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(54) **Compensation method for improving color purity and color temperature of a plasma display panel**

(57)   A compensation process for improving color saturation and image quality of a plasma display panel (PDP) is provided, wherein a brightness of light generated from each of red, green, and blue discharge cells of each pixel on said PDP is calculated through a numeric operation according to laws of color matching. The process comprises the step of increasing or decreasing the strength of input image signals of each of the red, green, and blue discharge cells in accordance with the calculation result for adjusting brightness of the generated red, green, and blue lights so as to subtract a visible light generated by gas in each of the red, green, and blue discharge cells during gas discharging, thereby eliminating an adverse effect of the visible light on color purity and color temperature of the PDP during gas discharging. This can obtain an image on PDP having an optimum color purity and color temperature and reduce the manufacturing cost.

FIG. 5

EP 1 255 238 A1
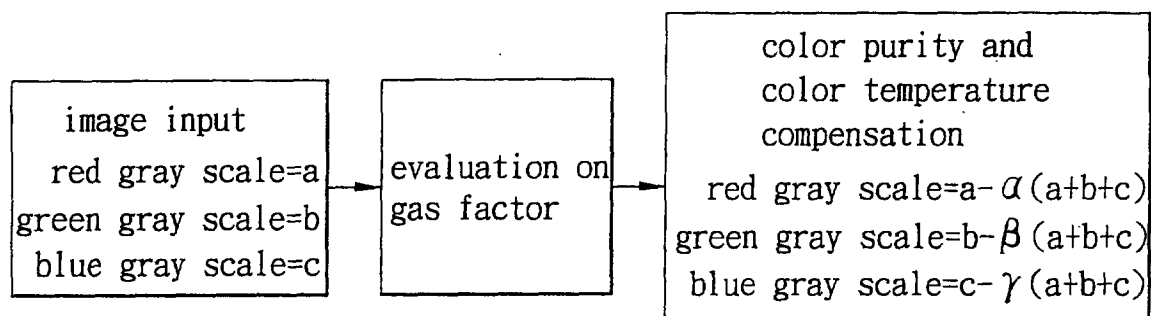
Description

FIELD OF THE INVENTION

5   **[0001]**   The present invention relates to plasma display panels and more particularly to a compensation method for improving color purity and color temperature of plasma display panel by adjusting the strength of input image signals.

BACKGROUND OF THE INVENTION

10   **[0002]**   A manufacturing process of a conventional alternating current discharge type plasma display panel (PDP) 10 is shown in FIG. 1. First, two different activation layers are formed on glass substrates 11. and 12 respectively. Then seal the peripheries of the glass substrates together. A mixed gas consisting of helium (He), neon (Ne), and xenon (Xe) (or argon (Ar)) having a predetermined mixing volume ratio is stored in a discharge space formed in between the glass substrates. A front plate 11 is defined as one that facing viewers. A plurality of parallel spaced transparent elec-

15   trodes 111, a plurality of parallel spaced bus electrodes 112, a dielectric layer 113, and a protective layer 114 are formed from the front plate 11 inwardly. From a corresponding rear plate 12 inwardly, a plurality of parallel spaced data electrodes 121, a dielectric layer 124, a plurality of parallel spaced ribs 122, and a uniform phosphor layer 123 are formed. When a voltage is applied on electrodes 111, 112, and 121, dielectric layers 113 and 124 will discharge in discharge cell 13 formed by adjacent spaced ribs 122. As a result, a ray having a desired color is emitted from phosphor layer 123.

