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(54) **LIQUID CRYSTAL DISPLAY DEVICE**

FLÜSSIGKRISTALLANZEIGEVORRICHTUNG

DISPOSITIF D'AFFICHAGE À CRISTAUX LIQUIDES

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Description

Technical Field

[0001] The present invention relates to a liquid crystal display, and in particular, to a reflective color liquid crystal display.

Background Art

[0002] A reflective liquid crystal display is known which displays images utilizing reflected light resulting from reflection of incident light by a reflective film formed on a back surface side of a liquid crystal. An example of the reflective liquid crystal display is a polymer network liquid crystal display (PNLCD) using polymer network liquid crystals (PNLCs). Unlike a display using normal liquid crystals, the PNLCD eliminates the need for a polarizing plate and thus enables bright reflective display.

[0003] For the PNLC, ultraviolet light is radiated to a solution containing photopolymerized precursors (monomers) mixed with liquid crystals to polymerize the monomers so that the liquid crystals are dispersed in the network of the resultant polymer. In a color PNLCD based on an active matrix scheme, for example, a color filter substrate (CF substrate) comprising a color filter and on which a reflective film is formed is disposed on the back side of a display surface, and a TFT substrate with TFTs (Thin Film Transistors) is disposed on the front side of the display surface (Patent Literatures 1 and 2).

[0004] Ultraviolet light is radiated to a cell in order to polymerize the monomers. However, when the reflective film is provided on the TFT substrate side, the ultraviolet light is radiated from the CF substrate side, and in this case, the color filter absorbs the ultraviolet light, disadvantageously preventing the monomers from being polymerized. Thus, the reflective film is formed on the CF substrate side and the TFT substrate is formed to be transmissive so that the monomers are polymerized by radiating ultraviolet light from the TFT substrate side.

[0005] However, disadvantageously, wiring lines around pixels on the TFT substrate may act to make the polymerization of the monomers near the wiring lines incomplete, reducing reflectance (scattering performance) and reliability. Another problem is that, since the CF substrate with the reflective film is disposed on the back side of the display surface, whereas the TFT substrate is disposed on the front side of the display surface, reflected light from the back surface of the TFT substrate may affect display performance (make the display garish) to significantly degrade visibility. Another problem is that areas in which the wiring lines and transistors are disposed are prevented from being utilized for display, aperture ratio may decrease.

Citation List

Patent Literature

[0006]

Patent Literature 1: Japanese Patent No. 3736076
Patent Literature 2: Jpn. Pat. Appln. KOKAI Publication No. 2011-95407

[0007] Prior art which is related to this field of technology can be found e.g. in document JP 2003 195350 A disclosing a liquid crystal display comprising: first and second substrates, a liquid crystal layer sandwiched between the first and second substrates, a common electrode provided on the first substrate, transistors provided on the second substrate for respective pixels, a reflective film provided on the transistors, a storage capacitance electrode provided on the transistors, a color filter provided on the reflective film, and pixel electrodes provided on the color filter and electrically connected to drain electrodes of the respective transistors; in document US 2003/0122980 A1 disclosing a liquid crystal display device with scattering layer and fabricating method thereof, and in document US 2010/0309416 A1 disclosing a liquid crystal display device.

Summary of Invention

Technical Problem

[0008] The present invention provides a liquid crystal display which allows a polymer in a liquid crystal layer to be uniformly formed and which enables an increase in aperture ratio.

Solution to Problem

[0009] The liquid crystal display of the invention is defined in claim 1. Further details are set out in the dependent claims.

Advantageous Effects of Invention

[0010] The present invention provides a liquid crystal display which allows a polymer in a liquid crystal layer to be uniformly formed and which enables an increase in aperture ratio.

Brief Description of Drawings

[0011]

FIG. 1 is a block diagram of a liquid crystal display according to a first embodiment.
FIG. 2 is a circuit diagram of a pixel.
FIG. 3 is a cross-sectional view of a liquid crystal panel according to a first comparative example use-

ful for understanding the invention.

FIG. 4A is schematic diagram illustrating an orientation state of a liquid crystal layer.

FIG. 4B is schematic diagram illustrating the orientation state of the liquid crystal layer.

FIG. 5 is a layout of a liquid crystal panel according to the first embodiment.

FIG. 6 is a cross-sectional view of the liquid crystal panel taken along line A-A' in FIG. 5.

FIG. 7 is a cross-sectional view of the liquid crystal panel taken along line B-B' in FIG. 5.

FIG. 8 is a cross-sectional view of a liquid crystal panel according to a second comparative example.

FIG. 9A is a diagram illustrating the state of a liquid crystal layer according to the second comparative example.

FIG. 9B is a diagram illustrating the state of the liquid crystal layer according to the second comparative example.

FIG. 10A is a diagram illustrating the state of a liquid crystal layer according to the first embodiment.

FIG. 10B is a diagram illustrating the state of the liquid crystal layer according to the first embodiment.

FIG. 11 is a diagram illustrating the state of reflected light from the liquid crystal panel according to the second comparative example.

FIG. 12 is a diagram illustrating the state of reflected light from the liquid crystal panel according to the first embodiment.

FIG. 13 is a layout of a liquid crystal panel according to a third comparative example.

FIG. 14 is a cross-sectional view of the liquid crystal panel taken along line B-B' in FIG. 13.

FIG. 15 is a cross-sectional view of a liquid crystal panel according to a fourth comparative example useful for understanding the invention.

FIG. 16 is a cross-sectional view of a liquid crystal panel according to a second embodiment of the invention.

FIG. 17 is a cross-sectional view of a liquid crystal panel according to a third embodiment of the invention, taken along an X-direction.

FIG. 18 is a cross-sectional view of the liquid crystal panel according to the third embodiment, taken along a Y-direction.

FIG. 19 is a cross-sectional view of the liquid crystal panel according to a modification of the third embodiment, taken along the X-direction.

Description of Embodiments

[0012] The embodiments of the present invention will be described below with reference to the accompanying drawings. Note that the drawings are schematic and conceptual, and the dimensions, ratios, and the like in the respective drawings are not necessary the same as those in reality. In addition, even the same portion may be shown in a different dimensional relationship or with different ratios in different drawings. Several embodiments to be described below represent examples of apparatuses and methods for embodying the technical idea of the present invention, and the technical idea of the present invention is not specified by the shapes, structures, and layouts of the constituent parts. Note that in the following explanation, the same reference numerals denote elements having the same functions and arrangements, and a repetitive explanation will be made only when necessary.

[First Embodiment]

[0013] FIG. 1 is a block diagram of a liquid crystal display 10 according to the first embodiment. The liquid crystal display 10 comprises a liquid crystal panel 11, a scanning driver (scanning line driving circuit) 12, a signal driver (signal line driving circuit) 13, a common voltage supply circuit 14, and a controller 15.

[0014] The liquid crystal panel 11 comprises a plurality of scanning lines GL each extending in a row direction (X-direction) and a plurality of signal lines SL each extending in a column direction (Y-direction). Pixels 16 are each disposed at a crossing area between each of the plurality of scanning lines GL and a corresponding one of the plurality of signal lines SL. The plurality of pixels 16 is arranged in a matrix.

[0015] FIG. 2 is a circuit diagram of one pixel 16. The pixel 16 comprises a thin film transistor (TFT) 17, a liquid crystal capacitor CLC, and a storage capacitor CS.

[0016] A source of the TFT 17 is electrically connected to the signal line SL. A gate of the TFT 17 is electrically connected to the scanning line GL. A drain of the TFT 17 is electrically connected to a pixel electrode and a transparent electrode disposed between the TFT and the pixel electrode. The pixel electrode provides the liquid crystal capacitor CLC along with a common electrode disposed opposite the pixel electrode and liquid crystals placed between the pixel electrode and the common electrode.

[0017] The storage capacitor CS is connected in parallel with the liquid crystal capacitor CLC. The storage capacitor CS suppresses a potential variation in the pixel electrode and holds a pixel voltage applied to the pixel electrode until the next pixel voltage is applied to the pixel electrode again. The storage capacitor CS comprises a reflective film, the transparent electrode, and an insulating film formed between the reflective film and the transparent electrode. A common voltage Vcom is applied to the common electrode and the reflective film by the common voltage supply circuit 14.

[0018] In the pixel 16 configured as described above, when the TFT 17 connected to the pixel electrode is turned on, the pixel voltage is applied to the pixel electrode via the signal line SL. The orientation state of the liquid crystals changes depending on the voltage difference between the pixel voltage and the common voltage Vcom. Thus, the transmissive state of the liquid crystals with respect to incident light and reflected light changes to provide image display.

[0019] The scanning driver 12 is connected to the plurality of scanning lines GL to sequentially drive the plurality of scanning lines GL based on a vertical control signal from the controller 15. The vertical control signal from the controller 15 is applied at every frame period. The "frame" refers to a period when a display signal is supplied to all the pixels in the liquid crystal panel to display one image.

[0020] The signal driver 13 is connected to the plurality of signal lines SL to load image data for one horizontal period based on a horizontal control signal from the controller 15. The horizontal control signal from the controller 15 is applied at every horizontal period that is a period when display signals for one row (one scanning line) in the liquid crystal panel 11 are transferred to the pixels. The signal driver 13 supplies the display signals corresponding to image data to the pixel electrodes via the signal lines SL.

[0021] The controller 15 generates various control signals allowing the liquid crystal panel 11 to display a desired image and supplies the control signals to the scanning driver 12, the signal driver 13, and the common voltage supply circuit 14.

[0022] In general, the liquid crystal display performs inversion driving (AC driving) in which the polarity of an electric field between the pixel electrode and the common electrode where the liquid crystals are placed is inverted. In the liquid crystal panel 11, the arrangement of the liquid crystal is determined depending on the electric field between the pixel electrode and the common electrode. However, continuous generation of an electric field of the same polarity between the pixel electrode and the common electrode may cause image persistence or degradation or destruction of the liquid crystals. Thus, this is prevented by periodically inverting the polarity of the electric field between the pixel electrode and the common electrode. Common inversion driving schemes are line inversion driving and frame inversion driving. The line inversion driving is a scheme in which the polarity of the electric field is inverted at every scanning line and also at every frame period. Furthermore, the frame inversion driving is a scheme in which the polarity of the electric field is inverted at every frame period for each pixel.

[0023] Next, a comparative configuration of the liquid crystal panel 11 will be described. FIG. 3 is a cross-sectional view of a comparative liquid crystal panel 11 taken along an extending direction of the scanning lines GL. The liquid crystal panel 11 comprises a reflective color PNLCD (Polymer Network Liquid Crystal Display) . Furthermore, the liquid crystal panel 11 uses an active matrix scheme in which an active element is disposed in each of the pixels.

[0024] In the present embodiment, a color filter CF is disposed on a TFT substrate 23 with a reflective film 24 formed thereon. Only a common electrode 21 is provided on an opposite substrate (COM substrate) 20. A common voltage Vcom is applied to the common electrode 21 by the common voltage supply circuit 14. The COM substrate 20 is disposed on a front side of a display surface. The TFT substrate 23 is disposed on a back side of the display surface. That is, incident light is incident through the COM substrate 20.

