US 20080192160A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2008/0192160 A1

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(43) Pub. Date: Aug. 14, 2008

(54) **LIQUID CRYSTAL DISPLAY DEVICE**

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(21) Appl. No.: **12/028,526**

(22) Filed: **Feb. 8, 2008**

(30) **Foreign Application Priority Data**

Feb. 14, 2007 (JP) 2007-034003

Publication Classification

(51) **Int. Cl.**
G02F 1/1335 (2006.01)
G02F 1/1343 (2006.01)

(52) **U.S. Cl.** **349/39**; 349/114

(57) **ABSTRACT**

A liquid crystal display device includes a substrate, signal lines provided on the substrate, scanning lines which are perpendicular to the signal lines, switching elements which are provided at intersection portions between the signal lines, pixel electrodes and storage capacitance electrodes which are disposed in a matrix on the substrate, a contact hole which connects the pixel electrode and the switching element, or the switching element and the storage capacitance electrode, a counter-substrate which is disposed to be opposed to the substrate, a counter-electrode which is formed on the counter-substrate, and a liquid crystal layer which is held between the substrates and is formed of a liquid crystal with a negative dielectric constant anisotropy, the counter-electrode having an electrode missing part which is disposed at a position that is opposed to the contact hole.

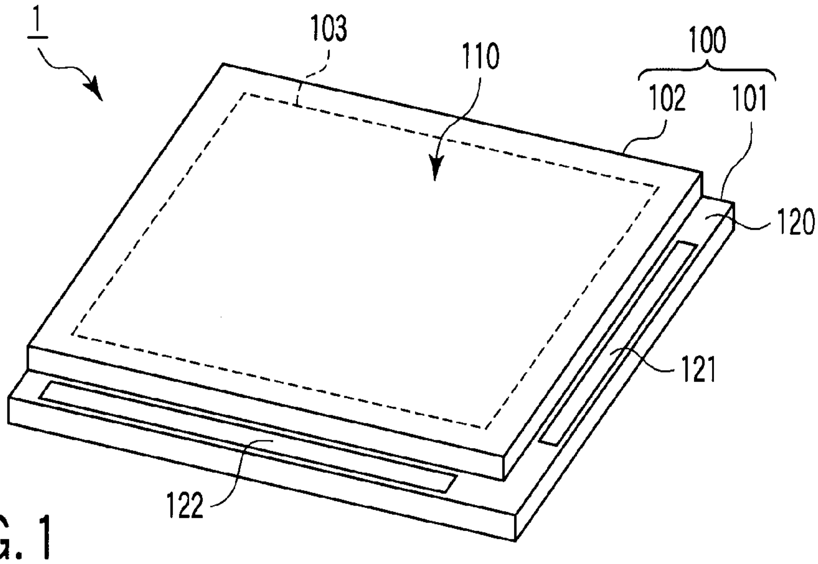

1
103
110
100
102
101
120
121
122

FIG. 1

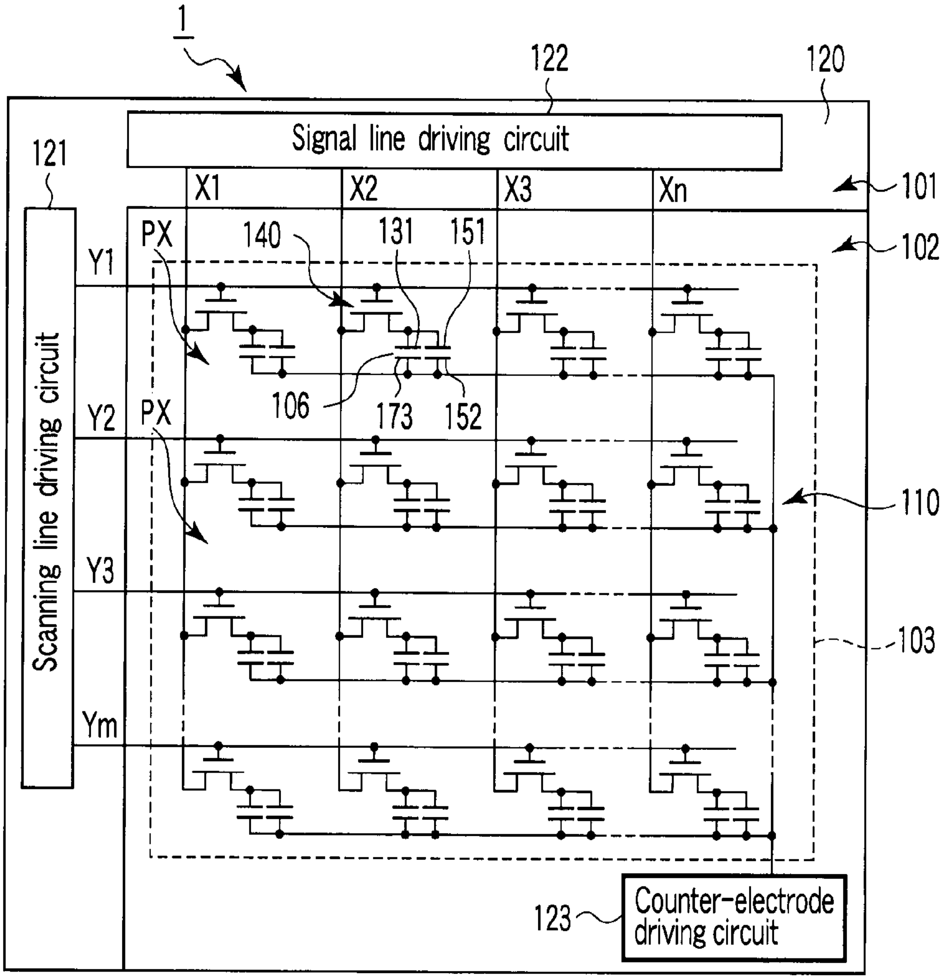

1
122
120
Signal line driving circuit
121
X1
X2
X3
Xn
101
100
102
Y1
PX
140
131
151
106
173
152
Y2
PX
Scanning line driving circuit
110
Y3
103
Ym
123
Counter-electrode driving circuit

