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(54) Method of manufacturing screen of color picture tube

(57) In manufacturing a phosphor screen of a color picture tube, a cured resist layer used in a photolithography process for a black matrix pattern may remain on a hole portion of the black matrix pattern formed on the inner surface of a glass panel without being removed completely in the washing process. In such a case, the pigment of a first optical filter layer remains adhered to the surface of the remained resist layer. This adhered pigment degrades substantially the brightness of luminescent colors of two other phosphors. Therefore, among the three color optical filter layers, the green optical filter layer, which has the minimum difference between a peak transmittance and a transmittance in other wavelength regions, is formed first. Accordingly, a level of an adverse effect of the remained green pigment on the emission of the blue and red phosphors can be suppressed to minimum.

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Description

The invention relates to a method of manufacturing a phosphor screen of a color picture tube having a phosphor screen with an optical filter.

Many of the color picture tubes used today have an optical filter layer between a glass panel and a phosphor layer in order to improve brightness and contrast of the phosphor screen. The phosphor screen with the optical filter comprises a dot-shaped or stripe-shaped optical filter layer which allows the transmittance of only wavelengths of red, green and blue formed on the inner surface of a glass panel having black matrixes or stripes, and a phosphor layer which is formed on the optical filter layer to emit red, green and blue lights.

This optical filter layer is obtained by successively forming red, blue and green filter layers on the inner surface of a glass panel having a black matrix pattern by photolithography.

It happens that a photo-cured resist may not be separated thoroughly but remain on a hole portion of the black matrix pattern formed on the inner surface of the panel, namely on the surface of a filter layer formed position. Such a phenomenon is conspicuous when an azide-based photosensitive agent or a water-soluble sensitizing solution containing a silane coupling agent is used. Therefore, when a first color filter layer is formed, a pigment-dispersed solution is coated on the surface of the photo-cured resist layer remained on the panel surface.

After forming a pattern of the first color filter layer, a position where another color pigment layer is formed was examined to find that the first color pigment was not separated thoroughly but partly remained on the surface of the remained resist. The residue of the first color pigment degrades the brightness of luminescent colors of the two other color phosphors and sometimes to a level that the brightness of white color does not satisfy practical use.

It is an object of the invention to provide a method of manufacturing a phosphor screen of a color picture tube capable of suppressing brightness from lowering due to a pigment of a first color optical filter layer adhered to a cured resist layer remained on the surface of hole portions of a black matrix pattern.

To achieve the above object, A method of manufacturing a phosphor screen of a color picture tube, comprising the following steps:

(a) forming a black matrix pattern in which a resist remains on a position where a optical filter layer is to be formed by coating the resist inside a panel, exposing and developing thereof;
(b) forming a pattern of a green optical filter layer by coating a green pigment inside the panel; and
(c) subsequently forming a pattern of a blue or red filter layer thereon.

Fig. 1A, Fig. 1B and Fig. 1C are diagrams showing spectral permeability of pigments for blue, green and red optical filters;
Fig. 2A, Fig. 2B, Fig. 2C, Fig. 2D, Fig. 2E and Fig. 2F are sectional views corresponding to respective processes of the method of manufacturing a phosphor screen of a color picture tube of a first embodiment of the invention;
Fig. 3A, Fig.3B, Fig. 3C and Fig. 3D are sectional views corresponding to respective main processes of the method of manufacturing a phosphor screen of a color picture tube of the first embodiment of the invention;
Fig. 4 is a flowchart showing the order of forming an optical filter layer of the first embodiment;
Fig. 5A, Fig. 5B, Fig. 5C, Fig. 5D, Fig. 5E and Fig. 5F are sectional views corresponding to respective processes of the method of manufacturing a phosphor screen of a color picture tube of a second embodiment of the invention;
Fig. 6A, Fig. 6B, Fig. 6C and Fig. 6D are sectional views corresponding to respective main processes of the method of manufacturing a phosphor screen of a color picture tube of the second embodiment of the invention; and
Fig. 7 is a flowchart showing the order of forming an optical filter of the second embodiment.

Embodiments of the invention will be described with reference to the attached drawings.

Figs. 1A, 1B and 1C show spectral transmittance of pigments for blue, green and red optical filter layers. Line A denotes the relationship between wave lengths of respective color pigments and transmittances, line B shows characteristic curves of phosphors of respective colors. It is seen from these figures that a difference between the peak transmittance of the green pigment and the transmittances of the blue and red phosphors at luminescence peak wavelengths (about 450 nm, about 630 nm) is quite small as compared with a difference between the peak transmittance of the blue pigment and the transmittances of the green and red phosphors at luminescence peak wavelengths (about 550 nm, about 630 nm) and with a difference between the peak transmittance of the red pigment and the transmittances of the blue and green phosphors at luminescence peak wavelengths (about 450 nm, about 550 nm).

