

REPLACED SHEETS		SG
☒ Description	: paged 01 to paged 33	
☒ Claim(s)	: paged 34 to paged 51	
☒ Drawing(s)	: paged 52 to paged 52	
☒ Abstract	: paged 52 to paged 52	

TITLE OF THE INVENTION

COLOR CATHODE RAY TUBE

BACKGROUND OF THE INVENTION

The present invention relates to a color cathode ray tube, particularly to a color cathode ray tube in which the effective region of a shadow mask is enlarged and the magnetism shielding characteristic and the howling prevention characteristic for assembling the shadow mask are improved.

A color cathode ray tube generally comprises a vacuum envelope (glass valve) provided with a panel which is arranged at the front side and in which a fluorescent screen is formed, a slender neck which is arranged at the rear side and in which electron gun is included, and a funnel connecting the panel and the neck; a shadow mask assembly fixed in the panel; a magnetic shield set in a tube at the joint between the panel and the funnel; and a deflection yoke set to the tube side of the joint between the funnel and the neck. Moreover, the shadow mask assembly includes a shadow mask provided with a surface curved toward the panel front and having a plurality of electron-beam passing holes and with a skirt extending downward from the margin of the curved surface, and a mask frame having a flange connected to an almost-rectangular

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side wall and the magnetic shield, which is constituted by fitting and securing the skirt to the side wall. Moreover, the shadow mask assembly is secured in the panel so that the curved surface of the shadow mask faces the fluorescent screen formed in the front panel.

In the case of the color cathode ray tube having the above structure, three electron beams are emitted from the three electron guns included in the neck respectively and properly deflected due to a magnetic field generated by the deflection yoke. Then, the three electron beams pass through the electron beam passing holes formed on the curved surface of the shadow mask and thereafter, each of them is projected on a phosphor region with a corresponding color on the fluorescent screen. Thus, a multicolor image is displayed on the front panel of the color cathode ray tube.

Figure 15 is a top view showing the structure of a shadow mask assembly used for an already-known color cathode ray tube.

In Figs. 15 and 16A and 16B, symbol 40 denotes a shadow mask assembly, 41 denotes a shadow mask, 42 denotes a curved surface, 43 denotes a skirt, 44 denotes a mask frame, 45 denotes a side wall of the

mask frame, 46 denotes a spring for setting the shadow mask assembly in a panel, 47 denotes a boss formed on the side wall of the mask frame toward the inside of the frame, and 48 denotes a flange of the mask frame.

5 Moreover, the shadow mask 41 includes the curved surface 42 having a plurality of electron beam passing holes (not illustrated) and the skirt 43 extending downward from the margin of the curved surface 42. The mask frame 44 has the side wall 45 and the flange 10 48 which are connected each other or press-molded into a rectangular shape. The spring 46 for setting the mask frame 44 in the panel is provided for the outside of the side wall 45. Moreover, the mask frame has a boss 47 for reinforcing the mechanical strength of the 15 side wall 45 and compensating the clearance of the joint face between the side wall 45 and the skirt 43. The skirt 43 of the shadow mask 41 is fitted to the side wall 45 of the mask frame 44 and the skirt 43 and the side wall 45 are spot-welded each other at several 20 portions and thereby, the shadow mask assembly 40 is constituted.

Figure 16A is a sectional view of a major side of the shadow mask shown in Fig. 15 and Figure 16B is a sectional view of a corner of the shadow mask assembly 25 shown in Fig. 15. When the shadow mask 41 is press-



molded, a warp occurs due to springback because of the press-molding. A warp value SB of the skirt 43 usually tends to decrease at a corner with a relatively large degree of contraction due to press-
5 molding and increase at the central portion with a relatively small degree of contraction. The bottom margin of the skirt of the shadow mask 41 after press-molded has a shape in which the middle of the side is slightly curved outward compared to the side nearby a
10 corner due to the warp. When fitting the skirt 43 of the shadow mask 41 into the side wall 45 of the mask frame 44, there is a problem that the skirt 43 contacts the side wall 45 at the middle of a side and a clearance 49 is produced between the skirt 43 of the
15 shadow mask 41 and the mask frame 44 at a corner.

Moreover, the margin of the curved surface 42 is molded so that the middle of a side is slightly curved outward in accordance with the shape of the margin of a panel glass. That is, to fit the skirt 33 to the
20 side wall 45 of the mask frame, the dimensions of various portions of the shadow mask 41 are set so that the middle of a side of the skirt is just stored in the side wall 45.

Moreover, when fitting the skirt 43 of the shadow
25 mask 41 press-molded at the above dimensions into the



side wall 45 of the mask frame 44, the clearance between the skirt 43 and the side wall 45 decreases at the middle of a side of the skirt 43 and increases at the corners of the skirt 43. Therefore, as shown in
5 Fig. 15, the boss 47 is formed at each corner of the side wall 45 so as to compensate spread of the clearance. The boss 47 is also properly formed at the middle of a side of the side wall 45 in order to reinforce the mechanical strength of the side wall 45.

10 Thus, the well-known shadow mask assembly 40 is molded so that the middle of a side of the margin of the curved surface 42 is slightly curved toward the outside when press-molding the shadow mask 41.. Therefore, the clearance between the skirt 43 and the
15 side wall 45 increases at the corners of the skirt 43. Moreover, problems occur that it is necessary to form the boss 47 at each corner of the side wall 45 and the effective region of the curved surface 42 to the size of the mask frame 44 is narrowed by a value equivalent
20 to the increase of the clearance.

Furthermore, in the case of the well-known shadow mask assembly 40, the contact area between the skirt 43 and the side wall 45 is restricted to the arranged portion of the boss 47 at each corner. Therefore, the
25 contact area between the skirt 43 and the side wall 45

is substantially small. In addition, because the contact area is small at corners, there is a problem that an effective magnetism shielding characteristic cannot be obtained.

5 The present invention is made to solve the above problems and its object is to provide a color cathode ray tube comprising a shadow mask assembly capable of enlarging the effective region of a curved surface to the size of a mask frame of the shadow mask assembly
10 and obtaining a superior magnetism shielding characteristic.

 Though USP 4,308,485 is present as a prior art, it does not suggest the present invention. Moreover, Japanese Utility Model Application No. 40942/1985 is
15 present as a prior art, in which springback when forming a shadow mask is considered. However, the shape of a mask frame for holding a shadow mask or the positional relation between the shadow mask and the mask frame is not disclosed at all.

