

TITLE OF THE INVENTION

METHOD FOR MANUFACTURING COLOR CATHODE RAY TUBE

BACKGROUND OF THE INVENTIONField of the Invention

The present invention relates to a method for manufacturing a color cathode ray tube, and more particularly to the method for manufacturing a color cathode ray tube which method is arranged to use a correction lens for determining a target spot of ultraviolet rays according to transformation of a panel glass resulting from its thermal expansion, for forming a phosphor screen.

Description of Prior Art

Conventionally, there has been proposed a one-gun three-beam type electron gun for cathode ray tube. If this type of cathode ray tube is a color tube, it is arranged so that an electron beam fired by an electron gun is passed through an aperture grill (color selecting mechanism) having a plurality of lengthwise patterned slits and applied onto the phosphor screen. In response to the application of the electron beam onto the phosphor screen, the predetermined number of phosphor are made active so that the image corresponding to the active phosphor is displayed on the screen. The phosphor screen of the cathode ray tube is composed of a carbon stripe for lowering a reflection factor of the screen against the ambient light and enhancing the contrast of the screen and red, green and blue phosphor each formed adjacently to the carbon stripe and in a

striped manner.

In the cathode ray tube arranged as described above, when the TV set is powered, a color signal outputted from a color signal input circuit is applied into an electron gun, so that an electron beam is fired to the phosphor screen. The electron beam fired by the electron gun is deflected by a magnetic field of a deflecting coil. Then, the deflected beam is passed through the slits of the aperture grill and then is applied onto the predetermined area of the phosphor screen. In response to the application of the deflected beam, the phosphor stripes are made active so that the corresponding image to the active phosphor is displayed on a face portion.

The carbon stripe as mentioned above is formed as follows.

At first, photoresist is coated and thermodried on an inner surface of a panel glass 14 served as a phosphor screen. Then, as shown in Fig.1, ultraviolet rays from a light source 15 passes through lengthwise patterned slits 16a of an aperture grill 16 and then is applied onto the photoresist. The corresponding photoresist to the UV-applied portion is sintered on the inner surface of the panel glass 14. On the other hand, the other portion of the photoresist is washed out. These series of operations result in forming a striped photoresist film. The ultraviolet rays fired from the light source 15 pass through a correction lens system 17 composed of plural kinds of lenses, through which the target spot of the ultraviolet rays is determined.

Then, on the inner surface of the panel glass 14 having

this photoresist film formed thereon, carbon slurry is evenly coated. Next, the carbon slurry is thermodried and reversely developed. These operations result in forming the carbon stripe on the area where no photoresist stripe is formed, that is, no ultraviolet rays are applied.

The phosphor stripe as mentioned above is formed as follows.

At first, any one of red, green and blue phosphor slurries is coated on the inner surface of the panel glass 14 having the carbon stripe formed thereon and then is thermodried. Then, the ultraviolet rays from the light source 15 are fired onto the thermodried phosphor slurry through the lengthwise patterned slits 16a of the aperture grill 16. The application of the ultraviolet rays employs the correction lens system used for forming the carbon stripe. The phosphor slurry on the UV-applied portion is exposed and developed for forming any one of the red, green and blue phosphor stripes. By repeating the abovementioned process three times, it is possible to form each of the red, green and blue phosphor stripes.

By this operation, the combinations of the black carbon stripe and the phosphor stripe formed adjacently to this carbon stripe compose the phosphor screen.

As described above, the carbon stripe is formed on the area where no ultraviolet rays are applied, so that the phosphor stripes are formed on the area where the ultraviolet rays are applied. The correction lens system 17 used for the exposure done in forming the carbon stripe is also used for the

exposure done in forming the phosphor stripes. The phosphor stripes are formed on the inner surface of the panel glass 14 adjacently to the carbon stripe.

