Search 335/210, 212; 313/412,
313/421, 425, 426, 427, 428

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[57] ABSTRACT

An improved convergence assembly adapted for use in color television tubes of the type not provided with internal pole shoes. External pole pieces are used in combination with a permanent magnet to effect primary and secondary sets of magnetic poles at desired locations about the periphery of the neck of the cathode ray tube. The primary, stronger sets of poles are given rise to through pole pieces having relatively low reluctance while the secondary, weaker poles are produced through pole pieces having substantially higher reluctance. The pole pieces thus provide a secondary field which offsets the effect of a portion of a primary field and allows electron beams to be individually adjusted.

19 Claims, 3 Drawing Figures

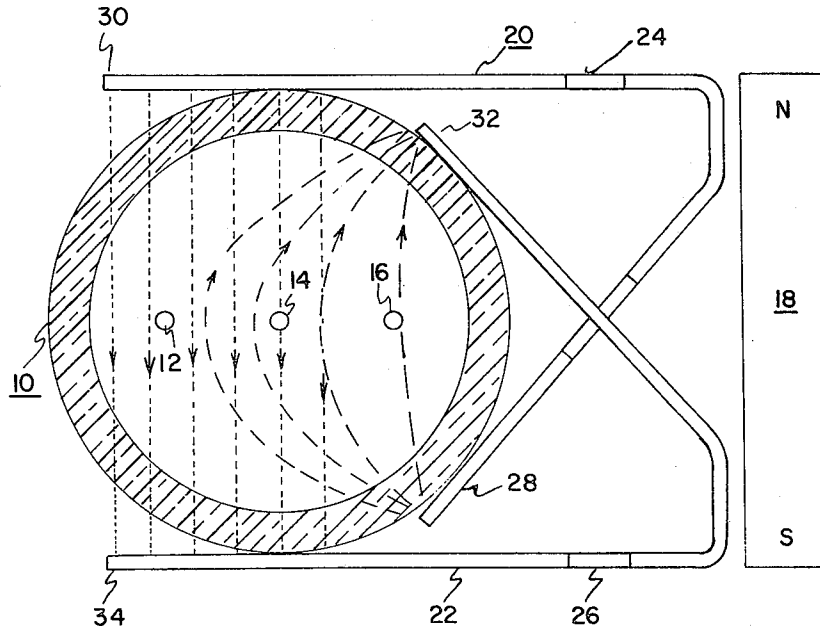


FIG. 1

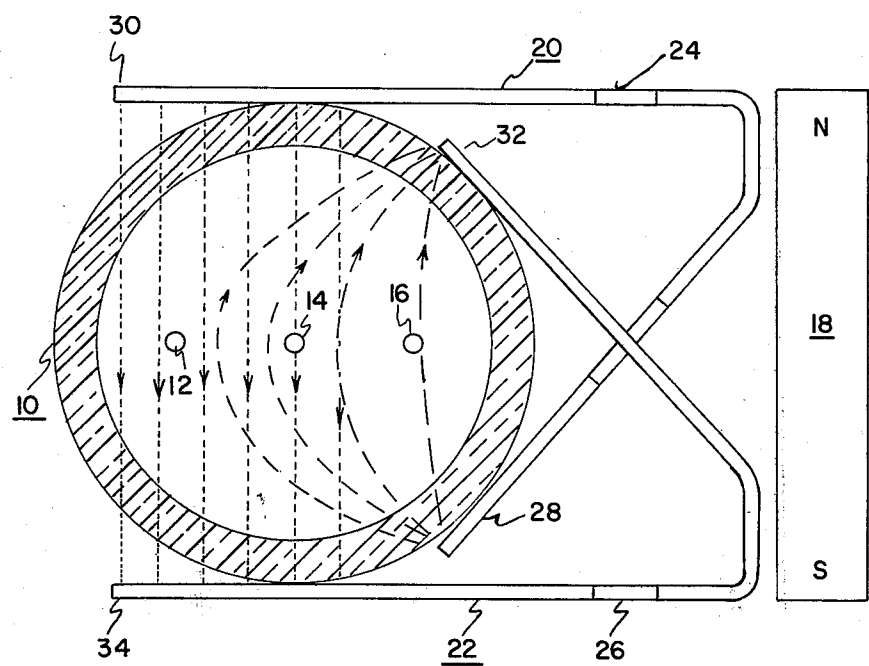


FIG. 2

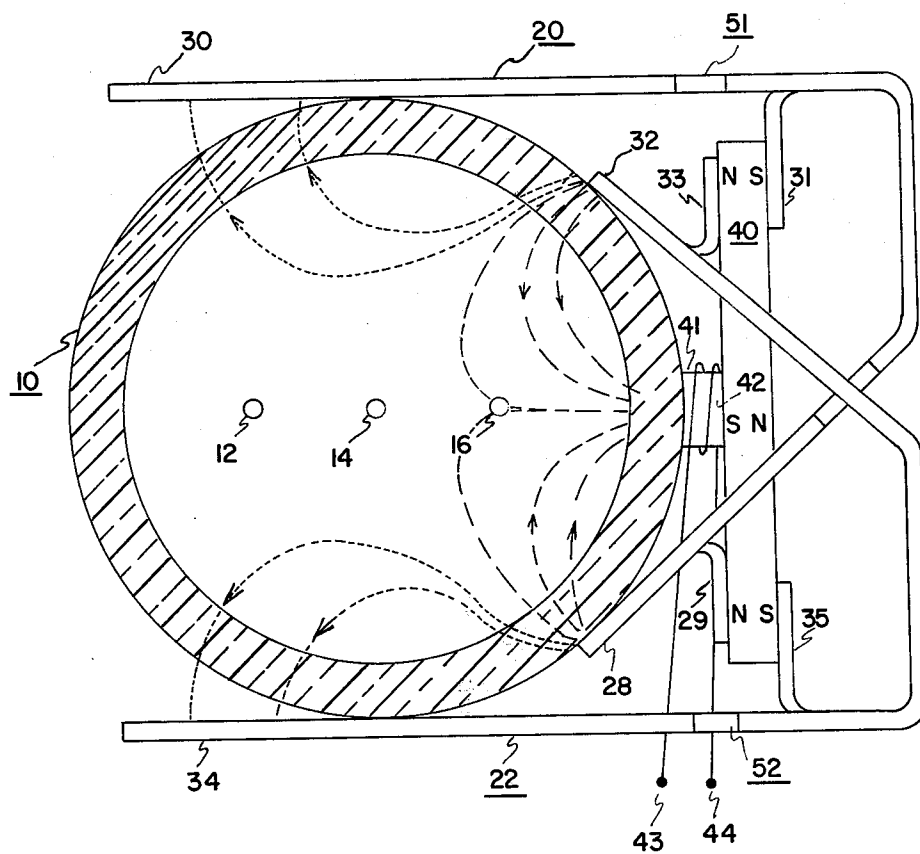
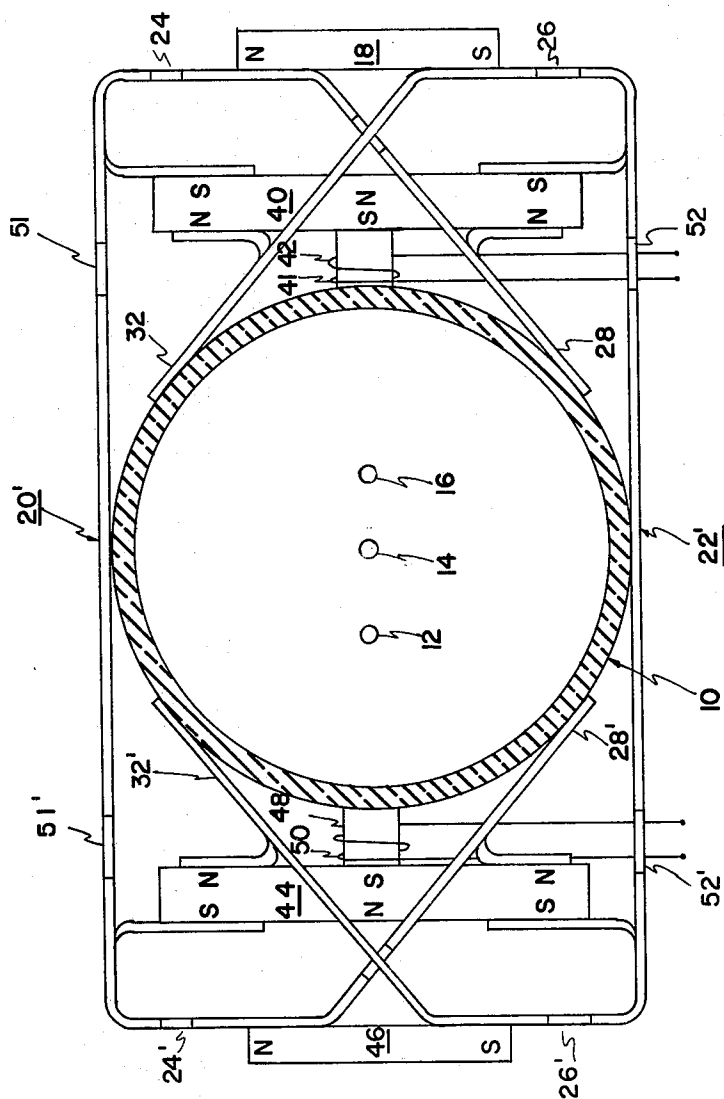