FIG. 2

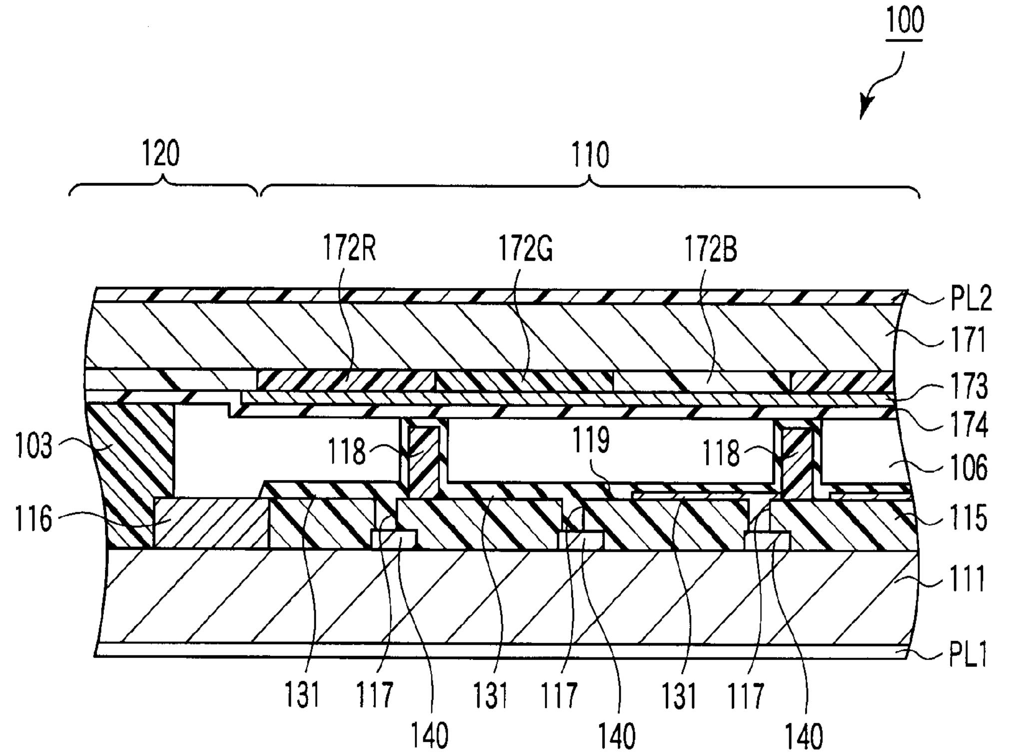

100
120
110
172R
172G
172B
PL2
171
173
174
103
118
119
118
106
116
115
111
PL1
131
117
140
131
117
140
131
117
140

FIG.3

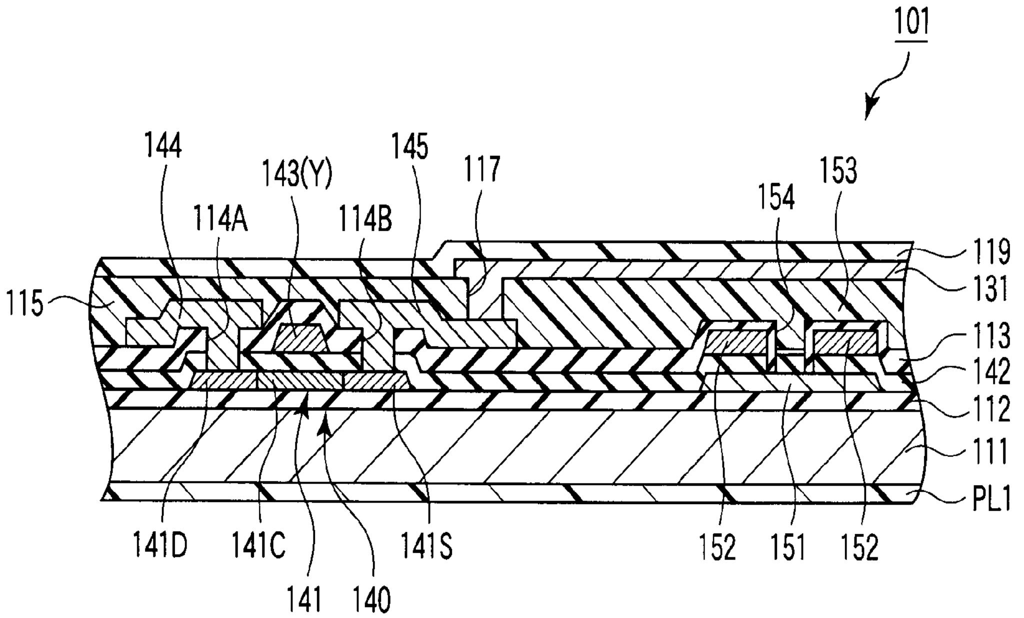

101
144
143(Y)
145
117
153
114A
114B
154
115
119
131
113
142
112
111
PL1
141D
141C
141S
152
151
152
141
140

FIG.4

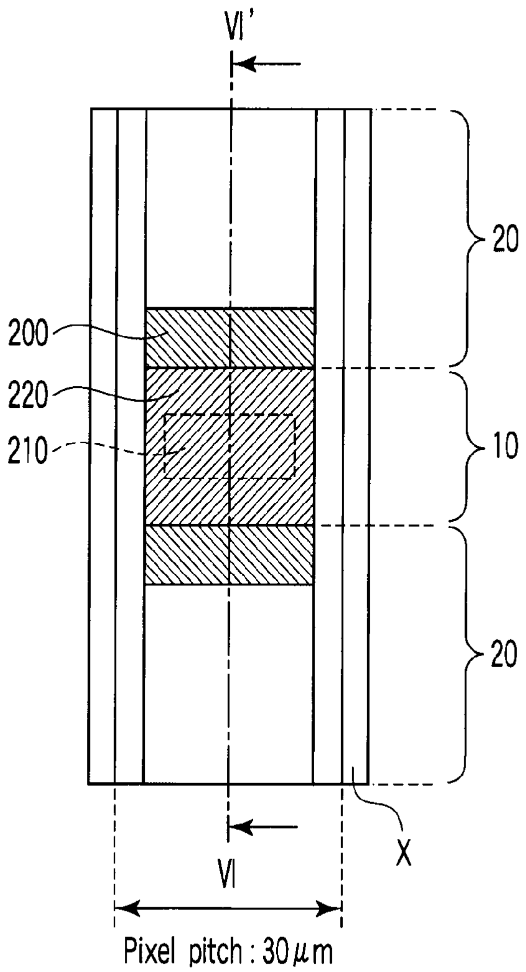

VI'
20
200
220
210
10
20
X
VI
Pixel pitch : 30μm

FIG. 5

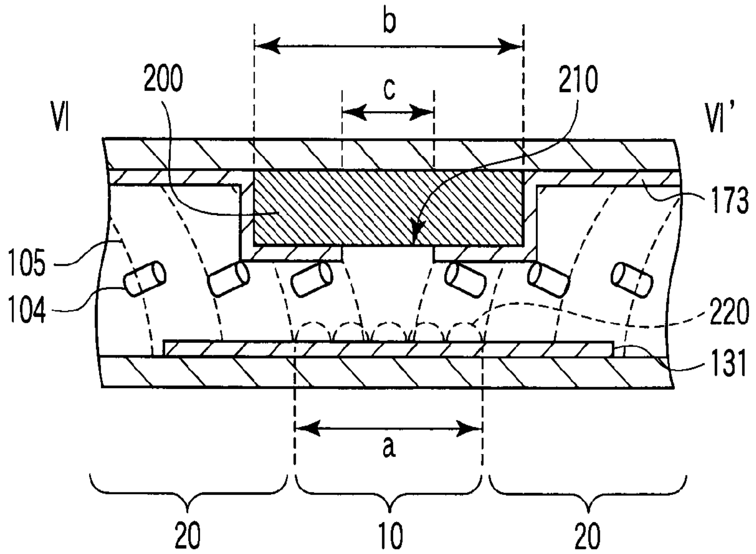

b
200
c
210
VI
VI'
173
105
104
220
131
a
20
10
20

FIG. 6

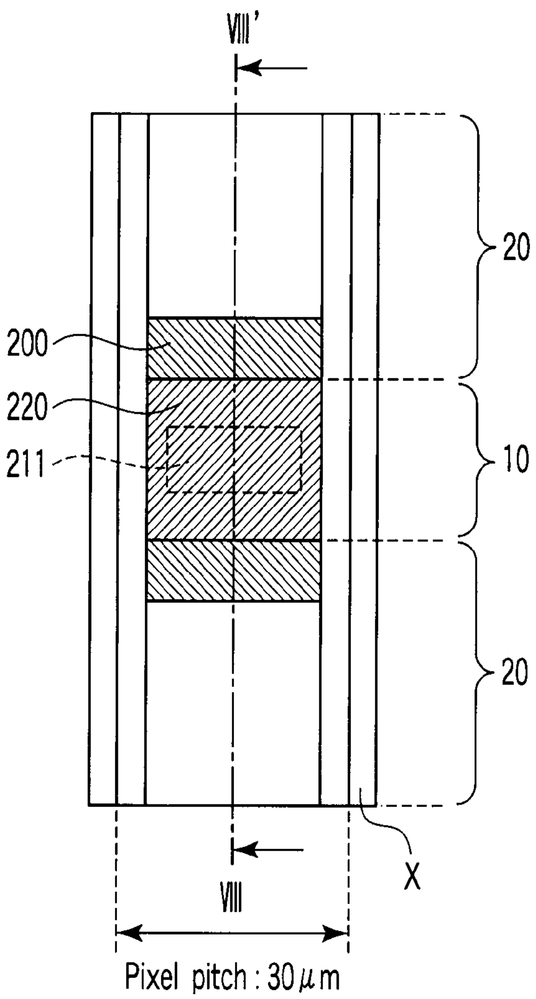

VIII'
20
200
220
211
10
20
X
VIII
Pixel pitch : 30 μm

FIG. 7

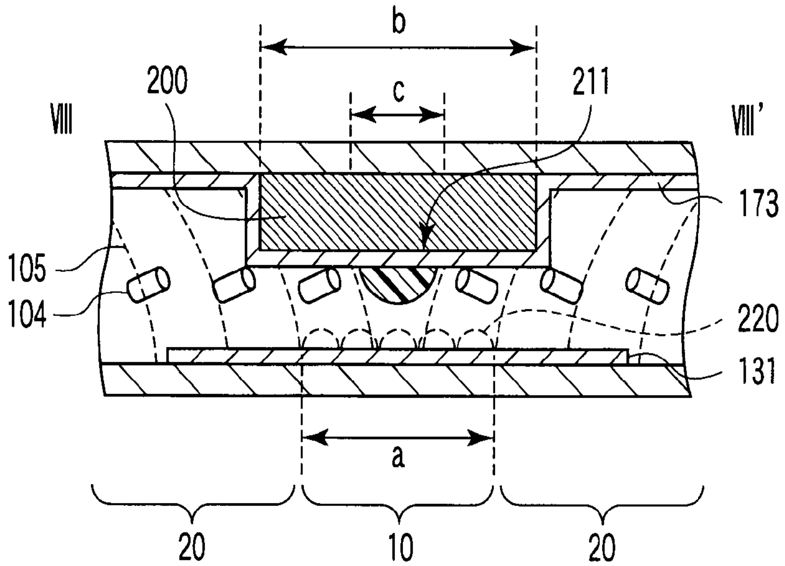

b
c
200
211
VIII
VIII'
173
105
104
220
131
a
20
10
20

FIG. 8

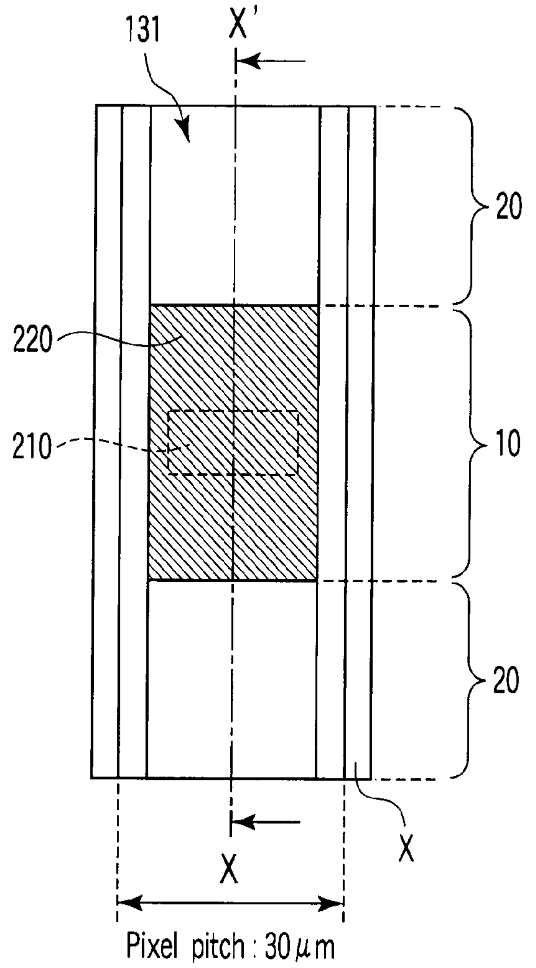

131
X'
20
220
210
10
20
X
X
Pixel pitch : 30μm

FIG. 9

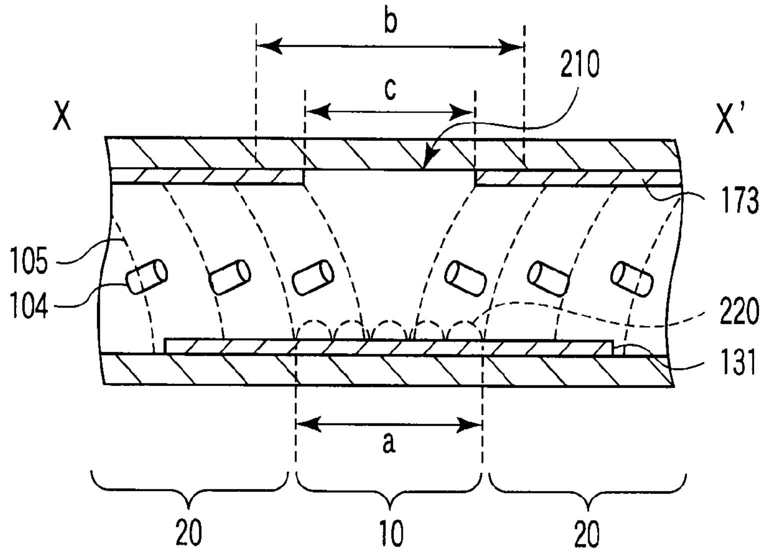

b
c
210
X
X'
173
105
104
220
131
a
20
10
20

FIG. 10

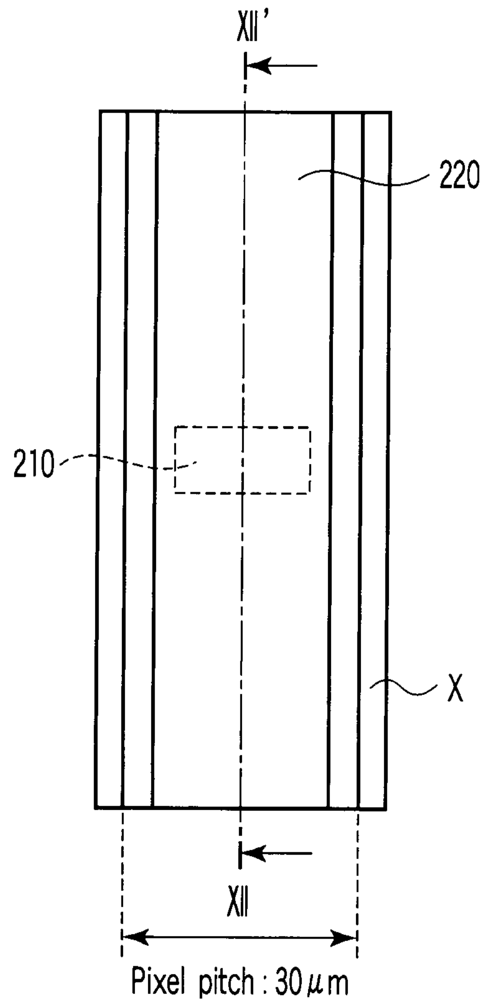

XII'
220
210
X
XII
Pixel pitch : 30μm

FIG. 11

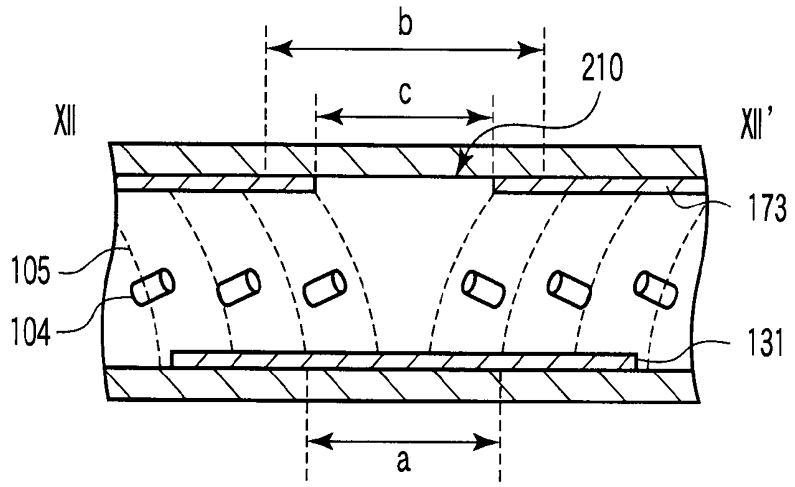
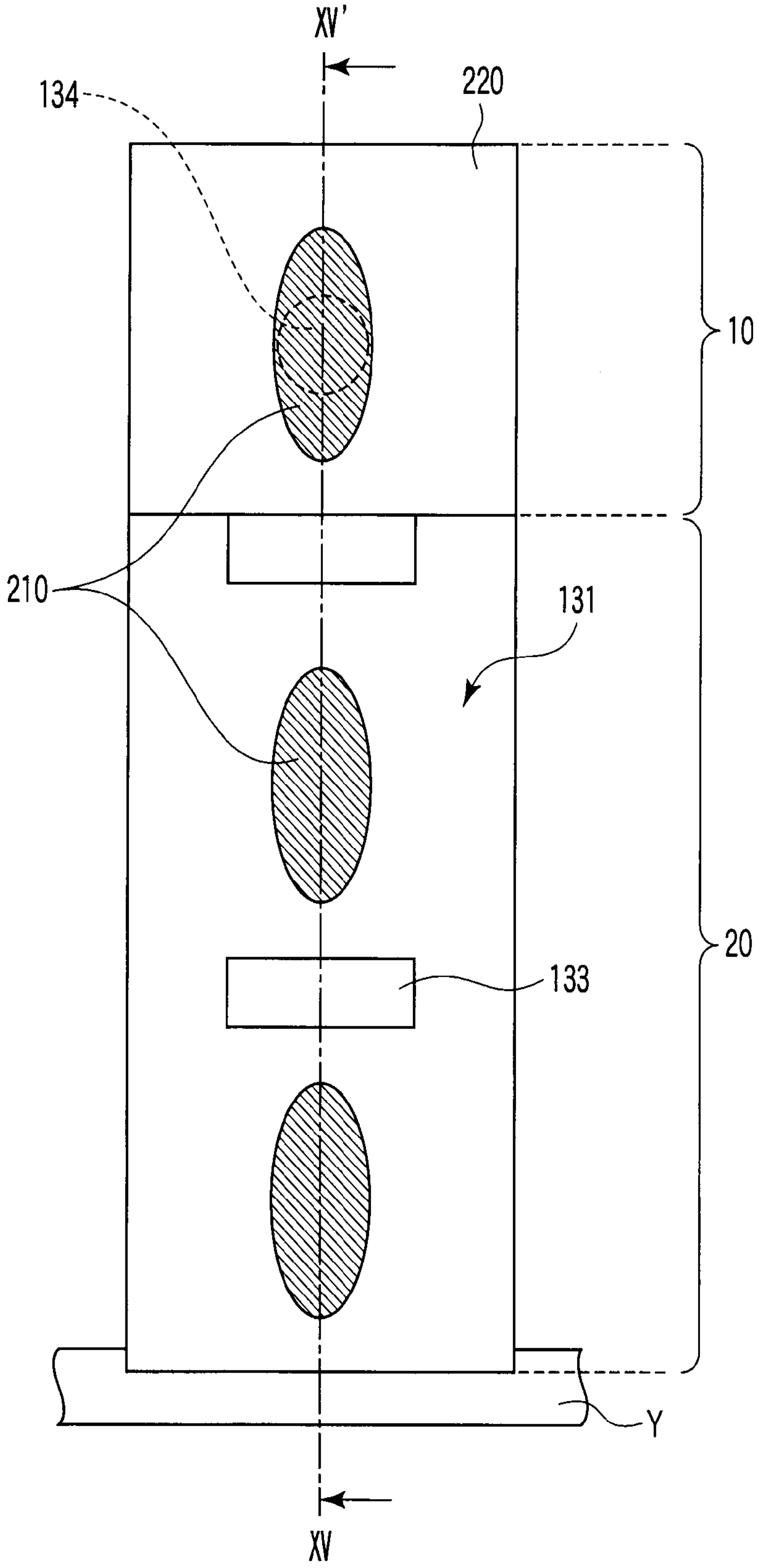

