

TITLE OF THE INVENTION

Color Cathode Ray Tube Having Improved Beam Convergence

BACKGROUND OF THE INVENTION

5 The present invention relates to a cathode ray tube, and in particular to a cathode ray tube provided with a beam convergence adjustment device.

10 A cathode ray tube is configured such that an electron beam from an electron gun is deflected and is projected onto a phosphor screen serving as a display screen to form an image thereon according to the amount of the electron beam. When an electron beam is deflected with accuracy, a high fidelity image can be formed. An electron beam must impinge on an intended position on the phosphor screen with accuracy.

15 In particular, in the case of a color cathode ray tube, three electron beams emitted from three electron guns are required to impinge on respective ones of the three adjacent phosphors luminescing in different colors, so that precise adjustment of electron beams is needed all the more.

20 Even if only one electron beam from an electron gun does not impinge on an intended phosphor, misregistration in colors occur in a picture element composed of three adjacent phosphors emitting three different colors.

25 Therefore, a color cathode ray tube is provided with a beam convergence adjustment device mounted around of the neck portion of

an evacuated envelope housing electron guns. The beam convergence adjustment device comprises a plurality of pairs of magnetic members individually rotatable around the neck portion and having the same number of magnetic poles, the number of the magnetic poles differing
5 from pair to pair (for example, three pairs of magnet members for producing two-pole magnetic field, four-pole magnet field and six-pole magnetic field, respectively). The paths of electron beams from respective electron guns can be adjusted by rotating respective magnetic members so that electron beams are finely adjusted to impinge
10 on an intended position on the phosphor screen.

However, when the display area of a cathode ray tube thus constituted is small (for example, a diagonal dimension of an effective display area is 41 cm or 46 cm), a red (R) bright spot produced on the red phosphor film by an electron beam for red, a green
15 (G) bright spot produced on the green phosphor film by an electron beam for green and a blue (B) bright spot produced on the blue phosphor film by an electron beam for blue sometimes appear excessively close to each other so that they may be perceived as a single spot by eyes. Latitude in beam convergence in such a color cathode ray tube is very
20 small and accurate adjustment cannot be achieved.

Even when the display area is comparatively large, a red (R) bright spot produced on the red phosphor film by an electron beam for red, a green (G) bright spot produced on the green phosphor film by an electron beam for green and a blue (B) bright spot produced
25 on the blue phosphor film by an electron beam for blue are spaced

comparatively large distances so that they may be perceived as three separate spots by eyes, a larger distance between the beam spots facilitates an electron beam convergence adjustment.

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SUMMARY OF THE INVENTION

The present invention is made in such circumstances and the purpose of the present invention is to provide a color cathode ray tube whose beam convergence can be easily achieved. According to an embodiment of the present invention, a color cathode ray tube includes

10 at least an evacuated envelope formed of a panel portion carrying a phosphor screen on an inner surface thereof, a neck portion, a funnel portion connecting the panel portion and the neck portion, a three-beam, in-line-type electron gun housed in the neck portion for generating a center electron beam and two side electron beams, a

15 deflection device mounted in the vicinity of a transition region between the funnel portion and the neck portion, a first adjustable magnetic field producing device mounted on the neck portion for moving the two side electron beams in mutually opposing directions, a second adjustable magnetic field producing device mounted on the neck

20 portion for moving the two side electron beams in a same direction, and a magnetic structure mounted on the neck portion for producing such a fixed magnetic field as to move the two side electron beams in mutually opposing directions. In a cathode ray tube thus constituted, proper rotation of the additional magnetic member for

25 producing a four-pole magnetic field, for example, varies paths of

the red and blue electron beams to increase or decrease the spacing between the red and blue electron beams on opposite sides of the green electron beam. A red (R) bright spot produced on the red phosphor film by a red electron beam, a green (G) bright spot produced on the green phosphor film by a green electron beam and a blue (B) bright spot produced on the blue phosphor film by a blue electron beam appear spaced great distances apart from each other so that latitude in electron beam convergence adjustment is increased. This provides a cathode ray tube in which beam convergence can be adjusted accurately.

