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(54) Liquid crystal display

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Ecran à cristaux liquides

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Description

Technical Field

[0001] The present invention relates to liquid crystal displays, and more particularly to segmented-pixel liquid crystal displays.

Background Art

[0002] Liquid crystal displays are flat displays that boast of high resolution, slimness, lightweight, low electric power consumption, and other advantages. In recent years, liquid crystal displays have seen improvement of display performance, improvement of fabrication capacity, and price competitiveness against other types of display, and accordingly they have been enjoying a rapidly growing market.

[0003] More recently, as the display quality of liquid crystal displays has been further improved, a problem in viewing angle characteristics has become apparent: the gamma characteristic varies between in orthogonal viewing and in oblique viewing; in other words, the gamma characteristic depends on the viewing angle. Here, the gamma characteristic denotes the dependence of display brightness on halftone levels. Thus, the fact that the gamma characteristic varies between in orthogonal viewing and in oblique viewing means that the way different halftone levels are displayed varies with the direction of viewing. This is annoying especially during the display of photograph images or of TV broadcasts, among others.

[0004] This problem of the viewing-angle dependence of the gamma characteristic is more remarkable in the multi-domain vertical alignment mode (MVA mode, as disclosed in JP-A-H11-242225) and in the axisymmetric aligned mode (ASM mode, as disclosed in JP-A-H10-186330) than in the in-plane switching mode (IPS mode, as disclosed in JP-B-S63-021907). On the other hand, with the IPS mode, it is more difficult, than with the MVA or ASM mode, to fabricate liquid crystal panels that offer high contrast in orthogonal viewing with satisfactory productivity. Hence, improvements addressing the viewing-angle dependence of the gamma characteristic are sought especially eagerly in MVA and ASM mode liquid crystal displays.

[0005] Under this background, the applicant of the present invention once proposed a technology whereby each pixel is segmented into two sub-pixels to which different voltages are applied to mitigate the viewing-angle dependence of the gamma characteristic (for example, in Patent Document 1 listed below).

Patent Document 1: JP-A-2004-078157, Claims
Patent Document 2: JP-A-H6-332009, Claims
Patent Document 3: JP-A-2004-062146, Embodiments

[0006] JP 2004 029 716 A discloses a liquid crystal display device in which to improve the range of viewing angles each pixel driving electrode is segmented, one example including three such electrode segments separated in a vertical direction, and the effective voltages impressed on the liquid crystal layer by the segmented electrode are adjusted.

[0007] EP 0 669 549 A discloses a liquid crystal display device in which each pixel electrode is divided into a plurality of sub pixel electrodes separated by a gap from each other; a control capacitor electrode is opposed to one or more of the sub pixel electrodes through an insulating film, and a part of such control capacitor electrode extends across the gap so that a drive voltage can be applied to the liquid crystal in the gap. One example has the control capacitor electrode at the centre of the pixel region and sub pixel electrodes overlapping marginal portions of the control capacitor electrode.

Disclosure of the Invention

Problems to be Solved by the Invention

[0008] Incidentally, the human eye tends to recognize pixels and borders by being attracted by light spots and areas. On the other hand, the recent trend toward increasingly large-screen liquid crystal displays has resulted in their having larger pixels than they have conventionally had. Under these circumstances, segmenting each pixel into two sub-pixels causes an inconvenience: as a result of the human eye recognizing pixels by tracing the lighter sub-pixel of each pixel, when an image with a straight border is displayed, the line of sight moves in a zigzag along the border, from one pixel with one halftone level to another having a different halftone level, often causing the viewer to perceive unsmoothness or unnatural hues. To be sure, in conventional liquid crystal displays, certain improvements have been made to address the viewing-angle dependence of the gamma characteristic; these improvements, however, are not quite satisfactory.

[0009] An object of the present invention is to provide a segmented-pixel liquid crystal display that does not produce unnaturalness even when displaying an image with a straight border and that offers a further improved gamma characteristic.

Means for Solving the Problem

[0010] According to the present invention there is provided a liquid crystal display having a plurality of pixels arrayed in a matrix, each pixel having a plurality of electrodes for applying an electric field to a liquid crystal layer, wherein each pixel includes first, second and third sub-pixels, said first, second and third sub-pixels having two different brightness levels when the pixel as a whole is in a given middle halftone state, and when the first sub-pixel has a highest brightness level and is called a bright sub-pixel and the second and third are called dim sub-pixels, one of said dim sub-pixels is located at one side of the pixel in the column or row direction, another of said dim sub-pixels is located at an opposite side of the pixel, and the bright sub-pixel is located between said one and another of said dim sub-pixels, wherein said first, second and third sub-pixels each have a liquid crystal capacitance between a sub-pixel electrode and common electrode disposed opposite each other across the liquid crystal layer, a single electrode being shared as the common electrodes of said first, second and third sub-pixels, said first, second and third sub-pixels each have an auxiliary capacitance between an auxiliary capacitance electrode electrically connected to the sub-pixel electrode and an auxiliary capacitance common electrode disposed opposite the auxiliary capacitance electrode and connected to an auxiliary capacitance conductor, two different auxiliary capacitance conductors are provided one for the bright sub-pixel and another for the dim sub-pixels, scanning lines are laid between mutually adjacent pixels, and, in each pixel, the two auxiliary capacitance conductors are laid parallel to the scanning lines, and a conductor electrode via which the display signal voltage is supplied to the sub-pixel electrode of the bright sub-pixel crosses the two auxiliary capacitance conductors.
With this arrangement controllability of the voltages applied to the sub-pixels is improved, as is aperture ratio.
Also, the arrangement helps cancel out the two parasitic capacitances formed where the conductor electrode crosses the auxiliary capacitance conductors, and thus helps improve image quality.
[0011] Preferably, the two side sub-pixels are given an identical brightness level.
[0012] From the viewpoint of further improving the gamma characteristic of the liquid crystal display, preferably, the ratio of the aperture area of the middle sub-pixel to the total aperture area of the two side sub-pixels is in the range from l : 1 to 1 : 4 and, preferably, the ratio between aperture areas of the two side sub-pixels is in the range from 1 : 1 to 1 : 4.
[0013] Preferably, an insulating layer is interposed between the auxiliary capacitance electrode and the auxiliary capacitance common electrode.
[0014] Preferably, there are provided: scanning lines extending in the row direction; signal lines extending in the column direction; and, for each pixel, at least two switching devices that are provided one for the middle sub-pixel and another for the side sub-pixels and that connect to a scanning line and a signal line each common to the three sub-pixels of the pixel. Moreover, preferably, the switching devices are turned on and off by a scanning signal voltage supplied to the common scanning line and, when the switching devices are on, a display signal voltage is supplied from the common signal line to the sub-pixel electrode and the auxiliary capacitance electrode of each of the middle and side sub-pixels; moreover, preferably, after the switching devices are turned off, the auxiliary capacitance common voltages at the auxiliary capacitance common electrodes of the middle and side sub-pixels vary such that the variations in those voltages as defined by the directions and degrees in which they vary differ between the middle sub-pixel and the side sub-pixels.
[0015] Here, for a higher aperture ratio, preferably, the switching devices are TFTs, and these TFTs are formed with a single semiconductor layer.
[0016] The auxiliary capacitance common voltages may invert the polarities thereof periodically. Preferably, the auxiliary capacitance common voltage applied to the auxiliary capacitance common electrode of the middle sub-pixel and the auxiliary capacitance common voltage applied to the auxiliary capacitance common electrodes of the side sub-pixels are 180 degrees out of phase with each other. Preferably, the auxiliary capacitance common voltage applied to the auxiliary capacitance common electrode of the middle sub-pixel and the auxiliary capacitance common voltage applied to the auxiliary capacitance common electrodes of the side sub-pixels have an equal amplitude.
[0017] Preferably, between every two mutually adjacent signal lines, display signal voltages applied thereto are given opposite polarities and, between every two pixels mutually adjacent in the row direction, the auxiliary capacitance electrodes and the auxiliary capacitance common electrodes of the middle and side sub-pixels are disposed in reversed patterns.
[0018] The sub-pixel electrodes of the three sub-pixels may be separate from one another, or may be continuous with each other.
[0019] From the viewpoint of preventing disturbed alignment in the liquid crystal layer and improving display quality, preferably, a metal layer is formed under a contact hole via which the conductor electrode via which the display signal voltage is supplied connects to the sub-pixel electrode, with an insulating layer interposed between the metal layer and the contact hole.

Brief Description of Drawings

[0020]

[Fig. 1] A plan view schematically showing the pixel structure in a liquid crystal display according to the invention.
[Fig. 2] A cross-sectional view along line A-A shown in Fig. 1.
[Fig. 3] A cross-sectional view along line B-B shown in Fig. 1.
[Fig. 4] A graph showing the viewing-angle dependence of the gamma characteristic in relation to the ratio of the aperture area of the middle sub-pixel to the ratio of the total aperture area of the side sub-pixels.
[Fig. 5] An enlarged plan view of the TFTs shown in Fig. 1.
[Fig. 6] A circuit diagram electrically equivalent to the pixel structure in the liquid crystal display shown in Fig. 1.
[Fig. 7] A diagram schematically showing an example of the voltage waveforms with which the liquid crystal display according to the invention is driven.
[Fig. 8] A plan view schematically showing the pixel structure in another liquid crystal display according to the invention.
[Fig. 9] A plan view schematically showing another example of the sub-pixel electrodes usable in the invention.