[0025] The TFT substrate 23 is formed to be completely reflective by comprising the reflective film 24 all over a surface of the TFT substrate 23. The reflective film 24 also functions as an electrode providing the storage capacitor CS. Thus, the common voltage Vcom is applied to the reflective film 24 by the common voltage supply circuit 14.

[0026] TFTs 17 and the reflective film 24 are provided on the TFT substrate 23. Electrodes 27 are provided on the TFTs 17 and the reflective film 24 via an insulating film 25. The electrodes 27 are electrically connected to drain electrodes of the respective TFTs 17 through respective contact plugs 26. Moreover, the color filter CF and a pixel electrode 28 are provided on each of the electrodes 27. A contact hole 30 is formed in a central portion of the color filter CF. The pixel electrode 28 is electrically connected to the electrode 27 through a contact plug 28A formed in the contact hole 30. A pixel voltage is applied to the pixel electrode 28 by the signal driver 13. The color filter CF comprises a plurality of coloring filters (coloring members), and specifically includes a red filter CF (R), a green filter CF (G), and a blue filter CF (B).

[0027] A liquid crystal layer 22 comprises a polymer network liquid crystal (PNLC) . The PNLC has a structure in which liquid crystals are dispersed in a polymer network, and the liquid crystals in the polymer network have a continuous phase. A photocurable resin may be used as a polymer layer. For example, for the PNLC, ultraviolet light is radiated to a solution containing photopolymerized polymer precursors (monomers) mixed with liquid crystals to polymerize the monomers so that the liquid crystals are dispersed in the network of the resultant polymer. As the liquid crystals, for example, nematic liquid crystals with positive dielectric anisotropy are used.

[0028] Alternatively, the liquid crystal layer 22 may be formed of polymer dispersed liquid crystals (PDLC). The PDLCs have a structure in which the polymer disperses the liquid crystals, that is, the liquid crystals are subjected to phase separation in the polymer.

[0029] When the liquid crystal panel 11 according to the present embodiment is manufactured, first, the TFT substrate 23 with the reflective film 24 and the color filter CF and the COM substrate 20 with the common electrode 21 are formed. The substrates are bonded together via a spacer using a seal member, to form a cell. Subsequently, in a vacuum atmosphere, a solution containing the liquid crystals mixed into the photopolymerized polymer precursors (monomers) is injected into the cell. Alternatively, a liquid crystal dropping method (ODF: One Drop Fill) may be used to inject the liquid crystals to between the substrates. That is, the solution is dropped into a seal material formed on one of the substrates like a frame, and the other substrate is bonded to the first substrate to form a cell. Subsequently, ultraviolet light, which allows the monomers to be polymerized, is radiated from the COM substrate 20 side. No object such as wiring lines which blocks the ultraviolet light is present, and thus, the stability of polymerization of the monomers is improved.

[0030] FIGS. 4A and 4B are schematic diagrams illustrating the orientation state of the liquid crystal layer 22. In FIGS. 4A and 4B, illustration of the color filter and the TFT is omitted.

[0031] As depicted in FIG. 4A, when, for example, 0 V is applied to the pixel electrode 28 and the common electrode 21 and no electric field is applied to the liquid crystal layer 22 (off state), liquid crystal molecules dispersed in the polymer network are randomly oriented. In this case, the refractive index of the polymer is different from the refractive index of the liquid crystal molecules, and thus, incident light from the COM substrate 20 side scatters in the liquid crystal layer 22 (scattering state). The scattered light is reflected by the reflective film 24 and emitted through the COM substrate 20 as scattered light. At this time, the liquid crystal layer 22 is observed to be in an opaque cloudy state, and display viewed on the observation side is white display.

[0032] As depicted in FIG. 4B, when, for example, a high voltage (for example, 5 V) is applied to the pixel electrode 28, 0 V is applied to the common electrode 21, and an electric field is applied to the liquid crystal layer 22 (on state), the liquid crystal molecules dispersed in the polymer network are oriented in the direction of the electric field. In this case, the refractive index of the polymer and the refractive index of the liquid crystal molecules are approximately equal. Thus, incident light from the COM substrate 20 side is not scattered and is transmitted through the liquid crystal layer 22 (transparent state) . Hence, reflected light is observed which results from reflection of the incident light by the reflective film 24. At this time, display light viewed on the observation side is specular light, and thus, light other than specularly reflected light is invisible and is black display (dark display) . In actuality, since the color filter CF is disposed on the TFT substrate 23 side, color display dependent on the color of the color filter CF is obtained.

[0033] Next, a specific configuration example of the liquid crystal panel 11 according to a first embodiment of the invention will be described. FIG. 5 is a layout of the liquid crystal panel 11. FIG. 6 is a cross-sectional view of the liquid crystal panel 11 taken along line A-A' in FIG. 5. FIG. 7 is a cross-sectional view of the liquid crystal panel 11 taken along line B-B' in FIG. 5.

[0034] Scanning lines GL extending in an X-direction are provided on the TFT substrate 23. The scanning line GL functions as a gate electrode of the TFT 17. A gate insulating film 31 is provided on the scanning line GL. A semiconductor layer 17A formed opposite the scanning line GL is provided on the gate insulating film 31. For example, amorphous silicon is used as the semiconductor layer 17A. A drain electrode 17B and a source electrode 17C are provided at respective opposite ends of the semiconductor layer 17A in a Y-direction so as to contact the semiconductor layer 17A.

[0035] The source electrode 17C is electrically connected to the signal line SL formed on the gate insulating film 31 and extending in the Y-direction. The drain electrode 17B comprises a first electrode extending in the X-direction and a second electrode extracted in the Y-direction. A contact plug 26 is provided on the second electrode. The TFT 17 comprises the semiconductor layer 17A, the semiconductor layer 17A, the drain electrode 17B, the source electrode 17C, the gate insulating film 31, and the scanning line (gate electrode) GL. For example, chromium (Cr), a molybdenum alloy (MoNb or the like), or an aluminum alloy (Al alloy) is used as the drain electrode 17B, the source electrode 17C, the scanning line GL, and the signal line SL. For example, a silicon nitride (SiN) is used as the gate insulating film 31.

[0036] An insulating film 32 is provided on the TFT 17, and the reflective film 24 is provided on the insulating film 32. The reflective film 24 is formed all over the pixel array except for areas through which the contact plugs 26 pass. The reflective film 24 also has a function to serve as an electrode of the storage capacitor CS. For example, an aluminum alloy (Al alloy) is used as the reflective film 24.

[0037] An insulating film 25 is provided on the reflective film 24, and the electrode 27 is provided on the insulating film 25. The electrode 27 has a function to electrically connect the drain electrode 17B of the TFT 17 and the pixel electrode 28 together and a function to set the capacitance of the storage capacitor CS to a predetermined value in accordance with the size of the planar shape of the electrode 27. Thus, the electrode 27 extends in the Y-direction and is electrically connected, at an end thereof in the Y-direction, to the drain electrode 17B of the TFT 17 through the contact plug 26. The electrode 27 is further electrically connected to the pixel electrode 28 through a contact plug 28A in the central portion of the pixel. The contact plug 26 may be formed integrally with the electrode 27 or the contact plug 26 and the electrode 27 may be individually formed. The contact plug 26 is formed of, for example, the same material as that of the electrode 27. In the present embodiment, the electrode 27 has approximately the same planar shape as that of the pixel electrode 28 in order to increase the capacitance of the storage capacitor CS. The electrode 27 comprises a transparent electrode, and for example, ITO (Indium Tin Oxide) is used as the electrode 27. For example, a silicon nitride (SiN) is used as the insulating films 25 and 32.

[0038] The color filter CF is provided on the electrode 27. The color filter CF has a planar shape the size of which is the same as the size of the pixel. A contact hole 30 is formed in the central portion of the color filter CF. The pixel electrode 28 is provided on the color filter CF. The pixel electrode 28 is electrically connected to the electrode 27 through the contact plug 28A formed in the contact hole 30. The contact plug 28A may be formed integrally with the pixel electrode 28 as depicted in FIG. 6 or the contact plug 28A and the pixel electrode 28 may be individually formed. The contact plug 28A is formed of, for example, the same material as that of the pixel electrode 28.

[0039] The COM substrate 20 is disposed opposite the TFT substrate 23. The liquid crystal layer 22, formed of a polymer network liquid crystal, is provided between the COM substrate 20 and the TFT substrate 23. The liquid crystal layer 22 is sealed by a seal member (not depicted in the drawings) that is used for bonding the COM substrate 20 and the TFT substrate 23. Only the common electrode 21 is provided on the liquid crystal layer 22 side of the COM substrate 20. The common electrode 21 or the pixel electrode 28 each comprise a transparent electrode, and for example, ITO is used as the common electrode 21 and the pixel electrode 28. As each of the COM substrate 20 and the TFT substrate 23, a transparent substrate formed of glass, quartz, plastic, or the like is used.

(Effects)

[0040] As described above in detail, in the first embodiment, the COM substrate 20 comprises only the common electrode 21 and is formed to be transmissive. The TFT substrate 23 comprises the plurality of TFTs 17, the reflective film 24, the plurality of transparent electrodes 27, the color filter CF, and the plurality of pixel electrodes 28 and is formed to be completely reflective. The liquid crystal layer 22, formed of a polymer network liquid crystal (PNLC), is provided between the COM substrate 20 and the TFT substrate 23. Thus, the color liquid crystal panel 11 is provided which is based on the active matrix scheme and which is reflective.

[0041] Therefore, according to the first embodiment, when ultraviolet light is radiated to the liquid crystal panel 11 in order to polymerize the monomers in the liquid crystal layer 22, the ultraviolet light can be radiated from the COM substrate 20 side, where no element that blocks the ultraviolet light is formed. This enables the monomers to be generally and stably polymerized, allowing the polymer to be uniformly formed in the liquid crystal layer 22. As a result, the reflectance (scattering performance) and reliability of the liquid crystal panel 11 can be improved.

[0042] Furthermore, since the COM substrate 20, on which only the common electrode 21 comprising a transparent electrode is formed, is disposed on the front side of the display surface, an area above the wiring line and transistor can be used as a display area. This enables an increase in aperture ratio.

[0043] For example, when the TFT substrate is disposed on the front side of the display surface, incident light is reflected by the TFTs and the wiring lines connected to the TFTs. Thus, the display area is glaring (garish). On the other hand, in the present embodiment, since no TFT and no wiring line are formed on the COM substrate 20 through which light is incident, the display surface can be prevented from appearing garish.

[0044] Furthermore, the liquid crystal panel 11 that can provide bright display can be implemented. For example, a twist nematic liquid crystal display element uses a polarizing plate. The polarizing plate absorbs a very large amount of light. In contrast, the liquid crystal panel 11 according to the present embodiment uses no polarizing plate and can thus provide bright display compared to the twist nematic liquid crystal display element and the like.