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BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, which form an integral part of the specification and are to be read in conjunction therewith, and in which like reference numerals designate similar components throughout the figures, and in which:

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Fig. 1 is a side view showing an embodiment of convergence adjustment means provided in a cathode ray tube according to the present invention.

Fig. 2 is a partially cutaway side view showing an embodiment of a cathode ray tube according to the present invention.

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Fig. 3 is an exploded view in perspective showing an embodiment of convergence adjustment means provided in an cathode ray tube according to the present invention.

Fig. 4 shows an cross sectional view taken on line IV-IV in Fig.

25 3.

Fig. 5 is a plan view showing an embodiment of a two-pole magnetic member provided in convergence adjustment means.

Fig. 6 is a plan view showing an embodiment of a four-pole magnetic member provided in convergence adjustment means according
5 to the present invention.

Fig. 7 is a plan view showing an embodiment of a six-pole magnetic member provided in convergence adjustment means.

Fig. 8A and Fig. 8B are illustrative drawings showing the effects of a color cathode ray tube according to the present
10 invention.

Fig. 9 is a plan view showing another embodiment of a four-pole magnetic member to be used for convergence adjustment means according to the present invention.

Fig. 10 is a plan view showing another embodiment of a six-pole
15 magnetic member to be used for convergence adjustment means.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 2 is a schematic view showing the overall structure of an embodiment of a cathode ray tube according to the present invention.
20 The evacuated envelope 1 is made of glass, and is composed of a panel portion 1A serving as a display portion of the cathode ray tube, a neck portion 1B housing an electron gun structure 2, and a funnel portion 1C smoothly connecting the panel portion 1A and the neck portion 1B. The diagonal dimension of an effective display area of
25 the panel portion 1A is, for example, 41 cm or 46 cm.

The electron gun structure 2 contained in the neck portion 1B has a constitution in which three electron guns are integrally arranged in the X axis, and three electron beams for generating red (R) light, green (G) light and blue(B) light are emitted toward the
5 panel portion 1A from the respective electron guns.

Phosphor films 4 are formed over the entire inner surface of the panel portion 1A. There are formed three phosphors for generating the red light, the green light and the blue light, respectively, adjacent to each other in an area corresponding to one
10 picture element in the phosphor films 4. The electron gun structure 2 is configured such that three electron beams 3 emitted therefrom impinge on the respective phosphors for generating the red light, green light and blue light constituting one picture element for displaying color.

15 A shadow mask 5 is disposed adjacent to the inner surface of the panel portion 1A carrying the phosphor films 4, and one electron beam aperture in the shadow mask 5 corresponds to one picture element for a color display.

The electron gun structure 2 is configured such that three
20 electron beams 3 emitted from therefrom 2 pass through the same electron aperture in the shadow mask at an instant, and impinge on the respective phosphors for generating the respective colors constituting one picture element disposed behind the shadow mask 5 and associated with the electron aperture in the shadow mask.

25 Outside the evacuated envelope 1, a deflection yoke 6 is

provided on the funnel portion 1C on the side thereof adjacent to the neck portion 1B. The three electron beams 3 emitted from the electron gun structure 2 are deflected in the horizontal or vertical direction by the function of the deflection yoke 6 to scan all the picture elements in the phosphor films 4, for example, from the left upper picture element to the right lower picture element.

A beam convergence adjustment means 7 is mounted around the neck portion 1B outside the evacuated envelope 1. The undeflected electron beams 3 emitted from the electron gun structure 2 are designed to impinge on the center of the phosphor screen 4, and if some of the undeflected three beams impinge on a position displaced from the center of the phosphor screen 4, the convergence adjustment means 7 adjusts the path of the electron beams for the undeflected three beams to impinge on the center of the phosphor screen.

Fig. 1 is a side view showing details of the convergence adjustment means 7. A reference numeral 11 denotes a holder mounted around the neck portion 1B of the evacuated envelope 1 of a cathode ray tube. The holder 11 is not detailed in Fig. 1, but as shown in an exploded view in perspective in Fig. 3 the holder 11 is composed of a cylindrical member to be fitted around the neck portion 1B, has a flange 11A at one end thereof, a side wall portion 11B extending from the flange 11A to the other end thereof, a threaded portion 11C to mate with a locking ring 15 to be described later, and a clamp-mounting portion 11D for fixing the cylindrical member around the neck portion 1B with a metal clamp 20.

