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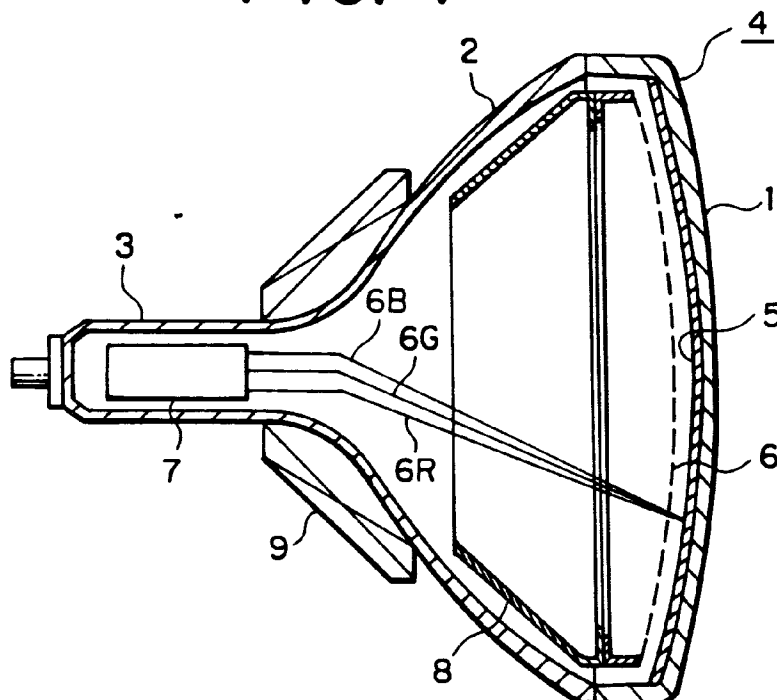
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(54) **Colour picture tube**

(57) In a colour picture tube (1,2,3) having a phosphor screen (5) composed of a blue-emitting phosphor, a green-emitting phosphor, and a red-emitting phosphor, the ratio A/B of the brightness A of the red-emitting

phosphor to the brightness B of the blue-emitting phosphor is 1.40 or more. Thus, red colour purity is improved without a decrease of the brightness of the phosphor screen. Consequently, a colour picture tube with a wide color reproducible region can be provided.

FIG. 1



Description

The present invention relates to a colour picture tube, in particular, to a colour picture tube having a large red reproducible region of a phosphor screen.

A conventional colour picture tube has an enclosure composed of a panel, a funnel, and a neck. A phosphor screen composed of a blue-emitting phosphor, a green-emitting phosphor, and a red-emitting phosphor is disposed on an inner surface of the panel. Electron beams emitted from an electron gun are scanned to the phosphor screen through a shadow mask. Thus, a colour picture is displayed. As important properties of the phosphor screen of a colour picture tube, there are brightness, contrast and colour purity of blue, green, and red that define the colour reproducible region. The properties of the phosphor screen largely depend on the light-emitting properties of individual phosphors that compose the phosphor screen.

Conventionally, a blue-emitting phosphor is composed of ZnS:Ag. A green-emitting phosphor is composed of ZnS:Cu, Au, Al, ZnS:Cu, Al, or a mixture thereof. A red-emitting phosphor is composed of Y₂O₂S:Eu.

With respect to the red-emitting phosphor Y₂O₂S:Eu, the emitting colour thereof is almost proportional to the concentration of Eu that is used as an activator. As listed in Table 1, the redness (namely, the red colour reproducible region) is proportional to the concentration of Eu. However, the concentration of Eu is reversely proportional to the red colour brightness. Thus, in consideration of the balance of both the properties, Y₂O₂S:Eu containing 3 to 7 % by weight of Eu is preferably used as the material of the red-emitting phosphor.

Table 1

Concentration of Eu (%) in Y ₂ O ₂ S:Eu	Chromaticity of Colour Picture Tube		Single Colour Brightness (Relative Value)	Unit Price of Phosphor (Relative Value)
	X	Y		
3.9	0.615	0.335	100	100
5.6	0.625	0.330	95	110

Table 1 lists measured values of a 17-inch colour picture tube of which pitches of phosphor dots are 0.28 mm.

However, in recent years, colour picture tubes have been widely used as display means for computers and so forth. The colour purity of blue, green, and red in these colour picture tubes should be improved for a wide colour reproducible region.