(Second Comparative Example)

[0045] FIG. 8 is a cross-sectional view of a liquid crystal panel according to a second comparative example. In the liquid crystal panel according to the second comparative example, a TFT substrate with TFTs is disposed on the front side of a display surface, and a color filter substrate with a reflective film and color filters is disposed on the back side of the display surface.

[0046] Specifically, a reflective film 101 is provided on a color filter substrate (CF substrate) 100. Color filters CF are provided on the reflective film 101. A common electrode 102 is provided on the color filters CF. TFTs 104 and pixel electrodes 105 electrically connected to the TFTs 104 are provided on a TFT substrate 103. A liquid crystal layer 106 formed of a polymer network liquid crystal is sandwiched between the CF substrate 100 and the TFT substrate 103.

[0047] As described above, in the second comparative example, the CF substrate 100 is formed to be reflective using the reflective film 101 formed thereon, and the TFT substrate 23 is formed to be transmissive. That is, incident light is incident through the TFT substrate 103. Hence, ultraviolet light used to polymerize monomers in the liquid crystal layer 106 is blocked by the TFTs 104 formed on the TFT substrate 103 and wiring lines connected to the TFTs 104. Thus, the second comparative example fails to generally polymerize the monomers.

[0048] FIGS. 9A and 9B are diagrams illustrating the state of the liquid crystal layer 106 according to the second comparative example. FIGS. 10A and 10B are diagrams illustrating the state of the liquid crystal layer 22 according to the first embodiment. FIG. 9A and FIG. 10A depict the liquid crystal layer having been irradiated with ultraviolet light in order to polymerize the monomers. FIG. 9B and FIG. 10B are partially enlarged views of FIG. 9A and FIG. 10A, respectively.

[0049] In the second comparative example, the polymer is not uniform, and particularly near the TFTs and the wiring lines, the liquid crystal layer fails to be sufficiently irradiated with ultraviolet light, resulting in insufficient polymerization of the monomers. On the other hand, in the present embodiment, the liquid crystal layer is generally and uniformly irradiated with ultraviolet light. Thus, the polymer is uniform, and the monomers are uniformly polymerized throughout the liquid crystal layer.

[0050] FIG. 11 is a diagram illustrating the state of reflected light on the liquid crystal panel according to the second comparative example. FIG. 12 is a diagram illustrating the state of reflected light on the liquid crystal panel according to the first embodiment. In the second comparative example, since incident light is reflected by the TFTs 104 and the wiring lines connected to the TFTs 104, the display on the liquid crystal panel is glaring (garish) . On the other hand, in the present embodiment, since no TFT and no wiring line are formed on the substrate side on which light is incident, the display on the liquid crystal panel can be prevented from appearing garish.

(Third Comparative Example)

[0051] In a third comparative example, a reflective film is used as an electrode of a storage capacitor CS, and a color filter is used as an interlayer insulating film of the storage capacitor CS.

[0052] FIG. 13 is a layout of a liquid crystal panel 11 according to the third comparative example. FIG. 14 is a cross-sectional view of the liquid crystal panel 11 taken along line B-B' in FIG. 13.

[0053] A reflective film 24 is provided on an insulating film 32. The reflective film 24 is formed all over a pixel array except for areas through which contact plugs 26 pass. The reflective film 24 also has a function to serve as an electrode of the storage capacitor CS. For example, an aluminum alloy (Al alloy) is used as the reflective film 24.

[0054] A color filter CF is provided on the reflective film 24. A pixel electrode 28 is provided on the color filter CF. The reflective film 24, the color filter CF, and the pixel electrode 28 provide the storage capacitor CS. That is, the color filter CF has not only a function to control the wavelength of transmitted light but also a function to serve as an interlayer insulating film of the storage capacitor CS. The color filters CF are formed of a resin containing a coloring material. A common voltage Vcom is applied to the reflective film 24 by a common voltage supply circuit 14.

[0055] The pixel electrode 28 is electrically connected to a drain electrode 17B of a TFT 17 through a contact plug 26 formed in the color filter CF and an insulating film 32. The contact plug 26 is electrically separated from the reflective film 24. The contact plug 26 may be formed integrally with the pixel electrode 28. The contact plug 26 and the pixel electrode 28 may be individually formed. The contact plug 26 is formed of, for example, the same material as that of the pixel electrode 28.

[0056] The third comparative example does not need the electrode 27 in the first embodiment. Hence, the laminate structure of the liquid crystal panel 11 can be simplified. For the other effects, the third comparative example is the same as the first embodiment.

(Fourth Comparative Example)

[0057] In a fourth comparative example, a reflective film 24 is formed in the same layer as the electrode 27 according to the first comparative example, and color filters CF are disposed on the reflective film 24.

[0058] FIG. 15 is a cross-sectional view of a liquid crystal panel 11 according to the fourth comparative example. The cross-sectional view in FIG. 15 corresponds to a cross-sectional view taken at the position of line B-B' in FIG. 5. A layout of the liquid crystal panel 11 according to the fourth comparative example corresponds to FIG. 5 in which the electrode 27 and the reflective film 24 are replaced with the reflective film 24 and an electrode 33, respectively.

[0059] The electrode 33 providing a storage capacitor CS is provided on the insulating film 32. The electrode 33 is formed all over a pixel array except for areas through which contact plugs 26 pass. The electrode 33 corresponds to an electrode of a storage capacitor CS. The electrode 33 comprises a transparent electrode, and for example, ITO is used as the electrode 33.

[0060] An insulating film 25 is provided on the electrode 33. The reflective film 24 is provided on the insulating film 25. The planar shape of the reflective film 24 is substantially the same as the planar shape of the pixel electrode 28. That is, in the first comparative example, the reflective film 24 is formed all over the pixel array as a continuous film (However, the reflective film 24 has openings through which contact plugs pass), whereas in the fourth comparative example, a plurality of reflective films 24 provided for the respective pixels are formed on the insulating film 25. For example, an aluminum alloy (Al alloy) is used as the reflective film 24. A color filter CF is provided on the reflective film 24. The pixel electrode 28 is provided on the color filter CF.

[0061] The reflective film 24 electrically connects the pixel electrode 28 and a source electrode 17B of a TFT 17 together. That is, the reflective film 24 is electrically connected to the pixel electrode 28 through a contact plug 28A formed in the color filter CF and electrically connected to the source electrode 17B of the TFT 17 through the contact plug 26. The contact plug 26 may be formed integrally with the pixel electrode 28 or the contact plug 26 and the pixel electrode 28 may be individually formed. The contact plug 26 is formed of, for example, the same material as that of the pixel electrode 28.

[0062] According to the fourth comparative example, the reflective film 24 can be disposed at a position closer to the color filter CF. For the other effects, the fourth comparative example is the first comparative example.

(Second Embodiment)

[0063] In a second embodiment, an insulating film (for example, an orientation film) is formed on a COM substrate 20 and on a TFT substrate 23 so as to contact a liquid crystal layer 22. This improves the insulation between the COM substrate 20 and the TFT substrate 23 to prevent possible short-circuiting between the COM substrate 20 and the TFT substrate 23.

[0064] FIG. 16 is a cross -sectional view of a liquid crystal panel 11 according to the second embodiment. The cross-sectional view in FIG. 16 corresponds to a cross-sectional view taken at the position of line B-B' in FIG. 5. An insulating film 40 is provided on a liquid crystal side of a common electrode 21. The insulating film 40 is formed all over the COM substrate 20.

[0065] An insulating film 41 is provided on a liquid crystal side of a pixel electrode 28. The insulating film 41 is formed all over the TFT substrate 23. For example, an orientation film is used as each of the insulating films 40 and 41, and a polyimide film is used as the orientation film. For the remaining part of the configuration, the second embodiment is the same as the first embodiment.

[0066] According to the second embodiment, the insulation between the COM substrate 20 and the TFT substrate 23 can be improved. This allows prevention of possible short-circuiting between the COM substrate 20 and the TFT substrate 23 while a voltage is being applied to the liquid crystal panel 11. Thus, the liquid crystal panel 11 with improved reliability can be provided. Furthermore, when an orientation film is used as each of the insulating film 40 and 41, the contact between each of the insulating films 40 and 41 and a liquid crystal layer 22 is improved. Consequently, the liquid crystal layer 22 can be suppressed from being defective, and the display quality of the liquid crystal panel 11 can thus be suppressed from being degraded.

[0067] The liquid crystal panel 11 may be configured to comprise only one of the insulating films 40 and 41. Even in this configuration, the insulation between the COM substrate 20 and the TFT substrate 23 can be improved.

(Third Embodiment]

[0068] In a third embodiment, a light-shielding layer (black matrix) is formed at boundary portions between a plurality of pixels to improve the contrast of a displayed image.

[0069] FIG. 17 is a cross-sectional view of a liquid crystal panel 11 according to the third embodiment, taken along an X-direction (an extending direction of scanning lines GL). FIG. 18 is a cross-sectional view of the liquid crystal panel 11 according to the third embodiment, taken along a Y-direction (an extending direction of signal lines SL). The cross-sectional view in FIG. 17 corresponds to a cross-sectional view taken at the position of line A-A' in FIG. 5. The cross-sectional view in FIG. 18 corresponds to a cross-sectional view taken at the position of line B-B' in FIG. 5.

[0070] A light-shielding layer (black matrix) BM is provided on an insulating film 25 and an electrode 27. The light-shielding layer BM is disposed at boundary portions between the plurality of pixels 16. In other words, the light-shielding layer BM is formed to enclose each of the plurality of pixels 16 and formed like mesh. The light-shielding layer BM has a function to shield a light-shielding target pattern formed on a TFT substrate 23 from light. Specifically, the light-shielding layer BM is disposed to cover wiring (scanning lines GL and signal lines SL) connected to TFTs 17. For example, a back organic resin may be used as the light-shielding layer BM. The light-shielding layer BM may be formed by mixing a black pigment (organic pigment, carbon black, titanium black, or the like) into a resin material such as photosensitive or non-photosensitive polyimide.

[0071] Color filters CF are provided on the light-shielding layer BM. For the remaining part of the configuration, the third embodiment is the same as the first embodiment.

[0072] According to the third embodiment, the light-shielding layer BM is disposed at the boundary portions between the plurality of pixels 16, allowing the contrast of the displayed image to be improved. In addition, when the light-shielding layer BM is installed, reflectance slightly decreases.

[0073] FIG. 19 is a cross-sectional view of a liquid crystal panel 11 according to a modification of the third embodiment, taken along the X-direction (the extending direction of the scanning lines GL).

[0074] At the boundary between adjacent pixels with different colors, two coloring members with different colors contained in the color filters CF are formed so as to overlap at ends of coloring members. The overlapping portions of the two coloring members in different colors function as a light-shielding layer (black matrix) BM.

[0075] At the boundary between pixels adjacent to each other in the Y-direction (the extending direction of the signal lines SL), the black matrix may be omitted as depicted in FIG. 7 or may be provided as depicted in FIG. 18.

