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(57) **ABSTRACT**

A liquid crystal display according to an embodiment of the present invention includes: a first substrate; a plurality of color filters formed on the first substrate and arranged in a matrix with an island shape; a plurality of pixel electrodes formed on the color filters; and a capacitor disposed between neighboring color filters in a column direction among the color filters, wherein two terminals forming the capacitor are disposed at a portion outside a position overlapping the color filters.

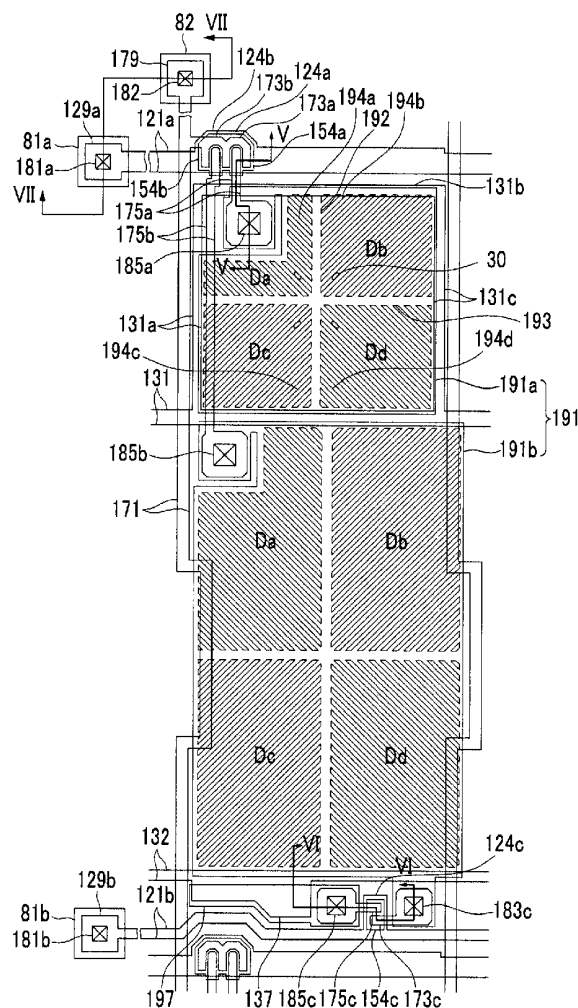


FIG. 1

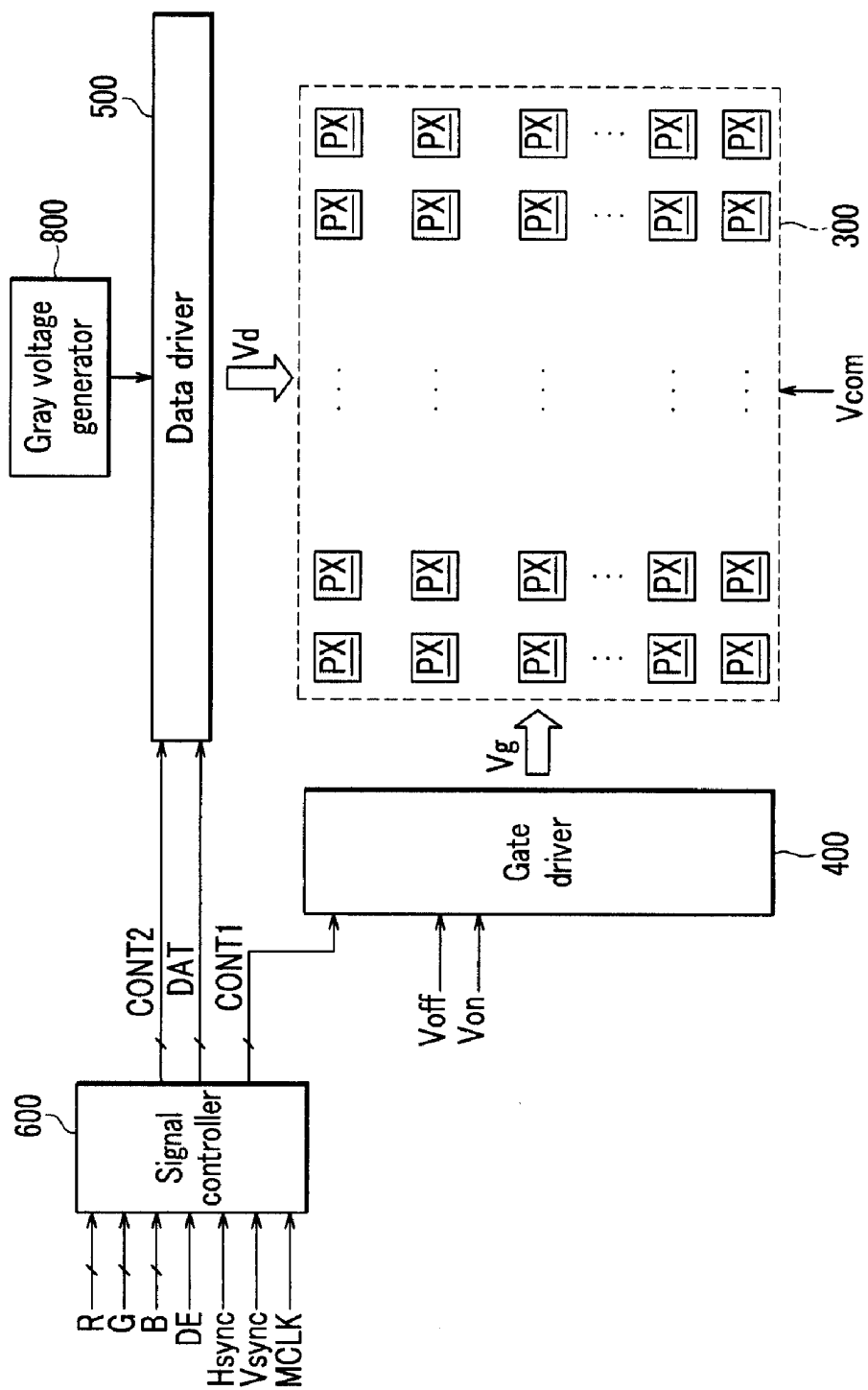


FIG.2

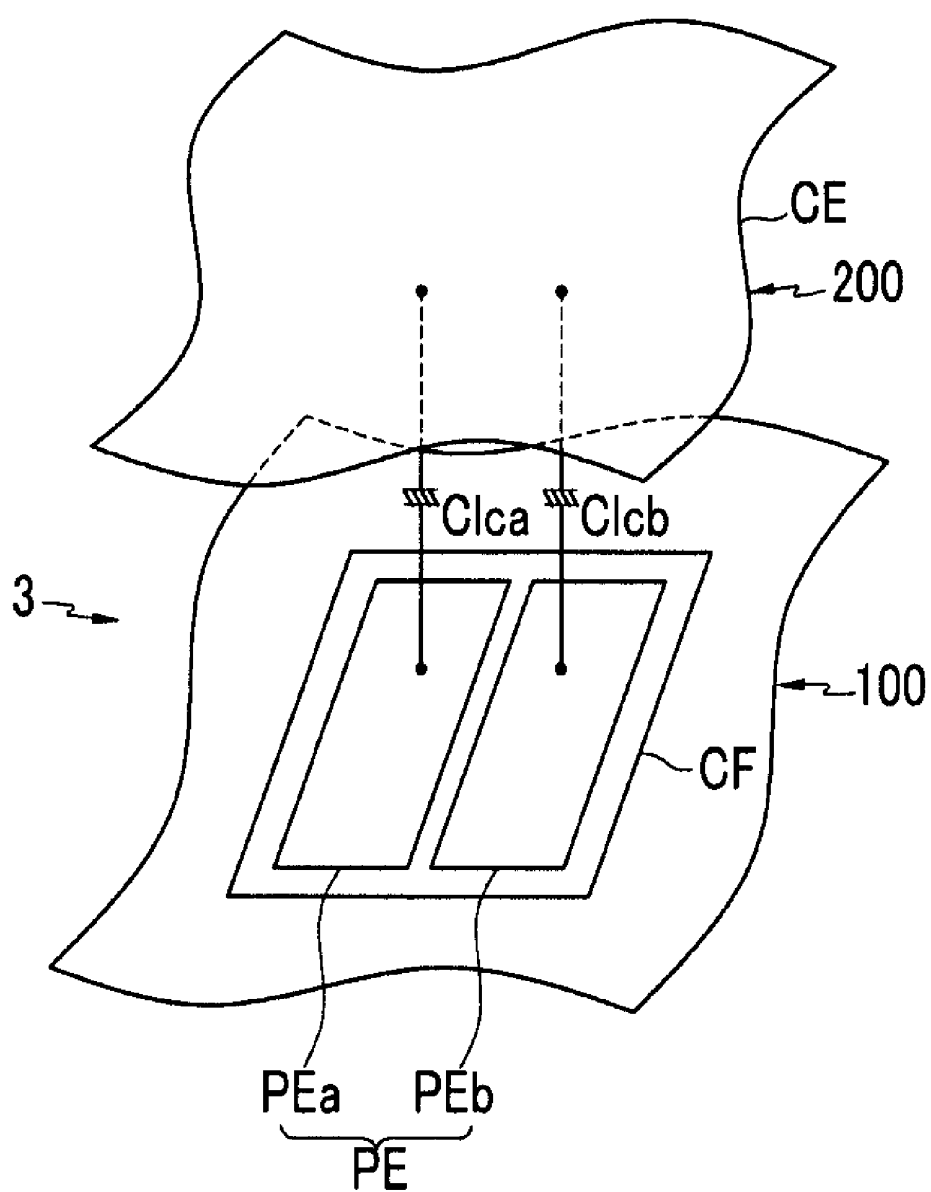


FIG.3

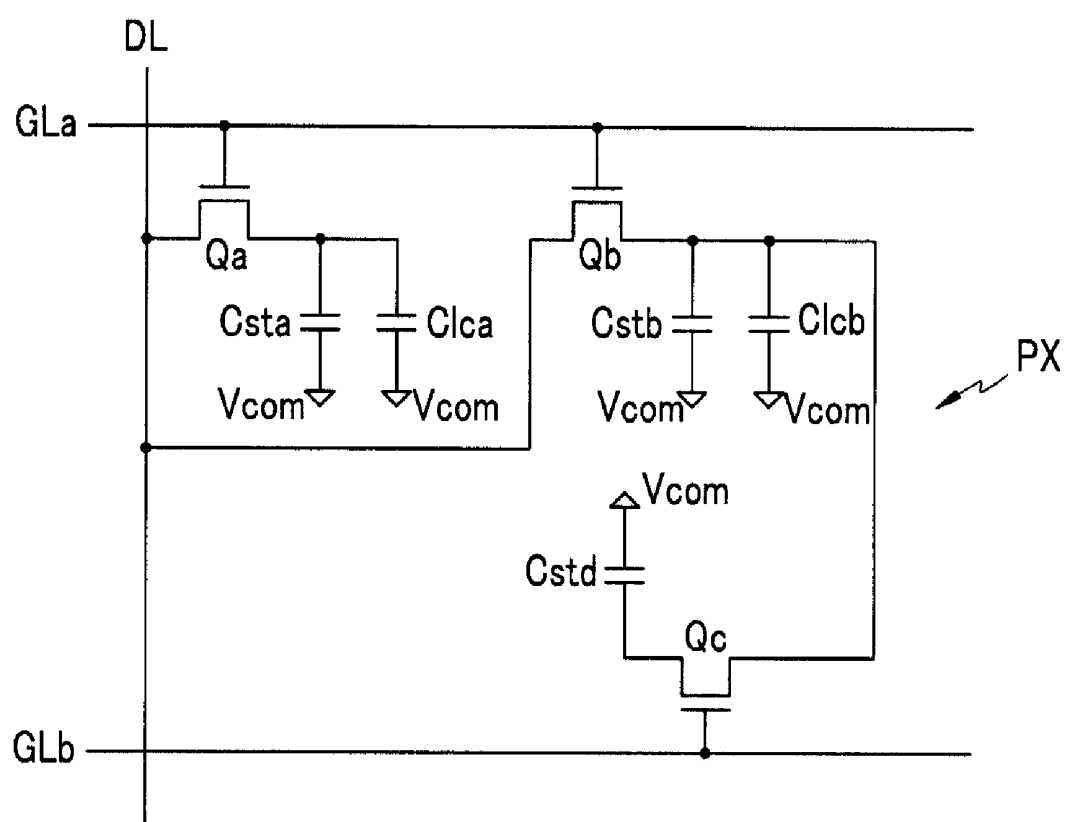


FIG. 4

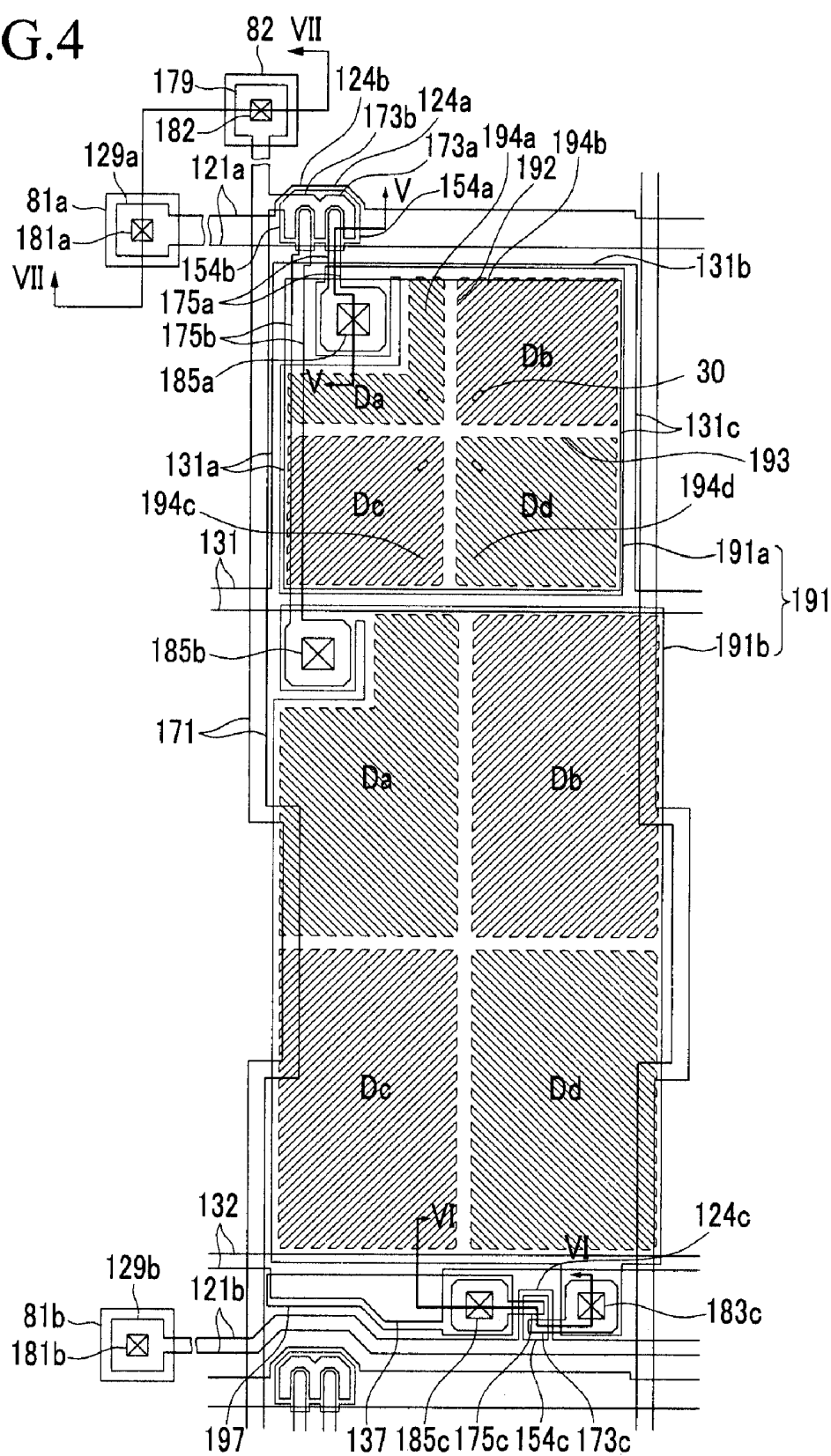


FIG.5

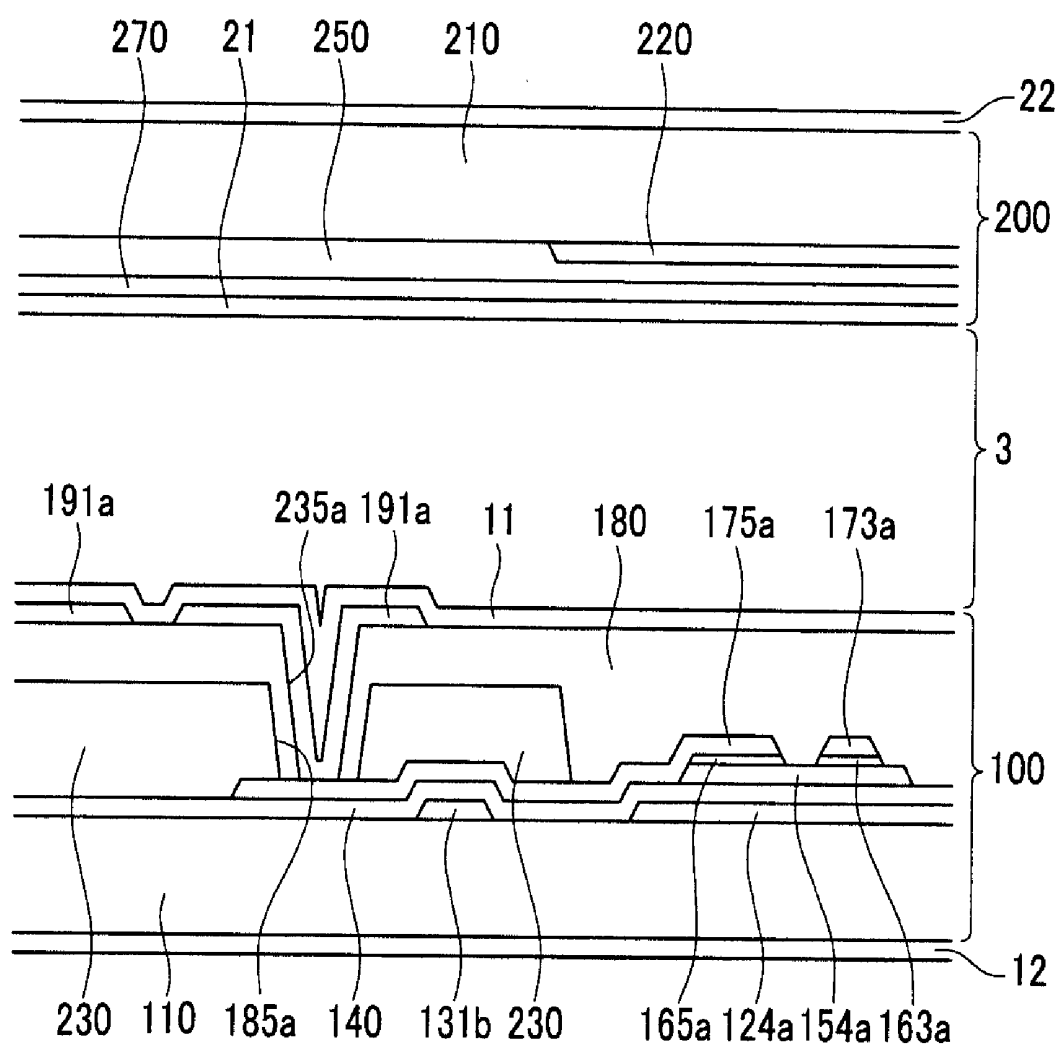


FIG.6

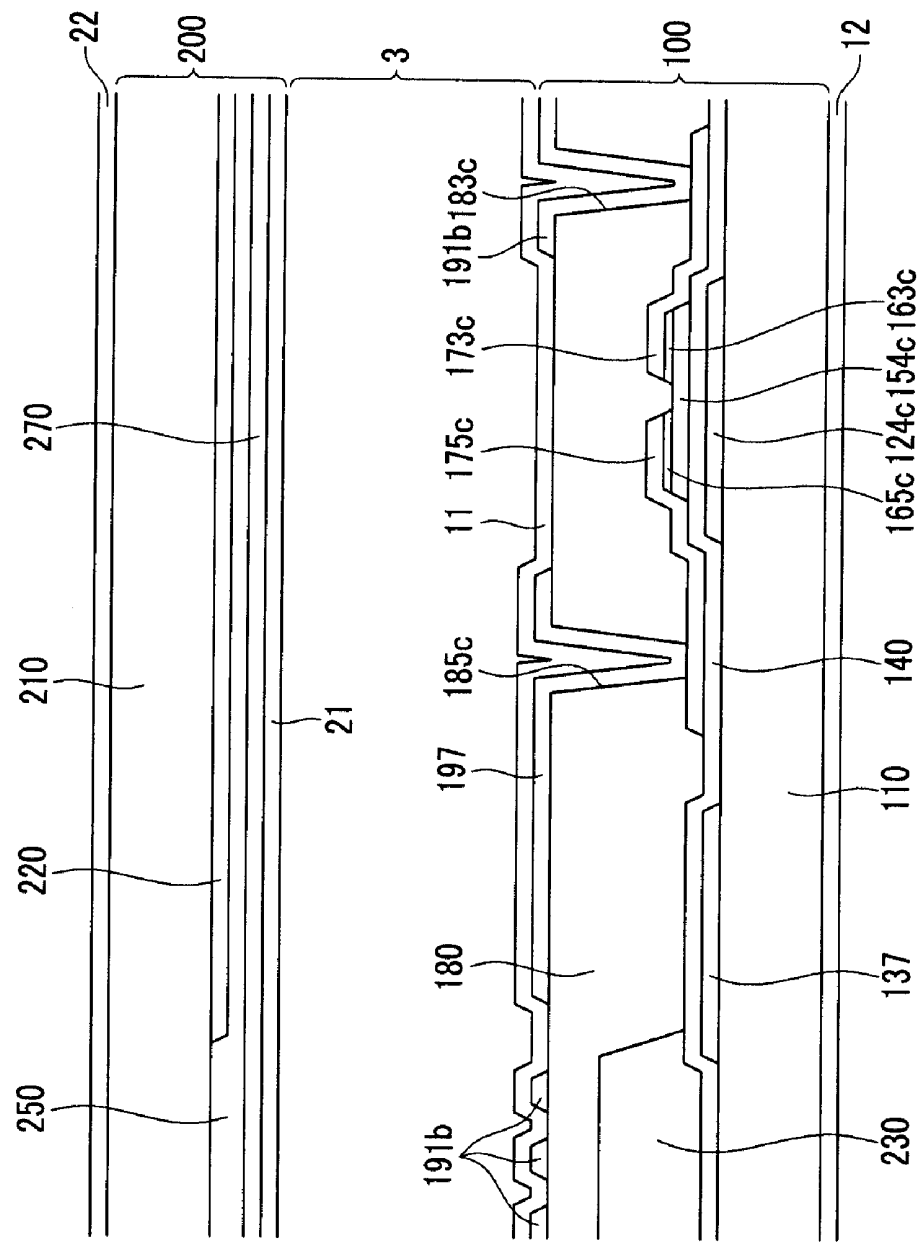


FIG.7

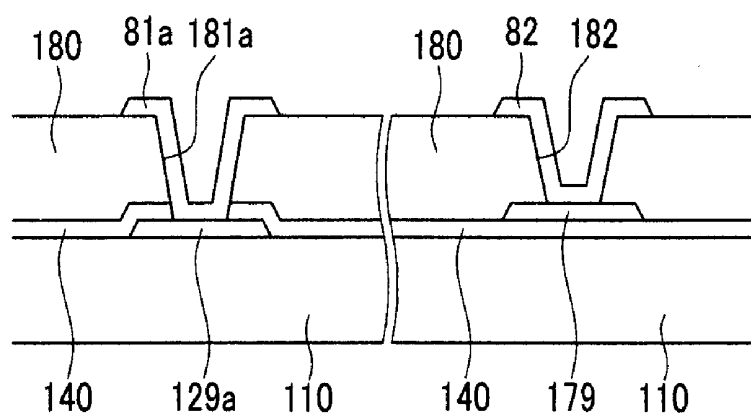
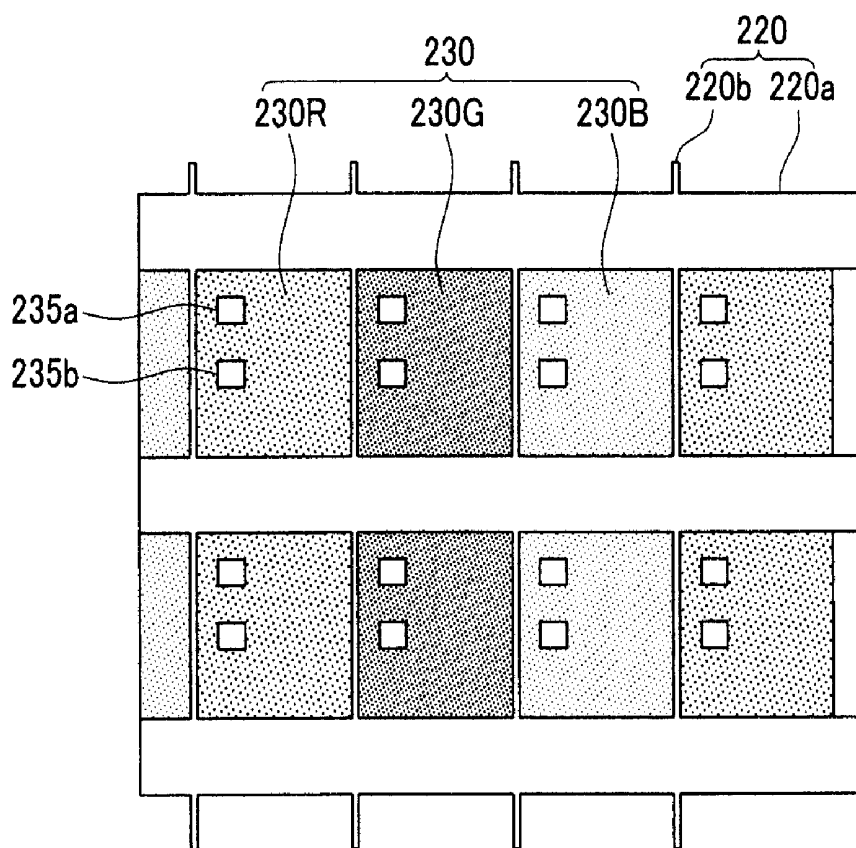


FIG.8



LIQUID CRYSTAL DISPLAY

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to and the benefit of Korean Patent Application No. 10-2008-0124676 filed in the Korean Intellectual Property Office on Dec. 9, 2008, the entire contents of which are incorporated herein by reference.

BACKGROUND

[0002] 1. Technical Field

[0003] The present invention generally relates to a liquid crystal display.

[0004] 2. Related Art

[0005] A liquid crystal display (hereinafter referred to as an LCD) is one of the most widely used flat panel displays. The typical LCD includes two display panels provided with electric field generating electrodes, such as pixel electrodes and a common electrode, and a liquid crystal layer interposed between the two display