As shown in Fig. 3 , a pair of magnetic members 12A for producing two-pole magnetic field, a magnetic member 12X for producing four-pole magnetic field, a pair of magnetic members 12B for producing four-pole magnetic field, and a pair of magnetic members 12C for
5 producing six-pole magnetic field in this order are slipped on the holder 11 from the side of the clamp-mounting portion 11D, with a spacer interposed between the pair 12A, the magnetic member 12X, the pair 12B and the 12C.

The respective magnetic members are ring-shaped and can be
10 rotated independently around the holder 11, and their detailed constitutions will be described later.

The spacer ring 13 is so ring-shaped as to have a hole into which the holder 11 is inserted, and has a protrusion at its inner periphery which is not shown in Fig. 3.

15 The protrusion of the space ring 13 slipped on the holder 11 engages with a groove (not shown) extending in the Z axis direction on the outer side wall of the holder 11, and suppresses the rotation of the spacer ring 13. In other words, when a magnetic member is rotated, the spacer ring 13 prevents the rotation of other magnetic
20 members adjacent to the magnetic member.

In addition to a plurality of magnetic members mounted on the holder 11 with spacer rings 13 interposed therebetween, a locking ring 15 is mounted on the holder 11 with a spacer ring 14 of the shape similar to that of the spacer ring 13, interposed between the magnetic
25 members and the locking ring 15. The locking ring 15 has a threaded

inner surface to mate with a threaded portion 11C of the holder 11.

When the beam convergence has been adjusted by rotating magnetic members, these magnetic members whose outermost magnetic member is pushed against the flange 11A are fastened tightly with
5 the lockring 15, and the rotation of the magnetic members is prevented. The spacer ring 14 functions to prevent the rotation of the locking ring 15 from rotating the magnetic members 12A, 12X, 12B and 12C.

Each of the magnetic members 12A for producing two-pole magnetic field has a tab 12P as shown in Fig. 4, a cross sectional
10 view taken on line IV-IV of Fig. 3. In beam convergence adjustment, the magnetic members 12A can be rotated around the neck portion 1B by moving the tab 12P in the directions of arrows shown in Fig. 4. A tab 12P is also provided in each of the magnetic members, a magnetic member 12 X for four-pole magnetic field, a pair of magnetic members
15 12B for four-pole magnetic field and a pair of magnetic members 12C for six-pole magnetic field. Magnetic members, 12A, 12B, 12X and 12C are manufactured by locally magnetizing magnetic material members or embedding a plurality of small magnet pieces at a plurality of positions in a nonmagnetic material, and the number of magnetized
20 positions or the arrangement of the magnetized positions in the magnetic members differ with the type of the magnetic members.

The magnetic member 12A for producing two-pole magnetic field disposes two poles of different polarities along the circumference at approximately equal intervals as shown in Fig. 5. The magnetic
25 members 12B, 12X for producing four-pole magnetic field dispose four

poles alternating in polarity along the circumference at approximately equal intervals as shown in Fig. 6. The magnetic member 12C for producing six-pole magnetic field disposes six poles alternating in polarity along the circumference at approximately equal intervals as shown in Fig. 7. The method of beam convergence adjustment by using magnetic members for two-pole, four-pole and six-pole magnetic fields is described in detail in U.S. Patent No. 3,725,831.

It is possible to use a magnetic member in which two pieces of magnets 30 are disposed at two places as shown in Fig. 9 as a magnetic member for four-pole magnetic field in place of the magnetic members 12B or 12X for four-pole magnetic field having a magnet at four places, or to use a magnetic member in which three pieces of magnets 30 are disposed at three places as shown in Fig. 10 as a magnetic member for six-pole magnetic field in place of a magnetic member 12C for six-pole magnetic field having a magnet at six places.

The operation principles of a four-pole magnet and a six-pole magnet shown in Fig. 10 are described in detail in US Patent No. 3,808,570.