However, with respect to the red-emitting phosphor, to improve the colour purity, the concentration of Eu should preferably be increased although the red colour brightness tends to decrease whilst the cost of the phosphor increases.

An object of the present invention is to provide a colour picture tube that allows the colour purity of red to be improved without any or any significant decrease of colour brightness of the phosphor screen, or without the need to increase the concentration of Eu.

The present invention provides a colour picture tube, comprising a panel and a phosphor screen disposed on an inner surface of the panel, the phosphor screen being composed of a blue-emission phosphor, a green-emitting phosphor, and a red-emitting phosphor, wherein the ratio A/B of the brightness A of the red-emitting phosphor to the brightness B of the blue-emitting phosphor is 1.40 or more.

The blue-emitting phosphor is preferably composed of silver-activated zinc sulfide (ZnS:Ag) containing 0.015 to 0.08 % by weight of silver (Ag). The red-emitting phosphor is preferably composed of europium-activated yttrium oxysulfide (Y₂O₂S:Eu) containing 3.5 % to 6.1 % by weight of europium (Eu).

Colour filters corresponding to the blue-emission phosphor, the green-emitting phosphor, and the red-emitting phosphor are preferably disposed between the phosphor screen and the panel.

In order that the invention may be illustrated, more easily appreciated and readily carried into effect by those skilled in the art, embodiments of the invention will now be described purely by way of non-limiting examples with reference to the accompanying drawings in which:

Fig. 1 is a sectional view showing the structure of a colour picture tube according to an embodiment of the present invention;

Fig. 2A is a plan view showing an example of the structure of a phosphor screen of the colour picture tube according to the embodiment;

Fig. 2B is a sectional view of the phosphor screen shown in Fig. 2A;

Fig. 3 is a sectional view showing a modification of the phosphor screen of the colour picture tube according to the embodiment;

Fig. 4A is a graph showing an example of a spectral reflectance of a blue filter shown in Fig. 3;
 Fig. 4B is a graph showing an example of a spectral reflectance of a green filter shown in Fig. 3;
 Fig. 4C is a graph showing an example of a spectral reflectance of a red filter shown in Fig. 3;
 Figs. 5A to 5G are sectional views showing a method for forming the phosphor screen shown in Figs. 2A and 2B; and
 Fig. 6 is a graph showing the relation between the ratio of the brightness of a red-emitting phosphor of the phosphor screen and the brightness of a blue-emitting phosphor thereof and the x-value of chromaticity of the red-emitting phosphor.

Referring to the drawings, Fig. 1 is a sectional view showing the structure of a colour picture tube according to an embodiment of the present invention.

As shown in Fig. 1, the colour picture tube has an enclosure 4 composed of a transmission panel 1, a funnel 2, and a neck 3. A phosphor screen 5 (that will be described later) is disposed on an inner surface of the panel 1. A shadow mask 6 is set close to the inner surface of the phosphor screen 5. An electron gun 7 that emits electron beams 6B, 6G, and 6R is disposed in the neck 3 of the enclosure 4. An inner shield 8 is disposed inside the funnel 2 and connected to the shadow mask 6. The inner shield 8 shields the electron beams 6B, 6G, and 6R emitted from the electron gun 7 from an outer magnetic field. A deflecting unit 9 is disposed outside the funnel 2. The deflecting unit 9 generates a magnetic field and thereby deflects the electron beams 6B, 6G, and 6R emitted from the electron gun 7. The electron beams 6B, 6G, and 6R deflected by the deflecting unit 9 horizontally and vertically scan the phosphor screen 5 through the shadow mask 6. Thus, a colour picture is displayed on the panel 1.

As shown in Figs. 2A and 2B, the phosphor screen 5 is composed of a matrix of a light absorbing layer 10 and phosphor dots 11B, 11G, and 11R. The phosphor dots 11B, 11G, and 11R are regularly disposed in respective circular spaces of the light absorbing layer 10. Alternatively, colour filters 12B, 12G, and 12R corresponding to the phosphor dots 11B, 11G, and 11R may be disposed between the phosphor dots 11B, 11G, and 11R and the panel 1, respectively, as shown in Fig. 3.

