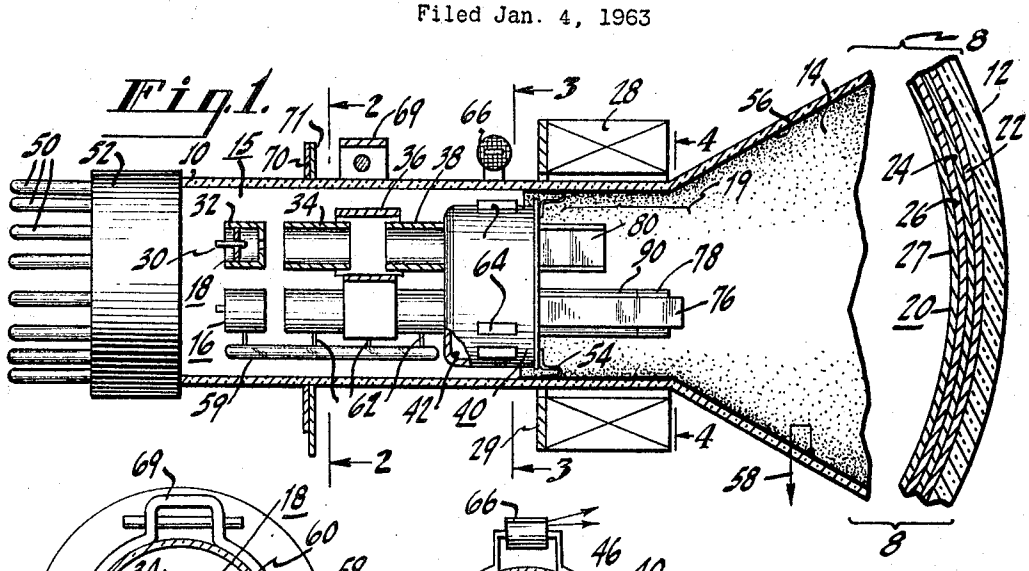
Aug. 9, 1966 J. J. THOMAS 3,265,915

CATHODE RAY TUBE

Filed Jan. 4, 1963

6305

Fig. 1.



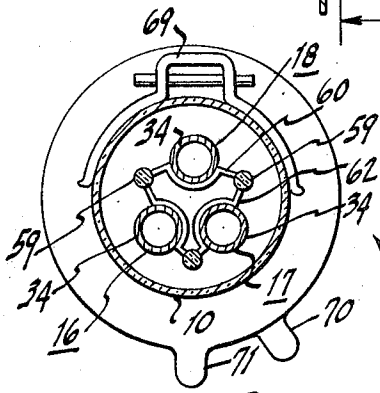


Fig. 2.

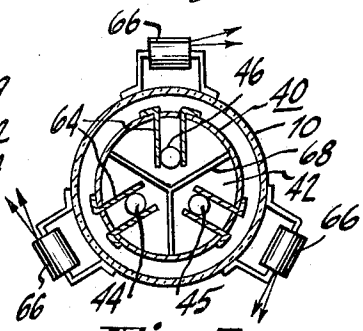


Fig. 3.

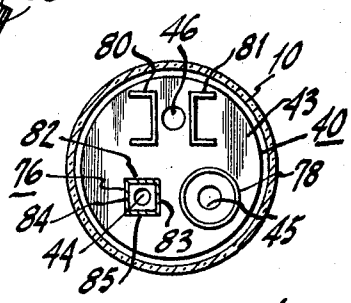


Fig. 4.

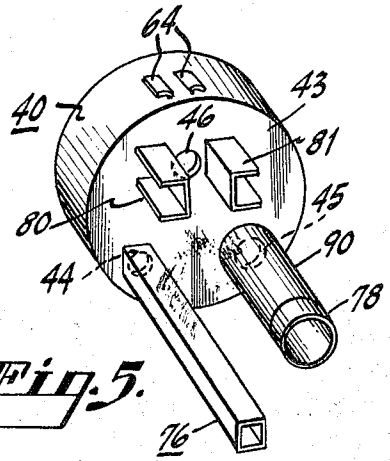


Fig. 5.

