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THREE IN-LINE GUN MAGNETIC CONVERGENCE SYSTEM

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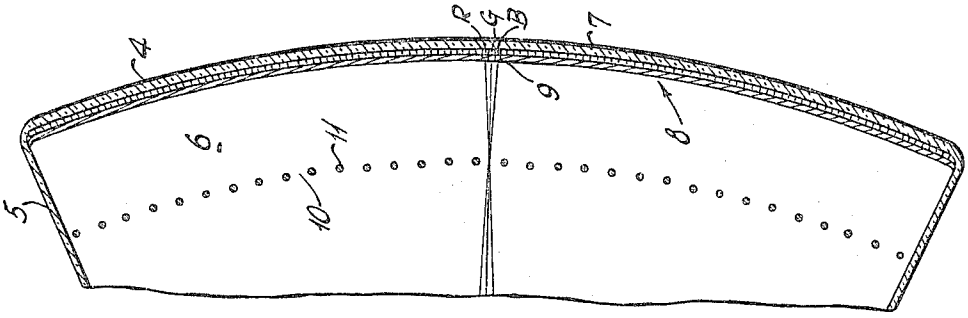


Fig. 3.

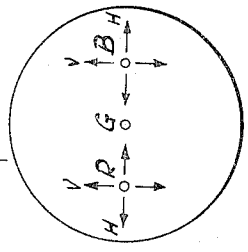


Fig. 2.

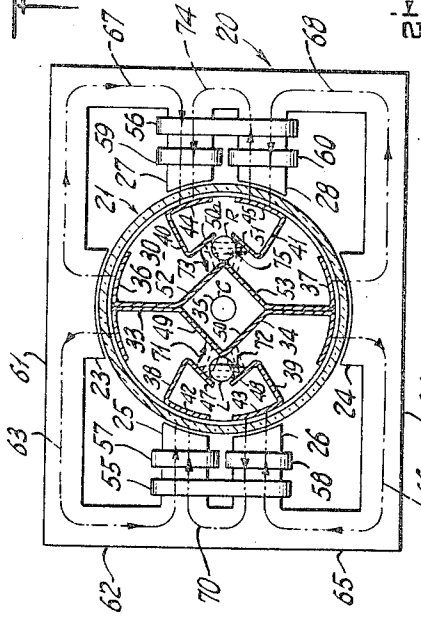
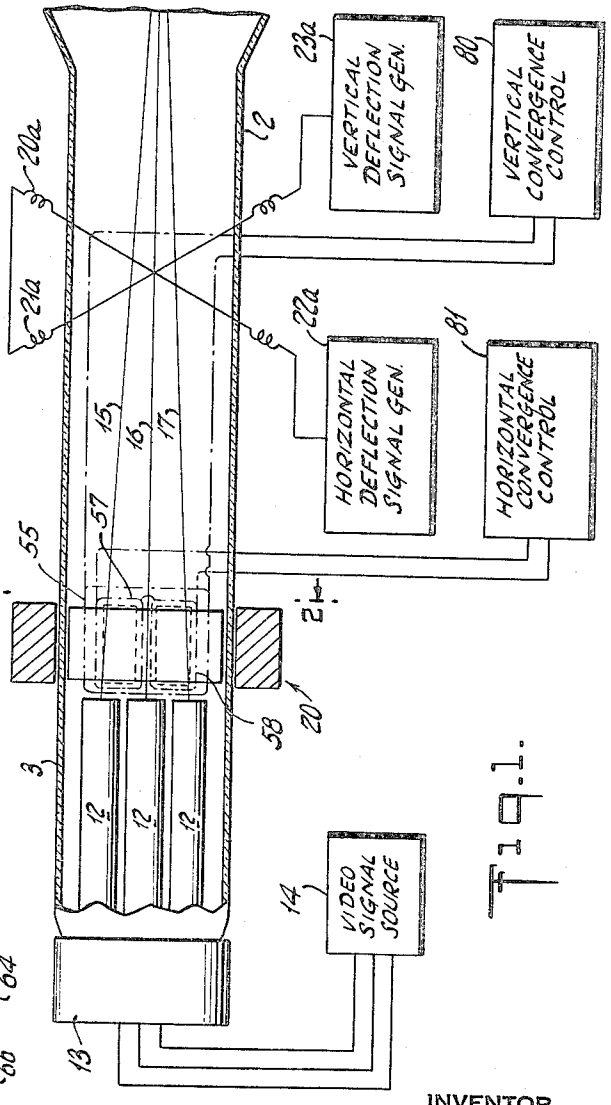


Fig. 1.