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SUMMARY OF THE INVENTION

To achieve the above object, the present invention mainly comprises the following means.

(1) The side of the margin of the curved surface
25 of an almost rectangular shadow mask is set so that it

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is curved inward. That is, the side is set to a curvature to be convex to (toward) the tube axis of a cathode ray tube. Moreover, the almost rectangular side wall of a mask frame is set so as to be linear or so as to have a curvature to be concave toward the tube axis of the cathode ray tube. Thereby, it is possible to obtain a sufficient clearance between the mask frame and the shadow mask for major and minor axes of the rectangle. Thus, it is possible to secure the mass productivity of the shadow mask even if the clearance is small on the diagonal axis. Moreover, it is possible to improve the magnetism shielding effect (effect of shielding the magnetism outside of a cathode ray tube) on the diagonal of a screen where the influence of the geomagnetism is maximized. Furthermore, it is possible to increase the diagonal effective diameter of the screen by a value equivalent to the decrease of the clearance due to the diagonal axis.

(2) The side of the margin of the curved surface of an almost rectangular shadow mask is set so as to be linear or so as to have a radius of curvature in which the side is curved outward and the radius of curvature of the side of the margin of the shadow mask is made larger than that of the inside of the side



wall of a mask frame corresponding to the side of the margin of the shadow mask. Thereby, because a sufficient clearance is obtained between the mask frame and the shadow mask for major and minor axes of the above rectangle, it is possible to secure the mass productivity of a shadow mask assembly by decreasing the clearance on the diagonal axis of the rectangle.

(3) Because a boss is formed at a portion including the root on which the flange of the side wall of the mask frame is set and the skirt of the shadow mask is secured on the boss, it is possible to maintain the mechanical strength of the mask frame, increase the effective diameter of the shadow mask, and moreover improve the magnetic coupling between the shadow mask and the mask frame.

(4) The clearance between the mask frame and the margin of the shadow mask is decreased at corners and a boss is provided from the proximal edge of the side wall with the flange at the side of the mask frame up to the distal edge of the side wall to decrease the clearance at this portion. Thus, because the small region of the clearance is limited it is possible to secure the mass productivity of a shadow mask assembly and obtain the advantages in the above Items (1) to (3).

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Therefore, according to the above means, the curved surface of a shadow mask is substantially enlarged at corners and the effective region of the curved surface is expanded. Moreover, because the contact area between a skirt and a side wall is expanded at corners, the magnetism shielding characteristic is improved at corners of the shadow mask assembly.

10 BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic sectional view showing an embodiment of a color cathode ray tube of the present invention;

Figure 2 is a perspective view showing an embodiment of the structure of a shadow mask assembly used for the color cathode ray tube shown in Fig. 1;

Figure 3 is a top view of the shadow mask assembly shown in Fig. 2;

Figure 4A is a sectional view of a corner showing an embodiment when mounting the shadow mask assembly shown in Fig. 2 on a color cathode ray tube;

Figure 4B is a sectional view of a corner showing another embodiment when mounting the shadow mask assembly shown in Fig. 2 on a color cathode ray tube;

Figure 5A is a sectional view of a corner of a

shadow mask assembly used for a color cathode ray tube of the present invention;

Figure 5B is a sectional view of a corner of a shadow mask assembly used for a color cathode ray tube of the present invention;

Figure 6 is an illustration showing an arrangement of electron beam passing holes of a shadow mask used for a color cathode ray tube of the present invention;

Figure 7A is a sectional view of an electron gun used for a color cathode ray tube of the present invention in the in-line direction;

Figure 7B is a sectional view of the electron gun shown in Fig. 7A vertical to the axis of the electron gun shown in Fig. 7A;

Figure 8 is a top view showing another embodiment of the structure of a shadow mask assembly used for a color cathode ray tube of the present invention;

Figure 9 is a top view showing still another embodiment of the structure of a shadow mask assembly used for a color cathode ray tube of the present invention;

Figure 10A is a sectional view of a major side of the shadow mask assembly shown in Fig. 9;

Figure 10B is a sectional view of a minor side of



the shadow mask assembly shown in Fig. 9;

Figure 10C is a sectional view of a corner of the shadow mask shown in Fig. 9;

Figure 11A is a sectional view of a major side
5 showing still another embodiment of the structure of a shadow mask assembly used for a color cathode ray tube of the present invention;

Figure 11B is a sectional view of a minor side
showing still another embodiment of the structure of a
10 shadow mask assembly used for a color cathode ray tube of the present invention;

Figure 11C is a sectional view of a corner
showing still another embodiment of the structure of a
shadow mask assembly used for a color cathode ray tube
15 of the present invention;

Figure 12 is a top view showing still another
embodiment of the structure of a shadow mask assembly
used for the color cathode ray tube shown in Fig. 1;

Figure 13A is a sectional view of a major side of
20 the shadow mask assembly shown in Fig. 12;

Figure 13B is a sectional view of a minor side of
the shadow mask assembly shown in Fig. 12;

Figure 13C is a sectional view of a corner of the
shadow mask assembly shown in Fig. 12;

25 Figure 13D is a sectional view of another

embodiment;

Figure 14A is a sectional view of a major side showing still another embodiment of the structure of a shadow mask assembly used for a color cathode ray tube of the present invention;

Figure 14B is a sectional view of a minor side showing still another embodiment of the structure of a shadow mask assembly used for a color cathode ray tube of the present invention;

Figure 14C is a sectional view of a corner showing still another embodiment of the structure of a shadow mask assembly used for a color cathode ray tube of the present invention;

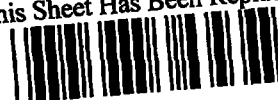
Figure 15 is a top view showing the structure of a shadow mask assembly used for a conventional color cathode ray tube; and

Figures 16A and 16B are sectional views of corners of the shadow mask assembly shown in Fig. 15.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiments of the present invention are described below by referring to the accompanying drawings.

Figure 1 is a schematic sectional view showing an embodiment of a color cathode ray tube of the present



invention.

In Fig. 1, symbol 1 denotes a panel, 2 denotes a neck, 3 denotes a funnel, 4 denotes a fluorescent screen, 5 denotes a shadow mask assembly, 6 denotes a shadow mask made of invar or AK (aluminium-killed), 7 denotes a mask frame made of mild steel or stainless steel, 8 denotes a deflecting yoke, 9 denotes a purity adjusting magnet, 10 denotes a center-beam static convergence adjusting magnet, 11 denotes a side-beam static convergence adjusting magnet, 12 denotes an electron gun, 13 denotes an electron beam, and 14 denotes a magnetic shield.