20   **[0003]**   Conventionally, in PDP 10 a plurality of parallel spaced transparent electrodes 111 are formed on inner surface of front plate 11 by sputtering and photolithography (or printing). Then a plurality of parallel spaced bus electrodes 112 are formed on the transparent electrodes 111 respectively by plating (or sputtering) and photolithography. The line impedance of the transparent electrodes 111 may be reduced by the provision of bus electrodes 112. In the following description, two adjacent transparent electrodes 111 (including bus electrodes 112) on the front plate 11 are represented

25   by X electrode and Y electrode respectively. A triple electrode is formed by X electrode, Y electrode and corresponding data electrode 121 on the rear plate 12. When a voltage is applied on the triple electrode, dielectric layers 113 and 124 will discharge in discharge cell 13 formed by adjacent spaced ribs 122. Hence, UV rays are emitted from the mixed gas stored therein. And in turn, phosphor layer 123 in discharge cell 13 is activated by the UV rays. As an end, a visible light is generated by red, green and blue phosphor layers, resulting in an image showing.

30   **[0004]**   In the conventional PDP 10, a mixed gas (which is a combination of neon (Ne) and xenon (Xe), a combination of helium (He), neon (Ne) and xenon (Xe), a combination of neon (Ne), xenon (Xe), and argon (Ar), or a combination of helium (He), neon (Ne), xenon (Xe) and argon (Ar)) is used. Note that neon (Ne) is the indispensable constituent component of any of the above combinations. When a discharge is occurred in any of the above combinations, an orange red of visible light O_g having a wavelength of about 586 nm is generated as shown in FIGS. 2a and 2b. Note

35   that the color of the visible light emitted during discharging may be one other than orange red if the combination of the mixed gas is changed. Such orange red of visible light generated by the gas in each of red, green, and blue discharge cells inevitably and adversely affects the color purity of PDP 10 and results in a lowering of color temperature of PDP 10.
    [0005]   Conventionally, as to the poor color purity and low color temperature of PDP caused by orange red of visible light during gas (mainly by Ne) discharging in discharge cell 13, a number of improvements have been proposed by

40   PDP manufacturers to mitigate the above problems. For example, NEC (Japan) implements a capsulated color filter technique. A filter 20 on front plate 11 is formed on each of corresponding red, green, and blue discharge cells 13 as shown in FIG. 3. With this, it is possible to filter out the orange red of visible light O_g from discharge cells 13, thereby increasing color purity and color temperature of PDP. However, the manufacturing cost is increased significantly because the manufacturing process of filters 20 is complex and the precision requirement is much higher. Another im-

45   provement technique is proposed by Matsushita (Japan) in which the sizes of red, green, and blue discharge cells 13 are made different one another as shown in FIG. 4. The size of blue discharge cell 13 is the largest among all discharge cells 13 for increasing color temperature of PDP. Also, the size of red discharge cell 13 is the smallest among all for decreasing the affecting degree on the color temperature of PDP. However, the manufacturing process is complex. Further, there is a great difficulty in driving such device.

50   **[0006]**   In view of the above, such conventional improvements are disadvantageous for the complex process and undesirable design of PDP since the construction of PDP is changed for eliminating the adverse effect of the generated orange red of visible light on the color purity and color temperature of PDP. Thus, it is desirable to provide a novel method for improving color purity and color temperature of PDP in order to overcome the above drawbacks of prior art.

55   SUMMARY OF THE INVENTION

    [0007]   It is an object of the present invention to provide a compensation process for improving color saturation and image quality of a plasma display panel (PDP), wherein a brightness of light generated from each of red, green, and

blue discharge cells of each pixel on said PDP is calculated through a numeric operation according to laws of color matching, the process comprising the step of increasing or decreasing the strength of input image signals of each of the red, green, and blue discharge cells in accordance with the calculation result for adjusting the brightness of the generated red, green, and blue lights so as to subtract a visible light generated by the gas in each of the red, green, and blue discharge cells during gas discharging, thereby eliminating an adverse effect of the visible light on color purity and color temperature of the PDP during gas discharging.