As described in the above, respective magnetic members, 12A, 12B, 12X and 12C, are arranged to be able to rotate independently and arbitrarily around the surface of the side wall portion 11B of the holder 11. Accordingly, the dispositions of respective magnetic members are changed, thereby the magnetic field distribution in the inside of the neck portion 1B where the electron beams pass through

is changed.

Therefore, when the undeflected electron beams 3 impinge on the position displaced from the center of the phosphor screen, the electron beams can be adjusted to impinge on the center of the screen
5 by changing the above-mentioned magnetic field.

The convergence adjustment means 7 is constituted by an insulating material such as synthetic resin except the metal fixing portion 11D, magnets embedded in a magnetic member 12, etc.

In the present embodiment, one piece of a magnetic member 12X
10 for producing four-pole magnetic field is added to the prior art beam convergence means. The added magnetic member 12X for four-pole magnetic field is disposed between the magnetic member 12A for two-pole magnetic field and a pair of magnetic members 12B for four-pole magnetic field with spacer rings 13 interposed
15 therebetween as shown in Fig. 1 and Fig. 3. However, the arrangement of the present invention is not limited to this, and the added magnetic member 12X can be positioned between the flange 11A and the pair of magnetic members 12A for two-pole magnetic field, between the magnetic members 12B for four-pole magnetic field and the magnetic
20 members 12C for six-pole magnetic field or between the magnetic members 12C for six-pole magnetic field and the locking ring 15.

The above-mentioned magnetic member 12X for four-pole magnetic field is adjusted independently of other magnetic members, and it is possible to increase or decrease a distance of an electron
25 beam for red or blue with respect to an electron beam for green

positioned therebetween by properly rotating the magnetic member 12X for four-pole magnetic field around the neck portion 1B.

In the above-mentioned embodiment, a magnetic member 12X for four-pole magnetic field is additionally provided, but in place of
5 such arrangement, the following arrangement is also good in which either the spacer ring 13 or the spacer ring 14 is so configured as to provide a four-pole magnetic field by locally magnetizing or embedding magnets and to be rotated around the neck portion by a tab added to it.

10 Thereby, the positional relations on the display screen among the bright beam spot 4(R) on the red phosphor produced by the electron beams for red, the bright beam spot 4(G) on the phosphor film 4 produced by the electron beams for green and the beam spot 4(B) on the phosphor film 4 produced by the electron beams for blue can be
15 changed from a state where respective spots are excessively close to each other as shown in Fig. 8A to a state as shown in Fig. 8B.

In the state as shown in Fig. 8A, three beam spots may be perceived as one beam spot by eyes, but in the state as shown in Fig. 8B three bright beam spots can be perceived as three separate beam
20 spots.

In the above-mentioned embodiment, when the red beam spot 4(R) and the blue beam spot 4(B) appear excessively close to the green beam spot 4(G), they are brought properly apart from the green beam spot, however, the present invention can be also utilized in a case
25 when the red beam spot 4(R) and the blue beam spot 4(B) are excessively

apart from the green beam spot 4(G), they can be brought properly close to the green beam spot (G). In this case, the magnetic member 12X shall be rotated by 90 degrees.

The gun structure of a color cathode ray tube are designed to
5 effect convergence of the three electron beams at the center of the phosphor screen. It is preferable that one gun structure can be used for a range of tube sizes and configurations for cost savings. When an electron gun designed for a cathode ray tube of a particular tube size and configuration is used for a cathode ray tube of another tube
10 size and configuration, a problem that three beam spots are not spaced at a proper distance from each other on the screen may occur; however, such a problem can be solved by the present invention.

According to the present invention, in beam convergence adjustment by observing a display screen, latitude in adjustment will
15 be increased, resulting in accurate convergence adjustment.

In the above-mentioned embodiment, the beam convergence adjustment means 7 is provided with a pair of magnetic members for two-pole magnetic field, a pair of magnetic members for four-pole magnetic field and a pair of magnetic members for six-pole magnetic
20 field; however an arrangement of the present invention is not limited to the one which is provided with all of them, or the one which is provided with a magnetic member having different number of poles is also good.

As clearly seen from the description in the above, the present
25 invention makes it possible to perform accurate convergence

adjustment.