[0076] The present invention is not limited to the embodiments described above, and can be embodied by modifying constituent elements without departing from the invention as defined by the claims. In

Reference Signs List

[0077] GL: scanning line, SL: signal line, CLC: liquid crystal capacitor, CS: storage capacitor, CF: color filter, BM: light-shielding layer, 10: liquid crystal display, 11: liquid crystal panel, 12: scanning driver, 13: signal driver, 14: common voltage supply circuit, 15: controller, 16: pixel, 17: TFT, 17A: semiconductor layer, 17B: drain electrode, 17C: source electrode, 20: COM substrate, 21: common electrode, 22: liquid crystal layer, 23: TFT substrate, 24: reflective film, 25 and 32: insulating film, 26 and 28A: contact plug, 27: electrode, 28: pixel electrode, 30: contact hole, 31: gate insulating film, 33: electrode, 40 and 41: orientation film, 100: CF substrate, 101: reflective film, 102: common electrode, 103: TFT substrate, 104: TFT, 105: pixel electrode, 106: liquid crystal layer

Claims

1. A liquid crystal display comprising:

   first and second substrates (20, 23);
   a liquid crystal layer (22) sandwiched between the first and second substrates (20, 23) and comprising a polymer network liquid crystal (PN-LC) or a polymer dispersed liquid crystal (PDLC);
   a common electrode (21) provided on the first substrate (20);
   transistors (17) provided on the second substrate (23) for respective pixels;
   a reflective film (24) provided above the transistors via a first insulating film (32);
   transparent electrodes (27) provided above the reflective film via a second insulating film (25), and electrically connected to drain electrodes of the transistors, respectively;
   color filters (CF) provided on the transparent electrodes, respectively; and
   pixel electrodes (28) provided on the color filters (CF), and electrically connected to the transparent electrodes (27), respectively,
   wherein the reflective film (24) overlaps all the transparent electrodes (27), and
   the transparent electrodes (27) with the reflective film (24) and the second insulating film (25) function as storage capacitors included in the respective pixels.

2. The liquid crystal display according to claim 1, wherein the transparent electrode (27) extends over the entire pixel electrode (28).

3. The liquid crystal display according to claim 1, further comprising first contact plugs (28A) provided in the color filters (CF), and respectively electrically connecting the pixel electrodes (28) and the transparent electrodes (27).

4. The liquid crystal display according to claim 3, wherein the first contact plugs (28A) are respectively arranged in center portions of the pixel electrodes (28).

5. The liquid crystal display according to claim 1, further comprising a third insulating film (41) provided on one or both of the first and second substrates (20, 23) in contact with the liquid crystal layer (22).

6. The liquid crystal display according to claim 1, further comprising a light-shielding layer (BM) provided at boundary portions between the pixels.

7. The liquid crystal display according to claim 1, wherein

   adjacent color filters (CF) overlap at ends thereof, and
   the overlapping portion functions as a light-shielding layer.

8. The liquid crystal display according to claim 1, wherein ultraviolet light used to polymerize monomers in the liquid crystal layer (22) is radiated from the first substrate side.

9. The liquid crystal display according to claim 1, wherein the common electrode (21) and the reflective film (24) are connected to a common voltage supply circuit (14).

10. The liquid crystal display according to claim 1, wherein the reflective film (24) overlaps the pixel electrodes (28).

11. The liquid crystal display according to claim 1, wherein the reflective film (24) covers the transistors (17).

12. The liquid crystal display according to claim 1, further comprising second contact plugs (26) that respectively electrically connect the transistors (17) and the transparent electrodes (27).

Patentansprüche

1. Flüssigkristallanzeige mit:

   ersten und zweiten Substraten (20, 23);
   einer Flüssigkristallschicht (22), die zwischen den ersten und zweiten Substraten (20, 23) eingebettet ist und einen polymervernetzten Flüssigkristall (PDLC) oder einen polymerdispergierten Flüssigkristall (PDLC) aufweist;
   einer gemeinsamen Elektrode (21), die auf dem ersten Substrat (20) bereitgestellt ist;
   Transistoren (17), die auf dem zweiten Substrat (23) für jeweilige Pixel bereitgestellt sind;
   einer reflektierenden Schicht (24), die über den Transistoren mittels einer ersten isolierenden Schicht (32) bereitgestellt ist;
   transparenten Elektroden (27), die oberhalb der reflektierenden Schicht mittels einer zweiten isolierenden Schicht (25) bereitgestellt sind und elektrisch jeweils mit Drain-Elektroden der Transistoren verbunden sind;
   Farbfilter (CF), die jeweils auf den transparenten Elektroden bereitgestellt sind; und
   Pixelelektroden (28), die auf den Farbfiltern (CF) bereitgestellt sind und jeweils elektrisch mit den transparenten Elektroden (27) verbunden sind, wobei
   die reflektierende Schicht (24) alle transparen-

ten Elektroden (27) überlappt, und
die transparenten Elektroden (27) mit der reflektierenden Schicht (24) und der zweiten isolierenden Schicht (25) als Speicherkapazitäten fungieren, die in den jeweiligen Pixeln enthalten sind.

2. Flüssigkristallanzeige nach Anspruch 1, wobei sich die transparente Elektrode (27) über die ganze Pixelelektrode (28) erstreckt.

3. Flüssigkristallanzeige nach Anspruch 1, ferner mit ersten Kontaktstopfen (28A), die in den Farbfiltern (CF) bereitgestellt sind und jeweils die Pixelelektroden (28) und die transparenten Elektroden (27) verbinden.

4. Flüssigkristallanzeige nach Anspruch 3, wobei die ersten Kontaktstopfen (28A) jeweils in zentralen Abschnitten der Pixelelektroden (28) angebracht sind.

5. Flüssigkristallanzeige nach Anspruch 1, ferner mit einer dritten isolierenden Schicht (41), die auf einem oder beiden der ersten und zweiten Substrate (20, 23) in Kontakt mit der Flüssigkristallschicht (22) bereitgestellt sind.

6. Flüssigkristallanzeige nach Anspruch 1, ferner mit einer Lichtabschirmschicht (BM), die an Grenzabschnitten zwischen den Pixeln bereitgestellt ist.

7. Flüssigkristallanzeige nach Anspruch 1, wobei benachbarte Farbfilter (CF) an ihren Enden überlappen, und
der überlappende Abschnitt als eine Lichtabschirmschicht fungiert.

8. Flüssigkristallanzeige nach Anspruch 1, wobei ultraviolettes Licht, das verwendet wird, um Monomere in der Flüssigkristallschicht (22) zu polymerisieren, von der Seite des ersten Substrats gestrahlt wird.

9. Flüssigkristallanzeige nach Anspruch 1, wobei die gemeinsame Elektrode (21) und die reflektierende Schicht (24) mit einer gemeinsamen Spannungsquellenschaltung (14) verbunden sind.

10. Flüssigkristallanzeige nach Anspruch 1, wobei die reflektierende Schicht (24) die Pixelelektroden (28) überlappt.

11. Flüssigkristallanzeige nach Anspruch 1, wobei die reflektierende Schicht (24) die Transistoren (17) bedeckt.

12. Flüssigkristallanzeige nach Anspruch 1, ferner mit zweiten Kontaktstopfen (26), die jeweils elektrisch die Transistoren (17) und die transparenten Elektroden (27) verbinden.

Revendications

1. Dispositif d'affichage à cristaux liquides comprenant :

des premier et deuxième substrats (20, 23) ;
une couche de cristaux liquides (22) enserrée entre les premier et deuxième substrats (20, 23) et comprenant un cristal liquide à réseau polymère (PNLC) ou un cristal liquide dispersé dans un polymère (PDLC) ;
une électrode commune (21) prévue sur le premier substrat (20) ;
des transistors (17) prévus sur le deuxième substrat (23) pour des pixels respectifs ;
un film réfléchissant (24) prévu au-dessus des transistors via un premier film isolant (32) ;
des électrodes transparentes (27) prévues au-dessus du film réfléchissant via un deuxième film isolant (25), et reliées électriquement à des électrodes de drain des transistors, respectivement ;
des filtres colorés (CF) prévus sur les électrodes transparentes, respectivement ; et
des électrodes de pixel (28) prévues sur les filtres colorés (CF), et reliées électriquement aux électrodes transparentes (27), respectivement,
dans lequel le film réfléchissant (24) chevauche toutes les électrodes transparentes (27), et
les électrodes transparentes (27) avec le film réfléchissant (24) et le deuxième film isolant (25) fonctionnent en tant que condensateurs de stockage inclus dans les pixels respectifs.

2. Dispositif d'affichage à cristaux liquides selon la revendication 1, dans lequel l'électrode transparente (27) s'étend sur toute l'électrode de pixel (28).

3. Dispositif d'affichage à cristaux liquides selon la revendication 1, comprenant en outre des premières prises de contact (28A) prévues dans les filtres colorés (CF), et reliant électriquement respectivement les électrodes de pixel (28) et les électrodes transparentes (27).

4. Dispositif d'affichage à cristaux liquides selon la revendication 3, dans lequel les premières prises de contact (28A) sont agencées respectivement dans des parties centrales des électrodes de pixel (28).

5. Dispositif d'affichage à cristaux liquides selon la revendication 1, comprenant en outre un troisième film isolant (41) prévu sur l'un et/ou l'autre des premier et deuxième substrats (20, 23) en contact avec la couche de cristaux liquides (22).

6. Dispositif d'affichage à cristaux liquides selon la revendication 1, comprenant en outre une couche de protection contre la lumière (BM) prévue au niveau de parties limites entre les pixels.

7. Dispositif d'affichage à cristaux liquides selon la revendication 1, dans lequel
des filtres colorés adjacents (CF) se chevauchent à leurs extrémités, et
la partie de chevauchement fonctionne en tant que couche de protection contre la lumière.

8. Dispositif d'affichage à cristaux liquides selon la revendication 1, dans lequel la lumière ultraviolette utilisée pour polymériser des monomères dans la couche de cristaux liquides (22) est émise par le côté de premier substrat.

9. Dispositif d'affichage à cristaux liquides selon la revendication 1, dans lequel l'électrode commune (21) et le film réfléchissant (24) sont reliés à un circuit commun d'alimentation en tension (14).

10. Dispositif d'affichage à cristaux liquides selon la revendication 1, dans lequel le film réfléchissant (24) chevauche les électrodes de pixel (28).

11. Dispositif d'affichage à cristaux liquides selon la revendication 1, dans lequel le film réfléchissant (24) recouvre les transistors (17).

12. Dispositif d'affichage à cristaux liquides selon la revendication 1, comprenant en outre des deuxièmes prises de contact (26) qui relient électriquement respectivement les transistors (17) et les électrodes transparentes (27).