[0008]   The above and other objects, features and advantages of the present invention will become apparent from the following detailed description taken with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

FIG. 1 is a sectional view of a conventional alternating current discharge type plasma display panel (PDP);
FIG. 2a and FIG. 2b are spectrum graphs measured from a pixel on a conventional alternating current discharge type plasma display panel (PDP) with different brightness;
FIG. 3 is a sectional view of another conventional technique utilized by NEC (Japan) illustrating the implementation of capsulated color filters;
FIG. 4 is a sectional view of still another conventional technique utilized by Matsushita (Japan) illustrating the implementation of different sizes of red, green, and blue discharge cells;
FIG. 5 is a block diagram of a preferred embodiment of compensation process according to the invention; and
FIG. 6 is a schematic diagram showing the circuitry implemented to increase or decrease the strength of input image signals of each of the red, green, and blue discharge cells for adjusting the brightness of the generated red, green, and blue lights.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0010]   Typically, an image shown on a well known PDP consists of a plurality of pixels. Note that the number of pixels is determined by the resolution of PDP. A pixel consists of three discharge cells capable of emitting red, green, and blue lights respectively. Hence, the color of a pixel of image shown on PDP is a mixture of red, green and blue lights emitted by respective discharge cell. For example, a, b, and c are gray scales of red, green and blue lights emitted by respective discharge cell of each pixel of PDP. Also, R_p, G_p, and B_p are brightness generated by unit gray scale of phosphor layer in red, green and blue discharge cells of each pixel of PDP. Further, O_g is brightness of orange red of visible light generated by unit gray scale during gas discharging. Hence, the brightness of red, green, and blue discharge cells and pixel may be expressed by equations (1), (2), (3) and (4) below:

brightness of red discharge cell = a R_p + a O_g (1),
brightness of green discharge cell = b G_p + b O_g (2),
brightness of blue discharge cell = c B_p + c O_g (3) and brightness of pixel = brightness of red discharge cell + brightness of green discharge cell + brightness of blue discharge cell
= a R_p + b G_p + c B_p + (a+b+c) O_g (4) , where (a+b+c) O_g is the adverse effect of thus generated orange red of visible light on PDP, i.e., the main factor for causing poor color purity and low color temperature of PDP.

[0011]   One aspect of the invention is to eliminate the adverse effect of such orange red of visible light on color purity and color temperature of PDP. Thus, laws of color matching proposed by Grassman is adopted in which the brightness of color generated by each of red, green and blue discharge cells may be calculated through a numeric operation as shown in FIG. 5. Further, with the implementation of circuitry shown in FIG. 6, the invention can increase or decrease the strength of input image signals (or input voltage) of each discharge cell and adjust the brightness of thus generated red, green or blue lights. Hence, the adverse effect of such orange red of visible light on color purity and color temperature of PDP may be eliminated. As a result, an image having an optimum color purity and color temperature is rendered, resulting in an elimination of the adverse effect of such orange red of visible light on color purity and color temperature of PDP experienced in prior art.

[0012]   In a first embodiment of the invention, orange red of visible light on PDP generated by gas discharging may be prepared by a predetermined mixing ratio of red, green and blue lights. For eliminating the orange red of visible light which has an adverse effect on PDP, it is possible to subtract thus additionally generated orange red of visible light from the light generated by red, green and blue discharge cells through a numeric operation. Also, the value of the subtracted orange red of visible light is calculated. As stated above, O_g is brightness of orange red of visible light generated during gas discharging and may be expressed by R_p, G_p and B_p, i.e., $O_g = \alpha R_p + \beta G_p + \gamma B_p$ where α, β

and γ are constants or variables. In compensation, the invention may subtract the term of $\alpha(a+b+c)R_p$ (i.e., brightness of light) from red discharge cell, subtract the term of $\beta(a+b+c)G_p$ from green discharge cell, and subtract the term of $\gamma(a+b+c)B_p$ from blue discharge cell respectively. Hence, the adverse effect of orange red of visible light on color purity and color temperature of PDP is eliminated, in which $\alpha(a+b+c)R_p$, $\beta(a+b+c)G_p$, and $\gamma(a+b+c)B_p$ are compensation functions.