Accordingly, it is seen that when the green optical filter layer among the three color optical filter layers, which has the smallest difference between the peak transmittance and the transmittance at the other wavelength range, is formed first, the green pigment residue does not greatly influence on the luminescence of the blue and red phosphors and degradation of the brightness of white can be suppressed to a level free from practical problems even if the green pigment remains on the position where the blue pigment layer is formed or the position where the red pigment layer is formed.

The green pigment has a concentration lower than those of the blue and red pigments. In this connection, the adverse effect of the green pigment residue on the luminescence of the other phosphors is not significant. Besides, the surface of the residue resist layer is covered with the green pigment, so that the second color pigment does not remain on the position where the third color pigment is formed.

Description will be made of reasons why the green pigment has a relatively low concentration. The spectral transmittance of the green pigment is approximate to a so-called visibility curve, and if the pigment concentration is excessively increased, the brightness of white is heavily lowered. Accordingly, the green pigment is selected to have a concentration of a relatively low value to a level that a body color can be compensated with brightness of white suppressed as low as possible. Meanwhile, the blue pigment is determined to have a value as high as possible to obtain the maximum effect of contrast because the effect of the concentration of the blue pigment is minimum to the brightness of white. The red pigment is determined to have a high value of concentration to a level that the body color does not get reddish.

When a body color of the phosphor layer of the color picture tube is measured by A MINORUTA spectral reflectometer CM-2002, each desirable value of a* and b* (on the CIE 1976 L* a* b* color system chromaticity diagram) is as follows.

The a* is more than -2.5 and less than -1.5.
The b* is more than -1.2 and less than -0.2.

This result of the measurement is based on the visual observation by the twenty observers.

Table 1 shows respective concentration of the green pigment layer and the blue pigment layer satisfying the above condition of a* and b*, for the phosphor layer in which the green pigment layer is first formed and the phosphor layer in which the blue pigment layer is first formed.

Table 1

Pigment layer Forming order	Blue pigment liquid concentration	Green pigment liquid concentration	a*	b*
B→G→R	16.5%	6.6%	Less than -1.8 More than -2.0	Less than -0.9 More than -1.2
G→B→R	18.3%	6.0%	Less than -1.9 More than -2.4	Less than -0.8 More than -1.1

As shown in table 1, the concentration of the green pigment liquid of the phosphor screen in which the green pigment layer is formed first can be lower than the concentration of the blue pigment liquid of the phosphor screen in which the blue pigment layer is formed first.

Although the blue pigment liquid concentration of the phosphor screen in which the green pigment layer is formed first is higher than the blue pigment liquid concentration of the phosphor screen in which the blue pigment later is formed first, such a degree of the blue pigment liquid concentration dose not almost influence on the white brightness of the phosphor layer and dose not induce any practical problem.

Thus the method of the present invention, by forming first the green pigment layer, and by the pigment remained on the position where the other color is to be formed, the green pigment liquid concentration can be set low, thereby the white brightness can be improved.

Concentration of the green pigment particle in the green optical filter layer is from 4.0 to 11.0% by weight, preferably from 5.1 to 11.0% by weight. This is Because, when the concentration of the green pigment particle in the green filter layer is less than 4.0% (preferably less than 5.1%)by weight, green composition is eliminated and a body color becomes magenta, and when the concentration of the green pigment particle in the green filter layer is more than 11.0% by weight, the green brightness remarkably decreases and the white brightness decreases.

The table 2 below shows the compared results of a green mono-color brightness, a red mono-color brightness and a white brightness between a case that the blue pigment layer is coated first and a case that the green pigment layer is coated first.

Table 2

Pigment layer Forming order	Green mono-color brightness	Red mono-color brightness	White brightness
B→G→R	STD	STD	STD
G→B→R	+7.5%	+10.6%	+6.9%

It is seen from the table 2 that the green mono-color brightness, the red mono-color brightness and the white brightness with the green pigment layer formed first are high as compared with the case when the blue pigment layer is formed first, and lowering of the brightness due to the pigment residue on the first color optical filter layer can be suppressed substantially.

The pigment to be used in the invention may be inorganic or organic. Especially preferable pigments include those which are uniformly dispersible into the filter layer of a phosphor layer with a filter and capable of giving sufficient transparency to the optical filter layer without causing light diffusion. And, the process of manufacturing a color picture tube has a high-temperature treatment, so that inorganic pigments are more preferable. Specifically, the following pigments can be used.