Moreover, a color cathode ray tube constitutes a vacuum envelope (glass valve) with the panel 1 which is arranged at the front side and in which the fluorescent screen 4 is formed, the slender neck 2 which is arranged at the rear side and in which the electron gun 12 is included, and the funnel 3 connecting the panel 1 and the neck 2.

The shadow mask 6 is provided with a curved surface having a plurality of electron beam passing holes and a skirt extending downward from the margin of the curved surface and the mask frame 7 is provided with a flange 71 and an almost rectangular side wall when viewed from the panel side.



The shadow mask assembly 5 arranged in the panel 1 is provided with the shadow mask 6 and the mask frame 7, the skirt of the shadow mask 6 is fitted and secured to the inside of the side wall of the mask frame 7 and the shadow mask 6 and the mask frame 7 are integrally constituted. The shadow mask assembly 5 is arranged in the panel so that the curved surface of the shadow mask 6 is convex toward the fluorescent screen 4.

The magnetic shield 14 is arranged in the tube constituting the color cathode ray tube and the deflecting yoke 8 is set to the tube side of the joint between funnel 3 and the neck 2. The purity adjusting magnet 9, center-beam static convergence adjusting magnet 10, and side-beam static convergence adjusting magnet 11 are arranged outside of the neck 2. Three electron beams 13 (only one electron beam is shown in Fig. 1) emitted from the electron gun 12 are deflected in a predetermined direction by a magnetic field generated by the deflecting yoke 8 and thereafter, they pass through a plurality of electron beam passing holes formed on the shadow mask 6 and respectively reach a picture element of a corresponding color on the fluorescent screen 4.

The operation of the color cathode ray tube



having the above structure, that is, the image display operation is the same as that of a well-known color cathode ray tube.

First Embodiment

5 Figure 2 is a perspective view showing an example of the shadow mask 5 used for the color cathode ray tube shown in Fig. 1 and Figure 3 is a top view of the shadow mask assembly 5 shown in Fig. 2.

10 In Figs. 2 and 3, symbol 6a denotes a curved surface of the shadow mask 6, 6b denotes a skirt of the shadow mask assembly 6, 6b₁, 6b₂, 6b₃, and 6b₄ denote four sides of the skirt 6b, 7a denotes a side wall of the mask frame 7, 7a₁, 7a₂, 7a₃, and 7a₄ denote four sides of the side wall 7a, 7b denotes a spring, 15 and 7c denotes a boss formed on the mask frame 7. In Figs. 2 and 3, other component same as that shown in Fig. 1 is provided with the same symbol. The axis A is an axis passing through the center of the shadow mask assembly and almost parallel with a minor side of the assembly and the axis B is an axis passing through 20 the center of the shadow mask assembly and almost parallel with a major side of the assembly.

25 Moreover, the shadow mask 6 includes the curved surface 6a having an effective region in which a plurality of electron beam passing holes (not

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illustrated) are formed and the skirt 6b extending downward from the margin of the curved surface 6a. The mask frame 7 has the side wall 7a formed to be almost rectangular by the four sides 7a₁, 7a₂, 7a₃, and 7a₄ and the flange 7l to which a magnetic shield is set. The spring 7b is set outside of the side wall 7a and the boss 7c is formed inside of the side wall 7a.

To form the skirt 6b on the shadow mask 6 by press-molding, the four sides 6b₁, 6b₂, 6b₃, and 6b₄ of the skirt 6b are molded so that the middle of each side is curved slightly inward (central direction of the shadow mask 6) from the side nearby a corner of the skirt. For example, in the case of the curved portion, the vicinity of the intersections between the major side 6b₁ or 6b₃ of the skirt and the axis A is curved most inward and symmetrically to the right and left of the intersection.

Moreover, the boss 7c of the frame 7 is formed on the axis A or at a position nearby the axis A so as to face the curved portion of the skirt.

To relatively increase the clearance 5l between sides when fitting the skirt 6b of the shadow mask into the side wall 7a of the mask frame at the middle of each side and relatively decrease it at each side nearby a corner, the boss 7c is formed at the middle

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of each of the four sides $7a_1$, $7a_2$, $7a_3$, and $7a_4$
(position facing a portion of the skirt curved inward)
but the boss 7c for welding is not formed at the four
corners formed by the four sides $7a_1$, $7a_2$, $7a_3$, and $7a_4$.

- 5 The weld between the skirt and the mask frame is
located in the vicinity of the middle of each side and
corners.

At corners, the curvature of the inner surface of
the frame and that of the skirt 6b are almost the same
10 each other or the curvature of the skirt is small than
that of the inner surface of the frame in order to
increase the contact area between the side wall 7a and
the skirt 6b.

Moreover, the contact area between the side wall
15 7a and the skirt 6b is a region reaches each side
constituting a range from corner to corner having a
curvature. At the contact area, it is permitted that
the bottom margin of the skirt contacts the side wall
7a at the contact area of a corner or the top margin
20 of the skirt contacts the side wall 7a. Moreover, it
is the best that the skirt contacts the side wall 7a
at the whole surface of a corner.

It is possible to weld the boss 7c to the inside
of the side wall 7a or to form the boss 7c by press-
25 molding the side wall 7a inward.

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By forming the above structure, the clearance between the skirt 6b and the middle of a side of the side wall 7a relatively increases at the faced planes between the four sides 6b₁, 6b₂, 6b₃, and 6b₄ of the skirt 6b of the shadow mask of the shadow mask assembly 5 on one hand and the four sides 7a₁, 7a₂, 7a₃, and 7a₄ of the side wall 7a of the mask frame on the other and the clearance at a corner relatively decreases. That is, the clearance at a corner is smaller than the clearance nearby the middle of a side. Thereby, it is possible to adequately secure the contact area between the skirt 6b and the side wall 7a at the corner between the skirt 6b and the side wall 7a and thereby, it is unnecessary to set the boss 7c at the corners of the side wall 7a.