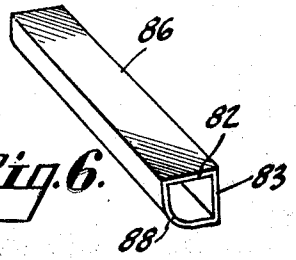


Fig. 6.

INVENTOR.
JOHN J. THOMAS
BY
William A. Zalesak
Attorney

United States Patent Office 3,265,915 Patented August 9, 1966

3,265,915

CATHODE RAY TUBE

John J. Thomas, Levittown, Pa., assignor to Radio Corporation of America, a corporation of Delaware

Filed Jan. 4, 1963, Ser. No. 249,362
5 Claims. (Cl. 313—70)

This invention relates to cathode ray tubes of the type utilizing differential penetration of a luminescent screen by a plurality of different velocity electron beams to obtain plural color image re-creation, and particularly to the mutual registering of the plurality of rasters produced by the plurality of electron beams.

One type of cathode ray tube referred to above includes a luminescent screen having three different phosphors which are disposed in superimposed layers, each of which is capable of emitting, for example, a different one of three primary colors, red, green, and blue. The tube further includes three electron guns, each adapted to project a different velocity electron beam through a common deflection field and onto the luminescent screen. The beams are deflected in two mutually perpendicular directions by the deflection field to scan a raster on the luminescent screen. Electrons of the lowest velocity beam excite the first phosphor layer to produce light of a first color; electrons of the medium velocity beam penetrate the first layer and excite the second layer to produce light of a second color; and electrons of the highest velocity beam penetrate both the first and second layers and excite the third layer to produce light of a third color. Proper current intensity modulation of the three beams enables production of any desired mixture of these three colors.

In tubes of the type described above, unless preventive or corrective means are provided, the three rasters produced by the three electron beams are of different size. This is because the three beams, being of different velocity, are deflected different amounts by the common deflection field.

Substantially equal size red, green, and blue rasters can be obtained by differentially shielding the beams from portions of the common deflection field. Individual magnetic tubular shields which extend different distances in the zone of the common deflection field can be disposed around the two lower velocity beams. Thus, the two lower velocity beams, which in the absence of the magnetic tubular shields would be deflected the greater amounts by the common field, are subjected to different selected fractions of the field and thereby receive substantially the same amount of deflection as does the highest velocity, unshielded, beam.

In such tubes, magnetic tubular shields serve their intended purpose to prevent creation of greatly different-size rasters and thus contribute greatly to raster register. However, their presence in the common deflection fields causes distortions of the fields, which although of relatively small magnitude, are complex in nature. The distortions, in turn, affect the different beams differently and thus cause slight misregister of the three rasters.

It is therefore an object of this invention to provide a plural beam cathode ray tube of the type having a magnetic tubular beam shield, which tube operates with improved register of the plurality of rasters produced thereby.

According to this invention, a cathode ray tube includes a magnetic tubular beam shield which has two mutually perpendicular flat side portions positioned within the deflection field zone. The flat side portions are each disposed parallel to a different one of the two mutually perpendicular directions of beam scan deflection. The beam shield is preferably of square cross-section. The length of the tubular shield is such that an amount of shielding is provided which will produce the desired size of raster scanned by the beam associated with that shield.

In the drawing:

FIG. 1 is a side elevation view partly in section and with parts broken away of a cathode ray tube incorporating a tubular magnetic shield embodying the invention;

FIGS. 2, 3 and 4 are transverse sections of the cathode ray tube of FIG. 1 taken, respectively, along lines 2—2, 3—3, and 4—4;

FIG. 5 is a perspective of a portion of the cathode ray tube of FIG. 1; and

FIG. 6 is a longitudinal section view of another form of tubular magnetic shield embodying the invention.

FIG. 1 illustrates a cathode ray tube 8 comprising an evacuated envelope including a neck section 10, a faceplate 12, and an interconnecting funnel section 14. Disposed within the neck 10 is an electron assembly 15 comprising, for example, three electron guns 16, 17, and 18 positioned side-by-side in a delta triangular arrangement symmetrically about the longitudinal axis of the gun assembly 15. In FIG. 1 gun 17 is hidden behind gun 16. The electron guns 16, 17, and 18 are respectively adapted to project lower, medium, and higher velocity electron beams through a common deflection zone 19 and toward the faceplate 12. For the purpose of brevity and clarity, the terms "L beam," "M beam," and "H beam" will be hereinafter used to refer respectively to the lowest velocity beam (and its gun 16), the medium velocity beam (and its gun 17), and the highest velocity beam (and its gun 18).