However, the panel glass 14 having the carbon stripes and the phosphor stripes formed thereon is minutely transformed mainly by thermal expansion in the process for thermodrying the photoresist and the phosphor slurry. Then, in the process for thermodrying the photoresist, the quantity of heat needed for thermodrying the photoresist is different from the quantity of heat needed for thermodrying the phosphor slurry. Hence, the transformation of the panel glass 14 in the process for thermodrying the photoresist is made different from the transformation of the panel glass 14 in the process for thermodrying the phosphor slurry. As a result, in a case that the correction lens system 17 used for the exposure done in forming the carbon stripe is used for the exposure done in forming the phosphor stripe, as shown in Fig.2, the phosphor stripes RS, GS, and BS are formed so that each stripe is passed over the carbon stripe CS into the adjacent area where the other color phosphor stripe is formed. As a result, when the image is displayed on the face portion, the manufactured color cathode ray tube degrades its white uniformity and brings about a defective portion resulting from protrusion of one color phosphor stripe to another color phosphor stripe.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to

provide a method for manufacturing a color cathode ray tube which method is arranged to use a correction lens system for exposure done in forming carbon stripes and another correction lens system for exposure done in forming color phosphor stripes for the purpose of correcting the target spots of the ultraviolet rays according to each transformation of the panel glass in the process for forming the carbon stripe or in the process for forming the phosphor stripe and thereby inhibiting to slip the target spot of the ultraviolet rays.

In carrying out the object, a method for manufacturing a color cathode ray tube according to an aspect of the invention includes the two main steps of forming carbon stripes and forming phosphor, the first main step of forming carbon stripes having the subsets of coating and thermodrying photoresist on an inner surface of a panel glass, exposing the photoresist through a first correction lens system for determining a color selection mechanism and a UV target spot, forming a carbon film on the inner surface of the panel glass after the exposure, and stripping the carbon film and reversely developing the photoresist, and the second main step of forming phosphor having the subsets of coating and thermodrying phosphor slurries on the inner surface of the panel glass after forming the carbon stripes, exposing the phosphor slurries through a second correction lens system for determining a UV target area according to each transformation of the panel glass for the color selecting mechanism and the thermodrying, and developing the phosphor slurries.

In the method for manufacturing a color cathode ray tube as described above, the first correction lens system operates to correct the UV target spot according to the transformation of the panel glass in the process for forming the carbon stripes. The second correction lens system operates to correct the UV target spot according to the transformation of the panel glass in the process for forming the phosphor stripes. Hence, the shift of the UV target spot in each process is modified so that the carbon stripes and the phosphor stripes are formed at the respective right locations.

BRIEF DESCRIPTION OF THE DRAWINGS

Other characteristics and advantages of the present invention appear more clearly from the following description and with reference to the accompanying drawings, in which:

Fig.1 is a model view exemplarily showing an exposure system used in the conventional method for manufacturing a cathode ray tube;

Fig.2 is an enlarged section showing an essential portion of a phosphor screen formed by the conventional method for manufacturing a cathode ray tube;

Fig.3 is a schematic perspective view for describing an internal structure of a cathode ray tube;

Fig.4 is an explanatory view showing a process for forming a phosphor screen;

Fig.5 is a schematic longitudinal section showing an exposing device;

Fig.6 is a model view exemplarily showing an exposing system provided in the process for exposing photoresist;

Fig.7 is a model view exemplarily showing an exposing system provided in the process for exposing a phosphor slurry; and

Fig.8 is an enlarged section showing an essential portion of a phosphor screen formed by the method for manufacturing a cathode ray tube according to the present invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

Later, the preferred embodiments of the present invention will be described in detail with reference to the appended drawings.

As shown in Fig.3, a single gun three-beam system cathode ray tube 1 is composed of a substantially flask-like funnel 2 molded as directed from one end to the other end and to a deflection angle given by a deflection yoke, a bulb 4 composed of a panel 3 connected to the other end of this funnel 2, an electron gun 5 located on one end of the funnel 2, and an aperture grill 6 served as a color selecting mechanism which is mounted on the inside of the panel 3.

The bulb 4 is formed to be substantially flask-like and uses glass whose barrier properties for X rays are excellent. This is because the color of the bulb 4 is not changed to a brown color if the electron beam accelerated by applying a high voltage is rushed against the bulb 4. The funnel 2 has one end cylindrically formed thereon. The electron gun 5 is located on

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this end. The funnel 2 is tapered from the cylindrical one end to the other end having the panel 3 connected thereto according to the deflection angle given by the deflection yoke.

