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Remarks:
Amended claims in accordance with Rule 137(2) EPC.

(54) Repeated-scan driving method for field sequential color liquid crystal display

(57) The present invention discloses a REPEATED-SCAN driving method, which applies to a field sequential color liquid crystal display, wherein each sequential-color cycle (31) of the multiplex-scan signal (30) has at least two stages of scans (32) to increase the luminous fluxes of all colors of backlights (20) and bring closer the total amounts of fluxes, whereby is achieved higher color saturation and better flux uniformity between the rows. Further, the method of the present invention controls the backlights (20) to form dark stages (21) between the intervals respectively of two different colors of the backlights (20) and controls the dark stage (21) to coincide with a color-mixing interval, which is caused by response delay of liquid crystal, to prevent from color distortion caused by color mixing. Therefore, the present invention can generate the pure colors and the designed derived colors accurately.

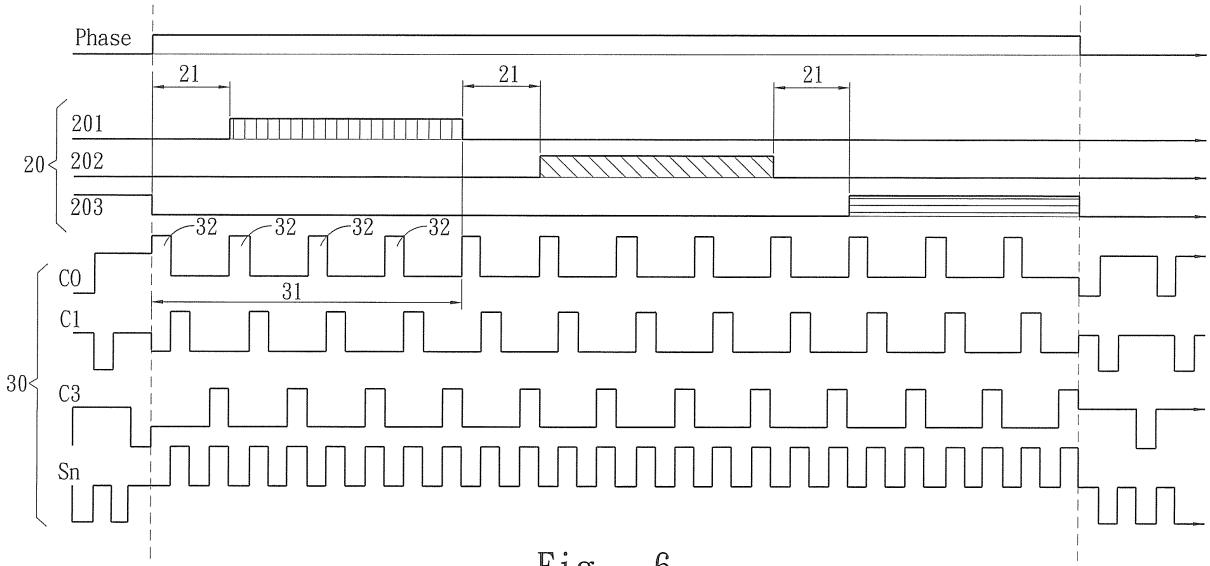

Fig . 6

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a REPEATED-SCAN driving method for an FSC LCD, particularly to an FSC LCD driving method, which can increase luminous flux and color saturation.

BACKGROUND OF THE INVENTION

[0002] In FSC LCD (Field Sequential Color Liquid Crystal Display), multi-color backlights are sequentially switched and pass through liquid crystal optical gates. FSC LCD opens and closes the liquid crystal optical gates to sequentially generate pure-color fields, and then the visual persistence of human eyes mixes the pure colors to present various colors. Refer to Fig.1. The control signal 1 is used to open and close the liquid crystal optical gates. However, the light transmission curve 2 cannot instantly reflect the control signal 1 because the delayed response of liquid crystal molecules. Thus, there are response delays 3 appearing in the light transmission curve 2.

[0003] Refer to Fig.2 a timing diagram of a conventional FSC LCD technology. In the timing diagram, the duty ratio is 1/4; C0, C1, and C3 (C2 is neglected) are the signals 4 scanning the common (row) electrodes of an LCD panel in a time-sharing multiplex mode; Sn is the signal 4 scanning the segment (column) electrodes of the LCD panel. The abovementioned signals 4 C0, C1, C3 and Sn cooperate with the multi-color backlights 5-a red backlight 6 (R), a green backlight 7 (G), and a blue backlight 8 (B), which sequentially and cyclically switch-to work.

[0004] Refer to Fig.3 a diagram schematically showing the luminous fluxes of colored lights of a conventional FSC LCD driven by the signals shown in Fig.2. In Fig.3, the integral areas (the fluxes) of the red backlight 6 (R), a green backlight 7 (G), and a blue backlight 8 (B) are small and inconsistent, and the latter color may mix with the former color. Thus, the row luminous fluxes 9 have problems of dimness and color distortion, as shown in Fig.4.

SUMMARY OF THE INVENTION

[0005] The primary objective of the present invention is to provide a REPEATED-SCAN driving method for an FSC LCD to increase the luminous fluxes, bring closer the total amounts of the fluxes, and decrease flux difference between rows, whereby is achieved higher color saturation and better flux uniformity between the rows.