Red pigment:

- Sicotrans Red 1-2817 (trade name, manufactured by BASF), ferric oxide based, particle diameter of 0.01 μm to 0.02 μm
- Chlmofartal Red A2B (trade name, manufactured by Ciba-Geigy), anthraquinone based, particle diameter of 0.01 μm Blue pigment:
- Cobalt Blue X (trade name, manufactured by Toyo Ganryo, cobalt aluminate (Al_2O_3-CoO) based, particle diameter of 0.01 μm to 0.02 μm
- Ultramarine Blue No. 8000 (trade name, manufactured by Daiichi Kasei Co., Ltd.), ultramarine blue based, particle diameter of 0.03 μm
- Lionol (trade name, manufactured by Toyo Ink Mfg. Co., Ltd.), phthalocyanine blue based, particle diameter of 0.01 μm

Green pigment:

- DAIPYROXIDE TM-GREEN #3320 (trade name, manufactured by Dainichiseika Color & Chemicals Mfg. Co., Ltd.), TiO_2-NiO-ZnO based, particle diameter of 0.01 μm to 0.02 μm
- DAIPYROXIDE TM-GREEN #3420 (trade name, manufactured by Dainichiseika Color & Chemicals Mfg. Co., Ltd.), CoO-Al_2O_3-Cr_2O_3 based, particle diameter of 0.01 μm to 0.02 μm
- D-801 (trade name, manufactured by Nippon Denko Co., Ltd.), Cr_2O_3 based, particle diameter of 0.35 μm
- Fastgen Green S (trade name, manufactured by Dainippon Ink and Chemicals, Inc.), chlorinated phthalocyanine green based, particle diameter of 0.01 μm
- Fastgen Green 2YK (trade name, manufactured by Dainippon Ink and Chemicals, Inc.), brominate phthalocyanine green based, particle diameter of 0.01 μm

The optical filter layer can be formed by the following method.

A pigment dispersant mainly consisting of pigment particles and polymer electrolyte pigment dispersing agent is coated on the inner surface of a faceplate on which a black matrix is formed. Coating methods include a spin coating method, a roller method and a dipping method. Among these methods, the spin coating method is the most promising method to obtain a predetermined uniform thickness. Then, the pigment-coated layer is dried. Drying can be made by any drying method such as heater drying, hot-air drying and long-term drying at room temperature if part of salt in polymer electrolytic salt can be dissociated simultaneously with volatilization of water content. A photo-resist layer is then formed on the dried pigment layer. The photo-resist layer is exposed to have a predetermined pattern by a high-pressure mercury lamp or the like and developed so to have a predetermined filter pattern. The aforesaid process of forming the optical filter layer is repeated in the order of green, blue and red.

And, the process of forming the photo-resist layer can be omitted by coating the pigment dispersant containing the photo-resist onto the inner surface of the faceplate having the black matrix.

A specific embodiment of the method of manufacturing a phosphor screen of a color picture tube of the invention

will be described.

As shown in Fig. 2A, an optical absorption layer 12 is formed as the black matrix on the inner surface of a panel 10 of the color picture tube. This optical absorption layer 12 is formed by the following method. A photo resist consisting of at least an aside-based photosensitive radical and polyvinyl pyrrolidone is coated onto the panel 10. Processes of exposing using a shadow mask, developing and drying are performed successively. Thus, a stripe-shaped or dot-shaped photo-cured film is formed on the panel 10. A light absorption material, e.g., graphite, is coated onto the photo-cure film and integrated therewith. Then, the photo-cured film is made brittle by 15% sulfamine acid, and the light absorption layer on the brittle photo-cured film is removed together with the light absorption material. Thus, the hole portion where the pigment layer and the phosphor layer shall be formed is exposed to form a patterned light absorption layer 12. At the time, a cured resist layer 13 having a thickness of about 200 angstrom remains on the surface of the hole portion as shown in Fig. 3A.

Green, blue and red pigment dispersants used are as follows.

Green pigment dispersant:

It is prepared by dispersing green pigment particles TiO_2-NiO-CoO-ZnO (manufactured by Dainichiseika Color & Chemicals Mfg. Co., Ltd., trade name: DAIPYROXIDE TM-GREEN #3320 (particle diameter of 0.01 μm to 0.02 μm)), a photo resist ADC+PVA, and a polymer electrolyte sodium salt of acrylic acid (trade name: Dispec N-40) at a ratio of 6.4 wt%, 2 wt% and 0.15 wt% into pure water. In this green pigment dispersant, a polymer electrolyte concentration-to-pigment concentration ratio is 0.023, a resist concentration-to-polymer electrolyte concentration ratio is 13.33, and a resist concentration-to-pigment concentration ratio is 0.313.

Blue pigment dispersant:

It is prepared by dispersing blue pigment particles cobalt aluminate (manufactured by Ganryo, trade name: Cobalt Blue X (particle diameter of 0.01 μm to 0.02 μm), a photo resist ammonium dichromate (ADC) + polyvinyl alcohol (PVA), and a polymer electrolyte ammonium salt of polyacrylic acid copolymer (manufactured by Allied Colloid, trade name: Dispec GA-40)) at a ratio of 18.0 wt%, 0.5 wt%, and 0.414 wt% into pure water. But, this blue pigment dispersant has a polymer electrolyte concentration-to-pigment concentration ratio of 0.023, a resist concentration-to-polymer electrolyte concentration ratio of 1.208, and a resist concentration-to-pigment concentration ratio of 0.028.

