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DESCRIPTION

"DEFLECTION DEVICE FOR USE
IN A COLOR CATHODE-RAY TUBE"Background of the Invention

1. Field of the Invention

The present invention relates to a deflection device for use in an in-line color cathode-ray tube, which is designed to deflect three electron beams passing in the same plane, and more particularly to a deflection device which has a convergence-correcting coil for eliminating mis-convergence in an in-line color cathode-ray tube of self-convergence type.

10 2. Description of the Related Art

Most color cathode-ray tubes have the structure shown in Fig. 1. As shown in Fig. 1, each of them comprises an envelope 2 formed of a panel 1 and a funnel 9 integral with the panel 1. It further comprises a phosphor screen 3 formed on the inner surface of the panel 1, a shadow mask 4 located in the envelope 2, an electron gun unit 8 located in the neck 6 of the envelope 2, and a deflection device 10 surrounding the adjoining portions of the neck 6 and large-diameter portion 9 of the envelope 2. The screen 3 consists of blue-light emitting phosphor stripes, green-light emitting phosphor stripes, and red-light emitting phosphor stripes. The shadow mask 4 opposes the phosphor screen 3 and has a number of apertures. The electron gun unit 8

generate horizontal and vertical deflection magnetic fields. The electron beams 7B, 7G, and 7R emitted from the gun unit 8 are deflected by the deflection magnetic fields generated by the unit 10, then pass through the apertures of the shadow mask 4, and finally applied to the phosphor screen 3. Excited by the beams 7B, 7G, and 7R, the phosphor stripes of the screen 3 emit blue light rays, green light rays, and red light rays. As a result, the cathode-ray tube displays a color image.

The electron gun unit 8 is a so-called "in-line type" designed to emit three electron beams, i.e., a center beam 7G and two side beams 7B and 7R which pass in the same plane. The horizontal deflection magnetic field generated by the unit 10 is shaped like a pincushion as is shown in Fig. 2A. By contrast, the vertical deflection magnetic field generated from the device 10 is shaped like a barrel as is illustrated in Fig. 2B. The magnetic fluxes 12H of the pincushion-shaped magnetic field deflects the electron beams 7B, 7G, and 7R in a horizontal plane, while the magnetic fluxes 12V of the barrel-shaped magnetic field deflects the electron beams 7B, 7G, and 7R in a vertical plane.

Self-convergence type in-line color cathode-ray tubes, described above, are commonly used in practice.

As Fig. 1 shows, the deflection device 10 comprises a horizontal deflection coil 13H for generating the pincushion-shaped horizontal deflection magnetic field, and a vertical deflection coil 13V for generating the barrel-shaped vertical deflection magnetic field. Generally, the coils 13H and 13V are a saddle type and a toroidal type, respectively. The pincushion-shaped horizontal deflection magnetic field 12H converges the electron beams 7B, 7B, and 7R toward one another in the horizontal plane extending in an x axis, whereas the

axis.

5 Even if the beams 7B, 7B, and 7R are so converged
by the pincushion-shaped magnetic field 12H and the
barrel-shaped magnetic field 12V, however, miscon-
vergence of the beams occurs at the corners of a display
screen 14 as shown in Fig. 3. In other words,
10 a blue-beam spot 15B, a green-beam spot 15G, and a red-
beam spot 15R are vertically displaced from one another
at the corners of the display screen 14. In most cases,
the mis-convergence can be eliminated by adjusting the
distance between the deflection center of the horizontal
15 deflection coil 13H and that of vertical deflection coil
13V.

As has been indicated, the deflection device 10
generates a horizontal deflection magnetic field 12H
shaped like a pincushion, and a vertical deflection
20 magnetic field 12V shaped like a barrel. Hence, the
three electron beams 7B, 7G, and 7R can be converged at
any position in the horizontal and vertical axes of the
display screen 14. As shown in Fig. 4, however, mis-
convergence of the beams takes place in intermediate
25 regions between the corners and the horizontal and ver-
tical axes of the screen 14. The red-beam spot 15R, for
example, is formed closer to the center of the screen 14
than the blue-beam spot 15B in the right half of the
screen 14, and is located farther from the center of the
30 screen 14 than the blue-beam spot 15B in the left half
of the screen 14. The mis-convergence of the electron
beams inevitably deteriorates the quality of the image
the cathode-ray tube displays.

The mis-convergence occurring at a position between
35 the vertical axis y of the screen 14 and the any corner
thereof may be minimized by altering the distribution of
the magnetic fluxes generated by the deflection device

image displayed.

5 Recently, not only the distance between the deflection centers of the deflection coils 13H and 13V is adjusted, but also a saturable reactor is used, varying, differentially at the vertical deflection frequency, the horizontal-deflection currents supplied to the upper and
10 lower coils constituting the horizontal deflection coil 13H. Mis-convergence in any corner of the screen 14 is eliminated almost completely. Mis-convergence can, therefore, be sufficiently reduced at any position in the horizontal and vertical axes of the screen 14 and at
15 any corner thereof, but not at a position between the vertical axis y of the screen 14 and the any corner thereof. That is, as shown in Fig. 4, mis-convergence remains between the axis y and each corner, such that the red-beam spot 15R is located farther to the center
20 of the screen 14 than the blue-beam spot 15B in the right half of the screen 14, and is located nearer the center of the screen 14 than the blue-beam spot 15B in the left half of the screen 14. The display screen 14, as a whole, has but poor convergence characteristic.
25

 The mis-convergence occurring between the axis y of the screen 14 and each corner thereof can be reduced by two alternative methods. The first is to alter the distribution of deflection magnetic fluxes. The second
30 is said same method used to minimize the mis-convergence at the corners of the screen 14. If either alternative method is performed, however, a prominent mis-convergence will occur at each corner of the display screen 14, inevitably degrading the convergence all over
35 the display screen 14.

 With the conventional method of eliminating or reducing mis-convergence in an in-line cathode-ray tube

vergence all over the display screen 14.

5 3. Summary of the Invention

 The object of this invention is to provide a deflection device for use in an in-line color cathode-ray tube of self-convergence type, which can much reduce not only mis-convergence at any point in the horizontal
10 an vertical axes of the screen of the tube and at any corner of the screen but also mis-convergence at intermediate regions between the corners and the horizontal and vertical axes.

 According to the invention, there is provided a
15 deflection device for use in a color cathode-ray tube having a center axis and means for emitting in-line electron beams, comprising:

 horizontal deflection means for deflecting the electron beams in a horizontal direction in response to
20 horizontal deflection signals, said horizontal deflection means including a pair of horizontal deflection coils for generating a pincushion-shaped horizontal deflection magnetic field;

 vertical deflection means for deflecting the
25 electron beams in a vertical direction in response to vertical deflection signals, said vertical deflection means including a pair of vertical deflection coils for generating a barrel-shaped vertical deflection magnetic field; and

30 correction means for correcting the deflection of the electron beams by applying a correction magnetic field to the electron beams in response to the horizontal deflection signals, said correction means including
35 a pair of correction coils which are located near a vertical axis orthogonal to said center axis and symmetrically with respect to the vertical axis and in which currents flow in synchronism with, and in

5 a deflection device for use in a color cathode-ray tube
having a center axis and means for emitting in-line
electron beams, comprising:

horizontal deflection means for deflecting the
electron beams in a horizontal direction in response to
horizontal deflection signals, said horizontal
10 deflection means including a pair of horizontal deflec-
tion coils for generating a pincushion-shaped horizontal
deflection magnetic field;

vertical deflection means for deflecting the
electron beams in a vertical direction in response to
15 vertical deflection signals, said vertical deflection
means including a pair of vertical deflection coils for
generating a barrel-shaped vertical deflection magnetic
field; and

correction means for correcting the deflection of
20 the electron beams by applying a correction magnetic
field to the electron beams in response to the horizon-
tal deflection signals, said correction means including
a first pair of correction coils which are located near
a vertical axis orthogonal to said center axis and sym-
25 metrically with respect to the vertical axis and in
which currents flow in synchronism with, and in a direc-
tion opposite to, the currents flowing in said horizon-
tal deflection coils, and a second pair of correction
coils which are located near said vertical axis and sym-
30 metrically with respect to said vertical axis and in
which currents flow in synchronism with, and in the same
opposite as, the currents flowing in said horizontal
deflection coils.

In an another aspect of the invention, there is
35 provided a deflection device comprising: a pair of hori-
zontal deflection coils for generating a pincushion-
shaped horizontal deflection magnetic field; a pair of

5 spaced by 10 cm or less from a plane containing the axis
of the device and a vertical axis extending at right
angles to the axis of the device and in which currents
flow in synchronism with and in an opposite direction
to currents flowing in the horizontal deflection
coils.

10 Located in the deflection region spaced by 10 cm or
less from a plane containing the axis of the device and
a vertical axis extending at right angles to the axis of
the device and in which currents flow in synchronism
with and in an opposite direction to currents flowing in
15 the horizontal deflection coils, the correction coils
generates a magnetic field which deflects the outermost
side electron beam more than the innermost side beam in
a horizontal plane, the outermost side beam being posi-
tioned more apart from the tube axis than the innermost
20 side beam, when the electron beams are directed to the
intermediate positions between the vertical axis of the
screen and any corner thereof. The innermost side beam
is more deflected than the outermost beam by the
pincushion-shaped horizontal deflection magnetic field
25 generated by the horizontal deflection coils, when the
electron beams are directed to the corners of the
screen. Hence, the correction coils can minimize the
mis-convergence between the vertical axis of the screen
and each corner of the screen, without degrading the
30 convergence all over the display screen.

In yet another aspect of this invention, there is
provided a deflection device for deflecting three
electron beams passing in the same plane, comprising: a
deflection yoke having a saddle-shaped horizontal
35 deflection coil for generating a pincushion-shaped hori-
zontal deflection magnetic field for deflecting the
three electron beams toward one another in a horizontal

5 tical plane; a first coil which is located at the rear
of the deflection yoke and in a plane containing the
central axis and vertical axis of the deflection yoke
and in which a current flows in synchronism with and in
an opposite direction to a current flowing in the hori-
zontal deflection coil; and a second coil which is
10 located in front of the deflection yoke and in a plane
containing the central axis and vertical axis of the
deflection yoke and in which a current flows in synchro-
nism with and in the same direction as a current flowing
in the horizontal deflection coil.

15 Since the first coil is located in the position
described above, and a current flows in this coil in the
direction specified above, the first coil generates a
magnetic field which reduces the vertical mis-
convergence remaining between the vertical axis of a
20 display screen and each corner thereof. Since the
second coil is located in the position described above,
and a current flows in the second coil in the direction
specified above, the second coil generates a magnetic
field which reduces the horizontal mis-convergence
25 caused by the first coil and remaining between the ver-
tical axis of a display screen and each corner thereof.
Hence, the first coil and the second coil cooperate to
effectively minimize the mis-convergence occurring at a
position between the vertical axis of a display screen
30 and each corner thereof.

4. Brief Description of the Drawings

Fig. 1 is a cross-sectional view schematically
showing a conventional color cathode-ray tube;

35 Fig. 2A is a diagram illustrating a pincushion-
shaped horizontal deflection magnetic field generated by
a deflection device for use in an in-line color cathode-
ray tube of self-convergence type;

tube of self-convergence type;

5 Fig. 3 is a diagram explaining mis-convergence occurring at the corners of the display screen of an in-line cathode-ray tube of self-convergence type;

 Fig. 4 is a diagram explaining mis-convergence remaining even after correcting the mis-convergence at
10 the corners of the display screen of the in-line cathode-ray tube of self-convergence type;

 Fig. 5A is a front view of a deflection device according to a first embodiment of the invention, which is designed for use in an in-line cathode-ray tube of
15 self-convergence type;

 Fig. 5B is a partly broken-away, side view of the deflection device shown in Fig. 5A;

 Fig. 6 is a diagram explaining how the deflection device shown in Figs. 5A and 5B reduces mis-
20 convergence;

 Figs. 7A and 7B are front views showing modifications of the deflection device shown in Figs. 5A and 5B;

 Fig. 8A is a front view of a deflection device according to a second embodiment of the invention, which is designed for use in an in-line cathode-ray tube of
25 self-convergence type;

 Fig. 8B is a partly broken-away, side view of the deflection device shown in Fig. 8A;

30 Fig. 9 is a diagram illustrating the mis-convergence caused by the magnetic field generated by the first coil of the deflection device shown in Figs. 8A and 8B; and

 Fig. 10 is a front view showing a modification of the deflection device shown in Figs. 8A and 8B.
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5. Detailed Description of the Preferred Embodiments
 Embodiments of the present invention, each being

5 Figs. 5A and 5B show a deflection device according
to a first embodiment of the present invention. This
deflection device comprises a separator 20 made of
synthetic resin. The separator 20 will serve as part of
the envelope of an in-line cathode-ray tube. It is
generally a tapered hollow cylinder, whose small-
10 diameter end and large-diameter ends are to be fixed to
the neck and funnel of the envelope the cathode-ray
tube, respectively.

 Inside the separator 20, a pair of saddle-shaped
horizontal deflecting coils 21 are located. A tapered,
15 hollow cylindrical core 22 is mounted on the separator
20 and positioned coaxial therewith. A pair of toroidal
vertical deflection coils 23 are wound around the core
22. The horizontal deflection coils 21 and the vertical
deflection coils 23 constitute a deflection coil 27.
20 The horizontal deflection coils generate a pincushion-
shaped horizontal deflection magnetic field, whereas the
vertical deflection coils 23 generate a barrel-shaped
vertical deflection magnetic field.

 The deflection device further comprises a pair of
25 correction coils 24, i.e., an upper correction coil and
a lower correction coil. Each correction coil 24 is
placed in a plane Z-Y which contains the axis ZD of the
deflection device and a vertical line extending at right
angles to the axis ZD. As is evident from Fig. 5A, the
30 halves of each turn of either correction coil 24 extend
substantially parallel to the plane Z-Y and are sym-
metrical with respect thereto.

 The vertical deflection coils 23 are connected to a
vertical deflection current source 40, and the horizon-
35 tal deflection coils 21 and the correction coils 24 are
connected to a horizontal deflection current source 42.
The correction coils 24 are connected to the horizontal

5 opposite to the direction in which the current flows in the coils 21.

Assume that the deflection device of Figs. 5A and 5B is incorporated in an in-line cathode-ray tube, and that currents simultaneously flow in the horizontal deflection coils 21 and the correction coils 24 in the directions specified above. Then, as shown in Fig. 6, the horizontal deflection coils 21 generate horizontal deflection magnetic fields 12H in a deflection region in which the three electron beams 7B, 7G, and 7R emitted from the electron gun unit of the cathode-ray tube. Simultaneously, the correction coils 24 generate correction magnetic fields 26 in the same deflection region. Since either correction magnetic field is a local one, the beams 7B, 7G, and 7R are deflected in different directions which are determined by the positions they take with respect to the correction field.

More precisely, when the deflecting magnetic field deflects the beams 7B, 7B, and 7R to an intermediate position between the vertical axis of the display screen of the cathode-ray tube and the upper-left corner of the display screen, the correction magnetic field 26 deflects the side beam 7B more than the other side beam 7R toward the horizontal axis, as can be understood from the arrows 32 and 33 shown in Fig. 6. When the deflecting magnetic field deflects the beams 7B, 7G, and 7R to the the upper-left corner of the display screen, the correction magnetic field 26 deflects the side beam 7B more toward the vertical axis and the side beam 7R more toward the horizontal axis than in the case where the beams 7B, 7G, and 7R are deflected to an intermediate position between the vertical axis of the screen and the upper-left corner thereof.

In contrast, when the deflecting magnetic field

deflected in a relation reverse to the relation in which
5 they are deflected in when the three beams are deflected
to the left edge of display screen. When the deflecting
magnetic field deflects the beams 7B, 7G, and 7R to the
lower edge of the display screen, the side beams 7B and
7R are deflected in a relation same as the relation in
10 which they are deflected when the three beams are
deflected to the upper edge of display screen.

Namely, since currents flow through the correction
coils 24 at the same time as the current in the horizon-
tal deflection coils 21 and in the opposite direction
15 thereto, the vertical mis-convergence (Fig. 4) at a
position between the vertical axis and any corner of the
screen can be much reduced, without jeopardizing the
convergence at the corners of the screen. As a result,
good convergence is attained at any position on the
20 display screen.

A deflection device according to this invention was
made for operating test. In the device, two correction
coils 24 were positioned such that their two-turn win-
dings were located at the distance of 5 mm from the ver-
25 tical axis of the deflection device. The device was
incorporated into a 23-inch, 110 color cathode-ray
tube, and the cathode-ray tube was operated. Mis-
convergence of 0.5 mm was seen at each corner of the
display screen. Simultaneously, mis-convergence of
30 0.7 mm in the same direction was observed at any posi-
tion between the vertical axis and each corner of the
display screen of the cathode-ray tube. The mis-
convergence at any position between the vertical axis
and each corner is less than half the mis-convergence
35 occurring in the case where a conventional deflection
device without correction coils is employed.

The use of the correction coils 24 increases the

field.

5 In the first embodiment, the correction coils 24
were so positioned that their windings were 5 mm away
from the vertical axis of the device. Nonetheless, the
windings may be located closer to or farther from the
vertical axis. They should not be positioned, however,
10 at a distance exceeding 10 mm from the plane containing
the vertical axis and center axis of the deflection
device. If the distance is more than 10 mm, the magne-
tic field the correction coils 24 generate can no longer
serve to reduce the mis-convergence occurring at any
15 position between the vertical axis and each corner of
the display screen.

 The more turns each correction coil 24 has, the
more greatly the coil 24 serves to reduce the mis-
convergence. An increase in the number of turns,
20 however, may reduce the deflection angle of the electron
beams 7B, 7G, and 7R and may adversely influence the
characteristics of the deflection device. The mis-
convergence at a midpoint between the vertical axis and
each corner of the screen is about 1 to 2 mm in most
25 cases. It would therefore suffice to reduce the mis-
convergence by about 1 to 2 mm. In view of this, it is
required that the correction coils 24 have five or less
turns each.

 Two modifications of the deflection device shown in
30 Figs. 5A and 5B will be described, with reference to
Figs. 7A and 7B.

 In the device of Figs. 5A and 5B, the correction
coils 24, positioned in the plane Z-Y, are shaped such
that the halves of each turn of either coil 24 extend
35 parallel to the plane Z-Y and are symmetrical with
respect thereto as is evident from Fig. 5A. Instead, as
is shown in Fig. 7B, the correction coils 24 may be

5 be shaped such that each turn may gradually approach the
Z-Y plane as it extends toward the large-diameter end of
the separator 20.

In the modification of Fig. 7A, the correction
coils 24 may be located in the large-diameter end por-
tion of the separator 20.