panels. In the LCD, voltages are applied to the electric field generating electrodes to generate an electric field in the liquid crystal layer. Due to the generated electric field, liquid crystal molecules of the liquid crystal layer are aligned and polarization of incident light is controlled, thereby displaying images. The LCD also includes switching elements connected to the respective pixel electrodes, and a plurality of signal lines such as gate lines and data lines for controlling the switching elements and applying voltages to the pixel electrodes. The liquid crystal display also includes color filters made of an organic material including pigments for realizing colors.

[0006] When the pixel electrodes and the color filters are formed on the different display panels, it is difficult to correctly align the pixel electrodes and the color filters, and an alignment error may be generated. To solve this problem, a color filter on array (CoA) structure in which the pixel electrodes and the color filters are formed on the same display panel is provided. In the color filter on array structure, the color filters, the pixel electrodes, a plurality of signal lines for applying the voltage to the pixel electrodes such as gate lines and data lines, and switching elements for driving them are formed on one display panel.

[0007] Among the LCDs, a vertical alignment (VA) mode LCD, which aligns liquid crystal (LC) molecules such that the long axes of the LC molecules are perpendicular to the panels in the absence of an electric field, is favored because of its high contrast ratio and wide reference viewing angle. In this case, the reference viewing angle refers to a viewing angle at which a contrast ratio is 1:10 or to a luminance inversion limit angle between grays (e.g., an angle at which gray-scale inversion begins to occur).

