(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 067 573 A2

(12) # EUROPEAN PATENT APPLICATION

(43) Date of publication:
10.01.2001 Bulletin 2001/02

(51) Int. Cl.7: **H01J 9/227**, H01J 29/18

(21) Application number: **00114519.2**

(22) Date of filing: **06.07.2000**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **09.07.1999 JP 19563699**

(71) Applicant:
Matsushita Electronics Corporation
Takatsuki-shi, Osaka 569-1193 (JP)

(72) Inventors:
- **Yamaguchi, Akihiro,**
Room 106
Takatsuki-shi, Osaka 569-0041 (JP)
- **Deguchi, Hiroshi**
Suita-shi, Osaka 565-0861 (JP)

(74) Representative:
Schwarzensteiner, Marie-Luise et al
Grape & Schwarzensteiner
Patentanwälte
Sebastiansplatz 7
80331 München (DE)

(54) **Method for producing a cathode-ray tube**

(57) In order to form a screen layer having less color fogging and coating unevenness in the course of production of a cathode-ray tube, a panel inner surface having a carbon layer (6) formed thereon is precoated with a solution of a nonionic surfactant (e.g., polyoxyethylene sorbitan fatty acid ester), and a phosphor layer (3) is formed on the panel inner surface (2).

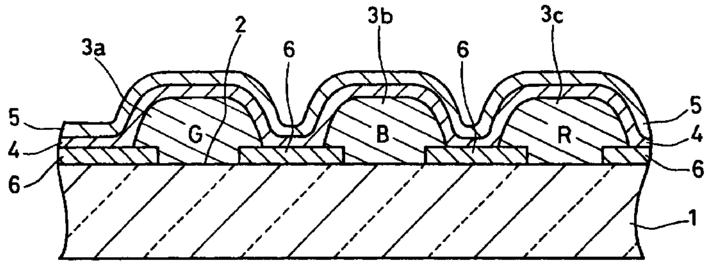

FIG. 1

EP 1 067 573 A2

Description

[0001] The present invention relates to a method for producing a cathode-ray tube used for television receivers, computer displays, and the like.

[0002] In general, formation of a screen layer according to a method for producing a cathode-ray tube includes forming a phosphor layer on a panel inner surface with a carbon layer formed thereon, coating the phosphor layer with a filming liquid and drying the filming liquid with a heater, air, or the like to form a filming layer on the phosphor layer, forming a metal layer on the filming layer by vapor deposition, and heating the resultant layered structure to a temperature at which an organic material in the filming layer is decomposed, thereby removing the filming layer.

[0003] Furthermore, in order to improve the adhesion of the phosphor layer with respect to the panel inner surface, the panel inner surface having the carbon layer formed thereon is precoated with polyvinyl alcohol (hereinafter, referred to as "PVA") to be a protective layer before forming the phosphor layer. For example, the phosphor layer is formed on the panel inner surface as follows: the panel inner surface having the carbon layer formed thereon is precoated with PVA; the resultant panel inner surface is coated with a coating solution for forming the phosphor layer, followed by drying; the phosphor layer is exposed to light through a shadow mask having a pattern to obtain an exposed area and an unexposed area; and the phosphor layer in the unexposed area is removed by development using pure water or the like, whereby red, blue, and green phosphor layers are formed in predetermined areas.

[0004] In recent years, with higher definition of a cathode-ray tube, degradation of color purity becomes more noticeable. According to the above-mentioned method for producing a cathode-ray tube, the panel inner surface having the carbon layer formed thereon is precoated with PVA before forming a phosphor layer; therefore, adhesion of the phosphor layer with respect to the panel inner surface is improved. However, in the course of development using pure water or the like, a part of the phosphor layer remains in an unexposed area, which causes "color fogging" (i.e., the color of the phosphor layer is mixed with that of another phosphor layer in the subsequent step), resulting in deterioration of the color purity of a cathode-ray tube.

