

CATHODE RAY TUBE AND COLOR SELECTION MECHANISM

BACKGROUND OF THE INVENTION

The present invention relates to a cathode ray tube used for TV sets, displays for computers, etc. and a color selection mechanism mounted in the cathode ray tube.

Referring to FIG. 1, there is shown a color cathode ray tube including a phosphor panel 11 having, on its inner side, a phosphor screen composed of color phosphors of red (R), green (G), and blue (B), a funnel 13 joined to the phosphor panel 11 via a frit seal portion 12, an electron gun 14 enclosed in a neck portion of the funnel 13, and a color selection mechanism 20 mounted on the inner side of the phosphor panel 11.

The color selection mechanism 20 is used for allowing an electron beam of each color emitted from the electron gun 14 to selectively pass therethrough. For this purpose, the color selection mechanism 20 includes, as shown in FIG. 2, a thin plate like color selection mask 21 on which electron beam apertures (small apertures or slit apertures) are arrayed in a specific pattern, and a rectangular frame 22 for supporting the color selection mask 21.

The color selection mask 21, if it is of a

Trinitron (registered trademark by Sony Corporation) type, has a plurality of rows of stripe-shaped slit apertures 21a as the electron beam apertures because stripe phosphors are arrayed on the phosphor panel 11.

Plate spring like supporting spring members 24 for mounting the color selection mechanism 20 to the phosphor panel 11 are mounted on the frame 22 via holders 23. Each supporting spring member 24 has, on its one end side, a lock hole.

Fixing pins 11a, each corresponding to the lock hole of the supporting spring member 24, are provided on an inner peripheral surface of the phosphor panel 11. The color selection mechanism 20 is mounted on the inner surface side of the phosphor panel 11 by inserting the fixing pins 11a in the lock holes of the supporting spring members 24.

The color selection mechanism 20 thus mounted on the inner side of the phosphor panel 11 possibly causes thermal expansion by the effect of electron beams emitted from the electron gun 14. The thermal expansion of the color selection mechanism 20 causes positional displacement of the slit apertures 21a of the color selection mechanism 21 relative to a phosphor screen of the phosphor panel 11, resulting in image deterioration

such as color shift.

To correct the positional displacement of the color selection mechanism 20 caused by thermal effect exerted thereon, the holder 23 interposed between the frame 22 and the supporting spring members 24 are made from a bimetal material. Even when the color selection mechanism 20 is subjected to thermal effect, the positional displacement of the color selection mechanism 20, particularly, a gap between the color selection mask 21 and the phosphor screen (hereinafter, such a gap is referred to as "grille height (GH)" can be optimized by making use of curved displacement of the bimetal material.

The supporting spring members 24 are generally mounted to the frame 22 of the color selection mechanism 20 as shown in FIGS. 3A and 3B. FIG. 3A shows a symmetric type mounting manner, in which the supporting members 24 opposed to each other are symmetric to each other, and FIG. 3B shows a so-called windmill type mounting manner, in which all the supporting spring members 24 are directed in the same rotational direction.

Each mounting type, however, has the following problem; namely, particularly, in the long-side direction (X direction in FIGS. 3A and 3B) of the color selection mechanism 20, each joint portion between the supporting

spring member 24 and the long-side frame member of the frame 22 is not provided at a center position (on the Y axis in FIGS. 3A and 3B) of the color selection mechanism 20 but offset therefrom. Accordingly, if the long-side frame members of the frame 22 are expanded by thermal effect exerted thereon, the whole color selection mechanism 21 is shifted in the X direction (hereinafter, referred to "X-shift"), thereby causing image deterioration such as color shift. In particular, if the slit apertures 21a of the color selection mask 21 are stripe-shaped, the X-shift in the direction perpendicular to the longitudinal direction of the slit apertures 21a causes a serious problem.

Such an X-shift occurs by curved deformations of the holders 23. When the color selection mechanism 20 is thermally expanded by the effect of electron beams, as shown in FIG. 4A, each holder 23 made from the bimetal material is heated and thereby curvedly deformed as shown by an arrow A. As shown in FIG. 4B, if it is assumed that the fixing pin 11 is movable, the supporting spring member 24 connected to the holder 23 is also inclinedly deformed by the curvedly deformed amount δ of the holder 23 (see ΔGH in the figure). In actual, however, the fixing pin 11a is not movable, with a result that the

whole color selection mechanism 20 is moved in the direction where it comes close to the inner surface of the phosphor panel 11 (in the direction shown by an arrow Z). The temperature compensation of the color selection mechanism 20 is thus performed. However, since the holders 23 are each not provided on the Y-axis of the color selection mechanism 20, the whole color selection mechanism 20 is slightly moved in the rotational direction (shown by character W in FIGS. 3A and 3B) by the effect of the curvedly deformed amount δ caused at the time of performing temperature compensation, thereby causing the X-shift.