List of Reference Symbols

[0021] 10a, 10b, 10c sub-pixels

11a, 11b, 11c, 11d sub-pixel electrodes
12 scanning lines
13 signal lines
140, 14E auxiliary capacitance conductors
15a, 15b, 15c TFTs (switching devices)
16a, 16b, 16c, 16d, 16e, 16a', 16b' extensions from drain electrodes
17a, 17b auxiliary capacitance electrodes
18a, 18b, 18c contact holes
19 metal layer
21 common electrode
141, 142, 141', 142' auxiliary capacitance common electrode
SC semiconductor layer
ClcO, $ClcE_1$, $ClcE_2$ liquid crystal capacitances
CcsO, CcsE auxiliary capacitances

Best Mode for Carrying Out the Invention

[0022] Hereinafter, liquid crystal displays embodying the present invention will be described with reference to the accompanying drawings. It should be understood that these embodiments are not meant to limit in any way how the invention is implemented.

[0023] Fig. 1 is a plan view schematically showing the pixel structure on the active matrix substrate of a liquid crystal display according to the invention, focusing on the pixel at line n, column m. Figs. 2 and 3 are cross-sectional view along lines A-A and B-B, respectively, shown in Fig. 1. Sub-pixel electrodes 11a-11c are arranged next to one another in the column direction. A scanning line 12(*n*) is laid between pixels to run laterally as seen in Fig. 1; a signal line 13(m) is laid between pixels to run longitudinally as seen in Fig. 1. Two auxiliary capacitance conductors 140 and 14E are laid parallel to the scanning line 12(*n*), between the sub-pixel electrodes 11a, 11b; and 11c. As switching devices, TFTs 15a-15c are provided at the intersection between the scanning line 12(*n*) and the signal line 13(*m*).

[0024] A drain electrode extension 16a from the TFT 15a runs over the auxiliary capacitance conductor 14E to reach above the auxiliary capacitance conductor 140, where a portion of the drain electrode extension 16a faces, across an insulating layer (unillustrated), an auxiliary capacitance common electrode 141 formed integrally with the auxiliary capacitance conductor 140 to function as an auxiliary capacitance electrode 17a. In this auxiliary capacitance electrode 17a, a contact hole 18a is formed to connect the drain electrode extension 16a to the sub-pixel electrode 11 a. Likewise, drain electrode extensions 16b and 16c merge together on the way to reach above the auxiliary capacitance conductor 14E, where a portion of the drain electrodes extension 16b and 16c faces, across an insulating layer (unillustrated), an auxiliary capacitance common electrode 142 formed integrally with the auxiliary capacitance conductor 14E to function as an auxiliary capacitance electrode 17b. In this auxiliary capacitance electrode 17b, a contact hole 18b is formed to connect the drain electrodes extension 16b and 16c to the sub-pixel electrode 11b (see Fig 2). From the auxiliary capacitance electrode 17b, a drain electrode extension 16d further extends to run over the auxiliary capacitance conductor 140 to reach above the sub-pixel electrode 11c, where the drain electrode extension 16d connects via a contact hole 18c to the sub-pixel electrode 11c (see Fig. 3).

[0025] As shown in Figs. 2 and 3, under the contact hole 18b, the auxiliary capacitance conductor 14E is formed with an insulating layer 21a interposed in between; under the contact hole 18c, a metal layer 19 forming an island is formed with an insulating layer 21 b interposed in between. This helps shield disturbed alignment in the liquid crystal layer, and thus helps improve image quality. The insulating layer 21 a, which forms an auxiliary capacitance, and the insulating layer 21b under the contact hole 18c are each, for example, the gate insulating layer of a TFT.

[0026] With this structure, an equal effective voltage is applied to the sub-pixel electrodes 11 b and 11c. Moreover, as will be described later, by supplying different auxiliary capacitance common voltages to the two auxiliary capacitance conductors 140 and 14E, it is possible to make the effective voltage at the sub-pixel electrode 11a higher than the effective voltage at the sub-pixel electrodes 11b and 11c. Thus, it is possible to make the brightness level of a sub-pixel 10a higher than the brightness level of sub-pixels 10b and 10c. This helps eliminate unnaturalness as is conventionally produced when an image with a straight border is displayed, and also helps further mitigate the viewing-angle dependence of the gamma characteristic.

[0027] Through experiments, the applicant has come to know that an effective way to mitigate the viewing-angle dependence of the gamma characteristic is to reduce the proportion of the aperture area of the sub-pixel 10a that has a higher brightness level. In Fig. 4 is a graph showing the viewing-angle dependence in relation to the ratio of the aperture area of the higher-brightness sub-pixel 10a (indicated as "high" in the graph) to the total aperture area of the lower-brightness sub-pixels 10b and 10c (indicated as "low" in the graph). In Fig. 4, the horizontal axis represents the halftone level observed in orthogonal viewing, and the vertical axis represents the viewing-angle dependence of the gamma characteristic observed at different aperture area ratios, namely "with no pixel segmentation", "at a high-to-low ratio of 1:1 ", "at a high-to-low ratio of 1:3", and "at a high-to-low ratio of 1:4", by using the halftone level observed in oblique viewing from 45 degrees upward, downward, leftward, and rightward. This graph shows the following. As the proportion of the "high" brightness aperture area decreases, the gamma characteristic becomes increasingly close to the ideal straight line, becoming closest to it when the high-to-low ratio is 1 : 3; as the "high" brightness aperture area further decreases (to 1:4), the gamma characteristic then becomes increasingly less close to the ideal straight line. Hence, the ratio of the aperture area of the higher brightness sub-pixel 10a to the total aperture area of the lower sub-pixels 10b and 10c is preferably in the range between 1 : 1 to 1 : 4, and further preferably in the range between 1 : 2.5 to 1 : 3.5. Incidentally, the relationship between, on one hand, the just mentioned viewing-angle dependence of the gamma characteristic in relation to the aperture area ratio and, on the other hand, transmissivity is explained in JP-A-2004-062146, a prior application by the same applicant.

[0028] Moreover, the ratio between the aperture areas of the sub-pixels 10b and 10c is preferably in the range from 1 : 1 to 1 : 4, and further preferably in the range from 1 : 1 to 1 : 2. With the higher-brightness sub-pixel located in a deviated position, an evaluation of the display quality of an image of a person revealed an unintended change in color at the border of a skin-color area, like where a skin-color area, such as representing the chin of a person, overlaps a single-color background, such as clothes. This phenomenon was alleviated when the higher-brightness sub-pixel was located closer to the center.

[0029] In the embodiment under discussion, TFTs (thin-film transistors) are used as switching devices. Fig. 5 is an enlarged view of the TFTs in the liquid crystal display shown in Fig. 1. On top of a gate electrode G formed as part of the scanning line 12(*n*), a gate insulating film (unillustrated) is formed, and, further on top, a semiconductor layer SC is formed. On top of this semiconductor layer SC, a source electrode S and three drain electrodes D_1, D_2, and D_3 are formed. From the source electrode S, a plurality of extensions extend substantially in the shape of a comb. The drain electrodes D_1, D_2, and D_3 are formed between these extensions, with a predetermined distance secured from them.

[0030] Forming the three TFTs 15a to 15c on a single semiconductor layer SC in this way helps give the pixel a larger aperture ratio than when they are formed separately. Moreover, by varying the width W and length L of the channel regions formed between the extensions of the source electrode S and the drain electrodes D_1, D_2, and D_3, it is possible to supply the desired current that suits the capacity of the pixel.

[0031] There are no particular restrictions on the shapes of the source electrode S, the drain electrodes D_1, D_2, and D_3, and the semiconductor layer SC; these may be given any shapes so long as no current leakage occurs. As switching devices, any conventionally known switching devices other than TFTs may instead be used, such as MIMs (metal insulator metals).

[0032] Fig. 6 is a schematic diagram showing a circuit equivalent to the liquid crystal display shown in Fig. 1. In this diagram, the liquid crystal capacitance corresponding to the sub-pixel 10a is indicated as ClcO, and the liquid crystal capacitances corresponding to the sub-pixels 10b and 10c is indicated as $ClcE_1$ and $ClcE_2$. The liquid crystal capacitances ClcO, $ClcE_1$, and $ClcE_2$ of the sub-pixels 10a, 10b, and 10c are formed by the sub-pixel electrodes 11 a to 11c, a common electrode 21, and the liquid crystal layer lying in between. The sub-pixel electrodes 11a to 11c are connected via the TFTs 15a to 15c to the signal line 13(*m*), and the gate electrode G (shown in Fig. 5) of the TFTs is connected to the scanning line 12(n)

[0033] A first auxiliary capacitance provided for the sub-pixel 10a and a second auxiliary capacitance provided for the sub-pixels 10b and 10c are indicated as CcsO and CscE in Fig. 6. The auxiliary capacitance electrode 17a of the first auxiliary capacitance CcsO is connected via the drain electrode extension 16a to the drain of the TFT 15a. The auxiliary capacitance electrode 17b of the second auxiliary capacitance CcsE is connected via the drain electrode extensions 16b and 16c to the drains of the TFTs 15b and 15c. The auxiliary capacitance electrodes 17a and 17b may be connected in any manner other than specifically illustrated, so long as they are electrically so connected as to receive voltages equal to those applied to the corresponding sub-pixel electrodes, namely the sub-pixel electrode 11a and the sub-pixel electrodes 11b and 11c, respectively; that is, the sub-pixel electrode 11a and the sub-pixel electrodes 11b and 11c have simply to be electrically connected, either directly or indirectly, to the corresponding auxiliary capacitance electrodes 17a and 17b, respectively.

[0034] The auxiliary capacitance common electrode 141 of the first auxiliary capacitance CcsO is connected to the auxiliary capacitance conductor 140, and the auxiliary capacitance common electrode 142 of the second auxiliary capacitance CcsE is connected to the auxiliary capacitance conductor 14E. With this structure, it is possible to apply different auxiliary capacitance common voltages to the auxiliary capacitance common electrodes 141 and 142 of the first and second auxiliary capacitance CcsO and CcsE, respectively. As will be described later, how the auxiliary capacitance common electrodes 141 and 142 are connected to the first and second auxiliary capacitances CcsO and CcsE is selected to suit the driving method adopted (for example, dot-inversion driving).