[0005] Furthermore, since PVA is polymer resin, the spreadability (hereinafter, referred to as "wettability") of a coating solution for a phosphor layer is poor over the entire panel inner surface coated with PVA. This causes coating unevenness visible to the naked eye, such as irregular line patterns, bubble patterns and fiber patterns. The irregular line patterns are formed in a radial shape on the surface of the phosphor layer. The irregular bubble patterns are formed in the phosphor layer. The irregular fiber patterns are formed as follows: threadlike fibers are formed in the shape of a spider web on the periphery of a coating unit, while the panel inner surface is coated with PVA, and they adhere to the panel inner surface to appear on the surface of the phosphor layer as irregular fiber patterns. The occurrence of such coating unevenness decreases the brightness of a cathode-ray tube.

[0006] Therefore, with the foregoing in mind, it is an object of the present invention to provide a method for producing a cathode-ray tube in which a screen layer with less color fogging and coating unevenness is formed and color purity and brightness can be enhanced.

[0007] According to a method for producing a cathode-ray tube of the present invention, a panel inner surface having a carbon layer formed thereon is coated (precoated) with a solution containing a nonionic surfactant, and thereafter, a phosphor layer is formed on the panel inner surface.

[0008] According to the production method of the present invention, a screen layer can be formed in which the wettability of a phosphor layer is improved over the entire panel inner surface, and color fogging and coating unevenness hardly occur.

[0009] These and other advantages of the present invention will become apparent to those skilled in the art upon reading and understanding the following detailed description with reference to the accompanying figures.

Figure 1 is a cross-sectional view showing the relevant portions of an embodiment of a glass panel of a cathode-ray tube in a method for producing a cathode-ray tube of the present invention.
Figure 2 is a block diagram illustrating an example of the production method of the present invention.

[0010] Hereinafter, preferred embodiments of a production method according to the present invention will be described.

[0011] An HLB (hydrophile-lipophile balance) of a nonionic surfactant is preferably 10 to 18. When the HLB is too low, coating unevenness called "repellence" occurs during coating, and when the HLB is too high, a defoaming property is degraded during foaming.

[0012] Specifically, it is preferable that the nonionic surfactant contains a sorbitan ester. More specifically, it is preferable that the nonionic surfactant contains polyoxyethylene sorbitan fatty acid ester. It is preferable that the solution containing polyoxyethylene sorbitan fatty acid ester is an aqueous solution containing polyoxyethylene sorbitan fatty acid ester. Furthermore, the concentration of polyoxyethylene sorbitan fatty acid ester in this solution is preferably 0.1 to 1.0% by weight.

[0013] Hereinafter, the present invention will be described by way of an embodiment with reference to the drawings.

[0014] Figure 1 is a cross-sectional view showing the relevant portions of a glass panel of a cathode-ray tube produced by a method for producing a cathode-ray tube in Embodiment of the present invention.

[0015] A glass panel 1 has a carbon layer 6, phosphor layers 3a, 3b, and 3c (corresponding to Green, Blue, and Red, respectively), a lacquer layer 4, and an aluminum layer 5, formed on an inner surface (panel inner surface) 2 in this order.

[0016] Figure 2 is a block diagram illustrating an embodiment of a method for producing a cathode-ray tube of the present invention.

[0017] First, the glass panel 1 is washed in a panel washing step 7. Thereafter, the panel inner surface 2 is coated with, for example, a polyvinyl pyrrolidone -bisazide type photosensitive solution (PVP type photosensitive solution) in a photosensitive solution coating step 8, followed by drying in a drying step 9. The glass panel 1 coated with the photosensitive layer is exposed to light through a shadow mask having a plurality of dot-shaped holes in a light-exposure step 10 so that the photosensitive layer will remain in areas for forming green, blue, and red phosphor layers 3a, 3b, and 3c, and developed in a developing step 11. Thus, the photosensitive layer is allowed to remain only in the areas where the green, blue, and red phosphor layers 3a, 3b, and 3c will be formed.

[0018] Next, the panel inner surface 2 is coated with, for example, liquid containing carbon particles in a carbon coating step 12, followed by drying in a drying step 13. Thereafter, only the photosensitive layer previously formed on the panel inner surface 2 is selectively removed in a developing step 14. Thus, a carbon layer 6 is formed only in a region other than the areas where the green, blue, and red phosphor layers 3a, 3b, and 3c will be formed.