WHAT IS CLAIMED IS:



1. A color cathode ray tube comprising at least
an evacuated envelope comprising a panel portion having a
5 phosphor screen on an inner surface thereof, a neck portion, and a
funnel portion connecting said panel portion and said neck portion,
a three-beam, in-line type electron gun housed in said neck
portion for generating a center electron beam and two side electron
beams,
10 a deflection device mounted in a vicinity of a transition
region between said funnel portion and said neck portion,
a first adjustable magnetic field producing device mounted on
said neck portion for moving said two side electron beams in mutually
opposing directions,
15 a second adjustable magnetic field producing device mounted
on said neck portion for moving said two side electron beams in a
same direction, and
a magnetic structure mounted on said neck portion for producing
such a fixed magnetic field as to move said two side electron beams
20 in mutually opposing directions,
2. A color cathode ray tube according to claim 1, wherein said
first adjustable magnetic field producing device produces a
four-pole field pattern.
3. A color cathode ray tube according to claim 1, wherein said
25 first adjustable magnetic field producing device comprises a pair



of individually rotatable four-pole magnetic rings.

4. A color cathode ray tube according to claim 1, wherein said first adjustable magnetic field producing device has a pair of rings each having four magnets alternating in polarity at 90* intervals
5 around a circumference of said neck portion.

5. A color cathode ray tube according to claim 1, wherein said first adjustable magnetic field producing device has a pair of rings each having two magnets on opposite sides of said neck portion with same poles of said magnets directed radially toward said neck portion.

10 6. A color cathode ray tube according to claim 1, wherein said magnetic structure includes four magnets spaced at 90° intervals around a circumference of said neck portion and alternating in polarity of an end closest to said neck portion of said four magnets.

7. A color cathode ray tube according to claim 6, wherein said
15 first adjustable magnetic field producing device produces a four-pole field pattern.

8. A color cathode ray tube according to claim 6, wherein said first adjustable magnetic field producing device comprises a pair of individually rotatable four-pole magnetic rings.

20 9. A color cathode ray tube according to claim 6, wherein said first adjustable magnetic field producing device has a pair of rings each having four magnets alternating in polarity at 90* intervals around a circumference of said neck portion.

10. A color cathode ray tube according to claim 6, wherein
25 said first adjustable magnetic field producing device has a pair of



rings each having two magnets on opposite sides of said neck portion with same poles of said magnets directed radially toward said neck portion.

11. A color cathode ray tube according to claim 1, wherein
5 said magnetic structure includes two magnets on opposite sides of said neck portion with same poles of said magnets directed radially toward said neck portion.

12. A color cathode ray tube according to claim 11, wherein
said first adjustable magnetic field producing device produces a
10 four-pole field pattern.

13. A color cathode ray tube according to claim 11, wherein
said first adjustable magnetic field producing device comprises a pair of individually rotatable four-pole magnetic rings.

14. A color cathode ray tube according to claim 11, wherein
15 said first adjustable magnetic field producing device has a pair of rings each having four magnets alternating in polarity at 90° intervals around a circumference of said neck portion.

15. A color cathode ray tube according to claim 11, wherein
said first adjustable magnetic field producing device has a pair of
20 rings each having two magnets on opposite sides of said neck portion with same poles of said magnets directed radially toward said neck portion.

16. A color cathode ray tube according to claim 1, wherein
said magnetic structure produces a four-pole magnetic field pattern.

25 17. A color cathode ray tube according to claim 1, wherein



said first adjustable magnetic field producing device produces a four-pole field pattern and

said second adjustable magnetic field producing device produces a six-pole field pattern.

5 18. A color cathode ray tube according to claim 1, wherein said cathode ray tube further comprises a pair of two-pole magnetic rings, each magnetized across a diameter thereof.

19. A color cathode ray tube having an electron beam convergence adjustment device for adjusting paths of electron beams
10 from an electron gun housed in a neck portion of an evacuated envelope,

said electron beam convergence adjustment device comprising a plurality of pairs of magnetic members having a same number of magnetic poles and adapted to be rotated individually around said neck portion, said number of magnetic poles depending upon said pairs,
15 and

a magnetic member for producing a fixed four-pole magnetic field disposed concentrically with said plurality of pairs of magnetic members.