Moreover, because it is unnecessary to set the boss 7c at the corners of the side wall 7a, the curved surface 6a of the shadow mask 6 substantially expands at corners and thereby, it is possible to expand the effective region of the curved surface 6a up to a value equivalent to the expansion of the curved surface 6a. Therefore, it is possible to form a corner into a square corner. Furthermore, because the contact area between the skirt 6b and the side wall 7a increases at corners, it is possible to improve the

magnetism shielding characteristic at corners of the shadow mask assembly 5. When the magnetism shielding characteristic is improved, the focus characteristic at corners is also improved.

5 The important point of the present invention is that the skirt of a shadow mask entirely contacts (closely contacts) the side wall of a frame at corners.

That is, the shadow mask has a curved surface
10 having an electron beam passing hole at its central portion and a skirt folded from the margin of the curved surface and extending in the tube axis direction and a top view of the margin projected on a plane vertical to the tube axis is an almost
15 rectangular shape whose major or minor side has a curvature convex toward the tube axis. Moreover, the mask frame is almost rectangular and its cross section is almost L-shaped, and the frame includes a side wall extending in the tube axis direction and a flange
20 extending the tube axis in the vertical direction and a top view obtained by projecting the inside of an end of the side wall at the fluorescent screen side on a plane vertical to the tube axis shows an almost
25 rectangular shape whose major or minor side is linear or has a curvature concave toward the tube axis.



Moreover, the skirt of the shadow mask is secured to the inside of the side wall of the mask frame.

Figure 4A is a sectional view of a corner showing an example of the case of setting the shadow mask assembly of this embodiment to a color cathode ray tube. Figure 4B is a sectional view of a corner showing another example of the case of setting the shadow mask assembly of this embodiment to a color cathode ray tube.

According to this embodiment, because it is unnecessary to form a boss at corners, it is possible to enlarge the flange 7 of a mask frame, closely contact a shadow mask and a magnetic shield each other at corners, improve the magnetic coupling, and particularly improve the beam landing tolerance at corners of a screen where the influence of geomagnetism is maximized.

The method for coupling the shadow mask and the magnetic shield in Fig. 4A or 4B is a method of forming a hole on the flange 71 of the mask frame and the flange 141 of the magnetic shield respectively and securing the flanges by a securing spring 15 through the holes.

Moreover, because the front end 712 of the side wall of the mask frame is upper than the margin 61 of



the curved surface of the shadow mask at corners, the effect of shielding external magnetism at the corners is further improved. Moreover, if the front end 712 of the side wall of the mask frame is upper than the margin 61 of the curved surface of the shadow mask over the whole circumference, it is possible to improve the effect of shielding external magnetism (particularly, geomagnetism) over the whole circumference.

10 Furthermore, because it is unnecessary to form a boss at corners, it is possible to form an effective portion of the shadow mask which corresponds to an effective screen and on which electron beam passing holes are formed up to the margin and expand the effective screen in the diagonal direction.

15 Furthermore, in the case of the present invention, if it is necessary to form a boss at corners because of any reason through the boss is normally unnecessary for the corners, it is possible to bring the whole of the skirt into contact with the side wall of the mask frame as shown in Figs. 5A and 5B. Thereby, it is possible to improve the coupling between the mask frame and the shadow mask. This is a point greatly different from the cross section of the corner of the prior art in Fig. 16B.



Figure 6 shows some of electron-beam passing holes arranged on a shadow mask. It is possible to obtain a more minute image as the shadow mask pitch P decreases. However, if the shadow mask pitch decreases, the electron-beam landing tolerance decreases and a phenomenon in which one electron beam hits phosphors of a plurality of colors to easily cause luminescence (so-called multicolor hitting). This phenomenon is referred to as purity deterioration. The purity deterioration is greatly influenced by geomagnetism and particularly frequently caused at corners of a screen where the deflection angle of an electron beam increases.

According to the present invention, because the magnetism shielding effect is improved at corners, it is possible to realize a fine-pitch color cathode ray tube with a shadow mask pitch P of 0.28 mm or less.

Figure 7A shows an electron gun. Figure 7B is a schematic view of a cathode K viewed from the line D-D in Fig. 7A. The electron gun 12 is a so-called large-diameter electron gun in which electrodes having a common envelope face three electron beams in a main lens. The electron gun has a characteristic that the convergence and focus are improved as the interval S between the three electron beams decreases. However,

if the dimension S of the electron gun is decreased,
the interval Q between the panel inside and the shadow
mask shown in Fig. 4A or 4B increases and a problem
occurs that the purity is deteriorated due to
5 geomagnetism.

The present invention makes it possible to secure
a sufficient landing tolerance even if the dimension S
of an electron gun is 5.5 mm or less because the
magnetism shielding effect is improved at a corner
10 where a problem frequently occurs.

In this case, the dimension S denotes a dimension
on the surface of a cathode as shown in Fig. 7.

Moreover, when the shadow mask pitch P is 0.28
mm, it is possible to secure the purity tolerance even
15 if the dimension S is 5.0 mm or less.

In the case of this embodiment, the skirt 6b is
press-molded so that the central portion of each of
the four corners 6b₁, 6b₂, 6b₃, and 6b₄ of the skirt 6b
is curved slightly inward from a side close to the
20 corners formed by the four sides. The above advantage
can also be obtained by applying the molding of this
embodiment only to the two facing sides 6b₁ and 6b₃ (or
6b₂ and 6b₄) of the skirt 6b and applying molding
according to a well-known mode to the two remaining
25 facing sides 6b₂ and 6b₄ (or 6b₁ and 6b₃) of the skirt



6b instead of applying the molding of this embodiment to the four sides 6b₁, 6b₂, 6b₃, and 6b₄ of the skirt 6b.

As described above, according to the present invention, it is possible to relatively increase the clearances of the central portions of the joint areas between the skirts of four sides of a shadow mask and the side walls of the four sides to which a mask frame corresponds and relatively decrease the clearances of the corners of them in a shadow mask assembly. Therefore, the advantages can be obtained that it is possible to sufficiently secure the contact area between a skirt and a side wall at a corner and it is unnecessary to set a boss to each corner of the side wall.

Moreover, according to the present invention, because it is unnecessary to set a boss to each corner of a side wall, the curved surface of a shadow mask is substantially expanded at corners and thereby, the effective region of the curved surface can be expanded. Furthermore, because the contact area between the skirt and the side wall increased at corners, the advantage can be obtained that it is possible to improve the magnetism shielding characteristic at corners of a shadow mask assembly.