The main face of the panel (panel glass) 3 is composed of a face portion 3a served as a screen. On the inner surface of the face portion 3a is formed a phosphor screen 8 which starts to be active when the electron gun 5 fires the electron beam 7 onto the screen 8.

The phosphor screen 8 is composed of a black carbon stripe CS formed on the inner surface of the face portion 3a and a red, a green and a blue phosphor stripes RS, GS and BS. The black carbon stripe CS is adjacent to each phosphor stripe. The carbon stripe CS serves to lower a reflection factor of the panel 3 against the ambient light and improve the contrast appearing when each color phosphor stripes RS, GS and BS are active.

The aperture grill 6 mounted on the inner side of the panel 3 allows the red, green and blue electron beams 7 fired by the electron gun 5 to pass therethrough, so that the electron beam 7 is applied onto only the corresponding color phosphor stripe, for the purpose of selecting the color. The aperture grill 6 is composed of a soft steel plate whose thickness is about 0.1 mm. The main face of the aperture grill 6 includes plural rows of striped slits 6a formed thereon. That is, the aperture grill 6 serves to select the color by passing the electron beam 7 through the plural rows of striped slits 6a. Then, this aperture grill 6 is supported by a pair of

longitudinal frames and a pair of lateral frames and is mounted on the inside of the panel 3 in a manner to be in parallel to the inner surface of the face portion 3a.

The electron gun 5 located in the funnel 2 employs a simple gun composition. The red, green and blue electron beams 7 emitted from three cathodes located in line are crossed at a center of one main lens. Then, the electron beam 7 dispersed in three directions are refracted by an electrostatic deflection plate and then is converged on the phosphor screen 8.

The cathode ray tube 1 is completed by jointing the panel 3 having the aperture grill 6 mounted thereon with the funnel 2 having an electron gun 5 located thereon.

In the cathode ray tube 1 composed as described above, when the TV set is powered, a color signal outputted from a color signal input circuit is applied into the electron gun 5. The electron beam 7 fired by the electron gun 5 is deflected through the effect of a magnetic field of a deflecting coil and then is applied onto the phosphor screen 8. The electron beam 7 fired by the electron gun 5 passes through the aperture grill 6 and then is applied onto the phosphor screen 8. This application makes the phosphor stripes RS, GS and BS composing the phosphor screen 8 active, so that the image corresponding to the beam-applied area of the phosphor screen 8 is displayed on the panel 3.

By the way, the phosphor screen 8 where the electron beam 7 is fired is formed on the inner surface of the panel 3

through the process for forming the carbon stripe CS and the process for forming the red, green and blue phosphor stripes RS, GS and BS.

As shown in Fig.4, the carbon stripe CS is formed through the process for coating the photoresist, the process for thermodrying the photoresist, the process for exposing the photoresist, the process for developing the photoresist, and the process for coating, drying and reversely developing the carbon slurry.

In the process for coating the photoresist, when the panel 3 is transported to the process for forming the carbon stripe CS, on the inner surface of the face portion 3a of the panel 3, the photoresist containing light-reactive insolubility against a solvent is evenly coated. In the next process for thermodrying the photoresist, the photoresist is thermodried for removing moisture therefrom. In this process, the face portion 3a is minutely transformed mainly by thermal expansion resulting from thermodrying of the photoresist.

After thermodrying the photoresist, the panel 3 is mounted to the aperture grill 6 at a distance from the photoresist. The aperture grill 6 is located in parallel to the inner surface of the face portion 3a. As shown in Fig.5, the panel 3 having the aperture grill 6 mounted therein is positioned and placed on the exposing device 9. Then, the photoresist is exposed.