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THREE IN-LINE GUN MAGNETIC CONVERGENCE SYSTEM

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This invention relates to cathode-ray tubes having three electron guns in general and is particularly directed to a magnetic conversion system for a 3 in-line electron gun system for effecting convergence of the three beams at a particular area.

Color cathode-ray tubes to which the present invention is particularly applicable generally include a luminescent screen comprising part of a target electrode in which different phosphor areas produce differently colored light when excited by electron beam components impinging thereon, means for producing and directing a plurality of electron beams toward the target electrodes and means for deflecting the beams thereby to scan a raster at the target electrode. In such tubes it is generally necessary to provide means for effecting substantial convergence of the different electron beams at all points of the raster scanned thereby at the target electrode. Heretofore, various means have been resorted to in an attempt to accomplish satisfactory beam convergence. However, they have been found generally unsatisfactory in that they resulted in complicated and expensive tube constructions, required considerable complicated control equipment, or effected undesirable distortion of the beams with resultant color impurities.

In-line gun arrangements have helped in part to solve some of the convergence problems inherent in triangular oriented gun arrangements in that such in-line arrangements have symmetry along an axis, or one line of symmetry, e.g., along the horizontal axis so that deflection in an up and down fashion, or along the vertical produces very little, if any, distortion along the vertical path due to non-convergence. Because there is inherent symmetry for an in-line arrangement, the beams will converge easier and correctly than that of the triad type guns which is compatible only with the dot-screen tube. However, line-screen tubes lend themselves conveniently to the in-line gun arrangement and correction therefore can be easily effected in both the horizontal and vertical direction, not possible with the triad guns. Convergence is usually disturbed by the beam deflecting magnetic components because of the nature of their design and operation. This distortion is inherent and correction therefor is necessary, such correction being easier for in-line gun arrangements.

The in-line gun arrangement has the central beam referred to as the reference beam, the other beams on either side converging therewith at the screen to produce the representative color. Hence, the outer beams are to be effected and controlled independently in both a vertical and horizontal direction for all positions of the central beam at the screen or raster surface. There are certain convergence systems which combine both magnetic and electrostatic correction to the in-line gun system. These systems, however, must apply high voltage potentials to the electrostatic converging plates through the glass bulbs from an external supply. This means drilling holes through the glass and exposing the tube to all the disadvantages that such holes produce, such as leakage, fracture and rupture, exposure and risks to persons, economy and etc.

Accordingly, it is the primary object of the present invention to provide a new and improved convergence system for color cathode-ray tubes.

Another object of the invention is to provide a complete magnetic convergence system for a 3 in-line gun color cathode-ray tube.

Another object of the invention is to produce a complete magnetic convergence system for a 3 in-line gun color cathode-ray tube having bi-directional correction control of the electron beams in both the vertical and horizontal beam paths to effect complete convergence.

A still further object of the invention is to produce a complete magnetic convergence system for a 3 in-line gun color cathode-ray tube which is simple and easy to operate, economical and reduces hazards due to exposure and reduces distortion due to mis-convergence.

Further objects and advantages of the invention will become apparent as the following description proceeds and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming part of these specifications.

In carrying out the objects of the invention, there is provided a cathode-ray tube including a target electrode, means for producing and directing several substantially coplanar electron beams toward the target electrode and means for deflecting the beams to effect scanning thereof at the target electrode. In particular there is provided magnetic structures within the tube and surrounding the in-line beams, as they emerge from their respective guns, the central beam being substantially shielded magnetically from the outer beams so that excitation, externally of the tube, of the magnetic structure about the outer beams causes the correction and convergence thereof in both the vertical and horizontal direction relative to and with the uncorrected central beam.

For a better understanding of the invention, reference may be had to the accompanying drawings in which:

FIGURE 1 is a schematic fragmentary illustration of a preferred form of the present invention.

FIGURE 2 is a sectional view taken along the line 2—2 of FIGURE 1 and looking in the direction of the arrows.

FIGURE 3 is a diagrammatic illustration of convergence effects attainable with the present system.

Now proceeding with a description of the invention and the respective figures, there is shown in FIGURE 1 a color cathode-ray tube structure generally designated **1** including an envelope **2** having a cylindrical neck portion **3**, a transparent viewing end or face plate portion **4** and a substantially conical transition portion **5**.