[0035] Next, a description will be given of the mechanism by which different voltages are applied, on one hand, to the sub-pixel electrode 11 a and, on the other hand, to the sub-pixel electrodes 11 b and 11c.

[0036] Fig. 7 shows the voltage waveforms of the signals fed to the pixel (n, m) shown in Fig. 6; that is, it shows how those signals change their voltage levels over time. In Fig. 7, at (a) is shown the waveform of the display signal voltage (halftone signal voltage) Vs supplied to a signal line 13; at (b) is shown the waveform of the scanning signal voltage Vg supplied to a scanning line 12; at (c) and (d) are shown the waveforms of the auxiliary capacitance common voltages VcsO and Vcse supplied to the auxiliary capacitance conductors 140 and 14E, respectively; at (e) and (f) are shown the waveforms of the voltages VlcO and VlcE applied to the liquid crystal capacitances $ClcE_1$ and $ClcE_2$ of the sub-pixel 10a and of the sub-pixels 10b and 10c, respectively.

[0037] The driving method shown in Fig. 7 is adopted when the invention is applied to a liquid crystal display that operates on a "1H dot inversion plus frame inversion" basis.

[0038] The display signal voltage Vs applied to a signal line 13 inverts its polarity every time a scanning line is selected (every 1H); in addition, between every two mutually adjacent signal lines, the display signal voltages applied thereto have opposite polarities (1H inversion). Moreover, the display signal voltages Vs on all the signal lines 13 invert their polarities every frame (frame inversion).

[0039] In the example under discussion, the cycle at which the auxiliary capacitance common voltages VcsO and Vcse invert their polarities is 2H; moreover, the auxiliary capacitance common voltages VcsO and Vcse have waveforms such that they have an equal amplitude and are 180 degrees out of phase with each other. The cycle at which the auxiliary capacitance common voltages VcsO and Vcse invert their polarities may be longer than 2H.

[0040] Now, with reference to Fig. 7, a description will be given of why the voltages VlcO and VlcE applied to the liquid crystal capacitance ClcO and to the liquid crystal capacitances $ClcE_1$ and $ClcE_2$ change their voltage levels as shown in Fig. 7.

[0041] At time T_1, the scanning signal voltage Vg turns from low (VgL) to high (VgH), and thereby brings the TFTs 15a to 15c into a conducting state, allowing the display signal voltage Vs on the signal line 13 to be applied to the sub-pixel electrodes 10a to 10c. The voltages applied across the liquid crystal capacitance ClcO and across the liquid crystal capacitances $ClcE_1$ and $ClcE_2$ are the differences between the voltages at the sub-pixel electrodes 11a to 11c and the voltage (Vcom) at the common electrode 21. That is, $VlcO = VlcE_1 = VlcE_2 = Vs - Vcom$.

[0042] At time T_2, the scanning signal voltage Vg turns from high (VgH) to low (VgL, < Vs), and thereby brings the TFTs 15a to 15c into a non-conducting state (off state), electrically insulating all the sub-pixels and the auxiliary capacitances from the signal line 13. At this point, under the influence of the parasitic capacitances etc. of the TFTs 15a to 15c, the voltages at the sub-pixel electrodes 11a to 11c momentarily fall by ΔVd, a phenomenon called "pulling".

[0043] At time T_3, the voltage VlcO at the liquid crystal capacitance ClcO changes under the influence of the voltage VcsO at the auxiliary capacitance common electrode 141 of the auxiliary capacitance CcsO, which electrode is electrically connected to the sub-pixel electrode 11a of the liquid crystal capacitance ClcO. Moreover, the voltage VlcE at the liquid crystal capacitances $ClcE_1$ and $ClcE_2$ changes under the influence of the voltage VcsE at the auxiliary capacitance common electrode 142 of the second auxiliary capacitance CcsE, which electrode is electrically connected to the sub-pixel electrodes 11 b and 11 c of the liquid crystal capacitances $ClcE_1$ and $ClcE_2$.

[0044] Here, suppose that, at time T_3, the auxiliary capacitance common voltage VcsO increases by VcsOp > 0 and the auxiliary capacitance common voltage VcsE decreases by VcsEp > 0. That is, let the whole amplitude Vp - p of the auxiliary capacitance common voltage VcsO be VcsOp, and let the whole amplitude of the auxiliary capacitance common voltage VcsE be VceEp.

[0045] Moreover, let the total capacitance of the liquid crystal capacitance ClcO and the auxiliary capacitance CcsO be $C_{pix}O$, and let the total capacitance of the liquid crystal capacitances $ClcE_1$ and $ClcE_2$ and the auxiliary capacitance CcsE be $C_{pix}E$. Then,

$$VlcO = Vs - \Delta Vd + VcsOp\,(CcsO / C_{pix}O) - Vcom,$$

and

$$VlcE = Vs - \Delta Vd + VcsEp\,(CcsE / C_{pix}E) - Vcom.$$

[0046] Next, at time T_4, likewise under the influence of the voltages VcsO and VceE at the auxiliary capacitance common electrodes, the voltages VlcO and VlcE restore their voltages at time T_2.

$$VlcO = Vs - \Delta Vd - Vcom,$$

and

$$VlcE = Vs - \Delta Vd - Vcom.$$

[0047] These changes in voltage are repeated until the voltage Vg(*n*) turns to VgH in the next frame. As a result, the voltages VlcO and VlcE come to have different effective values. Specifically, let the effective value of the voltage VlcO be $VlcO_{rms}$, and let the effective value of the voltage VlcE be $VlcE_{rms}$, then

$$VlcO_{rms} = Vs - \Delta Vd + (1/2)\,VcsOp\,(CcsO / C_{pix}O) - Vcom,$$

and

$$VlcE_{rms} = Vs - \Delta Vd - (1/2)\,VcsEp\,(CcsE / C_{pix}E) - Vcom$$

$$(\text{provided that } (Vs - \Delta Vd - Vcom) >> VcsOp\,(CcsO / C_{pix}O),$$

and

$$(Vs - \Delta Vd - Vcom) >> VcsEp\,(CcsE / C_{pix}E)).$$

Hence, let the differences between these effective values be $\Delta Vlc = VlcO_{rms} - VlcE_{rms}$, then

$$\Delta Vlc = [VcsOp\,(CcsO / C_{pix}O) + VcsEp\,(CcsE / C_{pix}E)]\,/2.$$

In this way, by controlling the voltages applied to the auxiliary capacitance common electrodes 141 and 142 of the auxiliary capacitances CcsO and CcsE connected to the sub-pixel electrodes 11a to 11c, it is possible to apply different voltages to the sub-pixel electrode 11a and to the sub-pixel electrodes 11b and 11c.

[0048] By interchanging the voltages VcsO and VcsE, it is possible to give the voltage VlcO a smaller effective value and the voltage VlcE a greater effective value. Alternatively, also by reversing the combination of the auxiliary capacitance conductors 140 and 14E connected to the auxiliary capacitance common electrodes 141 and 142 of the auxiliary capacitances CcsO and CcsE, it is possible to give the voltage VIcO a smaller effective value and the voltage VIcE a greater effective value.

[0049] Here, since the driving method adopted involves frame inversion, in the next frame, the polarity of the voltage Vs is inverted, so that Vlc < 0. Even then, the same results as described above can be obtained by inverting the polarities of VcsO and VcsE in synchronism with frame inversion.

[0050] Moreover, here, since the driving method adopted involves dot inversion, between every two mutually adjacent signal lines 13 (*m*) and 13(*m*+1), the display signal voltages supplied thereto have opposite polarities. Thus, to make the effective voltage applied to the sub-pixel electrode 11a' always higher than the effective voltage applied to the sub-pixel electrodes 11b' and 11c' even in the pixel (n, *m*+1) in the next frame, as shown in Fig. 8, it is necessary that the auxiliary capacitance electrode 17a' of the sub-pixel electrode 11a' face the auxiliary capacitance common electrode 142' of the auxiliary capacitance conductor 14E and that the auxiliary capacitance electrode 17b' of the sub-pixel electrodes 11b' and 11c' face the auxiliary capacitance common electrode 141' of the auxiliary capacitance conductor 140.

[0051] Here, in the pixel *(n, m),* since the drain electrode extension 16a of the sub-pixel electrode 11a crosses the two auxiliary capacitance conductors 140 and 14E, and the voltages applied to the auxiliary capacitance conductors 140 and 14E are 180 degrees out of phase with each other, the parasitic capacitances attributable to the drain electrode extension 16a and attributable to the auxiliary capacitance conductors 140 and 14E cancel out. On the other hand, in the pixel (n, *m*+1), although the drain electrode extension 16a' of the sub-pixel electrode 11a' does not need to cross the auxiliary capacitance conductor 140, if the drain electrode extension 16a' of the sub-pixel electrode 11a' crosses only the auxiliary capacitance conductor 14E, the above-mentioned parasitic capacitances do not cancel out, and cause uneven display between the sub-pixel electrodes 11a and 11a'. To overcome this inconvenience, it is recommended that a drain electrode extension 16e be formed to extend further from the auxiliary capacitance electrode 17a' of the sub-pixel electrode 11a' to reach above the auxiliary capacitance conductor 140 so that together the drain electrode extensions cross the two auxiliary capacitance conductors 140 and 14E.

[0052] In the liquid crystal display described above, the sub-pixel electrodes 11 a to 11c of the sub-pixels 10a to 10c are formed separately from one another (see Fig. 1); it is however also possible to form the sub-pixel electrodes 11 b and 11c as a single sub-pixel electrode 11d as shown in Fig. 9. Even in that case, just as described previously, by controlling the voltages applied to the auxiliary capacitance common electrodes 141 and 142 connected to the sub-pixel electrodes 11a and 11d, it is possible to apply different voltages to the sub-pixel electrodes 11a and 11d. In the liquid crystal display described above, the sub-pixels are arranged next to one another in the column direction; needless to say, it is also possible to arrange them in the row direction instead.