[0006] Another objective is to increase the luminous fluxes with the purity of colors maintained and without color mixing occurring, whereby is improved the problem of color distortion.

[0007] To achieve the abovementioned objectives, the present invention proposes a REPEATED-SCAN driving method for an FSC LCD and a device for realizing the same method. The method of the present invention comprises steps:

providing at least two colors of backlights, which sequentially switch; and

providing at least one multiplex-scan signal with the cycle of the color sequence corresponding to the timing of switching backlight colors, wherein each cycle of the multiplex-scan signal has at least two stages of scans.

[0008] In the present invention, a dark stage is arranged between the intervals respectively of two different colors of backlights and coincides with the color-mixing interval, which is caused by the response delay of liquid crystal, to prevent from mixing of different colors of backlights.

[0009] In the present invention, at least two stages of scans are arranged within every sequential-color cycle to increase the luminous fluxes, bring closer the total amounts thereof, and decrease flux variation between the rows, whereby colors may have higher saturation and uniformity. Further, the present invention provides a dark stage to prevent from mixing of different colors of backlights. Therefore, the present invention not only can prevent from color distortion of pure colors but also can present the correct derived colors.

[0010] The invention also provides a device for realizing the same method such as a controller and/or driver for driving a Field Sequential Color Liquid Crystal Display.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

Fig.1 is a diagram schematically showing the imperfect optical response of a conventional FSC LCD;

Fig.2 is a timing diagram of a conventional multiplex-scan technology for an FSC LCD;

Fig.3 is a diagram schematically showing the luminous fluxes of various colors of backlights of a conventional FSC LCD;

Fig.4 is a diagram schematically showing color mixing and flux variation between the rows in a conventional FSC LCD;

Fig.5 is a diagram schematically showing an FSC LCD according to the present invention;

Fig.6 is a timing diagram for controlling an FSC LCD according to a method of the present invention;

Fig.7 is a diagram schematically showing the luminous fluxes of various colors of backlights of an FSC LCD according to the present invention; and

Fig.8 is a diagram schematically showing color mixing and flux variation between the rows in an FSC LCD according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0012] Below, the embodiments are described in detail in cooperation with the drawings to demonstrate the objectives, characteristics and efficacies of the present invention.

[0013] Refer to Fig.5 and Fig.6. The present invention proposes a REPEATED-SCAN driving method for an FSC LCD 60 (Field Sequential Color Liquid Crystal Display). The method of the present invention provides at least two colors of backlights 20, which sequentially switch. In the method, a dark stage 21 is arranged between the intervals respectively of two different colors of backlights 20. The backlights 20 can include a red backlight 201, a green backlight 202 and a blue backlight 203, which sequentially switch. Besides, the dark stage 21 can be arranged in the very beginning of the backlights 20.

[0014] The present invention provides at least one multiplex-scan signal 30. The sequential-color cycles 31 of the scan signals 30 are corresponding to the timing of switching the colors of backlights 20. Each sequential-color cycle 31 has at least two stages of scans 32. In the drawings, the duty ratio of the multiplex-scan signal 30 is exemplified by 1/4. In the drawings, C0, C1, and C3 (C2 is neglected) are the signals scanning the common (row) electrodes of the LCD panel in a time-sharing mode, and Sn is the signal scanning the segment (column) electrodes of the LCD panel. In the drawings, the sequential-color cycle 31 having four stages of scans 32 is used as the exemplification.

[0015] Refer to Fig.7. The multiplex-scan signal 30 in Fig.6 drives the FSC LCD 60 to output the luminous fluxes of the red backlight 201, the green backlight 202, and the blue backlight 203 shown in Fig.7. From Fig.7, it is known that at least two stages of scans 32 are arranged within every sequential-color cycle 31 to increase the luminous fluxes, bring closer the total amounts of fluxes, and decrease flux variation between the rows. Thus, the present invention can increase color saturation and promote flux uniformity between the rows. Further, the method of the present invention can control the dark stage 21 to coincide with the color-mixing interval 40, which is caused by the response delay of liquid crystal. Thus, none color mixing occurs in the effective luminous interval 50, and color distortion is prevented. Therefore, the present invention can generate pure colors and derived colors accurately.

[0016] In conclusion, the method of the present invention provides at least two stages of scans 32 for each sequential-color cycle 31 to increase row fluxes 70, bring closer the total amounts of the fluxes, and decrease flux variation between the rows, as shown in Fig.8. Further, the method of the present invention controls the backlights 20 to form the dark stages 21 to prevent from the unwanted color mixing. Therefore, the present invention can generate the pure colors and the designed derived colors accurately.

[0017] In summary the present invention discloses a REPEATED-SCAN driving method, which applies to a field sequential color liquid crystal display 60, wherein each sequential-color cycle 31 of the multiplex-scan signal 30 has at least two stages of scans 32 to increase the luminous fluxes of all colors of backlights 20 and bring closer the total amounts of fluxes, whereby is achieved higher color saturation and better flux uniformity between the rows. Further, the method of the present invention controls the backlights 20 to form dark stages 21 between the intervals respectively of two different colors of the backlights 20 and controls the dark stage 21 to coincide with a color-mixing interval 40, which is caused by response delay of liquid crystal, to prevent from color distortion caused by color mixing. Therefore, the present invention can generate the pure colors and the designed derived colors accurately.