b
c
210
XII
XII'
173
105
104
131
a

FIG. 12

		First example	First comparative example	Second example	Third example
Width of reflective electrode	a	30	30	30	0
Width of stepped part	b	40	40	None	None
Slit/protrusion width	c	10 (slit width)	10 (protrusion width)	10 (slit width)	10(slit width)
Transmissive display	Screen quality (subjective evaluation)	Ok	Ok	Ok	Ok
	Transmittance (%)	3.2	3.2	4	4.4
	Contrast (CR)	450	450	450	600
	CR viewing angle: vertical/horizontal(cr≧10)	150/150	150/150	150/150	150/150
Reflective display	Screen quality (subjective evaluation)	Ok	Ok	Ok	–
	Reflectance	1.6	1.5	1.2	–
	Reflective CR	18	6	18	–
Notes		No problem	Low reflective CR	No problem	No problem

F I G. 13



F I G. 14

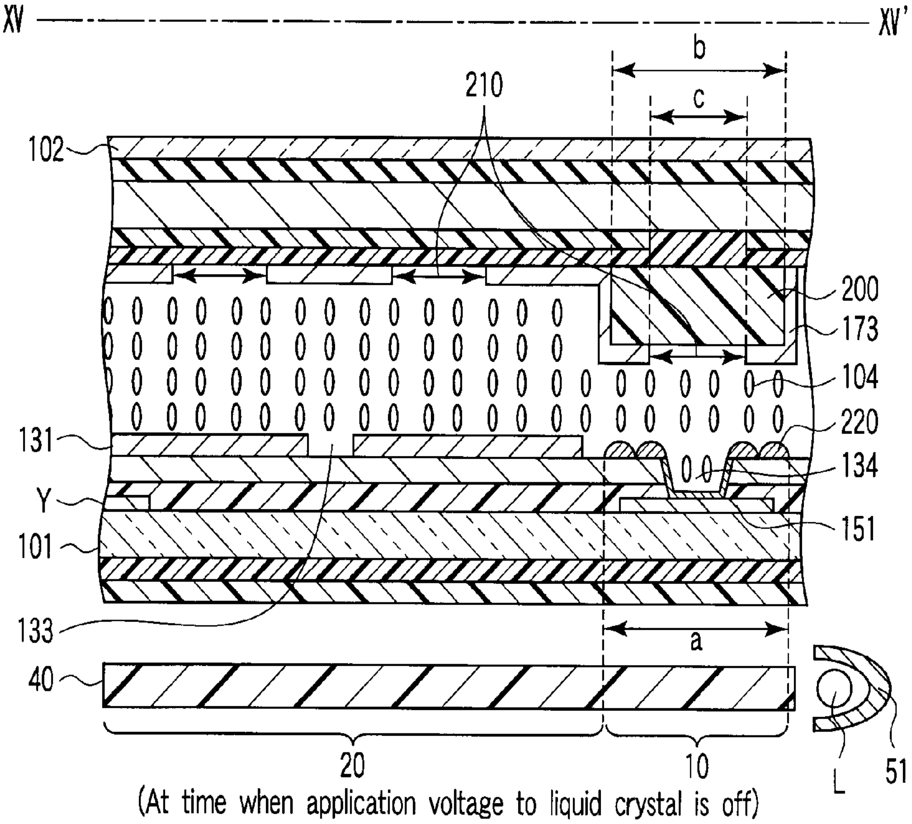


FIG. 15A

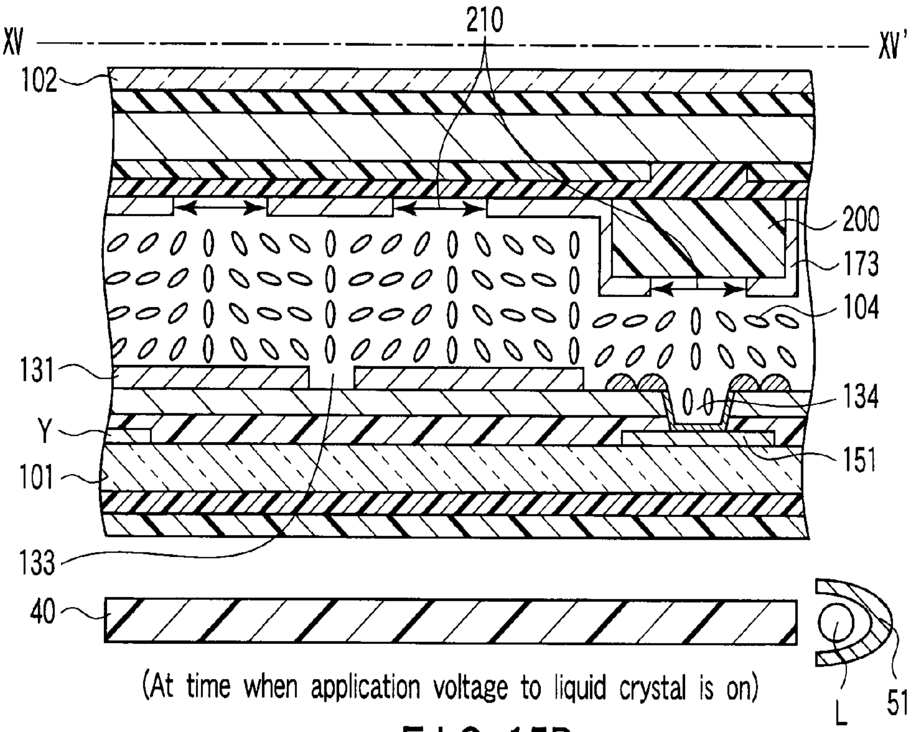
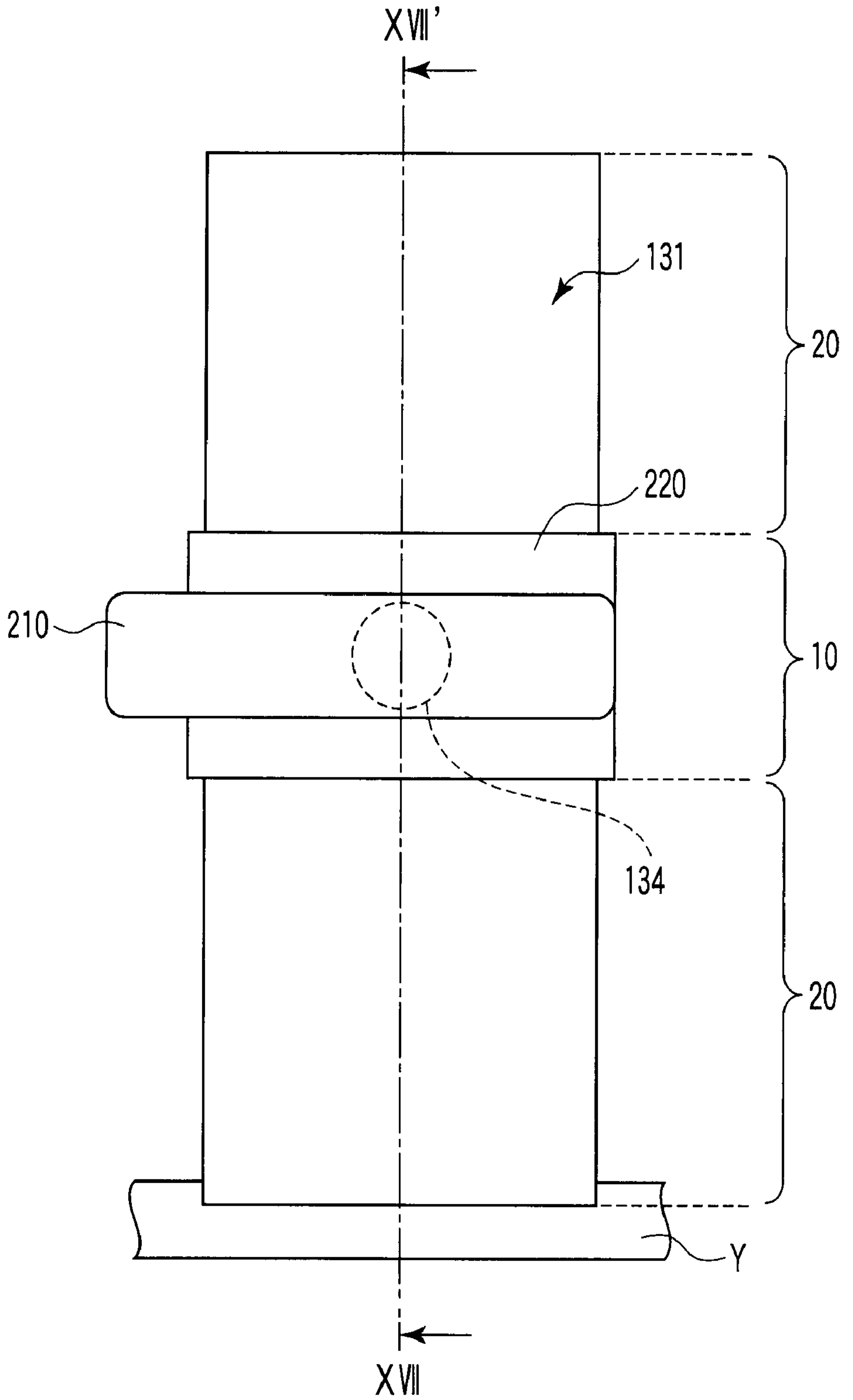