[0053] The embodiment described above demonstrates that the present invention contributes to improving the gamma characteristic in normally black mode liquid crystal displays, in particular MVA mode liquid crystal displays. It should however be understood that the present invention finds application in any other type of liquid crystal display, among others, IPS liquid crystal displays.

Industrial Applicability

[0054] Liquid crystal displays according to the invention offer an improved gamma characteristic with less viewing angle dependence than ever, and do not produce unsmoothness or unnatural hues along a border even when an image with a straight border is displayed. This makes liquid crystal displays according to the invention suitable for use in, for example, television monitors with large screens.

Claims

1. A liquid crystal display having a plurality of pixels arrayed in a matrix, each pixel having a plurality of electrodes (11a, 11b, 11c, 21; 11a, 11d, 21) for applying an electric field to a liquid crystal layer,
wherein each pixel includes first (10a), second (10b) and third (10c) sub-pixels, said first, second and third sub-pixels having two different brightness levels when the pixel as a whole is in a given middle halftone state, and
when the first sub-pixel has a highest brightness level and is called a bright sub-pixel and the second and third are called dim sub-pixels,
one of said dim sub-pixels is located at one side of the pixel in the column or row direction,

another of said dim sub-pixels is located at an opposite side of the pixel, and
the bright sub-pixel is located between said one and another of said dim sub-pixels, wherein
said first, second and third sub-pixels each have a liquid crystal capacitance between a sub-pixel electrode (11a, 11b, 11c; 11a, 11d) and common electrode (21) disposed opposite each other across the liquid crystal layer, a single electrode (21) being shared as the common electrodes of said first, second and third sub-pixels,
said first, second and third sub-pixels each have an auxiliary capacitance between an auxiliary capacitance electrode (17a, 17b) electrically connected to the sub-pixel electrode and an auxiliary capacitance common electrode (141, 142) disposed opposite the auxiliary capacitance electrode and connected to an auxiliary capacitance conductor (14O, 14E),
two different auxiliary capacitance conductors are provided one for the bright sub-pixel and another for the dim sub-pixels,
scanning lines (12) are laid between mutually adjacent pixels, and, in each pixel, the two auxiliary capacitance conductors are laid parallel to the scanning lines, and
a conductor electrode (16a; 16a', 16e) via which the display signal voltage is supplied to the sub-pixel electrode (11a, 11a') of the bright sub-pixel crosses the two auxiliary capacitance conductors.

2. The liquid crystal display according to claim 1,
wherein said one and another of the dim sub-pixels have an identical brightness level.

3. The liquid crystal display according to claim 1 or 2,
wherein a ratio of an aperture area of the bright sub-pixel to a total aperture area of the dim sub-pixels is in a range from 1 : 1 to 1 : 4.

4. The liquid crystal display according to any one of claims I to 3,
wherein a ratio between aperture areas of said one and another of the dim sub-pixels is in a range from 1 : I to 1 : 4.

5. The liquid crystal display according to any preceding claim,
wherein an insulating layer (21a) is interposed between the auxiliary capacitance electrode (17a, 17b) and the auxiliary capacitance common electrode (141, 142).

6. The liquid crystal display according to any preceding claim, the liquid crystal display further having
scanning lines (12) extending in the row direction,
signal lines (13) extending in the column direction, and,
for each pixel, at least two switching devices (15a, 15b, 15c) provided one for the bright sub-pixel and another for the dim sub-pixels, the switching devices connecting to a scanning line and a signal line each common to the three sub-pixels of the pixel,
wherein the switching devices are turned on and off by a scanning signal voltage supplied to the common scanning line and, when the switching devices are on, a display signal voltage is supplied from the common signal line to the sub-pixel electrode and the auxiliary capacitance electrode of each of the bright and dim sub-pixels, and
wherein, after the switching devices are turned off, auxiliary capacitance common voltages at the auxiliary capacitance common electrodes of the bright and dim sub-pixels vary such that variations in the auxiliary capacitance common voltages as defined by directions and degrees in which the auxiliary capacitance common voltages vary differ between the bright sub-pixel and the dim sub-pixels.

7. The liquid crystal display according to claim 6,
wherein the switching devices are TFTs, and these TFTs are formed with a single semiconductor layer.

8. The liquid crystal display according to any preceding claim,
wherein the auxiliary capacitance common voltages invert polarities thereof periodically.

9. The liquid crystal display according to claim 8,
wherein the auxiliary capacitance common voltage applied to the auxiliary capacitance common electrode of the bright sub-pixel and the auxiliary capacitance common voltage applied to the auxiliary capacitance common electrodes of the dim sub-pixels are 180 degrees out of phase with each other.

10. The liquid crystal display according to claim 9,
wherein the auxiliary capacitance common voltage applied to the auxiliary capacitance common electrode of the bright sub-pixel and the auxiliary capacitance common voltage applied to the auxiliary capacitance common elec-

trodes of the dim sub-pixels have an equal amplitude.

11. The liquid crystal display according to any one of claims 8 to 10, wherein, between every two mutually adjacent signal lines, display signal voltages applied thereto have opposite polarities and, between every two pixels mutually adjacent in the row direction, the auxiliary capacitance electrodes and the auxiliary capacitance common electrodes of the bright and dim sub-pixels are disposed in reversed patterns.

12. The liquid crystal display according to claim 1, wherein the two auxiliary capacitance conductors are laid between the sub-pixels.

13. The liquid crystal display according to any preceding claim, wherein the sub-pixel electrodes of said first, second and third sub-pixels are separate from one another.

14. The liquid crystal display according to any preceding claim, wherein the sub-pixel electrodes of said one and another of the dim sub-pixels are continuous with each other.

15. The liquid crystal display according to any preceding claim, wherein a metal layer (19) is formed under a contact hole via which a conductor electrode via which the display signal voltage is supplied connects to a sub-pixel electrode, with an insulating layer interposed between the metal layer and the contact hole.

Patentansprüche

1. Flüssigkristallanzeige, die mehrere Pixel besitzt, die in einer Matrix angeordnet sind, wobei jedes Pixel mehrere Elektroden (11a, 11b, 11c, 21; 11a, 11d, 21) zum Anlegen eines elektrischen Feldes an eine Flüssigkristallschicht besitzt,
wobei jedes Pixel ein erstes (10a), ein zweites (10b) und ein drittes (10c) Subpixel enthält, wobei das erste, das zweite und das dritte Subpixel zwei verschiedene Helligkeitsstufen besitzen, wenn das Pixel als Ganzes in einem vorgegebenen mittleren Halbtonzustand ist, und
wenn das erste Subpixel eine höchste Helligkeitsstufe besitzt und ein helles Subpixel genannt wird und das zweite und das dritte dunkle Subpixel genannt werden,
eines der dunklen Subpixel an einer Seite der Pixel in einer Spalten- oder Zeilenrichtung angeordnet ist,
ein weiteres der dunklen Subpixel an der gegenüberliegenden Seite der Pixel angeordnet ist und
das helle Subpixel zwischen dem einen und dem weiteren der dunklen Subpixel angeordnet ist, wobei
das erste, das zweite und das dritte Subpixel jeweils eine Flüssigkristallkapazität zwischen einer Subpixelelektrode (11a, 11b, 11c; 11a, 11d) und einer gemeinsamen Elektrode (21), die über die Flüssigkristallschicht einander gegenüberliegend angeordnet sind, besitzt, wobei eine einzelne Elektrode (21) als die gemeinsame Elektrode des ersten, zweiten und dritten Subpixels genutzt wird,
das erste, das zweite und das dritte Subpixel jeweils eine Hilfskapazität zwischen einer Hilfskapazitätselektrode (17a, 17b), die mit der Subpixelelektrode elektrisch verbunden ist, und einer gemeinsamen Hilfskapazitätselektrode (141, 142), die gegenüber der Hilfskapazitätselektrode angeordnet ist und mit einer Hilfskapazitätsleitung (140, 14E) verbunden ist, besitzt,
zwei verschiedene Hilfskapazitätsleitungen vorgesehen sind, eine für das helle Subpixel und eine weitere für die dunklen Subpixel,
Abtastleitungen (12) zwischen gegenseitig benachbarten Pixel verlegt sind und in jedem Pixel die zwei Hilfskapazitätsleitungen parallel zu den Abtastleitungen verlegt sind, und
eine Leitungselektrode (16a; 16a', 16e), über die die Anzeigesignalspannung an die Subpixelelektrode (11a, 11a') des hellen Subpixels angelegt wird, die zwei Hilfskapazitätsleitungen kreuzt.

2. Flüssigkristallanzeige nach Anspruch 1, wobei das eine und das weitere der dunklen Subpixel die gleiche Helligkeitsstufe besitzen.

3. Flüssigkristallanzeige nach Anspruch 1 oder 2, wobei ein Verhältnis eines Aperturbereichs des hellen Subpixels zu einem gesamten Aperturbereich des dunklen Subpixels in einem Bereich von 1:1 bis 1:4 liegt.

4. Flüssigkristallanzeige nach einem der Ansprüche 1 bis 3, wobei ein Verhältnis zwischen Aperturbereichen des einen und eines weiteren der dunklen Subpixel in einem Bereich von 1:1 bis 1:4 liegt.

5. Flüssigkristallanzeige nach einem der vorangehenden Ansprüche, wobei zwischen die Hilfskapazitätselektrode (17a, 17b) und die gemeinsame Hilfskapazitätselektrode (141, 142) eine Isolierschicht (21a) eingesehoben ist.