Claims

1. A repeated-scan driving method, which applies to a field sequential color liquid crystal display (60), **characterized by** steps:

   providing at least two colors of backlights (20), which sequentially switch;
   providing at least one multiplex-scan signal (30), wherein sequential-color cycles (31) of said multiplex-scan signal (30) are corresponding to timing of switching colors of said backlights (20), and wherein each of said sequential-color cycles (31) has at least two stages of scans (32).

2. The repeated-scan driving method according to claim 1, wherein a dark stage (21) is arranged between intervals respectively of two different colors of said backlights (20), and said dark stage (21) is controlled to coincide with a color-mixing interval (40), which is caused by response delay of liquid crystal.

3. The repeated-scan driving method according to claim 2, wherein said dark stage (21) is arranged in the very beginning of said backlight (20).

4. The repeated-scan driving method according to claim 1, wherein said backlights (20) include a red

backlight (201), a green backlight (202) and a blue backlight (203), which sequentially switch.

5. A device for driving a field sequential color liquid crystal display (60), **characterized in that**:

the display is providing at least two colors of backlights (20), which sequentially switch;
the device is providing at least one multiplex-scan signal (30), wherein sequential-color cycles (31) of said multiplex-scan signal (30) are corresponding to timing of switching colors of said backlights (20), and wherein each of said sequential-color cycles (31) has at least two stages of scans (32).

Amended claims in accordance with Rule 137(2) EPC.

1. A method for driving a field sequential color liquid crystal display, the method comprising the steps of:

switching sequentially at least two colors of backlights (20),
having at least two stages of scans (32) in each of the sequential-color cycles (31) of a scan signal (30),

wherein sequential-color cycles (31) of said scan signal (30) are corresponding to timing of switching colors of said backlights (20).

2. The method for driving a field sequential color liquid crystal display according to claim 1, wherein a dark stage (21) is arranged between intervals respectively of two different colors of said backlights (20), and said dark stage (21) is controlled to coincide with a color-mixing interval (40), which is caused by response delay of liquid crystal.

3. The method for driving a field sequential color liquid crystal display according to claim 2, wherein said dark stage (21) is arranged in the very beginning of said backlight (20).

4. The method for driving a field sequential color liquid crystal display according to claim 1, wherein said backlights (20) include a red backlight (201), a green backlight (202) and a blue backlight (203), which sequentially switch.