FIG. 15B



F I G. 16

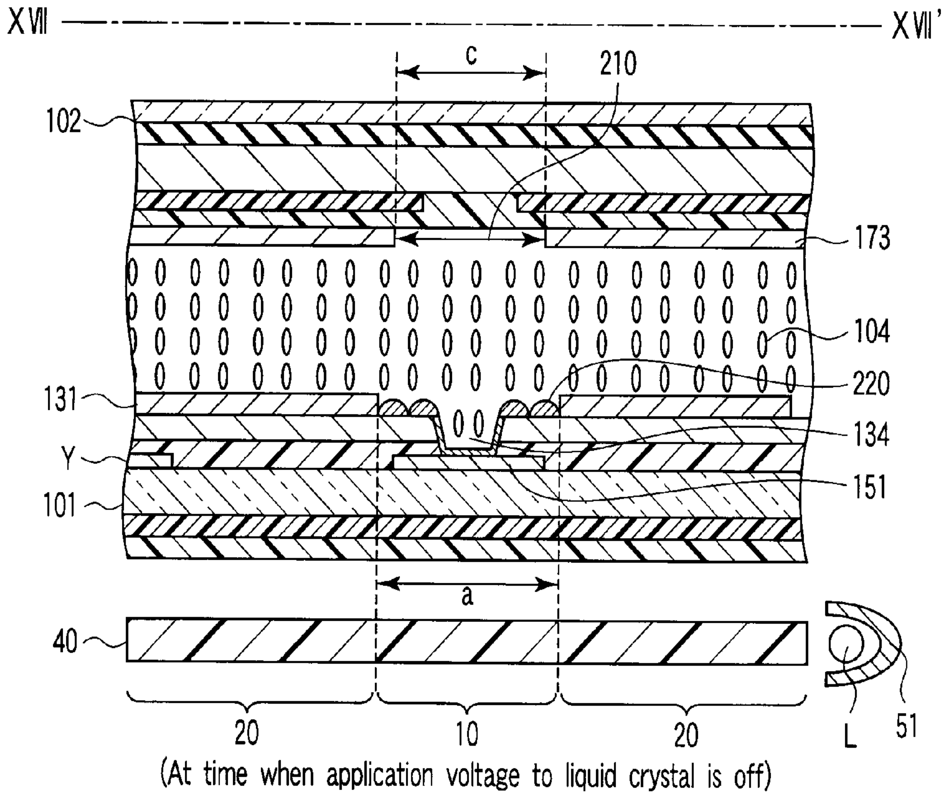


FIG. 17A

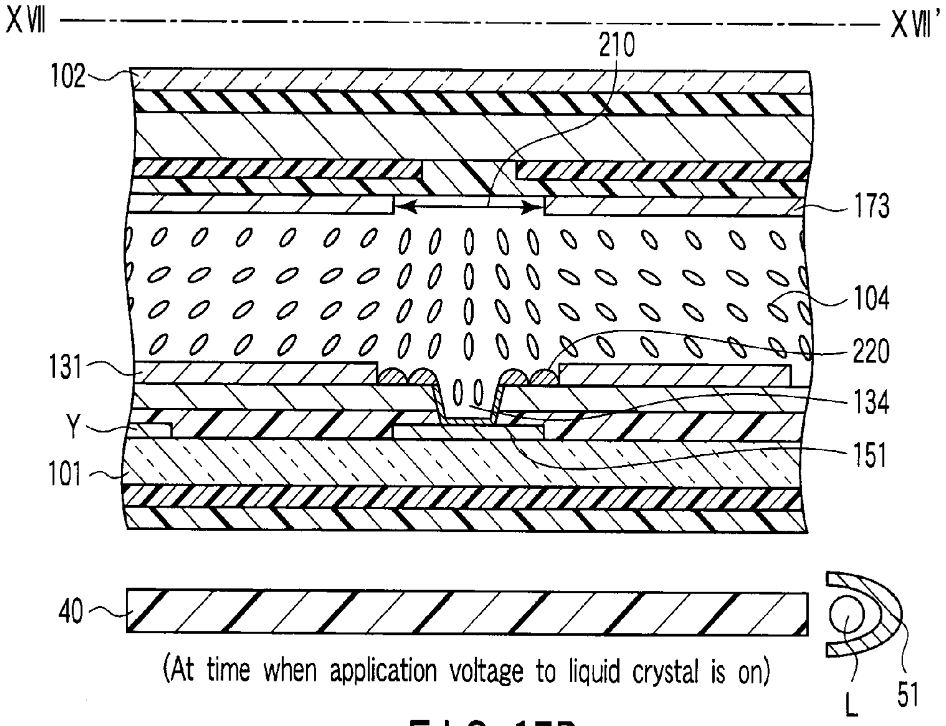


FIG. 17B

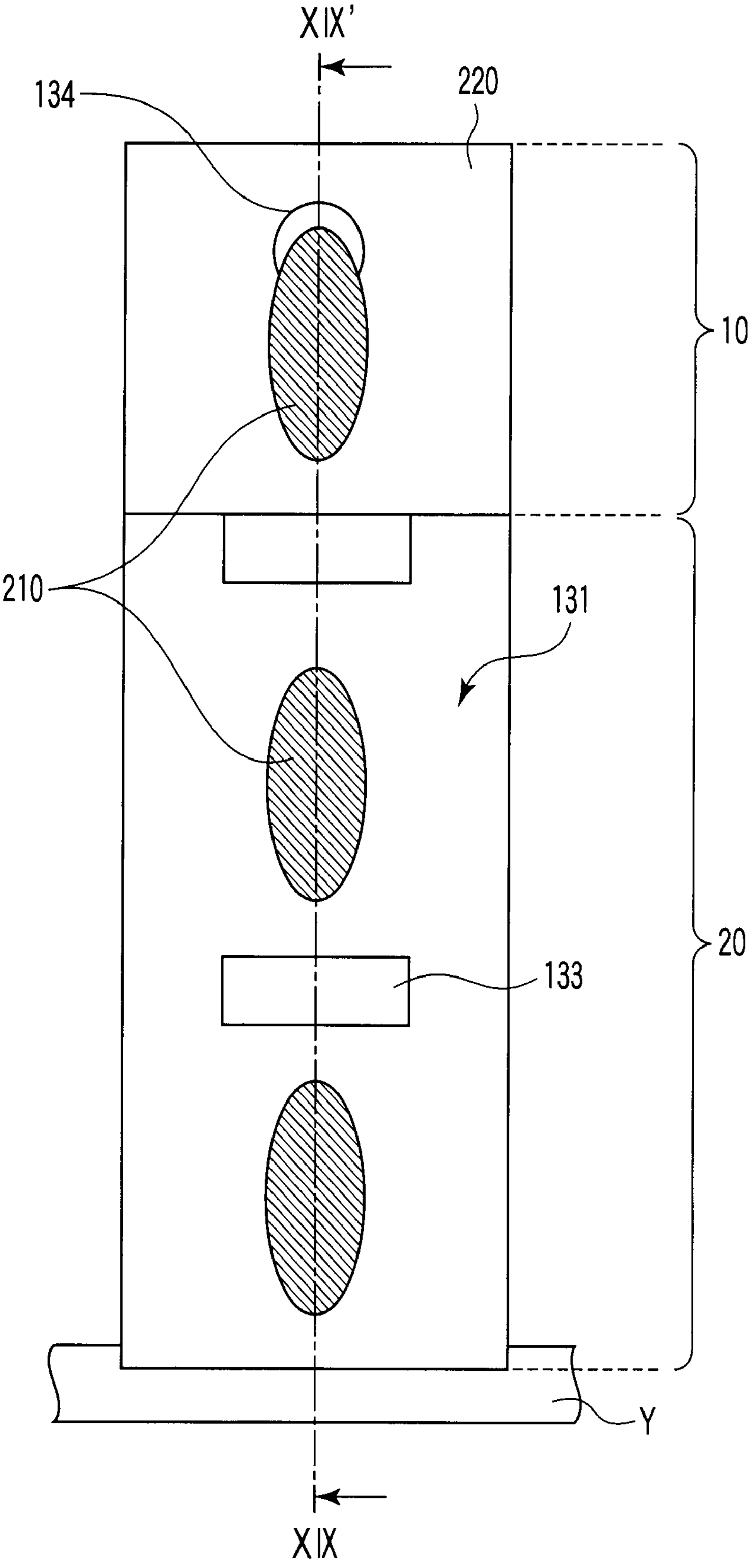


FIG. 18

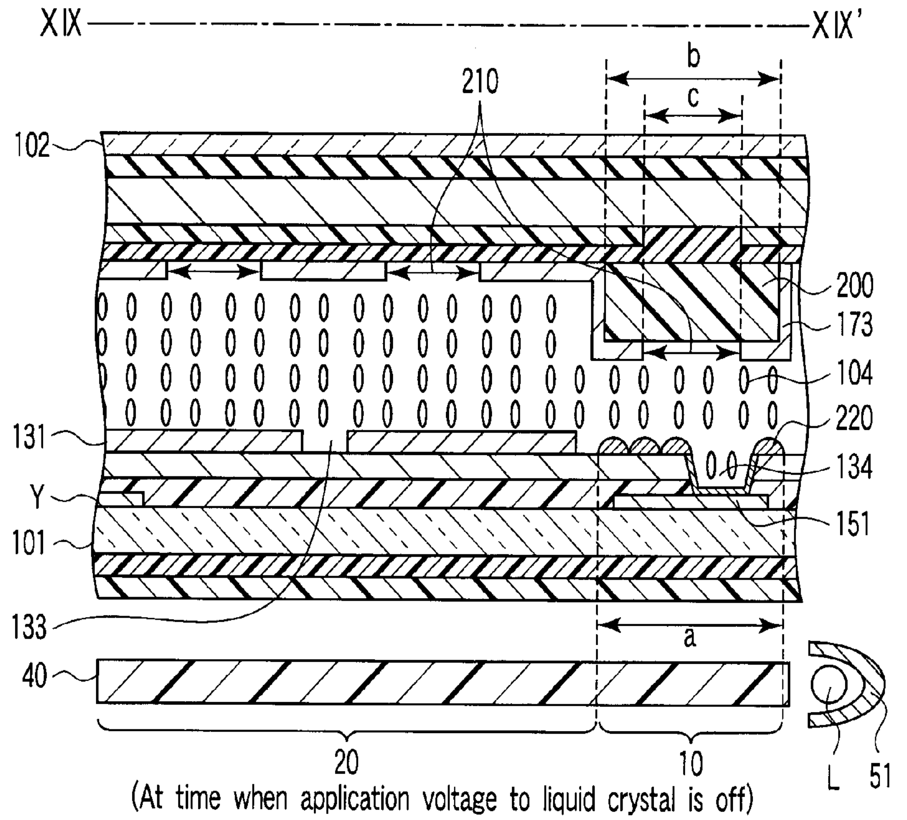


FIG. 19A

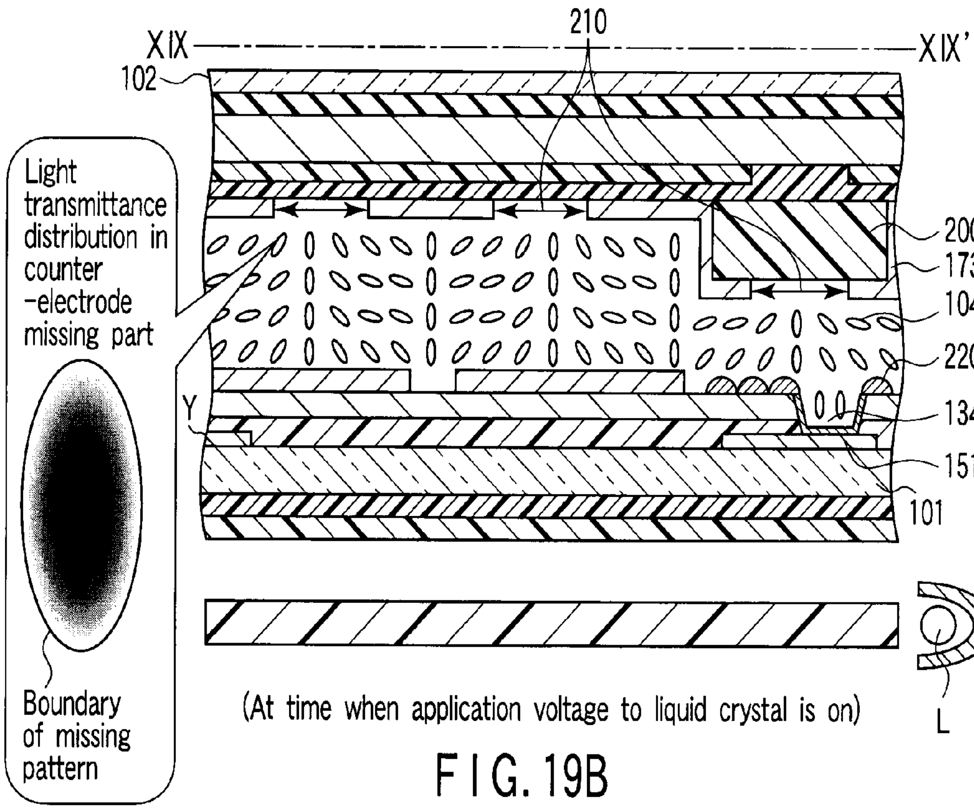


FIG. 19B

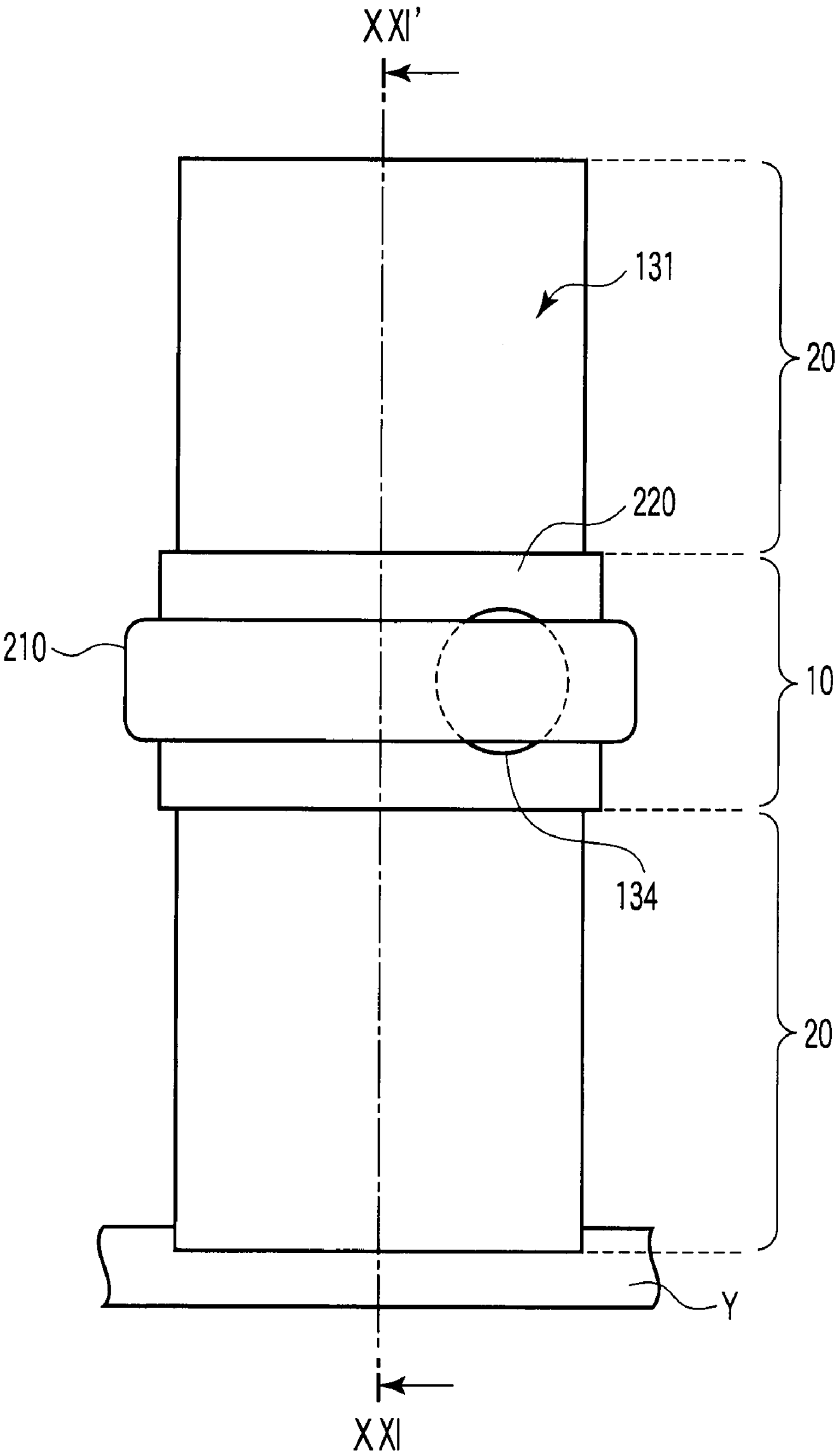


FIG. 20

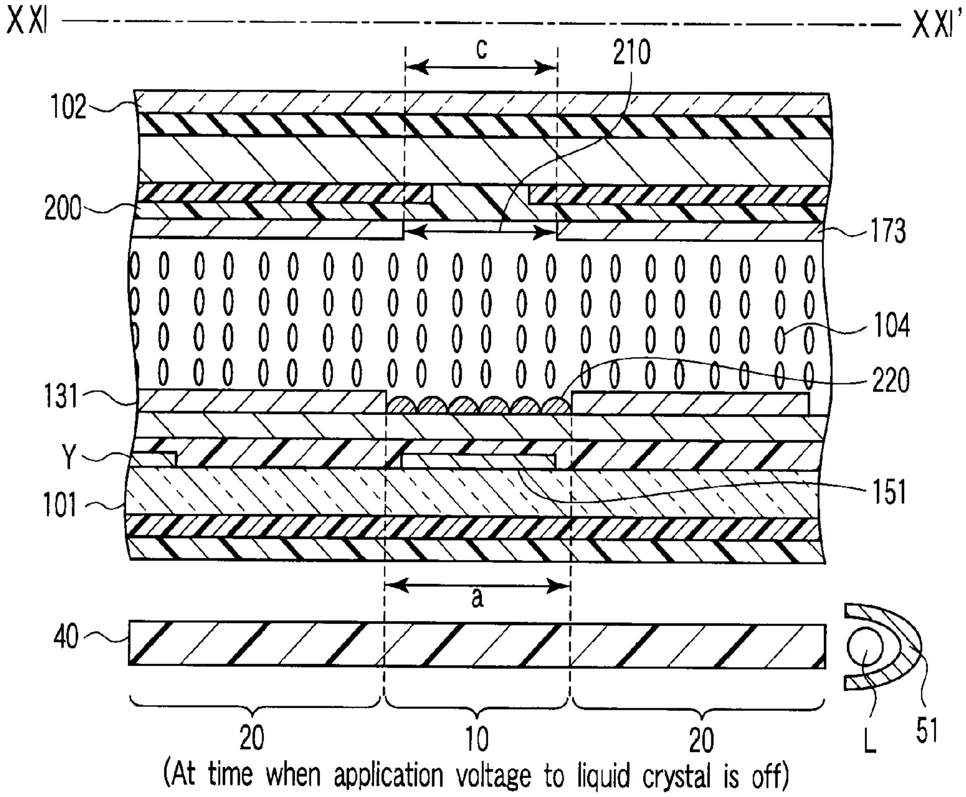


FIG. 21A

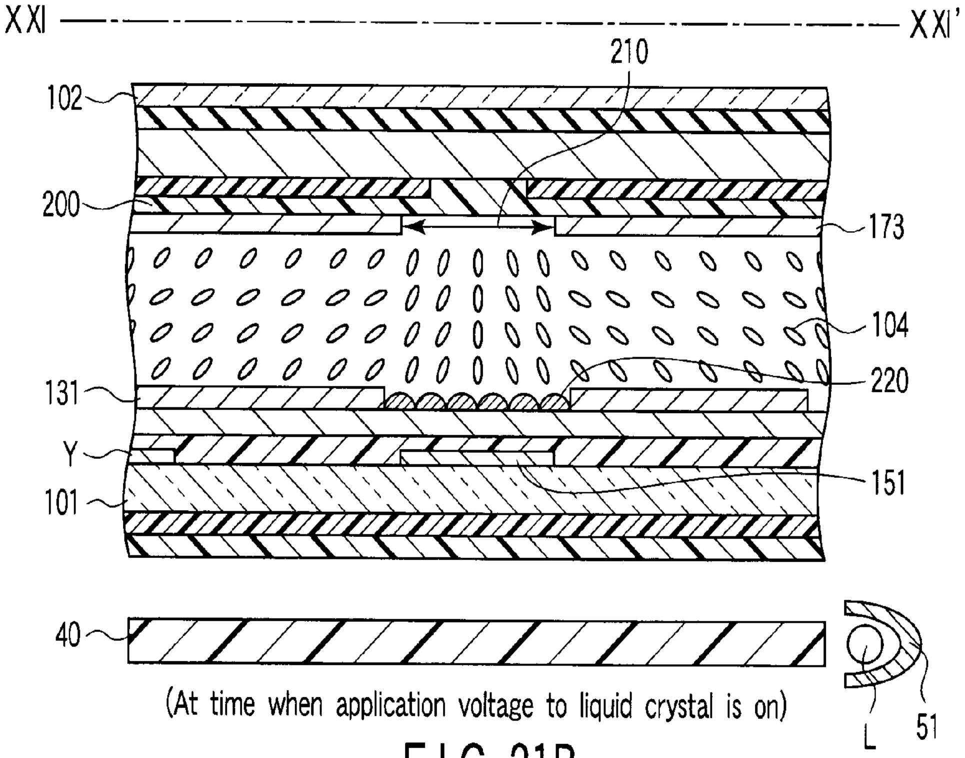


FIG. 21B

		First example	Second example	First comparative example	Second comparative example
Pixel pitch		166ppi	332ppi	166ppi	332ppi
Cell gap step		Present (multi-gap)	Absent (single gap)	Present (multi-gap)	Absent (single gap)
Polarizer structure		Circular polarization mode	Circular polarization mode	Circular polarization mode	Circular polarization mode
Pixel number		320(vertical) ×240(horizontal)RGB	640(vertical) ×480(horizontal)RGB	320(vertical) ×240(horizontal)RGB	640(vertical) ×480(horizontal)RGB
Alignment method		MVA	MVA	MVA	MVA
Pixel size		150 μm(vertical) ×50 μm(horizontal)	75 μm(vertical) ×25 μm(horizontal)	150 μm(vertical) ×50 μm(horizontal)	75 μm(vertical) ×25 μm(horizontal)
Missing area of counter -electrode on counter -substrate	Shape	Island shape	Horizontal stripe	Island shape	Horizontal stripe
	n (number per pixel)	Three (one in reflective region and two in transparent region)	1	Three (one in reflective region and two in transparent region)	1
	Width	25 μm(length)×10 μm(width)	Width10 μm	25 μm(length)×10 μm(width)	Width10 μm
	Position	Pixel central part (scanning line direction)	Pixel central part	Pixel central part (scanning line direction)	Pixel central part
	Direction	Perpendicular to scanning line direction	Parallel to scanning line direction	Perpendicular to scanning line direction	Parallel to scanning line direction
Position of contact hole		Central part relative to missing pattern	Central part relative to missing pattern	Non-central part relative to missing pattern	Non-central part relative to missing pattern
Transmission optical characteristics	Transmittance	5.00%	3.00%	5.00%	3.00%
	Contrast ratio	500	400	500	400
Reflection optical characteristics	Reflectance	2.50%	2.00%	2.00%	1.50%
	Contrast ratio	15	10	10	7
Alignment stability	Transmissive region	Stable	Stable	Stable	Stable
	Reflective region	Stable	Stable	Relatively unstable	Relatively unstable

FIG. 22

LIQUID CRYSTAL DISPLAY DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is based upon and claims the benefit of priority from prior Japanese Patent Application No. 2007-034003, filed Feb. 14, 2007, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates generally to a liquid crystal display device, and more particularly to a liquid crystal display device of a vertical alignment mode.

[0004] 2. Description of the Related Art

[0005] A liquid crystal display device has various features such as small thickness, light weight and low power consumption, and is applied to various uses, e.g. OA equipment, information terminals, timepieces, and TVs. In particular, a liquid crystal display device comprising thin-film transistors (TFTs) has high responsivity and, therefore, it is used as a monitor of a TV, a computer, etc., which displays a great deal of information.

[0006] In order to increase the display speed, consideration has been given to, in place of conventional display modes, an OCB mode, a VAN (Vertically Aligned Nematic) mode, a HAN (Hybrid Aligned Nematic) mode and a n alignment mode, which use nematic liquid crystals, and an SSFLC (Surface-Stabilized Ferroelectric Liquid Crystal) mode and an AFLC (Anti-Ferroelectric Liquid Crystal) mode, which use smectic liquid crystals.