The blue-emitting phosphor dot 11B is composed of ZnS:Ag. The green-emitting phosphor dot 11G is composed of ZnS:Cu, Au, Al, ZnS:Cu, Al, or a mixture thereof. The red-emitting phosphor dot 11R is composed of $Y_2O_2S:Eu$. The concentration of Ag that is an activator of the blue-emitting phosphor ZnS:Ag is in the range from 0.015 to 0.08 % by weight. The concentration of Eu that is an activator of the red-emitting phosphor $Y_2O_2S:Eu$ is in the range from 3.5 to 6.1 % by weight.

The blue filter 12B shown in Fig. 3 is composed of a pigment such as cobalt aluminate, ultramarine, or the like that has a spectral reflectance as represented, for example, by a curve 13 in Fig. 4A and effectively transmits the light from the blue-emitting phosphor. The green filter 12G is composed of a pigment such as $TiO_2-NiO-CoO-ZnO$, $COO-Al_2O_3-Cr_2O_3-TiO_2$, or the like that has a spectral reflectance as represented, for example, by a curve 14 in Fig. 4B and effectively transmits the light from the green-emitting phosphor. The red filter 12R is composed of a pigment such as ferric oxide, anthraquinone, or the like that has a spectral reflectance as represented, for example, by a curve 15 in Fig. 4C and effectively transmits the light from the red-emitting phosphor.

As shown in Figs. 5A to 5G, the phosphor screen 5 can be formed by a photographic printing method with a photo mask of a shadow mask.

With respect to the phosphor screen 5 shown in Figs. 2A and 2B, a photosensitive material is coated on the inner surface of the panel 1. The photosensitive material is dried and thereby a photoresist 16 is formed. The photoresist 16 is exposed through the shadow mask 6. A pattern corresponding to electron beam guide holes 17 of the shadow mask 6 is printed on the photoresist 16 (see Fig. 5A). Next, the patterned photoresist 16 is developed and thereby a resist 18 with a pattern corresponding to the electron beam guide holes 17 of the shadow mask 6 is formed (see Fig. 5B). A black light absorbing paint is coated on the inner surface of the panel 1 on which the resist 18 has been formed. The black light absorbing paint is dried and thereby a light absorbing layer 19 is formed (see Fig. 5C). With a remover, the light absorbing paint 19 is removed along with the resist 18. Thus, a matrix-shaped light absorbing layer 10 that has circular spaces 20 is formed on the inner surface of the panel 1 (see Fig. 5D).

Thereafter, a phosphor slurry whose main components are a blue-emitting phosphor and a photosensitive material is coated on the inner surface of the panel 1 (on which the matrix-shaped light absorbing layer 10 has been formed). Thereafter, the phosphor slurry is dried. Thus, a phosphor slurry layer 21 is formed (see Fig. 5E). Next, the phosphor slurry layer 21 is exposed through the shadow mask 6 and thereby a pattern corresponding to the electron beam guide holes 17 of the shadow mask 6 is patterned on the phosphor slurry layer 21. Thereafter, the patterned phosphor slurry layer 21 is developed and thereby the blue-emitting phosphor dot 11B is formed in a predetermined space of the light absorbing layer 10 (see Fig. 5F). With respect to the green-emitting phosphor and red-emitting phosphor, Figs. 5E and 5F of the blue-emitting phosphor are repeated. Thus, the green-emitting phosphor dot 11G and the red-emitting phosphor dot 11R are formed in respective predetermined spaces of the light absorbing layer 10 (see Fig. 5G).

As shown in Fig. 3, when the colour filters 12B, 12G, and 12R are disposed, after the matrix-shaped light absorbing layer 10 has been formed, before the phosphor slurry is coated, a pigment dispersion solution mainly composed of a

pigment, a polymer electrolyte, and a photosensitive material is coated and dried. Thus, a pigment layer is formed. In the same manner as the phosphor dot forming process, after the blue filter 12B, the green filter 12G, and red filter 12R are formed, the phosphor dots 11B, 11G, and 11R are formed.

In the phosphor screen 5, the blue-emitting phosphor dot 11B is composed of ZnS:Ag containing 0.015 to 0.08 % by weight of Ag as an activator. In addition, the red-emitting phosphor dot 11R is composed of $Y_2O_2S:Eu$ containing 3.5 to 6.1 % by weight of Eu as an activator. Moreover, the ratio A/B of the brightness A of the red-emitting phosphor to the brightness B of the blue-emitting phosphor is 1.40 or more. Thus, the colour purity of red is improved without a decrease of the brightness of the phosphor screen 5 in comparison with a conventional colour picture tube. Consequently, a colour picture tube with a wide colour reproducible region can be provided.