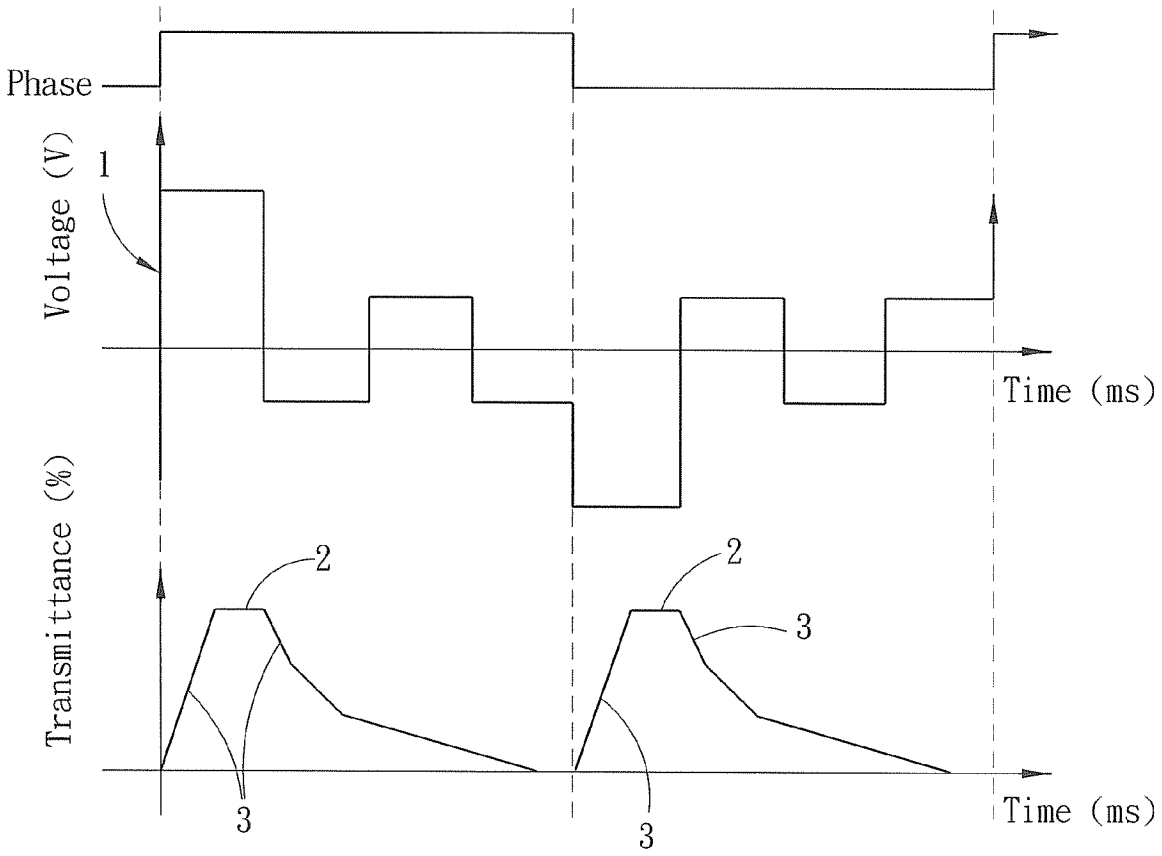

Fig. 1
PRIOR ART

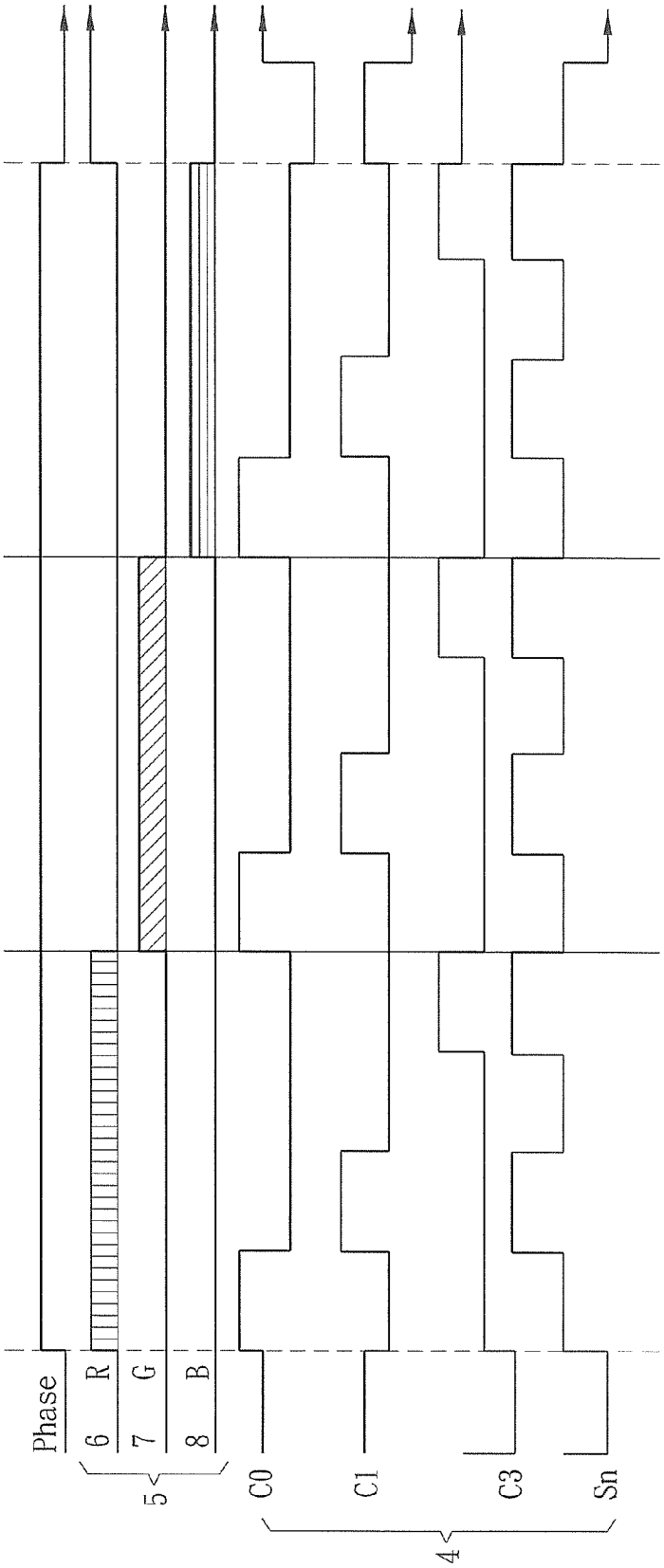

Fig. 2
PRIOR ART

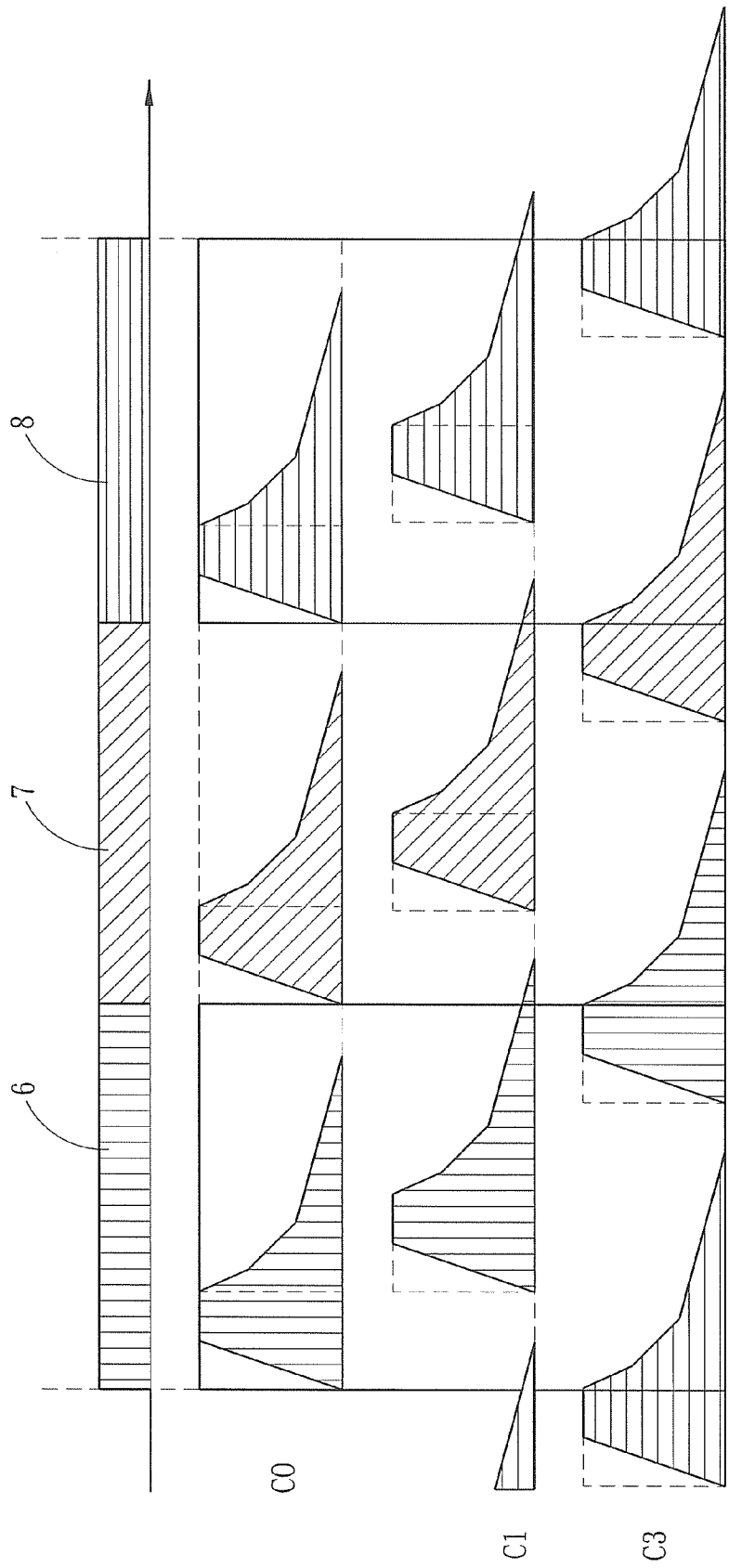

Fig. 3
PRIOR ART

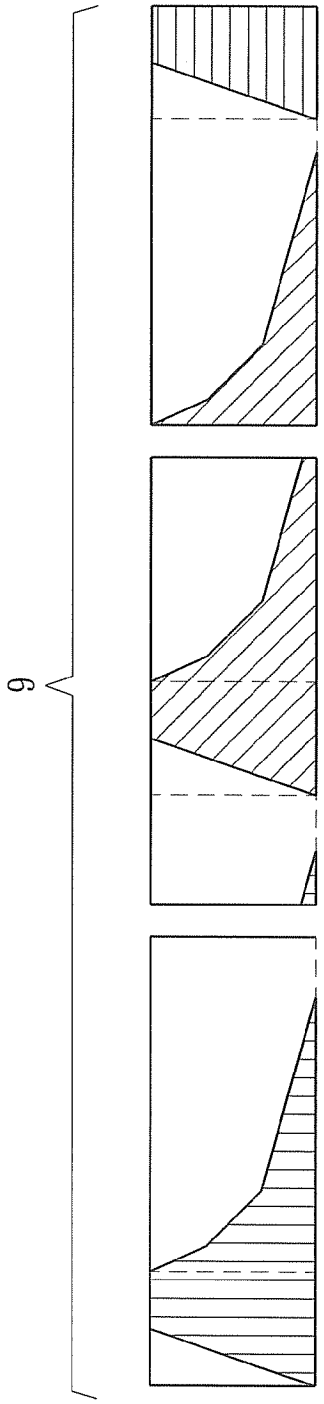

Fig. 4
PRIOR ART

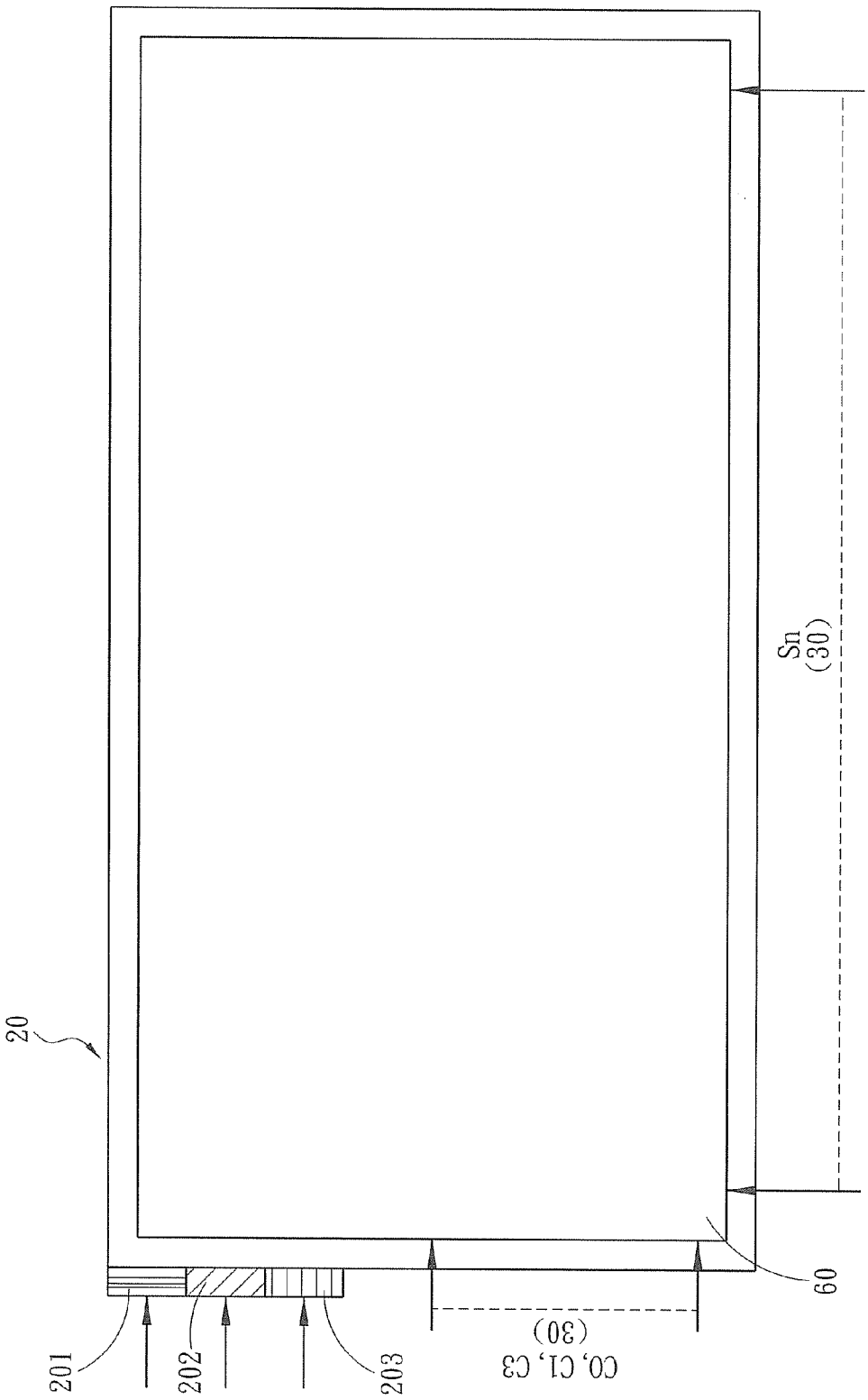

Fig. 5

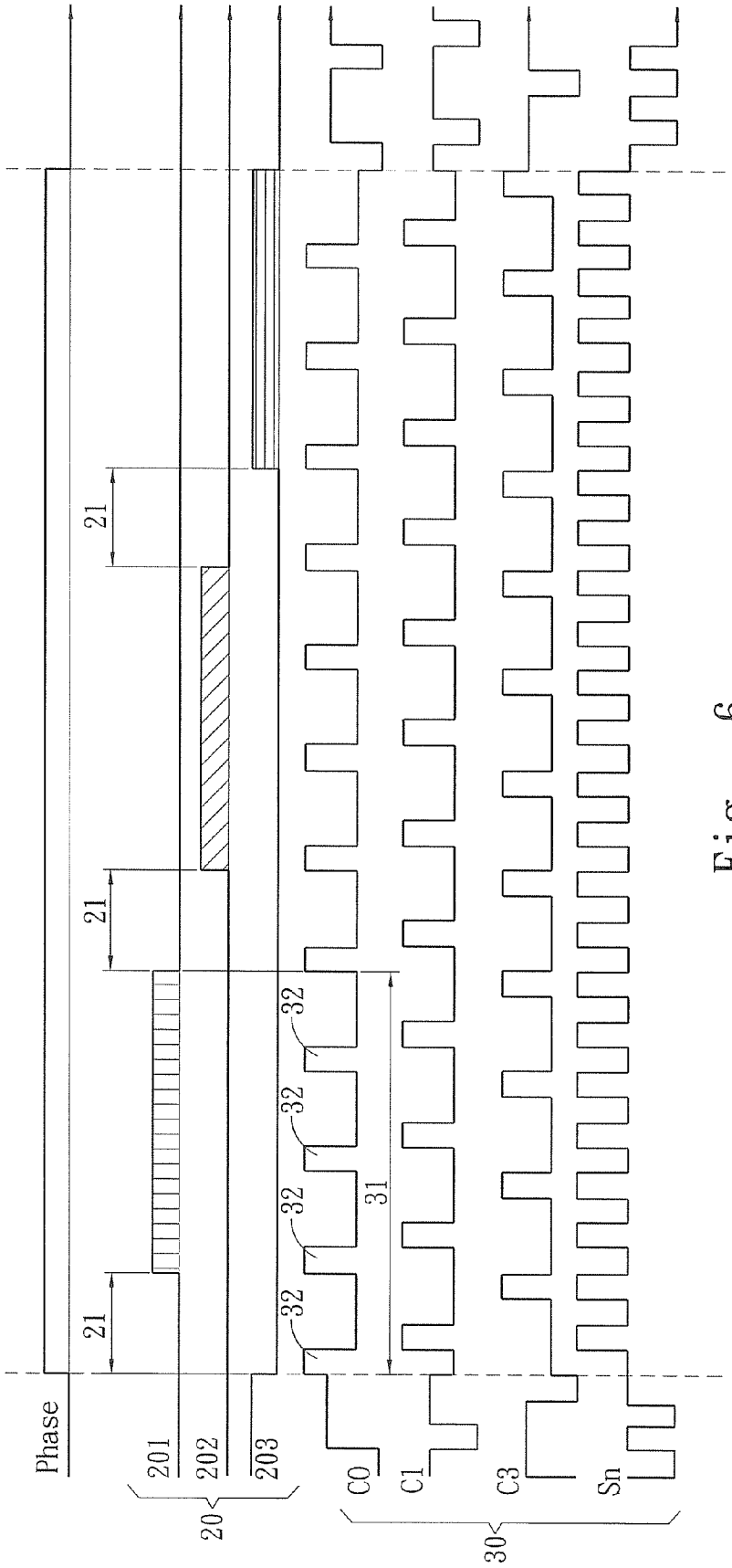

Fig. 6

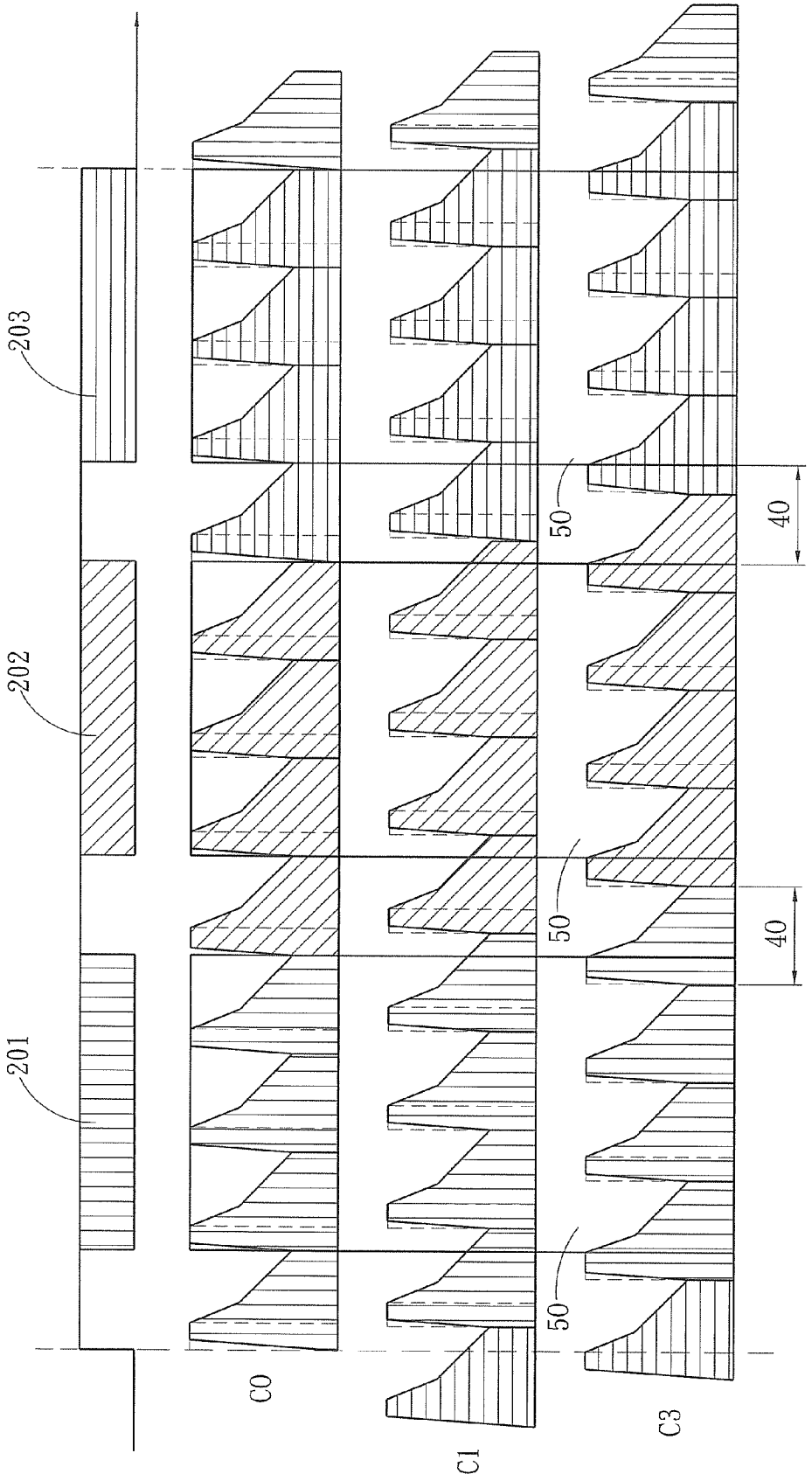

Fig. 7

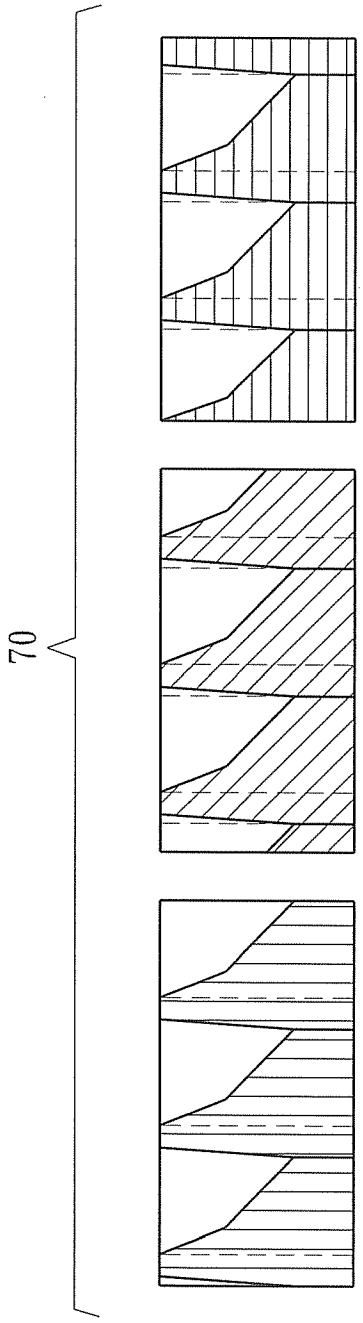

Fig. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 09 15 6874