[0007] Of these display modes, the VAN mode, in particular, has a higher response speed than the conventional TN (Twisted Nematic) mode. An additional feature of the VAN mode is that a rubbing process, which may lead to a defect such as an electrostatic breakage, can be made needless by vertical alignment. Particular attention is drawn to a multi-domain VAN mode in which the compensation design for a viewing angle is relatively easy (see, e.g. Japanese Patent No. 2565639).

[0008] Liquid crystal display devices are classified, according to display methods, into a reflective liquid crystal display device which makes use of ambient light, and a transmissive liquid crystal display device which makes use of backlight. In addition, there is known a transflective liquid crystal display device which adopts both the structures of the reflective liquid crystal display device and the transmissive liquid crystal display device.

[0009] In the transflective liquid crystal display device, a phase difference occurs in light passing through the liquid crystal layer between a transmissive display region and a reflective display region. Various means for eliminating such a phase difference have been proposed (see, e.g. Jpn. Pat. Appln. KOKAI Publication No. 2006-78742).

[0010] As regards the above-described liquid crystal display devices, however, in the case of a liquid crystal display device in which a short-side width of a pixel electrode is about 50 μm or less, there may occur an aperture ratio loss due to a protrusion disposed in the transmissive display region or light leakage at a part of an insulation layer due to a protrusion.

[0011] In addition, since a counter-electrode is not provided in a region of a counter-electrode missing pattern which is provided on the counter-substrate in order to control alignment, the electric field becomes lower in this region than in other regions. As a result, even at the time of application of voltage, the transmittance in the missing pattern region becomes lower than in the other regions.

[0012] Moreover, when voltage is applied, the region of the vicinity of a central part of the electrode missing part becomes a specific point in alignment of liquid crystal molecules, and this region transitions to an optically dark state. In short, in the vicinity of the central part of the electrode missing part, the transmittance decreases and loss in brightness may occur in some cases.

[0013] On the other hand, in the region where a contact hole, which is provided in the pixel electrode, is disposed, the thickness of the liquid crystal layer becomes different from a desired value due to the recess. Thus, a phase difference occurs in light between the region where the contact hole is disposed and the other region. Consequently, correct optical characteristics cannot be obtained in the region where the contact hole is disposed.

[0014] Further, there may be a case in which the state of alignment of liquid crystal molecules becomes unstable in the region where the contact hole is disposed, owing to the influence of the recess. As a result, when an image is displayed, there may occur degradation in quality of a screen image, such as persistence or roughness.