The exposing device 9 is composed of a frame 10 on which the panel 3 is positioned and placed, an UV lamp 11 for applying UV onto the inner surface of the face portion 3a of

the panel 3, and a correction lens system 12 (13) for determining the target position of the UV applied by the UV lamp 11. The correction lens system 12 (13), as shown in Figs. 6 and 7, is composed of a combination of correction lenses 12a, 12b (13b), 12c, and 12d for properly determining the UV target spot. The lens 12a serves to position the UV target spot according to the incident angle of the electron beam 7. The lens 12b (13b) serves to correct the exposing area according to the target spot of each color electron beam 7. The lens 12c serves to correct illuminance of the ultraviolet rays. The lens 12d is a spare lens of the lens 12a. The first correction lens system 12 (13) uses the first correction lens system 12 when performing the exposure in forming the carbon stripe. The second correction lens system 13 is used when performing the exposure in forming the phosphor stripes.

The panel 3 having the aperture grill 6 mounted thereto is positioned and placed on the frame 10 of the exposing device 9. In the process for exposing the photoresist, as shown in Fig. 6, the ultraviolet rays emitted by the ultraviolet lamp 11 of the exposing device 9 passes through the first correction lens system 12 for exposing the predetermined area of the photoresist coated on the inner surface of the face portion 3a. This exposed photoresist is sintered on the inner surface of the face portion 3a.

When applying the ultraviolet rays in correspondence to each color electron beam 7, by changing the lens 12b, which is one lens of the first correction lens system 12, the first

correction lens system 12 is adjusted to each color electron beam 7. Then, the ultraviolet rays are passed through the first correction lens 12 for each color for performing the exposure three times. For example, the first exposure is executed through the first correction lens system 12 having the corresponding lens 12b to the green electron beam. Then, the second and the third exposures are executed through the first correction lens system 12 whose lens 12b is changed according to the blue electron beam or the red electron beam.

Theses exposures are executed through the aperture grill 6 mounted to the panel 3. Hence, the ultraviolet rays emitted by the UV lamp 11 serve to expose the photoresist in a striped manner which corresponds to the striped slits 6a of the aperture grill 6 and sinter the photoresist on the inner surface of the face portion 3a in a striped manner.

After the process for exposing the photoresist, the panel 3 is unloaded from the frame 10 of the exposing device 9 and then the aperture grill 6 is removed from the panel 3. In the process for developing the photoresist, the exposed photoresist is developed. On the other hand, the unexposed area of the photoresist is washed out. On the inner surface of the face 3a is formed photoresist stripes.

Next, in the process for coating, drying, and reversely developing the carbon slurry, on the inner surface of the face portion 3a where the photoresist stripes are formed, the carbon slurry is evenly coated. By decomposing the photoresist stripes, the carbon slurry coated on the photoresist is striped

together with the photoresist. As a result, the carbon slurry coated on the area where the photoresist stripes are not formed is left. The carbon stripes CS are formed on the inner surface of the face portion 3a by developing the left carbon slurry.

In the process for exposing the photoresist, the UV target spot is adjusted to coincide with the target spot of the electron beam 7 through the first correction lens system 12. Hence, the carbon stripe CS is formed on the spot where no electron beam is applied. On the other hand, on the spot where the electron beam 7 is applied, that is, the carbon stripe CS is not formed, each color phosphor stripes RS, GS and BS are formed in the later process for forming the phosphor stripes.

In turn, the description will be oriented to the process for forming each color phosphor stripe RS, GS or BS. This embodiment is arranged to form the green phosphor stripe GS, the blue phosphor stripe BS, and the red phosphor stripe RS in the describing sequence. The forming sequence of each color phosphor stripe GS, BS or RS is not limited to the abovementioned sequence.

The green phosphor stripe GS is formed through the process for coating the green phosphor slurry, the process for thermodrying the green phosphor slurry, the process for exposing the green phosphor slurry, and the process for developing the green phosphor slurry.

On the inner surface of the face portion 3a having the carbon stripes CS formed thereon, in the process S6 of coating the green phosphor slurry, there is evenly coated a green

phosphor slurry containing a green phosphor and a sensitive material mixed therewith. Then, in the process for thermodrying the green phosphor slurry, the green phosphor slurry is thermodried for removing the moisture. The quantity of heat required for thermodrying the green phosphor slurry is different from the quantity of heat required for thermodrying the photoresist. Hence, the transformation of the panel 3 appearing in the process for thermodrying the green phosphor slurry is different from the transformation of the panel 3 appearing in the process for thermodrying the photoresist.