A luminescent screen 20 on the faceplate 12 includes three layers 22, 24, and 26 of different phosphors, each of which luminesceses in a different one of the three primary colors, red, green, and blue. In the drawings the phosphor layers 22, 24, and 26 are representatively shown as continuous. However, the layers may be provided in other suitable forms such as a multiplicity of particles each of which includes superimposed coatings of different phosphors.

The tube 8 is operated so that electrons of the L beam will excite the first phosphor layer 26 to produce light of a first primary color; electrons of the M beam will penetrate the first phosphor layer 26 and excite the second phosphor layer 24 to produce light of a second primary color; and electrons of the H beam will penetrate both the first and second phosphor layers 26 and 24 and excite the third phosphor layer 22 to produce light of a third primary color. A metal backing layer 27 of, e.g., aluminum, is disposed on the phosphor layer 26 as is known in the art. If desired, the screen 20 may include nonluminescent separator layers between the phosphor layers to improve the operational characteristics of the screen.

As an adjunct to the electron tube 8, a magnetic deflection yoke 28 is provided which closely encircles the envelope of the tube. The yoke 28, when suitably energized, is adapted to create horizontal and vertical magnetic deflection fields in the deflection zone 19 to cause the three separate beams of the electron guns 16, 17, and 18 to scan a desired raster or pattern on the luminescent screen 20. A shield 29 is provided at the rear of the yoke 28 to reduce the rearward extent of the fringe portion of the deflection fields formed by the yoke.

Each of the electron guns 16, 17, and 18 comprises a plurality of coaxial tubular electrodes. Each gun includes a tubular cathode 30 having an end wall which is coated with a suitable electron emissive material.

Each cathode 30 is insulatingly mounted within a centrally apertured control grid cup 32. Disposed coaxially beyond the control grid cups 32, in the order named, are for each gun, a tubular first anode 34, a tubular focusing electrode 36, and a tubular second anode 38. The focusing electrode 36 of each gun surrounds and slightly overlaps the adjacent ends of the same gun's two anodes 34 and 38.

The three first anodes 34 and the three second anodes 38 are all electrically connected to each other. The three focus electrodes 36 are likewise electrically connected to each other but are separate from the anodes. In order to properly focus the different velocity electron beams, the spacing between the two anodes of each gun may be different from that of the other two guns.

The anodes 38 are mounted on a cylindrical convergence cage 40 which is electrically common to all three of the electron guns 16, 17, and 18. The convergence cage 40 comprises a cup which has an end wall 42 and which is closed at its open end with an end plate 43. Both the end wall 42 and the end plate 43 are provided with apertures 44, 45, and 46 which are coaxial respectively with the three electron guns 16, 17, and 18.

The cathodes 30 and control grids 32, of the electron guns 16, 17, and 18 are individually connected to different ones of a plurality of lead-in conductors 50 which are sealed through the vacuum envelope in a stem base 52. Thus, each of these electrodes can be energized independently of the others to provide electron beams of different velocities which are independently focused in the region of the screen 20. The interconnected focusing electrodes 36 are also energized through one of the stem leads 50.

The convergence cage 40 is provided with a plurality of spring snubbers 54 which bear outwardly against the neck 10 of the envelope. An electrically conductive coating 56 disposed on the internal surface of the envelope extends over the funnel 14 and into the neck 10 a distance sufficient to make contact with the snubbers 54. The coating 56 also extends into electrical contact with the metal backing layer 27 of the luminescent screen 20. Terminal means, such as is illustrated schematically by the arrow 58, is provided for applying a suitable electrical potential to the coating electrode 56, the anodes 34 and 38, and the luminescent screen 20.