[0015] Besides, if there is a positional displacement between the central part of the electrode missing pattern and the part where the contact hole is disposed, the optical losses due to the respective parts may be combined and the optical characteristics of the liquid crystal display device may deteriorate.

BRIEF SUMMARY OF THE INVENTION

[0016] The present invention has been made in consideration of the above-described problems, and the object of the invention is to provide a liquid crystal display device which suppresses degradation in optical characteristics and a decrease in quality of a display screen.

[0017] According to an aspect of the present invention, there is provided a liquid crystal display device comprising: an array substrate; a plurality of signal lines provided on the array substrate; a plurality of scanning lines which are perpendicular to the plurality of signal lines; switching elements which are provided at intersection portions between the signal lines and the scanning lines and are connected to the signal lines and the scanning lines; pixel electrodes and storage capacitance electrodes which are disposed in a matrix on the array substrate; a contact hole which connects the pixel electrode and the switching element, or the pixel electrode and the storage capacitance electrode; a counter-substrate which is disposed to be opposed to the array substrate, with a gap being formed therebetween; a counter-electrode which is formed on the counter-substrate; and a liquid crystal layer which is held between the array substrate and the counter-substrate and is formed of a liquid crystal with a negative dielectric constant anisotropy, the counter-electrode having an electrode missing part which is disposed at a position that is opposed to the contact hole.

[0018] The present invention can provide a liquid crystal display device which suppresses degradation in optical characteristics and a decrease in quality of a display screen.

[0019] Additional objects and advantages of the invention will be set forth in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and obtained by means of the instrumentalities and combinations particularly pointed out hereinafter.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

[0020] The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention, and together with the general description given above and the detailed description of the embodiments given below, serve to explain the principles of the invention.

[0021] FIG. **1** is a perspective view showing an example of a liquid crystal display device according to a first embodiment of the present invention;

[0022] FIG. **2** is a view for describing an example of the structure of the liquid crystal display device shown in FIG. **1**;

[0023] FIG. **3** is a cross-sectional view for describing in detail an example of the structure of the liquid crystal display device shown in FIG. **1**;

[0024] FIG. **4** shows an example of a cross-sectional structure of an array substrate in the vicinity of an intersection between a scanning line and a signal line in the liquid crystal display device shown in FIG. **1**;

[0025] FIG. **5** is a view for describing an example of the structure of a display pixel of a liquid crystal display device according to a first example of the liquid crystal display device of the first embodiment of the present invention;

[0026] FIG. **6** shows an example of a cross section of the display pixel shown in FIG. **5**, the cross-section being taken along line VI-VI' in FIG. **5**;

[0027] FIG. **7** is a view for describing an example of the structure of a display pixel of a liquid crystal display device according to a first comparative example of the liquid crystal display device of the first embodiment of the invention;

[0028] FIG. **8** shows an example of a cross section of the display pixel shown in FIG. **7**, the cross section being taken along line VIII-VIII' in FIG. **5**;

[0029] FIG. **9** is a view for describing an example of the structure of a display pixel of a liquid crystal display device according to a second example of the liquid crystal display device of the first embodiment of the invention;

[0030] FIG. **10** shows an example of a cross section of the display pixel shown in FIG. **9**, the cross section being taken along line X-X' in FIG. **9**;

[0031] FIG. **11** is a view for describing an example of the structure of a display pixel of a liquid crystal display device according to a third example of the liquid crystal display device of the first embodiment of the invention;

[0032] FIG. **12** shows an example of a cross section of the display pixel shown in FIG. **11**, the cross section being taken along line XII-XII' in FIG. **11**;

[0033] FIG. **13** is a table showing an example of the evaluation result of the liquid crystal display devices according to the examples and the comparative example of the liquid crystal display device of the first embodiment of the invention;

[0034] FIG. **14** is a view for describing an example of the structure of a display pixel of a liquid crystal display device according to a first example of a liquid crystal display device relating to a second embodiment of the present invention;

[0035] FIG. **15**A shows an example of a cross section of the display pixel shown in FIG. **14**, the cross-section being taken along line XV-XV' in FIG. **14**;

[0036] FIG. **15**B shows another example of a cross section of the display pixel shown in FIG. **14**, the cross-section being taken along line XV-XV' in FIG. **14**;

[0037] FIG. **16** is a view for describing an example of the structure of a display pixel of a liquid crystal display device according to a second example of the liquid crystal display device of the second embodiment of the invention;

[0038] FIG. **17**A shows an example of a cross section of the display pixel shown in FIG. **16**, the cross-section being taken along line XVII-XVII' in FIG. **16**;

[0039] FIG. **17**B shows another example of a cross section of the display pixel shown in FIG. **16**, the cross-section being taken along line XVII-XVII' in FIG. **16**;

[0040] FIG. **18** is a view for describing an example of the structure of a display pixel of a liquid crystal display device according to a first comparative example of the liquid crystal display device of the second embodiment of the invention;

[0041] FIG. **19**A shows an example of a cross section of the display pixel shown in FIG. **18**, the cross section being taken along line XIX-XIX' in FIG. **18**;

[0042] FIG. **19**B shows another example of a cross section of the display pixel shown in FIG. **18**, the cross section being taken along line XIX-XIX' in FIG. **18**;

[0043] FIG. **20** is a view for describing an example of the structure of a display pixel of a liquid crystal display device according to a second comparative example of the liquid crystal display device of the second embodiment of the invention;

[0044] FIG. **21**A shows an example of a cross section of the display pixel shown in FIG. **20**, the cross section being taken along line XXI-XXI' in FIG. **20**;

[0045] FIG. **21**B shows another example of a cross section of the display pixel shown in FIG. **20**, the cross section being taken along line XXI-XXI' in FIG. **20**; and

[0046] FIG. **22** is a table showing an example of the evaluation result of the liquid crystal display devices according to the examples and the comparative examples of the liquid crystal display device of the second embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0047] A first embodiment of a liquid crystal display device according to the present invention will now be described with reference to the accompanying drawings. A liquid crystal display device **1** according to the first embodiment comprises, as shown in FIG. **1**, a liquid crystal display panel **100** which includes an array substrate **101**, a counter-substrate **102** which is disposed to be opposed to the array substrate **101** with a gap being formed therebetween, and a liquid crystal layer **106** which is held between the array substrate **101** and the counter-substrate **102**.

[0048] The liquid crystal display panel **100** has a display area **110** which is composed of a plurality of matrix-arrayed display pixels PX, and a peripheral area **120** which surrounds the display area **110**. As shown in FIG. **1**, the display area **110** is formed within a region surrounded by an outer edge seal member **103**, and the peripheral area **120** is disposed along the outer periphery of the display area **110**.

[0049] As shown in FIG. **2**, a plurality of signal lines X1 to Xn and a plurality of scanning lines Y1 to Ym are disposed on the display area **110** so as to intersect with each other. In the peripheral area **120** shown in FIG. **1**, the array substrate **101** includes a scanning line driving circuit **121** which drives the scanning lines Y1 to Ym, and a signal line driving circuit **122** which drives the signal lines X1 to Xn.

[0050] In the display area **110**, the array substrate **101** includes an (m×n) pixel electrodes **131** which are disposed in the respective display pixels PX and are arranged in a matrix. On the other hand, the counter-substrate **102** includes a counter-electrode **173** which is opposed to all the pixel electrodes **131**, with a liquid crystal **104** being interposed.

[0051] The liquid crystal **104** of the liquid crystal layer **106** has a negative dielectric constant anisotropy. In the state in which no voltage is applied between the pixel electrode **131** and the counter-electrode **173** or in the state in which a voltage less than a threshold value is applied therebetween, the liquid crystal **104** is aligned substantially vertical to the array substrate **101** or the counter-substrate **102**.

[0052] On the other hand, in the state in which a voltage of the threshold value or more is applied between the pixel electrode **131** and the counter-electrode **173**, the liquid crystal **104** is aligned oblique to or substantially parallel to the array substrate **101** or the counter-substrate **102**. At this time, the liquid crystal **104** has such characteristics that the direction of inclination of the liquid crystal **104** is substantially determined by the direction of electric force lines **105**.

[0053] The array substrate **101** includes an (m×n) number of thin-film transistors (TFTs) which are disposed as switching elements **140** near intersections between the scanning lines Y and signal lines X in association with the (m×n) pixel electrodes **131**.

[0054] A source electrode **145** (shown in FIG. **4**) of the switching element **140** is connected to the associated signal line X (or formed integral with the signal line X). A gate electrode **143** (shown in FIG. **4**) of the switching element **140** is connected to the associated scanning line Y (or formed integral with the scanning line Y). A drain electrode **144** (shown in FIG. **4**) of the switching element **140** is connected to the associated pixel electrode **131** (or formed integral with the pixel electrode **131**).

[0055] In addition, the array substrate **101** includes storage capacitance electrodes **151** which are set at the same potential as the associated pixel electrodes **131**. Further, the array substrate **101** includes storage capacitance lines **152** which are disposed to be opposed to the associated storage capacitance electrodes **151** and constitute storage capacitances between the storage capacitance lines **152** and the storage capacitance electrodes **151**, and a counter-electrode driving circuit **123** which is connected to the storage capacitance lines **152** and the counter-electrode **173**.

[0056] The counter-electrode driving circuit **123** executes control to set each storage capacitance line **152** and the counter-electrode **173** at a predetermined potential. The storage capacitance is constituted by each storage capacitance electrode **151** and the storage capacitance line **152** that is connected thereto.

[0057] FIG. **3** is a cross-sectional view of the liquid crystal display panel **100** at a region near the boundary between the peripheral area **120** and the display area **110**. FIG. **4** is a cross-sectional view of the array substrate **101** at a region near the intersection between the scanning line Y and signal line X shown in FIG. **2**. The structural parts shown in FIG. **3** and FIG. **4** will be described below.

[0058] As shown in FIG. **3** and FIG. **4**, the array substrate **101** includes a transparent insulative substrate **111** such as a glass substrate, and also includes a polarizer plate PL1 which is attached to the back side of the insulative substrate **111**. In the display area **110**, an undercoat layer **112** is disposed on the insulative substrate **111**. The switching elements **140** are disposed on the undercoat layer **112**.

[0059] The switching element **140** includes a semiconductor layer **141** which is formed of a polysilicon film on the undercoat layer **112**. The semiconductor layer **141** comprises a channel region **141**C, and a drain region **141**D and a source region **141**S which are formed by doping impurities on both sides of the channel region **141**C. In addition, the storage capacitance electrode **151**, which is formed of an impurity-doped polysilicon film, is disposed on the undercoat layer **112**.

[0060] A gate insulation film **142** is formed on the undercoat layer **112**, semiconductor layer **141** and storage capacitance electrode **151**. The gate electrode **143**, the scanning line Y that is integral with the gate electrode **143**, and the storage capacitance line **152** are formed on the gate insulation film **142**. A part of the storage capacitance line **152** is opposed to the storage capacitance electrode **151**. The storage capacitance line **152** is formed of the same material as the scanning line Y and extends substantially parallel to the scanning line Y.

[0061] An interlayer insulation film **113** is disposed on the gate insulation film **142**, gate electrode **143**, scanning line Y and storage capacitance line **152**. The drain electrode **144**, signal line X, source electrode **145** and contact electrode **153** are disposed on the interlayer insulation film **113**.

[0062] The signal line X is disposed substantially perpendicular to the scanning line Y and the storage capacitance line **152**. The signal line X, scanning line Y and storage capacitance line **152** are formed of a low resistance material having light-blocking properties.

[0063] For example, the scanning line Y and storage capacitance line **152** are formed of molybdenum-tungsten. The signal line X is, in most cases, formed of aluminum. The drain electrode **144** and the source electrode **145** are connected to the drain region **141**D and source region **141**S via contact holes **114**A and **114**B that penetrate the gate insulation film **142** and interlayer insulation film **113**.

[0064] The contact electrode **153** is connected to the storage capacitance electrode **151** via a contact hole **154** that penetrates the gate insulation film **142** and interlayer insulation film **113**. The contact electrode **153** is formed of the same material as the drain electrode **144** and source electrode **145**.

[0065] In the display area **110**, a transparent resin layer **115** is further disposed on the interlayer insulation film **113**, drain electrode **144**, source electrode **145**, scanning line Y, signal line X and contact electrode **153**. In the peripheral area **120**, a light-blocking layer **116** is further disposed.

[0066] The pixel electrode **131**, which is formed of a light-transmissive electrically conductive material such as ITO (Indium Tin Oxide), is disposed on the transparent resin layer **115**. The pixel electrode **131** is connected to the source electrode **145** of the switching element **140** via a contact hole **117** that penetrates the transparent resin layer **115**. In addition, columnar spacers **118**, each having a height of, e.g. 2.0 μm, are disposed on the transparent resin layer **115**.