Particularly in the case of a horizontally-long color cathode ray tube with a panel aspect ratio of 16:9 or 16:10, it is possible to greatly improve the focus characteristic by applying the present invention because the focus is deteriorated at corners.

Second Embodiment

Figure 8 is a top view of the shadow mask assembly of the second embodiment of the present invention. Symbol RF1 denotes the radius of curvature of a major side of the inside of a side wall, RM1 denotes the radius of curvature of the margin of a shadow mask, RF2 denotes the radius of curvature of a minor side of the inside of the side wall, and RM2 denotes the radius of curvature of a minor side of the margin of the shadow mask. Other portion same as that in Fig. 3 is provided with the same symbol.

In the case of this embodiment, the radius of curvature RF1 or RF2 of the inside of the side wall on a side of the mask frame 7 is set to a value smaller than the radius of curvature RM1 or RM2. According to this embodiment, it is possible to relatively increase the clearances of the central portions of the joint areas between the skirts of the four sides of a shadow mask and the side walls of the four sides to which a



mask frame corresponds and relatively decrease the clearances of the corners of them in a shadow mask assembly. Moreover, it is possible to secure the assembling mass productivity of a shadow mask and a mask frame even by increasing the clearance between the skirt of the shadow mask and the inside of the side wall of the mask frame at a side and thereby decreasing the clearance at a corner.

That is, the shadow mask is provided with a curved surface having an electron-beam passing hole at its central portion and a skirt folded from the margin of the curved surface and extending in the tube axis direction. A top view obtained by projecting the margin of the curved surface on a plane vertical to the tube axis shows an almost-rectangular shape whose major or minor side is linear or has a curvature concave toward the tube axis and each radius of curvature is RM_1 or RM_2 . Moreover, the mask frame is almost rectangular, whose cross section is almost L-shaped and which includes a side wall extending in the tube axis direction and a flange extending in the direction vertical to the tube axis. A top view obtained by projecting the inside of the fluorescent screen side of the side wall on a plane vertical to the tube axis shows an almost-rectangular shape whose



major or minor side has a curvature concave toward the tube axis. Furthermore, each radius of curvature is $RF1$ or $RF2$, the relation between the above radii of curvatures meets the inequality $RM1 > RF1$ or $RM2 > RF2$, and the skirt of the shadow mask is secured to the side wall of the mask frame.

In this case, it is preferable to set the radii of curvatures of major and minor sides so that the radius of curvature of the margin of the curved surface of the shadow mask is larger than them, that is, the inequalities $RM1 > RF1$ and $RM2 > RF2$ can be obtained. However, when either of major and minor sides meets the above relation, advantages of the present invention can be obtained.

Other structures, functions, and advantages of this embodiment are the same as those of the first embodiment.

Third Embodiment

Figure 9 is a top view of the shadow mask assembly of the third embodiment of the present invention. A portion same as that in Fig. 3 is provided with the same symbol. In the case of this embodiment, the shadow mask 6 is made of invar. Because invar is hard, the skirt 6b is short formed.



Figure 10A shows a sectional view of the major side in Fig. 9, taken along the line A-A in Fig. 9, Figure 10B shows a sectional view of the minor side in Fig. 9, taken along the line B-B in Fig. 9, and Figure 10C shows a sectional view of the corner in fig. 9, taken along the line C-C in Fig. 9.

The feature of this embodiment is that the skirt 6b of the shadow mask is located more closely to the side wall of the mask frame than to the boss 7c formed at the proximal edge between the flange 71a and the side wall 7a, that is, the skirt 6b is located more closely to the fluorescent screen than to the boss 7c formed at the proximal edge. Thereby, even if the skirt 6b of the shadow mask made of invar is shortened, the operability is improved without the shadow mask's reaching the flange 71 of the mask frame because the skirt 6b is located above the boss 7c. Moreover, the mechanical strength of the mask frame is improved by the boss 7c. In this case, a corner does not always require a boss.

That is, the shadow is provided with a curved surface having an electron beam passing hole at its central portion and a skirt folded from the margin of the curved surface and extending in the tube axis direction. Moreover, the mask frame is almost

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rectangular, whose cross section is almost L-shaped and which includes a wide wall extending in the tube axis direction and a flange extending the tube axis in the vertical direction vertical and has a boss

5 including the proximal edge with the flange at its wide wall. Moreover, the skirt of the shadow mask is located more closely to the fluorescent screen than to any one of bosses including the proximal edge with the flange and the shadow mask skirt is secured to the
10 inside of the side wall of the mask frame.

Symbol L_a denotes the distance between the inside of the side-wall front end of the mask frame at a major side and the margin of the curved surface of the shadow mask, L_b denotes the distance between the
15 inside of side-wall front end of the mask frame at a minor side and the margin of the curved surface of the shadow mask, and L_c denotes the distance between the inside of the side-wall front end of the mask frame at a corner and the margin of the curved surface of the
20 shadow mask. In the case of the distances between the inside of the side-wall front end of the mask frame and the margin of the curved surface of the shadow mask, it is preferable that the distance L_c at a corner is smaller than the distance L_a at a major side
25 or the distance L_b at a minor side. This is the same



as the case of the first or second embodiment. That is, because L_a or L_b is larger than L_c , the contact area at a corner increases.

5 Figs. 11A, 11B, and 11C are sectional views of a shadow mask assembly in which a boss of a mask frame is formed at two stages. Figure 11A shows a sectional view of a major side, Figure 11B shows a sectional view of a minor side, and Figure 11C shows a sectional view of a corner. In the case of the major side shown
10 in Fig. 11A and the minor side shown in Fig. 11B, a shallow boss 7c2 is formed above a deep boss 7c1 (fluorescent screen side). However, no boss is formed at the corner shown in Fig. 11C. Moreover, the mask frame 7 is welded with the shadow mask 6 by the
15 shallow boss 7c2 on the major or minor side.

When a boss of the mask frame is formed at a plurality of stages, it is permitted that the skirt of the shadow mask is located above the deepest boss formed at the proximal edge of the side wall of the
20 mask frame with the flange.

By executing the third embodiment together with the first and second embodiments, it is possible to obtain not only the above advantages but also the advantages of these embodiments.

25



Fourth Embodiment

Figure 12 is a top view of the shadow mask of the fourth embodiment of the present invention. A portion same as that in Fig. 3 is provided with the same symbol. In the case of this embodiment, the shadow mask 6 is made of invar.