[0013]　Hence, after the compensation on image of PDP by the invention, the brightness of red discharge cell, green discharge cell, blue discharge cell, and pixel may be expressed by equations (5), (6), (7) and (8) below:

$$\text{brightness of red discharge cell} = a\,R_p + a\,O_g - \alpha(a+b+c)R_p \qquad\qquad 5$$

$$\text{brightness of green discharge cell} = b\,G_p + b\,O_g - \beta(a+b+c)G_p \qquad\qquad 6$$

$$\text{brightness of blue discharge cell} = c\,B_p + c\,O_g - \gamma(a+b+c)B_p \qquad\qquad 7$$

, and

$$\text{brightness of pixel} = \text{brightness of red discharge cell} + \text{brightness of green}$$

$$\text{discharge cell} + \text{brightness of blue discharge cell}$$

$$= a\,R_p + bG_p + cB_p + (a+b+c)O_g - \alpha(a+b+c)R_p - \beta(a+b+c)G_p - \gamma(a+b+c)B_p$$

$$= aR_p + bG_p + cB_p \qquad\qquad 8$$

[0014]　Since brightness of orange red of visible light O_g generated during gas discharging may be expressed by R_p, G_p and B_p, i.e. $O_g = \alpha R_p + \beta G_p + \gamma B_p$, thus it is apparent from equation (8) that the orange red of visible light O_g component of brightness of pixel is subtracted after compensation. Thus, the adverse effect of orange red of visible light on PDP is eliminated.

[0015]　In a second embodiment of the invention, orange red of visible light on PDP generated by gas discharging may be prepared by a predetermined mixing ratio of red and green lights. It is possible to add the orange red of visible light component generated by red discharge cell and the orange red of visible light component generated by green discharge cell through a numeric operation to obtain a complete orange red of visible light, i.e., $O_g = \alpha R_p + \beta G_p$ (i.e., $\gamma=0$). It is also possible to adjust strength of input image signals of red and green discharge cells respectively. Further, brightness terms of $\alpha(a+b+c)R_p$ and $\beta(a+b+c)G_p$ (i.e. the above compensation functions) are subtracted from the light generated by red discharge cell and green discharge cell respectively. The ratio of generated red and green may be adjusted to a suitable one for completely eliminating the adverse effect of orange red of visible light on color purity and color temperature of PDP, resulting in a rendering of an optimum color purity and color temperature.

[0016]　In a third embodiment of the invention when the discharge conditions of red, green and blue discharge cells are different from one another, the compensation functions may be expressed by $(\alpha_R a + \alpha_G b + \alpha_B c)R_p$, $(\beta_R a + \beta_G b + \beta_B c)G_p$, and $(\gamma_R a + \gamma_G b + \gamma_B c)B_p$ where α_R, α_G, α_B, β_R, β_G, β_B, γ_R, γ_G and γ_B are constants or variables depending on the gas discharging conditions.

[0017]　In brief, the compensation process of the invention for improving color purity and color temperature of PDP comprises the step of increasing or decreasing the strength of input image signals of each of red, green, and blue discharge cells for adjusting the brightness of generated red, green, and blue lights so as to subtract orange red of visible light generated by each of the red, green, and blue discharge cells during gas discharging. This can completely eliminate the adverse effect of orange red of visible light on color purity and color temperature of PDP. Most importantly, there is no need to modify the construction of PDP or perform an additional processing thereon. This is simple, resulting in a reduction in the manufacturing cost. When the constituent components of mixed gas are changed, resulting in a generation of visible light having a color other than above, the compensation process of the invention is still applicable.

[0018]　While the invention has been described by means of specific embodiments, numerous modifications and variations could be made thereto by those skilled in the art without departing from the scope and spirit of the invention set forth in the claims.

Claims

1. A compensation process for improving color saturation and image quality of a plasma display panel (PDP) wherein a brightness of light generated from each of red, green, and blue discharge cells of each pixel on said PDP is calculated through a numeric operation according to laws of color matching, said process comprising the step of increasing or decreasing strength of input image signals of each of said red, green, and blue discharge cells in accordance with the calculation result for adjusting said brightness of said generated red, green, and blue lights so as to subtract a visible light generated by the gas in each of said red, green, and blue discharge cells during gas discharging, thereby eliminating an adverse effect of said visible light on color purity and color temperature of said PDP during gas discharging.