Red pigment dispersant:

It is prepared by dispersing red pigment particles Fe_2O_3 fine particles (particle diameter of 0.01 μm to 0.02 μm), a photo resist ADC+PVA, and a polymer electrolyte ammonium salt of polyoxyethylene alkyl ether sulfate (manufactured by Dai-ichi Kogyo Seiyaku Co., Ltd., trade name: Hytenol 08) at a ratio of 3.0 wt%, 2 wt% and 0.069 wt% into pure water. But, this red pigment dispersant has a polymer electrolyte concentration-to-pigment concentration ratio of 0.023, a resist concentration-to-polymer electrolyte concentration ratio of 29.0, and a resist concentration-to-pigment concentration ratio of 0.67.

Respective optical filter layers are patterned by the process shown in Fig. 4 using the above-described green, blue and red pigment dispersants.

First, a green pigment dispersant is coated to form a first color optical filter layer on the inner surface of the panel 10 of the color picture tube kept at 30°C (step A). Then, the panel 10 is spun at 100 to 150 rpm to spin off an excess portion of the pigment dispersant and also to make the green pigment dispersant have a uniform thickness. It is then dried by a heater at 120°C for three to four minutes (step B). Thus, a green pigment-coated layer 20G is obtained as shown in Fig. 2B and Fig. 3B.

As shown in Fig. 2C, the green pigment-coated layer 20G is exposed to have a predetermined pattern through an unillustrated shadow mask by a high-pressure mercury lamp (step C). A developing solution consisting of, for example, an alkaline solution (pH 9) containing NaOH is then sprayed under a liquid pressure of 2 to 10 kg/cm^2 (step D), and it is dried (step E). Thus, a green pigment layer 30G having a predetermined pattern is formed as shown in Fig. 2D. The green pigment on the position where the blue pigment layer and the red pigment layer are formed is not separated completely from the surface of the remained cured resist layer 13, and a green pigment layer 22G having a small thickness remains on the remained cured resist layer 13 as shown in Fig. 3C.

And, a blue pigment layer 30B and a red pigment layer 30R are formed in the same process as the above-described process of forming the green pigment layer. In the processes of forming these pigment layers, an alkaline solution containing LiCl is used as the developing solution. Thus, a desired filter pattern consisting of the green pigment layer 30G, the blue pigment layer 30B and the red pigment layer 30R is obtained as shown in Fig. 2E. It is seen from Fig. 3D that the blue pigment layer 30B (and the red pigment layer 30R) is laminated on the green pigment layer 22G remained on

the surface of the remained cured resist layer 13.

As shown in Fig. 2F, a green phosphor layer 40G, a blue phosphor layer 40B and a red phosphor layer 40R are formed on the green pigment layer 30G, the blue pigment layer 30B and the red pigment layer 30R by a normal method.

Green, blue and red phosphor suspensions consist of the following compositions.

Green phosphor suspension:

It is prepared by mixing 100g of green phosphor (ZnS:Cu, Al), 8g of polyvinyl alcohol, 0.40g of ammonium dichromate, 0.01g of a surface-active agent and 160g of pure water.

Blue phosphor suspension:

It is prepared by mixing 100g of blue phosphor (ZnS:Ag, Cl), 5g of polyvinyl alcohol, 0.30g of ammonium dichromate, 0.01g of a surface-active agent and 140g of pure water.

Red phosphor suspension:

It is prepared by mixing 100g of red phosphor (Y_2O_2S:Eu), 10g of polyvinyl alcohol, 0.50g of ammonium dichromate, 0.01g of a surface-active agent and 190g of pure water.

The remained cured resist layer 13 is removed by burning in the subsequent process.

Another embodiment of the method of manufacturing a phosphor screen of a color picture tube of the invention will be described.

First, a light absorption layer 12 is formed as the black matrix on the inner surface of the panel 10 of the color picture tube as shown in Fig. 5A. A cured resist layer 13 having a thickness of about 200 angstroms remains on the surface of a hole portion of this panel 10 as shown in Fig. 6A.

Green, blue and red pigment dispersants used have the following composition not containing a photo resist.

Green pigment dispersant:

It is prepared by dispersing green pigment particles TiO_2-NiO-CoO-ZnO (manufactured by Dainichiseika Color & Chemicals Mfg. Co., Ltd., trade name: DAIPYROXIDE TM-GREEN #3320 (particle diameter of 0.01 μm to 0.02 μm)) and a polymer electrolyte sodium salt of acrylic acid (trade name: Dispec N-40) at a ratio of 6.4 wt% and 0.147 wt% into pure water. A ratio of the polymer electrolyte concentration to the pigment concentration is 0.023.

Blue pigment dispersant:

It is prepared by dispersing blue pigment particles cobalt aluminate (manufactured by Toyo Ganryo, trade name: Cobalt Blue X (particle diameter of 0.01 μm to 0.02 μm) and a polymer electrolyte ammonium salt of polyacrylic acid copolymer (manufactured by Allied Colloid, trade name: Dispec GA-40)) at a ratio of 18.0 wt% and 0.414 wt% into pure water. But, a ratio of the polymer electrolyte concentration to the pigment concentration is 0.023.