A feature of this embodiment is that the boss 7c formed at a side of a mask frame is formed on the whole side wall 7a in the height direction. Thereby, it is possible to further improve the adhesion degree between the skirt 6b of the shadow mask and the inside of the side wall 7a of the mask frame at their joint (specifically, the skirt 6b and the inside of the side wall 7a are joined by spot welding). It inevitably becomes difficult to set the shadow mask in the mask frame because the boss 7c is formed up to the top of the side wall 7a. However, this is not a big problem because the region of the boss 7c is small.

Moreover, by forming a tapered portion T at the front end of the portion of the side wall 7c where the boss 7c is formed, it becomes easy to set the shadow mask in the mask frame.

That is, the shadow mask is provided with a curved surface having an electron beam passing hole at its central portion and a skirt folded from the margin



of the curved surface and extending in the tube axis direction. The mask frame is almost rectangular, whose cross section is L-shaped, and which includes a side wall extending in the tube axis direction and a flange extending the tube axis in the vertical direction. The side wall is provided with a portion having a boss between the proximal edge with the flange and the fluorescent screen end of the side wall and the skirt of the shadow mask is secured to the inside of the side wall of the mask frame.

For example, Fig. 13A is a sectional view of the major side in Fig. 12, taken along the line A-A in Fig. 12, in which the tapered portion T is formed at the front end of the portion of the side wall 7a where the boss 7c is formed. Figure 13B is a sectional view of the minor side in Fig. 12, taken along the line B-B in Fig. 12, in which the boss 7c is formed at the front end of the portion of the side wall 7a where the boss 7c is formed. Figure 13C is a sectional view of the corner in Fig. 12, taken along the line C-C in Fig. 12, in which the boss 7c is not formed at the corner or the tapered portion T is not present. Figure 13D is another example when the tapered portion T is formed, in which the top of the frame is tilted outward.

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Fig. 14A is a sectional view of a major side of a shadow mask assembly in which the depth of a boss has two stages, in which the tapered portion T is formed at the front end of the portion of the side wall 7a

5 where the boss is formed. Figure 14B is a sectional view of a minor side of a shadow mask assembly in which the depth of a boss has two stages, which the tapered portion T is formed at the front end of the portion of the side wall 7a where the boss is formed.

10 Figure 14C is a sectional view of a corner of a shadow mask assembly in which a boss whose depth has two stages is formed at a side, in which no boss is formed at corners or the tapered portion T is not present. The advantage of a boss whose depth has two stages is
15 as described in the third embodiment.

Furthermore, by executing the fourth embodiment together with the above first, second, and third embodiments, it is possible to obtain not only the above advantages but also the advantages of those
20 embodiments.





What is claimed is:

1. A color cathode ray tube comprising a tube provided with a panel in which a fluorescent screen is formed, a neck including an electron gun, and a funnel
5 for connecting the panel and the neck in the tube axis direction; and a shadow mask assembly and an inner shield provided for the shadow mask assembly both of which are set in the tube; wherein

the shadow mask assembly includes a shadow mask,
10 a mask frame, and a spring for setting the shadow mask assembly to the panel,

the shadow mask has a curved surface having an electron beam passing hole and a skirt folded from the margin of the curved surface and extending in the tube
15 axis direction, and a top view obtained by projecting the margin on a plane vertical to the tube axis is an almost rectangular shape whose major or minor side has a curvature convex to the tube axis,

the mask frame is almost rectangular, whose cross
20 section is almost L-shaped and which includes a side wall extending in the tube axis direction and a flange extending the tube axis in the vertical direction, and a top view obtained by projecting the inside of the fluorescent screen end of the side wall on a plane
25 vertical to the tube axis is an almost rectangular





shape whose major or minor side is linear or has a curvature concave to the tube axis, and

the skirt of the shadow mask is secured to the inside of the side wall of the mask frame.

5

2. A color cathode ray tube according to claim 1, wherein both major and minor sides of the top view of the margin of the almost rectangular shadow mask have a curvature convex to the tube axis.

10

3. A color cathode ray tube according to claims 1 and 2, wherein a corner R of the top view of the margin of the almost rectangular shadow mask is almost equal to a corner R of the top view of the portion contacting the shadow mask skirt in the side wall of the mask frame in the direction vertical to the tube axis.

15

4. A color cathode ray tube according to claims 1 and 2, wherein the gap between the shadow-mask margin whose top view is almost rectangular and the inside of the mask-frame side wall in the direction vertical to the tube axis is smaller at corners than at the major or minor side of the rectangle.

20

5. A color cathode ray tube according to claims

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1 and 2, wherein a boss is formed on the side wall of a side of the almost rectangular mask frame and the side wall facing the skirt of the shadow mask keeps an almost uniform distance from the shadow mask skirt.

5

6. A color cathode ray tube according to claims 1 and 2, wherein a boss is formed on the side wall of a side of the almost rectangular mask frame but no boss is formed at corners.

10

7. A color cathode ray tube according to claims 1 and 2, wherein the gap between the shadow-mask margin whose top view is almost rectangular and the inside of the mask-frame side wall is smaller at corners than at the axis of the rectangle and the side-wall front end of the mask frame is located more closely to the fluorescent screen than to the margin of the shadow mask at corners.

15

20

8. A color cathode ray tube according to claims 1 and 2, wherein the gap between the shadow-mask margin whose top view is almost rectangular and the inside of the mask-frame side wall is smaller at corners than at the axis of the rectangle and the side-wall front end of the mask frame is located more

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closely to the fluorescent screen than to the margin of the shadow mask on the whole circumference.

5 9. A color cathode ray tube according to claims 1 and 2, wherein a corner of the effective portion of an almost-rectangular shadow mask corresponding to an effective screen and having a hole is a square corner.

10 10. A color cathode ray tube according to claims 1 and 2, wherein the inner shield is set to corners of the almost-rectangular mask frame.

15 11. A color cathode ray tube according to claims 1 and 2, wherein a hole for setting an inner shield by a securing spring is formed on the flange of a corner of the almost-rectangular mask frame.

20 12. A color cathode ray tube according to claims 1 and 2, wherein the shadow mask is made of invar.

13. A color cathode ray tube according to claims 1 and 2, wherein the shadow mask is made of invar, electron beam passing holes is round holes, and the pitch between the round holes is 0.28 mm or less.