[0067] An alignment film **119** is disposed on the transparent resin layer **115** and pixel electrodes **131** so as to cover the columnar spacers **118**. The alignment film **119** functions to align the liquid crystal **104** of the liquid crystal layer **106** in a direction substantially perpendicular to the substrate surface of the array substrate **101**.

[0068] On the other hand, the counter-substrate **102** includes a transparent insulative substrate **171** such as a glass substrate, and a polarizer plate PL**2** is attached to the front side of the insulative substrate **171**. In the display area **110**, the counter-substrate **102** includes a red color filter layer **172**R, a green color filter layer **172**G and a blue color filter layer **172**B, which are disposed on the insulative substrate **171**. The counter-electrode **173** is disposed on the color filters so that the counter-electrode **173** may be opposed to all the pixel electrodes **131**.

[0069] The counter-electrode **173** is formed of a light-transmissive electrically conductive material such as ITO. An alignment film **174** is disposed on the counter-electrode **173**. The alignment film **174** functions to align the liquid crystal **104** of the liquid crystal layer **106** in a direction substantially perpendicular to the substrate surface of the counter-substrate **102**. The array substrate **101** and counter-substrate **102** are attached to each other via the outer edge seal member **103**.

[0070] The alignment film **119** is directly formed on the pixel electrodes **131**, and the alignment film **174** is directly formed on the counter-electrode **173**. In addition, protrusions, or the like, may be formed of an insulation film as means for aligning liquid crystal molecules. This insulation film is, for example, an inorganic thin film of SiO_2, SiNx or Al_2O_3, or an organic thin film of polyimide, photoresist resin or high-polymer liquid crystal.

[0071] In the case where the insulation film is an inorganic thin film, the insulation film may be formed by evaporation deposition, sputtering, CVD (Chemical Vapor Deposition) or a solution coating method. In the case where the insulation film is an organic thin film, the following methods may be adopted. For example, a solution of an organic substance or a solution of a precursor thereof is used and is coated by a spinner coating method, a screen print coating method or a roll coating method, and the coated film is cured under pre-determined curing conditions (e.g. heating, light radiation). Alternatively, the insulation film may be formed by evaporation deposition, sputtering, CVD, or LB (Langumuir-Blodgett) method.

[0072] The liquid crystal display device **1** according to the present embodiment includes an area light source unit (not shown) which is disposed on the back side of the liquid crystal display panel **100**. The area light source unit includes, for example, a cold cathode tube as a light source, a light guide which guides light that is emitted from the cold cathode tube to the liquid crystal display panel **100** side, and various optical sheets.

[0073] Next, examples and a comparative example of the liquid crystal display device **1** according to the present embodiment will be described. These examples are described for the purpose of easier understanding of the present invention, and do not restrict the scope of the invention. Further, the present invention may be variously modified in use without departing from the spirit of the invention.

[0074] To begin with, a first example of the liquid crystal display device **1** according to the present embodiment is described. In this example, the liquid crystal display device **1** includes a liquid crystal display panel **100** in which the pitch of arrangement of display pixels PX is about 300 ppi. The size of the display pixel PX is about 90 μm in the long side and about 30 μm in the short side.

[0075] In the liquid crystal display panel **100**, the array substrate **101** and counter-substrate **102** are formed by the process described in the embodiment so as to have a pixel structure as shown in FIG. **5** and FIG. **6**.

[0076] Specifically, the pixel electrode **131** includes a transmissive electrode and a reflective electrode **220** which has a projection-and-recess-shaped surface. Accordingly, the liquid crystal display device **1** of the present example is a transflective liquid crystal display device. A resin insulation layer **200** is disposed on the counter-substrate **102** so as to be opposed to the reflective electrode **220** of the array substrate **101**, and a counter-electrode **173** is disposed on the resin insulation layer **200**.

[0077] The counter-electrode **173** has an electrode missing part **210** at a position that is opposed to the reflective electrode **220**. Specifically, the electrode missing part **210** of the counter-electrode **173** is provided on the resin insulation layer **200**. The electrode missing part **210** restricts the direction of the tilt of the liquid crystal **104** of the liquid crystal layer **106** when a voltage is applied to the liquid crystal layer **106**. In other words, when a voltage is applied to the liquid crystal layer **106**, the liquid crystal **104** of the liquid crystal layer **106** tilts toward the electrode missing part **210**, as shown in FIG. **6**.

[0078] In this example, the width a of the reflective electrode **220** of the array substrate **101** is set at about 30 μm, and the width b of the resin insulation layer **200** disposed on the counter-substrate **102** is set at about 40 μm. The electrode missing part **210** is disposed such that the short side width c thereof is about 10 μm.

[0079] Accordingly, as shown in FIG. **5** and FIG. **6**, the resin insulation layer **200** is disposed so as to cover the reflective electrode **220**. In short, the resin insulation layer **200** is opposed to the reflective electrode **220**. The electrode missing part **210** is disposed on the resin insulation layer **200** so as to face the reflective electrode **220**.

[0080] Alignment films (not shown), which exhibit verticality, were coated with a thickness of about 100 nm on the array substrate **101** and the counter-substrate **102**, and the liquid crystal display panel **100** was assembled by the ordinary process. Then, the liquid crystal **104** with a negative dielectric constant anisotropy was filled in the liquid crystal display panel **100**, and the liquid crystal display panel **100** was assembled in the liquid crystal display device **1**.

[0081] FIG. **13** shows a result of evaluation of the liquid crystal display device **1**. As shown in FIG. **13**, in the case of this liquid crystal display device **1**, no problem occurred in the transmissive display and reflective display.

[0082] Next, a first comparative example of the liquid crystal display device **1** according to the present embodiment is described. In this example, the liquid crystal display device **1** includes a liquid crystal display panel **100** in which the pitch of arrangement of display pixels PX is about 300 ppi. The size of the display pixel PX is about 90 μm in the long side and about 30 μm in the short side.

[0083] In the liquid crystal display panel **100**, the array substrate **101** and counter-substrate **102** are formed by the process described in the above embodiment so as to have a pixel structure as shown in FIG. **7** and FIG. **8**. In this comparative example, the pitch of arrangement of display pixels PX is the length of the short side of the pixel electrode **131**.

[0084] Specifically, like the liquid crystal display device of the above-described first example, the pixel electrode **131** includes a transmissive electrode and a reflective electrode **220** which has a projection-and-recess-shaped surface. Accordingly, the liquid crystal display device **1** of the present comparative example is a transflective liquid crystal display device. A resin insulation layer **200** is disposed on the counter-substrate **102** so as to be opposed to the reflective electrode **220**.

[0085] A counter-electrode **173** is disposed on the resin insulation layer **200**, and a protrusion **211** is disposed on the counter-electrode **173** so as to face the reflective electrode **220**. The protrusion **211** restricts the direction of the tilt of the liquid crystal **104** of the liquid crystal layer **106** when a voltage is applied to the liquid crystal **104**. In other words, when a voltage is applied to the liquid crystal layer **106**, the liquid crystal **104** tilts toward the protrusion **211**, as shown in FIG. **8**.

[0086] In the liquid crystal display device **1** of this comparative example, the width a of the reflective electrode **220** is set at about 30 μm, and the width b of the resin insulation layer **200** disposed on the counter-substrate **102** is set at about 40 μm. The width c of the protrusion **211** is set at about 10 μm.

[0087] Accordingly, as shown in FIG. **7** and FIG. **8**, the resin insulation layer **200** is disposed so as to cover the reflective electrode **220**. In short, the resin insulation layer **200** is opposed to the reflective electrode **220**. The protrusion **211** is disposed on the resin insulation layer **200** so as to face the reflective electrode **220**.

[0088] Alignment films (not shown), which exhibit verticality, were coated with a thickness of about 100 nm on the array substrate **101** and the counter-substrate **102**, and the liquid crystal display panel **100** was assembled by the ordinary process. Then, the liquid crystal **104** with a negative dielectric constant anisotropy was filled in the liquid crystal display panel **100**, and the liquid crystal display panel **100** was assembled in the liquid crystal display device **1**.

[0089] FIG. **13** shows a result of evaluation of the above-described liquid crystal display device **1**. As shown in FIG. **13**, in the case of this liquid crystal display device **1**, no problem occurred in the transmissive display and reflective display. However, the reflective contrast was lower than in the liquid crystal display device **1** according to the first example.

[0090] Next, a second example of the liquid crystal display device **1** according to the present embodiment is described. In this example, the liquid crystal display device **1** includes a liquid crystal display panel **100** in which the pitch of arrangement of display pixels PX is about 300 ppi. The size of the display pixel PX is about 90 μm in the long side and about 30 μm in the short side.

[0091] In the liquid crystal display panel **100**, the array substrate **101** and counter-substrate **102** are formed by the process described in the above embodiment so as to have the pixel structure as shown in FIG. **9** and FIG. **10**. In the liquid crystal display device **1** of this second example, unlike the liquid crystal display device **1** of the first example, the counter-substrate **102** does not include the resin insulation layer **200**.

[0092] On the other hand, like the liquid crystal display device **1** of the first example, the pixel electrode **131** includes a transmissive electrode and a reflective electrode **220** which has a projection-and-recess-shaped surface. Accordingly, the liquid crystal display device **1** of the present example is a transflective liquid crystal display device. The counter-electrode **173** has an electrode missing part **210** which faces the reflective electrode **220**.

[0093] In this example, the width a of the reflective electrode **220** of the array substrate **101** was set at about 30 μm. An electrode missing part **210**, which restricts the direction of the tilt of the liquid crystal **104**, is provided on the counter-substrate **102**, and the short side width c of the electrode missing part **210** was set at about 10 μm.

[0094] Alignment films (not shown), which exhibit verticality, were coated with a thickness of about 100 nm on the array substrate **101** and the counter-substrate **102**, and the cell was assembled by the ordinary process. Then, the liquid crystal **104** with a negative dielectric constant anisotropy was filled in the cell, and the module was assembled.

[0095] FIG. **13** shows a result of evaluation of the liquid crystal display device **1** according to this example. As shown in FIG. **13**, in the case of this liquid crystal display device **1**, no particular problem occurred in the display, although the reflectance at the time of reflective display was slightly low.

[0096] Next, a third example of the liquid crystal display device **1** according to the present embodiment is described. In this example, the liquid crystal display device **1** includes a liquid crystal display panel **100** in which the pitch of arrangement of display pixels PX is about 300 ppi. The size of the display pixel PX is about 90 μm in the long side and about 30 μm in the short side.

[0097] In the liquid crystal display panel **100**, the array substrate **101** and counter-substrate **102** were formed by the process described in the above embodiment so as to have a pixel structure as shown in FIG. **11** and FIG. **12**.

[0098] Specifically, as shown in FIG. **11** and FIG. **12**, the pixel electrode **131** of the liquid crystal display device **1** of this example includes only the transmissive electrode, and does not include the reflective electrode **220**. Accordingly, the liquid crystal display device **1** of this example is a transmissive liquid crystal display device.

[0099] The counter-electrode **173** has an electrode missing part **210** which faces the transmissive electrode of the pixel electrode **131**. The width c in the short-side direction of the electrode missing part **210** was set at about 10 μm.

[0100] FIG. **13** shows a result of evaluation of the liquid crystal display device according to this example. As shown in FIG. **13**, although the liquid crystal display device of this example is unable to perform reflective display, no problem occurred in the transmissive display.

[0101] In the above-described examples and comparative example relating to the present embodiment, the electrode missing part **210** has a substantially rectangular shape with the width c of about 10 μm and the length of about 20 μm. However, if the width is about 5 μm and the length is about 5 μm or more, the shape of the electrode missing part is not restricted.

[0102] As regards the relationship in dimension between the width a of the reflective electrode **220** and the width b of the resin insulation layer **200** of the counter-electrode **102**, the width b of the resin insulation layer **200** of the counter-electrode **102** has to be greater than the width a of the reflective electrode **220**.

[0103] Specifically, in the case where the width b of the resin insulation layer **200** of the counter-electrode **102** is less than the width a of the reflective electrode **220** and a reflective display region **10** includes a part where the thickness of the liquid crystal layer **106** is the same as in a transmissive display region **20**, the color and gradation at the time of reflective display may deviate from optimal ones, and the display quality may deteriorate.

[0104] On the other hand, as is understood from the above result, in the case where the width b of the resin insulation layer **200** of the counter-electrode **102** is greater than the width a of the reflective electrode **220** and the thickness of the liquid crystal layer **106** in the reflective display region **10** is less than the thickness of the liquid crystal layer **106** in the transmissive display region **20**, no abnormality occurs in the color and gradation even at the time of reflective display, and a good display condition can be attained at the time of transmissive display.

[0105] As regards the vertical-alignment liquid crystal display device, there is a case in which a viewing angle compensation plate is used so that the viewing angle characteristics may become better as the transmittance becomes lower. In this case, a part with the same thickness of the liquid crystal layer as in the reflective display region **10** is formed in the transmissive display region **20**. Thereby, the part with low transmittance is mixedly included, and the contrast viewing angle increases and the viewing angle characteristics are improved.