Red pigment dispersant:

It is prepared by dispersing red pigment particles Fe_2O_3 fine particles (particle diameter of 0.01 μm to 0.02 μm) and a polymer electrolyte ammonium salt of polyoxyethylene alkyl ether sulfate (Dai-ichi Kogyo Seiyaku Co., Ltd., trade name: Hytenol 08) at a ratio of 3.0 wt% and 0.105 wt% into pure water. But, a ratio of the polymer electrolyte concentration to the pigment concentration is 0.035.

Respective filter layers are patterned using the above-described green, blue and red pigment dispersants by the process shown in Fig. 7.

First, a green pigment dispersant is coated to form a first color optical filter layer on the inner surface of the panel 10 of the color picture tube kept at 30°C (step F). Then, the panel 10 is spun at 100 to 150 rpm to spin off an excess portion of the pigment dispersant and also to make the green pigment dispersant have a uniform thickness. It is then dried by a heater at 120°C for three to four minutes (step B). Thus, a green pigment-coated layer 20G is obtained.

Then, a photo resist solution consisting of polyvinyl alcohol (3 wt%), ammonium dichromate (0.20 wt%), a surface-active agent (0.01 wt%) and pure water is coated by the same process as the pigment layer forming process (step G1) and dried (step H). Thus, a photo resist layer 25 is laminated on a green pigment-coated layer 21G as shown in Fig. 5B.

Then, as shown in Fig. 5C, the green pigment-coated layer 20G is exposed to have a predetermined pattern through an unillustrated shadow mask by a high-pressure mercury lamp (step C). According to the production process

of this embodiment, an exposure time is about 1/5 as compared with the time in the previous production process.

Subsequently, a developing solution consisting of, for example, an alkaline solution (pH 9) containing NaOH is sprayed under a liquid pressure of 2 to 10 kg/cm^2 (step D), and it is dried (step E). As shown in Fig. 5D, a pattern having the green pigment-coated layer 21G and the photo resist layer 25 laminated is obtained. The green pigment on the position where the blue pigment layer and the red pigment layer are formed is not separated completely from the surface of the remained cured resist layer 13, and a green pigment layer 22G having a small thickness remains on the remained cured resist layer 13 as shown in Fig. 6C.

Then, a blue pigment layer 30B and a red pigment layer 30R are formed in the same process as the above-described process of forming the green pigment layer. In the process of forming those pigment layers, an alkaline solution containing Na_2CO_3 is used as the developing solution. Thus, a desired filter pattern consisting of the green pigment layer 31G, the blue pigment layer 31B and the red pigment layer 31R is obtained on the inner surface of the panel 10 as shown in Fig. 5E. It is seen from Fig. 6D that the blue pigment layer 30B (and the red pigment layer 30R) is laminated on the green pigment layer 22G remained on the surface of the remained cured resist layer 13.

After removing the resist layer 25 from the respective blue, green and red pigment layers, phosphor layers 41G, 41B, 41R are formed by a normal method as shown in Fig. 5F. And, the green, blue and red phosphor suspensions obtained are the same as those in the above-described embodiment. And, the cured resist layer 13 remained on the surface of a hole portion of the inner surface of the panel 10 removed by burning in the subsequent process.

Claims

1. A method of manufacturing a phosphor screen of a color picture tube, comprising the following steps:

   (a) forming a black matrix pattern in which a resist remains on a position where a optical filter layer is to be formed by coating the resist inside a panel, exposing and developing thereof;
   (b) forming a pattern of a green optical filter layer by coating a green pigment inside the panel; and
   (c) subsequently forming a pattern of a blue or red filter layer thereon.

2. The method of manufacturing a phosphor screen of a color picture tube as set forth in claim 1; wherein, a resist used in the step (a) is a water-soluble photosensitive liquid containing at least an azide-based sensitizer or a silane coupling agent.

3. The method of manufacturing a phosphor screen of a color picture tube as set forth in claim 1; wherein, the respective optical filter layers have a dot-shaped or stripe-shaped pattern.