25 14. A color cathode ray tube according to claims

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1 and 2, wherein the shadow mask is made of invar,
electron beam passing holes are round holes, the pitch
between the round holes is 0.28 mm or less, and the
interval between three electron beams of the electron
5 gun for generating three electron beams is 5.5 mm or
less on the cathode surface.

15. A color cathode ray tube comprising a tube
provided with a panel in which a fluorescent screen is
10 formed, a neck including an electron gun, and a funnel
for connecting the panel and the neck in the tube axis
direction; and a shadow mask assembly and an inner
shield provided for the shadow mask assembly both of
which are set in the tube; wherein

15 the shadow mask assembly includes a shadow mask,
a mask frame, and a spring for setting the shadow mask
assembly to the panel,

the shadow mask has a curved surface having an
electron beam passing hole and a skirt folded from the
20 margin of the curved surface and extending in the tube
axis direction, and a top view obtained by projecting
the margin on a plane vertical to the tube axis is an
almost rectangular shape whose major or minor side has
a curvature convex to the tube axis, and each radius
25 of curvature is RM1 or RM2,

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the mask frame is almost rectangular, whose cross section is almost L-shaped and which includes a side wall extending in the tube axis direction and a flange extending the tube axis in the vertical direction, and
5 a top view obtained by projecting the inside of the fluorescent screen end of the side wall on a plane vertical to the tube axis is an almost rectangular shape whose major or minor side is linear or has a curvature concave to the tube axis, and each radius of
10 curvature is RF1 or RF2;

the relation between the radii of curvatures meets the inequalities $RM1 > RF1$ or $RM2 > RF2$; and

the shadow-mask skirt is secured to the inside of the side wall of the mask frame.

15

16. A color cathode ray tube according to claim 15, wherein the relation between the radii of curvatures RM1, RM2, RF1, and RF2 meets the inequalities $RM1 > RF1$ and $RM2 > RF2$.

20

17. A color cathode ray tube according to claims 15 and 16, wherein the gap between the shadow-mask margin whose top view is almost rectangular and the inside of the mask-frame side wall in the direction vertical to the tube axis is smaller at corners than
25 at the major or minor side of the rectangle.





18. A color cathode ray tube according to claims
15 and 16, wherein a boss is formed on the side wall
of a side of the almost-rectangular mask frame and the
5 side wall facing the shadow-mask skirt keeps an almost
uniform distance from the shadow-mask skirt at
corners.

19. A color cathode ray tube according to claims
10 15 and 16, wherein a boss is formed on the side wall
of a side of the almost-rectangular mask frame but no
boss is formed at corners.

20. A color cathode ray tube according to claims
15 15 and 16, wherein the gap between the shadow-mask
margin whose top view is almost rectangular and the
inside of the mask-frame side wall is smaller at
corners than at the axis of the rectangle and the
front end of the mask-frame side wall is located more
20 closely to the fluorescent screen than to the shadow-
mask margin at corners.

21. A color cathode ray tube according to claims
15 and 16, wherein the gap between the shadow-mask
25 margin whose top view is almost rectangular and the





inside of the mask-frame side wall is smaller at corners than at the axis of the rectangle and the front end of the mask-frame side wall is located more closely to the fluorescent screen than to the shadow-mask margin on the whole circumference.

22. A color cathode ray tube according to claims 15 and 16, wherein a corner of the effective portion of an almost-rectangular shadow mask corresponding to an effective screen and having a hole is a square corner.

23. A color cathode ray tube according to claims 15 and 16, wherein the inner shield is set to corners of the almost-rectangular mask frame.

24. A color cathode ray tube according to claims 15 and 16, wherein a hole for setting an inner shield by a securing spring is formed on the flange of a corner of the almost-rectangular mask frame.

25. A color cathode ray tube according to claims 15 and 16, wherein the shadow mask is made of invar.

26. A color cathode ray tube according to claims 15 and 16, wherein the shadow mask is made of invar

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and electron beam passing holes are round holes, and the pitch between the round holes is 0.28 mm or less.

27. A color cathode ray tube according to claims
5 15 and 16, wherein the shadow mask is made of invar, electron beam passing holes are round holes, the pitch between the round holes is 0.28 mm or less, and the interval between three electron beams of the electron gun for generating three electron beams is 5.5 mm or
10 less on the cathode surface.

28. A color cathode ray tube comprising a tube provided with a panel in which a fluorescent screen is formed, a neck including an electron gun, and a funnel
15 for connecting the panel and the neck in the tube axis direction; and a shadow mask assembly and an inner shield provided for the shadow mask assembly both of which are set in the tube; wherein

the shadow mask assembly includes a shadow mask
20 made of invar, a mask frame, and a spring for setting the shadow mask assembly to the panel,

the shadow mask has a curved surface having an electron beam passing hole and a skirt folded from the margin of the curved surface and extending in the tube
25 axis direction,

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the mask frame is almost rectangular, whose cross section is almost L-shaped and which includes a side wall extending in the tube axis direction and a flange extending the tube axis in the vertical direction, and

5 the side wall is provided with a boss including a proximal edge with a flange, the shadow-mask skirt is located more closely to the fluorescent screen than to any one of bosses including a proximal edge with the flange, and the shadow-mask skirt is secured to the
10 inside of the mask-frame side wall.

29. A color cathode ray tube according to claim 28, wherein the mask-frame side wall has a first boss including a proximal edge between the side wall and a
15 flange and a second boss formed at an almost same position in the frame circumference direction and more closely to the fluorescent screen than to the first boss and having a depth smaller than that of the first boss, and the skirt of a shadow mask is present at the
20 fluorescent screen side of the first boss.

30. A color cathode ray tube according to claims 28 and 29, wherein the bosses are not present at corners.

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31. A color cathode ray tube according to claim
28, wherein

a top view obtained by projecting the shadow-mask
margin on a plane vertical to the tube axis is an
5 almost-rectangular shape whose major or minor side has
a curvature convex to the tube axis, and

a major or minor side of a top view obtained by
projecting the inside of the fluorescent screen end of
the mask-frame side wall on a plane vertical to the
10 tube axis is linear or has a curvature concave to the
tube axis.

32. A color cathode ray tube according to claim
28, wherein

15 a top view obtained by projecting the shadow-mask
margin on a plane vertical to the tube axis is an
almost-rectangular shape whose major or minor side has
a curvature convex to the tube axis, and

a major or minor side of a top view obtained by
20 projecting the inside of the fluorescent screen end of
the mask-frame side wall in the direction vertical to
the tube axis is linear or has a curvature concave to
the tube axis.