The electrodes of each of the electron guns 16, 17, and 18 are maintained in fixed spaced coaxial relationship in a well-known manner such as by mounting them on three glass rods 59 which extend along the guns. Each of the electrodes 32, 34, 36, and 38 of each of the three guns is fixed to the glass rods in a manner similar to that illustrated for the first anodes 34 in FIG. 2. As shown in FIG. 2, the electrode 34 of gun 18 is attached to a central arcuate section of a strap 60 whose ends are embedded into two of the glass rods 59. The electrodes of guns 16 and 17 and the other electrodes of gun 18 are mounted by similar straps 62 to different pairs of the glass rods 59. The strap 60 on the electrode 34 of the H gun 18 may be made of magnetic material for a purpose hereinafter described. Further details of the mounting of the electron guns 16, 17, and 18 have been omitted from the drawing for purposes of clarity.

Because the three electron guns 16, 17, and 18 are non-coaxial with respect to the tube 8, each gun being mounted slightly off the longitudinal axis of the tube, both static and dynamic convergence of the three beams is provided to compensate for this off-axis mounting. Such convergence is in accordance with known color television receiver techniques.

Approximate convergence may be provided by mounting each gun at a small angle with respect to the longitudinal axis of the tube 8 so that the three electron beams, when undeflected, are caused to converge approximately at a common point near the center of the luminescent screen 20. The angle which each gun makes with the

tube axis is determined by the dimensions of the tube. In cathode ray tubes of the type described having a tube length of about 19 to 25 inches, this angle is in the order of 1°1'.

Dynamic convergence may be provided as shown in FIG. 3. A separate pair of pole pieces 64 are disposed on opposite sides of each beam within the convergence cage 40. The pole pieces 64 are axially spaced back from the end plate 43 to reduce interference by the fringe of the deflection fields with the fields generated by pole pieces 64.

Associated with each pair of pole pieces 64 is a separate electromagnet 66 disposed externally of the tube envelope adjacent to the ends of the pole pieces. More refined arrangements, such as those incorporating a pair of electromagnetic windings in place of the single winding 66, are known in the art but for the sake of brevity and clarity are not herein detailed. A Y-shaped magnetic shield 68 is disposed within the convergence cage for shielding each beam from the convergence fields of the other beams.

Energization of the coils of the electromagnets 66 will impart to the respective electron beams a small radial directional component of deflection toward or away from the longitudinal axis of the tube 8. A varying current synchronized with, and related to, the amount of scanning deflection of the three beams is applied to each electromagnet 66 to provide the desired dynamic convergence of the three beams.

Also, in accordance with known techniques, all three beams are brought to a precise static convergence at the center of the luminescent screen 20 by means provided for adjusting the lateral position of one of the electron beams. This is accomplished by a magnetic field established in the path of the H beam by a permanent magnet assembly 69 (best seen in FIG. 2). In order to help shape the field of the magnet assembly 69 in the path of the H beam, the mounting strap 60 may in some instances be made of magnetic material. The field produced by the magnet assembly 69 is transverse to the direction of the magnetic field established between the pole pieces 64 (FIG. 3) for the H beam. This permits a lateral adjustment of the position of one of the three electron beams (viz the beam produced by the electron gun 18 in the illustrated embodiment) in a direction which is normal to the radial adjustment of this same beam as provided by the convergence pole pieces 64.

If desired, the poles of the magnet assembly 69 (FIG. 2) may be dynamically energized to provide an additional means contributing to the shaping of the H beam raster for the purpose of registering this raster with the rasters of the L and M beams.

A pair of thin-plate permanent ring magnets 70 and 71 (FIG. 1) are disposed around the tube neck 10 behind the magnet assembly 69. The ring magnets 70 and 71 are individually rotatable relative to each other to provide a desired intensity magnetic field transversely of the neck 10. This serves to laterally position the three beams as a unit so that they have an optimum relationship with the deflection fields in the deflection zone 19.

The L beam gun 16 and M beam gun 17 (FIG. 2) are provided with—or have associated therewith—tubular magnetic shield members (i.e., magnetic shunts) 76 and 78, (FIGS. 1, 4 and 5) respectively. The tubular shields 76 and 78 extend from and are so positioned with respect to the electron gun apparatus that they are disposed within the deflection zone 19. They may be mounted on the end plate 43.

Deflection field enhancer elements 80 and 81 (FIGS. 1, 4 and 5) of magnetic material are disposed on opposite sides of the H beam path. The enhancer elements 80 and 81 are attached to the end plate 43 and extend along the H beam path into the deflection zone 19. The enhancer elements 80 and 81 are preferably right angle U-shaped channel members disposed with their sides

parallel to the horizontal and vertical directions of deflection, with their adjacent sides opposite each other, and with their open sides facing away from each other. However, other cross sectional shapes, such as tubular members of rectangular cross-section can be used. The purpose and advantages of the field enhancers **80** and **81** are more fully described hereinafter.