[0008] In order to cause side visibility to approximate front visibility in the vertical alignment mode LCD, a method of causing a difference in transmittance by dividing one pixel into two subpixels and applying different voltages to the two subpixels has been suggested.

[0009] The above information disclosed in this Background section is only for enhancement of understanding of the background of the invention and therefore it may contain

information that does not form the prior art that is already known in this country to a person of ordinary skill in the art.

SUMMARY

[0010] Embodiments of the present invention generally may prevent a process deviation generated at each pixel when forming a color filter, may increase the aperture ratio of a liquid crystal display, and may reduce parasitic capacitance generated between a pixel electrode and a gate line, thereby minimizing a kickback voltage.

[0011] A liquid crystal display according to an embodiment of the present invention includes: a first substrate; a plurality of color filters formed with an island shape on the first substrate and arranged in a matrix; a plurality of pixel electrodes formed on the color filters; and a capacitor disposed between neighboring color filters in a column direction among the color filters, wherein two terminals forming the capacitor are disposed at a portion outside a position overlapping the color filters.

[0012] Each pixel electrode may include a first subpixel electrode and a second subpixel electrode, and a plurality of first thin film transistors connected to the first subpixel electrodes, a plurality of second thin film transistors connected to the second subpixel electrodes, a plurality of third thin film transistors connected to the second subpixel electrodes, a plurality of first gate lines connected to the first and second thin film transistors, a plurality of data lines connected to the first and second thin film transistors, and a plurality of second gate lines connected to the third thin film transistors may be further included. The first and second gate lines may be disposed between the neighboring color filters in the column direction among the color filters.

[0013] The first and second gate lines may be disposed outside a portion overlapping the pixel electrodes. The capacitor may be connected to the second subpixel electrode through the third thin film transistor. The third thin film transistor may be connected to the second subpixel electrode through a contact hole. The contact hole may be disposed between the neighboring color filters in the column direction among the color filters. One terminal of the capacitor may include the same material as the first and second gate lines, and the other terminal of the capacitor may include the same material as the pixel electrode. The third thin film transistor may be turned on after the first and second thin film transistors are turned on. A light blocking member overlapping a space between the color filters may be further included. A second substrate facing the first substrate may be further included, wherein the light blocking member may be formed on the second substrate. The first and second subpixel electrodes may include a plurality of cutouts, and directions of the edges of the cutouts may be different from each other. The edges of the cutouts may form 45 degree or 135 degree angles with the first and second gate lines.