In a colour picture tube having the phosphor screen 5 composed of a blue-emitting phosphor, a green-emitting phosphor, and a red-emitting phosphor, the ratio A/B of the brightness A of the red-emitting phosphor to the brightness B of the blue-emitting phosphor largely affects the increase of the color reproducible region. In other words, as is clear from chromaticity coordinates, the chromaticity value x of the blue-emitting phosphor is much smaller than the chromaticity value x of the red-emitting phosphor. In addition, the colour picture tube has the shadow mask 6, the inner shield 8, and so forth in the paths of the electron beams 6B, 6G, and 6R. Thus, even if the electron beam 6R causes the red-emitting phosphor dot 11R to selectively light, the electron beam 6R collides with the shadow mask 6, the inner shield 8 and so forth and thereby scatters. Consequently, the scattered electron beam 6R causes the adjacent blue-emitting phosphor dot 11B and green-emitting phosphor dot 11G to light. As a result, an additive colour mixing takes place and thereby the chromaticity value varies.

Table 2 lists experimental results for variations of chromaticity values due to the additive colour mixing. In the experiment, using a single colour tube (17 inches; phosphor dot pitches = 0.28 mm) having only red-emitting phosphor dots and a three colour tube (conventional colour picture tube) having blue, green, and red-emitting phosphor dots, red chromaticity values thereof were measured. As is clear from Table 2, the red chromaticity values x largely vary.

Table 2

	Red chromaticity	
	X	Y
Single- colour tube	0.638	0.346
Three-colour tube	0.608	0.343

Using a colour picture tube (17 inches; phosphor dot pitches = 0.28 mm) having a phosphor screen 5 (blue-emitting phosphor ZnS:Ag containing 0.02 % by weight of Ag and red-emitting phosphor $Y_2O_2S:Eu$ containing 3.9 % by weight of Eu) with a blue colour filter 12B, a green colour filter 12G, and a red colour filter 12R shown in Fig. 3, the ratio A/B of the brightness A of the red-emitting phosphor to the brightness B of the blue-emitting phosphor was varied and the variation of the red chromaticity values was experimented. The ratio A/B was varied in the condition that the coating amount of the blue-emitting phosphor was kept at 46 ± 1 mg in 16 cm^2 and that the coating amount of the red-emitting phosphor was varied in the range from 50 mg to 75 mg in 16 cm^2 . Table 3 and Fig. 6 show the experimental results.

Table 3

Brightness of red-emitting phosphor (cd/m^2)/brightness of blue-emitting phosphor (cd/m^2) in colour picture tube	Red chromaticity in colour picture tube *	
	X	Y
$28.2/21.8 = 1.294$	0.608	0.334
$28.6/21.4 = 1.336$	0.609	0.335
$32.5/22.7 = 1.432$	0.613	0.336
$31.3/21.3 = 1.469$	0.617	0.336
$34.4/21.4 = 1.607$	0.624	0.338

* Measured by spectroradiometer MCPD-1000 (OTSUKA ELECTRONICS CO., LTD.)

The experimental results show that the red chromaticity is proportional to the ratio A/B of the brightness A of the red-emitting phosphor to the brightness B of the blue-emitting phosphor.

On the other hand, to widen the colour reproducible region, the red chromaticity value x should be 0.612 or more. To satisfy this condition, it is clear that the ratio A/B of the brightness A of the red-emitting phosphor to the brightness

B of the blue-emitting phosphor should be 1.40 or more.

In the above embodiments, a colour picture tube having a phosphor screen composed of a matrix-shaped light absorbing layer and blue, green, and red-emitting phosphor dots regularly formed in circular spaces of the light absorbing layer was described. In addition, a colour picture tube having colour filters disposed between phosphor dots and a panel was described. However, the present invention can be applied to a colour picture tube having a phosphor screen composed of a stripe-shaped light absorbing layer and red, green, and red-emitting phosphor stripes regularly disposed in the stripe-shaped spaces of the light absorbing layer. In addition, the present invention can be applied to a colour picture tube having colour filters disposed between the phosphor stripes and the panel.