6. Flüssigkristallanzeige nach einem der vorangehenden Ansprüche, wobei die Flüssigkristallanzeige ferner besitzt:

Abtastleitungen (12), die sich in der Zeilenrichtung erstrecken,
Signalleitungen (13), die sich in der Spaltenrichtung erstrecken, und
für jedes Pixel mindestens zwei Schaltvorrichtungen (15a, 15b, 15c), von denen eine für das helle Subpixel und die weitere für die dunklen Subpixel vorgesehen ist, wobei die Schaltvorrichtungen an eine Abtastleitung und eine Signalleitung, wovon jede den drei Subpixeln des Pixels gemeinsam ist, angeschlossen ist,
wobei die Schaltvorrichtungen durch eine Abtastsignalspannung, die an die gemeinsame Abtastleitung geliefert wird, ein- und ausgeschaltet werden und, wenn die Schaltvorrichtungen eingeschaltet sind, eine Anzeigesignalspannung von der gemeinsamen Signalleitung an die Subpixelelektrode und die Hilfskapazitätselektrode von jedem des hellen und der dunklen Subpixel geliefert wird, und
wobei, nachdem die Schaltvorrichtungen ausgeschaltet worden sind, gemeinsame Hilfskapazitätsspannungen an den gemeinsamen Hilfskapazitätselektroden des hellen und der dunklen Subpixel variieren, so dass Variationen in den gemeinsamen Hilfskapazitätsspannungen die durch Richtungen und Grade, in denen die gemeinsamen Hilfskapazitätsspannungen variieren, festgelegt sind, zwischen dem hellen Subpixel und den dunklen Subpixeln verschieden sind.

7. Flüssigkristallanzeige nach Anspruch 6, wobei die Schaltvorrichtungen TFTs sind und diese TFTs mit einer einzelnen Halbleiterschicht gebildet sind.

8. Flüssigkristallanzeige nach einem der vorangehende Ansprüche, wobei die gemeinsame Hilfskapazitätsspannung ihre Polaritäten periodisch umkehrt.

9. Flüssigkristallanzeige nach Anspruch 8, wobei die gemeinsame Hilfskapazitätsspannung, die an die gemeinsame Hilfskapazitätselektrode des hellen Subpixels angelegt wird, und die gemeinsame Hilfskapazitätsspannung, die an die gemeinsamen Hilfskapazitätselektroden der dunklen Subpixel angelegt wird, um 180 Grad phasenverschoben sind.

10. Flüssigkristallanzeige nach Anspruch 9, wobei die gemeinsame Hilfskapazitätsspannung, die an die gemeinsame Hilfskapazitätselektrode des hellen Subpixels angelegt wird, und die gemeinsame Hilfskapazitätsspannung, die an die gemeinsamen Hilfskapazitätselektroden der dunklen Subpixel angelegt wird, eine gleiche Amplitude besitzen.

11. Flüssigkristallanzeige nach einem der Ansprüche 8 bis 10, wobei zwischen je zwei gegenseitig benachbarten Signalleitungen die daran angelegten Anzeigesignalspannungen entgegengesetzte Polaritäten aufweisen und zwischen je zwei gegenseitig in der Reihenrichtung benachbarten Pixeln die Hilfskapazitätselektroden und die gemeinsame Hilfskapazitätselektroden des hellen und der dunklen Subpixel in umgekehrten Mustern angeordnet sind.

12. Flüssigkristallanzeige nach Anspruch 1, wobei die zwei Hilfskapazitätsleitutigen zwischen den Subpixeln verlegt sind.

13. Flüssigkristallanzeige nach einem der vorangehenden Ansprüche, wobei die Subpixelelektroden des ersten, des zweiten und des dritten Subpixels voreinander getrennt sind.

14. Flüssigkristallanzeige nach einem der vorangehenden Ansprüche, wobei die Subpixelektroden des einen und des weiteren der dunklen Subpixel ineinander übergehen.

15. Flüssigkristallanzeige nach einem der vorangehenden Anspruche, wobei eine Metallschicht (19) unter einem Kontaktloch, über das eine Leitungselektrode, über die die Anzeigesignalspannung angelegt wird, an eine Subpixelelektrode angeschlossen ist, gebildet ist, wobei eine Isolierschicht zwischen die Metallschicht und das Kontaktloch eingeschoben ist.

Revendications

1. Ecran à cristaux liquides comprenant une pluralité de pixels disposés selon une matrice, chaque pixel comprenant une pluralité d'électrodes (11a, 11b, 11c, 21, 21 ; 11a, 11d, 21) pour appliquer un champ électrique à une couche de cristaux liquides,
dans lequel chaque pixel comprend un premier sous-pixel (10a), un deuxième sous-pixel (10b) et un troisième sous-pixel (10c), les premier, deuxième et troisième sous-pixels présentant deux niveaux de luminosité différents lorsque le pixel dans son ensemble est dans un état de demi-teinte intermédiaire donné, et
lorsque le premier sous-pixel présente un niveau de luminosité le plus élevé et est appelé un sous-pixel lumineux et que les deuxième et troisième sont appelés sous-pixels de faible luminosité,
un sous-pixel parmi lesdits sous-pixels de faible luminosité est situé sur un côté du pixel dans la direction de colonne ou de rangée,
un autre sous-pixel parmi lesdits sous-pixels de faible luminosité est situé sur un côté opposé du pixel, et
le sous-pixel lumineux est situé entre ledit sous-pixel et ledit autre sous-pixel parmi lesdits sous-pixels de faible luminosité, dans lequel
lesdits premier, deuxième et troisième sous-pixels comprennent chacun une capacité de cristaux liquides entre une électrode de sous-pixel (11a, 11, 11c; 11a, 11d) et une électrode commune (21) disposées en regard l'une de l'autre à travers la couche de cristaux liquides, une électrode unique (21) étant partagée sous forme des électrodes communes desdits premier, deuxième et troisième sous-pixels,
lesdits premier, deuxième et troisième sous-pixels présentent chacun une capacité auxiliaire entre une électrode de capacité auxiliaire (17a, 17b) connectée électriquement à l'électrode de sous-pixel et une électrode commune de capacité auxiliaire (141, 142) disposée en regard de l'électrode de capacité auxiliaire et connectée à un conducteur de capacité auxiliaire (140, 14E),
deux conducteurs de capacité auxiliaire différents sont prévus dont un pour le sous-pixel lumineux et un autre pour les sous-pixels de faible luminosité,
des lignes de balayage (12) sont disposées entre des pixels mutuellement adjacents, et, dans chaque pixel, les deux conducteurs de capacité auxiliaire sont disposés parallèlement aux lignes de balayage, et
une électrode de conducteur (16a ; 16a', 16e), par l'intermédiaire de laquelle la tension de signal d'affichage est fournie à l'électrode de sous-pixel (11a, 11a') du sous-pixel lumineux, croise les deux conducteurs de capacité auxiliaire.

2. Ecran à cristaux liquides conformément à la revendication 1,
dans lequel ledit sous-pixel et ledit autre sous-pixel parmi lesdits sous-pixels de faible luminosité présentent un niveau de luminosité identique.

3. Ecran à cristaux liquides conformément à la revendication 1 ou 2,
dans lequel un rapport d'une surface d'ouverture du sous-pixel lumineux à une surface d'ouverture totale des sous-pixels de faible luminosité est dans une plage allant de 1 : 1 à 1 : 4.

4. Ecran à cristaux liquides conformément à l'une quelconque des revendications 1 à 3,
dans lequel un rapport entre des surfaces d'ouverture dudit sous-pixel et dudit autre sous-pixel parmi lesdits sous-pixels de faible luminosité est compris dans une plage allant de 1 : 1 à 1 : 4.

5. Ecran à cristaux liquides conformément à l'une quelconque des revendications précédentes,
dans lequel une couche isolante (21 a) est interposée entre l'électrode de capacité auxiliaire (17a, 17b) et l'électrode commune de capacité auxiliaire (141, 142).

6. Ecran à cristaux liquides conformément à l'une quelconque des revendications précédentes, ledit écran comprenant en outre
des lignes de balayage (12) s'étendant dans la direction de rangée,
des lignes de balayage (13) s'étendant dans la direction de colonne, et,
pour chaque pixel, au moins deux dispositifs de commutation (15a, 15b, 15c) dont un est prévu pour le sous-pixel lumineux et un autre est prévu pour les sous-pixels de faible luminosité, les dispositifs de commutation étant connectés à une ligne de balayage et à une ligne de signal qui sont chacune communes aux trois sous-pixels du pixel, dans lequel les dispositifs de commutation sont activés et désactivés par une tension de signal de balayage fournie

à la ligne de balayage commune et, lorsque les dispositifs de commutation sont activés, une tension de signal d'affichage est fournie de la ligne de signal commune à l'électrode de sous-pixel et à l'électrode de capacité auxiliaire de chacun d'entre le sous-pixel lumineux et les sous-pixels de faible luminosité, et
dans lequel, une fois les dispositifs de commutation désactivés, des tensions communes de capacité auxiliaire au niveau des électrodes communes de capacité auxiliaire du sous-pixel lumineux et des sous-pixels de faible luminosité varient, de sorte que des variations des tensions communes de capacité auxiliaire telles que définies par des directions et des degrés dans lesquels les tensions communes de capacité auxiliaire varient sont différentes entre le sous-pixel lumineux et les sous-pixels de faible luminosité.

7. Ecran à cristaux liquides conformément à la revendication 6,
dans lequel les dispositifs de commutation sont des transistors à couches minces (TFT), et ces TFT sont constitués d'une couche semiconductrice unique.

8. Ecran à cristaux liquides conformément à l'une quelconque des revendications précédentes,
dans lequel les tensions communes de capacité auxiliaire inversent leurs polarités périodiquement.