The electron gun apparatus **15** is angularly oriented about the longitudinal axis of the tube **8** relative to the luminescent screen **20** and to the deflection yoke **28** so that the electron gun **18** producing the unshielded H beam is disposed in the central plane which is perpendicular to the scan produced by the higher frequency one of the two mutually perpendicular deflection fields. According to present day practices in home television receivers the unshielded H beam would be disposed in the central longitudinal vertical plane of the tube **8**. Such an orientation has proved to reduce objectionable raster distortion.

The L beam shield **76** comprises a magnetic tubular member including at least two flat side portions **82** and **83**. Each of the flat sides **82** and **83** is disposed parallel to a different one of the two mutually perpendicular directions of beam scan. The flat side **82** is disposed in a horizontal plane and the flat side **83** is disposed in a vertical plane. The horizontal and vertical flat sides **82** and **83** are further disposed to face generally, inwardly of the array of three guns **16**, **17** and **18**. The horizontal flat side **82** faces generally, toward one of the other guns, viz, the H beam gun **18**, and the vertical flat side **83** faces the other of the other two guns, viz, the M beam gun **17**.

In a preferred form, as shown in the drawings, the tubular L beam shield **76** has a square cross-section. Alternatively, however, the tubular shield **76** may, for example, be of rectangular cross-section or the two side portions **84** and **85** may be replaced by a single curved surface or by three or more flat side sections.

FIG. 6 illustrates an alternative L beam shield structure **86** which also includes the two flat side portions **82** and **83**. In the tubular shield **86**, a side portion **88** is provided which includes a quarter cylindrical curvature. The single curved side portion **88** of shield **86** is in place of the two flat sides **84** and **85** of the shield **76**.

The arrangement of the L beam shield's wall portion other than the inwardly facing horizontal and vertical flat sides **82** and **83**, is not critical as to shape. The main consideration is that this remaining wall portion be shaped and disposed so as not to be struck by the L beam in normal operation of the cathode ray tube **8**. The square cross-sectional shape shown is preferred in order that the end of the tubular L beam shield **76** be symmetrical about the undeflected L beam path. The distortion of the deflection field dipping into the open end of the tubular L beam shield thus has minimum adverse effect on the L beam raster.

The M beam shield **78** comprises a magnetic tubular member preferably of circular cross-section. It is substantially circular and preferably of substantially larger cross-section than the L beam shield **76**. The M beam shield **78** is preferably disposed between the ends of the L beam shield **76** on the distal end of a tubular nonmagnetic support member **90** which is in turn attached to the end plate **43**.

The combination of a square cross-sectioned L beam shield **76** and a circular cross-sectioned M beam shield **78**, which is of larger diameter and shorter length than the L beam shield and which is positioned between the ends of the L beam shield, has given the best raster register and uniformity of all variations of shield shape and shield disposition yet tried.

By virtue of the different lengths of the shields **76** and **78** and their disposition in the deflection zone **19**, the L beam and the M beam are shielded from the deflection field over different portions of their travel therethrough. The L and M beams are thus subjected to the

deflection field for a shorter period of time than they would be in the absence of the shields **76** and **78**. By properly relating the lengths of the shields **76** and **78** to the relative beam velocities and to the shape and length of the magnetic deflection field, the L and M beams are subjected to the deflection field for specific time durations which will result in their being deflected substantially the same amount as the unshielded H beam.

The M beam shield is spaced from the end plate **43** on the end of the support member **90** so that the distortion of the deflection fields which it and the L beam shield cause will be more nearly symmetrical and thus less objectionable.

Because the M beam shield **78** is appreciably spaced from the end plate **43**, the M beam is deflected somewhat before it reaches the shield **78**. Because of this deflection, the M beam shield **78** must be made larger in diameter than the L beam shield **76** in order to prevent the deflected M beam from striking the shield elements.