[0014] According to embodiments of the present invention, parasitic capacitance generated between a pixel electrode and a gate line may be decreased such that a kick-back voltage may be minimized. Also, the color filter may be removed (e.g., removed, not formed, or formed to avoid) at a portion where a process deviation may be generated at each pixel such that uniformity of the process is maintained and the aperture ratio may be increased.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. 1 is a block diagram of a liquid crystal display according to an embodiment of the present invention.

[0016] FIG. 2 is an equivalent circuit diagram of two subpixels and a structure of a liquid crystal display according to an embodiment of the present invention.

[0017] FIG. 3 is an equivalent circuit diagram of one pixel of a liquid crystal display according to an embodiment of the present invention.

[0018] FIG. 4 is a layout view of a liquid crystal panel assembly according to an embodiment of the present invention.

[0019] FIG. 5, FIG. 6, and FIG. 7 are cross-sectional views of the liquid crystal panel assembly shown in FIG. 4 taken along the lines V-V, VI-VI, and VII-VII, respectively, in accordance with one or more embodiments of the present invention.

[0020] FIG. 8 is a layout view of color filters in a liquid crystal display according to an embodiment of the present invention.

DETAILED DESCRIPTION

[0021] Embodiments of the present invention will be described more fully hereinafter with reference to the accompanying drawings, in which embodiments of the invention are shown. As those skilled in the art would realize, the described embodiments may be modified in various different ways, all without departing from the spirit or scope of the present invention.

[0022] In the drawings, the thickness, for example, of layers, films, panels, and regions may be exaggerated for clarity. Like reference numerals designate like elements throughout the specification. It will be understood that when an element such as a layer, film, region, or substrate is referred to as being “on” another element, it can be directly on the other element or intervening elements may also be present. In contrast, when an element is referred to as being “directly on” another element, there are no intervening elements present.

[0023] A liquid crystal display according to an embodiment of the present invention will now be described with reference to FIG. 1 through FIG. 3. FIG. 1 is a block diagram of a liquid crystal display according to an embodiment of the present invention; FIG. 2 is an equivalent circuit diagram of two subpixels and a structure of a liquid crystal display according to an embodiment of the present invention; and FIG. 3 is an equivalent circuit diagram of one pixel of a liquid crystal display according to an embodiment of the present invention.

[0024] As shown in FIG. 1, a liquid crystal display according to an embodiment of the present invention includes a liquid crystal panel assembly 300, a gate driver 400, a data driver 500, a gray voltage generator 800, and a signal controller 600.

[0025] The liquid crystal panel assembly 300, in a view of an equivalent circuit, includes a plurality of signal lines GLa, GLb, and DL (referring to FIG. 3), and a plurality of pairs of upper and lower pixels PX that are connected thereto and arranged approximately in the form of a matrix. Meanwhile, as seen from the structure of FIG. 2, the liquid crystal panel assembly 300 includes a lower panel 100 and an upper panel 200 facing each other, and a liquid crystal layer 3 interposed between lower panel 100 and upper panel 200.

[0026] Referring to FIG. 3, the signal lines include a plurality of gate lines GLa and GLb transmitting a gate signal (referred to as “scanning signal”), a plurality of data lines DL transmitting a data voltage Vd, and a plurality of storage electrode lines (not shown). The gate lines GLa and GLb extend in an approximate row direction and run substantially

parallel to one another, and the data lines DL extend in a column direction and run substantially parallel to each other.

[0027] Each of the pixels PX includes a pair of subpixels, and each sub-pixel includes liquid crystal capacitors Clca and Clcb. The two subpixels include switching elements Qa, Qb, and Qc connected to the gate lines GLa and GLb, the data line DL, and the liquid crystal capacitors Clca and Clcb.

[0028] The liquid crystal capacitors Clca and Clcb include subpixel electrodes PEa and PEb of the lower display panel 100 and a common electrode CE of the upper display panel 200 as two terminals, respectively, and the liquid crystal layer 3 between the subpixel electrodes PEa and PEb and the common electrode CE serves as a dielectric material. A pair of subpixel electrodes PEa and PEb that are separated from each other form one pixel electrode PE. The common electrode CE is formed on the entire surface of the upper display panel 200, and a common voltage Vcom is applied to the common electrode CE. The liquid crystal layer 3 has negative dielectric anisotropy, and liquid crystal molecules of the liquid crystal layer 3 may be aligned such that their major axes are perpendicular to the surfaces of the two display panels when an electric field is not applied. Differently from FIG. 2, the common electrode CE may be formed on the lower display panel 100, and at least one of the two electrodes PE and CE may have a linear shape or a bar shape.

[0029] In order to realize color display, each pixel PX may uniquely display one of the primary colors (spatial division) or each pixel PX may temporally alternate the display of primary colors (temporal division). The primary colors are then spatially or temporally synthesized, and thus a desired color is recognized. Examples of the primary colors may include three primary colors of red, green, and blue. FIG. 2 shows an example of the spatial division. In FIG. 2, each pixel PX has a color filter CF that represents one of the primary colors in a region of the lower display panel 100. Unlike FIG. 2, the color filter CF may be formed in the lower display panel 100.

[0030] Polarizers (not shown) for providing light polarization are provided on outer surfaces of the display panels 100 and 200, and the polarization axis of the two polarizers may be crossed. One of the two polarizers may be omitted in the case of a reflective liquid crystal display. In the case of the crossed polarizers, the light incident to the liquid crystal layer 3 is blocked when an electric field is not applied.

[0031] Referring again to FIG. 1, the gray voltage generator 800 generates all gray voltages or a predetermined number of the gray voltages (or reference gray voltages) related to transmittance of the pixels PX. The (reference) gray voltages may include one set having a positive value for a common voltage Vcom, and another set having a negative value.

[0032] The gate driver 400 is connected to the gate lines GLa and GLb of the liquid crystal panel assembly 300, and applies gate signals obtained by combining (e.g., modulating) a gate-on voltage Von and a gate-off voltage Voff to the gate lines GLa and GLb.

[0033] The data driver 500 is connected to the data lines DL of the liquid crystal panel assembly 300, and selects the data signals from the gray voltage generator 800 to apply them to the data lines DL as data voltages. However, when the gray voltage generator 800 does not supply a voltage for all grays but supplies only a predetermined number of reference gray voltages, the data driver 500 may divide the reference gray voltages to select image data signals.

[0034] The signal controller 600 controls the gate driver 400 and the data driver 500.

[0035] Each of the drivers 400, 500, 600, and 800 may be directly mounted on the liquid crystal panel assembly 300 in the form of at least one IC chip, may be mounted on a flexible printed circuit film (not shown) and then mounted on the liquid crystal panel assembly 300 in the form of a tape carrier package (TCP), or may be mounted on a separate printed circuit board (not shown). Alternatively, the drivers 400, 500, 600, and 800 may be integrated with the liquid crystal panel assembly 300 together with, for example, the signal lines GLa, GLb, and DL and the thin film transistor switching elements Qa, Qb, and Qc. The drivers 400, 500, 600, and 800 may be integrated into a single chip. In this case, at least one of the drivers or at least one circuit forming the drivers may be arranged outside the single chip.

[0036] A liquid crystal panel assembly according to an embodiment of the present invention will now be described in detail with reference to FIG. 3 to FIG. 8. Referring to FIG. 3, the liquid crystal panel assembly according to the present embodiment includes signal lines including neighboring first and second gate lines GLa and GLb and a data line DL, and a plurality of pixels PX that are connected to the signal lines.