9. Ecran à cristaux liquides conformément à la revendication 8,
dans lequel la tension commune de capacité auxiliaire appliquée à l'électrode commune de capacité auxiliaire du sous-pixel lumineux et la tension commune de capacité auxiliaire appliquée aux électrodes communes de capacité auxiliaire des sous-pixels de faible luminosité sont de 180 degrés hors phase l'une par rapport à l'autre.

10. Ecran à cristaux liquides conformément à la revendication 9,
dans lequel la tension commune de capacité auxiliaire appliquée à l'électrode commune de capacité auxiliaire du sous-pixel lumineux et la tension commune de capacité auxiliaire appliquée aux électrodes communes de capacité auxiliaire des sous-pixels de faible luminosité présentent une amplitude égale.

11. Ecran à cristaux liquides conformément à l'une quelconque des revendications 8 à 10,
dans lequel, entre toutes les deux lignes de signal mutuellement adjacentes, des tensions de signal d'affichage qui leur sont appliquées présentent des polarités opposées et, entre tous les deux pixels mutuellement adjacents dans la direction de rangée, les électrodes de capacité auxiliaire et les électrodes communes de capacité auxiliaire du sous-pixel lumineux et des sous-pixels de faible luminosité sont disposées selon des motifs inversés.

12. Ecran à cristaux liquides conformément à la revendication 1, dans lequel les deux conducteurs de capacité auxiliaire sont disposés entre les sous-pixels.

13. Ecran à cristaux liquides conformément à l'une quelconque des revendications précédentes,
dans lequel les électrodes de sous-pixel des premier, deuxième et troisième sous-pixels sont séparées les unes des autres.

14. Ecran à cristaux liquides conformément à l'une quelconque des revendications précédentes,
dans lequel les électrodes de sous-pixel dudit sous-pixel et dudit autre sous-pixel parmi lesdits sous-pixels de faible luminosité sont continues entre elles.

15. Ecran à cristaux liquides conformément à l'une quelconque des revendications précédentes,
dans lequel une couche métallique (19) est formée sous un trou de contact par l'intermédiaire duquel une électrode de conducteur par l'intermédiaire de laquelle la tension de signal d'affichage est fournie est connectée à une électrode de sous-pixel, une couche isolante étant interposée entre la couche métallique et le trou de contact.

FIG.1

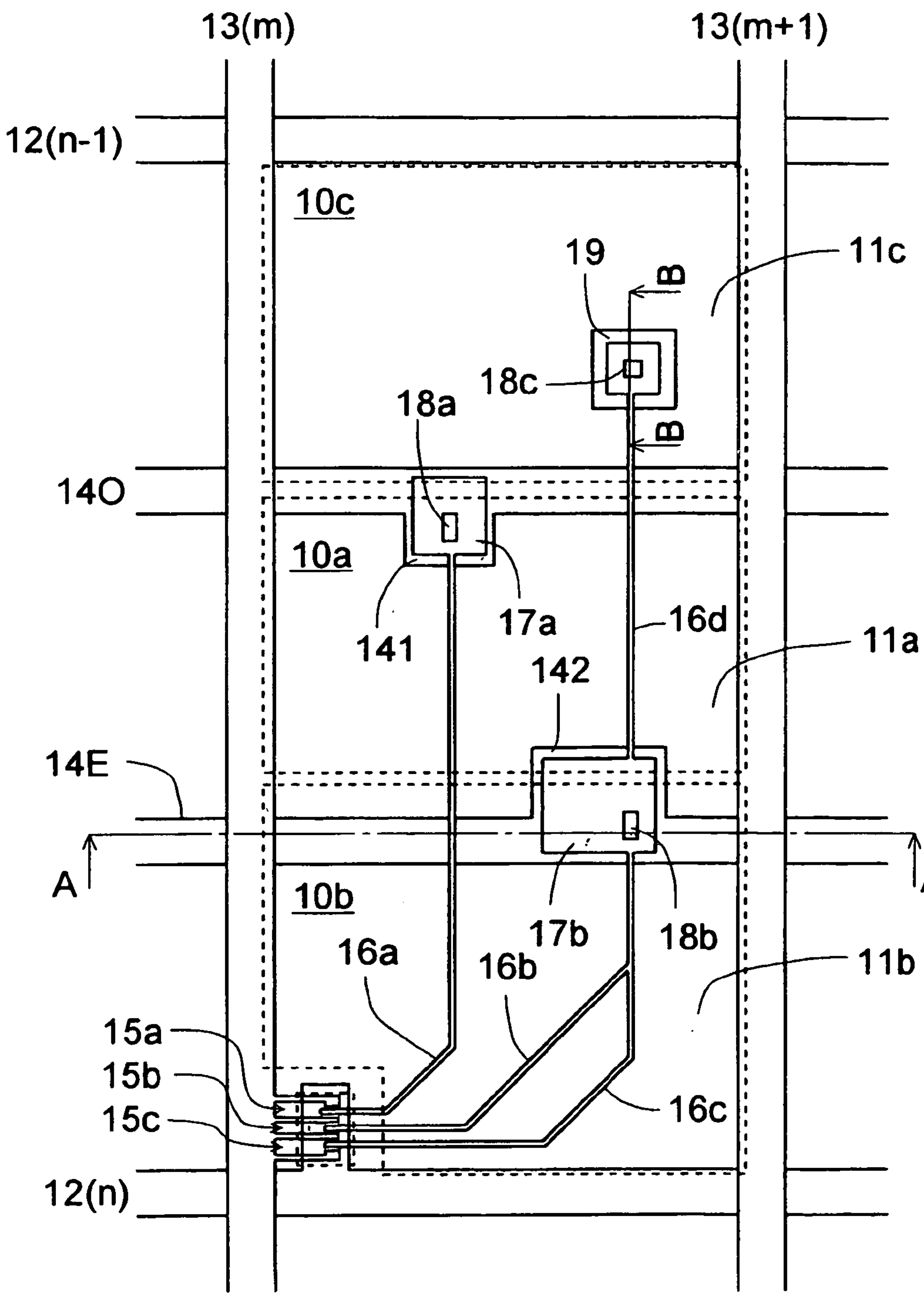

13(m)
13(m+1)
12(n-1)
10c
19
11c
B
18c
18a
B
14O
10a
17a
141
16d
11a
142
14E
A
A
10b
17b
18b
16a
16b
11b
15a
15b
15c
16c
12(n)