The M beam shield is made larger in diameter than the L beam shield for the further purpose of symmetrizing the field distortion which is caused by the shields **76** and **78** and which the unshielded H beam encounters. Since the M beam shield is shorter than the L beam shield **76**, it would ordinarily cause less distortion of the deflection fields. However, its larger diameter compensates for its smaller cumulative length so that the distortions caused by the shields **76** and **78** are more nearly equal and thus produce an overall more nearly symmetrized distortion. In addition to this distortion, which can be compensated for by proper convergence fields, a second order distortion of complex nature which causes a skewing of the H beam raster exists if a circularly tubular L beam shield is used.

In a skewing of the type in question, the skewed H beam raster is distorted from an otherwise rectangular shape to that of a parallelogram with horizontal top and bottom boundaries and nonvertical side boundaries. This type of distortion is difficult to correct by conventional techniques, such as by the applying of special signal voltages to the dynamic convergence magnets **66**. A horizontal raster shape adjustment is needed; but the convergence system **64–66** provides displacement of the H beam only in the vertical direction.

The distortions which cause skewing of the H beam raster are relatively complex in nature, and the factors which create these distortions are not completely understood with certainty. However, some of the contributing factors are believed to include: (a) the difference of diameters of the L and M beam shields, (b) the difference of lengths of the L and M beam shields, (c) the fact that the L and M beam shields do not co-extend, and (d) the fact that the L and M beam shields are positioned in the fringe portion of the deflection fields where the fields are extremely nonuniform in strength.

Whatever the causes of raster-skewing distortions, their effect is apparently to cause the average, or effective, shape of the magnetic lines of force of the vertical deflection field to be tilted from a desired horizontal path. And whatever the mechanism of correction which the use of a flat-sided L beam shield has on the shaping of these lines of force, the apparent effect is to cause the lines to follow more nearly horizontal paths.

I do not intend that my invention be predicated upon, or otherwise limited by, any particular theory as to the cause and correction of the skewed H beam raster. Whatever the cause, and whatever the mechanism of correction, the fact remains that the use of a flat-sided L beam shield **76** according to my invention does reduce skewing of the H beam raster.

Tubular shields such as the shields **76** and **78** have been successfully used in a three-gun, twenty-three inch, rectangular, 92° cathode ray tube in which the cathode of the H beam gun is operated at −7 kilovolts, the M beam gun cathode at ground, the L beam gun cathode at +6

kilovolts, and the luminescent screen at +19 kilovolts. In such a system the L beam shield **76** has been provided as a tubular element 1⅜ inches long and having a square cross-section ¼ inch on each side. The M beam shield **78** has been provided as a tubular element ⅜ inch long and having a circular cross-section ⅜ inch in diameter. The distal end of the M beam shield **78** was spaced ⅛ inch back from the distal end of the L beam shield **76**. Such shields have been made from a combination of alloys sold commercially and designated "Netic" and "Conetic." In one embodiment each shield **76** and **78** consisted of a four mil thick "Netic" tube snugly fitted over a four mil thick "Conetic" tube. Another commercially available alloy which has been found to be suitable is that sold by Allegheny Ludlum Co. and identified as alloy No. 4750. Ten mil thick material of alloy No. 4750 has been used for the shields.

Regarding the functioning of the enhancers **80** and **81**, if a pair of enhancers are disposed in both the horizontal and vertical fields, they will enhance the strength of the deflection field in one direction, e.g., horizontal, and decrease the strength of the field in the perpendicular direction, e.g., vertical, in the space between the enhancers which is the region of the electron beam path with which they are associated. If the horizontal and vertical deflection fields are not coextensive and the enhancers are disposed in only one of the fields, they will affect only that field.

Since enhancers are placed adjacent a particular beam path and primarily associated therewith (e.g., enhancers **80** and **81** for the H beam), they primarily affect the deflection field only locally for the particular beam associated therewith. Enhancers act as magnetic conductors which are placed in the gap between a pair of deflection coils and thus decrease the reluctance of the deflection field flux path in the localized area occupied by the enhancers.

The pair of H beam enhancers **80** and **81**, being aligned in a horizontal plane, conduct the horizontally directed flux lines producing the vertical H beam deflection and thus enhance the vertical deflection of the H beam and thereby expand the H beam raster vertically.