As shown in FIG. 4C, the X-shift of the color selection mechanism 20 causes the color selection mask 21 to be shifted in the direction X. As a result, a landing position of an electron beam on the phosphor screen, at which the electron beam which has passed through the slit aperture 21a of the color selection mask 21 arrives, is shifted ($P \rightarrow P'$), thereby causing image deterioration such as color shift.

To suppress the curved deformation of each holder 23, which is one of factors causing the X-shift, it may be considered to reduce the curvedly deformed amount δ of the holder 23 by shortening a height of the supporting

spring member 24, that is, a distance between the holder 23 and the fixing pin 11a (which is designated by character "d" in FIG. 4A); however, if the curvedly deformed amount δ of the holder 23 is reduced, it becomes difficult to ensure a deformed amount ΔGH at the time when the color selection mechanism 20 is made closer to the inner surface side of the phosphor panel 11. That is to say, as the curvedly deformed amount δ of each holder 23 made from the bimetal material becomes larger, the X-shift of the color selection mechanism 20 becomes larger; however, if the curvedly deformed amount δ of the holder 23 is less than a specific value, it is difficult to optimize the grille height (GH) when the color selection mechanism 20 is subjected to thermal effect.

Such a problem becomes serious particularly if the long-side frame member of the frame 22 is made from a material having a large thermal expansion coefficient. To be more specific, if the long-side frame member of the frame 22 is made from a material having a large thermal expansion coefficient, it is essential to increase the curvedly deformed amount δ of the holder 23, so that the X-shift of the color selection mechanism 20 may be increased. Accordingly, for a high definition cathode ray tube used as a display for computers, since an allowable

color shift is set to a small value, a long-side frame member of a frame must be made from a relatively expensive material having a small thermal expansion coefficient, thereby raising the material cost.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a cathode ray tube capable of suppressing occurrence of X-shift due to thermal effect, and increasing a tolerance to image deterioration such as color shift by optimizing a grille height, thereby enhancing an image quality, and to provide a color selection mechanism mounted in the cathode ray tube.

To achieve the above object, according to a first aspect of the present invention, there is provided a cathode ray tube including: a frame to which a color selection mask having electron beam apertures is stretchingly mounted; and a plate spring like supporting spring member for supporting the frame; wherein the supporting spring member is made from a material having a thermal expansion coefficient larger than that of a frame member of the frame.

According to the above object, according to a second aspect of the present invention, there is provided

a color selection mechanism mounted in a cathode ray tube, including: a frame to which a color selection mask having electron beam apertures is stretchingly mounted; and a plate spring like supporting spring member for supporting the frame; wherein the supporting spring member is made from a material having a thermal expansion coefficient larger than that of a frame member of the frame.

With these configurations of the cathode ray tube and the color selection mechanism, since the thermal expansion coefficient of the supporting spring member is larger than that of the frame member of the frame, even if a joint portion between the supporting spring member and the frame member of the frame is offset, the X-shift of the frame member due to the offset can be corrected by the thermal expansion of the supporting spring member; and even if the bimetal supporting member is interposed between the supporting spring member and the frame member of the frame, the effect due to the curved deformation of the bimetal supporting member is corrected by the thermal expansion of the supporting spring member.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view showing a configuration example of a general cathode ray tube;

FIG. 2 is a perspective view showing a configuration example of a color selection mechanism used for a cathode ray tube;

FIGS. 3A and 3B are views showing mounting examples of supporting spring members in a cathode ray tube;

FIGS. 4A and 4B are views schematically showing a supporting structure of a color selection mechanism, and FIG. 4C is a view schematically showing an occurrence state of color shift;

FIG. 5 is a conceptual view showing an essential portion of a supporting structure of a color selection mechanism of the present invention;

FIG. 6 is a diagram showing a change in color shift depending on a difference in thermal expansion coefficient between a long-side frame member of a frame of a color selection mechanism and a supporting spring member; and

FIG. 7A is a diagram showing a pattern of color shift before correction of X-shift, and FIG. 7B is a diagram showing a pattern of color shift after correction of X-shift.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A cathode ray tube and a color selection mechanism

according to the present invention will be hereinafter described with reference to the accompanying drawings.