FIG.2

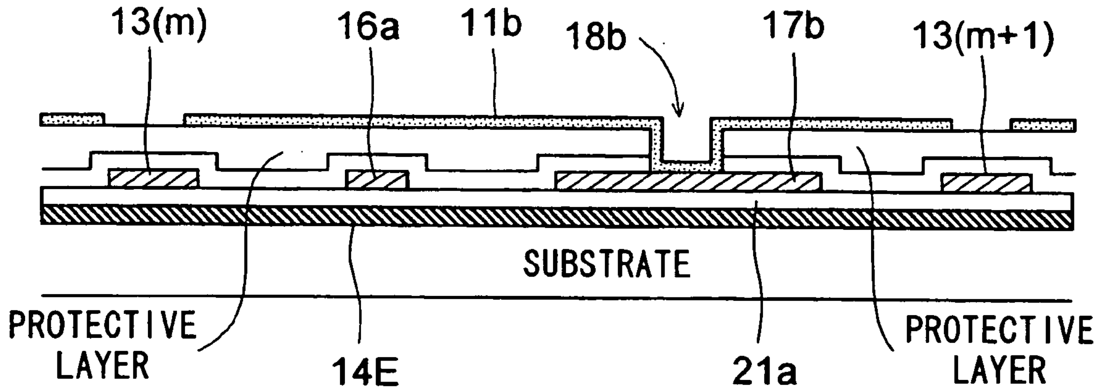


FIG.3

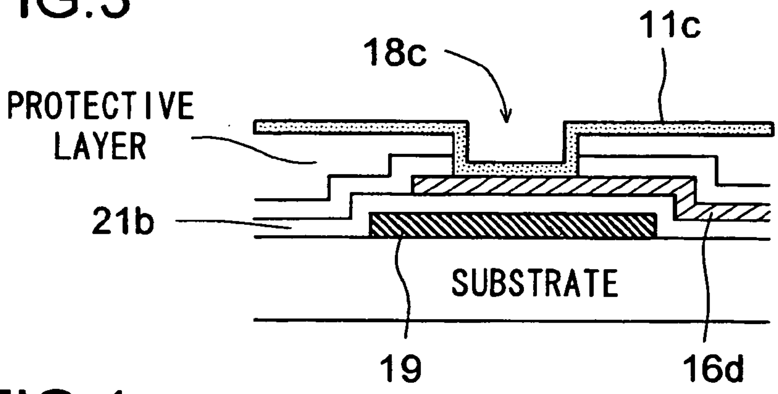


FIG.4

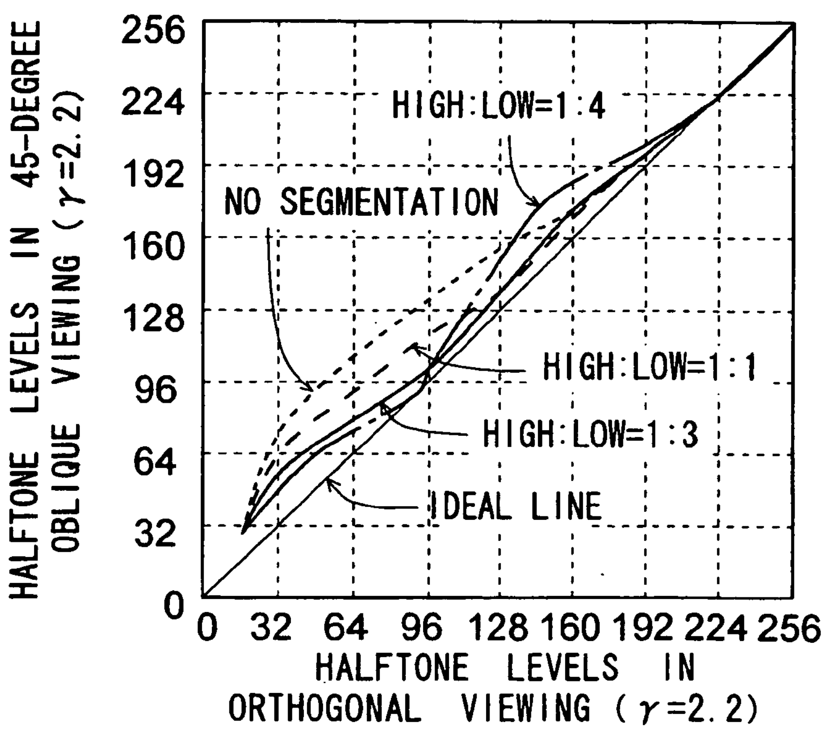


FIG.5

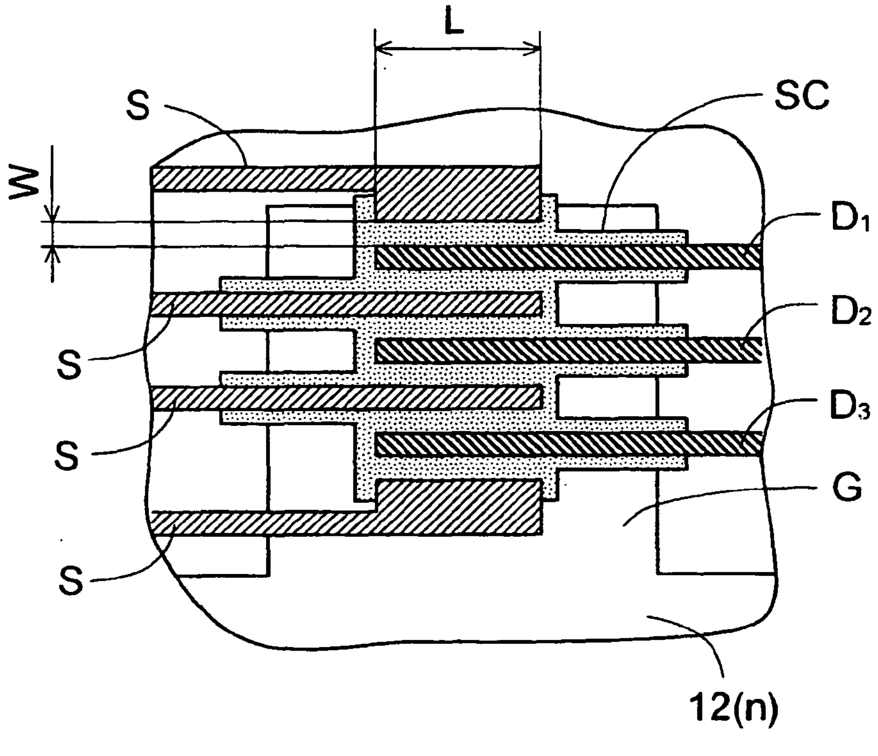


FIG.6

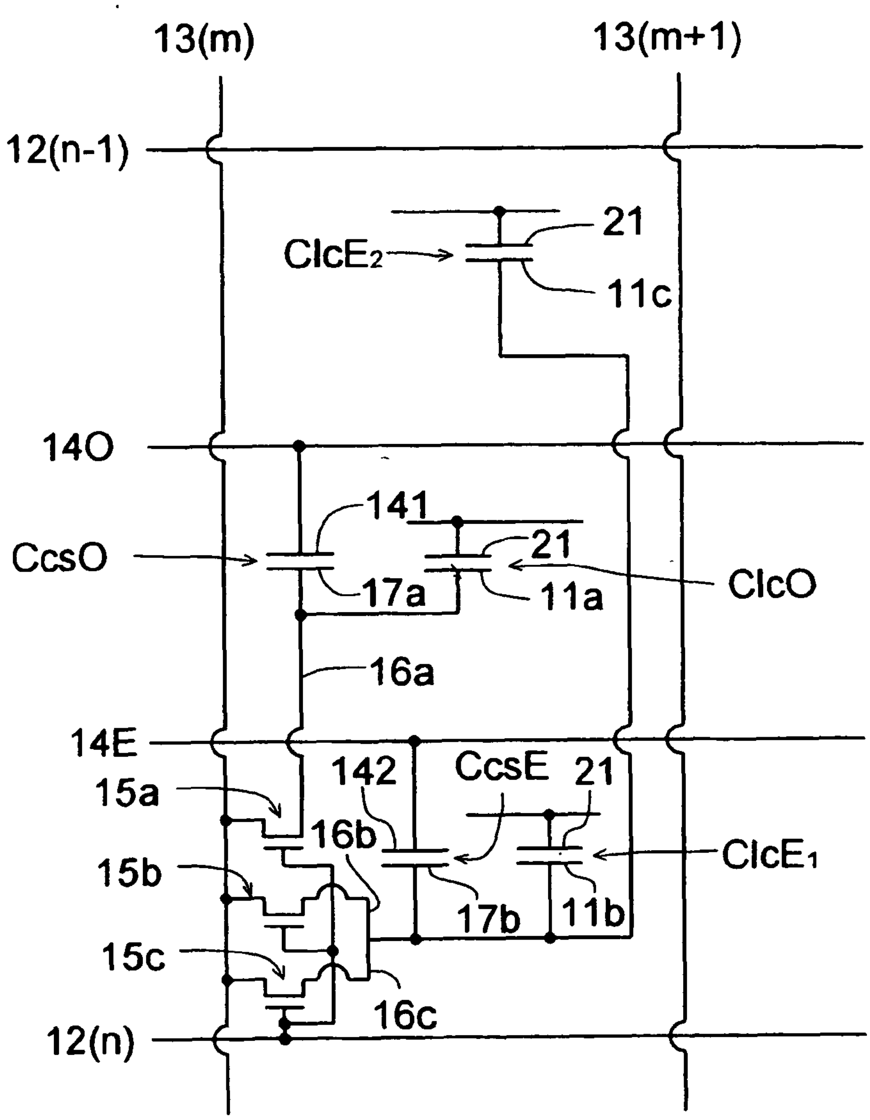

13(m)
13(m+1)
12(n-1)
ClcE2
21
11c
14O
141
CcsO
21
17a
11a
ClcO
16a
14E
142
CcsE
21
15a
16b
ClcE1
15b
17b
11b
15c
16c
12(n)

FIG.7

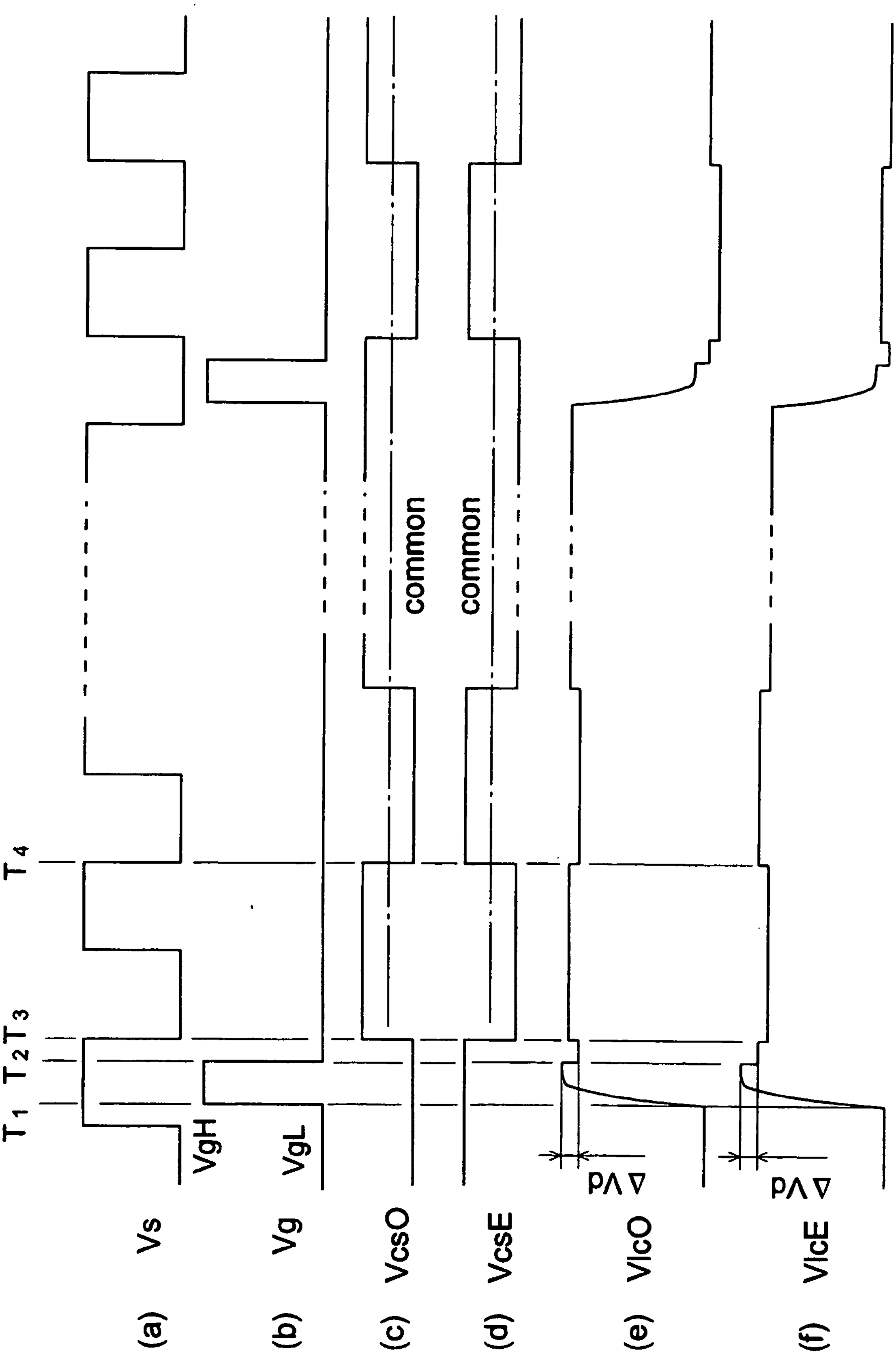

T1
T2
T3
T4
(a) Vs
(b) Vg
VgH
VgL
(c) VcsO
(d) VcsE
common
common
(e) VlcO
ΔVd
(f) VlcE
ΔVd