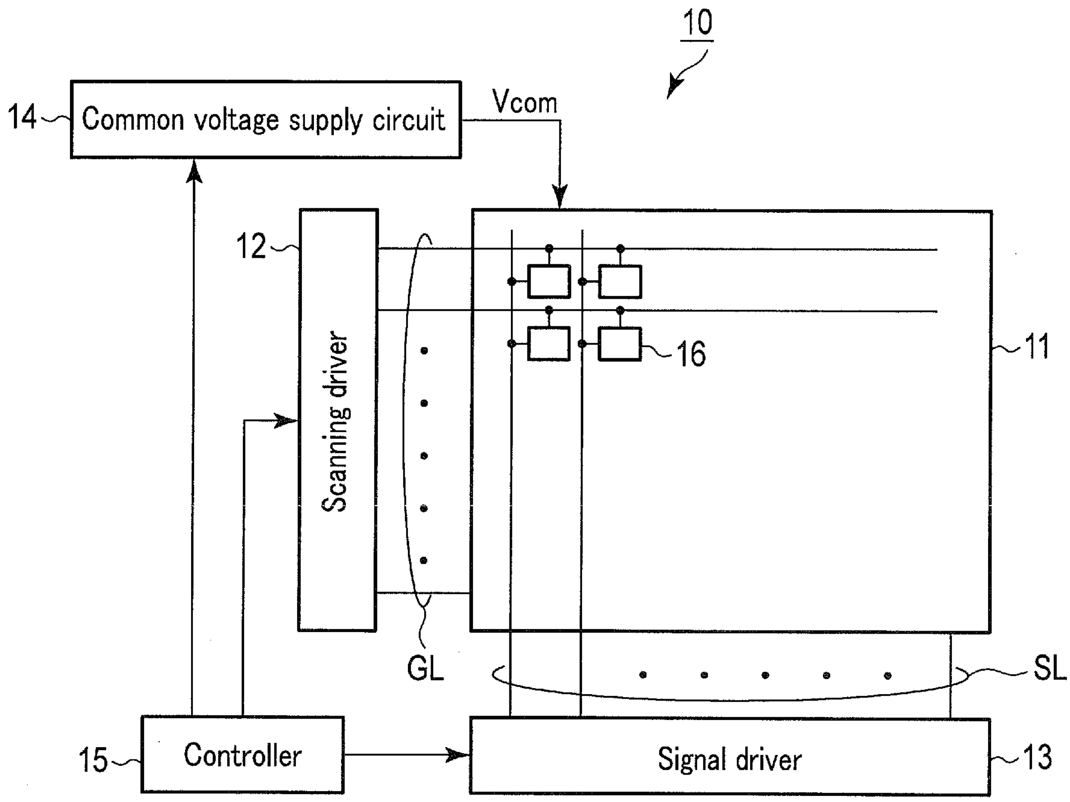

10
14
Common voltage supply circuit
Vcom
12
Scanning driver
16
11
GL
SL
15
Controller
Signal driver
13

FIG. 1

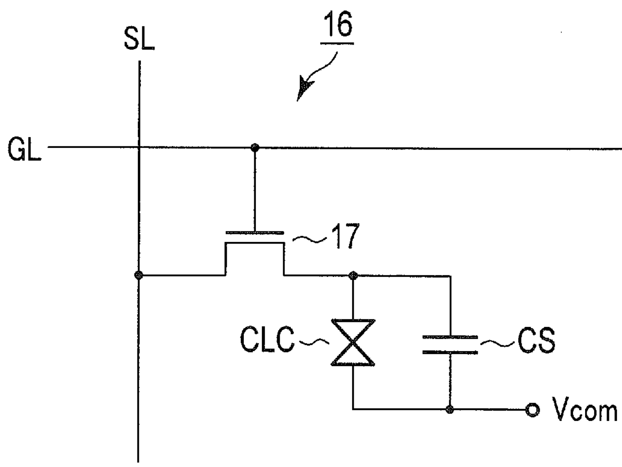
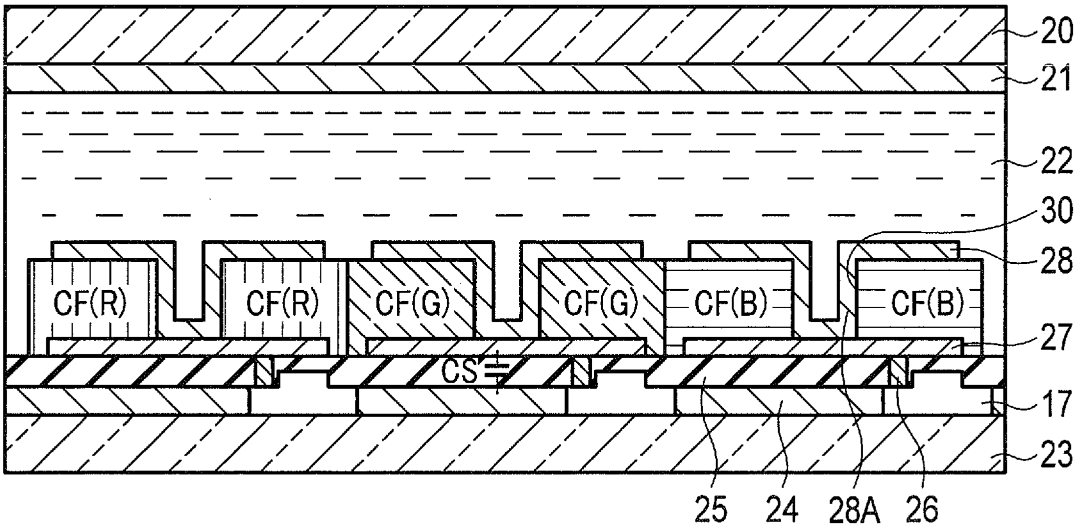

SL
16
GL
17
CLC
CS
Vcom

FIG. 2



F I G. 3

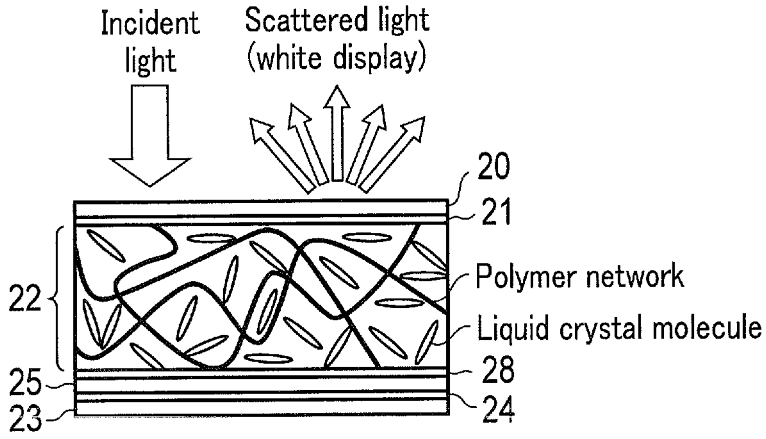

Incident light
Scattered light (white display)
20
21
22
Polymer network
Liquid crystal molecule
25
28
23
24

FIG. 4A

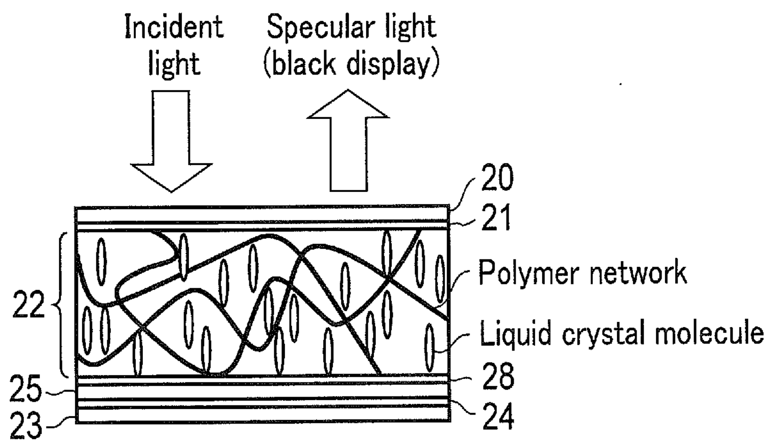

Incident light
Specular light (black display)
20
21
22
Polymer network
Liquid crystal molecule
25
28
23
24

FIG. 4B

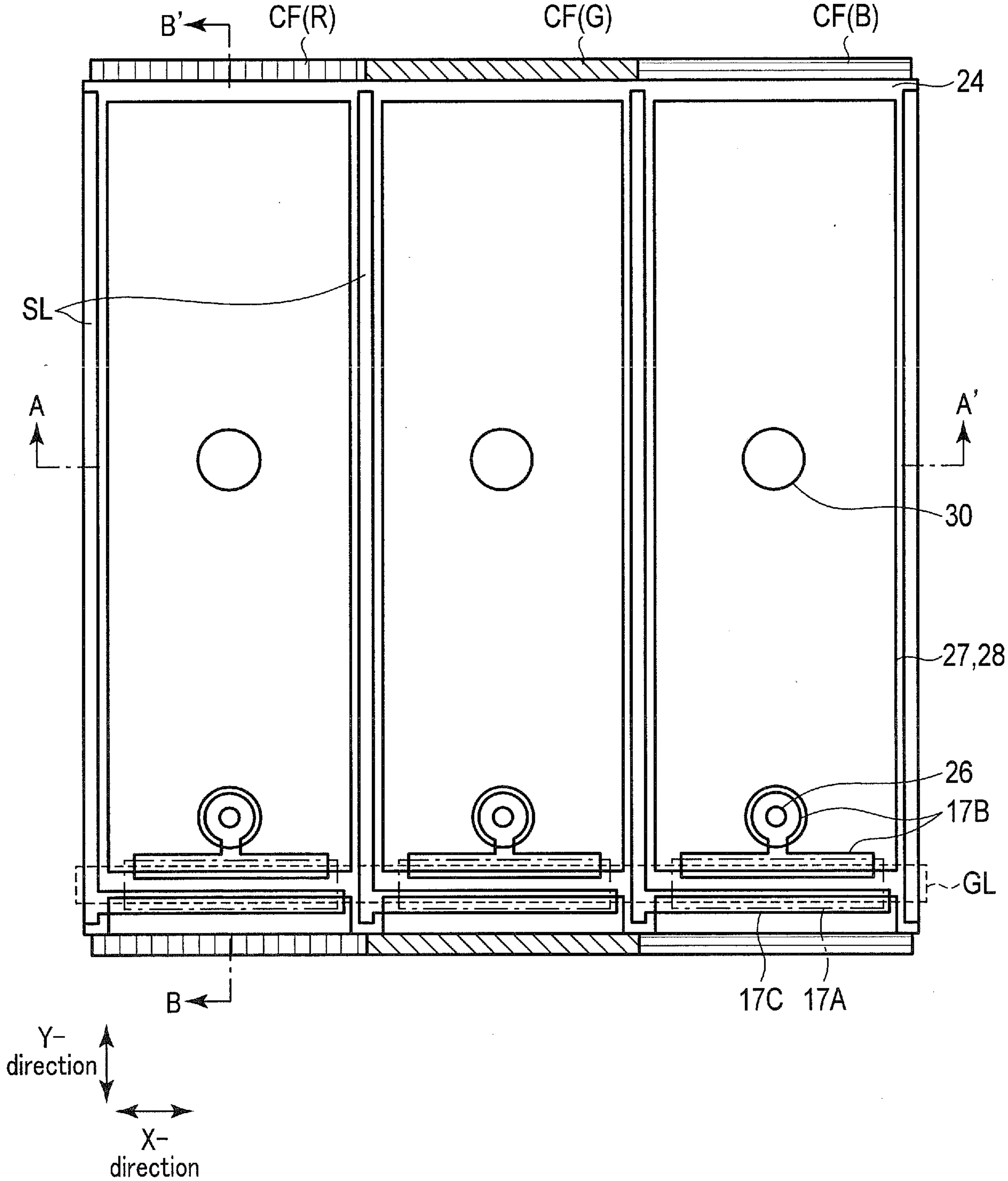

B'
CF(R)
CF(G)
CF(B)
24
SL
A
A'
30
27,28
26
17B
GL
B
17C
17A
Y-
direction
X-
direction