A cathode ray tube and a color selection mechanism according to an embodiment of the present invention have basic configurations similar to those of the related art cathode ray tube and color selection mechanism which have been already described with respect to FIGS. 1, 2, and 3A and 3B, and further, shapes of parts constituting the cathode ray tube and the color selection mechanism according to this embodiment are also similar to those of the parts constituting the related art cathode ray tube and color selection mechanism. Specifically, according to this embodiment, as shown in FIG. 5, a supporting structure of the color selection mechanism is configured such that supporting spring members 1 are individually mounted to frame members 3 of a frame via holders 2 made from a bimetal material, whereby the color selection mechanism is supported in the cathode ray tube.

According to the cathode ray tube and the color selection mechanism in this embodiment, however, a material of the supporting spring member 1 is significantly different from the material of the related art supporting spring member. More specifically, a thermal expansion coefficient of the material of the

supporting spring member 1 is set to be larger than a thermal expansion coefficient of a material of the frame member 3 of the frame of the color selection mechanism.

As the material of the frame member 3 of the frame, there is used a stainless steel or a chromium-molybdenum steel. A chromium-molybdenum steel has a thermal expansion coefficient larger than that of a stainless steel but is advantageous in that it is relatively inexpensive. In addition, the frame members 3 of the frame may often include long-side frame members (A members) and short-side frame members (B members); however, according to this embodiment, it is assumed that the long-side frame member and the short-side frame member are made from the same material.

The supporting spring member 1 is made from a material which has a thermal expansion coefficient larger than that of the material of the frame member 3 of the frame, with a difference therebetween being specified in a range of by $2.0 \times 10^{-6}/^{\circ}\text{C}$ to $6.5 \times 10^{-6}/^{\circ}\text{C}$.

In particular, if the frame member 3 is made from a chromium-molybdenum steel, the supporting spring member 1 is made from a material which has a thermal expansion coefficient larger than that of the material of the frame member 3, with a difference therebetween being specified,

as shown in FIG. 6, in a range of $3.5 \times 10^{-6}/^{\circ}\text{C}$ to $6.5 \times 10^{-6}/^{\circ}\text{C}$ (shown by hatching in the figure).

The material of the supporting spring member 1 is also specified to have a mechanical strength of a specific value or more, specifically, specified such that a degree of permanent set of elasticity thereof is set to be 10% or less at normal temperature (about 25°C) and to be 25% or less in an environment higher than normal temperature.

The degree of permanent set of elasticity of the supporting spring member 1 is determined by a pressing test. In this pressing test, the supporting spring member 1 is repeatedly subjected to elastic deformation, and a degree of permanent set of the supporting spring member 1 is measured. Concretely, the permanent set of the spring is determined by a change in free length of the spring before and after the pressing test. Accordingly, the degree of permanent set of the spring in a range of 10% or less at normal temperature means that, as a result of the pressing test at normal temperature, a change in free length of the spring before and after the pressing test is in a range of 0 to 10%. Meanwhile, the degree of permanent set of the spring in a range of 25% or less in a high temperature environment means that, as a result of

the pressing test in a temperature environment equivalent to a heat-treatment temperature for the cathode ray tube (for example, about 470°C X15 minutes), a change in free length of the spring before and after the pressing test is in a range of 0 to 25%. It is to be noted that conditions for the pressing test (for example, pressing force and elastically deformed amount) may be suitably determined on the basis of an elastic modulus, allowable deformed amount, and the like of the supporting spring member 1.

As the material of the supporting spring member 1, which satisfies the above requirements, there may be used a spring steel containing manganese (Mn) and chromium (Cr), the balance being iron (Fe), more specifically, a spring steel containing a large amount of Mn and a small amount of Cr, the balance being Fe, or a spring steel containing a small amount of Mn and a large amount of Cr, the balance being Fe.