Located at the viewing end of the envelope **2** is a target electrode structure generally designated **6**. The structure **6** includes the face plate portion **4** of the envelope, a phosphorescent material coating or screen **7** on the inner surface of the face plate portion **4**, which screen preferably comprises phosphors capable of producing light of different colors in response to any impingement thereon by charged particles or electrons. The screen **7** preferably comprises red, green and blue light-producing phosphors deposited or arranged on the inner surface of the face plate in repeated triplets of vertical red, green and blue phosphor stripes **9**, in the manner illustrated exaggeratedly in FIGURE 1 at R, G and B.

Formed over the screen **7** is an electron permeable conductive layer **8** which can comprise aluminum or any other suitable conductive material and constitutes what shall hereinafter be referred to as the first electrode in the target electrode structure **6**. Also included in the target electrode structure **6** and provided for cooperating with the first electrode **8** is a second electrode in the form of a grille generally designated **10**. The grill **10** comprises a plurality of closely spaced wires **11** extending substantially parallel to each other and to the stripes of phosphorescent material comprising the screen **7**. The

size and spacing of the grille wires **11** are also illustrated exaggeratedly in the drawing.

By means not shown the second electrode **10** is supported for conforming substantially to the curvature of the face plate **4** so as to provide substantially uniform spacing between the first and second electrodes **8** and **10**, respectively, across the target electrode. In the just described target electrode structure the first electrode **8** is adapted for being maintained at a potential higher than that of the second electrode **10**, thereby to set up and maintain a predetermined electric field in the inter-electrode region defined by the electrodes. By virtue of its construction, the second electrode **10** is permeable to charged particles or electrons directed toward the screen. Thus, during the operation of the tube **1**, electron beams directed toward the target electrode by beam producing means, which will be described hereinafter, are admitted into the inter-electrode region through the spaces between the wires **11** and travel through this region for striking or impinging upon the phosphorescent material screen **7**. In the inter-electrode region the higher potential of the conductive layer or first electrode **8** is effective for attracting and thereby accelerating the movement of the electrons comprising the beam toward the screen thereby to increase the striking force of the electrons on the screen whereby color brightness is increased. Additionally, the second electrode **10** serves properly to focus the electron beam entering the inter-electrode region and to direct them onto the phosphor stripes in a predetermined and desired manner.

Provided for producing the electron beam for impinging on the screen, and located in the neck portion **3** of the tube envelope, is a plurality of electron beam producing means or guns **12**. The guns **12** are preferably substantially coplanar, or arranged in a substantial planar array extending perpendicular to the phosphor stripes of the screen **7** and the wires of the grille **10**. Additionally, the guns **12** are equal in number to the number of primary colors in which an image is to be reproduced on the screen **7**; and, therefore, in the illustrated embodiment three guns are provided. Each of the guns **12** may be of the conventional type, consisting of a cathode, a control grid, one or more accelerating electrodes and a focusing electrode, none of which elements need be specifically illustrated or described. The three guns **12** are suitably connected through an insulative tube base **13** to a conventional video signal source generally designated **14**; and in accordance with color intelligence received from the source **14**, the guns **12** produce and direct toward the target electrode **6** schematically represented beams **15**, **16** and **17** which extend in a substantially parallel array.

It will be seen that, while I have shown and described the beam producing means as constituting a plurality of individual electron gun structure, any means may be employed for producing and directing toward the target electrode a plurality of electron beams.

By means of horizontal and vertical deflection coils schematically illustrated and designated **20***a* and **21***a*, respectively, the beam components emanating from the guns **12** are deflected in both horizontal and vertical planes of deflection thereby to scan a raster at the target electrode **6**. The operation of the horizontal and vertical deflection coil is controlled by conventional horizontal and vertical deflection signal generators generally designated **22***a* and **23***a*, respectively, the construction and operation of which are well-known in the art.

In a tube structure, such as that described above and as seen in FIGURE 1, the guns **12** are physically aligned in a parallel array in substantially the same plane for directing the beams **15**, **16** and **17** toward the target electrode in substantially the same horizontal plane.