10 As has been indicated, the deflection device of
Figs. 5A and 5B, designed for use in a color cathode-ray
tube, comprises a pair of horizontal deflection coils 21
for generating a pincushion-shaped horizontal deflection
magnetic field and a pair of vertical deflection coils
15 23 for generating a barrel-shaped vertical deflection
magnetic field. It further comprises a pair of correc-
tion coils 24, which are spaced by 10 mm or less from
the plane containing the axis of the device and a ver-
tical axis extending at right angles to the axis of the
20 device. Currents flow in these coils 24, in synchronism
with and in an opposite direction to the currents
flowing in the horizontal deflection coils 21, whereby
the coils 24 generate a magnetic field. This magnetic
field deflects the side beams (i.e., two of the three
25 electron beams emitted from the electron gun unit of the
cathode-ray tube), in a specific manner. That is, when
the electron beams are directed to the intermediate
positions between the vertical axis and the each corners
of the screen, the outermost side beam which is posi-
30 tioned more remote from the tube axis than the inner-
most side beam or center beam is more deflected toward
the horizontal axis than the other innermost side beam.
In contrary, when the electron beams are directed to the
any corner of the screen, the innermost is more
35 deflected toward the horizontal axis than the outermost
side beam. As a result, the mis-convergence at any
position between the vertical axis and each corner of

tion on the display screen of the cathode-ray tube.

5 Another deflection device according to the present invention will be described, with reference of Figs. 8A, 8B, and 9.

 As shown in Figs. 8A and 8B, an additional coil assembly 51 is located in the plane containing the
10 vertical axis (y axis) and center axis (z axis) of a deflection yoke 27. In other words, the assembly 51 is positioned near the neck of the envelope of the cathode-ray tube in which the device is to be used. The additional coil assembly 51 comprises a pair of coils 24A
15 and another pair of coils 24B. The coils 24B of the first pair are connected to the horizontal deflection coils 21. Currents flow in the coils 24A in synchronism with, and in the opposite direction to, those currents flowing in the horizontal deflecting coils 21. The
20 coils 24A of the second pair are located adjacent to the coils 24B, at the front of the deflection yoke 27 (that is, within the large-diameter end of the funnel of the envelope). Currents flow in these coil 24A in
25 synchronism with, and in the same direction as, the currents flowing in the horizontal deflecting coils 21.

 The coils 24A and the coils 24B are connected together, in end-to-end fashion, forming a coil unit. Each pair of coils of the assembly 51 is formed by
30 winding an insulated wire, forming an annular coil having about five turns, by flattening the annular coil into an elongated one, and by twisting the elongated coil 180° at the middle portion thereof.

 Referring back to Fig. 6, the horizontal deflection coils 21 generate horizontal deflection magnetic
35 fields 12H in a deflection region in which the three electron beams 7B, 7G, and 7R emitted from the electron

magnetic field either coil 24B generates is a local one.
5 Therefore, the beams 7B, 7G, and 7R are deflected in different directions which are determined by the positions they take with respect to the magnetic field generated by the coil 24B.

10 When the beams 7B, 7G, and 7R are deflected in the deflection region (Fig. 6) by the vertical deflection magnetic field 12V and the horizontal deflection magnetic field 12H and are applied toward a position between the vertical axis of the screen of the cathode-ray tube and any corner of the screen, the magnetic field 26
15 generated by each coil 24B deflects the side electron beam 7B more toward the horizontal axis (x axis) of the screen as indicated by an arrow 32 than the other side beam 7R is deflected toward the horizontal axis of the screen as indicated by an arrow 33. On the other hand,
20 when the beams 7B, 7G, and 7R are deflected in the deflection region (Fig. 6) by the vertical and horizontal deflection magnetic fields 12V and 12H and are applied toward any corner of the display screen, the magnetic field 26 generated by each coil 24B deflects
25 the side electron beam 7B more away from, and the other side beam 7R more toward, the horizontal axis (x axis) of the screen than in the case where the beams 7B, 7G, and 7R are deflected toward a position between the vertical axis of the screen and any corner of
30 thereof.

When the electron beams 7B, 7G, and 7R are deflected toward an upper-right position on the display screen by the vertical and horizontal deflection magnetic fields 12V and 12H, the magnetic field 26 generated
35 by each coil 24B deflects the side electron beams 7B and 7R in a relation reverse to that relation which the beams 7B and 7R have when the beams 7B, 7G, and 7R are

by the deflection magnetic fields 12V and 12H, the
5 magnetic field 26 generated by each coil 24B deflects
the side electron beams 7B and 7R in the same way as in
the case where the beams 7B, 7G, and 7R are deflected
toward an upper-left position on the screen or toward
the upper-right position of the screen. Hence, the
10 vertical mis-convergence at a position between the ver-
tical axis of the screen and any corner thereof can be
reduced, without jeopardizing the convergence at the
corner of the display screen.

When the coils 24B are energized, however, a
15 current flowing in the opposite direction to the hori-
zontal deflection currents flowing in the coils 24B
reduce the intensity of the pincushion-shaped horizontal
deflection magnetic field 12H. Consequently, horizontal
mis-convergence of the side beams 7B and 7R occurs as is
20 indicated by the side-beam patterns 15B and 15R shown in
Fig. 9. Nonetheless, this horizontal mis-convergence of
the side beams is minimized since the currents, which
flow in the coils 24A of the second pair in the same
direction as the currents flowing in the horizontal
25 deflection coils 21, intensify the pincushion-shaped
horizontal deflection magnetic field 12H at the region
near the front end of the deflection yoke 26.

In the deflection device of Figs. 8A and 8B, the
coils 24A and the coils 24B form an integral unit, i.e.,
30 the additional coil assembly 51. The assembly 51 is
relatively simple in structure and can yet minimize the
vertical mis-convergence at a position between the ver-
tical axis of the screen and any corner thereof.

As described above, the coils 24A and the coils
35 24B, which constitute the additional coil assembly 51,
are positioned in the plane containing the center and
vertical axes of the deflection yoke 26. It is

the coils 24B of the first pair and the coils 24A of the
5 second pair are of the same shape and the same size.
Instead, as is shown in Fig. 10, the coils 24A may have
a width L_2 , and the coils 24B may have a width L_1 ,
each measured in the horizontal direction, where
10 $L_1 < L_2$. In this case, it is possible to adjust the
ratio of improvement of the vertical mis-convergence,
occurring at an intermediate position between the ver-
tical axis of the screen and any corner thereof to the
horizontal mis-convergence.

As has been indicated, in the embodiment of
15 Figs. 8A and 8B, the coils 24B, in which currents flow
in synchronism with and in the opposite direction to
those currents flowing in the horizontal deflecting
coils 21, are located in the plane containing the center
and vertical axes of the screen and at the rear of the
20 deflection yoke 26; and the coils 24A, in which currents
flow in synchronism with and in the same direction as
the currents flowing in the horizontal deflecting coils
21, are located in that plane and at the front of the
deflection yoke 17. The coils 24B generate a magnetic
25 field which reduces the vertical mis-convergence of the
side beam occurring at a position between the vertical
axis of the screen and any corner thereof. The coils
24A generate a magnetic field which minimizes the
horizontal mis-convergence caused by the magnetic field
30 generated by the coils 24B. As a result, sufficient
convergence of the three beams 7B, 7G, and 7R can be
maintained at any position on the display screen of the
cathode-ray tube.

ray tube (1) having a center axis and means (8) for emitting in-line electron beams, comprising:

5 horizontal deflection means (21) for deflecting the electron beams in a horizontal direction in response to horizontal deflection signals, said horizontal deflection means (21) including a pair of horizontal deflection coils for generating a pincushion-shaped horizontal deflection magnetic field; and

10 vertical deflection means (23) for deflecting the electron beams in a vertical direction in response to vertical deflection signals, said vertical deflection means (23) including a pair of vertical deflection coils for generating a barrel-shaped vertical deflection magnetic field;

15 characterized by further comprising:

correction means (24, 24A, 24B) for correcting the deflection of the electron beams by applying a correction magnetic field to the electron beams in response to the horizontal deflection signals, said correction means (24, 24A, 24B) including a pair of correction coils which are located near a vertical axis orthogonal to said center axis and symmetrically with respect to the vertical axis and in which currents flow in synchronism with, and in a direction opposite to, the currents flowing in said horizontal deflection coils (21).

20 2. The deflection device according to claim 1, characterized in that said horizontal deflection coils (21) are saddle-shaped.

30 3. A deflection device for use in a color cathode-ray tube (1) having a center axis and means (8) for emitting in-line electron beams, comprising:

horizontal deflection means (21) for deflecting the electron beams in a horizontal direction in response to horizontal deflection signals, said horizontal

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5 vertical deflection means (23) for deflecting the
electron beams in a vertical direction in response to
vertical deflection signals, said vertical deflection
means (23) including a pair of vertical deflection coils
for generating a barrel-shaped vertical deflection
magnetic field;
10 characterized in that
correction means (24, 24A, 24B) for correcting the
deflection of the electron beams by applying a correc-
tion magnetic field to the electron beams in response to
the horizontal deflection signals, said correction means
15 (24, 24A, 24B) including a first pair of correction
coils which are located near a vertical axis orthogonal
to said center axis and symmetrically with respect to
the vertical axis and in which currents flow in
synchronism with, and in a direction opposite to, the
20 currents flowing in said horizontal deflection coils
(21), and a second pair of correction coils (24, 24A,
24B) which are located near said vertical axis and sym-
metrically with respect to said vertical axis and in
which currents flow in synchronism with, and in the same
25 opposite as, the currents flowing in said horizontal
deflection coils (21).
4. The deflection device according to claim 3,
characterized in that said horizontal deflection coils
(21) are saddle-shaped.
30 5. The deflection device according to claim 3,
characterized in that said correction coils (24B) of the
first pair are arranged between said second pair of
correction coils (24A) and said means (8) for emitting
in-line electron beams.

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tube, which has a pair of horizontal deflection coils
(21) for generating a pincushion-shaped horizontal
deflection magnetic field, a pair of vertical deflection
5 coils (23) for generating a barrel-shaped vertical
deflection magnetic field. The deflection device
further comprises a pair of correction coils (24) each
of which is located at a distance of 10 mm or less from
a plane containing the center and vertical axes of the
10 device, and in each of which a current flows in synchro-
nism with, and in a direction opposite to, the currents
flowing in the horizontal deflection coils.

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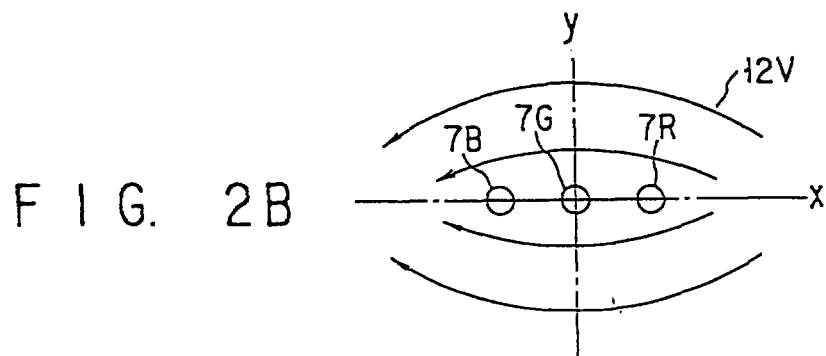
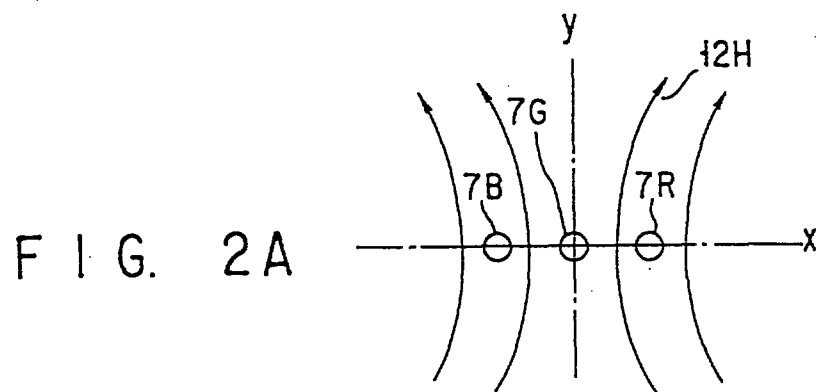
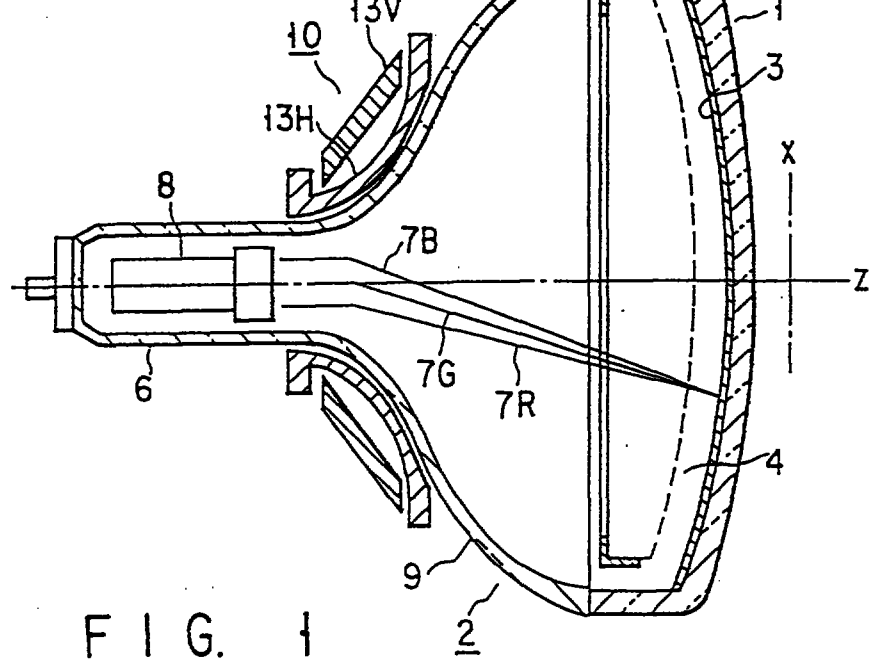