FIG.8

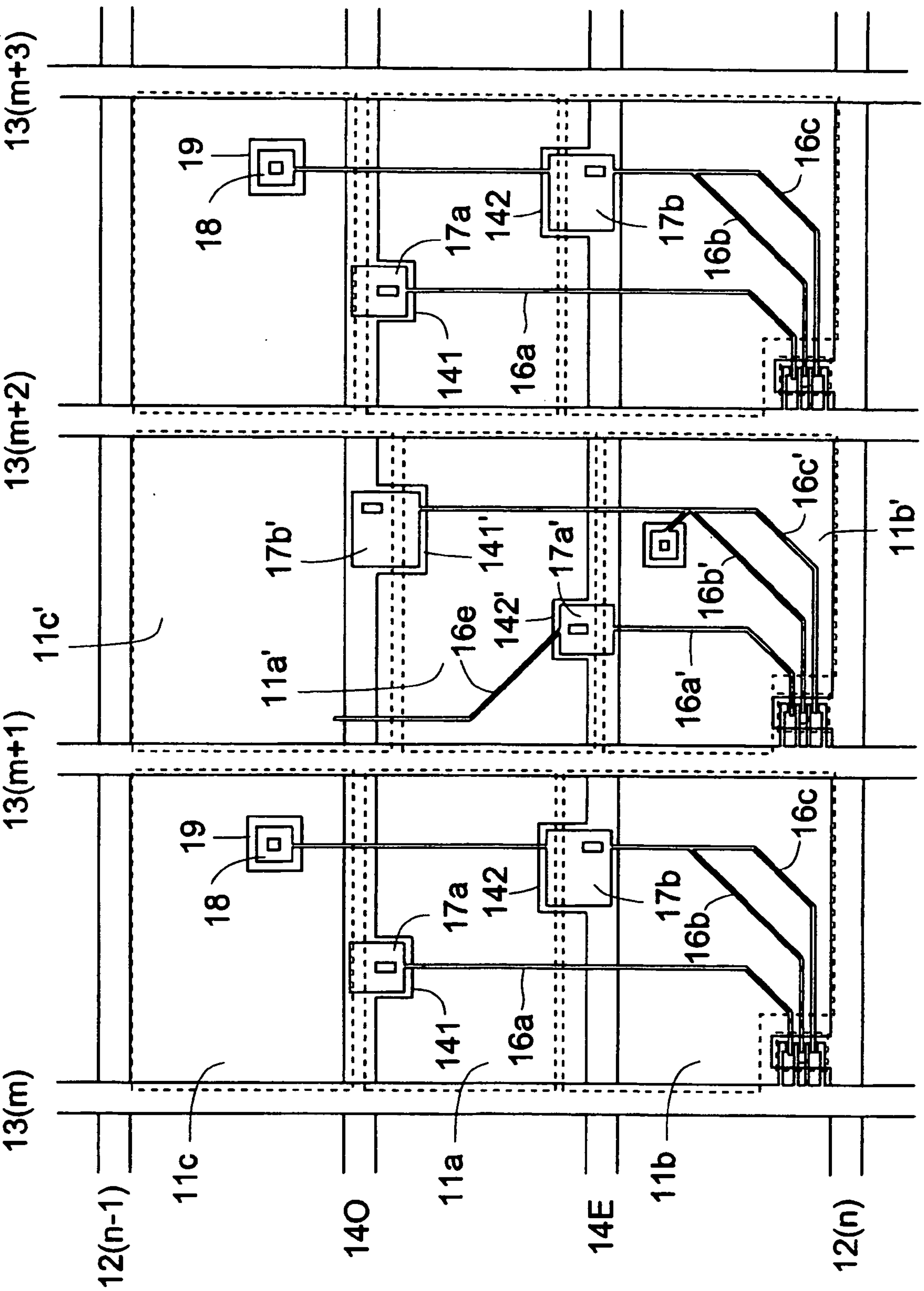
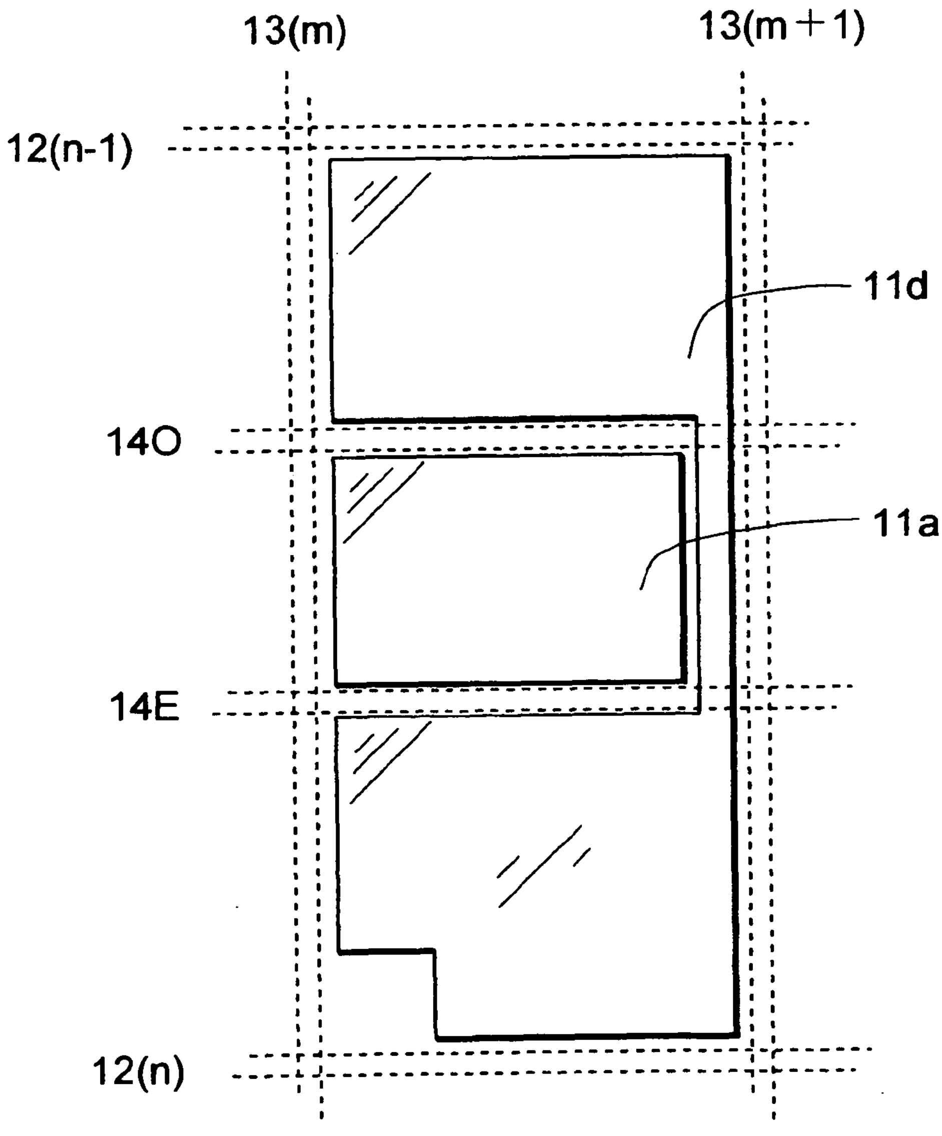

13(m+3)
13(m+2)
13(m+1)
13(m)
12(n-1)
14O
14E
12(n)
11c
11a
11b
19
18
17a
142
17b
141
16a
16b
16c
17b'
141'
17a'
142'
11c'
11a'
16e
16b'
16c'
16a'
11b'

FIG.9



REFERENCES CITED IN THE DESCRIPTION

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- JP H6332009 A **[0005]**
- JP 2004062146 A **[0005] [0027]**
- JP 2004029716 A **[0006]**
- EP 0669549 A **[0007]**

专利名称(译)	液晶显示器		
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申请号	EP2008013136	申请日	2005-10-04
[标]申请(专利权)人(译)	夏普株式会社		
申请(专利权)人(译)	夏普株式会社		
当前申请(专利权)人(译)	夏普株式会社		
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其他公开文献	EP1978398A3 EP1978398A2		
外部链接	Espacenet		

摘要(译)

分段像素液晶显示器具有多个像素，每个像素具有三个子像素10a-10c，即一个中间和两个侧子像素，在列方向或行方向上彼此相邻排列。当像素整体处于给定的中间半色调状态时，子像素10a-10c具有不同的亮度等级，并且中间子像素10a具有最高的亮度等级。这消除了当显示具有直边界的图像时传统上产生的不自然，并且进一步改善了伽玛特性。

$$Vlc0 = Vs - \Delta Vd + Vcs0p\,(Ccs0 / C_{pix}0) - Vcom,$$