In order to obtain the necessary convergence of the electron beams **15**, **16** and **17** at the target electrode, and as perhaps better seen in FIGURE 2, there is provided

beam convergence means comprising a magnetic yoke assembly **20** of any suitable magnetic type material substantially rectangular in configuration having a central aperture portion **21** disposed to permit the neck portion **3** of the tube **1** to penetrate therethrough. In particular the yoke has an array of external pole pieces, arranged about the magnetic periphery in paired fashion, a first pair **23** and **24** being diametrically opposed on each side of the central beam gun and perpendicular to the plane of the 3 in-line guns. A second pair of diametrically opposed pole pieces, each of which is split into two poles **25**, **25** and **27**, **28**, are each displaced by 90 degrees from the first pair of pole pieces so that they lie in a line substantially parallel to the plane of the in-line guns. The respective pole pieces have their inward projections, at the magnetic periphery, curved in a direction to match the curvature of the tube neck to minimize the air gap between the said neck and pole piece.

The convergence means further comprises an internal magnetic assembly **30** disposed within the neck portion of the cathode-ray tube and forming a continuation of the magnetic pole pieces forming a part of the yoke assembly **20**. In particular the internal magnetic assembly comprises a pair of spaced supporting metallic and non-magnetic circular end discs **31** and **32** attached to the longitudinal ends of the I-shaped pole piece member **33**, the said member having an apertured central portion **34** diamond-shaped to accommodate and surround the central beam aperture **35** and central beam **16** to substantially shield it from any magnetic fields which would otherwise tend to permeate the area in which the beam path lies. The I-shaped pole piece **33** has its external flange members **36** and **37** curved in a manner so that its curvature matches the curvature of the pole pieces **23** and **24** with which it is radially and axially aligned, respectively, thereby permitting the smallest possible flux leakage across the respective pole pieces.

In quadrature with the I-shaped pole piece **33** and diametrically opposed are dual channel-shaped pole pieces **38**, **39** and **40**, **41** each also attached at their longitudinal extremities to the spaced apart end discs **31** and **32**, with their open ends facing each other. The channel-shaped pole pieces **38** and **39** each have one of their sides **41** and **43** in proximity to split pole members **25** and **26**, respectively, and curved according to said pole members again to permit the smallest possible flux leakage path between the respective pole piece members. Similarly, the channel-shaped pole pieces **40** and **41** each have one of their sides **44** and **45** in proximity to split pole members **27** and **28**, respectively, and also curved according to said pole members for the same reasons as stated above. The channel-shaped pole pieces **38** and **39** each have their other sides **47**, **48** directed inwardly toward the periphery of the tube neck **3** so as to substantially form a V-shaped configuration with the apexes of the V cut off. The channel sides are also substantially parallel to sides **49** and **50** forming two sides of the diamond-shaped apertured portion **34** of the I-shaped pole piece **33**. Again in a similar manner the channel-shaped pole pieces **40** and **41** each have their other sides **50** and **51** directed inwardly toward the periphery of the tube neck **3** so as to substantially form a V-shaped configuration again with the apex of the V cut off. Here again the channel sides are substantially parallel to sides **52** and **53** forming the remaining two sides of the diamond-shaped aperture of the I-shaped pole piece **33**.

The external convergence assembly **20** is provided with energizing coils **55** and **56** completely circumscribing, respectively, the outer perimeter of the split pole pieces **25**, **26** and **27**, **28** and each energized in a manner so as to produce a magnetic field, to be described. Also provided are energizing coils **57** and **58** each completely circumscribing, respectively, the perimeter of each split pole piece **25** and **26**. Coils **59** and **60** each completely cir-

cumscribe, respectively, the perimeter of each of the split pole pieces 27 and 28.

In operation, when coil 55 is energized, the flux field lines will pass through split pole pieces 25 and 26 in the same direction, through their respective pole faces and around the perimeter of the channel-shaped pole pieces 38 and 39 and across the gap defined by the V-shaped channel sides 47 and 48 and diamond-shaped aperture sides 49 and 50. The magnetic field across this gap produces a perpendicular force upon the beam L transverse to this field so as to impart motion thereto in a vertical direction, i.e., at right angles to the array of electron guns. The flux line across the gap terminates in the I-shaped pole piece at its apex and continues along the web portion of the pole piece and exits along the flanges 36 and 37 of the I-shaped pole piece 33. The flux lines exiting from the flanged portion 36 of I-shaped pole piece thereafter crosses the gap between the said flanges and diametrically opposed pole pieces 23 and 24 and continues along magnetic paths 61 and 62 and pole piece 25 to form a closed loop 63. The flux line exiting from the flanged portion 37 of the I-shaped pole piece flows through pole piece 24 and continues along magnetic paths 64 and 65 and pole piece 26 to form a second closed loop 66. The closed loops 63 and 66 generated by the coil 55 produces the magnetic flux (MMF) across the gap previously defined to impart motion to the left beam in a vertical direction. Since the coil 56 is the mirror image of coil 55, a similar condition prevails in that closed loop of magnetic flux lines 67 and 68 are also produced part of which traverses the gap between sides 50 and 51 of pole pieces 40 and 41, and aperture sides 52 and 53, respectively, to impart motion to the right beam R in a vertical direction.