FIG. 3

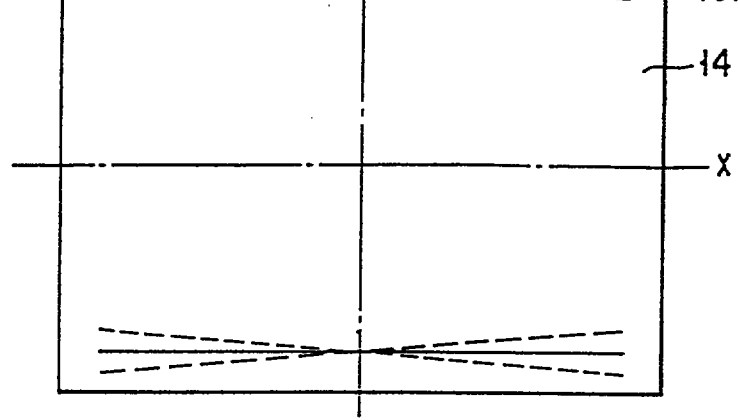


FIG. 4

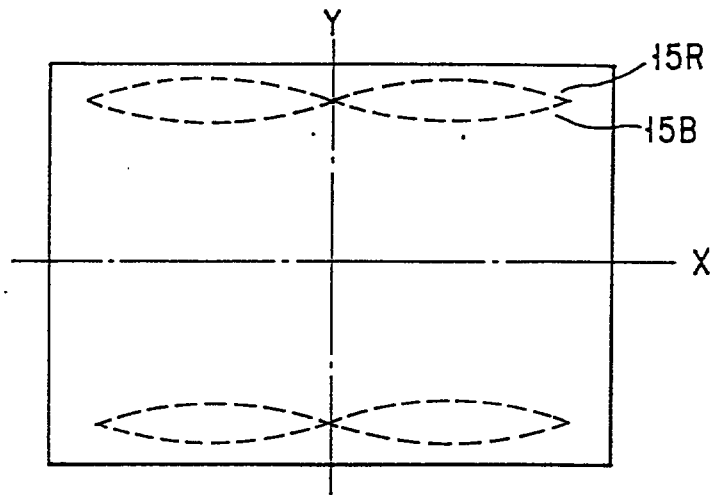
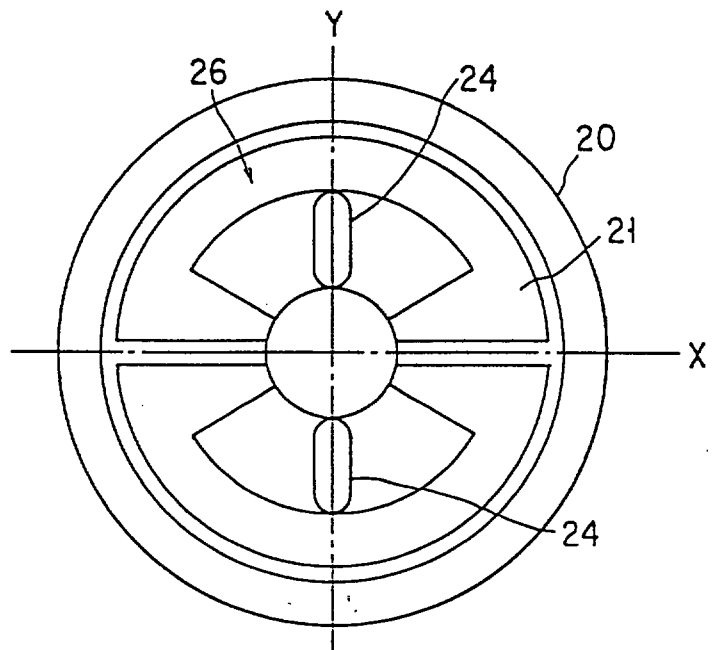
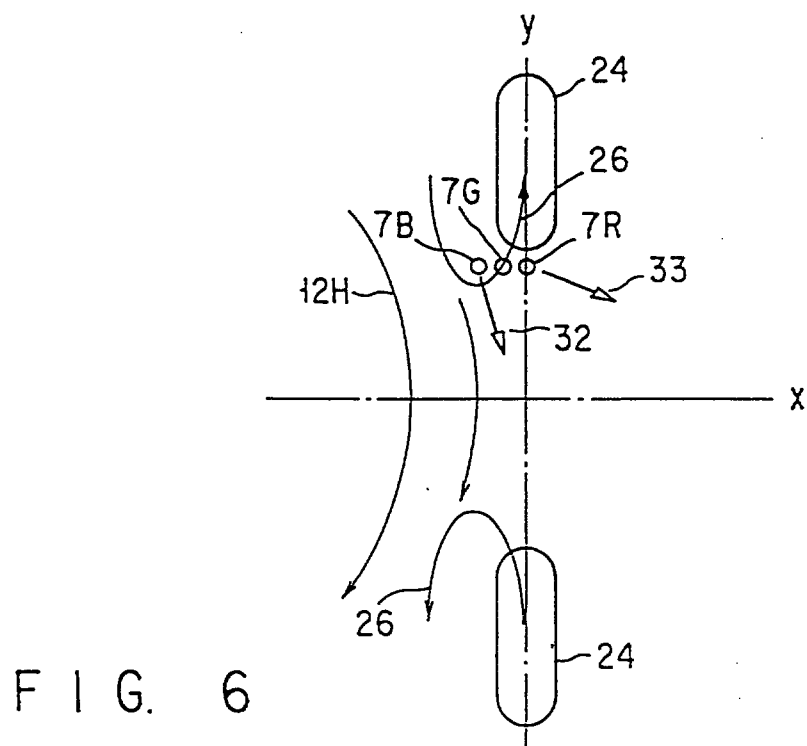
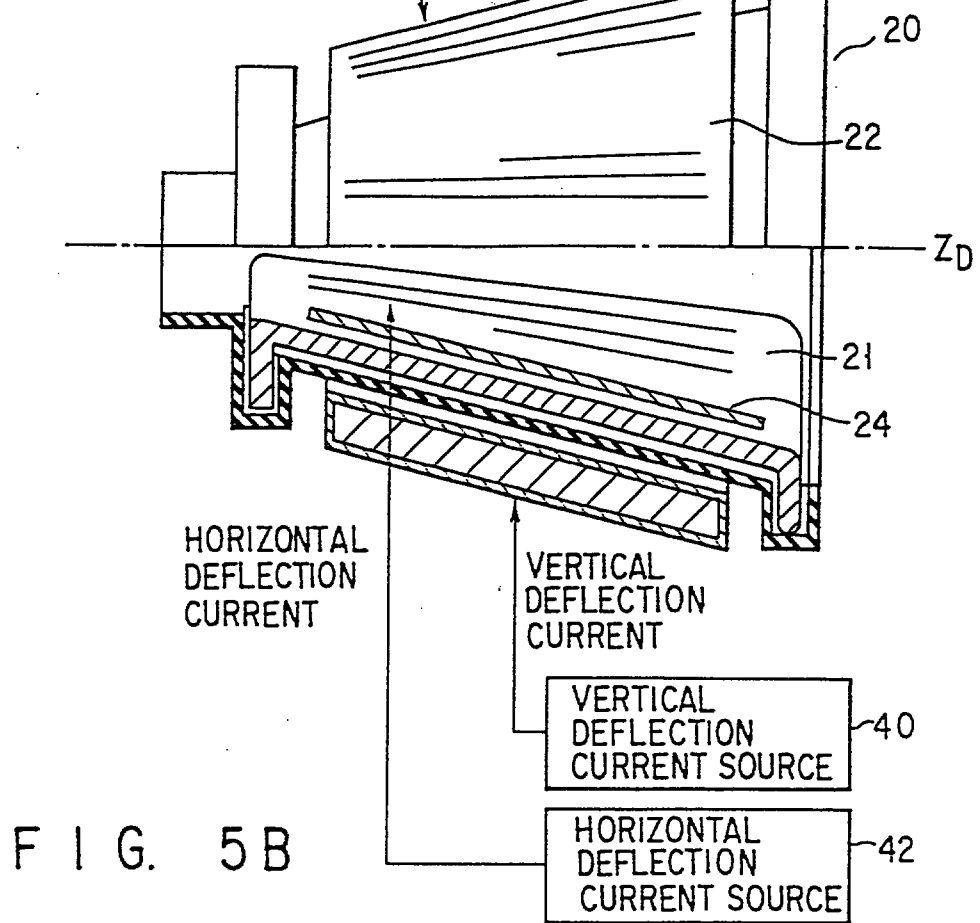


FIG. 5A





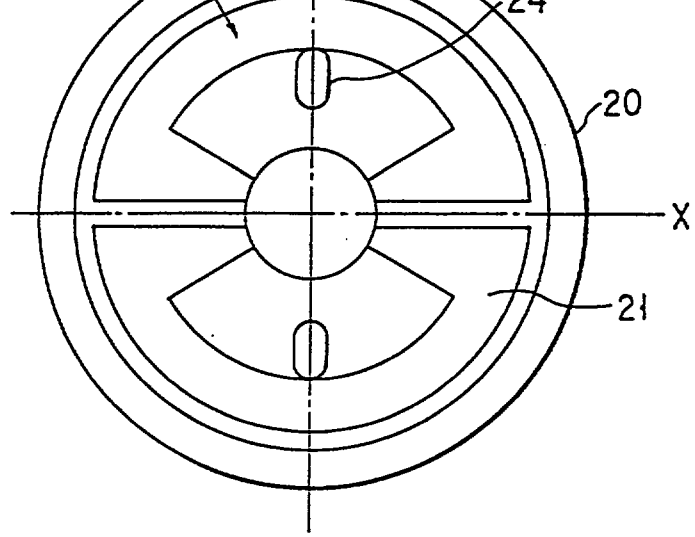


FIG. 7A

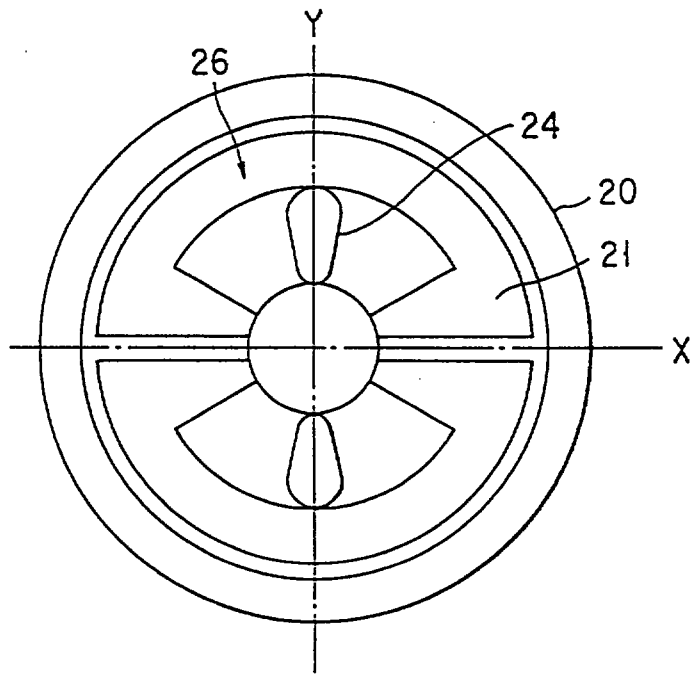


FIG. 7B

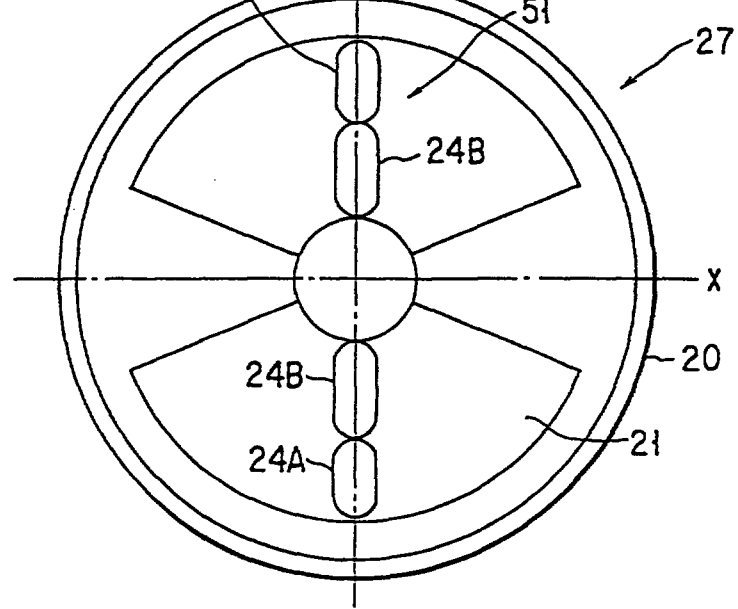


FIG. 8A

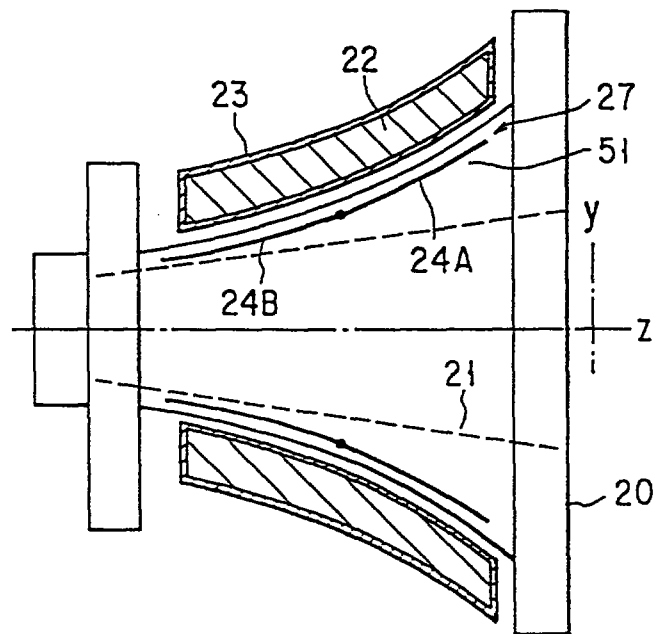


FIG. 8B

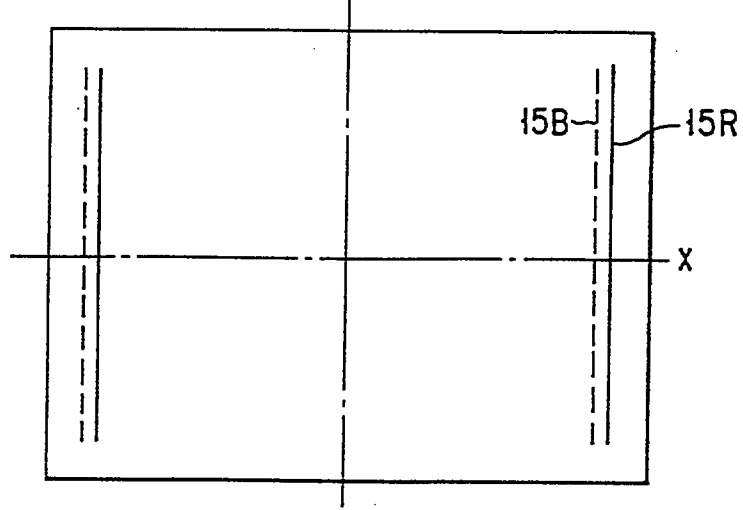


FIG. 9

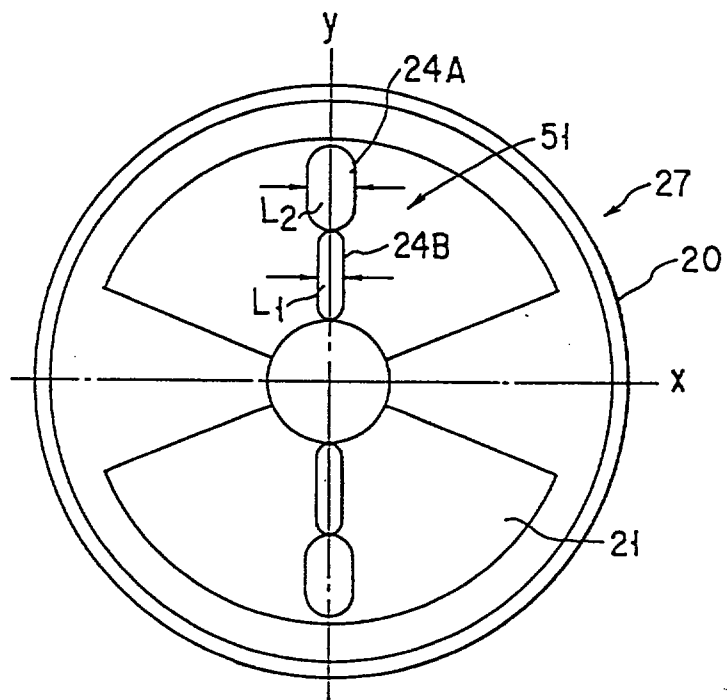


FIG. 10

D E S C R I P T I O N

"DEFLECTION DEVICE FOR USE
IN A COLOR CATHODE-RAY TUBE"Background of the Invention

1. Field of the Invention

The present invention relates to a deflection device for use in an in-line color cathode-ray tube, which is designed to deflect three electron beams passing in the same plane, and more particularly to a deflection device which has a convergence-correcting coil for eliminating mis-convergence in an in-line color cathode-ray tube of self-convergence type.

2. Description of the Related Art

Most color cathode-ray tubes have the structure shown in Fig. 1. As shown in Fig. 1, each of them comprises an envelope 2 formed of a panel 1 and a funnel 9 integral with the panel 1. It further comprises a phosphor screen 3 formed on the inner surface of the panel 1, a shadow mask 4 located in the envelope 2, an electron gun unit 8 located in the neck 6 of the envelope 2, and a deflection device 10 surrounding the adjoining portions of the neck 6 and large-diameter portion 9 of the envelope 2. The screen 3 consists of blue-light emitting phosphor stripes, green-light emitting phosphor stripes, and red-light emitting phosphor stripes. The shadow mask 4 opposes the phosphor screen 3 and has a number of apertures. The electron gun unit 8

5 fields. The electron beams 7B, 7G, and 7R emitted from
the gun unit 8 are deflected by the deflection magnetic
fields generated by the unit 10, then pass through the
apertures of the shadow mask 4, and finally applied to
the phosphor screen 3. Excited by the beams 7B, 7G, and
10 7R, the phosphor stripes of the screen 3 emit blue light
rays, green light rays, and red light rays. As a
result, the cathode-ray tube displays a color image.

The electron gun unit 8 is a so-called "in-line
type" designed to emit three electron beams, i.e., a
15 center beam 7G and two side beams 7B and 7R which pass
in the same plane. The horizontal deflection magnetic
field generated by the unit 10 is shaped like a pin-
cushion as is shown in Fig. 2A. By contrast, the ver-
tical deflection magnetic field generated from the
20 device 10 is shaped like a barrel as is illustrated in
Fig. 2B. The magnetic fluxes 12H of the pincushion-
shaped magnetic field deflects the electron beams 7B,
7G, and 7R in a horizontal plane, while the magnetic
fluxes 12V of the barrel-shaped magnetic field deflects
25 the electron beams 7B, 7G, and 7R in a vertical plane.

Self-convergence type in-line color cathode-ray
tubes, described above, are commonly used in practice.

As Fig. 1 shows, the deflection device 10 comprises
a horizontal deflection coil 13H for generating the
30 pincushion-shaped horizontal deflection magnetic field,
and a vertical deflection coil 13V for generating the
barrel-shaped vertical deflection magnetic field.
Generally, the coils 13H and 13V are a saddle type and a
toroidal type, respectively. The pincushion-shaped
35 horizontal deflection magnetic field 12H converges the
electron beams 7B, 7G, and 7R toward one another in the
horizontal plane extending in an x axis, whereas the

5 Even if the beams 7B, 7B, and 7R are so converged
by the pincushion-shaped magnetic field 12H and the
barrel-shaped magnetic field 12V, however, miscon-
vergence of the beams occurs at the corners of a display
screen 14 as shown in Fig. 3. In other words,
10 a blue-beam spot 15B, a green-beam spot 15G, and a red-
beam spot 15R are vertically displaced from one another
at the corners of the display screen 14. In most cases,
the mis-convergence can be eliminated by adjusting the
distance between the deflection center of the horizontal
15 deflection coil 13H and that of vertical deflection coil
13V.

As has been indicated, the deflection device 10
generates a horizontal deflection magnetic field 12H
shaped like a pincushion, and a vertical deflection
20 magnetic field 12V shaped like a barrel. Hence, the
three electron beams 7B, 7G, and 7R can be converged at
any position in the horizontal and vertical axes of the
display screen 14. As shown in Fig. 4, however, mis-
convergence of the beams takes place in intermediate
25 regions between the corners and the horizontal and ver-
tical axes of the screen 14. The red-beam spot 15R, for
example, is formed closer to the center of the screen 14
than the blue-beam spot 15B in the right half of the
screen 14, and is located farther from the center of the
30 screen 14 than the blue-beam spot 15B in the left half
of the screen 14. The mis-convergence of the electron
beams inevitably deteriorates the quality of the image
the cathode-ray tube displays.

The mis-convergence occurring at a position between
35 the vertical axis y of the screen 14 and the any corner
thereof may be minimized by altering the distribution of
the magnetic fluxes generated by the deflection device

5 Recently, not only the distance between the deflection centers of the deflection coils 13H and 13V is adjusted, but also a saturable reactor is used, varying, differentially at the vertical deflection frequency, the horizontal-deflection currents supplied to the upper and
10 lower coils constituting the horizontal deflection coil 13H. Mis-convergence in any corner of the screen 14 is eliminated almost completely. Mis-convergence can, therefore, be sufficiently reduced at any position in the horizontal and vertical axes of the screen 14 and at
15 any corner thereof, but not at a position between the vertical axis y of the screen 14 and the any corner thereof. That is, as shown in Fig. 4, mis-convergence remains between the axis y and each corner, such that the red-beam spot 15R is located farther to the center
20 of the screen 14 than the blue-beam spot 15B in the right half of the screen 14, and is located nearer the center of the screen 14 than the blue-beam spot 15B in the left half of the screen 14. The display screen 14, as a whole, has but poor convergence characteristic.
25

 The mis-convergence occurring between the axis y of the screen 14 and each corner thereof can be reduced by two alternative methods. The first is to alter the distribution of deflection magnetic fluxes. The second
30 is said same method used to minimize the mis-convergence at the corners of the screen 14. If either alternative method is performed, however, a prominent mis-convergence will occur at each corner of the display screen 14, inevitably degrading the convergence all over
35 the display screen 14.

 With the conventional method of eliminating or reducing mis-convergence in an in-line cathode-ray tube

The object of this invention is to provide a deflection device for use in an in-line color cathode-ray tube of self-convergence type, which can much reduce not only mis-convergence at any point in the horizontal
10 an vertical axes of the screen of the tube and at any corner of the screen but also mis-convergence at intermediate regions between the corners and the horizontal and vertical axes.