[0037] The pixel PX includes the first, second, and third switching elements Qa, Qb, and Qc, the first and second liquid crystal capacitors Clca and Clcb, and a step-down capacitor Cstd. The first and second switching elements Qa and Qb are respectively connected to the first gate line GLa and the data line DL, and the third switching element Qc is connected to the second gate line GLb.

[0038] The first and second switching elements Qa and Qb are three terminal elements such as thin film transistors provided in the lower panel 100, the control terminals of which are connected to one of the first gate lines GLa, the input terminals of which are connected to the data line DL, and the output terminals of which are respectively connected to the first/second liquid crystal capacitors Clca/Clcb and the first/second storage capacitors Csta/Cstb.

[0039] The third switching element Qc is also a three terminal element such as a thin film transistor provided in the lower panel 100, the control terminal of which is connected to one of the second gate lines GLb, the input terminal of which is connected to the second liquid crystal capacitor Clcb, and the output terminal of which is connected to the step-down capacitor Cstd.

[0040] The first/second storage capacitors Csta/Cstb are connected to the first/second switching elements Qa/Qb and the common voltage Vcom, and function to assist the first/second liquid crystal capacitors Clca/Clcb. The first/second storage capacitors Csta/Cstb are formed by overlapping the storage electrode line of the lower panel 100 and the pixel electrode PE with an insulator interposed therebetween. A predetermined voltage such as the common voltage Vcom is applied to the storage electrode signal line. The first and second storage capacitors Csta and Cstb may be omitted, if necessary.

[0041] The step-down capacitor Cstd is connected to the output terminal of the third switching element Qc and the common voltage Vcom. The step-down capacitor Cstd is formed by overlapping a capacitive electrode line (not shown) provided in the lower panel 100 and the output electrode of the third switching element Qc via the insulator therebetween, and the capacitive electrode line is applied with a predetermined voltage such as the common voltage Vcom.

[0042] The liquid crystal panel assembly according to an embodiment of the present invention will now be described in detail with reference to FIG. 4 to FIG. 7. FIG. 4 is a layout view of a liquid crystal panel assembly according to an embodiment of the present invention, and FIG. 5, FIG. 6, and FIG. 7 are cross-sectional views of the liquid crystal panel assembly shown in FIG. 4 taken along the lines V-V, VI-VI, and VII-VII, respectively, in accordance with one or more embodiments.

[0043] A liquid crystal display according to the present embodiment includes the lower panel 100 and the upper panel 200 facing each other, the liquid crystal layer 3 disposed between the two display panels 100 and 200, and a pair of polarizers 12 and 22 attached on the outside surfaces, respectively, of the display panels 100 and 200.

[0044] Firstly, the lower panel 100 will be described.

[0045] A plurality of gate conductors including a plurality of first and second gate lines 121a and 121b, a plurality of storage electrode lines 131, and capacitive electrode lines 132 are formed on an insulation substrate 110. The first gate line 121a include first and second gate electrodes 124a and 124b, and an end portion 129a, and the second gate line 121b includes a third gate electrode 124c and an end portion 129b.

[0046] The storage electrode line 131 includes a first storage electrode 131a extending vertically (e.g., orthogonally) to the first and second gate lines 121a and 121b, a second storage electrode 131b extending parallel to the first and second gate lines 121a and 121b, and a third storage electrode 131c extending vertically (e.g., orthogonally) to the first and second gate lines 121a and 121b. The capacitive electrode line 132 includes a first capacitive electrode 137 extending downward (e.g., orthogonally) to the first and second gate lines 121a and 121b) with a wide area.

[0047] A gate insulating layer 140 is formed on the gate conductors 121a, 121b, 131, and 132. First, second, and third semiconductor islands 154a, 154b, and 154c are formed on the gate insulating layer 140, and a plurality of the first ohmic contacts 163a and 165a, second ohmic contacts (not shown), and third ohmic contacts 163c and 165c are formed thereon.

[0048] A data conductor including a plurality of data lines 171, a plurality of first, second, and third drain electrodes 175a, 175b, and 175c, and an electrode member 173c are formed on the first ohmic contacts 163a and 165a, the second ohmic contacts (not shown), and the third ohmic contacts 163c and 165c, and on the gate insulating layer 140. Each data line 171 includes a plurality of first and second source electrodes 173a and 173b, and an end portion 179 having a large area for contact with another layer or an external driving circuit. An electrode member 173c forms the third source electrode.

[0049] The first, second, and third drain electrodes 175a, 175b, and 175c include one end portion with a wide area and the other end portion of a bar type. The bar end portions of the first/second drain electrodes 175a/175b are enclosed by the first/second source electrodes 173a/173b. The bar end portion of the third drain electrode 175c is opposite to the third source electrode 173c.

[0050] The first/second/third gate electrodes 124a/124b/124c, the first/second/third source electrodes 173a/173b/173c and the first/second/third drain electrodes 175a/175b/175c form the first/second/third thin film transistors (TFT) Qa/Qb/Qc along with the first/second/third semiconductor islands 154a/154b/154c, and the channels of the thin film transistors are respectively formed in the semiconductor

islands **154a/154b/154c** between the source electrodes **173a/173b/173c** and the drain electrodes **175a/175b/175c**.

[0051] A plurality of color filters **230** are formed on the data conductors **171**, **175a**, **175b**, **175c**, and **173c** and exposed portion of the semiconductor islands **154a**, **154b**, and **154c**. Each of the color filters **230** may display one of the primary colors such as the three primary colors of red, green, and blue. The color filters **230** may be made of a photosensitive organic material including pigments. The color filters **230** may have first and second through holes **235a** and **235b**.

[0052] A passivation layer **180** is formed on the color filters **230**. The passivation layer **180** may be made of an inorganic insulator or an organic insulator, and may have a flat surface. Examples of the inorganic insulator may be silicon nitride and silicon oxide. The organic insulator may have photosensitivity, and the dielectric constant thereof may be established to be about 4.0 or less. Alternatively, the passivation layer **180** may have a dual-layer structure of a lower inorganic layer and an upper organic layer such that it does no harm to the exposed portions of the semiconductors **154a** and **154b** while exerting the excellent insulating characteristics of an organic layer, and may be omitted if necessary.

[0053] The passivation layer **180** has a plurality of contact holes **182**, **183c**, **185a**, **185b**, and **185c** respectively exposing the end portions **179** of the data lines **171**, the wide end portions of the third source electrode **173c**, the wide end portions of the first drain electrodes **175a**, the wide end portions of the second drain electrode **175b**, and the wide end portions of the third drain electrodes **175c**, and the passivation layer **180** and the gate insulating layer **140** have a plurality of contact holes **181a** and **181b** respectively exposing the end portions **129a** and **129b** of the gate lines **121a** and **121b**. The contact holes **185a** and **185b** accord with the positions and the shapes of the through holes **235a** and **235b** of the color filters **230**.

[0054] A plurality of pixel electrodes **191** including first and second subpixel electrodes **191a** and **191b**, a second capacitive electrode **197**, and a plurality of contact assistants **81a**, **81b**, and **82** are formed on the passivation layer **180**.

[0055] The first and second subpixel electrodes **191a** and **191b** are adjacent to each other in the column direction, and the first and second subpixel electrodes **191a** and **191b** respectively include a transverse stem **193**, a longitudinal stem **192** intersecting the transverse stem **193**, and a plurality of first to fourth cutouts **194a**, **194b**, **194c**, and **194d**. Also, the first and second subpixel electrodes **191a** and **191b** are divided into a first subregion Da, a second subregion Db, a third subregion Dc, and a fourth subregion Dd by the transverse stem **193** and the longitudinal stem **192**, and the subregions Da-Dd respectively include the plurality of first, second, third, and fourth cutouts **194a**, **194b**, **194c**, and **194d**.