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2008/018588 A1 (YOSHIHARA TOSHIAKI [JP] ET AL) 24 January 2008 (2008-01-24) * paragraphs [0039], [0070], [0085] - [0093]; figure 10 *	1-5	INV. G09G3/36 ADD. G09G3/34
X	US 6 570 554 B1 (MAKINO TETSUYA [JP] ET AL) 27 May 2003 (2003-05-27) * paragraphs [0012] - [0025], [0090] - [0096]; figures 4-6,10 *	1-5	
A	WO 2006/095304 A (KONINKL PHILIPS ELECTRONICS NV [NL]; BOIKO EUGENE [GB]; HUGHES JOHN R) 14 September 2006 (2006-09-14) * paragraphs [0055] - [0059]; figures 5,6 *	1-5	
A	WO 2006/114732 A (KONINKL PHILIPS ELECTRONICS NV [NL]; HECTOR JASON R [GB]; HUGHES JOHN) 2 November 2006 (2006-11-02) * page 6 - page 12; figures 3-5 *	1-5	

TECHNICAL FIELDS SEARCHED (IPC)
G09G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	2 July 2009	Pichon, Jean-Michel

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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O : non-written disclosure
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L : document cited for other reasons

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 09 15 6874

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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02-07-2009

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		JP 2008533519 T	21-08-2008
WO 2006114732 A	02-11-2006	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

专利名称(译)	场序彩色液晶显示器的重复扫描驱动方法		
公开(公告)号	EP2237261A1	公开(公告)日	2010-10-06
申请号	EP2009156874	申请日	2009-03-31
申请(专利权)人(译)	POWERTIP科技股份有限公司.		
当前申请(专利权)人(译)	POWERTIP科技股份有限公司.		
[标]发明人	WANG SHYH YUEH CHEN CHIA HUI HUANG CHIU YUAN CHIEN CHUN TSAI		