According to the invention, there is provided a
15 deflection device for use in a color cathode-ray tube having a center axis and means for emitting in-line electron beams, comprising:

horizontal deflection means for deflecting the electron beams in a horizontal direction in response to
20 horizontal deflection signals, said horizontal deflection means including a pair of horizontal deflection coils for generating a pincushion-shaped horizontal deflection magnetic field;

vertical deflection means for deflecting the
25 electron beams in a vertical direction in response to vertical deflection signals, said vertical deflection means including a pair of vertical deflection coils for generating a barrel-shaped vertical deflection magnetic field; and

30 correction means for correcting the deflection of the electron beams by applying a correction magnetic field to the electron beams in response to the horizontal deflection signals, said correction means including a pair of correction coils which are located near a ver-
35 tical axis orthogonal to said center axis and symmetrically with respect to the vertical axis and in which currents flow in synchronism with, and in

5 having a center axis and means for emitting in-line
electron beams, comprising:

 horizontal deflection means for deflecting the
electron beams in a horizontal direction in response to
horizontal deflection signals, said horizontal
10 deflection means including a pair of horizontal deflec-
tion coils for generating a pincushion-shaped horizontal
deflection magnetic field;

 vertical deflection means for deflecting the
electron beams in a vertical direction in response to
15 vertical deflection signals, said vertical deflection
means including a pair of vertical deflection coils for
generating a barrel-shaped vertical deflection magnetic
field; and

 correction means for correcting the deflection of
20 the electron beams by applying a correction magnetic
field to the electron beams in response to the horizon-
tal deflection signals, said correction means including
a first pair of correction coils which are located near
a vertical axis orthogonal to said center axis and sym-
25 metrically with respect to the vertical axis and in
which currents flow in synchronism with, and in a direc-
tion opposite to, the currents flowing in said horizon-
tal deflection coils, and a second pair of correction
coils which are located near said vertical axis and sym-
30 metrically with respect to said vertical axis and in
which currents flow in synchronism with, and in the same
opposite as, the currents flowing in said horizontal
deflection coils.

 In an another aspect of the invention, there is
35 provided a deflection device comprising: a pair of hori-
zontal deflection coils for generating a pincushion-
shaped horizontal deflection magnetic field; a pair of

5 of the device and a vertical axis extending at right angles to the axis of the device and in which currents flow in synchronism with and in an opposite direction to currents flowing in the horizontal deflection coils.

10 Located in the deflection region spaced by 10 cm or less from a plane containing the axis of the device and a vertical axis extending at right angles to the axis of the device and in which currents flow in synchronism with and in an opposite direction to currents flowing in
15 the horizontal deflection coils, the correction coils generates a magnetic field which deflects the outermost side electron beam more than the innermost side beam in a horizontal plane, the outermost side beam being positioned more apart from the tube axis than the innermost
20 side beam, when the electron beams are directed to the intermediate positions between the vertical axis of the screen and any corner thereof. The innermost side beam is more deflected than the outermost beam by the pincushion-shaped horizontal deflection magnetic field
25 generated by the horizontal deflection coils, when the electron beams are directed to the corners of the screen. Hence, the correction coils can minimize the mis-convergence between the vertical axis of the screen and each corner of the screen, without degrading the
30 convergence all over the display screen.

In yet another aspect of this invention, there is provided a deflection device for deflecting three electron beams passing in the same plane, comprising: a deflection yoke having a saddle-shaped horizontal
35 deflection coil for generating a pincushion-shaped horizontal deflection magnetic field for deflecting the three electron beams toward one another in a horizontal

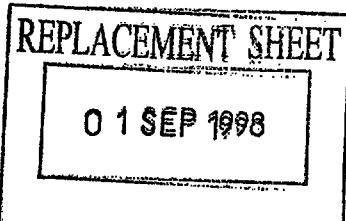
5 of the deflection yoke and in a plane containing the
central axis and vertical axis of the deflection yoke
and in which a current flows in synchronism with and in
an opposite direction to a current flowing in the hori-
zontal deflection coil; and a second coil which is
10 located in front of the deflection yoke and in a plane
containing the central axis and vertical axis of the
deflection yoke and in which a current flows in synchro-
nism with and in the same direction as a current flowing
in the horizontal deflection coil.

15 Since the first coil is located in the position
described above, and a current flows in this coil in the
direction specified above, the first coil generates a
magnetic field which reduces the vertical mis-
convergence remaining between the vertical axis of a
20 display screen and each corner thereof. Since the
second coil is located in the position described above,
and a current flows in the second coil in the direction
specified above, the second coil generates a magnetic
field which reduces the horizontal mis-convergence
25 caused by the first coil and remaining between the ver-
tical axis of a display screen and each corner thereof.
Hence, the first coil and the second coil cooperate to
effectively minimize the mis-convergence occurring at a
position between the vertical axis of a display screen
30 and each corner thereof.

4. Brief Description of the Drawings

Fig. 1 is a cross-sectional view schematically
showing a conventional color cathode-ray tube;

35 Fig. 2A is a diagram illustrating a pincushion-
shaped horizontal deflection magnetic field generated by
a deflection device for use in an in-line color cathode-
ray tube of self-convergence type;



5 Fig. 3 is a diagram explaining mis-convergence
occurring at the corners of the display screen of an in-
line cathode-ray tube of self-convergence type;

 Fig. 4 is a diagram explaining mis-convergence
remaining even after correcting the mis-convergence at
10 the corners of the display screen of the in-line
cathode-ray tube of self-convergence type;

 Fig. 5A is a front view of a deflection device
according to a first embodiment of the invention, which
is designed for use in an in-line cathode-ray tube of
15 self-convergence type;

 Fig. 5B is a partly broken-away, side view of the
deflection device shown in Fig. 5A;

 Fig. 6 is a diagram explaining how the deflection
device shown in Figs. 5A and 5B reduces mis-
20 convergence;

 Figs. 7A and 7B are front views showing modifica-
tions of the deflection device shown in Figs. 5A and
5B;

 Fig. 8A is a front view of a deflection device
25 according to a second embodiment of the invention, which
is designed for use in an in-line cathode-ray tube of
self-convergence type;

 Fig. 8B is a partly broken-away, side view of the
deflection device shown in Fig. 8A;

30 Fig. 9 is a diagram illustrating the mis-
convergence caused by the magnetic field generated by
the first coil of the deflection device shown in
Figs. 8A and 8B; and

 Fig. 10 is a front view showing a modification of
35 the deflection device shown in Figs. 8A and 8B.

5. Detailed Description of the Preferred Embodiments
 Embodiments of the present invention, each being

5 to a first embodiment of the present invention. This
deflection device comprises a separator 20 made of
synthetic resin. The separator 20 will serve as part of
the envelope of an in-line cathode-ray tube. It is
generally a tapered hollow cylinder, whose small-
10 diameter end and large-diameter ends are to be fixed to
the neck and funnel of the envelope the cathode-ray
tube, respectively.

Inside the separator 20, a pair of saddle-shaped
horizontal deflecting coils 21 are located. A tapered,
15 hollow cylindrical core 22 is mounted on the separator
20 and positioned coaxial therewith. A pair of toroidal
vertical deflection coils 23 are wound around the core
22. The horizontal deflection coils 21 and the vertical
deflection coils 23 constitute a deflection coil 27.
20 The horizontal deflection coils generate a pincushion-
shaped horizontal deflection magnetic field, whereas the
vertical deflection coils 23 generate a barrel-shaped
vertical deflection magnetic field.

The deflection device further comprises a pair of
25 correction coils 24, i.e., an upper correction coil and
a lower correction coil. Each correction coil 24 is
placed in a plane Z-Y which contains the axis ZD of the
deflection device and a vertical line extending at right
angles to the axis ZD. As is evident from Fig. 5A, the
30 halves of each turn of either correction coil 24 extend
substantially parallel to the plane Z-Y and are sym-
metrical with respect thereto.

The vertical deflection coils 23 are connected to a
vertical deflection current source 40, and the horizon-
35 tal deflection coils 21 and the correction coils 24 are
connected to a horizontal deflection current source 42.
The correction coils 24 are connected to the horizontal

5 the coils 21.

Assume that the deflection device of Figs. 5A and 5B is incorporated in an in-line cathode-ray tube, and that currents simultaneously flow in the horizontal deflection coils 21 and the correction coils 24 in the
10 directions specified above. Then, as shown in Fig. 6, the horizontal deflection coils 21 generate horizontal deflection magnetic fields 12H in a deflection region in which the three electron beams 7B, 7G, and 7R emitted from the electron gun unit of the cathode-ray tube.
15 Simultaneously, the correction coils 24 generate correction magnetic fields 26 in the same deflection region. Since either correction magnetic field is a local one, the beams 7B, 7G, and 7R are deflected in different directions which are determined by the positions they
20 take with respect to the correction field.

More precisely, when the deflecting magnetic field deflects the beams 7B, 7B, and 7R to an intermediate position between the vertical axis of the display screen of the cathode-ray tube and the upper-left corner of the
25 display screen, the correction magnetic field 26 deflects the side beam 7B more than the other side beam 7R toward the horizontal axis, as can be understood from the arrows 32 and 33 shown in Fig. 6. When the deflecting magnetic field deflects the beams 7B, 7G, and
30 7R to the the upper-left corner of the display screen, the correction magnetic field 26 deflects the side beam 7B more toward the vertical axis and the side beam 7R more toward the horizontal axis than in the case where the beams 7B, 7G, and 7R are deflected to an inter-
35 mediate position between the vertical axis of the screen and the upper-left corner thereof.

In contrast, when the deflecting magnetic field

5 they are deflected in when the three beams are deflected
to the left edge of display screen. When the deflecting
magnetic field deflects the beams 7B, 7G, and 7R to the
lower edge of the display screen, the side beams 7B and
7R are deflected in a relation same as the relation in
10 which they are deflected when the three beams are
deflected to the upper edge of display screen.

Namely, since currents flow through the correction
coils 24 at the same time as the current in the horizon-
tal deflection coils 21 and in the opposite direction
15 thereto, the vertical mis-convergence (Fig. 4) at a
position between the vertical axis and any corner of the
screen can be much reduced, without jeopardizing the
convergence at the corners of the screen. As a result,
good convergence is attained at any position on the
20 display screen.

A deflection device according to this invention was
made for operating test. In the device, two correction
coils 24 were positioned such that their two-turn win-
dings were located at the distance of 5 mm from the ver-
25 tical axis of the deflection device. The device was
incorporated into a 23-inch, 110 color cathode-ray
tube, and the cathode-ray tube was operated. Mis-
convergence of 0.5 mm was seen at each corner of the
display screen. Simultaneously, mis-convergence of
30 0.7 mm in the same direction was observed at any posi-
tion between the vertical axis and each corner of the
display screen of the cathode-ray tube. The mis-
convergence at any position between the vertical axis
and each corner is less than half the mis-convergence
35 occurring in the case where a conventional deflection
device without correction coils is employed.

The use of the correction coils 24 increases the

5 In the first embodiment, the correction coils 24
were so positioned that their windings were 5 mm away
from the vertical axis of the device. Nonetheless, the
windings may be located closer to or farther from the
vertical axis. They should not be positioned, however,
10 at a distance exceeding 10 mm from the plane containing
the vertical axis and center axis of the deflection
device. If the distance is more than 10 mm, the magne-
tic field the correction coils 24 generate can no longer
serve to reduce the mis-convergence occurring at any
15 position between the vertical axis and each corner of
the display screen.

The more turns each correction coil 24 has, the
more greatly the coil 24 serves to reduce the mis-
convergence. An increase in the number of turns,
20 however, may reduce the deflection angle of the electron
beams 7B, 7G, and 7R and may adversely influence the
characteristics of the deflection device. The mis-
convergence at a midpoint between the vertical axis and
each corner of the screen is about 1 to 2 mm in most
25 cases. It would therefore suffice to reduce the mis-
convergence by about 1 to 2 mm. In view of this, it is
required that the correction coils 24 have five or less
turns each.

Two modifications of the deflection device shown in
30 Figs. 5A and 5B will be described, with reference to
Figs. 7A and 7B.

In the device of Figs. 5A and 5B, the correction
coils 24, positioned in the plane Z-Y, are shaped such
that the halves of each turn of either coil 24 extend
35 parallel to the plane Z-Y and are symmetrical with
respect thereto as is evident from Fig. 5A. Instead, as
is shown in Fig. 7B, the correction coils 24 may be

5 Z-Y plane as it extends toward the large-diameter end of the separator 20.

In the modification of Fig. 7A, the correction coils 24 may be located in the large-diameter end portion of the separator 20.

10 As has been indicated, the deflection device of Figs. 5A and 5B, designed for use in a color cathode-ray tube, comprises a pair of horizontal deflection coils 21 for generating a pincushion-shaped horizontal deflection magnetic field and a pair of vertical deflection coils
15 23 for generating a barrel-shaped vertical deflection magnetic field. It further comprises a pair of correction coils 24, which are spaced by 10 mm or less from the plane containing the axis of the device and a vertical axis extending at right angles to the axis of the
20 device. Currents flow in these coils 24, in synchronism with and in an opposite direction to the currents flowing in the horizontal deflection coils 21, whereby the coils 24 generate a magnetic field. This magnetic field deflects the side beams (i.e., two of the three
25 electron beams emitted from the electron gun unit of the cathode-ray tube), in a specific manner. That is, when the electron beams are directed to the intermediate positions between the vertical axis and the each corners of the screen, the outermost side beam which is posi-
30 tioned more remote from the tube axis than the innermost side beam or center beam is more deflected toward the horizontal axis than the other innermost side beam. In contrary, when the electron beams are directed to the any corner of the screen, the innermost is more
35 deflected toward the horizontal axis than the outermost side beam. As a result, the mis-convergence at any position between the vertical axis and each corner of

5 Another deflection device according to the present invention will be described, with reference of Figs. 8A, 8B, and 9.

As shown in Figs. 8A and 8B, an additional coil assembly 51 is located in the plane containing the
10 vertical axis (y axis) and center axis (z axis) of a deflection yoke 27. In other words, the assembly 51 is positioned near the neck of the envelope of the cathode-ray tube in which the device is to be used. The additional coil assembly 51 comprises a pair of coils 24A
15 and another pair of coils 24B. The coils 24B of the first pair are connected to the horizontal deflection coils 21. Currents flow in the coils 24A in synchronism with, and in the opposite direction to, those currents flowing in the horizontal deflecting coils 21. The
20 coils 24A of the second pair are located adjacent to the coils 24B, at the front of the deflection yoke 27 (that is, within the large-diameter end of the funnel of the envelope). Currents flow in these coil 24A in synchronism with, and in the same direction as, the
25 currents flowing in the horizontal deflecting coils 21.

The coils 24A and the coils 24B are connected together, in end-to-end fashion, forming a coil unit. Each pair of coils of the assembly 51 is formed by
30 winding an insulated wire, forming an annular coil having about five turns, by flattening the annular coil into an elongated one, and by twisting the elongated coil 180° at the middle portion thereof.

Referring back to Fig. 6, the horizontal deflection coils 21 generate horizontal deflection magnetic
35 fields 12H in a deflection region in which the three electron beams 7B, 7G, and 7R emitted from the electron

5 Therefore, the beams 7B, 7G, and 7R are deflected in different directions which are determined by the positions they take with respect to the magnetic field generated by the coil 24B.

10 When the beams 7B, 7G, and 7R are deflected in the deflection region (Fig. 6) by the vertical deflection magnetic field 12V and the horizontal deflection magnetic field 12H and are applied toward a position between the vertical axis of the screen of the cathode-ray tube and any corner of the screen, the magnetic field 26
15 generated by each coil 24B deflects the side electron beam 7B more toward the horizontal axis (x axis) of the screen as indicated by an arrow 32 than the other side beam 7R is deflected toward the horizontal axis of the screen as indicated by an arrow 33. On the other hand,
20 when the beams 7B, 7G, and 7R are deflected in the deflection region (Fig. 6) by the vertical and horizontal deflection magnetic fields 12V and 12H and are applied toward any corner of the display screen, the magnetic field 26 generated by each coil 24B deflects
25 the side electron beam 7B more away from, and the other side beam 7R more toward, the horizontal axis (x axis) of the screen than in the case where the beams 7B, 7G, and 7R are deflected toward a position between the vertical axis of the screen and any corner of
30 thereof.

When the electron beams 7B, 7G, and 7R are deflected toward an upper-right position on the display screen by the vertical and horizontal deflection magnetic fields 12V and 12H, the magnetic field 26 generated
35 by each coil 24B deflects the side electron beams 7B and 7R in a relation reverse to that relation which the beams 7B and 7R have when the beams 7B, 7G, and 7R are

5 magnetic field 26 generated by each coil 24B deflects
the side electron beams 7B and 7R in the same way as in
the case where the beams 7B, 7G, and 7R are deflected
toward an upper-left position on the screen or toward
the upper-right position of the screen. Hence, the
10 vertical mis-convergence at a position between the ver-
tical axis of the screen and any corner thereof can be
reduced, without jeopardizing the convergence at the
corner of the display screen.

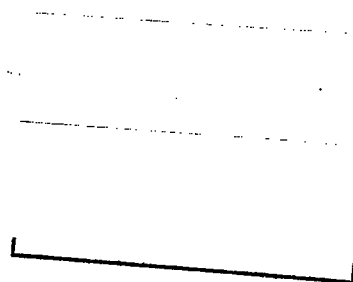
When the coils 24B are energized, however, a
15 current flowing in the opposite direction to the hori-
zontal deflection currents flowing in the coils 24B
reduce the intensity of the pincushion-shaped horizontal
deflection magnetic field 12H. Consequently, horizontal
mis-convergence of the side beams 7B and 7R occurs as is
20 indicated by the side-beam patterns 15B and 15R shown in
Fig. 9. Nonetheless, this horizontal mis-convergence of
the side beams is minimized since the currents, which
flow in the coils 24A of the second pair in the same
direction as the currents flowing in the horizontal
25 deflection coils 21, intensify the pincushion-shaped
horizontal deflection magnetic field 12H at the region
near the front end of the deflection yoke 26.

In the deflection device of Figs. 8A and 8B, the
coils 24A and the coils 24B form an integral unit, i.e.,
30 the additional coil assembly 51. The assembly 51 is
relatively simple in structure and can yet minimize the
vertical mis-convergence at a position between the ver-
tical axis of the screen and any corner thereof.

As described above, the coils 24A and the coils
35 24B, which constitute the additional coil assembly 51,
are positioned in the plane containing the center and
vertical axes of the deflection yoke 26. It is

5 the coils 24B of the first pair and the coils 24A of the
second pair are of the same shape and the same size.
Instead, as is shown in Fig. 10, the coils 24A may have
a width L_2 , and the coils 24B may have a width L_1 ,
each measured in the horizontal direction, where
10 $L_1 < L_2$. In this case, it is possible to adjust the
ratio of improvement of the vertical mis-convergence,
occurring at an intermediate position between the ver-
tical axis of the screen and any corner thereof to the
horizontal mis-convergence.