After thermodrying the green phosphor slurry, the panel 3 is mounted to the aperture grill 6 at the same location as the mounting location of the aperture grill 6 in the process for forming the carbon stripes CS. The panel 3 having the aperture grill 6 mounted thereto is positioned and placed on the exposing device 9 used in the process for exposing the photoresist. Then, the process is started for exposing the green phosphor slurry.

In the process for exposing the green phosphor slurry, the UV lamp 11 of the exposing device 9 operates to apply the ultraviolet rays to a given spot of the green phosphor slurry coated on the inner surface of the face portion 3a. Then, the UV-applied area of the green phosphor slurry is sintered on the inner surface of the face portion 3a.

In the process for exposing the green phosphor slurry, the UV target spot of the UV lamp 11 is determined by the second correction lens system 13. The ultraviolet rays are passed

through the aperture grill 6 when they are applied onto the slurry. This aperture grill 6 is served to expose the area of the green phosphor slurry where no carbon stripes CS are formed.

The second correction lens system 13 includes the lens 13b for the transformation of the panel 3 in place of the lens 12b for correcting the UV target spot according to each color electron beam included in the lenses composing the first correction lens system 12.

As mentioned above, since the quantity of heat required for thermodrying the photoresist is different from the quantity of heat required for thermodrying the green phosphor slurry, the transformation of the panel 3 appearing in thermodrying the photoresist is different from that appearing in thermodrying the green phosphor slurry. Hence, if the first correction system 12 is used for the process for exposing the green phosphor slurry without change, the exposing spot is partially shifted. The shift of the exposing spot results in forming the green phosphor stripe GS so that the green phosphor stripe GS is protruded over the carbon stripe CS to the adjacent area where another color phosphor stripe is formed.

To overcome this drawback, therefore, the method according to this embodiment is arranged to calculate a difference of transformation of the panel 3 based on the difference of a surface temperature of the panel 3 and expose the phosphor slurry through the second correction lens system 13 for the difference of transformation. As a result, the phosphor stripes

GS, BS and RS are formed at right locations.

For example, in the case of using the panel 3 having the phosphor screen 8 of $(X \times Y) = (194 \text{ mm} \times 145 \text{ mm})$, at the coordinate position of $(X, Y) = (190 \text{ mm}, 135 \text{ mm})$, at the change of the surface temperature of the panel 3 by 1°C , the difference of the transformation of the panel 3 takes place. This difference corresponds to the $1 \mu\text{m}$ difference of the UV target spot. It is assured that this difference disappears by performing the exposure through the second correction lens system 13 arranged as described above.

In addition, the second correction lens system 13 may be composed by changing any one of the lenses composing the first correction lens system 12 used in the process for forming the carbon stripes only if the UV target spot can be corrected according to the transformation of the panel 3 caused mainly by thermal expansion. In addition to the foregoing correction lenses 12a, 12b, 12c and 12d, the second correction lens system 13 may have a new lens for determining the UV target spot.

In the process for forming the green phosphor stripe, for composing the second correction lens system 13, the lens 13b for correcting the exposure spot for the target spot of each color electron beam 7 uses the lens for the green electron beam 7. The UV target spot is thus determined according to the target spot of the green electron beam 7.

After the process for exposing the green phosphor slurry, the panel 3 is let down from the frame 10 of the exposing device 9. Then, the aperture grill 6 is removed from the panel

3. In the process for developing the green phosphor slurry, the exposed green phosphor slurry is developed. By this, the green phosphor stripe GS is formed on the spot of the inner surface of the face portion 3a where no carbon stripe CS is formed.

Next, in the same process as the process for forming the green phosphor stripes (the process for coating, thermodrying, exposing and developing the blue phosphor slurry), the blue phosphor stripe BS is formed on the inner surface of the face portion 3a. It is located in the right or the left hand of the green phosphor stripe GS with the carbon stripe CS laid therebetween.

In this process for forming the blue phosphor stripe, the exposure uses the second correction lens system 13. With the lens system 13, the UV target spot is corrected according to the difference of the transformation of the panel 3 resulting from the different of the quantity of heat.