The supporting spring member 1 made from the above-described material has the following advantage: namely, since the thermal expansion coefficient of the supporting spring member 1 is larger than that of the frame member 3 of the frame, even if the joint portions between the supporting spring members 1 and the frame members 3 are

offset, the X-shift of the color selection mechanism caused by the offset is corrected by the thermal expansions of the supporting spring members 1. More specifically, even if the joint portions between the supporting spring members 1 and the frame members 3 in the long-side direction of the color selection mechanism are offset from the center positions of the color selection mechanism, since the thermal expansion coefficient of the supporting members 1 is larger than that of the frame members 3 of the frame, the X-shift due to the thermal expansions of the frame members 3 are corrected by deformations of the supporting spring members 1 in the direction opposed to the X-shift, with a result that image deterioration such as color shift can be suppressed.

The correction by thermal expansion of the supporting spring member 1 is also effective for the X-shift caused by curved deformation of the holder 2 interposed between the supporting spring member 1 and the frame member 3. To be more specific, when being subjected to thermal effect of electron beams, the color selection mechanism causes the X-shift by an elongation of the frame member 3 of the frame due to thermal expansion thereof (see (1) of FIG. 5) and an inclination of the

holder 1 due to curved deformation thereof (see (2) of FIG. 5); however, since the supporting spring member 1 is made from the material having the thermal expansion coefficient larger than that of the frame member 3, an elongation of the supporting spring member 1 due to thermal expansion thereof becomes larger than the total deformation of (1) and (2), to thereby suppress the X-shift of the whole color selection mechanism.

If the elongation of the supporting spring member 1 due to thermal expansion thereof is set with the inclination of the holder 2 due to curved deformation thereof taken into account, the X-shift can be suppressed without reducing the curvedly deformed amount of the holder 2, so that it is possible to optimize the grille height (GH) when the color selection mechanism is subjected to thermal effect.

The thermal expansion coefficient of the supporting spring member 1 with the curvedly deformed amount of the holder 2 taken into account is, as described above, set to be larger than that of the frame member 3, with a difference therebetween being specified in the range of $2.0 \times 10^{-6}/^{\circ}\text{C}$ to $6.5 \times 10^{-6}/^{\circ}\text{C}$. In particular, in the case where the frame member 3 is made from a chromium-molybdenum steel, the thermal expansion coefficient of

the supporting spring member 1 is, as described above, preferably set to be larger than that of the frame member 3, with a difference therebetween being specified in the range of $3.5 \times 10^{-6}/^{\circ}\text{C}$ to $6.5 \times 10^{-6}/^{\circ}\text{C}$. In the latter case, since the thermal expansion coefficient of a chromium-molybdenum steel is larger than that of a stainless steel, the difference in thermal expansion coefficient between the supporting spring member 1 and the frame member 3 is specified with not only the inclination of the holder 2 due to curved deformation thereof but also the thermal expansion of the frame member 3 taken into account.

In this way, by suppressing the X-shift of the whole color selection mechanism, the cathode ray tube using the color selection mechanism can increase a tolerance to image deterioration such as color shift even when the color selection mechanism is subjected to thermal effect of electron beams. According to the related art cathode ray tube, as shown in FIG. 7A, random color shift or the like occurs in each region on a screen resulting from the X-shift of the whole color selection mechanism. According to the cathode ray tube of the present invention, as shown in FIG. 7B, even when the color selection mechanism is subjected to thermal effect of electron beams, color shift or the like is made as

small as possible near a central portion of the screen (near the Y-axis of the color selection mechanism), and amounts of color shift or the like are equalized near both ends of the screen. As a result, a quality of an image displayed on the cathode ray tube of the present invention is superior to a quality of an image displayed on the related art cathode ray tube.

According to the above-described color selection mechanism and the cathode ray tube using the color selection mechanism, since the X-shift of the color selection mechanism can be corrected without reducing the curvedly deformed amount of the holder 2, a tolerance to image deterioration such as color shift can be further increased, so that a quality of an image displayed on the cathode ray tube can be significantly enhanced. This contributes to extension of the degree of freedom in curved deformation of the holder 2. Specifically, when the thermal expansion coefficient of the supporting spring member 1 is changed into a value required for the color selection mechanism, the curvedly deformed amount of the holder 2 can be set while being not limited by the X-shift. As a result, it is possible to extend the freedom in design of each of the color selection mechanism and the whole cathode ray tube.