FIG. 3



CONVERGENCE MEANS FOR INLINE-TYPE CATHODE RAY TUBE

This is a continuation of application Ser. No. 336,514, filed Feb. 28, 1973.

BACKGROUND OF THE INVENTION

The present invention relates to color television receivers and, more particularly, to convergence means for adjustably positioning individual ones of a plurality of electron beams within the neck of a cathode ray tube.

Of the various types of color television display means that have been devised, the predominant system is one utilizing a cathode ray tube of the shadow mask variety and having three electron beams produced therein. Electron gun means in the neck of the tube produce three individual beams which are disposed in either a triangular (delta) or planar (in-line) array. In the absence of deflection, the beams are aligned to converge in the plane of a perforate metal mask disposed just behind a phosphorcovered faceplate of the tube. The mask, called a shadow mask, allows each beam to impinge upon only phosphors of a predetermined type, shielding or "shadowing" other phosphors from the beam. To be effective, such a system requires that the beam converge at approximately the plane of the mask throughout the scansion process. However, as the beams are scanned back and forth across the surface of the mask, the distance from the center of deflection to the faceplate changes, so that dynamic convergence means are needed to vary the convergence angle of the beams as a function of deflection. Ideally, in the absence of deflection the beams will be perfectly converged at the center of the shadow mask. This so-called static convergence, is, however, extremely difficult to achieve in mass-produced tubes since electron gun alignment and spacing necessarily varies from one tube to another. In order to compensate for such imperfections in the construction of the tube, adjustable means must then be provided for initially converging the beams. Such beams, termed static convergence means, ordinarily take the form of adjustable permanent magnets which are in magnetic communication with the region through which the electron beams pass. In many instances, it has been found feasible to combine the static and dynamic convergence means, utilizing the same magnetic core elements or pole pieces to produce both static and time-varying magnetic fields within the neck of the cathode ray tube. The convergence means commonly included wire-wound magnetic cores disposed without the neck of the cathode ray tube, and magnetic elements termed pole shoes disposed within the tube for communicating and confining the magnetic fields to areas through which the electron beams must pass.

Recently it has been found that acceptable dynamic convergence may be achieved through the use of additional windings incorporated into the deflection means. In this event no separate, external magnetic means need be provided for dynamic convergence, and so a separate static convergence means must be devised. In order to take full advantage of the incorporation of the dynamic convergence means with the deflection means, it is desirable to simultaneously eliminate the pole shoes from within the neck of the cathode ray tube.

Several solutions to this problem have been devised. In one approach, a plurality of permanent magnets are displaced opposite one another by affixing them to annular mountings, or rings. By rotating the rings individually or together the net magnetic field created within the neck of the cathode ray tube may be varied, causing the positions of the electron beams to change. However, adjustment of such a system is inordinately complex since the paths upon which the beams travel comprise a series of ellipses. Further, changing the magnetic field to displace one beam effects a displacement of all beams which in turn necessitates other, corrective adjustments. This interrelationship, termed "beam chasing," complicates the procedure by which the receiver is adjusted and adds to the expense of production and maintenance.

Other means devised to provide static convergence of the beams include U-shaped or E-shaped magnetic cores adjustably positioned about the neck of the tube. However, when used with cathode ray tubes having no internal pole shoes, the fringe effects of the fields also give rise to the "chasing" phenomenon, substantially increasing the complexity of adjustment.

In addition to the beam chasing problem, which necessitates repeated offsetting or compensatory adjustments, with the prior art means it is often difficult to converge the beams and still maintain the proper relationship of the beam pattern with respect to the electron guns. In this case, one or more of the beams is forced to exit from its electron gun slightly off center. Since the final electrode in most electron guns is the focusing electrode, this off-center exodus produces an undesirable defocusing of the beam.

It will therefore be appreciated that it would be desirable to provide static convergence means for a multi-beam color cathode ray tube not having pole shoes within the neck thereof, which allows the beams to be easily adjusted without "chasing."