[0019] Next, in a spraying step 15, an aqueous solution of a nonionic surfactant (preferably, polyoxyethylene sorbitan fatty acid ester) having a concentration of 0.1 to 1.0% by weight, diluted with pure water, is sprayed onto the panel inner surface 2 with the carbon layer 6 formed thereon, followed by drying.

[0020] Then, in a phosphor coating step 16, the resultant panel inner surface 2 having the carbon layer 6 formed thereon is coated with a coating solution that is a mixture of green (first color) phosphor particles, PVA, and ammonium bichromate, followed by drying in a drying step 17. Then, the resultant panel inner surface 2 is exposed to light through a shadow mask in a light-exposure step 18. High-pressure hot pure water is poured over the panel inner surface 2 in a developing step 19 so as to peel off the green phosphor layer in an unexposed area formed in the phosphor coating step 16, whereby a green phosphor layer 3a is formed in a predetermined area.

[0021] Next, the phosphor coating step 16, the drying step 17, the light-exposure step 18, and the developing step 19 are repeated in the same way as above to form a blue (second color) phosphor layer 3b in a predetermined area. Similarly, the coating step 16, the drying step 17, the light-exposure step 18, and the developing step 19 are repeated to form a red (third color) phosphor layer 3c in a predetermined area.

[0022] Next, the panel inner surface 2 having the green, blue, and red phosphor layers 3a, 3b, and 3c formed thereon is coated with a lacquer coating solution in a coating step 20, followed by drying in a drying step 21. Then, an aluminum layer 5 is formed on the panel inner surface 2 with the lacquer layer 4 formed thereon by vapor deposition of aluminum in a vapor deposition step 22.

[0023] Then, the glass panel 1 with the aluminum layer 5 formed thereon is heated in a heating furnace at 400°C to 450°C in a baking step 23, whereby an organic material in the lacquer layer 4 is decomposed for removal of the lacquer layer 4. Consequently, a screen layer is obtained in which the carbon layer 6, the phosphor layers 3a, 3b, and 3c, and the aluminum layer 5 are formed in this order on the panel inner surface 2.

[0024] According to the method for producing a cathode-ray tube of the present invention, the panel inner surface 2 having the carbon layer 6 formed thereon is precoated with a diluted aqueous solution of polyoxyethylene sorbitan fatty acid ester. Therefore, a screen layer can be formed in which the wettability of the phosphor layers 3a, 3b, and 3c is improved over the entire panel inner surface 2, and color fogging and coating unevenness such as irregular line, bubble and fiber patterns hardly are formed. Consequently, the color purity and brightness of a cathode-ray tube can be enhanced.

[0025] Furthermore, by setting the concentration of an aqueous solution of polyoxyethylene sorbitan fatty acid ester in a range of 0.1 to 1.0% by weight, a screen layer can be formed in which coating unevenness such as irregular bubble and fiber patterns hardly are formed.

[0026] A nonionic surfactant to be used is not limited to polyoxyethylene sorbitan fatty acid ester as long as the above-mentioned effect is obtained. Furthermore, a solution containing a plurality of kinds of surfactants may be used. An example of a surfactant that can be used together includes a nonionic surfactant (e.g., Pluronic, produced by Asahi Denka Kogyo K.K.) in which ethylene oxide is added to propylene glycol. Furthermore, a component other than a nonionic surfactant may be mixed in the solution. In this case, it is preferable that a nonionic surfactant, in particular, polyoxyethylene sorbitan fatty acid ester is used as a main component (occupying at least 50% by weight) of a solute.

[0027] As described above, it is preferable that a solution of a nonionic surfactant is sprayed onto a panel inner surface. This is because bubbles can be reduced, compared with the case of coating the panel inner surface with a paste containing a surfactant by printing. Furthermore, spraying of a nonionic surfactant solution renders blending of a paste unnecessary, which results in an improvement in mass-production.