Moreover, the present invention can be applied to a colour picture tube that does not have the above-described matrix-shaped or stripe-shaped light absorbing layer.

As described above, according to the present invention, in a colour picture tube having a phosphor screen composed of a blue-emitting phosphor, a green-emitting phosphor, and a red-emitting phosphor, since the ratio A/B of the brightness A of the red-emitting phosphor to the brightness B of the blue-emitting phosphor is 1.40 or more, the red chromaticity is improved without a decrease of the brightness of the phosphor screen. Thus, a colour picture tube with a wide colour reproducible region can be obtained.

Although the present invention has been shown and described with respect to an embodiment by way of non-limiting example, it should be understood by those skilled in the art that the foregoing and various other changes, omissions, and additions in the form and detail thereof may be made therein without departing from the spirit and scope of the present invention.

Claims

1. A colour picture tube, comprising:

a panel; and

a phosphor screen disposed on an inner surface of said panel, said phosphor screen being composed of a blue-emission phosphor, a green-emitting phosphor, and a red-emitting phosphor,

wherein the ratio A/B of the brightness A of the red-emitting phosphor to the brightness B of the blue-emitting phosphor is 1.40 or more.

2. A colour picture tube as claimed in claim 1,

wherein the blue-emitting phosphor is composed of silver-activated zinc sulfide containing 0.015 to 0.08 % by weight of silver, and

wherein the red-emitting phosphor is composed of europium-activated yttrium oxysulfide containing 3.5 % to 6.1 % by weight of europium.

3. A colour picture tube as claimed in claim 1 or 2,

wherein colour filters corresponding to the blue-emission phosphor, the green-emitting phosphor, and the red-emitting phosphor are disposed between said phosphor screen and said panel.