It is therefore an object of the present invention to provide improved static convergence means which do not require the presence of pole shoes within the neck of the cathode ray tube.

It is another object of the present invention to provide static convergence means which substantially eliminates electron beam chasing.

It is still another object of the present invention to provide static convergence means by which the position of individual electron beams may be varied in a horizontal or vertical direction.

It is a further object of the invention to provide static convergence means disposed in a single plane and which allows the horizontal or vertical position of ones of a plurality of electron beams to be individually adjusted.

SUMMARY OF THE INVENTION

Briefly, stated, in accordance with one aspect of the invention the foregoing objects are achieved by providing permanent magnetic means having a pair of magnetic poles on either side of the neck of a cathode ray tube. Each pole is in magnetic communication with a pair of points about the periphery of the neck of the cathode ray tube by means of pole pieces forming two magnetic paths. One path has substantially more reluctance than the other so that a first, relatively strong set and the second, relatively weak set of magnetic poles is produced about the tube neck. The second, weaker

set of poles is oriented to substantially cancel the fringe effects of the first, stronger set.

In a further embodiment, second magnetic means are associated with the pole pieces for producing other sets of magnetic fields which are displaced at effectively 90° to the first-mentioned sets.

BRIEF DESCRIPTION OF THE DRAWINGS

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention, it is believed that the invention will be better understood from the following description of the preferred embodiment taken in conjunction with the accompanying drawings in which:

FIG. 1 illustrates one aspect of the present invention whereby horizontal displacement of electron beams is effected;

FIG. 2 illustrates another aspect of the invention whereby vertical displacement of electron beams may be achieved; and

FIG. 3 exemplifies a combination of the embodiments of FIGS. 1 and 2.

DESCRIPTION OF A PREFERRED EMBODIMENT

FIG. 1 illustrates a transverse section of a plural-beam color television cathode ray tube showing a portion of a magnetic convergence assembly. Extending axially within the neck portion of cathode ray tube 10 are three electron beams 12, 14 and 16. The electron beams are arrayed in a common plane and advantageously converge at the viewing screen of the tube to excite phosphor segments which produce red, blue or green light. While it is theoretically possible to construct a tube having electron gun structures oriented to achieve proper convergence of the beams without the use of auxiliary beam aiming means, in practice it has been found necessary to provide means for adjusting the position of individual beams with respect to the other.

The adjusting means contemplated by the present invention comprise a permanent magnet 18 and associated pole pieces 20 and 22. Each pole piece is provided with a magnetic restriction such as the areas of reduced cross-section 24 and 26 of pole pieces 20 and 22, respectively. The areas of reduced cross-section, hereinafter referred to as magnetic restrictions, serve to divide each pole piece into two segments; a first segment which comprises a magnetic path of relatively low reluctance and a second segment which constitutes a path of substantially higher reluctance. Pole piece 20 is bent in a manner calculated to bring its opposite ends 28 and 30 into close proximity with the neck portion of tube 10. Similarly, the ends 32 and 34 of pole piece 22 are disposed about tube neck at points between the points at which ends 28 and 30 are located.

Permanent magnet 18 is disposed in close proximity to the pole pieces at points intermediate to the ends thereof. Each pole piece thus effectively becomes an extension of the magnetic pole with which it is associated. Pole piece 20 may be considered a bifurcated north or N pole, while pole pieces 22 constitutes a split south or S pole. Due to the presence of magnetic restrictions 24 and 26, for a given amount of magnetomotive force (MMF) the amount of magnetic flux arising from ends 30 and 34 is substantially less than that which will arise from ends 28 and 32. Pole piece end

28 may thus be considered to comprise a "strong" N pole while end 30 constitutes a "weak" N pole. In like manner pole piece end 32 constitutes a stronger S pole than does opposite end 34.

Two magnetic fields, or sets of magnetic flux lines, now arise within the tube neck. A first, relatively strong field arises between pole piece ends 28 and 32. This field is considered to extend in an upward direction, lines of flux being considered to flow from an N to an S pole. As shown by the dashed lines between the pole piece ends, the flux lines traverse the plane of beams 12, 14 and 16 in a direction perpendicular thereto, and exert a continuously diminishing influence upon beams 14 and 12. The effect of these lines of flux is to effect a rightward displacement of the beams with beam 16 being displaced further than beams 14 and 12.