2. The compensation process of claim 1, wherein said visible light is expressed by an addition of a value of said red light, a value of said green light, and a value of said blue light respectively generated by each of red, green, and blue discharge cells of each pixel on said PDP through said numeric operation according to laws of color matching.

3. The compensation process of claim 1, wherein said visible light is expressed by an addition of two values of any two different color lights respectively generated by each of two different discharge cells of each pixel on said PDP through said numeric operation according to laws of color matching.

4. The compensation process of claim 1, wherein said visible light is expressed by a value of any one color light generated by corresponding discharge cell of each pixel on said PDP through said numeric operation according to laws of color matching.

5. The compensation process of claim 1, wherein said visible light is an orange red generated by neon discharging.

6. The compensation process of claim 5, wherein said visible light is expressed by an addition of a value of said red light and a value of said green light generated by corresponding discharge cells of each pixel on said PDP through said numeric operation according to laws of color matching.

7. The compensation process of claim 2, 3, 4, or 6, further comprising the step of adjusting said strength of said input image signals of each of said red, green, and blue discharge cells based on said values so as to subtract a visible light generated by gas in each of said red, green, and blue discharge cells during gas discharging.
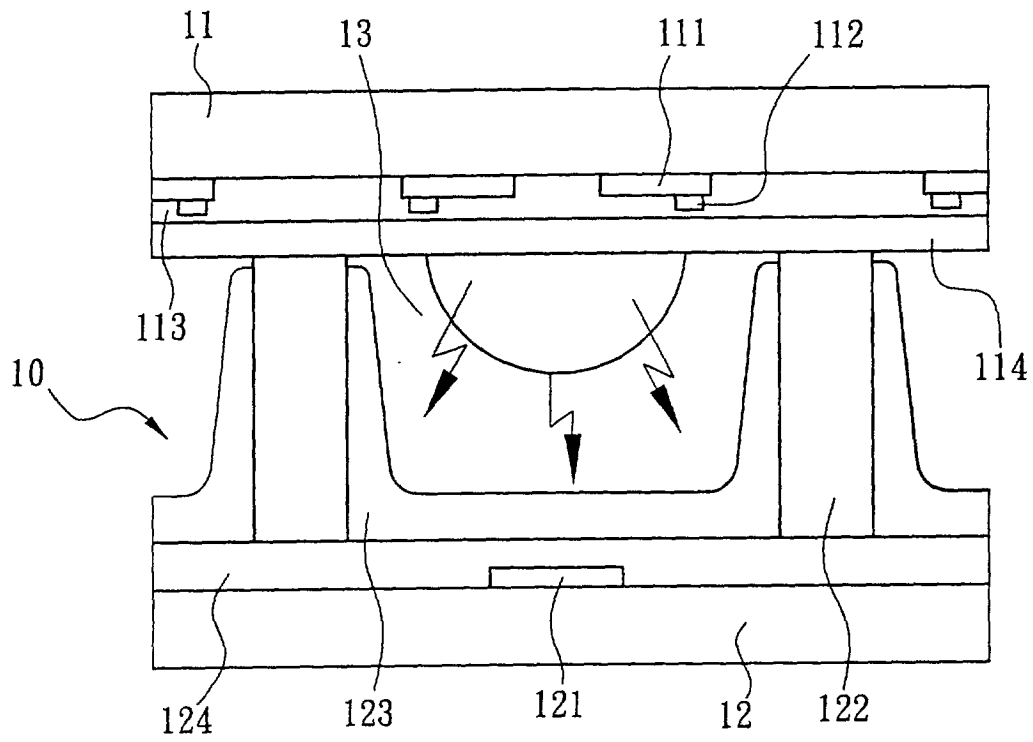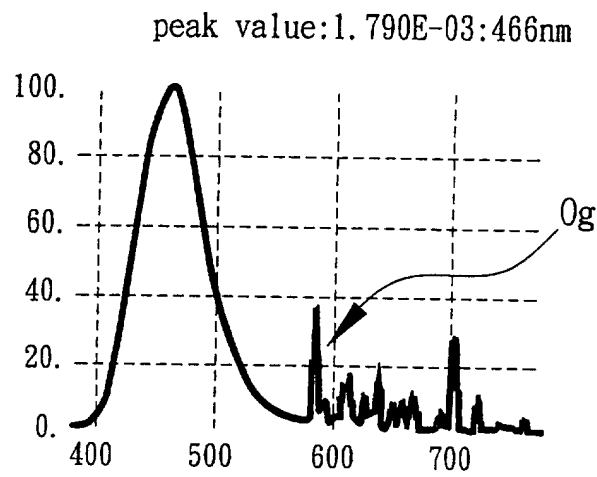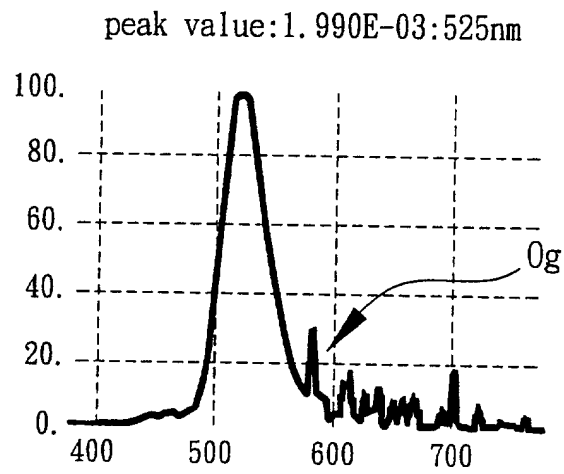
FIG.1 (Prior Art)