FIG. 5

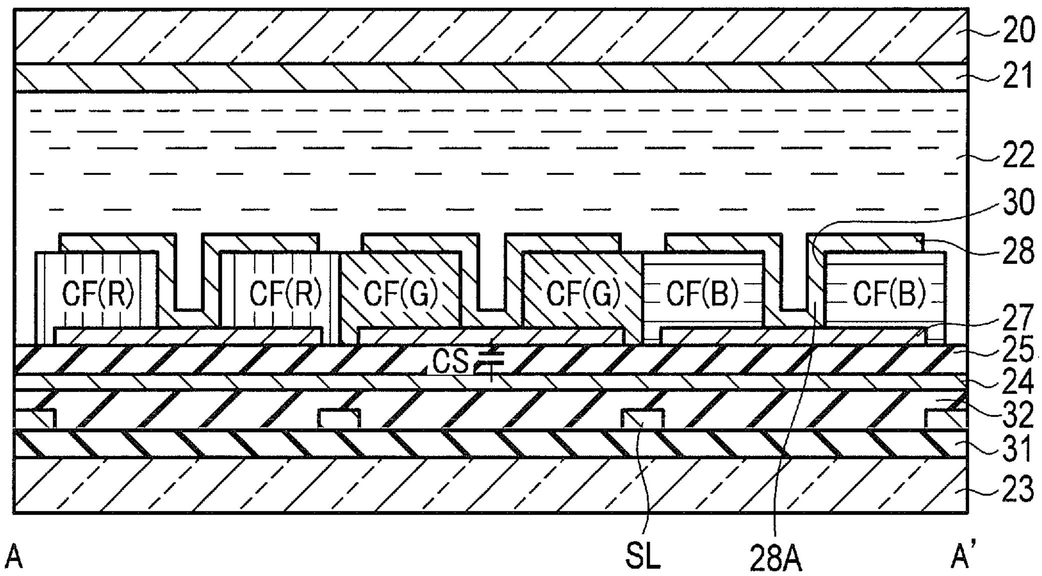

20
21
22
30
28
CF(R)
CF(R)
CF(G)
CF(G)
CF(B)
CF(B)
27
25
CS
24
32
31
23
A
SL
28A
A'

FIG. 6

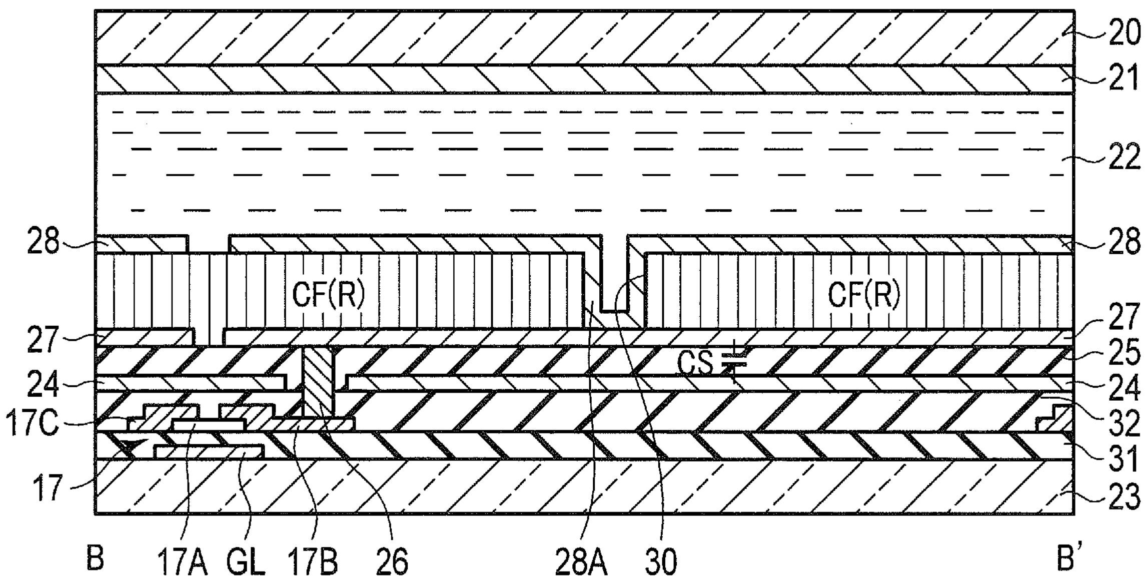
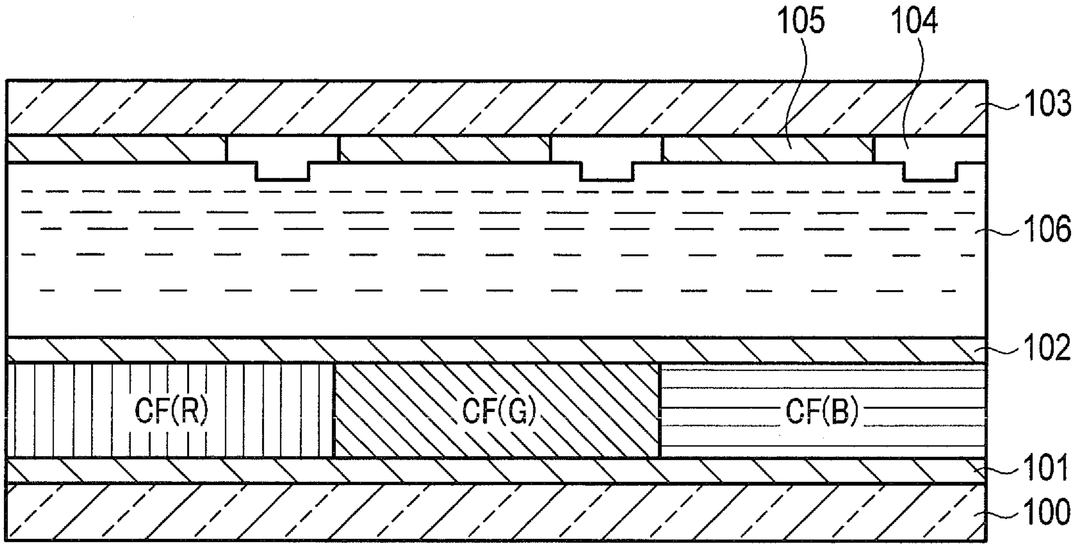
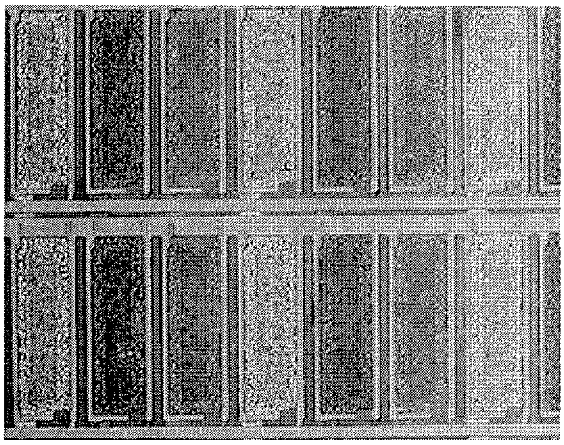

20
21
22
28
28
CF(R)
CF(R)
27
27
25
25
CS
24
24
17C
32
31
17
23
B
17A
GL
17B
26
28A
30
B'