Example

[0028] Hereinafter, the present invention will be described in detail by way of an example. However, the present invention is not limited by the following example.
[0029] In a method for producing a cathode-ray tube of the present invention shown in Figure 2, a display monitor tube (51 cm (21 in.)) was used as a panel, and an aqueous solution of polyoxyethylene sorbitan fatty acid ester (e.g., Sorgen TW-20; HLB = 16.7, produced by Dai-Ichi Kogyo Seiyaku Co., Ltd.) was used in the spraying step 15. A screen layer was formed on the panel inner surface by varying the concentration of the aqueous solution to 0.03, 0.1, 0.2, 0.5, 1.0, and 3.0% by weight (hereinafter, these panels will be referred to as products of the present invention).
[0030] For comparison, a PVA aqueous solution was used in place of an aqueous solution of polyoxyethylene sorbitan fatty acid ester in the spraying step 15, and the other conditions were set to be the same as above. Then, a screen layer was formed on the panel inner surface by varying the concentration of the PVA aqueous solution (e.g., EG-40, produced by The Nippon Synthetic Chemical Industry, Co., Ltd.) to 0.03, 0.1, 0.2, 0.5, 1.0, and 3.0% by weight (hereinafter, these panels will be referred to as comparative products).
[0031] Each panel thus produced was examined for color fogging, dot defects, coating unevenness, and brightness. Tables 1 and 2 show the results of the products of the present invention and those of the comparative products, respectively.
[0032] Color fogging was determined by measuring, when the green (first color) phosphor layer was formed on the panel inner surface, the number of green phosphors in unexposed areas corresponding to those where the blue (second color) phosphor layer and the red (third color) phosphor layer will be formed. More specifically, if the remaining number of dots including non-intended (green, in this case) phosphors in the phosphor layers 3b and 3c becomes 8 or more, quality problems related to brightness and color purity are likely to occur. Therefore, in the column of "Color fogging" in Tables 1 and 2, "○ " represents the case where the total remaining number of dots including non-intended phosphors in one panel was 6 or less, and "• " represents the case where the total remaining number of dots including non-intended phosphors in one panel was 7 or more.
[0033] Regarding dot defects, a minimum dot defect size of the green phosphor layer in each panel was measured by varying continuously an exposure amount through a shadow mask in the light-exposure step 18, and an average of minimum dot defect sizes of the phosphor layers in 10 panels was calculated. The values thus obtained were indicated as relative values assuming that an average of minimum dot defect sizes of the phosphor layers, which have been formed on the panel inner surfaces omitting the spraying step 15, was set to be 100. In the column "Minimum dot defect size" in Tables 1 and 2, "○ " represents the case where the relative value was 100 or less, and "X" represents the case where the relative value was more than 100.
[0034] Coating unevenness such as irregular line, bubble and fiber patterns on a screen layer was checked by irradiating light onto the panel inner surface with the screen layer formed thereon, and visually inspecting the panel outer surface. In the column "Coating unevenness" in Tables 1 and 2, "○ " represents the case where no coating unevenness was observed in 10 panels, and "X" represents the case where any of the coating unevenness was observed in 10 panels. The nature of the coating unevenness is described in the parentheses.
[0035] Brightness was checked as follows. Brightness of the green phosphor layer was measured at the center of a rectangular screen in a cathode-ray tube in which a screen layer has been formed on the panel inner surface, by using a CRT color analyzer (CA-100, produced by Minolta Camera Co., Ltd.) and the average brightness of the phosphor layers in 10 panels was calculated. The values thus obtained were indicated as relative values assuming that the average brightness of the phosphor layers, which have been formed on the panel inner surfaces omitting the spraying step 15, was set to be 100.