In particular, in the case where the frame member 3 is made from a chromium-molybdenum steel, by setting the difference in thermal expansion coefficient between the supporting spring member 1 and the frame member 3 to a value ranging from $3.5 \times 10^{-6}/^{\circ}\text{C}$ to $6.5 \times 10^{-6}/^{\circ}\text{C}$, as shown in FIG. 6, an average amount of color shift near the center of the screen (near the Y-axis of the color selection mechanism) can be suppressed in a range of $\pm 3\%$. As a result, even if a chromium-molybdenum steel which is relatively inexpensive but has a large thermal expansion coefficient is used as the material of the frame member 3, it is possible to realize a cathode ray tube capable of exhibiting an excellent image quality. Specifically, for a high definition cathode ray tube in which an allowable color shift amount is set to a small value and which is used as a display for computers, since a chromium-molybdenum steel can be used as the material of the frame member 3, it is possible to reduce the material cost as compared with the related art cathode ray tube. Further, according to the present invention, the frame 3 made from a chromium-molybdenum alloy can be commonly used for a frame of a TV set in which an allowable color shift amount is set to a value larger than that in a high definition cathode ray tube.

According to this embodiment, the thermal expansion coefficient of the supporting spring member 1 is set to be larger than that of the frame member 3; however, since the degree of permanent set of elasticity of the supporting spring member 1 is set to be 10% or less at normal temperature and 25% or less in a high temperature environment, the mechanical strength of the supporting spring member 1 can be kept at a specific level or more, with a result that the quality of the cathode ray tube can be prevented from being degraded.

The arrangement of the supporting spring members 1 described in this embodiment may be determined in accordance with a mounting state of the supporting spring members in the color selection mechanism 20. For example, in the symmetric mounting manner shown in FIG. 3A, in which the supporting members opposed to each other are symmetric, the four supporting spring members on the long-side and short-side or the two supporting spring members on the long-side may be replaced with the supporting spring members 1 described in this embodiment. In the windmill type mounting manner shown in FIG. 3B, in which all the supporting spring members are directed in the same rotational direction, only one of the supporting spring members may be replaced with the supporting spring

member 1 described in this embodiment in accordance with the rotational direction (shown by character W) due to thermal effect.

As described above, according to the cathode ray tube and the color selection mechanism of the present invention, since the thermal expansion coefficient of the supporting spring member is larger than that of the frame member of the frame, even if the joint portions between the supporting spring members and the frame members of the frame are offset, the X-shift of the color selection mechanism due to the offset can be corrected by the thermal expansions of the supporting spring members. That is to say, even if the color selection mechanism is subjected to thermal effect of electron beams, a tolerance to image deterioration such as color shift can be increased. Further, the grille height can be optimized irrespective of correction of the X-shift. Accordingly, it is possible to enhance a display image quality obtained by the cathode ray tube and the color selection mechanism according to the present invention as compared with a display image quality obtained by the related art cathode ray tube and color selection mechanism.

While the preferred embodiment of the present invention has been described using specific terms, such

description is for illustrative purposes only, and it is to be understood that changes and variations may be made without departing from the spirit or scope of the following claims.



CLAIMS

1. Apparatus for a cathode ray tube comprising:
a frame on which a colour selection mask having electron beam apertures is stretchingly mounted; and
a plate spring like supporting spring member for supporting said frame;
wherein said supporting spring member is made from a material having a thermal expansion coefficient larger than that of a frame member of said frame.
2. Apparatus according to claim 1,
wherein said supporting spring member is mounted on said frame member via a bimetal supporting member which is curvedly deformed by heat given thereto.
3. Apparatus according to claim 1 or 2,
wherein the difference in thermal expansion coefficient between said supporting spring member and said frame member is in a range of from $2.0 \times 10^{-6}/^{\circ}\text{C}$ to $6.5 \times 10^{-6}/^{\circ}\text{C}$.
4. Apparatus according to claim 3, wherein said frame member is made from a chromium-molybdenum steel and the difference in thermal expansion coefficient between said supporting spring member and said frame member is in a range of from $3.5 \times 10^{-6}/^{\circ}\text{C}$ to $6.5 \times 10^{-6}/^{\circ}\text{C}$.
5. Apparatus according to any one of the preceding claims,



wherein said material of said supporting spring member has a degree of a permanent set of elasticity in a range of 10% or less at normal temperature and 25% or less at a temperature higher than normal temperature.

6. A colour selection mechanism for mounting in a cathode ray tube, comprising apparatus according to any one of the preceding claims.

7. A cathode ray tube including apparatus according to any one of claims 1 to 5.

8. A cathode ray tube having a colour selection mechanism according to claim 6 mounted therein.

9. A television or monitor comprising a cathode ray tube according to claim 7 or 8.