FIG. 1 A

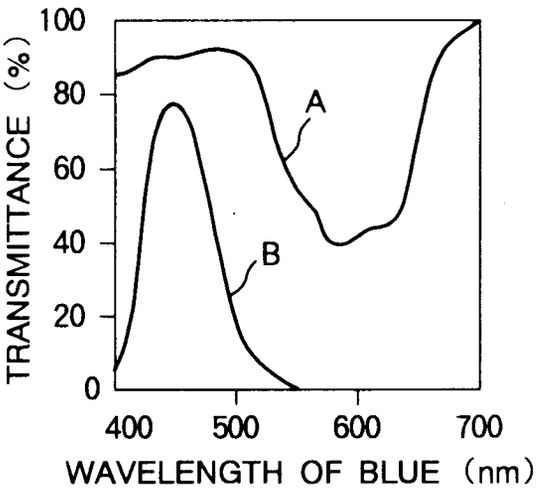


FIG. 1 B

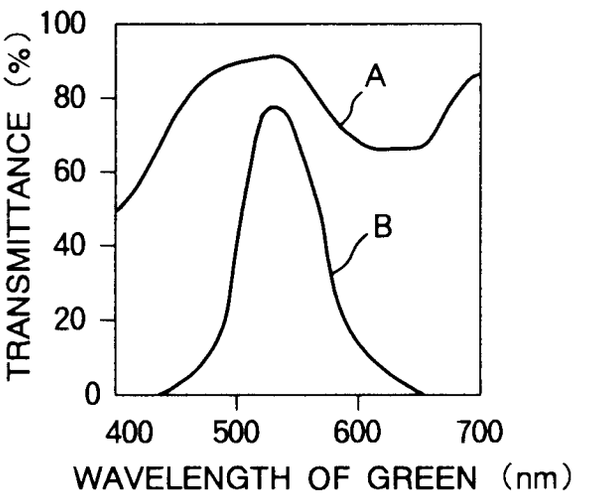


FIG. 1 C

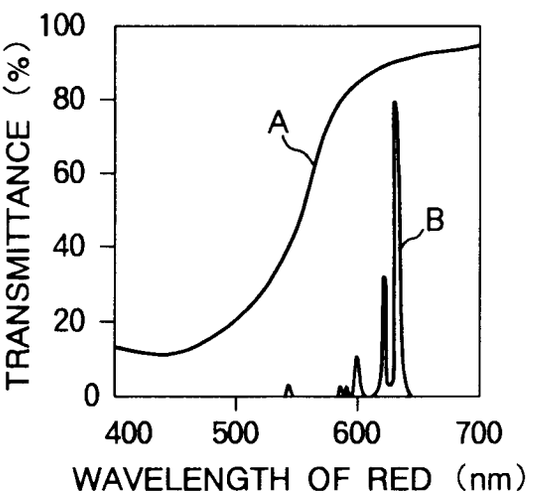


FIG. 2 A

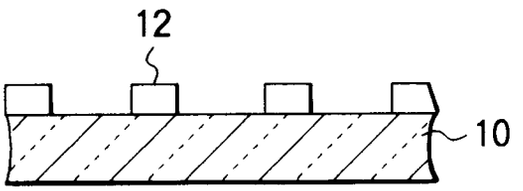


FIG. 2 B

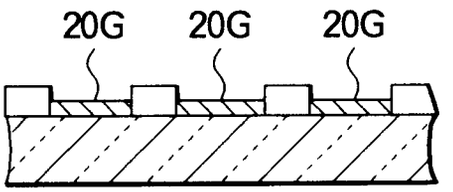


FIG. 2 C

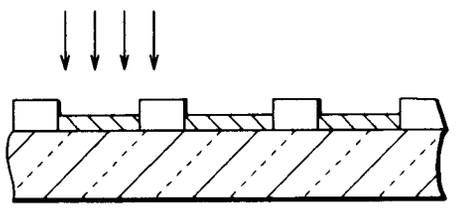


FIG. 2 D

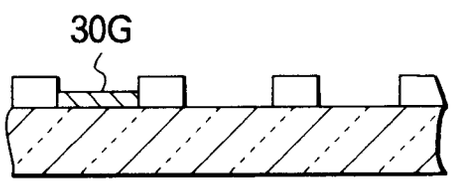


FIG. 2 E

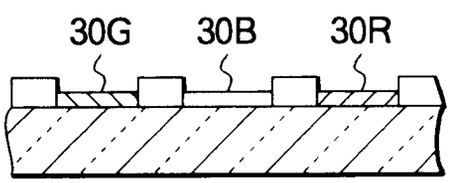


FIG. 2 F

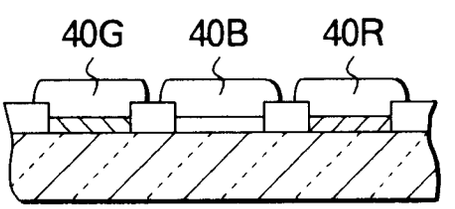


FIG. 3A

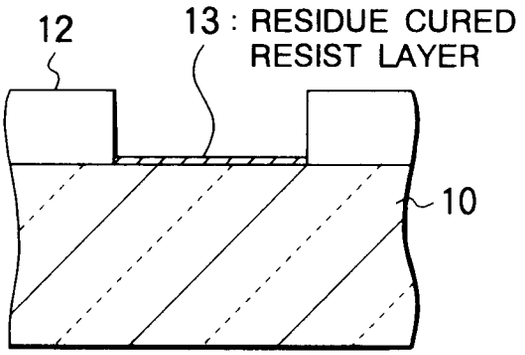