It will be noted that in contradistinction to many prior-art convergence systems no pole shoes are provided within the neck of cathode ray tube 10. Prior-art systems commonly comprise a pair of pole shoes disposed on opposite sides of each of the end beams. The pole shoes serve to confine lines of magnetic flux to a small, well-defined area through which a given beam passes, and minimize the amount of stray or "fringe" magnetic flux in the area of the neighboring beams. While deletion of the internal pole shoes facilitates the shortening of the tube neck, their absence substantially increases the magnitude of stray or fringe fields, increasing the interaction therebetween and complicating beam adjustment.

In the absence of the second ends of the pole pieces a change in the effective value of magnet 18, which may be achieved by displacing or rotating magnet 18, would displace not one but all of the electron beams laterally within the tube neck. If a second, mirror-image magnetic arrangement were provided at the left-hand side of the figure to provide reversely directed, adjustable field the undesired movement of beams 12 and 14 could be compensated for but in the process beam 16 would also undergo a slight displacement. This phenomenon, termed "beam chasing," is characteristic of many prior-art static convergence devices which do not use internal pole shoes and adds substantially to the complexity of the adjustment procedure. Further, with such devices the finally adjusted beam array is in some cases displaced from the center of the tube. This forces the beams to exit from their respective electron guns at slightly off-center positions, preventing the proper focusing of the beams.

The present invention, however, avoids the undesirable effects adverted to above such as beam chasing and defocusing. In particular, a downwardly directed magnetic field arises between pole piece ends 30 and 34 by virtue of the association of pole pieces 20, 22 with opposite poles of magnet 18. Due to the presence of magnetic restrictions 24 and 26 the strength of the field arising between ends 30 and 34, represented by the dotted lines, is substantially less than that arising between ends 28 and 32. By a judicious choice of restriction size the lesser or secondary field extending about beams 12 and 14 is made to be substantially equal to the fringe portions of the stronger field which extend to the same area.

In this manner a self-cancellation of the fringe field flux takes place so that variations in the effective strength of magnet 18 procures the horizontal displacement of only beam 16. Beam chasing is substantially

eliminated and static convergence may be obtained through a relatively simple adjustment procedure.

In order to effect the displacement of beam 12, a complementary magnet and pole piece assembly is provided. This assembly may advantageously be a mirror image of the one illustrated in FIG. 1, and may be combined therewith as will be later described.

FIG. 2 shows the combination of pole pieces 20 and 22 with a second magnetic means 40, the combination giving rise to magnetic fields suitable for producing the vertical translation of ones of electron beams 12, 14 and 16. While pole pieces 20 and 22 may be formed in the same manner as those of FIG. 1, it will be recognized that their configuration may be varied from that illustrated in order to suit a particular application.

Magnet 40 comprises three pairs of magnetic poles, being magnetized transversely at the middle and at the ends thereof. In this manner alternating poles are produced at opposite sides of the magnet. Magnet 40 is advantageously cylindrical so that rotation thereof about its vertical axis varies the strength and/or direction of the magnetic field produced thereby. Ends 28 and 32 of pole pieces 20 and 22 are brought into close contact with the lower and upper ends, respectively, of magnet 40 by means of extensions or tabs 29 and 33. Due to their close proximity to the ends of the magnet, relatively strong north or N poles arise at pole piece ends 28 and 32. Although lines of flux would normally extend directly from the end N poles to the central S pole of the magnet, the pole pieces serve to extend the lines of flux within the neck of cathode ray tube 10 as shown by the dashed lines. An additional pole piece 41 may be interposed between the neck of the tube and the central, S pole of the magnet to increase the directivity of the field. Lines of flux may now considered to be emanating from pole piece ends 28 and 32, flowing into the neck of the tube in an arcuate fashion and returning to pole piece 41. The flux pattern which arises is indicated by dashed lines, it being apparent that the effective net flux arising at the horizontal centerline of the tube and extending through the planar beam array is oriented in a substantially horizontal direction to effect vertical displacement of the beam. In the illustrated embodiment, the rightwardly-directed lines of flux cause a downward displacement of beam 16.

In the absence of second ends 30, 34 of pole pieces 20 and 22 it will be understood that the fringe effects of the magnetic fields extending from ends 28 and 32 would also produce a downward deflection of beams 12 and 14. This deflection, while markedly less than the displacement of beam 16, prevents the individual adjustment of beam 16. If a complementary magnetic element is disposed at the left-hand side of the tube to form a mirror image of the assembly depicted in FIG. 2, beams 12 and 14 can now be adjustably displaced to counteract the fringe effects of the field of magnet 40. However, in so doing beam 16 would also be slightly displaced due to the fringe effects of the left-hand assembly. The illustrated right-hand assembly would then have to be re-adjusted, causing another unwanted displacement of beams 12 and 14. This "chasing" phenomenon, already referred to above, unduly complicates the adjustment procedure for the static convergence assembly.