In following the path of least reluctance, the horizontal flux lines of the vertical deflection field are bent toward and pass through the enhancers **80** and **81**. The enhancers may be thought of as gathering the flux lines from surrounding areas concentrating them. Since the enhancers are arranged serially in the direction of the flux lines, the flux in the area between the enhancers **80** and **81** is concentrated and provides a stronger vertical deflection field of the H beam than would otherwise exist without the enhancers. This serves to expand the height of the H beam raster. At the same time, the vertical flux lines of the horizontal deflection field are bent toward and pass through the enhancers **80** and **81**. Since the enhancers are arranged in parallel in the direction of the horizontal deflection flux lines, they gather flux which would otherwise pass between the enhancers, and thereby the enhancers lower the flux concentration in that area and provide a weaker horizontal deflection field for the H beam. This results in a horizontal contraction of the H beam raster. The vertical expansion and horizontal contraction of the resulting H beam raster are additive in effecting a change of the aspect ratio of the raster.

What is claimed is:

1. A cathode ray tube having a deflection zone in which beam deflection fields can be established for deflecting an electron beam in two mutually perpendicular directions, said tube comprising:

(a) a luminescent screen;

(b) an electron gun for projecting an electron beam along a path through said deflection zone toward said screen; and

(c) a tubular shield disposed in said deflection zone and surrounding said path;

(d) said tubular shield having two flat side portions, each of which is parallel to a different one of said mutually perpendicular directions.

2. A cathode ray tube adapted to have magnetic deflection fields established in a deflection zone for deflecting an electron beam in two mutually perpendicular directions, said cathode ray tube comprising:

(a) a luminescent screen;

(b) an electron gun for projecting an electron beam toward said screen along a path through said deflection zone; and

(c) a tubular shield disposed in said deflection zone and surrounding said path for shielding said path from portions of said fields;

(d) said tubular shield having a rectangular cross-section with its flat sides aligned with said mutually perpendicular directions.

3. A cathode ray tube having a deflection zone adapted to have magnetic deflection fields established therein for deflecting an electron beam in two mutually perpendicular directions, said cathode ray tube comprising:

(a) a luminescent screen; and

(b) a delta array of three electron guns for projecting three separate electron beams along three separate paths through said deflection zone toward said screen;

(c) one of said guns including a magnetic tubular shield surrounding its beam path in a portion of said deflection zone;

(d) said tubular shield having two adjacent flat side portions, each of which is parallel to a different one of said two mutually perpendicular directions and which face generally inward of said delta array.

4. A cathode ray tube having a deflection zone and comprising:

(a) a luminescent screen;

(b) a delta array of three electron guns for projecting three separate electron beams along respectively separate paths through said deflection zone toward said screen;

(c) a magnetic tubular shield of rectangular cross-section disposed in said deflection zone and surrounding the beam path of a first one of said guns; and

(d) a magnetic tubular shield of circular cross-section disposed in said deflection zone and surrounding the beam path of a second one of said guns;

(e) one of the flat sides of said rectangular tubular shield facing said beam path of said second gun, and an adjacent flat side of said rectangular tubular shield facing generally toward the beam path of the third one of said guns.

5. A cathode ray tube adapted to have horizontal and vertical magnetic deflection fields established in a deflection zone for deflecting an electron beam in mutually perpendicular horizontal and vertical directions, said cathode ray tube comprising:

(a) a luminescent screen;

(b) a delta array of three electron guns for projecting three separate and different velocity electron beams toward said screen along three separate paths through said deflection zone; the one of said guns adapted to project the highest velocity beam being disposed in the central longitudinal vertical plane of said cathode ray tube;

(c) a magnetic tubular shield of square cross-section disposed in said deflection zone coaxially with the one of said guns adapted to project the lowest velocity beam;

(d) a magnetic tubular shield of circular cross-section disposed in said deflection zone coaxially with the one of said guns adapted to project the intermediate velocity beam;

(e) said circular tubular shield being of larger cross-sectional size and of shorter length than said square tubular shield and being axially disposed between the ends of said square tubular shield;

(f) said square tubular shield having one of its flat sides disposed vertically and facing the path of said intermediate velocity beam, and having an adjacent one of its flat sides disposed horizontally and facing generally toward the path of said highest velocity beam.

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GEORGE N. WESTBY, *Primary Examiner.*

V. LAFRANCHI, *Examiner.*