As has been indicated, in the embodiment of
15 Figs. 8A and 8B, the coils 24B, in which currents flow
in synchronism with and in the opposite direction to
those currents flowing in the horizontal deflecting
coils 21, are located in the plane containing the center
and vertical axes of the screen and at the rear of the
20 deflection yoke 26; and the coils 24A, in which currents
flow in synchronism with and in the same direction as
the currents flowing in the horizontal deflecting coils
21, are located in that plane and at the front of the
deflection yoke 17. The coils 24B generate a magnetic
25 field which reduces the vertical mis-convergence of the
side beam occurring at a position between the vertical
axis of the screen and any corner thereof. The coils
24A generate a magnetic field which minimizes the
horizontal mis-convergence caused by the magnetic field
30 generated by the coils 24B. As a result, sufficient
convergence of the three beams 7B, 7G, and 7R can be
maintained at any position on the display screen of the
cathode-ray tube.



(1) having an envelope (2), a center axis (Z_D), a vertical axis (Y) orthogonal to the center axis (Z_D), a horizontal axis (X) orthogonal to the center axis (Z_D) and orthogonal to the vertical axis (Y), and means (8) for emitting in-line electron beams ($7_R, 7_G, 7_B$), the deflection device comprising:

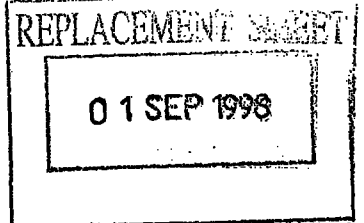
horizontal deflection means for deflecting the electron beams ($7_R, 7_G, 7_B$) in a horizontal direction in response to a horizontal deflection signal, the horizontal deflection means including a pair of saddle shaped horizontal deflection coils (21) for generating a pincushion-shaped horizontal deflection magnetic field (12H);

vertical deflection means for deflecting the electron beams ($7_R, 7_G, 7_B$) in a vertical direction in response to a vertical deflection signal, the vertical deflection means including a pair of vertical deflection coils (23) for generating a barrel-shaped vertical deflection magnetic field (12V); and

correction means (24, 24A, 24B) for correcting the deflection of the electron beams ($7_R, 7_G, 7_B$) by applying a correction magnetic field (26) to the electron beams in response to the horizontal deflection signal, said correction means (24, 24A, 24B) including a pair of first correction coils (24, 24B) arranged in symmetry with respect to a plane containing the center axis (Z_D) and the horizontal axis (X), wherein each of said first correction coils (24, 24B) is located in symmetry with respect to a plane containing the center axis (Z_D) and the vertical axis (Y);

characterized in that

each of said first correction coils (24, 24B) is located in a space defined between the corresponding saddle shaped

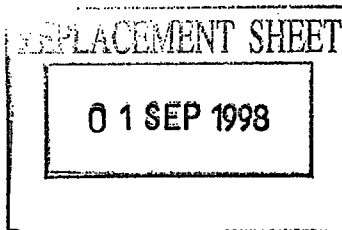


the current flowing in the horizontal deflection coils (21) such that a magnetic field is generated for minimizing a misconvergence of the electron beams at an intermediate position between the corners and the vertical axis of a screen.

2. The deflection device according to claim 1, characterized in that said correction means includes a pair of second correction coils (24A) which are located in a space defined between the corresponding saddle shaped horizontal deflection coil (21) and the envelope (2) and in symmetry with respect to the plane containing the center axis (Z_D) and the vertical axis (Y), wherein currents flow through the pair of second correction coils (24A) in synchronism with, and in the same direction as, the current flowing in the horizontal deflection coils (21).

3. The deflection device according to claim 2, characterized in that said first correction coils (24B) are arranged between said second correction coils (24A) and said means (8) for emitting in-line electron beams.

4. The deflection device according to claim 1, 2 or 3, characterized in that the windings of the first and second correction coils (24, 24A, 24B) extending in symmetry with respect to the plane containing the center axis (Z_D) and the vertical axis (y) orthogonal to the center axis (Z_D) are positioned within a distance of 10mm from that plane.



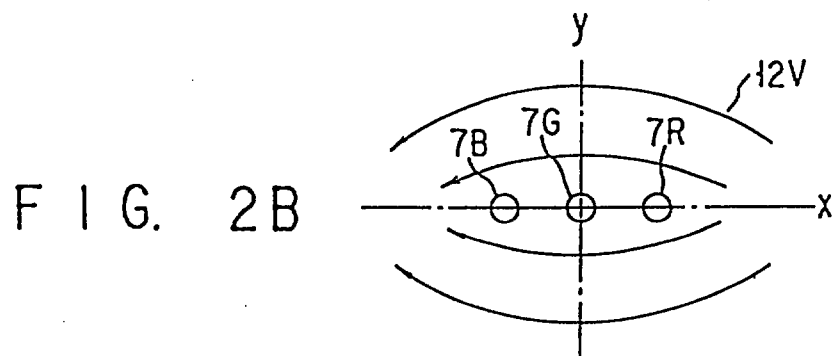
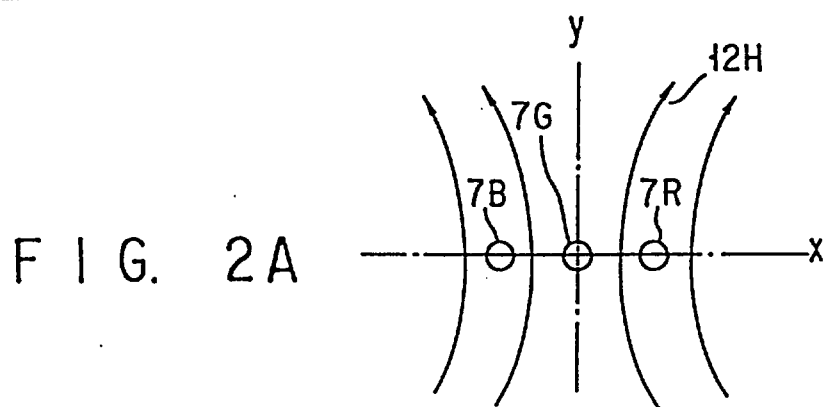
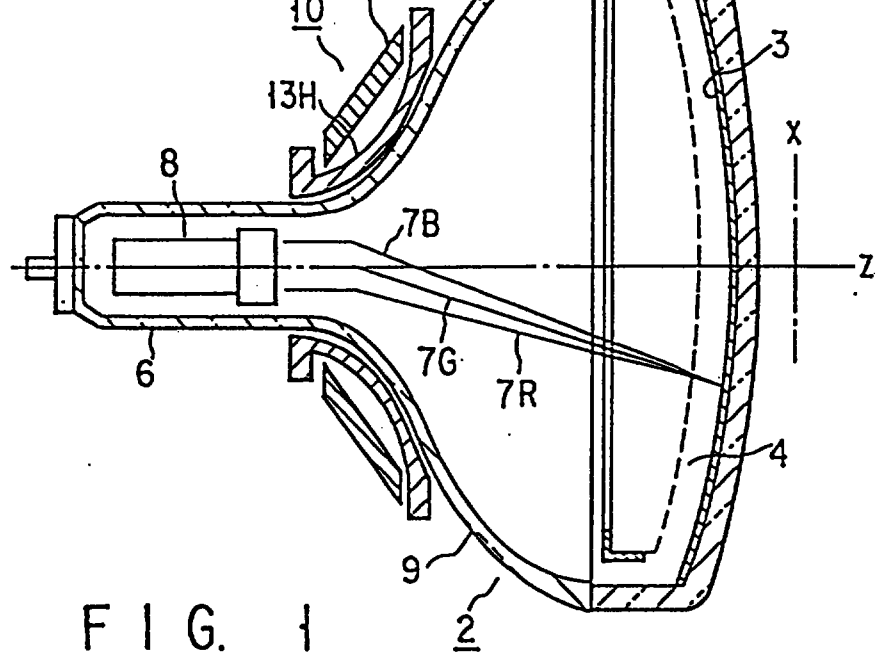


FIG. 3

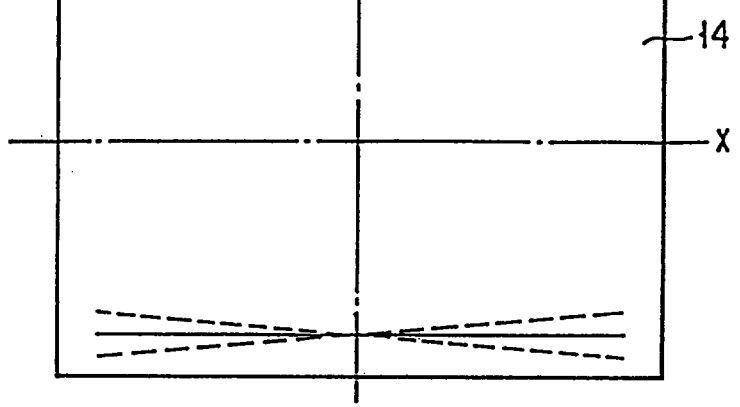


FIG. 4

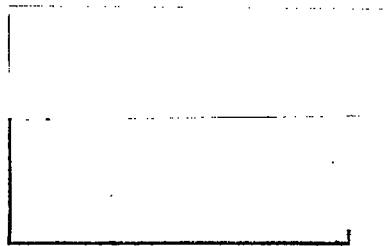
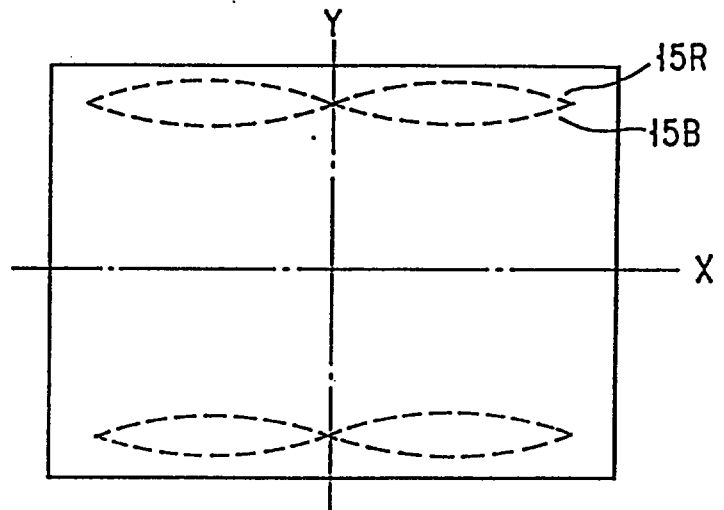
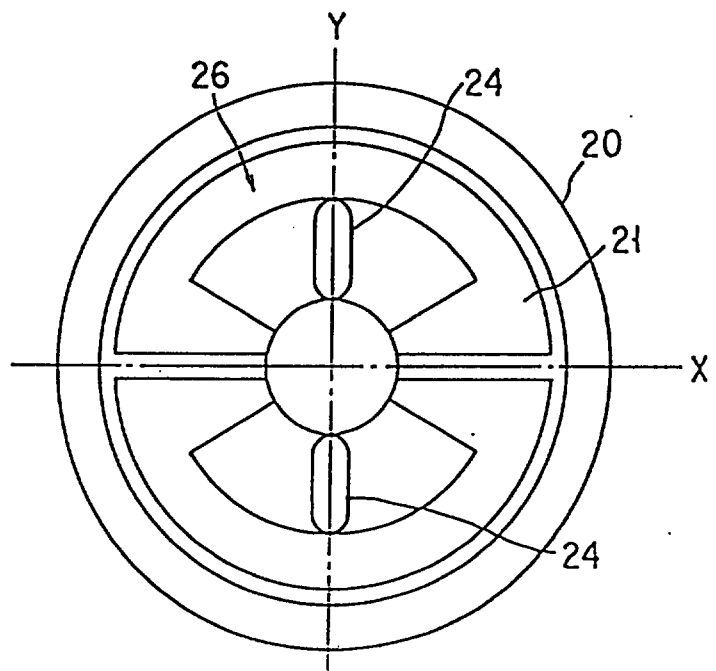
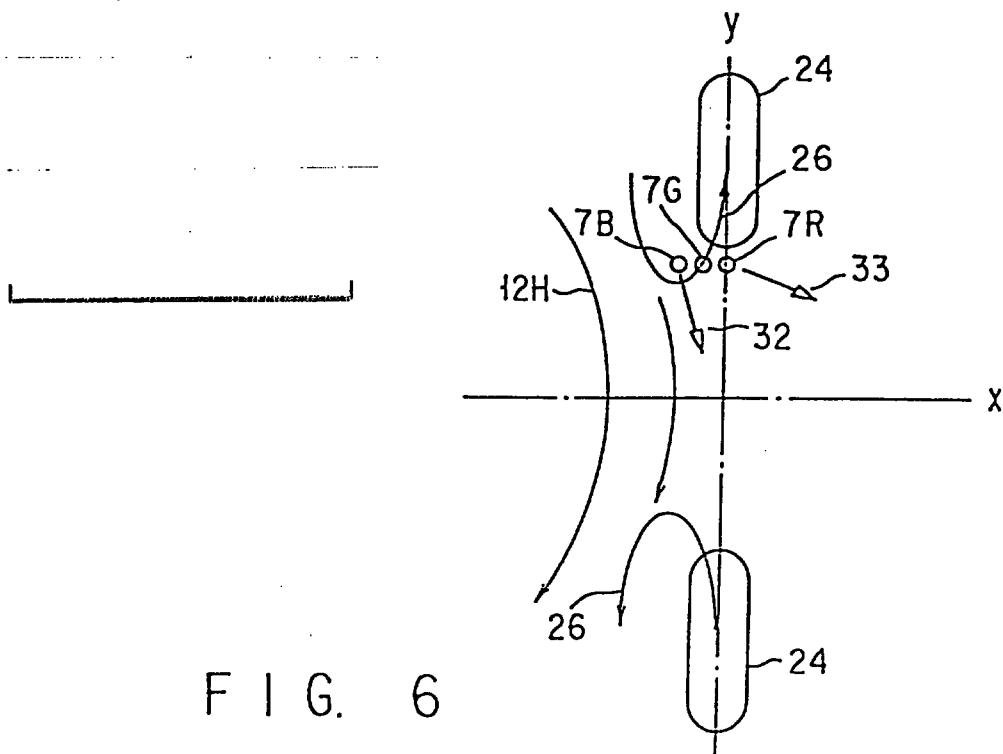
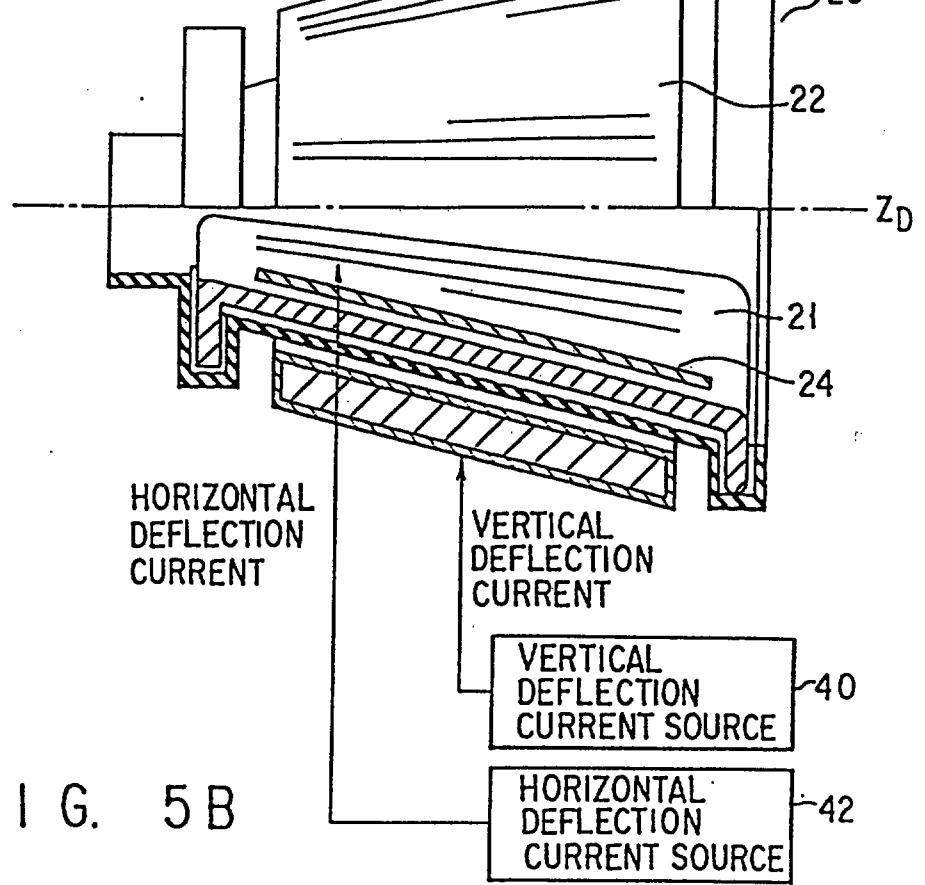