33. A color cathode ray tube according to claim.
25 28, wherein a top view obtained by projecting the

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shadow-mask margin on a plane vertical to the tube axis is an almost-rectangular shape whose major or minor side is linear or has a curvature concave to the tube axis and each curvature is RM1 or RM2, a top view
5 obtained by projecting the inside of the fluorescent screen end of the mask-frame side wall on a plane vertical to the tube axis is an almost-rectangular shape whose major or minor side has a curvature concave i to the tube axis and each radius of
10 curvature is RF1 or RF2, and the relation between the radii of curvatures meets the inequality $RM1 > RF1$ or $RM2 > RF2$.

34. A color cathode ray tube according to claim
15 28, wherein a top view obtained by projecting the shadow-mask margin on a plane vertical to the tube axis is an almost-rectangular shape whose major or minor side is linear or has a curvature concave to the tube axis and each curvature is RM1 or RM2, a top view
20 obtained by projecting the inside of the fluorescent screen end of the mask-frame side wall on a plane vertical to the tube axis is an almost-rectangular shape whose major or minor side has a curvature concave to the tube axis and each radius of curvature
25 is RF1 or RF2, and the relation between the radii of





curvatures meets the inequalities $RM1 > RF1$ and $RM2 > RF2$.

35. A color cathode ray tube according to claim
5 28, wherein the distance between the shadow-mask
margin and the inside of the mask-frame side wall in
the direction vertical to the tube axis is smaller at
corners than at the major or minor side of the
rectangle.

10

36. A color cathode ray tube according to claims
28, 29, and 34, wherein the electron beam passing
holes of the shadow mask are round holes, the pitch
between the holes is 0.28 mm or less, and the interval
15 between three electron beams of the electron gun for
generating three electron beams is 5.5 mm or less on
the cathode surface.

37. A color cathode ray tube comprising a tube
20 provided with a panel in which a fluorescent screen is
formed, a neck including an electron gun, and a funnel
for connecting the panel and the neck in the tube axis
direction; and a shadow mask assembly and an inner
shield provided for the shadow mask assembly both of
25 which are set in the tube; wherein

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the shadow mask assembly includes a shadow mask made of invar, a mask frame, and a spring for setting the shadow mask assembly to the panel,

5 the shadow mask has a curved surface having an electron beam passing hole and a skirt folded from the margin of the curved surface and extending in the tube axis direction,

10 the mask frame is almost rectangular, whose cross section is almost L-shaped and which includes a side wall extending in the tube axis direction and a flange extending the tube axis in the vertical direction, and

15 the side wall is provided with a portion having a boss between the proximal edge with a flange and the fluorescent screen end of the side wall and the shadow-mask skirt is secured to the inside of the mask-frame side wall.

38. A color cathode ray tube according to claim 37, wherein the mask-frame side wall has a first boss including a proximal edge between the side wall and a flange and a second boss formed at an almost same position in the frame circumference direction and more closely to the fluorescent screen than to the first boss and having a depth smaller than that of the first boss, the skirt of a shadow mask is present at the

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fluorescent screen side of the first boss, and the shadow-mask skirt is located more closely to the fluorescent screen than to the first boss.

5 39. A color cathode ray tube according to claims 37 and 38, wherein the bosses are not present at corners.

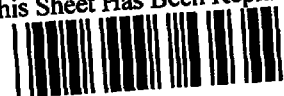
10 40. A color cathode ray tube according to claims 37 and 38, wherein a tapered portion is formed at the fluorescent screen end of a boss formed up to the fluorescent screen end of the mask-frame side wall toward the inside of the mask frame.

15 41. A color cathode ray tube according to claim 37, wherein

a top view obtained by projecting the shadow-mask margin on a plane vertical to the tube axis is an almost rectangular shape whose major or minor side has
20 a curvature convex to the tube axis, and

a major or minor side of a top view obtained by projecting the inside of the fluorescent screen end of the mask-frame side wall on a plane vertical to the tube axis is linear or has a curvature concave to the
25 tube axis.

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42. A color cathode ray tube according to claim
37, wherein

5 a top view obtained by projecting the shadow-mask
margin on a plane vertical to the tube axis is an
almost-rectangular shape whose major or minor side has
a curvature convex to the tube axis, and

10 a major or minor side of a top view obtained by
projecting the inside of the fluorescent screen end of
the mask-frame side wall on a plane vertical to the
tube axis is linear or has a curvature concave to the
tube axis.

43. A color cathode ray tube according to claim
15 37, wherein a top view obtained by projecting the
shadow-mask margin on a plane vertical to the tube
axis is an almost-rectangular shape whose major or
minor side is linear or has a curvature concave to the
tube axis, each radius of curvature is RF1 or RF2, a
20 top view obtained by projecting the inside of the
fluorescent surface end of the mask-frame side wall on
a plane vertical to the tube axis is an almost-
rectangular shape whose major or minor side has a
curvature concave toward the tube axis and each radius
25 of curvature is RF1 or RF2, and the relation between





the radii of curvatures meets the inequality $RM1 > RF1$
or $RM2 > RF2$.

44. A color cathode ray tube according to claim
5 37, wherein a top view obtained by projecting the
shadow-mask margin on a plane vertical to the tube
axis is an almost-rectangular shape whose major or
minor side is linear or has a curvature concave to the
tube axis and each radius of curvature is $RM1$ or $RM2$,
10 and a top view obtained by projecting the inside of
the fluorescent screen end of the mask frame side wall
on a plane vertical to the tube axis is an almost-
rectangular shape whose major or minor side is linear
or has a curvature concave to the tube axis and each
15 radius of curvature is $RF1$ or $RF2$, and the relation
between the radii of curvatures meets the inequalities
 $RM1 > RF1$ and $RM2 > RF2$.

45. A color cathode ray tube according to claims
20 37, 38, 41, and 43, wherein the distance between the
shadow-mask margin and the inside of the mask-frame
side wall in the direction vertical to the tube axis
is smaller at corners than at the major or minor axis
of the rectangle.

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46. A color cathode ray tube according to claims
37, 38, 41, and 43, wherein the electron beam passing
holes on the shadow mask are round holes, the pitch
between the holes is 0.28 mm or less, and the interval
5 between three electron beams of the electron gun for
generating three electron beams is 5.5 mm or less on
the cathode surface.

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