Each of the split pole pieces 25 and 26 have individual exciting coils 57 and 58 wound about their respective perimeters and connected in series relation to produce a single closed flux line or loop 70. The closed flux line 70 traverses each of the split pole pieces 25 and 26 in opposite directions. In effect, it passes through pole piece 25 and across the gap occupied by the tube neck. Thereafter it passes around the periphery of the channel-like pole piece 38 in a transverse direction and exits therefrom into the air-gap defined by the V-shaped channel sides 47 and 48, which respectively form a side of the said pole pieces 38 and 39. The flux line thereafter enters the channel-like pole piece 39, through its side 48 and around the periphery thereof to exit therefrom along the side 43 and again across the gap occupied by the tube neck. Finally, the flux line enters the other split pole piece 26 to complete the closed loop 70. From an examination of the flux path indicated by the closed loop 70 it can be seen that the flux lines across the V-shaped air gap, defined by the channel-like sides 47 and 48 of pole pieces 38 and 39, flow in a substantially vertical direction and are orthogonal to the flux lines across the gap defined by the said sides 47 and 48 and sides 49 and 50 of the I-shaped apertured portion thereof. Hence there is produced by closed loops 63 and 66 a magnetic field in the area of the left beam L directed in a substantially horizontal direction and indicated by reference number 71. Also, there is produced by closed loop 70 a magnetic field in the area of the same left beam L directed in a substantially vertical direction and indicated by reference number 72. The right beam R is likewise affected by closed loops 67 and 68 which produce a substantially horizontal magnetic field in the said beam area and is indicated by reference number 73 while closed loop 74 substantially produces a vertical magnetic field in the area of the right beam R and designated by reference number 75.

In operation the current variation in coil 55 produces a variation in the horizontal magnetic field 71 causing a vertical variation in the directional movement of the left beam L, while a current variation in the coils 57 and 58 produces a variation in the vertical magnetic field 72 causing a corresponding horizontal variation in the directional movement of the same left beam L. Similarly, current variations in coils 56, 59 and 60 produce directional movements of the right electron beam R in a vertical and horizontal direction. It can be appreciated that the central electron beam C, being substantially shielded by the apertured portion 34 of the I-shaped pole piece 33 from any magnetic fields is minimally affected by any of the magnetic fields causing the desired directional movements of the left and right beams. It thus becomes obvious that any variation in registry or convergence of the three beams at a fixed point of impingement at the screen area can be corrected by suitably directing the left or right electron beams to permit them to intercept the central or reference beam at the desired impingement point. This is pictorially represented in FIGURE 3 which shows, for illustrative purposes, three beams, each designated by R, G and B, or red, green and blue, it being understood that these are the colors generated by the impingement of the beam on the particular colored phosphors. Here G, or green, is the central or reference beam and has no correction imposed thereon, the central beam being directed to the target surface in accordance with standard deflection techniques. However, generally both the red and blue beams, due to various reasons as hereinabove explained, fail to register or intercept the central or green beam at the same point so that correction is necessary. As shown in FIGURE 3, the red and blue beams can be corrected orthogonally to permit the three beams to be in the same plane and to converge at the same point. In the arrangement shown any type of mis-registry and non-alignment can be corrected for, a fact not possible with prior arrangements of magnetic convergence systems. The applicant has provided a simple all-magnetic convergence system that can compensate for any type of mis-registry, accomplishing this by correcting only the outer beams while leaving the central beam intact or without correction. It is a fact that the central beam is the reference beam and regardless of its position relative to the target or screen surface, it is assumed to be the correct position because, as stated, it is the reference beam. Correction is applied to the outer beams relative to the reference beam and made to converge thereon at the correct point of impingement. The correct point of impingement is that point where all three beams converge to produce in the aggregate a white field of color at the color screen.

In describing the magnetic convergence assembly, and especially that portion thereof referred to as the internal magnetic assembly 30, it can be appreciated that the channel-shaped pole pieces 38 and 39 and 40 and 41 along with I-shaped pole piece 33 comprise what is called a single-stacked array in that all the pole piece elements are aligned in a single radial plane. This is in comparison to those convergence assemblies which use a double-stacked array where, e.g., a set of pole pieces to correct for one axis is set apart and axially displaced from a set of pole pieces necessary to correct for another axis. Hence you have a pair of off-set assemblies which in effect creates a desymmetrical array of pole pieces and produce a possible interaction between the correcting magnetic fields. This situation is not possible in the single-stacked array as disclosed herein.