FIG. 5A





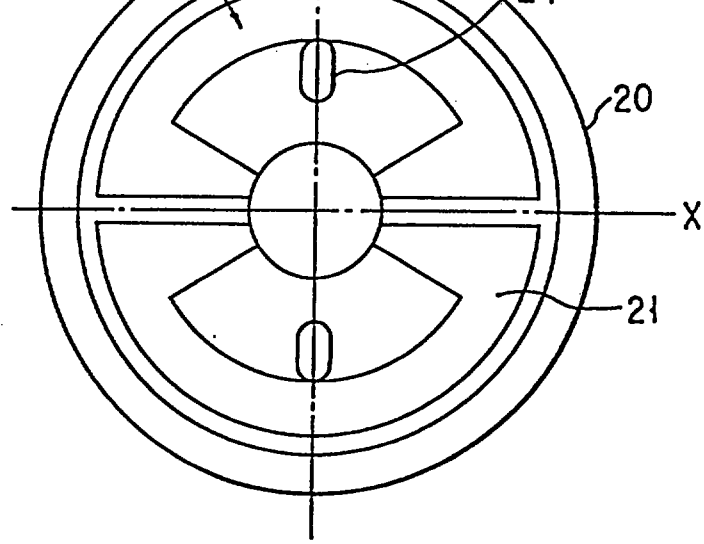


FIG. 7A

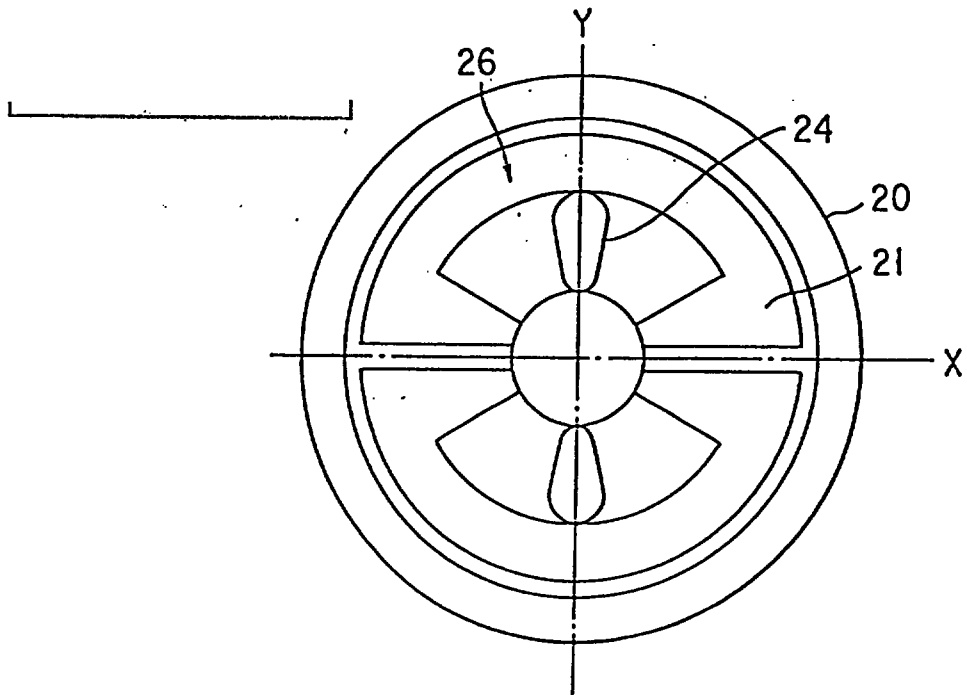


FIG. 7B

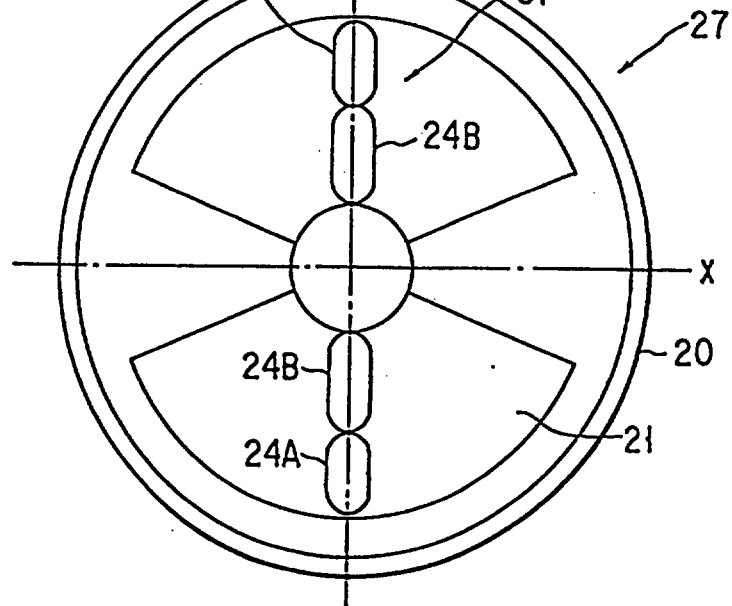


FIG. 8A

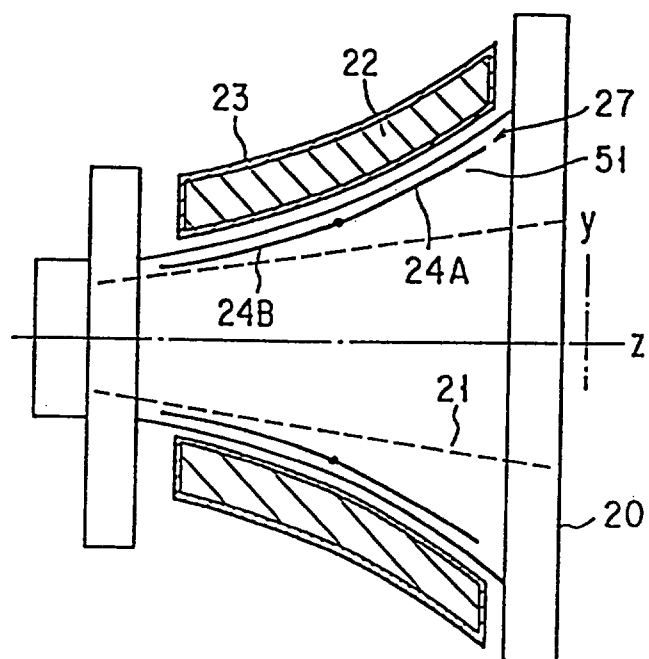
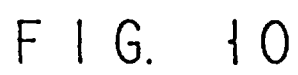


FIG. 8B



1. A deflection device for use in a color cathode ray tube (1) having an envelope (2), a center axis (Z_D), a vertical axis (Y) orthogonal to the center axis (Z_D), a horizontal axis (X) orthogonal to the center axis (Z_D) and orthogonal to the vertical axis (Y), and means (8) for emitting in-line electron beams ($7_R, 7_G, 7_B$), the deflection device comprising:

horizontal deflection means for deflecting the electron beams ($7_R, 7_G, 7_B$) in a horizontal direction in response to a horizontal deflection signal, the horizontal deflection means including a pair of saddle shaped horizontal deflection coils (21) for generating a pincushion-shaped horizontal deflection magnetic field (12H);

vertical deflection means for deflecting the electron beams ($7_R, 7_G, 7_B$) in a vertical direction in response to a vertical deflection signal, the vertical deflection means including a pair of vertical deflection coils (23) for generating a barrel-shaped vertical deflection magnetic field (12V); and

correction means (24, 24A, 24B, 51) for correcting the deflection of the electron beams ($7_R, 7_G, 7_B$) by applying a correction magnetic field (26) to the electron beams in response to the horizontal deflection signal, said correction means (24, 24A, 24B, 51) including a pair of first correction coils (24, 24B) arranged in symmetry with respect to a plane containing the center axis (Z_D) and the horizontal axis (X), wherein each of said first correction coils (24, 24B) is located in symmetry with respect to a plane containing the center axis (Z_D) and the vertical axis (Y), and each of said first correction coils (24, 24B) is located in a space defined between the corresponding saddle shaped horizontal deflection coil (21) and the envelope (2);

the current flowing in the horizontal deflection coils (21);

5 and

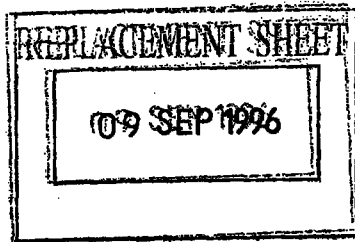
said correction means includes a pair of second correction coils (24A) which are located in a space defined between the corresponding saddle shaped horizontal deflection coil (21) and the envelope (2) and in symmetry with respect to the plane containing the center axis (Z_D) and the vertical axis (Y), wherein currents flow through the pair of second correction coils (24A) in synchronism with and in the same direction as the current flowing in the horizontal deflection coils (21).

2. The deflection device according to claim 1, characterized in that said first correction coils (24B) are arranged between said second correction coils (24A) and said means (8) for emitting in-line electron beams.

3. The deflection device according to claim 1 or 2, characterized in that the windings of the first and second correction coils (24, 24A, 24B) extending in symmetry with respect to the plane containing the center axis (Z_D) and the vertical axis (y) orthogonal to the center axis (Z_D) are positioned within a distance of 10mm from that plane.

REPLACEMENT SHEET

11 SEP 1998



- 1 -

DESCRIPTION

"DEFLECTION DEVICE FOR USE IN A COLOR CATHODE-RAY TUBE"

Background of the Invention

1. Field of the Invention

The present invention relates to a deflection device for use in an in-line color cathode-ray tube, which is designed to deflect three electron beams passing in the same plane, and more particularly to a deflection device which has a convergence-correcting coil for eliminating mis-convergence in an in-line color cathode-ray tube of self-convergence type.

2. Description of the Related Art

Most color cathode-ray tubes have the structure shown in Fig. 1. As shown in Fig. 1, each of them comprises an envelope 2 formed of a panel 1 and a funnel 9 integral with the panel 1. It further comprises a phosphor screen 3 formed on the inner surface of the panel 1, a shadow mask 4 located in the envelope 2, an electron gun unit 8 located in the neck 6 of the envelope 2, and a deflection device 10 surrounding the adjoining portions of the neck 6 and large-diameter portion 9 of the envelope 2. The screen 3 consists of blue-light emitting phosphor stripes, green-light emitting phosphor stripes, and red-light emitting phosphor stripes. The shadow mask 4 opposes the phosphor screen 3 and has a number of apertures. The electron gun unit 8

generate horizontal and vertical deflection magnetic fields. The electron beams 7B, 7G, and 7R emitted from the gun unit 8 are deflected by the deflection magnetic fields generated by the unit 10, then pass through the apertures of the shadow mask 4, and finally applied to the phosphor screen 3. Excited by the beams 7B, 7G, and 7R, the phosphor stripes of the screen 3 emit blue light rays, green light rays, and red light rays. As a result, the cathode-ray tube displays a color image.

The electron gun unit 8 is a so-called "in-line type" designed to emit three electron beams, i.e., a center beam 7G and two side beams 7B and 7R which pass in the same plane. The horizontal deflection magnetic field generated by the unit 10 is shaped like a pincushion as is shown in Fig. 2A. By contrast, the vertical deflection magnetic field generated from the device 10 is shaped like a barrel as is illustrated in Fig. 2B. The magnetic fluxes 12H of the pincushion-shaped magnetic field deflects the electron beams 7B, 7G, and 7R in a horizontal plane, while the magnetic fluxes 12V of the barrel-shaped magnetic field deflects the electron beams 7B, 7G, and 7R in a vertical plane.

Self-convergence type in-line color cathode-ray tubes, described above, are commonly used in practice.

As Fig. 1 shows, the deflection device 10 comprises a horizontal deflection coil 13H for generating the pincushion-shaped horizontal deflection magnetic field, and a vertical deflection coil 13V for generating the barrel-shaped vertical deflection magnetic field. Generally, the coils 13H and 13V are a saddle type and a toroidal type, respectively. The pincushion-shaped horizontal deflection magnetic field 12H converges the electron beams 7B, 7B, and 7R toward one another in the horizontal plane extending in an x axis, whereas the

axis.

5 Even if the beams 7B, 7G, and 7R are so converged
by the pincushion-shaped magnetic field 12H and the
barrel-shaped magnetic field 12V, however, miscon-
vergence of the beams occurs at the corners of a display
screen 14 as shown in Fig. 3. In other words,
10 a blue-beam spot 15B, a green-beam spot 15G, and a red-
beam spot 15R are vertically displaced from one another
at the corners of the display screen 14. In most cases,
the mis-convergence can be eliminated by adjusting the
distance between the deflection center of the horizontal
15 deflection coil 13H and that of vertical deflection coil
13V.

As has been indicated, the deflection device 10
generates a horizontal deflection magnetic field 12H
shaped like a pincushion, and a vertical deflection
20 magnetic field 12V shaped like a barrel. Hence, the
three electron beams 7B, 7G, and 7R can be converged at
any position in the horizontal and vertical axes of the
display screen 14. As shown in Fig. 4, however, mis-
convergence of the beams takes place in intermediate
25 regions between the corners and the horizontal and ver-
tical axes of the screen 14. The red-beam spot 15R, for
example, is formed closer to the center of the screen 14
than the blue-beam spot 15B in the right half of the
screen 14, and is located farther from the center of the
30 screen 14 than the blue-beam spot 15B in the left half
of the screen 14. The mis-convergence of the electron
beams inevitably deteriorates the quality of the image
the cathode-ray tube displays.

The mis-convergence occurring at a position between
35 the vertical axis y of the screen 14 and the any corner
thereof may be minimized by altering the distribution of
the magnetic fluxes generated by the deflection device

image displayed.

5 Recently, not only the distance between the deflection centers of the deflection coils 13H and 13V is adjusted, but also a saturable reactor is used, varying, differentially at the vertical deflection frequency, the horizontal-deflection currents supplied to the upper and
10 lower coils constituting the horizontal deflection coil 13H. Mis-convergence in any corner of the screen 14 is eliminated almost completely. Mis-convergence can, therefore, be sufficiently reduced at any position in the horizontal and vertical axes of the screen 14 and at
15 any corner thereof, but not at a position between the vertical axis y of the screen 14 and the any corner thereof. That is, as shown in Fig. 4, mis-convergence remains between the axis y and each corner, such that the red-beam spot 15R is located farther to the center
20 of the screen 14 than the blue-beam spot 15B in the right half of the screen 14, and is located nearer the center of the screen 14 than the blue-beam spot 15B in the left half of the screen 14. The display screen 14, as a whole, has but poor convergence characteristic.
25

 The mis-convergence occurring between the axis y of the screen 14 and each corner thereof can be reduced by two alternative methods. The first is to alter the distribution of deflection magnetic fluxes. The second
30 is said same method used to minimize the mis-convergence at the corners of the screen 14. If either alternative method is performed, however, a prominent mis-convergence will occur at each corner of the display screen 14, inevitably degrading the convergence all over
35 the display screen 14.

 With the conventional method of eliminating or reducing mis-convergence in an in-line cathode-ray tube

vergence all over the display screen 14.

5 3. Summary of the Invention

 The object of this invention is to provide a deflection device for use in an in-line color cathode-ray tube of self-convergence type, which can much reduce not only mis-convergence at any point in the horizontal
10 an vertical axes of the screen of the tube and at any corner of the screen but also mis-convergence at intermediate regions between the corners and the horizontal and vertical axes.

 According to the invention, there is provided a
15 deflection device for use in a color cathode-ray tube having a center axis and means for emitting in-line electron beams, comprising:

 horizontal deflection means for deflecting the electron beams in a horizontal direction in response to
20 horizontal deflection signals, said horizontal deflection means including a pair of horizontal deflection coils for generating a pincushion-shaped horizontal deflection magnetic field;

 vertical deflection means for deflecting the
25 electron beams in a vertical direction in response to vertical deflection signals, said vertical deflection means including a pair of vertical deflection coils for generating a barrel-shaped vertical deflection magnetic field; and

30 correction means for correcting the deflection of the electron beams by applying a correction magnetic field to the electron beams in response to the horizontal deflection signals, said correction means including
35 a pair of correction coils which are located near a vertical axis orthogonal to said center axis and symmetrically with respect to the vertical axis and in which currents flow in synchronism with, and in

a deflection device for use in a color cathode-ray tube
5 having a center axis and means for emitting in-line
electron beams, comprising:
horizontal deflection means for deflecting the
electron beams in a horizontal direction in response to
horizontal deflection signals, said horizontal
10 deflection means including a pair of horizontal deflec-
tion coils for generating a pincushion-shaped horizontal
deflection magnetic field;
vertical deflection means for deflecting the
electron beams in a vertical direction in response to
15 vertical deflection signals, said vertical deflection
means including a pair of vertical deflection coils for
generating a barrel-shaped vertical deflection magnetic
field; and
correction means for correcting the deflection of
20 the electron beams by applying a correction magnetic
field to the electron beams in response to the horizon-
tal deflection signals, said correction means including
a first pair of correction coils which are located near
a vertical axis orthogonal to said center axis and sym-
25 metrically with respect to the vertical axis and in
which currents flow in synchronism with, and in a direc-
tion opposite to, the currents flowing in said horizon-
tal deflection coils, and a second pair of correction
coils which are located near said vertical axis and sym-
30 metrically with respect to said vertical axis and in
which currents flow in synchronism with, and in the same
opposite as, the currents flowing in said horizontal
deflection coils.

In an another aspect of the invention, there is
35 provided a deflection device comprising: a pair of hori-
zontal deflection coils for generating a pincushion-
shaped horizontal deflection magnetic field; a pair of

5 spaced by 10 cm or less from a plane containing the axis
of the device and a vertical axis extending at right
angles to the axis of the device and in which currents
flow in synchronism with and in an opposite direction
to currents flowing in the horizontal deflection
coils.

10 Located in the deflection region spaced by 10 cm or
less from a plane containing the axis of the device and
a vertical axis extending at right angles to the axis of
the device and in which currents flow in synchronism
with and in an opposite direction to currents flowing in
15 the horizontal deflection coils, the correction coils
generates a magnetic field which deflects the outermost
side electron beam more than the innermost side beam in
a horizontal plane, the outermost side beam being posi-
tioned more apart from the tube axis than the innermost
20 side beam, when the electron beams are directed to the
intermediate positions between the vertical axis of the
screen and any corner thereof. The innermost side beam
is more deflected than the outermost beam by the
pincushion-shaped horizontal deflection magnetic field
25 generated by the horizontal deflection coils, when the
electron beams are directed to the corners of the
screen. Hence, the correction coils can minimize the
mis-convergence between the vertical axis of the screen
and each corner of the screen, without degrading the
30 convergence all over the display screen.

In yet another aspect of this invention, there is
provided a deflection device for deflecting three
electron beams passing in the same plane, comprising: a
deflection yoke having a saddle-shaped horizontal
35 deflection coil for generating a pincushion-shaped hori-
zontal deflection magnetic field for deflecting the
three electron beams toward one another in a horizontal

5 tical plane; a first coil which is located at the rear
of the deflection yoke and in a plane containing the
central axis and vertical axis of the deflection yoke
and in which a current flows in synchronism with and in
an opposite direction to a current flowing in the hori-
zontal deflection coil; and a second coil which is
10 located in front of the deflection yoke and in a plane
containing the central axis and vertical axis of the
deflection yoke and in which a current flows in synchro-
nism with and in the same direction as a current flowing
in the horizontal deflection coil.

15 Since the first coil is located in the position
described above, and a current flows in this coil in the
direction specified above, the first coil generates a
magnetic field which reduces the vertical mis-
convergence remaining between the vertical axis of a
20 display screen and each corner thereof. Since the
second coil is located in the position described above,
and a current flows in the second coil in the direction
specified above, the second coil generates a magnetic
field which reduces the horizontal mis-convergence
25 caused by the first coil and remaining between the ver-
tical axis of a display screen and each corner thereof.
Hence, the first coil and the second coil cooperate to
effectively minimize the mis-convergence occurring at a
position between the vertical axis of a display screen
30 and each corner thereof.