The S poles at the upper and lower ends of magnet 40 which are opposite the N poles already referred to are placed in magnetic communication with the second

ends 30 and 34 of pole pieces 20 and 22, respectively. This may be achieved through the use of upstanding tabs 31 and 35 as shown, or by any other practical means. In any event, magnetic restrictions such as areas of reduced cross section 51 and 52 are interposed between the south or S pole of magnet 40 and second ends 30 and 34 of the pole pieces. Relatively weak S poles are thus caused to arise along ends 30 and 34. These weak or secondary poles serve to attract some of the lines of flux emanating from N poles 28 and 32, which would otherwise constitute portions of a fringe field tending to deflect beams 12 and 14 in a downward sense. The net effect is then to set up a weak fringe which extends opposite to that arising between first pole piece ends 28 and 32 and the center of magnet 40. A rough approximation of the secondary or cancelling magnetic field is shown in FIG. 2, being represented by the dotted lines therein.

It is now apparent that the fringe effects of the first or primary poles creates a net flux component extending horizontally to the right, while the effects of the secondary, cancelling field effects a net magnetic field which extends horizontally to the left. The fringe effect of the primary magnetic field on beams 12 and 14 may thus be substantially offset, and the position of beam 16 may be varied through adjustment of magnet 40 without giving rise to the "chasing" phenomenon referred to hereinabove.

If desired, dynamic vertical correction may be achieved through the provision of a winding 42 upon pole piece 41. Terminals 43 and 44 of winding 42 may have applied thereto a sawtooth-like current which varies with the vertical deflection rate so as to effect a vertical displacement of ones of the end beams of the array in synchronism with deflection thereof.

FIG. 3 shows a combination of the embodiments of FIGS. 1 and 2, along with the complementary or mirror-image counterparts thereof formed at the left-hand side of the tube neck. The embodiment of FIG. 3 thus provides vertical and horizontal beam adjustment capability at both the left and the right-hand sides of the beam array.

Upper and lower pole pieces 20' and 22' are extended to provide symmetrically-formed ends at either side of the neck of the cathode ray tube 10. Magnetic restriction 51' is formed symmetrically with restriction 51 upon upper pole piece 20', and restriction 52' formed symmetrically with restriction 52 upon lower pole piece 22'. A six-pole vertical convergence magnet 44 and a two-pole horizontal convergence adjustment magnet 46 are associated with the leftward ends of the pole pieces. Similarly, an additional small pole piece 48 is interposed between the center section of magnet 44 and the neck of the cathode ray tube 10. A vertical dynamic convergence winding 50 may be formed thereon, in the manner of winding 42 of pole piece 41.

It will be noted that in the embodiment of the invention shown in FIG. 3 two sets of magnetic restrictions are now present at either side of the pole piece structure. The reason for this is two-fold. First, with the illustrated configuration should common magnetic restrictions be used for both vertical and horizontal positioning magnets, the vertical magnets and the tabs associated therewith could constitute additional flux paths of relatively low reluctance. These paths would divert flux from the horizontal convergence magnets and distort the desired magnetic field. Secondly, it is desirable to

place the restrictions as close as possible to the magnetic poles to preclude the existence of strongly-magnetized portions of the "weaker" flux path which could also serve to distort the desired magnetic field.

The primary magnetic fields which extend vertically through the plane of the electron beams 12, 14 and 16 now arise between poles 32 and 28 and 32' and 28'. The secondary fields arise between the control areas of the pole pieces. Depending on the orientation of horizontal convergence magnets 18 and 46, these fields may extend in a common direction to displace the electron beams either leftward or rightward, or may extend in opposite directions to spread apart or to converge the end beams 12 and 16. Similarly, vertical convergence magnets 40 and 44 may be oriented to produce fields which achieve a vertical displacement of the electron beams in a common direction, or one magnet may be rotated 180° with respect to the other to cause one of the end beams 12, 16 to move vertically in a sense opposite the movement the other.