Table 1

Products of the present invention (Aqueous solution of polyoxyethylene sorbitan fatty acid ester)				
Concentration of aqueous solution (wt%)	Color fogging (pieces)	Minimum dot defect size (relative value)	Coating unevenness	Brightness (relative value)
0.03	○ (5)	○ (100)	X (irregular line patterns)	100
0.1	○ (3)	○ (100)	○	103

Table 1 (continued)

Products of the present invention (Aqueous solution of polyoxyethylene sorbitan fatty acid ester)				
Concentration of aqueous solution (wt%)	Color fogging (pieces)	Minimum dot defect size (relative value)	Coating unevenness	Brightness (relative value)
0.2	○ (3)	○ (100)	○	104
0.5	○ (4)	○ (98)	○	104
1.0	○ (2)	○ (97)	○	103
3.0	○ (3)	○ (95)	X (irregular bubble patterns)	102

Table 2

Comparative products (PVA aqueous solution)				
Concentration of aqueous solution (wt%)	Color fogging (pieces)	Minimum dot defect size (relative value)	Coating unevenness	Brightness (relative value)
0.03	○ (6)	○ (100)	X	100
0.1	○ (6)	○ (100)	X	99
0.2	X (7)	○ (97)	X	96
0.5	○ (6)	○ (96)	X	97
1.0	X (8)	○ (95)	X	96
3.0	X (9)	X (107)	X	95

[0036] As shown in Table 1, in the products of the present invention, when the concentration of an aqueous solution of polyoxyethlene sorbitan fatty acid ester type is in a range of 0.1 to 1.0% by weight, a screen layer can be formed in which color fogging, coating unevenness, and the like hardly occur. More specifically, regarding color fogging, when the concentration was in a range of 0.03 to 3.0% by weight, an average remaining number of non-intended phosphors was confirmed to be 5 or less. Regarding coating unevenness, when the concentration was 0.03% by weight, irregular line patterns were observed, and when the concentration was 3.0% by weight, irregular bubble patterns were observed. Furthermore, in the products of the present invention, it was found from the results of the minimum dot defect size that although adhesion was improved slightly in a region with a high concentration, adhesion was nearly constant irrespective of the change in concentration.

[0037] As shown in Table 2, in the comparative products, when the concentration of a PVA type aqueous solution was 0.03 to 3.0% by weight, an average remaining number of non-intended phosphors was confirmed to be 6 to 9, and color fogging was increased with an increase in the concentration of PVA. Regarding coating unevenness, when the concentration of PVA was 0.03 to 1.0% by weight, irregular line, bubble and fiber patterns were observed, and when the concentration of PVA was 3.0% by weight, irregular bubble and fiber patterns were observed. Furthermore, in the comparative products, it was found from the results of the minimum dot defect size that although adhesion was likely to improve with an increase in the concentration of PVA, adhesion decreased markedly at a concentration of PVA of more than 1% by weight.

[0038] When the panel inner surface is not coated with polyoxyethylene sorbitan fatty acid ester or PVA, color fogging and coating unevenness become more noticeable.

[0039] Thus, in the products of the present invention, in particular, color fogging and coating unevenness are less likely to occur, compared with the comparative products, and color purity and brightness are enhanced in a cathode-ray tube using the glass panel of the present invention.

[0040] In the above description, before the green phosphor layer is formed, the panel inner surface having the carbon layer formed thereon is precoated with an aqueous solution of polyoxyethylene sorbitan fatty acid ester (nonionic surfactant) by spraying it onto the surface in the spraying step 15, followed by drying. The present invention is not limited thereto. Before forming the blue phosphor layer or the red phosphor layer, the panel inner surface having the carbon layer formed thereon may be precoated with an aqueous solution of polyoxyethylene sorbitan fatty acid ester by spraying it onto the surface, followed by drying. Alternatively, before forming the blue phosphor layer and before forming the red phosphor layer, the panel inner surface having the carbon layer formed thereon may be precoated with an aqueous solution of polyoxyethylene sorbitan fatty acid ester by spraying it onto the surface, followed by drying. Alternatively, the panel inner surface having the carbon layer formed thereon may be precoated with an aqueous solution of polyoxyethylene sorbitan fatty acid ester, followed by drying, in the steps (e.g., coating step) other than the spraying step.

[0041] Furthermore, in Embodiment of the present invention, green, blue, and red phosphor layers are formed in this order. However, the order of formation of phosphor layers is not particularly limited. For example, blue, green, and red phosphor layers may be formed in this order.