4. Brief Description of the Drawings

Fig. 1 is a cross-sectional view schematically
showing a conventional color cathode-ray tube;

35 Fig. 2A is a diagram illustrating a pincushion-
shaped horizontal deflection magnetic field generated by
a deflection device for use in an in-line color cathode-
ray tube of self-convergence type;

tube of self-convergence type;

5

Fig. 3 is a diagram explaining mis-convergence occurring at the corners of the display screen of an in-line cathode-ray tube of self-convergence type;

10

Fig. 4 is a diagram explaining mis-convergence remaining even after correcting the mis-convergence at the corners of the display screen of the in-line cathode-ray tube of self-convergence type;

15

Fig. 5A is a front view of a deflection device according to a first embodiment of the invention, which is designed for use in an in-line cathode-ray tube of self-convergence type;

Fig. 5B is a partly broken-away, side view of the deflection device shown in Fig. 5A;

20

Fig. 6 is a diagram explaining how the deflection device shown in Figs. 5A and 5B reduces mis-convergence;

Figs. 7A and 7B are front views showing modifications of the deflection device shown in Figs. 5A and 5B;

25

Fig. 8A is a front view of a deflection device according to a second embodiment of the invention, which is designed for use in an in-line cathode-ray tube of self-convergence type;

30

Fig. 8B is a partly broken-away, side view of the deflection device shown in Fig. 8A;

Fig. 9 is a diagram illustrating the mis-convergence caused by the magnetic field generated by the first coil of the deflection device shown in Figs. 8A and 8B; and

35

Fig. 10 is a front view showing a modification of the deflection device shown in Figs. 8A and 8B.

5. Detailed Description of the Preferred Embodiments
Embodiments of the present invention, each being

5 to a first embodiment of the present invention. This
deflection device comprises a separator 20 made of
synthetic resin. The separator 20 will serve as part of
the envelope of an in-line cathode-ray tube. It is
generally a tapered hollow cylinder, whose small-
10 diameter end and large-diameter ends are to be fixed to
the neck and funnel of the envelope the cathode-ray
tube, respectively.

Inside the separator 20, a pair of saddle-shaped
horizontal deflecting coils 21 are located. A tapered,
15 hollow cylindrical core 22 is mounted on the separator
20 and positioned coaxial therewith. A pair of toroidal
vertical deflection coils 23 are wound around the core
22. The horizontal deflection coils 21 and the vertical
deflection coils 23 constitute a deflection coil 27.
20 The horizontal deflection coils generate a pincushion-
shaped horizontal deflection magnetic field, whereas the
vertical deflection coils 23 generate a barrel-shaped
vertical deflection magnetic field.

The deflection device further comprises a pair of
25 correction coils 24, i.e., an upper correction coil and
a lower correction coil. Each correction coil 24 is
placed in a plane Z-Y which contains the axis ZD of the
deflection device and a vertical line extending at right
angles to the axis ZD. As is evident from Fig. 5A, the
30 halves of each turn of either correction coil 24 extend
substantially parallel to the plane Z-Y and are sym-
metrical with respect thereto.

The vertical deflection coils 23 are connected to a
vertical deflection current source 40, and the horizon-
35 tal deflection coils 21 and the correction coils 24 are
connected to a horizontal deflection current source 42.
The correction coils 24 are connected to the horizontal

5 opposite to the direction in which the current flows in the coils 21.

Assume that the deflection device of Figs. 5A and 5B is incorporated in an in-line cathode-ray tube, and that currents simultaneously flow in the horizontal deflection coils 21 and the correction coils 24 in the directions specified above. Then, as shown in Fig. 6, the horizontal deflection coils 21 generate horizontal deflection magnetic fields 12H in a deflection region in which the three electron beams 7B, 7G, and 7R emitted from the electron gun unit of the cathode-ray tube. Simultaneously, the correction coils 24 generate correction magnetic fields 26 in the same deflection region. Since either correction magnetic field is a local one, the beams 7B, 7G, and 7R are deflected in different directions which are determined by the positions they take with respect to the correction field.

More precisely, when the deflecting magnetic field deflects the beams 7B, 7B, and 7R to an intermediate position between the vertical axis of the display screen of the cathode-ray tube and the upper-left corner of the display screen, the correction magnetic field 26 deflects the side beam 7B more than the other side beam 7R toward the horizontal axis, as can be understood from the arrows 32 and 33 shown in Fig. 6. When the deflecting magnetic field deflects the beams 7B, 7G, and 7R to the the upper-left corner of the display screen, the correction magnetic field 26 deflects the side beam 7B more toward the vertical axis and the side beam 7R more toward the horizontal axis than in the case where the beams 7B, 7G, and 7R are deflected to an intermediate position between the vertical axis of the screen and the upper-left corner thereof.

In contrast, when the deflecting magnetic field

deflected in a relation reverse to the relation in which
5 they are deflected in when the three beams are deflected
to the left edge of display screen. When the deflecting
magnetic field deflects the beams 7B, 7G, and 7R to the
lower edge of the display screen, the side beams 7B and
7R are deflected in a relation same as the relation in
10 which they are deflected when the three beams are
deflected to the upper edge of display screen.

Namely, since currents flow through the correction
coils 24 at the same time as the current in the horizon-
tal deflection coils 21 and in the opposite direction
15 thereto, the vertical mis-convergence (Fig. 4) at a
position between the vertical axis and any corner of the
screen can be much reduced, without jeopardizing the
convergence at the corners of the screen. As a result,
good convergence is attained at any position on the
20 display screen.

A deflection device according to this invention was
made for operating test. In the device, two correction
coils 24 were positioned such that their two-turn win-
dings were located at the distance of 5 mm from the ver-
25 tical axis of the deflection device. The device was
incorporated into a 23-inch, 110 color cathode-ray
tube, and the cathode-ray tube was operated. Mis-
convergence of 0.5 mm was seen at each corner of the
display screen. Simultaneously, mis-convergence of
30 0.7 mm in the same direction was observed at any posi-
tion between the vertical axis and each corner of the
display screen of the cathode-ray tube. The mis-
convergence at any position between the vertical axis
and each corner is less than half the mis-convergence
35 occurring in the case where a conventional deflection
device without correction coils is employed.

The use of the correction coils 24 increases the

field.

5 In the first embodiment, the correction coils 24
were so positioned that their windings were 5 mm away
from the vertical axis of the device. Nonetheless, the
windings may be located closer to or farther from the
vertical axis. They should not be positioned, however,
10 at a distance exceeding 10 mm from the plane containing
the vertical axis and center axis of the deflection
device. If the distance is more than 10 mm, the magne-
tic field the correction coils 24 generate can no longer
serve to reduce the mis-convergence occurring at any
15 position between the vertical axis and each corner of
the display screen.

 The more turns each correction coil 24 has, the
more greatly the coil 24 serves to reduce the mis-
convergence. An increase in the number of turns,
20 however, may reduce the deflection angle of the electron
beams 7B, 7G, and 7R and may adversely influence the
characteristics of the deflection device. The mis-
convergence at a midpoint between the vertical axis and
each corner of the screen is about 1 to 2 mm in most
25 cases. It would therefore suffice to reduce the mis-
convergence by about 1 to 2 mm. In view of this, it is
required that the correction coils 24 have five or less
turns each.

 Two modifications of the deflection device shown in
30 Figs. 5A and 5B will be described, with reference to
Figs. 7A and 7B.

 In the device of Figs. 5A and 5B, the correction
coils 24, positioned in the plane Z-Y, are shaped such
that the halves of each turn of either coil 24 extend
35 parallel to the plane Z-Y and are symmetrical with
respect thereto as is evident from Fig. 5A. Instead, as
is shown in Fig. 7B, the correction coils 24 may be

5 be shaped such that each turn may gradually approach the
Z-Y plane as it extends toward the large-diameter end of
the separator 20.

In the modification of Fig. 7A, the correction
coils 24 may be located in the large-diameter end por-
tion of the separator 20.

10 As has been indicated, the deflection device of
Figs. 5A and 5B, designed for use in a color cathode-ray
tube, comprises a pair of horizontal deflection coils 21
for generating a pincushion-shaped horizontal deflection
magnetic field and a pair of vertical deflection coils
15 23 for generating a barrel-shaped vertical deflection
magnetic field. It further comprises a pair of correc-
tion coils 24, which are spaced by 10 mm or less from
the plane containing the axis of the device and a ver-
tical axis extending at right angles to the axis of the
20 device. Currents flow in these coils 24, in synchronism
with and in an opposite direction to the currents
flowing in the horizontal deflection coils 21, whereby
the coils 24 generate a magnetic field. This magnetic
field deflects the side beams (i.e., two of the three
25 electron beams emitted from the electron gun unit of the
cathode-ray tube), in a specific manner. That is, when
the electron beams are directed to the intermediate
positions between the vertical axis and the each corners
of the screen, the outermost side beam which is posi-
30 tioned more remote from the tube axis than the inner-
most side beam or center beam is more deflected toward
the horizontal axis than the other innermost side beam.
In contrary, when the electron beams are directed to the
any corner of the screen, the innermost is more
35 deflected toward the horizontal axis than the outermost
side beam. As a result, the mis-convergence at any
position between the vertical axis and each corner of

tion on the display screen of the cathode-ray tube.

5 Another deflection device according to the present invention will be described, with reference of Figs. 8A, 8B, and 9.

10 As shown in Figs. 8A and 8B, an additional coil assembly 51 is located in the plane containing the vertical axis (y axis) and center axis (z axis) of a deflection yoke 27. In other words, the assembly 5 is positioned near the neck of the envelope of the cathode-ray tube in which the device is to be used. The additional coil assembly 51 comprises a pair of coils 24A and another pair of coils 24B. The coils 24B of the first pair are connected to the horizontal deflection coils 21. Currents flow in the coils 24A in synchronism with, and in the opposite direction to, those currents flowing in the horizontal deflecting coils 21. The coils 24A of the second pair are located adjacent to the coils 24B, at the front of the deflection yoke 27 (that is, within the large-diameter end of the funnel of the envelope). Currents flow in these coil 24A in synchronism with, and in the same direction as, the currents flowing in the horizontal deflecting coils 21.

25 The coils 24A and the coils 24B are connected together, in end-to-end fashion, forming a coil unit. Each pair of coils of the assembly 51 is formed by winding an insulated wire, forming an annular coil having about five turns, by flattening the annular coil into an elongated one, and by twisting the elongated coil 180° at the middle portion thereof.

30 Referring back to Fig. 6, the horizontal deflection coils 21 generate horizontal deflection magnetic fields 12H in a deflection region in which the three electron beams 7B, 7G, and 7R emitted from the electron

magnetic field either coil 24B generates is a local one.

5 Therefore, the beams 7B, 7G, and 7R are deflected in different directions which are determined by the positions they take with respect to the magnetic field generated by the coil 24B.

10 When the beams 7B, 7G, and 7R are deflected in the deflection region (Fig. 6) by the vertical deflection magnetic field 12V and the horizontal deflection magnetic field 12H and are applied toward a position between the vertical axis of the screen of the cathode-ray tube and any corner of the screen, the magnetic field 26
15 generated by each coil 24B deflects the side electron beam 7B more toward the horizontal axis (x axis) of the screen as indicated by an arrow 32 than the other side beam 7R is deflected toward the horizontal axis of the screen as indicated by an arrow 33. On the other hand,
20 when the beams 7B, 7G, and 7R are deflected in the deflection region (Fig. 6) by the vertical and horizontal deflection magnetic fields 12V and 12H and are applied toward any corner of the display screen, the magnetic field 26 generated by each coil 24B deflects
25 the side electron beam 7B more away from, and the other side beam 7R more toward, the horizontal axis (x axis) of the screen than in the case where the beams 7B, 7G, and 7R are deflected toward a position between the vertical axis of the screen and any corner of
30 thereof.

When the electron beams 7B, 7G, and 7R are deflected toward an upper-right position on the display screen by the vertical and horizontal deflection magnetic fields 12V and 12H, the magnetic field 26 generated
35 by each coil 24B deflects the side electron beams 7B and 7R in a relation reverse to that relation which the beams 7B and 7R have when the beams 7B, 7G, and 7R are

by the deflection magnetic fields 12V and 12H, the
5 magnetic field 26 generated by each coil 24B deflects
the side electron beams 7B and 7R in the same way as in
the case where the beams 7B, 7G, and 7R are deflected
toward an upper-left position on the screen or toward
the upper-right position of the screen. Hence, the
10 vertical mis-convergence at a position between the ver-
tical axis of the screen and any corner thereof can be
reduced, without jeopardizing the convergence at the
corner of the display screen.

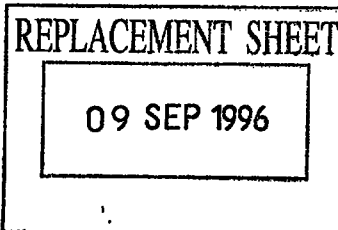
When the coils 24B are energized, however, a
15 current flowing in the opposite direction to the hori-
zontal deflection currents flowing in the coils 24B
reduce the intensity of the pincushion-shaped horizontal
deflection magnetic field 12H. Consequently, horizontal
mis-convergence of the side beams 7B and 7R occurs as is
20 indicated by the side-beam patterns 15B and 15R shown in
Fig. 9. Nonetheless, this horizontal mis-convergence of
the side beams is minimized since the currents, which
flow in the coils 24A of the second pair in the same
direction as the currents flowing in the horizontal
25 deflection coils 21, intensify the pincushion-shaped
horizontal deflection magnetic field 12H at the region
near the front end of the deflection yoke 26.

In the deflection device of Figs. 8A and 8B, the
coils 24A and the coils 24B form an integral unit, i.e.,
30 the additional coil assembly 51. The assembly 51 is
relatively simple in structure and can yet minimize the
vertical mis-convergence at a position between the ver-
tical axis of the screen and any corner thereof.

As described above, the coils 24A and the coils
35 24B, which constitute the additional coil assembly 51,
are positioned in the plane containing the center and
vertical axes of the deflection yoke 26. It is

the coils 24B of the first pair and the coils 24A of the
5 second pair are of the same shape and the same size.
Instead, as is shown in Fig. 10, the coils 24A may have
a width L_2 , and the coils 24B may have a width L_1 ,
each measured in the horizontal direction, where
10 $L_1 < L_2$. In this case, it is possible to adjust the
ratio of improvement of the vertical mis-convergence,
occurring at an intermediate position between the ver-
tical axis of the screen and any corner thereof to the
horizontal mis-convergence.

As has been indicated, in the embodiment of
15 Figs. 8A and 8B, the coils 24B, in which currents flow
in synchronism with and in the opposite direction to
those currents flowing in the horizontal deflecting
coils 21, are located in the plane containing the center
and vertical axes of the screen and at the rear of the
20 deflection yoke 26; and the coils 24A, in which currents
flow in synchronism with and in the same direction as
the currents flowing in the horizontal deflecting coils
21, are located in that plane and at the front of the
deflection yoke 17. The coils 24B generate a magnetic
25 field which reduces the vertical mis-convergence of the
side beam occurring at a position between the vertical
axis of the screen and any corner thereof. The coils
24A generate a magnetic field which minimizes the
horizontal mis-convergence caused by the magnetic field
30 generated by the coils 24B. As a result, sufficient
convergence of the three beams 7B, 7G, and 7R can be
maintained at any position on the display screen of the
cathode-ray tube.



ray tube (1) having a center axis and means (8) for emitting in-line electron beams, comprising:

5 horizontal deflection means (21) for deflecting the electron beams in a horizontal direction in response to horizontal deflection signals, said horizontal deflection means (21) including a pair of horizontal deflection coils for generating a pincushion-shaped horizontal deflection magnetic field; and

10 vertical deflection means (23) for deflecting the electron beams in a vertical direction in response to vertical deflection signals, said vertical deflection means (23) including a pair of vertical deflection coils for generating a barrel-shaped vertical deflection magnetic field;

15 characterized by further comprising:

correction means (24, 24A, 24B) for correcting the deflection of the electron beams by applying a correction magnetic field to the electron beams in response to the horizontal deflection signals, said correction means (24, 24A, 24B) including a pair of correction coils which are located near a vertical axis orthogonal to said center axis and symmetrically with respect to the vertical axis and in which currents flow in synchronism with, and in a direction opposite to, the currents flowing in said horizontal deflection coils (21).

20 2. The deflection device according to claim 1, characterized in that said horizontal deflection coils (21) are saddle-shaped.

30 3. A deflection device for use in a color cathode-ray tube (1) having a center axis and means (8) for emitting in-line electron beams, comprising:

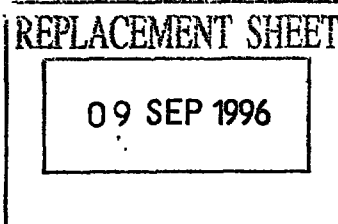
horizontal deflection means (21) for deflecting the electron beams in a horizontal direction in response to horizontal deflection signals, said horizontal

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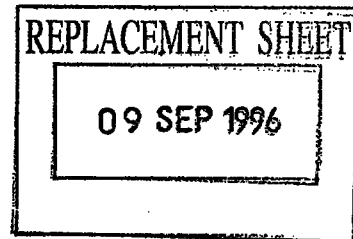
5 vertical deflection means (23) for deflecting the
electron beams in a vertical direction in response to
vertical deflection signals, said vertical deflection
means (23) including a pair of vertical deflection coils
for generating a barrel-shaped vertical deflection
magnetic field;
10 characterized in that
correction means (24, 24A, 24B) for correcting the
deflection of the electron beams by applying a correc-
tion magnetic field to the electron beams in response to
the horizontal deflection signals, said correction means
15 (24, 24A, 24B) including a first pair of correction
coils which are located near a vertical axis orthogonal
to said center axis and symmetrically with respect to
the vertical axis and in which currents flow in
synchronism with, and in a direction opposite to, the
20 currents flowing in said horizontal deflection coils
(21), and a second pair of correction coils (24, 24A,
24B) which are located near said vertical axis and sym-
metrically with respect to said vertical axis and in
which currents flow in synchronism with, and in the same
25 opposite as, the currents flowing in said horizontal
deflection coils (21).
4. The deflection device according to claim 3,
characterized in that said horizontal deflection coils
(21) are saddle-shaped.
30 5. The deflection device according to claim 3,
characterized in that said correction coils (24B) of the
first pair are arranged between said second pair of
correction coils (24A) and said means (8) for emitting
in-line electron beams.

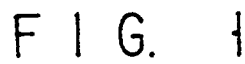
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device, which has a pair of horizontal deflection coils
(21) for generating a pincushion-shaped horizontal
deflection magnetic field, a pair of vertical deflection
5 coils (23) for generating a barrel-shaped vertical
deflection magnetic field. The deflection device
further comprises a pair of correction coils (24) each
of which is located at a distance of 10 mm or less from
a plane containing the center and vertical axes of the
10 device, and in each of which a current flows in synchro-
nism with, and in a direction opposite to, the currents
flowing in the horizontal deflection coils.

Figs. 5A and 5B.