The presence of the second, symmetrical set of magnetic restrictions 24', 26' and 51', 52' serve a dual purpose in the embodiment of FIG. 3. Firstly, they serve to attenuate the strength of the secondary poles arising at the horizontal center of each pole piece of the pole pieces 20' and 22'. As described above, this produces weak "secondary" fields which offset the effect of "primary" fields arising due to the primary, stronger magnetic poles at ends 28, 32 and 28', 32' of the pole pieces. However, the restrictions also present a barrier to flux produced by magnets located at the opposite side of the cathode ray tube neck. Thus, for instance, the weak N flux produced by the N pole of right-hand magnet 18 is attenuated after traversing restrictions 24 and 51 in order to support a weak cancellation field across the neck of the cathode ray tube. In addition, the presence of restriction 51' adds measurably to the reluctance presented to the lines of flux from the right-hand magnet 18 and thus serves to effectively isolate the left-hand magnetic system from lines of flux emanating from the right-hand system. Of course, a similar effect arises at the right-hand end of the system wherein restrictions 51 and 52 effectively isolate the right-hand extremities from the effect of magnets 44 and 46.

It will now be seen that an improved vertical and horizontal static convergence assembly has been described, which allows the static positioning of individual ones of an array of electron beams without the fringing or "chasing" phenomenon. In addition, due to the substantially perpendicular orientation of the net vertical and horizontal positioning fields, ones of the beams may be adjustably positioned along paths lying at right angles to one another. Still further these right angle paths lie substantially in vertical and horizontal planes, respectively so that vertical and horizontal convergence of the beam array may easily be achieved. Rectilinear displacement of the beams is effected by means of a static convergence assembly lying in a single plane, allowing the further diminution in neck length of the cathode ray tube.

As will be evident from the foregoing description, certain aspects of the invention are not limited to the particular details of the examples illustrated, and it is therefore contemplated that other modifications or applications will occur to those skilled in the art. It is accordingly intended that the appended claims shall

cover all such modifications and applications as do not depart from the true spirit and scope of the invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. Static convergence means for use with a cathode ray tube having a plurality of electron beams disposed in a predetermined array and extending therein, comprising:

permanent magnetic means having at least a pair of poles;

a first plurality of pole piece means extending from said poles for supporting a first magnetic field which traverses the beam array in a first direction;

a second plurality of pole piece means extending from said poles for supporting a second magnetic field which traverses the beam array in a direction opposite said first direction;

said second magnetic field substantially offsetting the effect of said first magnetic field upon predetermined ones of the electron beams.

2. Static convergence means for adjustably determining the relative position of ones of a set of electron means extending within the neck of a cathode ray tube, comprising:

permanent magnetic means having a first and a second magnetic pole;

first means for forming first and second magnetic paths between said first magnetic pole and first and second points about the tube neck, said second path having a higher reluctance than said first path;

second means for forming third and fourth magnetic paths between said second magnetic pole and third and fourth points about the tube neck, said fourth path having a higher reluctance than said third path;

said first, second, third and fourth points lying in a substantially common plane.

3. The invention defined in claim 2, further including:

second permanent magnetic means having a first and a second magnetic pole;

third means for forming fifth and sixth magnetic paths between said first magnetic pole of said second permanent magnetic means and fifth and sixth points about the tube neck, said sixth path having a higher reluctance than said fifth path;

fourth means for forming seventh and eighth magnetic paths between said second magnetic pole of said second permanent magnet means and seventh and eighth points about the tube neck, said eighth path having a higher reluctance than said seventh path;

said third and fourth means being adapted to be disposed symmetrically with said first and second means about the tube neck.

4. The invention defined in claim 3, wherein said first and said third points are disposed between said second and said fourth points, and said fifth and said seventh points are disposed between said sixth and said eighth points.

5. The invention defined in claim 4, wherein the magnetic fields arising between said first and said third, and said fifth and said seventh, points are substantially stronger than those arising between said second and fourth, and said sixth and eighth, points.

6. Static convergence means for adjustably positioning ones of a set of three electron beams arrayed in a

substantially common plane and extending within the neck of a shadow-mask type color television cathode ray tube, comprising:

first and second permanent magnet means disposed at opposite ends of the beam array;

a first plurality of magnetic path means for connecting opposite poles of each of said magnet means to points about the tube neck located on opposite sides of the plane;

a second plurality of magnetic path means for connecting opposite poles of each of said magnet means to points about said tube neck located on opposite sides of the plane, said second magnetic path means having substantially less reluctance than said first magnetic path means, the first and second magnetic path means extending from any given pole connecting said pole to points lying on opposite sides of said plane.

7. The invention defined in claim 6, wherein the points connected to the poles of a given permanent magnet means by ones of said second plurality of magnetic path means are disposed intermediate the points connected to the poles of said permanent magnet means by ones of said first plurality of magnetic path means.