FIG. 1

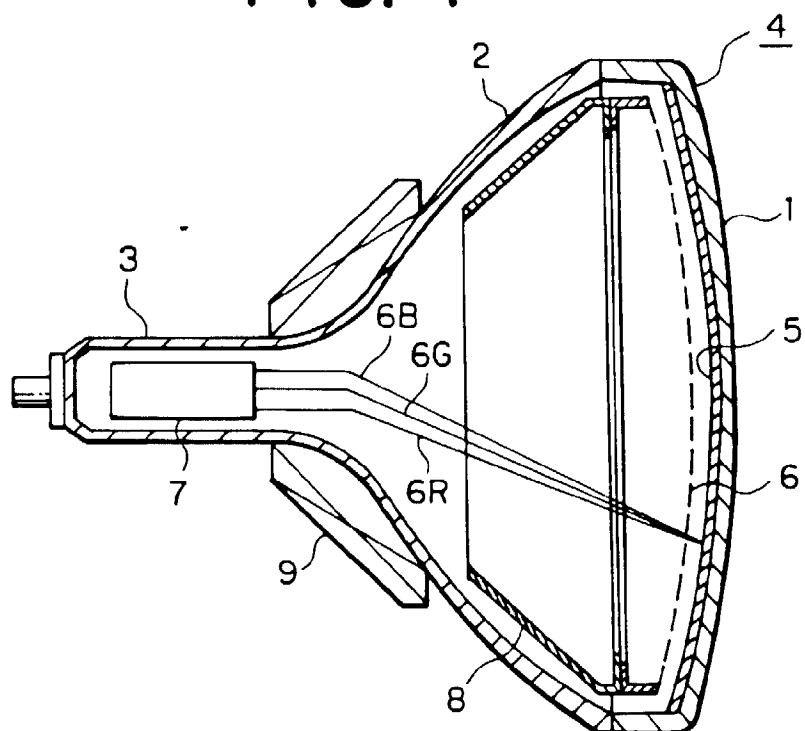


FIG. 2A

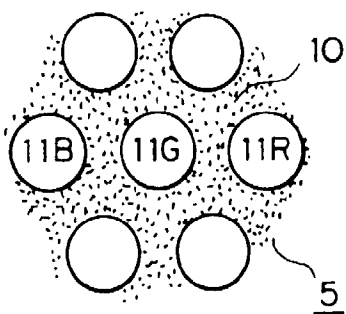


FIG. 2B

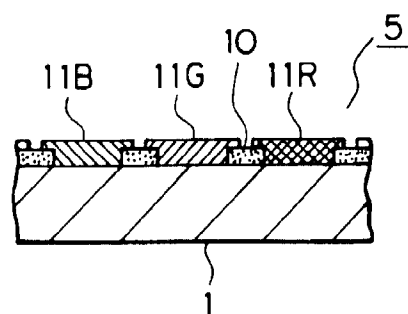


FIG. 3

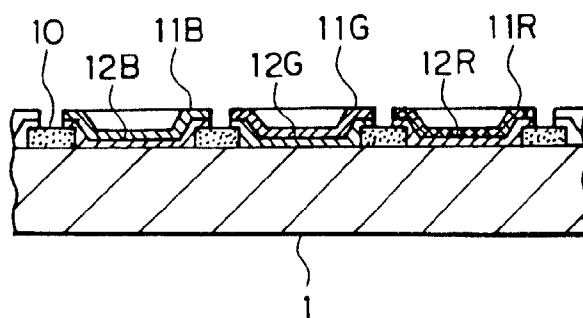


FIG. 4A

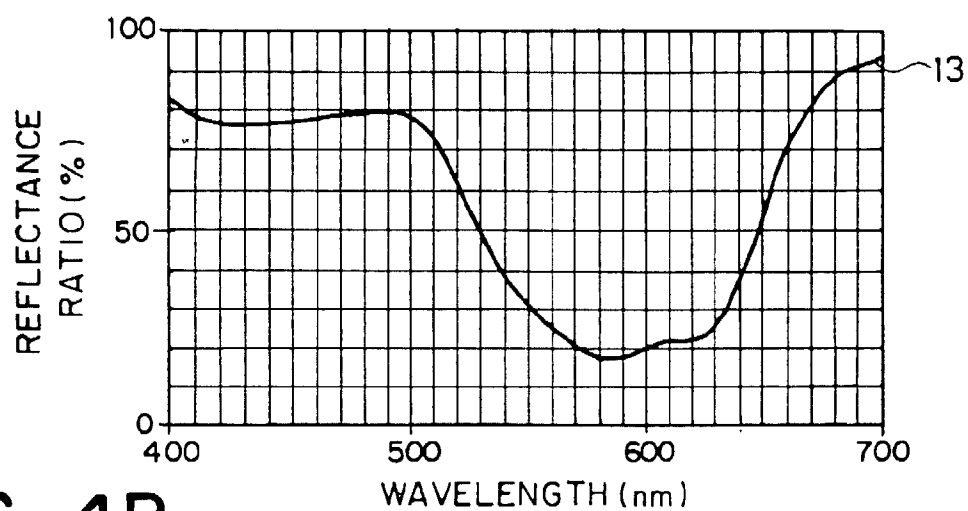


FIG. 4B

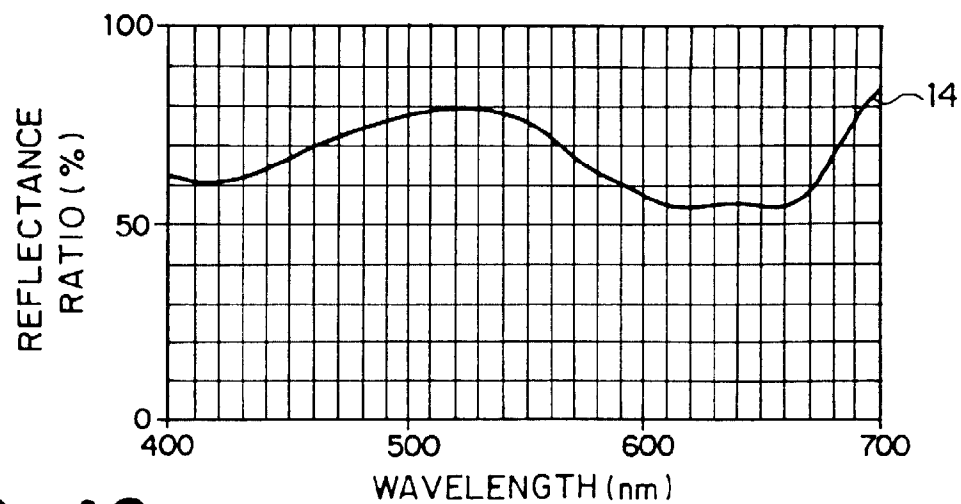


FIG. 4C

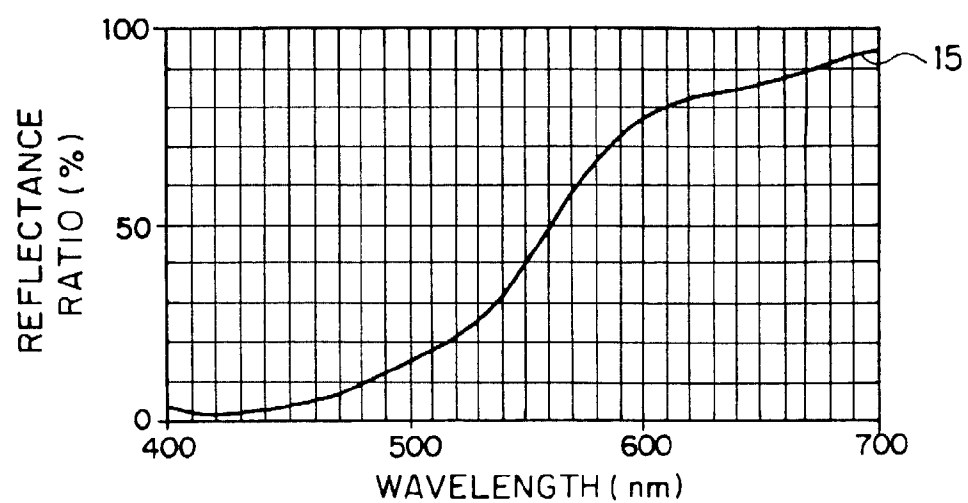


FIG. 5A

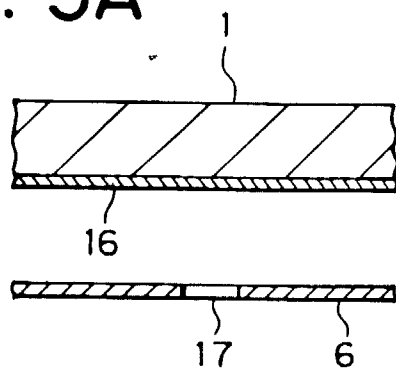


FIG. 5E

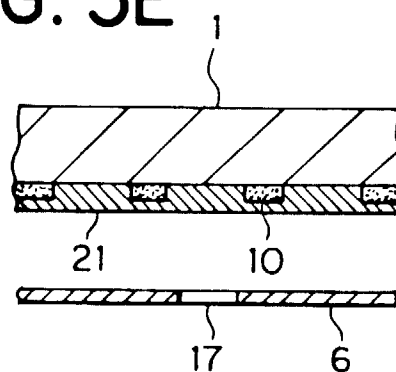