发明人	WANG, SHYH-YUEH CHEN, CHIA-HUI HUANG, CHIU-YUAN CHIEN, CHUN-TSAI		
IPC分类号	G09G3/36 G09G3/34		
CPC分类号	G09G3/3622 G09G3/3413 G09G2310/0235 G09G2320/0242		
外部链接	Espacenet		

摘要(译)

本发明公开了一种REPEATED-SCAN驱动方法，应用于场序彩色液晶显示器，其中多路扫描信号（30）的每个连续色彩周期（31）具有至少两个扫描阶段（32）。增加所有颜色的背光源（20）的光通量并使通量的总量更接近，从而实现更高的色彩饱和度和更好的通道之间的通量均匀性。此外，本发明的方法控制背光源（20）以分别在两种不同颜色的背光源（20）的间隔之间形成暗阶段（21），并控制暗阶段（21）以与颜色混合一致。间隔是由液晶的响应延迟引起的，以防止颜色混合引起的颜色失真。因此，本发明可以精确地产生纯色和设计的衍生色。

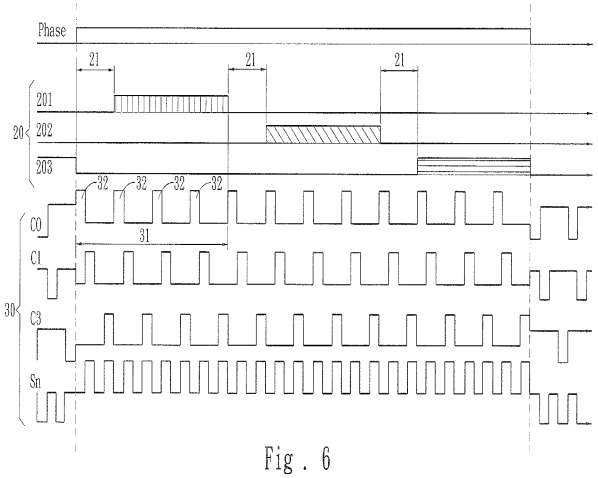

Fig . 6