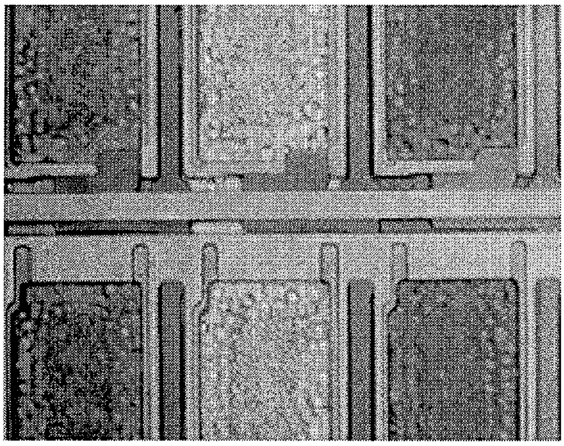
FIG. 7



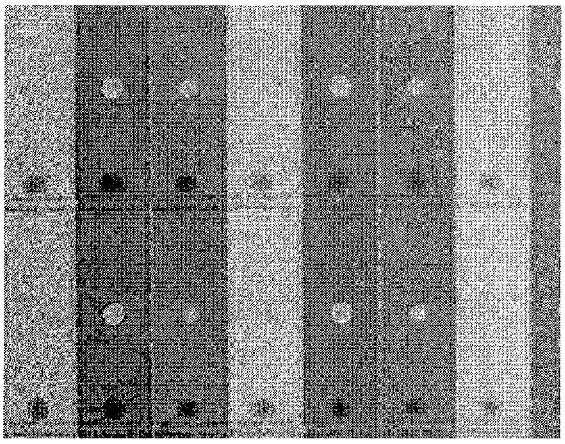
F I G. 8



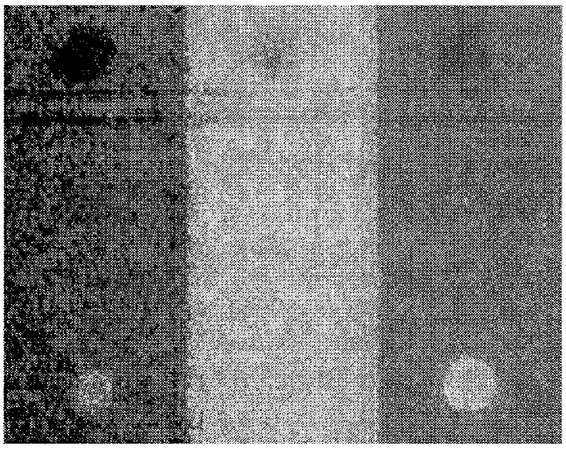
F I G. 9A



F I G. 9B



F I G. 10A



F I G. 10B

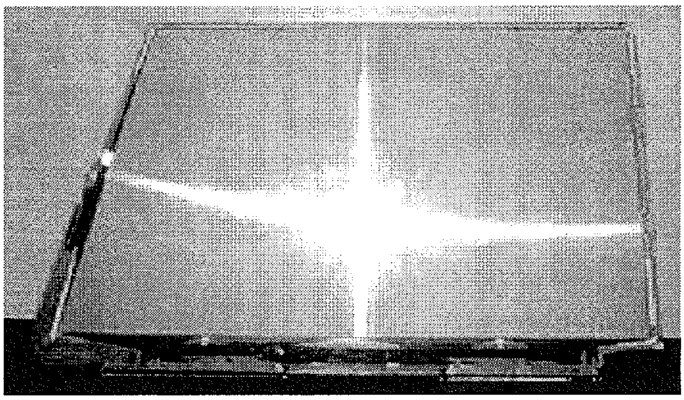


FIG. 11

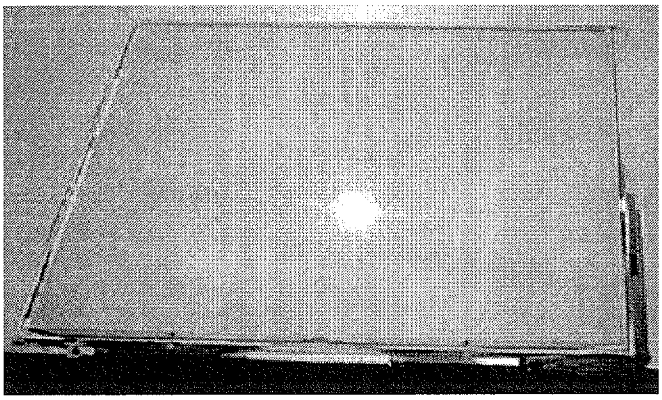


FIG. 12

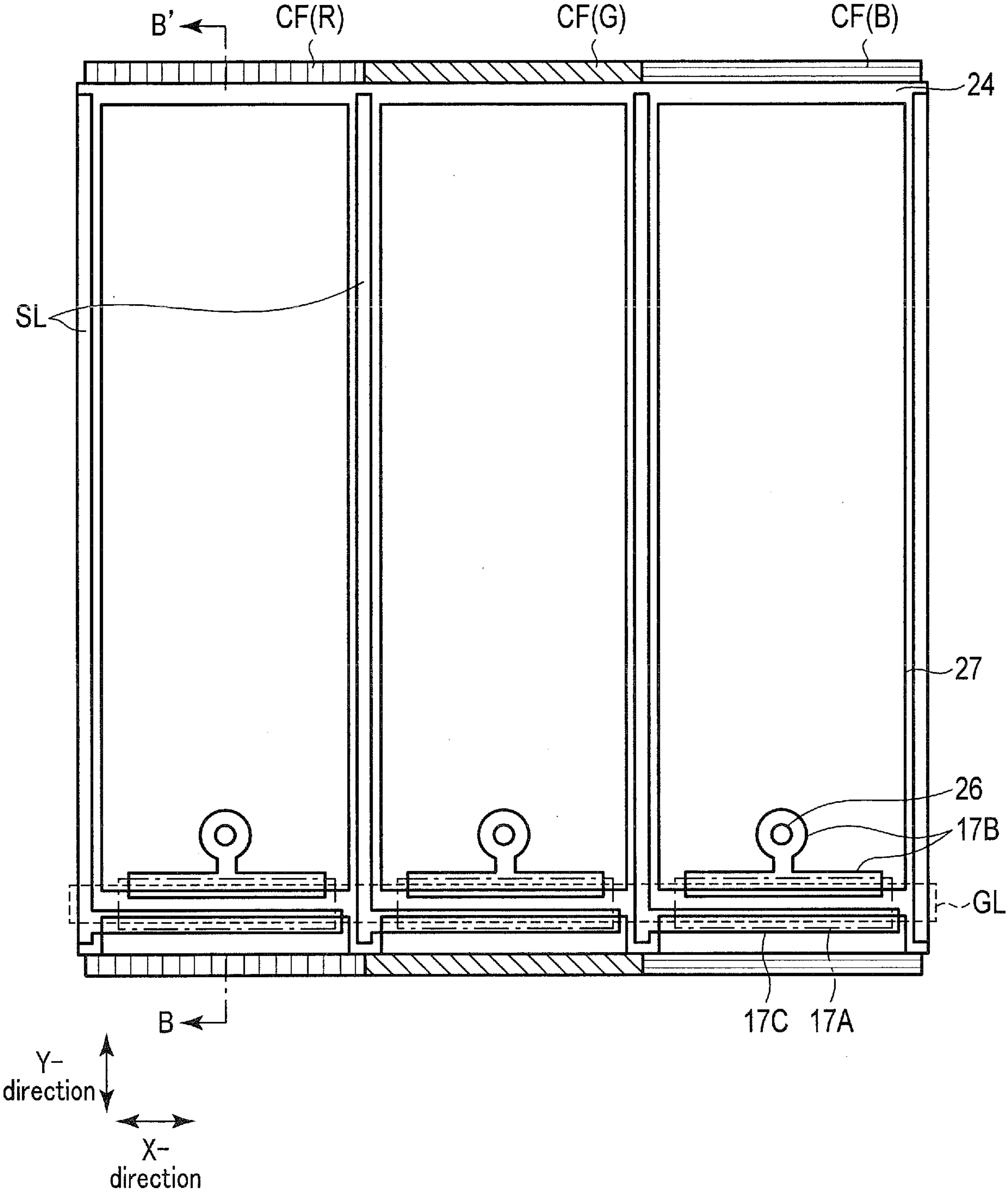
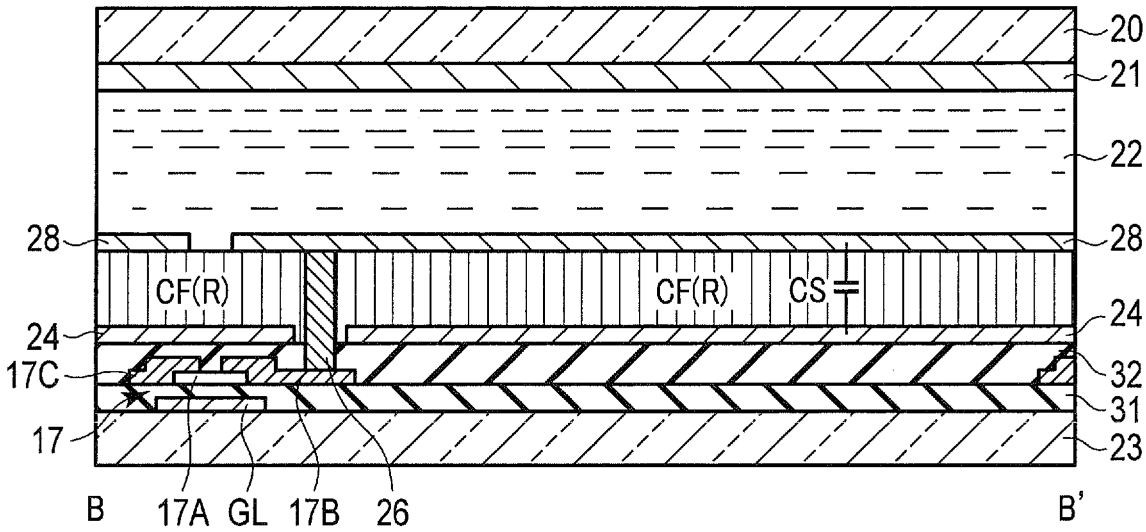
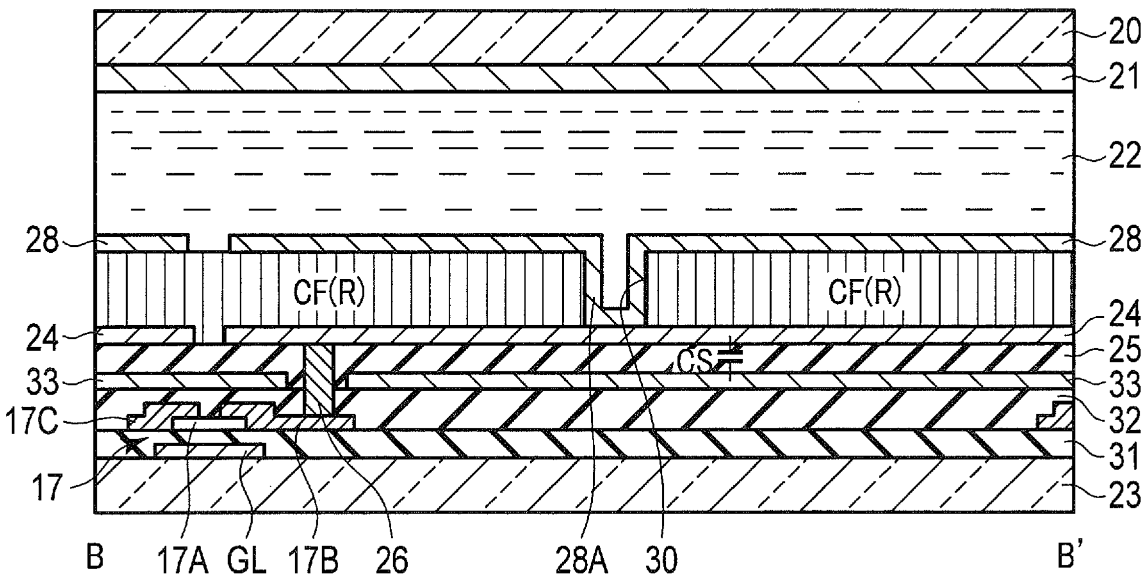

B'
CF(R)
CF(G)
CF(B)
24
SL
27
26
17B
GL
B
17C
17A
Y-
direction
X-
direction

FIG. 13


20
21
22
28
28
CF(R)
CF(R)
CS
24
24
17C
32
31
17
23
B
17A
GL
17B
26
B'

F I G. 14


20
21
22
28
28
CF(R)
CF(R)
24
24
25
CS
33
33
17C
32
31
17
23
B
17A
GL
17B
26
28A
30
B'