The coils 55 and 56 for effecting vertical variations of the outside beams L and R are each connected to vertical magnetic convergence control source 80 and coils 57, 58, 59 and 60 are connected to horizontal magnetic convergence control source 81. These adjustable control sources may be any suitable arrangement adapted for independently, variably energizing each of the said coils in a given plus or minus polarity of current for effecting motion of the beam in the desired forward and/or backward direction from its static position. It will be possible, for the purpose of effecting dynamic convergence,

that sources 80 and 81 be associated with scanning means 23*a* and 22*a*, respectively, in any well-known manner to accomplish the said convergence.

From the foregoing, while a specific embodiment of the invention has been shown and described, it is not desired that the invention be limited to the particular form shown and described, and it is intended by the appended claims to cover all modifications within the spirit and scope of the invention.

Having described the invention what is claimed is:

1. A cathode-ray tube comprising an envelope, a target electrode, means for directing a plurality of substantially coplanar electron beams toward said target electrode, one of said beams constituting a reference beam, first magnetic means including pole pieces internal and external to the tube envelope for producing a first magnetic field in proximity to the outer electron beams and disposed to alter their movements in a first direction, second magnetic means including pole pieces internal and external to the tube envelope for producing a second magnetic field in proximity to the outer electron beams and disposed to alter their movements in a second direction, and energizing means connected to said magnetic means to cause the excitation thereof and thereby control the movements of the said outer beam independently of said reference beam to cause the convergence of all said beams.

2. A cathode-ray tube comprising an envelope, a target electrode, means for directing a plurality of substantially coplanar electron beams toward said target electrode, one of said beams constituting a reference beam, first magnetic means including pole pieces internal and external to the tube envelope for producing a first magnetic field in proximity to the outer electron beams and disposed to alter their aligment in a first direction, second magnetic means including pole pieces internal and external to the tube envelope for producing a second magnetic field orthogonal to the first and in proximity to the outer electron beams and disposed to alter their alignment in a second direction, and energizing means connected to said magnetic means to cause the quadrature excitation thereof and thereby direct the alignment of the said outer beam orthogonal to the said reference beam and free of any inter-action therewith to cause the convergence of all said beams.

3. A cathode-ray tube comprising an envelope, a target electrode, means for directing a plurality of substantially coplanar electron beams toward said target electrode, one of said beams constituting a reference beam, first magnetic means including pole pieces internal and external to the tube envelope for producing a first magnetic field in proximity to the outer electron beams and disposed to alter their aligment in a first direction, second magnetic means including pole pieces internal and external to the tube envelope for producing a second magnetic field orthogonal to the first magnetic field and in proximity to the outer electron beams and disposed to alter their alignment in a second direction, the first and second magnetic means stacked in a single plane array, and energizing means connected to said magnetic means to cause the quadrature excitation thereof and thereby direct the alignment of the said outer beam orthogonal to the said reference beam and free of any interaction therewith to cause the convergence of all said beams.

4. A cathode-ray tube according to claim 3 and wherein at least one of said internal pole pieces of the said magnetic means includes an apertured portion disposed to surround and substantially shield the reference beam from any magnetic fields.

5. A cathode-ray tube according to claim 3 and wherein the said first and second magnetic means each have their respective pole pieces diametrically opposed.

6. A cathode-ray tube according to claim 5 and wherein the said diametrically opposed pole pieces of the second magnetic means are split into pairs.

7. A cathode-ray tube comprising an envelope, a target electrode, means for directing a plurality of substantially coplanar electron beams toward said target electrode, one of said beams constituting a reference beam, first magnetic means including pole pieces internal and external to the tube envelope for producing a first magnetic field in proximity to the outer electron beams, second magnetic means including pole pieces internal and external to the tube envelope for producing a second magnetic field orthogonal to the first magnetic field and in proximity to the outer electron beams, the magnetic means constituting a single-stacked magnetic assembly, and energizing means connected to said magnetic means to cause the excitation thereof to produce active and leakage flux therein in a symmetrical and orthogonal manner and thereby control the movements of the said outer beam orthogonal to said reference beam to cause the convergence of all said beams.

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