In the process for forming the blue phosphor stripe, among the lenses composing the second correction lens system 13, the lens 13b for correcting the exposure spot corresponding to the target spot of each color electron beam 7 uses the lens for the blue electron beam 7. The UV target spot is determined according to the target spot of the blue electron beam 7.

Next, along the same process (for coating, thermodrying, exposing and developing red phosphor slurry) as the process for forming the green phosphor stripe or the blue phosphor stripe, the red phosphor stripe RS. is formed on the inner surface of the face portion 3a so that the red phosphor stripe RS. is

located on the right or the left hand of the green phosphor stripe GS.

Also in the process for forming the red phosphor stripe, in exposure, the second correction lens system 13 is used for correcting the UV target spot according to the difference of the transformation of the panel 3 resulting from the difference of heat quantity.

Further, in the process for forming the red phosphor stripe, the second correction lens system 13 uses the lens for the red electron beam 7 as the lens 13b for correcting the exposure spot in correspondence with the target spot of each color electron beam 7. It means that the UV target spot is determined so that it may correspond to the target spot of the red electron beam 7.

The foregoing series of processes, as shown in Fig.8, make it possible to form on the inner surface of the face portion 3a of the panel 3 the green phosphor stripe GS, the blue phosphor stripe BS and the red phosphor stripe RS arranged in sequence, resulting in forming the phosphor screen 8. Further, in this embodiment, the process for forming the carbon stripe and the process for forming the phosphor stripes utilize the correction lens system 12 or 13 for correcting the UV target spot according to the transformation of the panel 3 in each process. As shown in Fig.8, therefore, this prevents the color phosphor stripes GS, BS and RS from being protruded into the adjacent color phosphor stripe over the carbon stripe CS. The resulting cathode ray tube 1 can display a high-definition

image without degrade of white uniformity when the image is displayed on the face portion 3a.

As set forth above, the method for manufacturing a color cathode ray tube according to the present invention is arranged to apply ultraviolet rays through the correction lens system for adjusting the UV target spot according to the transformation of the panel glass caused mainly by thermal expansion, for forming the carbon stripe and each color phosphor stripe at their right spots. This thus prevents each color phosphor stripe from being protruded into the adjacent color phosphor stripe over the carbon stripe. Further, this also inhibits to degrade the white uniformity of the color cathode ray tube and protrude one color of the phosphor screen into another color.

Many widely different embodiments of the present invention may be constructed without departing from the spirit and scope of the present invention. It should be understood that the present invention is not limited to the specific embodiments described in the specification, except as defined in the appended claims.

WHAT IS CLAIMED IS:

1. A method for manufacturing a color cathode ray tube having a phosphor screen formed of plural combinations of color phosphor stripes and carbon stripes adjacent to each said color phosphor stripe, said phosphor screen formed on the inner surface of a panel glass, comprising:

the first step of forming carbon stripes; and

the second step of forming phosphor stripes,

said first step including the subsets of;

coating and thermodrying photoresist on the inner surface of said panel glass,

exposing said photoresist through a first correction lens system for determining a color selection mechanism and a target spot,

coating a carbon film on the inner surface of said panel glass,

said second step including the subsets of;

after forming said carbon stripes, coating color phosphor slurries on the inner surface of said panel glass and thermodrying said color phosphor slurries;

exposing said carbon slurries through a second correction lens for determining a target spot according to transformation of said panel glass appearing in said color selection and thermodrying; and

developing said color phosphor slurries.



2. The method for manufacturing a color cathode ray tube as claimed in claim 1, wherein said first or second correction lens system is composed of plural lenses and said second correction lens system has one different lens from said first correction lens system.

3. The method for manufacturing a color cathode ray tube as claimed in claim 1, wherein said first or second correction lens system is composed of plural lenses, and said second correction lens system is composed of the lenses composing said first correction lens system and a new one lens.

4. The method for manufacturing a color cathode ray tube as claimed in claim 1, wherein said second correction lens system is arranged to have a curvature for the corresponding correction to the difference of transformation caused by thermal expansion of said panel.