FIG. 3B

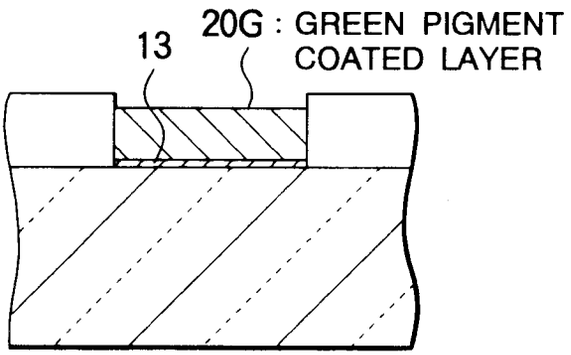


FIG. 3C

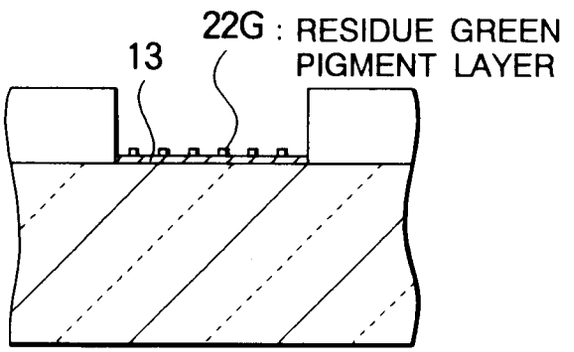


FIG. 3D

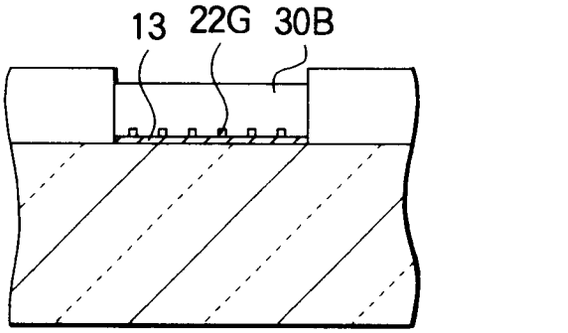


FIG. 4

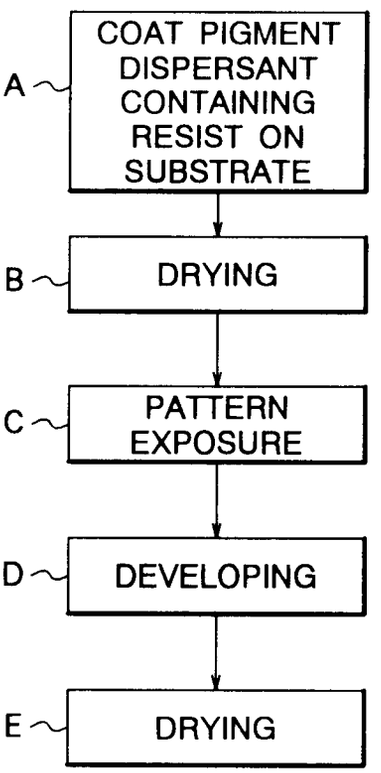

A
COAT PIGMENT DISPERSANT CONTAINING RESIST ON SUBSTRATE
B
DRYING
C
PATTERN EXPOSURE
D
DEVELOPING
E
DRYING

FIG. 5 A

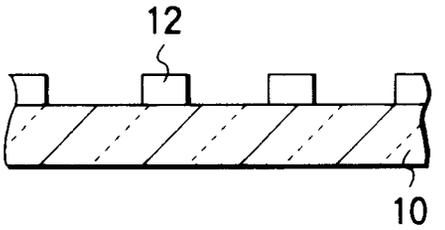


FIG. 5 B

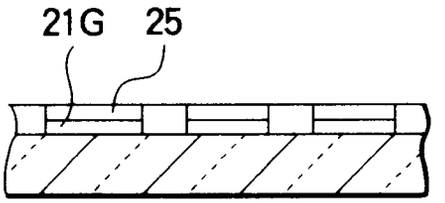


FIG. 5 C

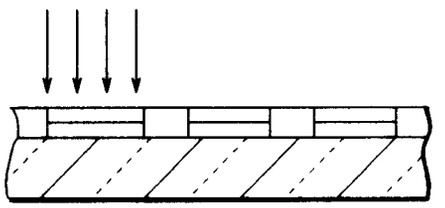


FIG. 5 D