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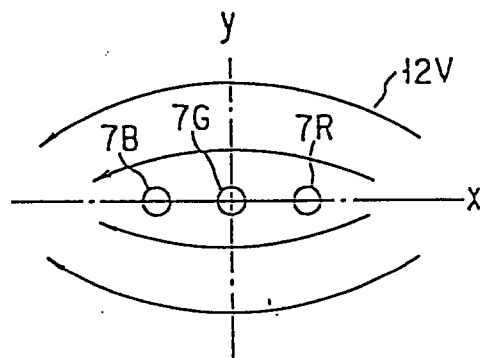
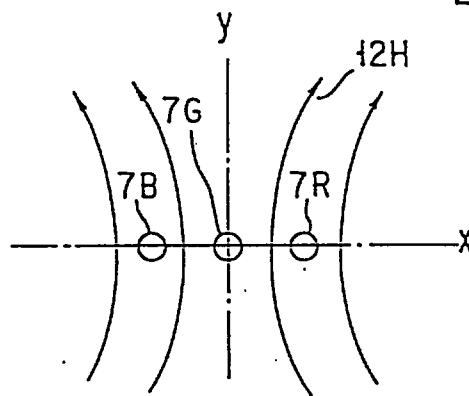


FIG. 3

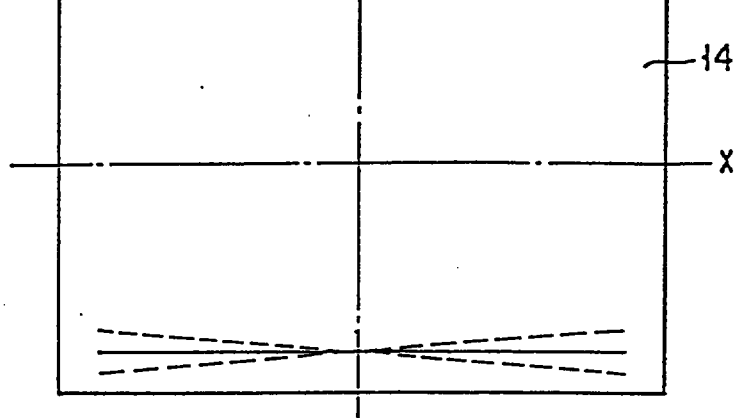


FIG. 4

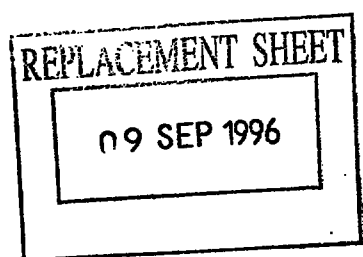
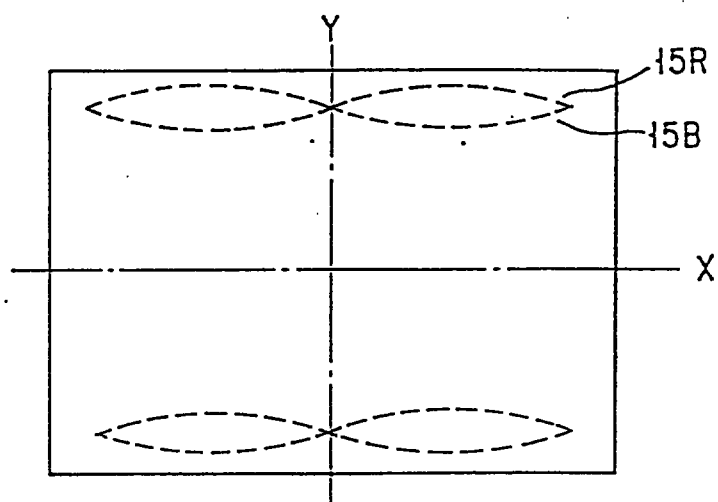
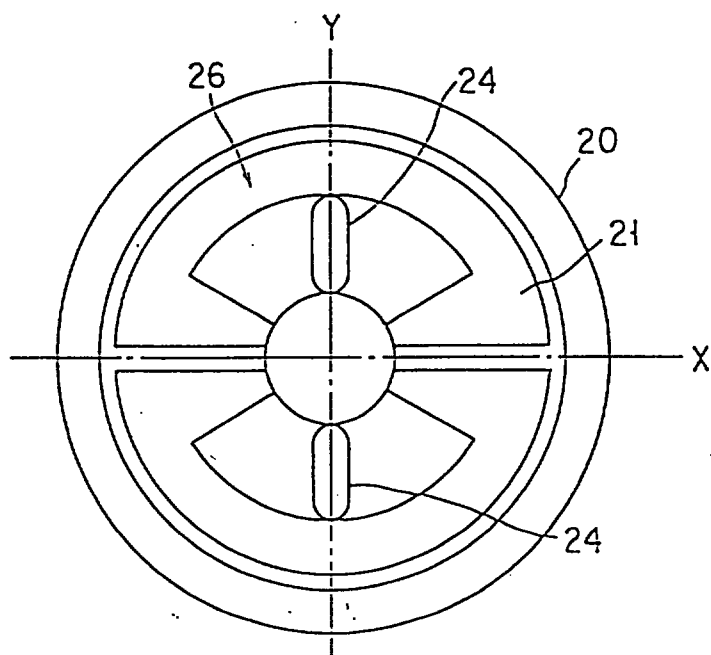
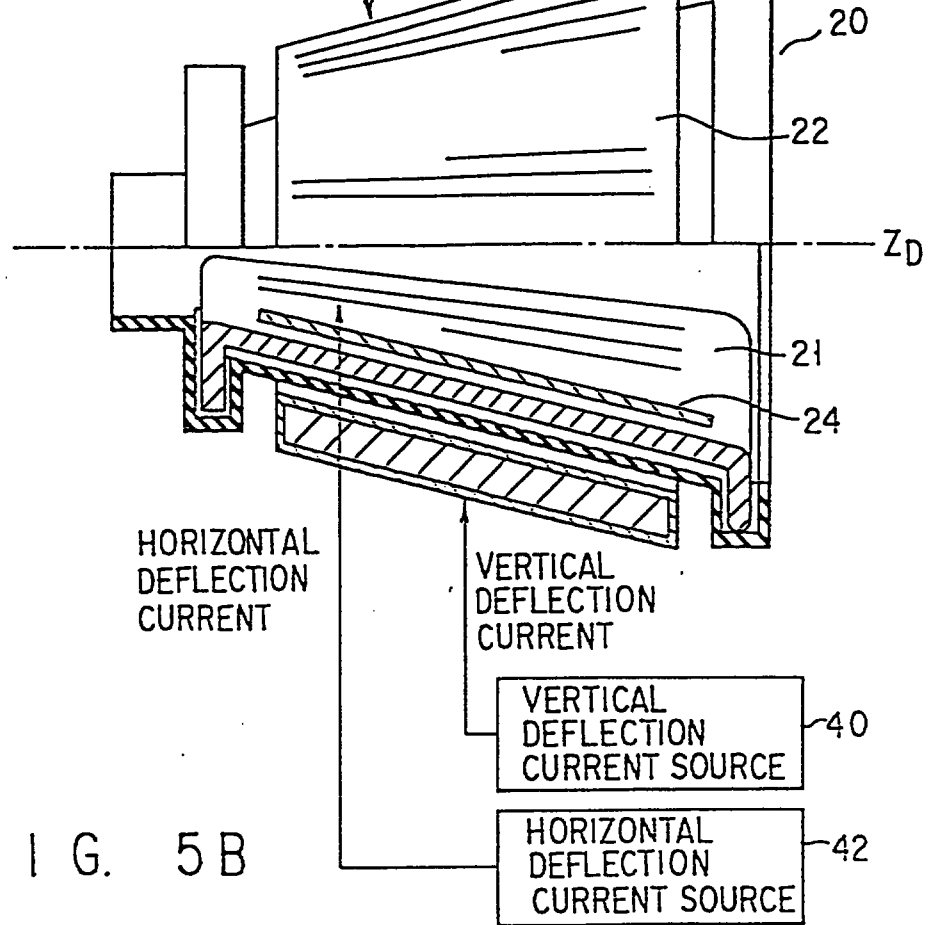


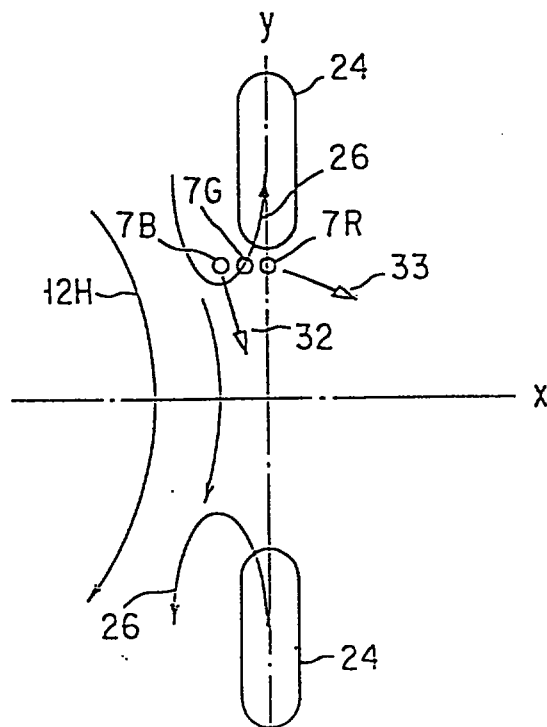
FIG. 5A





REPLACEMENT SHEET

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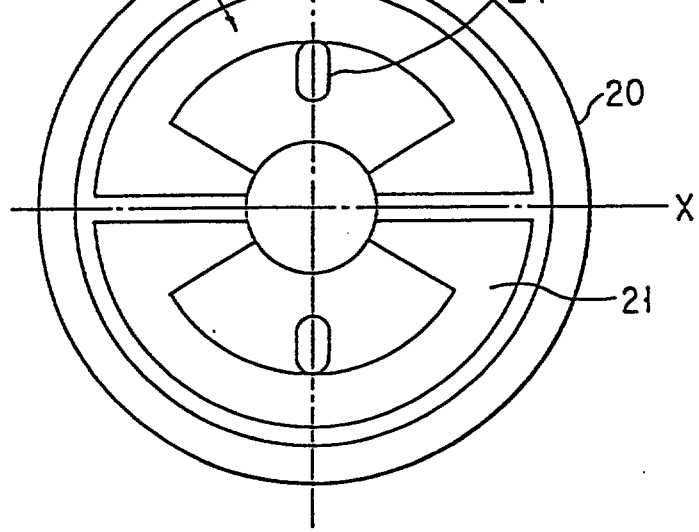


FIG. 7A

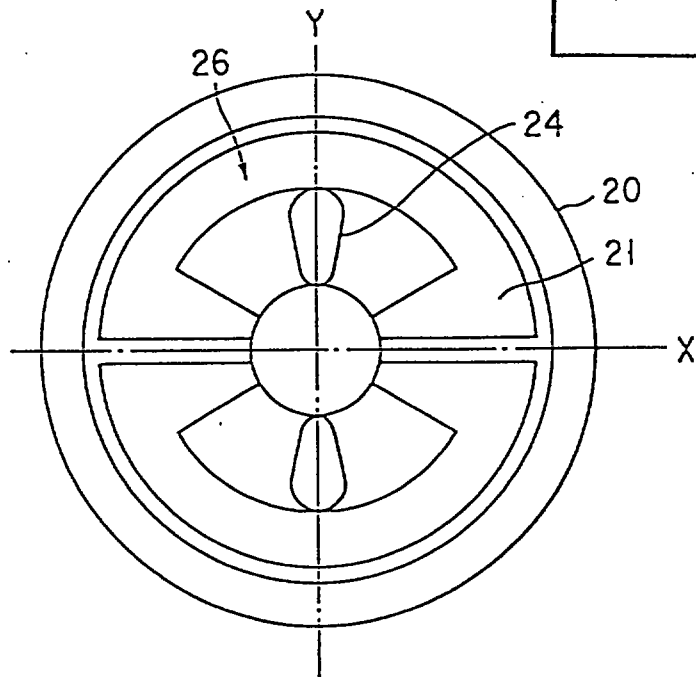
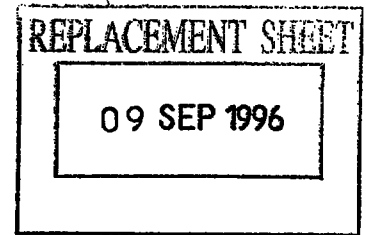


FIG. 7B

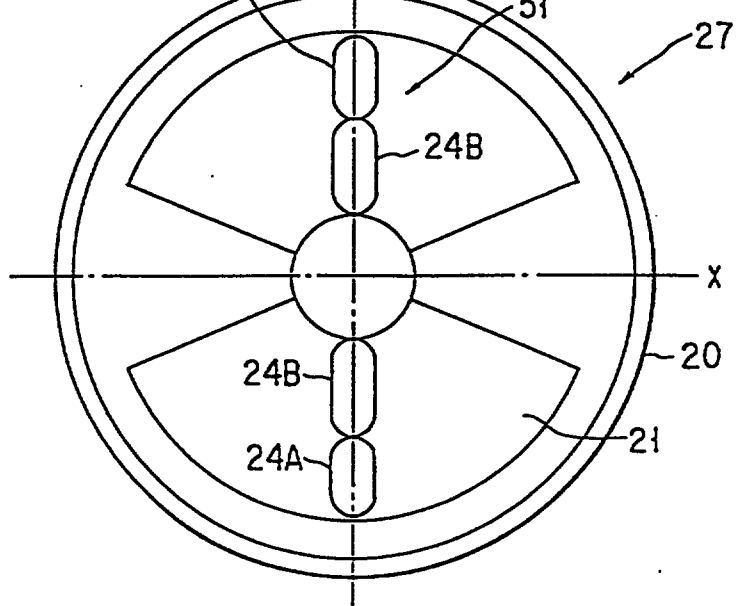


FIG. 8A

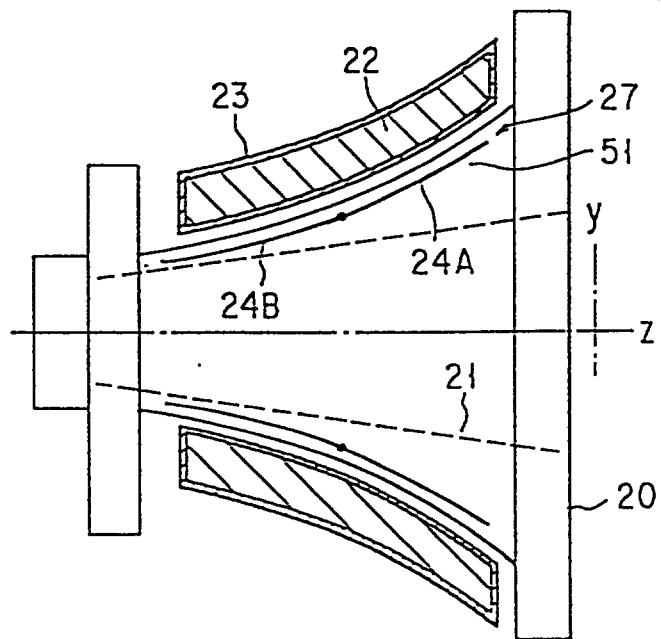
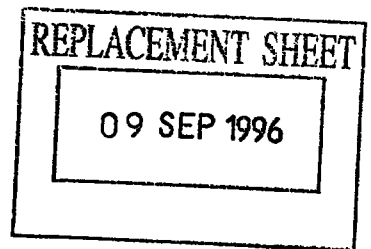


FIG. 8B

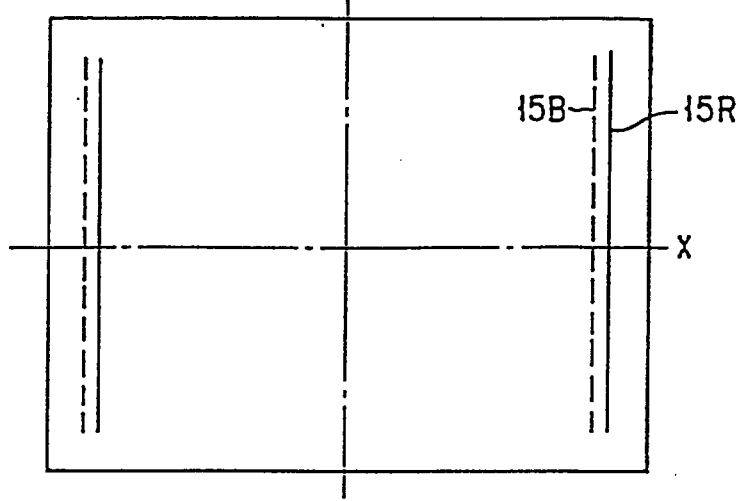


FIG. 9

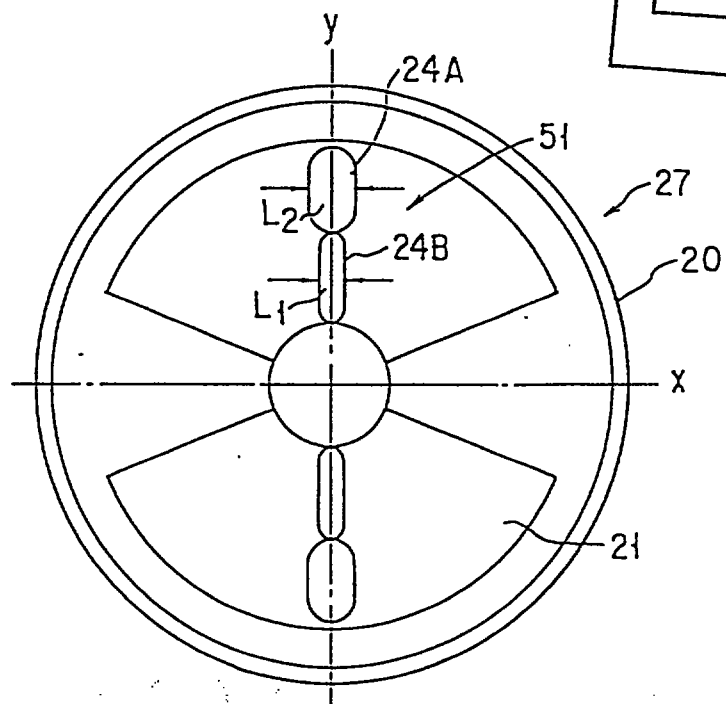
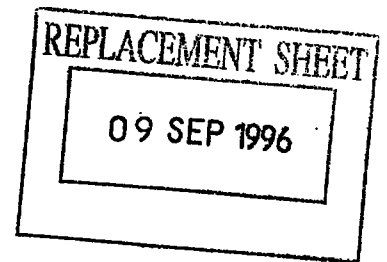


FIG. 10