[0056] The first cutout **194a** obliquely extends from the transverse stem **193** or the longitudinal stem **192** in the upper-left direction, and the second cutout **194b** obliquely extends from the transverse stem **193** or the longitudinal stem **192** in the upper-right direction. Also, the third cutout **194c** obliquely extends from the transverse stem **193** or the longitudinal stem **192** in the lower-left direction, and the fourth cutout **194d** obliquely extends from the transverse stem **193** or the longitudinal stem **192** in the lower-right direction.

[0057] The first to fourth cutouts **194a-194d** form an angle of about 45 degrees or 135 degrees with the gate lines **121** or

the transverse stem **193**. Also, the cutouts **194a-194d** of two neighboring sub-regions Da-Dd may be perpendicular to each other.

[0058] The first/second subpixel electrodes **191a/191b** are connected to the first/second drain electrodes **175a/175b** through the first/second contact holes **185a/185b** and receive data voltages Vd from the first/second drain electrodes **175a/175b**. The first/second subpixel electrodes **191a/191b**, with the data voltages Vd applied, and the common electrode **270** of the common electrode panel **200** generate an electric field that determines the orientations of liquid crystal molecules of the liquid crystal layer **3** between the two electrodes **191** and **270**. Accordingly, the luminance of the light transmitted through the liquid crystal layer **3** differs depending on the thusly determined orientation of the liquid crystal molecules.

[0059] The edges of the first to fourth cutouts **194a-194d** distort the electric field, and form a horizontal component that determines an inclined direction of liquid crystal molecules of liquid crystal layer **3**. The horizontal component of the electric field is almost parallel to the edges the first to fourth cutouts **194a-194d**. Accordingly, liquid crystal molecules of liquid crystal layer **3** may be inclined in the direction parallel to the lengthwise direction of the minute cutouts **194a-194d**. In an embodiment of the present invention, one pixel PX includes four subregions Da-Dd where the lengthwise directions of the cutouts **194a-194d** are extended in all four directions such that the inclined directions of the liquid crystal molecules **30** include all four directions. Therefore, the viewing angle of the liquid crystal display is widened by varying the inclined directions of the liquid crystal molecules.

[0060] In addition, the second subpixel electrode **191b** is physically and electrically connected to the third source electrode **173c** through the contact hole **185c**. The first gate line **121a** and the second gate line **121b** are disposed between a plurality of pixel electrodes **191** that are neighboring in the column direction, and all of the first and second gate lines **121a** and **121b** do not overlap the pixel electrodes **191**.

[0061] In addition, if the gate-on voltage is applied to the gate line **121**, the thin film transistor Q connected thereto is turned on. Accordingly, during the time that the gate-on voltage is applied to the gate line **121**, the data voltages applied to the data line **171** are transmitted to the pixel electrode **191** through the thin film transistor Q that is turned on thereby to be represented as a pixel electrode voltage. Next, when changing from a gate-on voltage to a gate-off voltage, a pixel electrode voltage drops slightly by a predetermined degree that is referred to as a kick-back voltage ΔV_k . The kick-back voltage ΔV_k may be represented by the following equation.

$$\Delta V_k = \frac{C_{gd}}{C_{lc} + C_{st} + C_{gd}} \times \Delta V_g$$

[0062] Here, C_{lc} is capacitance of the liquid crystal capacitor, C_{st} is capacitance of the storage capacitor, C_{gd} is a parasitic capacitance between the gate electrodes **124a**, **124b**, and **124c**, and other electrodes such as the drain electrodes **175a**, **175b**, and **175c** or the pixel electrode **191**, and ΔV_g is a difference between the gate-on voltage and the gate-off voltage. Accordingly, the kick back voltage ΔV_k is increased as the parasitic capacitance between the first to third gate electrodes **124a**, **124b**, and **124c** and the pixel electrode **191** is increased. According to embodiments of the present invention, all of the first and second gate lines **121a** and **121b** do not

overlap the pixel electrodes **191** such that the parasitic capacitance between the first to third gate electrodes **124a**, **124b**, and **124c** and the pixel electrode **191** is small, thereby reducing the kick-back voltage ΔV_k .

[0063] The second capacitive electrode **197** overlaps the first capacitive electrode **137**, and is physically and electrically connected to the third drain electrode **175c** through the contact hole **185c**. The first capacitive electrode **137** and the second capacitive electrode **197** are overlapped with each other via the passivation layer **180** and the gate insulating layer **140**, thereby forming the step-down capacitor Cstd.

[0064] The contact assistants **81a**, **81b**, and **82** are connected to the end portions **129a** and **129b** of the gate lines **121a** and **121b** and the end portions **179** of the data lines **171** through the contact holes **181a**, **181b**, and **182**, respectively. The contact assistants **81a**, **81b**, and **82** may enhance adhesion of the end portions **129a** and **129b** of the gate lines **121a** and **121b** and the end portions **179** of the data lines **171** to external devices, and protect them. An alignment layer **11** may be formed on the pixel electrodes **191** and the contact assistants **81a**, **81b**, and **82**.

[0065] Now, the upper panel **200** will be described.

[0066] A light blocking member **220** is formed on an insulation substrate **210**. The light blocking member **220** is referred to as a black matrix, and prevents light leakage. An overcoat **250** is formed on the light blocking member **220**. A common electrode **270** is formed on the overcoat **250**. An alignment layer **21** is formed on the common electrode **270**.

[0067] The liquid crystal layer **3** has negative dielectric anisotropy, and the liquid crystal molecules of the liquid crystal layer **3** may be aligned so that a major axis thereof is perpendicular to the surface of the two display panels in the absence of an electric field.

[0068] Next, a color filter according to an embodiment of the present invention will be described with reference to FIG. 8 and the above-described FIG. 4 to FIG. 6. FIG. 8 is a layout view of a color filter and a light blocking member in a liquid crystal display according to an embodiment of the present invention.

[0069] Referring to FIG. 8, the color filters **230** include red color filters **230R**, green color filters **230G**, and blue color filters **230B**; the color filters **230R**, **230G**, and **230B** having different colors are arranged in the row direction; and color filters **230R**, **230G**, and **230B** having the same color are arranged in the column direction. Each color filter **230** is disposed with an island shape in a region enclosed by the first gate line **121a** and the second gate line **121b**, and between two data lines **171**.

[0070] The light blocking member **220** is formed between the color filters **230**. In other words, the light blocking member **220** is formed in a region where the first gate lines **121a**, the second gate lines **121b**, and the data lines **171** exist. The light blocking member **220** includes a transverse portion **220a** overlapping the first and second gate lines **121a** and **121b**, and a longitudinal portion **220b** overlapping the data lines **171**. Accordingly, the color filters **230** are presented in the region enclosed by the transverse portion **220a** and the longitudinal portion **220b** of the light blocking member **220**.

[0071] If the color filters **230** overlap the transverse portion **220a** of the light blocking member **220**, that is, the first and second gate lines **121a** and **121b**, and the capacitive electrode

lines **132** overlap each other, the color filter **230** must have an opening on the portion where the first capacitive electrode **137** and the second capacitive electrode **197** are overlapped with each other to obtain the capacitance of the step-down capacitor Cstd. Also, to obtain the path of the contact holes **183c** and **185c**, the color filters **230** must include a through hole. In this case, to match the capacitance of the step-down capacitor Cstd between the pixels having the different color filters **230R**, **230G**, and **230B**, it might be required that the openings formed in the different color filters **230R**, **230G**, and **230B** are formed with the same size. However, three color filters **230R**, **230G**, and **230B** are made of different materials such that a process deviation may be generated when forming the opening, and it is difficult to match the capacitance of the step-down capacitor Cstd between the pixels having the different color filters **230R**, **230G**, and **230B**. Also, when forming the through hole in the color filters **230** to form the contact holes **183c** and **185c**, the area of the region corresponding to the transverse portion **220a** of the light blocking member **220** might be increased to obtain the size of the through hole, thus, decreasing the aperture ratio of the liquid crystal display. According to an embodiment of the present invention, however, the color filters **230** do not exist in (e.g., are formed to avoid) the region corresponding to the transverse portion **220a** of the light blocking member **220** such that it is not necessary to form the opening overlapping the first capacitive electrode **137** and the second capacitive electrode **197** in the color filters **230**. Accordingly, for an embodiment, there is no concern with process deviation for forming openings in each of the color filters **230R**, **230G**, and **230B**. Also, for an embodiment, it is not necessary to form the through hole for the path of the contact holes **183c** and **185c** in the color filters **230** such that it is not necessary to increase the area of the region corresponding to the transverse portion **220a** of the light blocking member **220**, thereby relatively increasing the aperture ratio of the liquid crystal display.