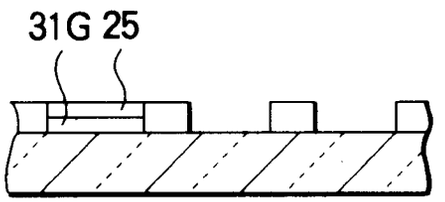


FIG. 5 E

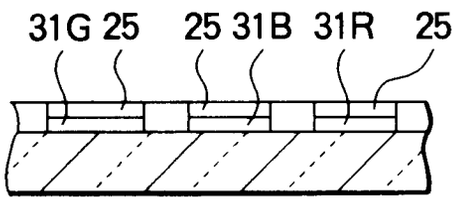


FIG. 5 F

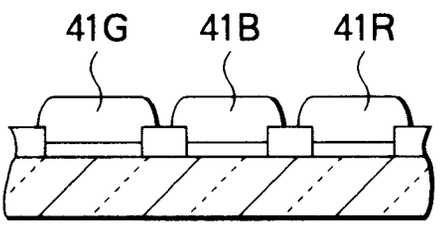


FIG. 6 A

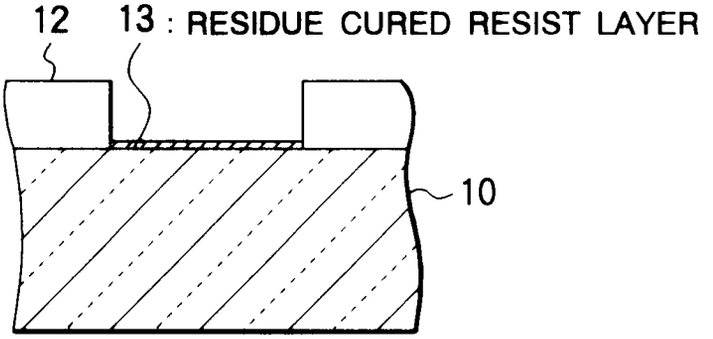


FIG. 6 B

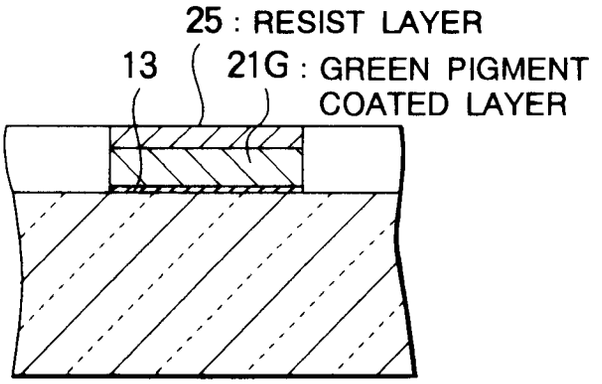


FIG. 6 C

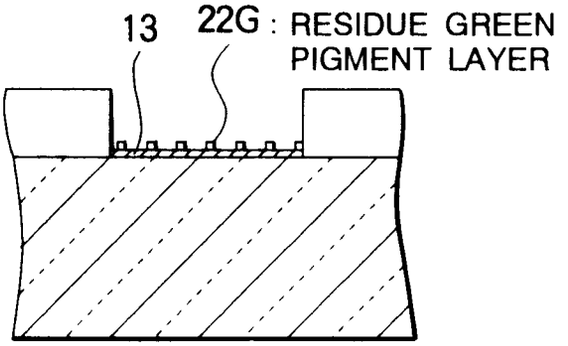


FIG. 6 D

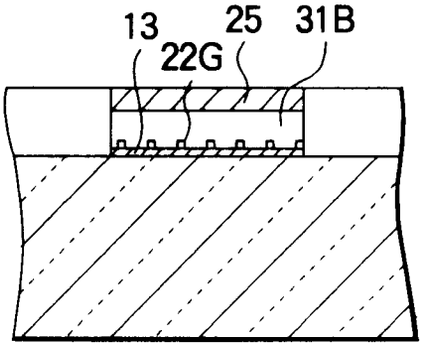
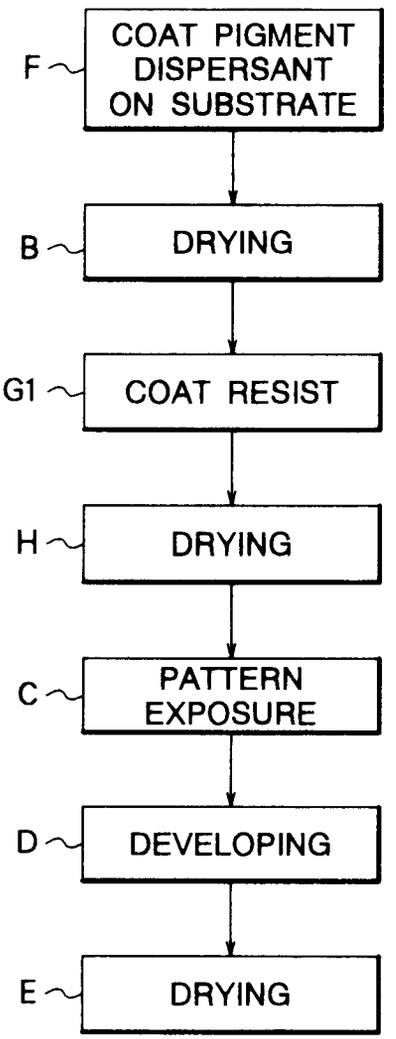


FIG. 7


F
COAT PIGMENT DISPERSANT ON SUBSTRATE
B
DRYING
G1
COAT RESIST
H
DRYING
C
PATTERN EXPOSURE
D
DEVELOPING
E
DRYING