8. The invention defined in claim 7, further including third and fourth permanent magnet means having poles of a first type disposed adjacent the opposite ends of the beam array and poles of a second type disposed above and below the plane;

means for magnetically coupling poles of said first type to ones of said first magnetic path means; and means for coupling poles of said second type to ones of said second plurality of magnetic path means.

9. The invention defined in claim 8, wherein said third and said fourth permanent magnet means comprise elongate permanent magnets magnetized transversely at the center and the ends thereof to provide six magnetic poles.

10. Static convergence means for use with a color television cathode ray tube of the type characterized by the absence of pole shoes within the neck portion thereof, and having a plurality of electron beams arrayed in a common plane and extending within the neck portion, comprising:

first and second elongate pole piece means each comprising end portions and an intermediate portion, said intermediate portions being adapted to extend on opposite sides of the tube neck and substantially parallel to the plane of the beams, the ends of each of said pole piece means extending to points about the neck which lie at the opposite side of the plane from the intermediate portion thereof; first and second horizontal convergence magnets disposed at opposite ends of the beam array and having poles thereof disposed in close conjunction to points between the mid points and the ends of each of said pole pieces;

said pole pieces having magnetic restrictions formed therein between the midpoints thereof and said points disposed in close conjunction with said magnetic poles.

11. The invention defined in claim 10, further including:

first and second elongate vertical convergence magnet means magnetized transversely near the middle

and the ends thereof to comprise a plurality of first and second magnetic poles;

first means extending from points intermediate said midpoints and said magnetic restrictions of said pole piece means to ones of said first poles of said vertical convergence magnet means;

second means extending from the end portions of said pole piece means to ones of said second poles of said vertical convergence magnet means;

third pole piece means extending from ones of said first poles of said vertical convergence magnet means to points about the neck which lie substantially in the plane of the arrayed electron beams; said first pole piece means having second magnetic restrictions formed therein between the midpoints thereof and said first means.

12. Static convergence means for adjustably positioning ones of three electron beams arranged in a substantially planar array and extending within the neck of a color television cathode ray tube, comprising:

magnet means disposed at each end of said array adjacent said neck and containing magnetic poles, magnetic flux conducting means external to the neck of said cathode ray tube conducting flux between said poles so as to pass through said neck to effect the positioning of at least one said electron beams, said magnetic flux conducting means being arranged with respect to each magnet means to produce a primary magnetic field through said neck and a secondary magnetic field through said neck to control the reach of said primary field so that said primary magnetic field substantially effects the positioning of one of said electron beams.

13. The invention defined in claim 12 wherein said magnet means comprise a permanent magnet adjustably positioned at each end of said array and said magnetic flux conducting means comprise pole piece means associated with each permanent magnet to channel magnetic flux to form said primary field in proximity to the electron beam adjacent said permanent magnet,

said pole piece means being arranged to channel magnetic flux to form said secondary magnetic field in proximity to the other electron beams to offset the affect of said primary field on said other two electron beams.

14. The invention recited in claim 13 wherein the poles of each permanent magnet and said pole piece means are arranged to control horizontal movement of the electron beam adjacent to said permanent magnet.

15. The invention recited in claim 13 wherein the poles of each permanent magnet and said pole piece means are arranged to control vertical movement of the electron beam adjacent to said permanent magnet.

16. The invention recited in claim 12 wherein said magnet means comprise a pair of permanent magnets adjustably positioned at each end of said array and said magnetic flux conducting means comprise pole piece means associated with each pair of permanent magnets to channel magnetic flux to form said primary field for each permanent magnet in proximity to the electron beam adjacent to said permanent magnet and to channel magnetic flux to form said secondary field for each permanent magnet in proximity to the other two electron beams to offset the affect of said primary field on said other two electron beams.

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17. The invention recited in claim 16 wherein ones of said pole piece means have a higher reluctance than the others of said pole piece means such that said secondary field is weaker than said primary field for each permanent magnet and is substantially equal to the fringe portion of said primary field that affects said other two electron beams.

18. The invention recited in claim 17 wherein the higher reluctance in said ones of said pole piece means is formed by magnetic restrictions of such size and placement to control the relative strength of each pri-

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mary and secondary field and to minimize interference between the fluxes generated by different ones of said permanent magnets.

19. The invention recited in claim 18 wherein one of the permanent magnets in each pair of permanent magnets is movable to adjust the position of the electron beam adjacent to said pair in a horizontal direction and the other of said permanent magnets in each pair is movable to adjust the same electron beam in a vertical direction.

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