FIG. 5B

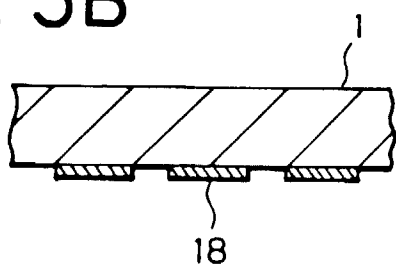


FIG. 5F

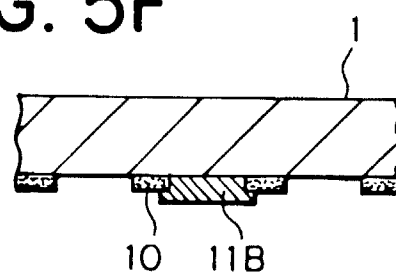


FIG. 5C

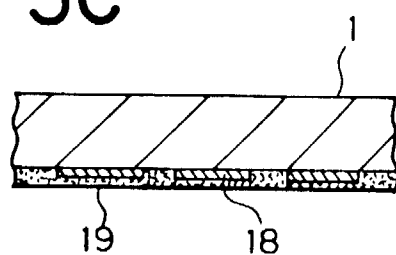


FIG. 5G

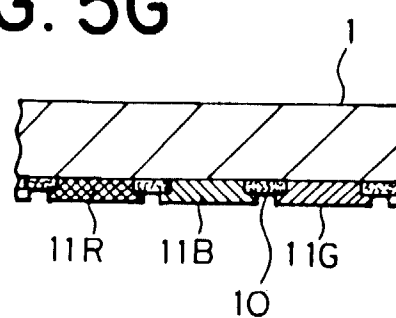


FIG. 5D

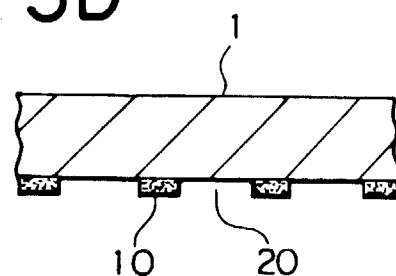
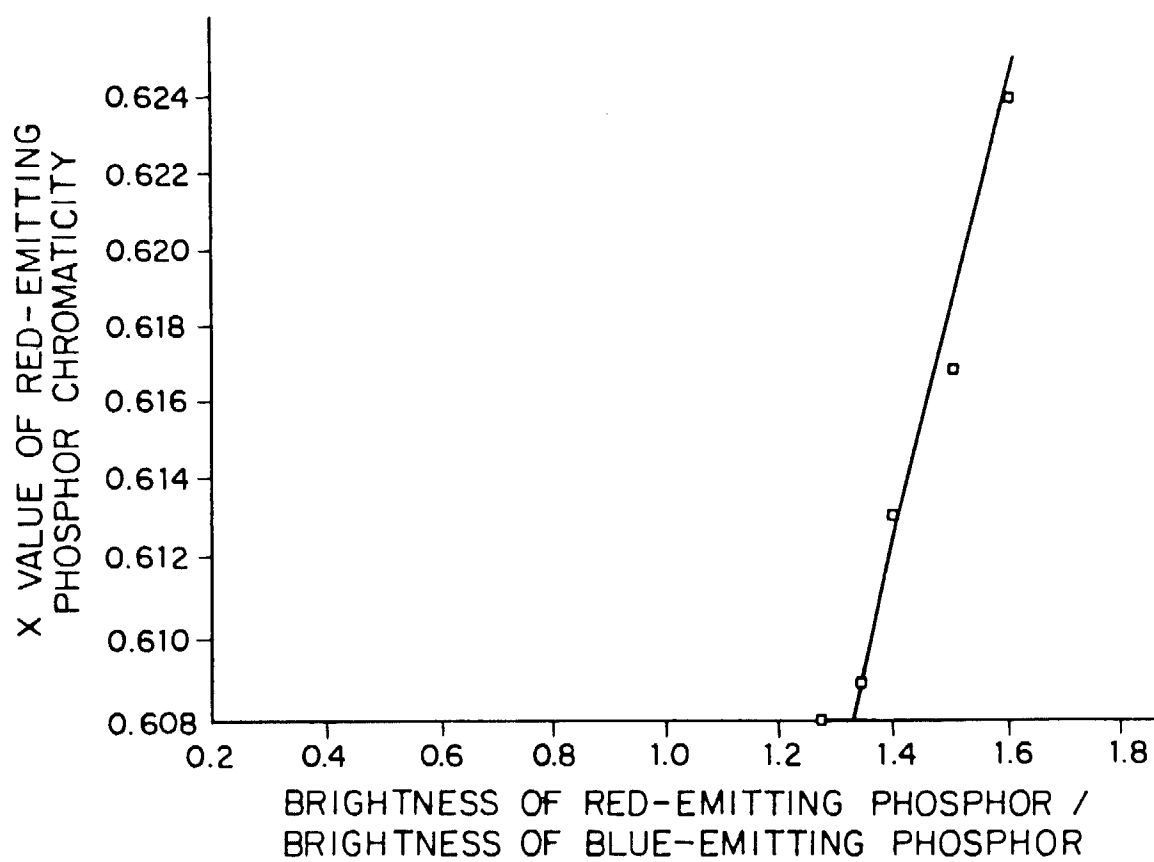


FIG. 6





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 98 30 4353

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	EP 0 129 620 A (IBM) 2 January 1985 * claim 1 *	1	H01J29/20 H01J29/32 H01J29/18 H01J29/30
A	US 4 814 666 A (IWASAKI KAZUHI TO ET AL) 21 March 1989 * claims 1-9 *	1,2	
A	EP 0 529 098 A (KASEI OPTONIX) 3 March 1993 * claim 1 *	1,2	
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			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			H01J
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 1 October 1998	Examiner Van den Bulcke, E
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