[0042] As described above, according to the method for producing a cathode-ray tube of the present invention, a panel inner surface with a carbon layer formed thereon is precoated with an aqueous solution of nonionic surfactant, whereby a screen layer can be formed in which color fogging and coating unevenness hardly occur. Furthermore, in a cathode-ray tube using such a panel, color purity and brightness can be enhanced.

Claims

1. A method for producing a cathode-ray tube comprising: coating a panel inner surface having a carbon layer formed thereon with a solution containing a nonionic surfactant; and forming a phosphor layer on the panel inner surface.

2. A method for producing a cathode-ray tube according to claim 1, wherein an HLB of the nonionic surfactant is in a range of 10 to 18.

3. A method for producing a cathode-ray tube according to claim 1, wherein the nonionic surfactant contains a sorbitan ester.

4. A method for producing a cathode-ray tube according to claim 1, wherein the nonionic surfactant is polyoxyethylene sorbitan fatty acid ester.

5. A method for producing a cathode-ray tube according to claim 4, wherein the polyoxyethylene sorbitan fatty acid ester is applied in an aqueous solution containing polyoxyethylene sorbitan fatty acid ester.

6. A method for producing a cathode-ray tube according to claim 5, wherein a concentration of polyoxyethylene sorbitan fatty acid ester in the solution of polyoxyethylene sorbitan fatty acid ester is in a range of 0.1 to 1.0% by weight.

7. A method for producing a cathode-ray tube according to any of claims 1 to 6, wherein a solution containing a nonionic surfactant is sprayed onto a panel inner surface.