[0072] The operation of the LCD according to one embodiment of the present invention will be described hereinafter with reference to FIG. 1 through FIG. 3.

[0073] The signal controller **600** receives input image signals R, G, and B and input control signals for controlling the display from an external graphics controller (not shown). The input image signals R, G, and B involve luminance information of each pixel PX, and the luminance has a predetermined number of grays, for example $1024=2^{10}$, $256=2^8$, or $64=2^6$ grays. Examples of the input control signals are a vertical synchronization signal Vsync, a horizontal synchronizing signal Hsync, a main clock signal MCLK, and a data enable signal DE.

[0074] The signal controller **600** appropriately processes the input image signals R, G, and B to match operating conditions of the liquid crystal panel assembly **300** based on the input image signals R, G, and B and the input control signals. Moreover, the signal controller **600** generates a gate control signal CONT1 and a data control signal CONT2, sends the gate control signal CONT1 to the gate driver **400**, and sends the data control signal CONT2 and the processed image signal DAT to the data driver **500**. The output image signal DAT as a digital signal has a value (or gray) of a predetermined number.

[0075] The data driver **500** receives the digital image signal DAT for the pixel PX of one row according to the data control signal CONT2 generated by the signal controller **600**, and selects a gray voltage corresponding to each digital image signal DAT. Then, the data driver **500** converts the digital image signal DAT into an analog data voltage to apply the converted digital image signal to a relevant data line DL.

[0076] The gate driver **400** applies a gate-on voltage Von to the gate lines GLa and GLb according to the gate control signal CONT1 generated by the signal controller **600** to turn on the switching elements Qa, Qb, and Qc connected to the gate lines GLa and GLb. In this case, a data voltage Vd applied to the data line DL is applied to the relevant pixel PX through the turned-on first and second switching elements Qa and Qb.

[0077] A specific pixel row, for example focusing on the i-th pixel row, will be described below.

[0078] The first gate signal is applied to the first gate line GLa of the i-th row, and the second gate line GLb is applied with the second gate signal. If the first gate signal is changed from the gate-off voltage Voff to the gate-on voltage Von, the first and second switching elements Qa and Qb connected thereto are turned on. Accordingly, the data voltage Vd applied to the data line DL is applied to the first and second subpixel electrodes PEa and PEb through the turned-on first and second switching elements Qa and Qb. Here, the same data voltage Vd is applied to the first and second subpixel electrodes PEa and PEb. The first and second liquid crystal capacitors Clca and Clcb are charged with the same value as a difference between the common voltage and the data voltage Vd.

[0079] Then, when the first gate signal is changed to the gate-off voltage Voff from the gate-on voltage Von and at the same time the second gate signal is changed to the gate-on voltage Von from the gate-off voltage Voff, the first and second switching elements Qa and Qb are turned off and the third switching element Qc is turned on. Then, electrical charges move from the second subpixel electrode PEb to the third drain electrode **175c** through the third switching element Qc. For this reason, the charging voltage of the second liquid crystal capacitor Clcb is lowered, and the step-down capacitor Cstd is charged with electricity. The charging voltage of the second liquid crystal capacitor Clcb is decreased by the capacitance of the step-down capacitor Cstd such that the charging voltage of the second liquid crystal capacitor Clcb is lower than the changing voltage of the first liquid crystal capacitor Clca.

[0080] At this time, the charging voltages of the two liquid crystal capacitors Clca and Clcb show different gamma curves, and the gamma curve of one pixel voltage is a curved line that is synthesized from these different gamma curves. The synthetic gamma curve in the front should be corrected so as to conform to the most suitable reference gamma curve in the front, and the synthetic gamma curve in the side should be corrected so as to be extremely close to the reference gamma curve in the front. As described above, due to conversion of the image data, side visibility is improved.

[0081] By repeating the above procedure by a unit of one horizontal period which is denoted by "1H" and is equal to one period of a horizontal synchronizing signal Hsync and a data enable signal DE, a data voltage Vd is applied to all pixels PX to display an image of one frame.

[0082] When the next frame starts after finishing one frame, the state of an inversion signal RVS applied to the data driver

500 is controlled such that the polarity of the data voltage Vd applied to each pixel PX is opposite to that of the previous frame.

[0083] While embodiments of this invention have been described in connection with what are presently considered to be practical embodiments, it is to be understood that the invention is not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

What is claimed is:

1. A liquid crystal display comprising:

a first substrate;

a plurality of color filters formed with an island shape on the first substrate and arranged in a matrix;

a plurality of pixel electrodes formed on the color filters; and

a capacitor disposed between neighboring color filters in a column direction among the color filters,

wherein two terminals forming the capacitor are disposed at a portion outside a position overlapping the color filters.

2. The liquid crystal display of claim 1, wherein each pixel electrode comprises a first subpixel electrode and a second subpixel electrode, with the liquid crystal display further comprising:

a plurality of first thin film transistors connected to the first subpixel electrodes;

a plurality of second thin film transistors connected to the second subpixel electrodes;

a plurality of third thin film transistors connected to the second subpixel electrodes;

a plurality of first gate lines connected to the first and second thin film transistors;

a plurality of data lines connected to the first and second thin film transistors; and

a plurality of second gate lines connected to the third thin film transistors.

3. The liquid crystal display of claim 2, wherein

the first and second gate lines are disposed between the neighboring color filters in the column direction among the color filters.

4. The liquid crystal display of claim 3, wherein the first and second gate lines are disposed outside a portion overlapping the pixel electrodes.

5. The liquid crystal display of claim 3, wherein the capacitor is connected to the second subpixel electrode through the third thin film transistor.

6. The liquid crystal display of claim 5, wherein the third thin film transistor is connected to the second subpixel electrode through a contact hole.

7. The liquid crystal display of claim 6, wherein the contact hole is disposed between the neighboring color filters in the column direction among the color filters.

8. The liquid crystal display of claim 5, wherein one terminal of the capacitor comprises the same material as the first and second gate lines, and the other terminal of the capacitor comprises the same material as the pixel electrode.

9. The liquid crystal display of claim **5**, wherein the third thin film transistor is turned on after the first and second thin film transistors are turned on.

10. The liquid crystal display of claim **5**, further comprising a light blocking member overlapping a space between the color filters.

11. The liquid crystal display of claim **10**, further comprising a second substrate facing the first substrate, wherein the light blocking member is formed on the second substrate.

12. The liquid crystal display of claim **5**, wherein the first and second subpixel electrodes comprise a plurality of cutouts, and directions of the edges of the cutouts are different from each other.

13. The liquid crystal display of claim **12**, wherein the edges of the cutouts form 45 degree or 135 degree angles with the first and second gate lines.

* * * * *

专利名称(译)	液晶显示器		
公开(公告)号	US20100141860A1	公开(公告)日	2010-06-10
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其他公开文献	US8477253		
外部链接	Espacenet USPTO		

摘要(译)

根据本发明实施例的液晶显示器包括：第一基板;多个滤色器，形成在第一基板上，并以岛状排列成矩阵状;多个像素电极形成在滤色器上;在滤色器中沿列方向设置在相邻滤色器之间的电容器，其中形成电容器的两个端子设置在与滤色器重叠的位置之外的部分处。