peak value:1.790E-03:466nm

(a)

FIG. 2a (Prior Art)

peak value:1.990E-03:525nm

(b)

FIG. 2b (Prior Art)

⇨light emitted by neon

⇨ ⇨ ⇨light emitted by
excited phosphor layer

R(red)   G(green)   B(blue)

20   20   20   11

122   13   123   12   122

FIG. 3 (Prior Art)

11

122

12   13   122   13

FIG. 4 (Prior Art)

image input

red gray scale=a

green gray scale=b

blue gray scale=c

→

evaluation on gas factor

→

color purity and color temperature compensation

red gray scale=a- α (a+b+c)

green gray scale=b- β (a+b+c)

blue gray scale=c- γ (a+b+c)

FIG. 5

red signal input

green signal input

blue signal input

$+$

α $\times$

β $\times$

γ $\times$

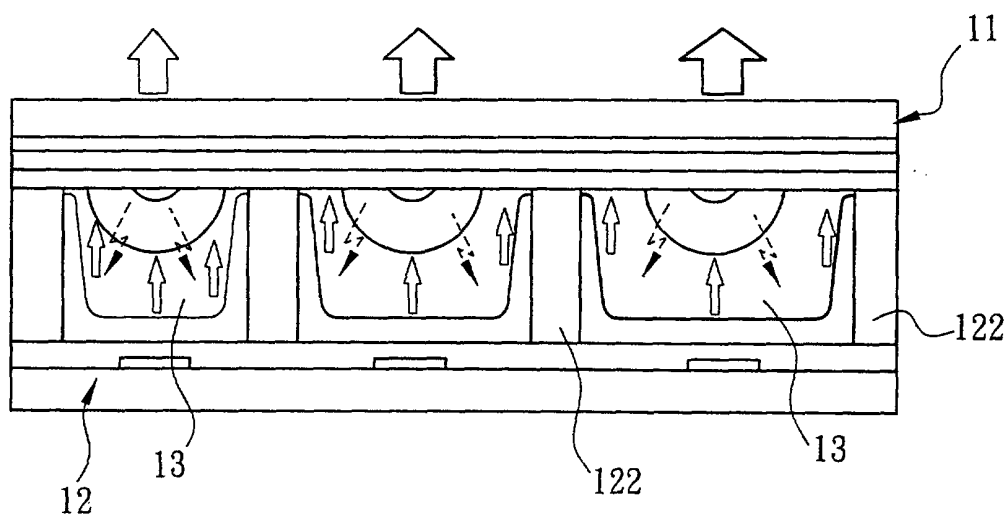$-$ red signal output

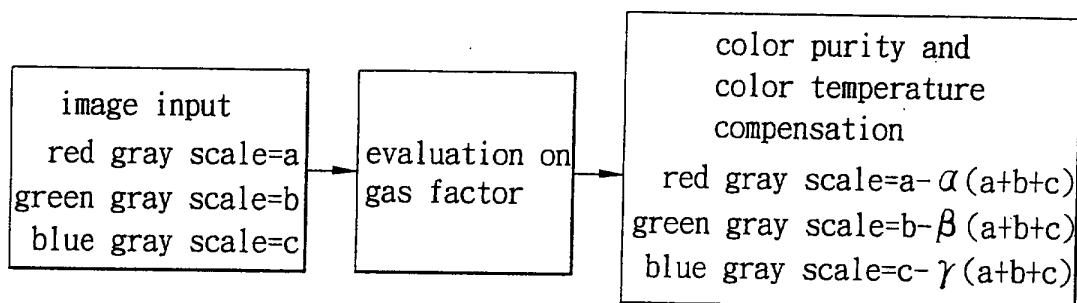$-$ green signal output