F I G. 15

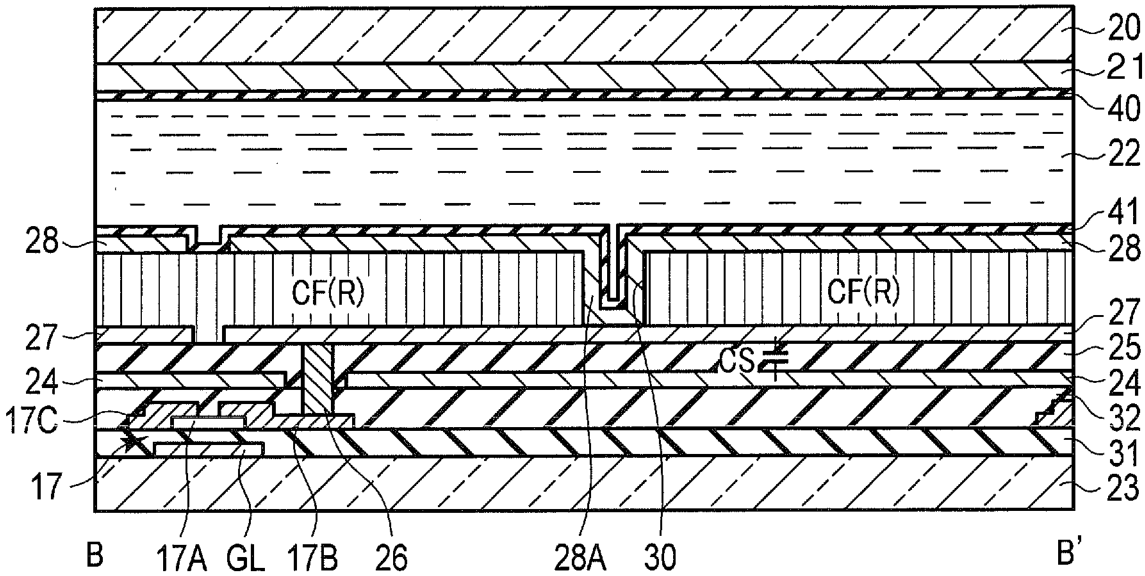

20
21
40
22
41
28
28
CF(R)
CF(R)
27
27
25
CS
24
24
17C
32
31
17
23
B
17A
GL
17B
26
28A
30
B'

FIG. 16

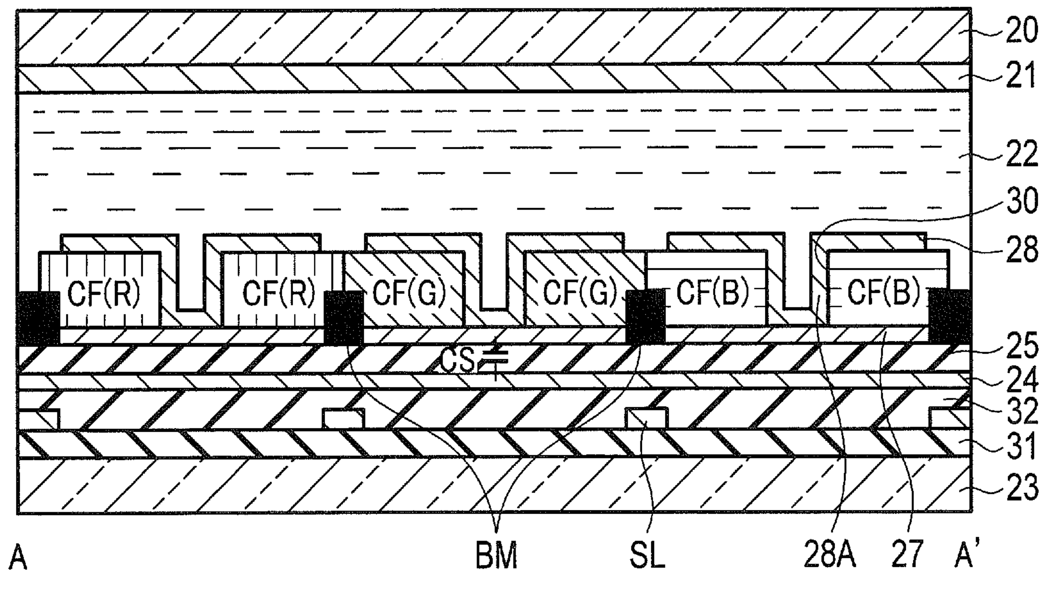
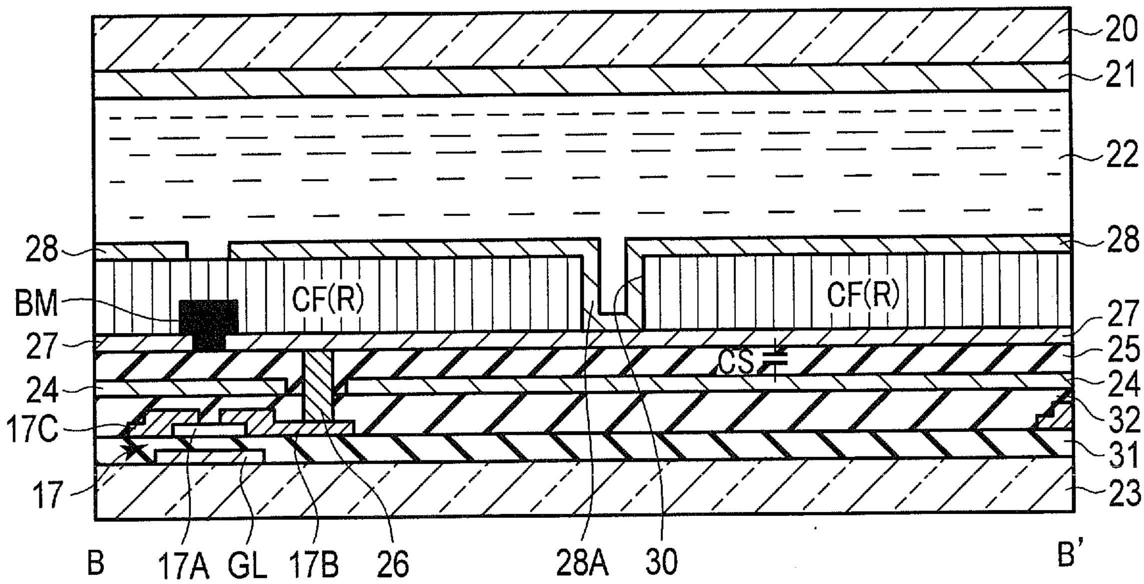
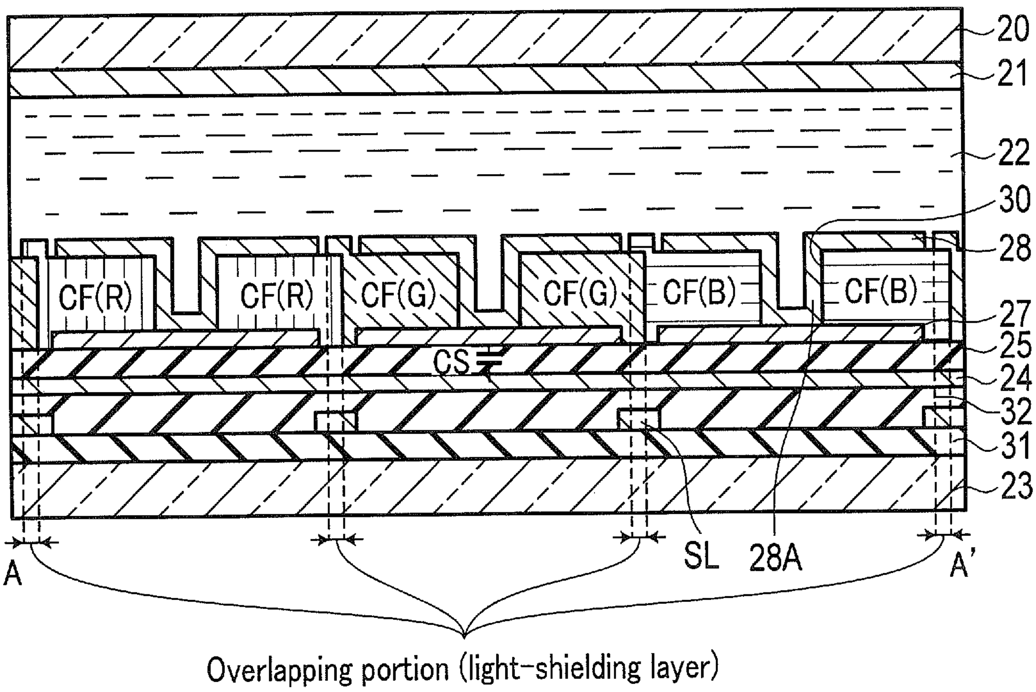

20
21
22
30
28
CF(R)
CF(R)
CF(G)
CF(G)
CF(B)
CF(B)
25
CS
24
32
31
23
A
BM
SL
28A
27
A'

FIG. 17


20
21
22
28
BM
CF(R)
CF(R)
28
27
25
CS
27
24
24
32
17C
31
17
23
B
17A
GL
17B
26
28A
30
B'

F I G. 18


20
21
22
30
28
CF(R)
CF(R)
CF(G)
CF(G)
CF(B)
CF(B)
27
25
CS
24
32
31
23
A
SL
28A
A'
Overlapping portion (light-shielding layer)

F I G. 19

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

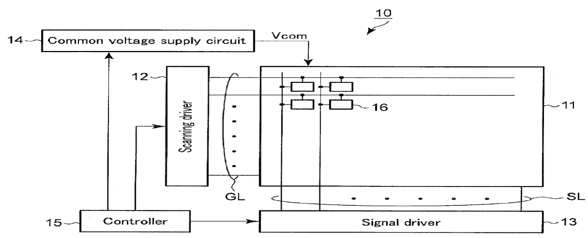
- JP 3736076 B **[0006]**
- JP 2011095407 A **[0006]**
- JP 2003195350 A **[0007]**
- US 20030122980 A1 **[0007]**
- US 20100309416 A1 **[0007]**

patsnap

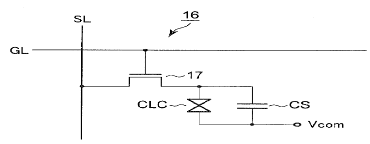
专利名称(译)	液晶显示装置		
公开(公告)号	EP2916166B1	公开(公告)日	2019-05-15
申请号	EP2013850282	申请日	2013-10-29
申请(专利权)人(译)	ORTUS TECHNOLOGY CO.，LTD.		
当前申请(专利权)人(译)	ORTUS TECHNOLOGY CO.，LTD.		
[标]发明人	ARAI NORIHIRO KOBAYASHI KUNPEI MIZUSAKO RYOTA		
发明人	ARAI, NORIHIRO KOBAYASHI, KUNPEI MIZUSAKO, RYOTA		
IPC分类号	G02F1/1334 G02F1/1335 G02F1/1343 G02F1/1368 G02F1/1362		
CPC分类号	G02F1/133553 G02F1/133345 G02F1/1334 G02F1/133512 G02F1/136213 G02F1/1368 G02F2001/13345 G02F2001/136222 G02F2201/40 G02F2203/02		
代理机构(译)	TBK		
优先权	2012242715 2012-11-02 JP		
其他公开文献	EP2916166A1 EP2916166A4		
外部链接	Espacenet		

摘要(译)

液晶显示器（11）包括：基板（20），（23）;液晶层（22）夹在基板（20），（23）之间，包括聚合物网络液晶（PNLC）或聚合物分散液晶（PDLC）;公共电极（21）设置在基板（20）上;晶体管（17）设置在基板（23）上，用于各个像素;设置在晶体管（17）上的反射膜（24）;设置在反射膜（24）上的滤色器（CF）;像素电极（28）设置在滤色器（CF）上并电连接到各个晶体管（17）的漏电极。



F I G. 1



F I G. 2