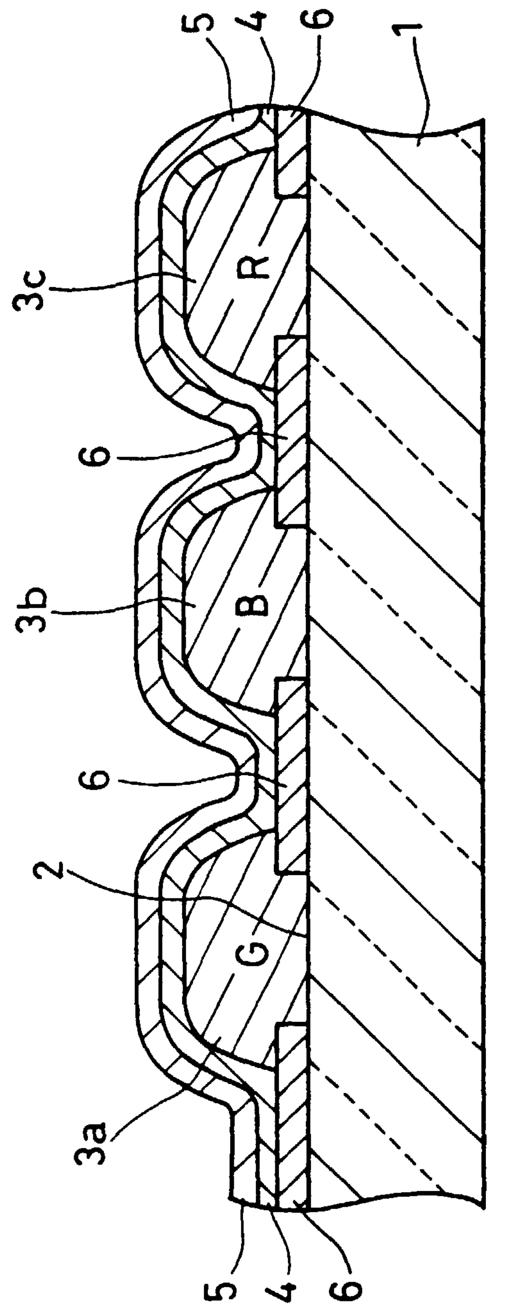

FIG. 1

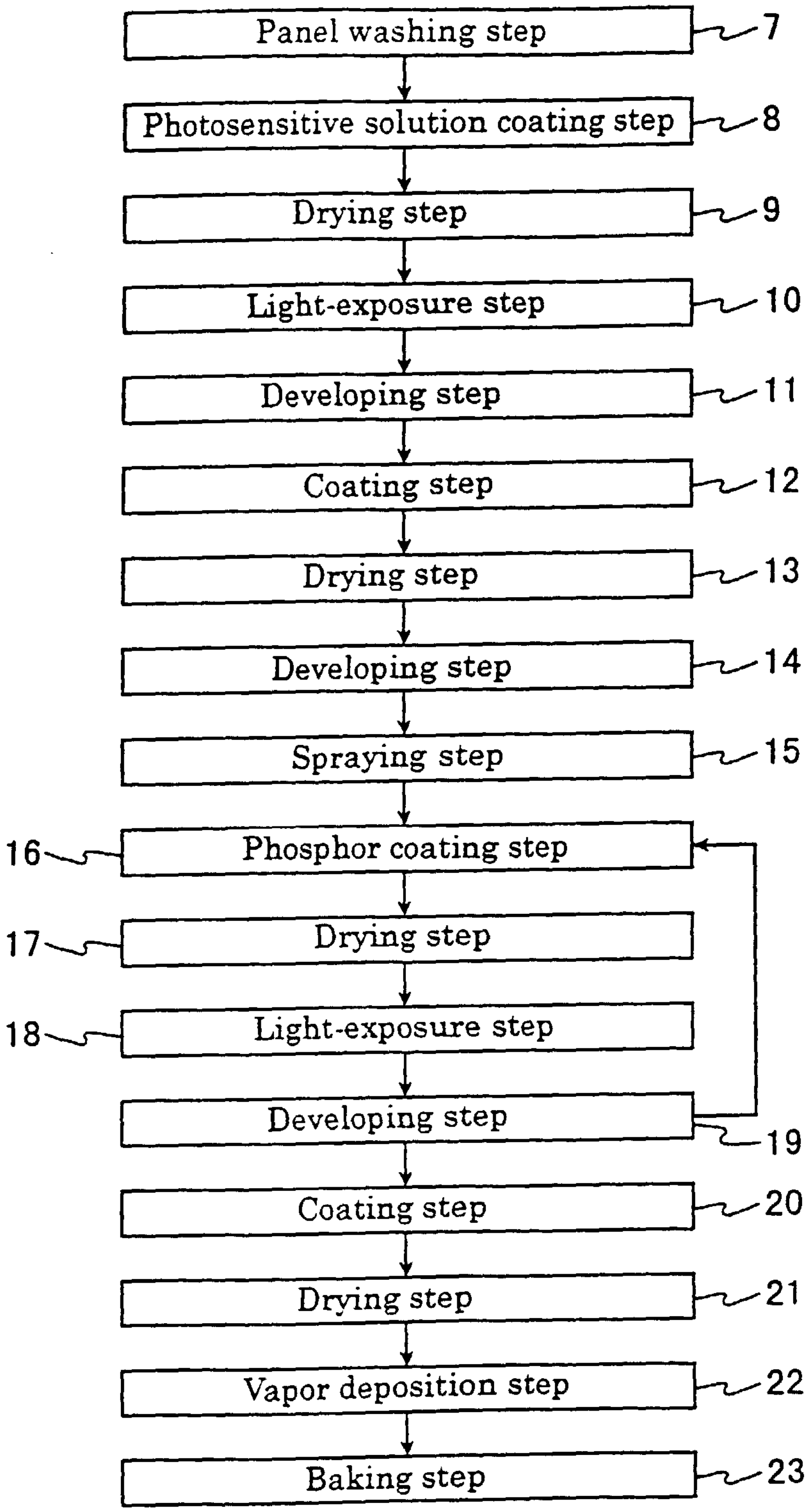
Panel washing step
7
Photosensitive solution coating step
8
Drying step
9
Light-exposure step
10
Developing step
11
Coating step
12
Drying step
13
Developing step
14
Spraying step
15
16
Phosphor coating step
17
Drying step
18
Light-exposure step
Developing step
19
Coating step
20
Drying step
21
Vapor deposition step
22
Baking step
23

FIG . 2