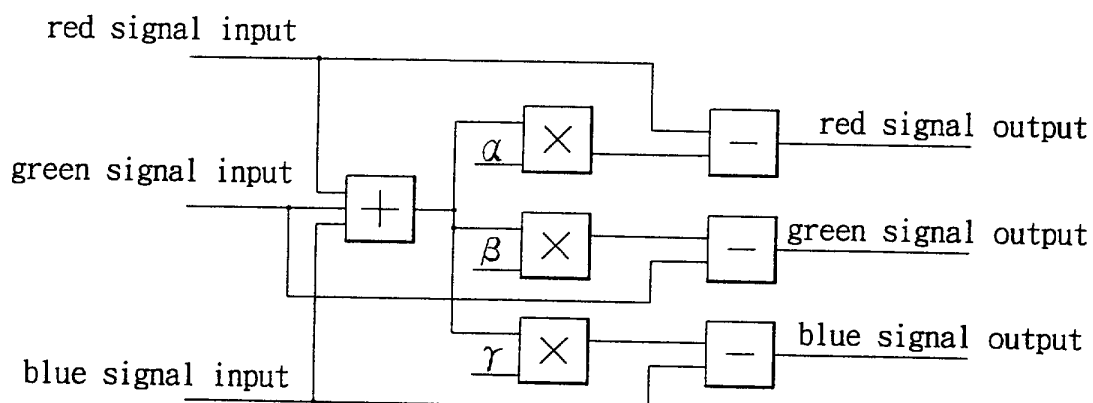
$-$ blue signal output

FIG. 6

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 01 11 0881

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.7)
A	EP 0 813 220 A (FUJITSU LTD.) 17 December 1997 (1997-12-17) * abstract * * page 2, line 55 - page 3, line 4 * * page 5, line 47 - line 55; figures 2,13-19 *	1-7	G09G3/28
A	EP 0 764 966 A (HITACHI LTD.) 26 March 1997 (1997-03-26) * abstract * * column 2, line 3 - line 27 * * column 4, line 39 - column 5, line 14; figures 1-11 *	1-7	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)
G09G H01J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	6 December 2001	O'Reilly, D

CATEGORY OF CITED DOCUMENTS

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**   EP 01 11 0881

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