[0106] Further, in cases other than the above-described examples, if the resin insulation layer **200** is not formed in the reflective display region **10** and an electrode missing part **210** with a greater width than the reflective electrode **220** is formed, the voltage at the electrode missing part **210** becomes lower than at the part where the electrode missing part **210** is not provided on the counter-electrode **172**, although the thickness of the liquid crystal layer of the reflective display region **10** is greater than the optimal condition. Thus, an optimal value was obtained for the phase variation of the liquid crystal layer **106**.

[0107] Thus, in this case, in the fabrication process of the liquid crystal display device, the process of forming the resin simulation layer **200** can be eliminated, and the display quality at the time of transmissive display and reflective display can be improved.

[0108] Specifically, the above-described first embodiment can provide a liquid crystal display device which can prevent occurrence of abnormality in color and gradation in the reflective display region **10**, and can suppress degradation in optical characteristics and deterioration in display screen quality.

[0109] In the liquid crystal display device according to the first embodiment, the reflective display region **10** is disposed substantially in parallel with the short sides of the display pixel PX at the central part along the long sides of the display pixel PX. Thereby, the state of alignment of liquid crystal molecules included in the liquid crystal **104** can be made substantially symmetric on the upper and lower sides of the reflective display region.

[0110] Moreover, in the liquid crystal display device according to the first embodiment, the width of the short side of the pixel electrode **131** is set at 50 μm or less. Thereby, when a voltage is applied to the liquid crystal **104**, even the electric force lines, which are generated near the end edges of the display pixel PX, are also tilted due to the influence of the electrode missing part **210**.

[0111] Thus, by disposing the reflective display region **10** substantially in parallel with the short sides of the display pixel PX at the central part along the long sides of the display pixel PX and by setting the short side width of the pixel electrode **131** at about 50 μm or less, the direction of the tilt of the liquid crystal molecules can be restricted in the entirety of the display pixel PX.

[0112] Next, a liquid crystal display device according to a second embodiment of the present invention will now be described with reference to the accompanying drawings. In the description below, the structural parts common to those of the liquid crystal display device **1** according to the first embodiment are denoted by like reference numerals, and a description thereof is omitted.

[0113] The liquid crystal display device **1** according to the second embodiment comprises, like the first embodiment, a liquid crystal display panel **100** which includes an array substrate **101**, a counter-substrate **102** which is disposed to be opposed to the array substrate **101** with a gap being formed therebetween, and a liquid crystal layer **106** which is held between the array substrate **101** and the counter-substrate **102**.

[0114] The liquid crystal display panel **100** has a display area **110** which is composed of a plurality of matrix-arrayed display pixels PX. The array substrate **101** includes pixel electrodes **131** which are disposed in the respective display pixels PX.

[0115] The pixel electrode **131** includes a transmissive electrode which is disposed at least in a transmissive display region **20**, and a reflective electrode **220** which is disposed in a reflective display region **10**. The reflective electrode **220** has a projection-and-recess-shaped surface. Accordingly, the liquid crystal display device **1** of the present embodiment is a transflective liquid crystal display device.

[0116] A pixel electrode **131** and a storage capacitance electrode **151** on the array substrate **101** are disposed in different layers, with an insulation layer being interposed, in such a manner that the pixel electrode **131** and the storage capacitance electrode **151** are opposed to each other. The pixel electrode **131** and storage capacitance electrode **151** are electrically connected by a contact electrode **153** via a contact hole **134**. Further, the pixel electrode **131** and storage capacitance electrode **151** are connected to the signal line X via the switching element **140**.

[0117] Like the above-described first embodiment, the array substrate **101** includes storage capacitance lines **152** which are disposed to be opposed to the associated storage capacitance electrodes **151** and constitute storage capacitances between the storage capacitance lines **152** and the storage capacitance electrodes **151**, and a counter-electrode driving circuit **123** which is connected to the storage capacitance lines **152** and the counter-electrode **173**. The counter-electrode driving circuit **123** executes control to set each storage capacitance line **152** and the counter-electrode **173** at a predetermined potential. The storage capacitance is constituted by each storage capacitance electrode **151** and the storage capacitance line **152** that is connected thereto.

[0118] The pixel electrode **131** and storage capacitance electrode **151** may be directly connected via the contact hole **134**, without intervention of the contact electrode **153**. In the drawings mentioned below, for the purpose of the convenience of description of the embodiment, depiction of the switching element **140**, storage capacitance line **152**, contact electrode **153** and signal line X is omitted.

[0119] In the liquid crystal display device **1** according to the present embodiment, the contact hole **134** is disposed in the reflective display region **10** of the display pixel PX.

[0120] The counter-substrate **102** includes a counter-electrode **173** which is opposed to all the pixel electrodes **131** of the array substrate **101**. Like the liquid crystal display device **1** according to the first embodiment, the counter-electrode **173** is formed by sputtering ITO.

[0121] The pattern of the electrode missing part **210** of the counter-electrode **173** was formed by PEP. Although not shown, vertical alignment films, which are formed of polyimide as a main ingredient, are provided on those sides of the array substrate **101** and counter-substrate **102**, which face the liquid crystal layer **106**.

[0122] In the liquid crystal display device **1** of the present embodiment, the electrode missing part **210** of the counter-electrode **173** and the contact hole **134** of the array substrate **101** are disposed at the same position. In short, the contact hole **134** is disposed to be opposed to the electrode missing part **210**.

[0123] In addition, in the liquid crystal display device **1** of the present embodiment, like the liquid crystal display device of the above-described first embodiment, the liquid crystal layer **106** includes a nematic liquid crystal material which has a negative dielectric constant anisotropy.

[0124] Furthermore, the liquid crystal display device **1** of the present embodiment includes an area light source unit which is disposed on the back side of the liquid crystal display panel **100**. The area light source unit includes, for example, a cold cathode tube L as a light source, a light guide **40** which guides light that is emitted from the cold cathode tube L to the liquid crystal display panel **100** side, and various optical sheets (not shown).

[0125] Next, a first example of the liquid crystal display device **1** according to the second embodiment is described with reference to the accompanying drawings. The liquid crystal display device **1** according to this example includes a liquid crystal display panel **100** in which the pitch of arrangement of display pixels PX is about 166 ppi, and the number of display pixels is 320(vertical)×240 (horizontal). The size of the display pixel PX is about 150 μm in the long side and about 50 μm in the short side.

[0126] As shown in FIG. **14**, FIG. **15**A and FIG. **15**B, the array substrate **101** has an electrode missing part **133** in each pixel electrode **131**. In other words, the pixel electrode **131** is divided into a plurality of regions by the electrode missing part **133**.

[0127] The counter-electrode **173** includes a resin insulation layer **200** which is disposed in the reflective display region **10** of the display pixel PX. In the liquid crystal display device **1** of the present example, the resin insulation layer **200** is disposed in a layer under the counter-electrode **173**.

[0128] The counter-electrode **173** includes electrode missing parts **210**. In the liquid crystal display device **1** of the present example, as shown in FIG. **14**, in each display pixel PX, two electrode missing parts **210** are disposed in the transmissive display region **20**, and one electrode missing part **210** is disposed in the reflective display region **10**.

[0129] The electrode missing part **210** of the counter-electrode **173** functions to control the alignment of the liquid crystal **104** of the liquid crystal layer **106**. Specifically, as shown in FIG. **15**A and FIG. **15**B, in the state in which no voltage is applied to the liquid crystal layer **106**, the major axis (director) of the liquid crystal **104** is aligned substantially perpendicular to the array substrate **101** and counter-substrate **102**. In the state in which a voltage is applied to the liquid crystal layer **106**, the major axis (director) of the liquid crystal **104** is aligned substantially perpendicular to the electric force lines which are generated between the pixel electrode **131** and the counter-electrode **173**. Accordingly, when a voltage is applied to the liquid crystal layer **106**, the liquid crystal **104** is aligned so as to tilt toward the electrode missing part **210**.

[0130] As described above, by providing the counter-electrode **173** with the electrode missing parts **210**, the direction of the electric force lines, which are generated between the pixel electrode **131** and the counter-electrode **173**, can be adjusted and the alignment of the liquid crystal **104** can be controlled.

[0131] In the liquid crystal display device according to the present example, the electrode missing part **210**, which is disposed in the reflective display region **10**, is disposed so as to overlap with the contact hole **134**. In other words, as shown in FIG. **14**, the contact hole **134** is so disposed as to face a central part of the electrode missing part **210**.

[0132] In this example, the central part of the electrode missing part **210** is a part where the major axis and minor axis of the substantially elliptic electrode missing part **210** intersect. In the liquid crystal display device according to the present example, the width a of the reflective electrode **220** in the long-side direction of the pixel electrode **131** is 100 μm, the width b of the resin insulation layer **200** is 50 μm, and the width c of the electrode missing part **210** is 10 μm. In addition, in the liquid crystal display device **1** according to the present example, the width in the short-side direction of the electrode missing part **210** is about 10 μm, and the width in the short-side direction of the contact hole **134** is about 8 μm.

[0133] FIG. **22** shows a result of evaluation of the above-described liquid crystal display device. As shown in FIG. **22**, in the liquid crystal display device **1** of the present example, both the reflectance and contrast ratio at the time of reflective display were good, and the liquid crystal alignment state in the reflective display region **10** was stable.

[0134] Next, a liquid crystal display device according to a second example of the present embodiment is described with reference to the accompanying drawings. As shown in FIG. **16**, FIG. **17**A and FIG. **17**B, in the liquid crystal display device according to this example, a reflective display region **10** is disposed at a central part in the long-side direction of the display pixel PX so as to cross the display pixel PX. Transmissive display regions **20** are disposed on both sides of the reflective display area **10**. In other words, in the liquid crystal display device **1** according to this example, the reflective display region **10** extends substantially parallel to the short sides of the pixel electrode **131**.

[0135] In the liquid crystal display device **1** according to this second example, like the liquid crystal display device according to the above-described first example, the pixel electrode **131** and storage capacitance electrode **151** are electrically connected via the contact hole **134**.

[0136] The counter-electrode **173** includes an electrode missing part **210**. In the liquid crystal display device of the present example, the electrode missing part **210** is provided at one location in the reflective display area **10** in each display pixel **10**. The electrode missing part **210** restricts the direction of the tilt of the liquid crystal **104** when a voltage is applied to the liquid crystal layer **106**.

[0137] Specifically, as shown in FIG. **17**A and FIG. **17**B, in the state in which no voltage is applied to the liquid crystal layer **106**, the major axis (director) of the liquid crystal **104** is aligned substantially perpendicular to the array substrate **101** and counter-substrate **102**. In the state in which a voltage is applied to the liquid crystal layer **106**, the major axis (director) of the liquid crystal **104** is aligned substantially perpendicular to the electric force lines which are generated between the pixel electrode **131** and the counter-electrode **173**. Accordingly, when a voltage is applied to the liquid crystal layer **106**, the liquid crystal **104** is aligned so as to tilt toward the electrode missing part **210**.

[0138] In the planar direction of the array substrate **101**, the electrode missing part **210** is disposed at a position overlapping with the contact hole **134**. In other words, in the liquid crystal display device according to the present example, the central part of the contact hole **134** is positioned at the central part of the electrode missing part **210**, and is opposed to the electrode missing part **210**.

[0139] In the present example, the central part of the electrode missing part **210** is a part where the distance from the long sides of the electrode missing part **210** is equal and the distance from the short sides is equal. In the liquid crystal display device according to the present example, the width in the short-side direction of the contact hole **134** is about 8 μm. In addition, in the liquid crystal display device according to the present example, the width a of the reflective electrode **220** in the long-side direction of the pixel electrode **131** is 50 μm, and the width c of the electrode missing part **210** is 10 μm.

[0140] FIG. **22** shows a result of evaluation of the above-described liquid crystal display device. As shown in FIG. **22**, in the liquid crystal display device of the present example, both the reflectance and contrast ratio at the time of reflective display were good, and the liquid crystal alignment state in the reflective display region **10** was stable.

[0141] Next, a first comparative example of the liquid crystal display device according to the present embodiment is described with reference to the accompanying drawings. As shown in FIG. **18**, FIG. **19**A and FIG. **19**B, the liquid crystal display device according to the present comparative example is the same as the liquid crystal display device according to the first example, except for the position of the contact hole **134**.

[0142] Specifically, in the liquid crystal display device according to the present comparative example, the central position of the contact hole **134** is displaced from the central position of the electrode missing part **210**. Thus, there is a part where the contact hole **134** does not overlap the electrode missing part **210**, and the part, where the contact hole **134** overlaps the electrode missing part **210**, decreases.

[0143] FIG. **22** shows a result of evaluation of the above-described liquid crystal display device. As shown in FIG. **22**, in the liquid crystal display device of the present comparative example, both the reflectance and contrast ratio at the time of reflective display were good, but the liquid crystal alignment state in the reflective display region **10** was relatively unstable.

[0144] As shown in FIG. **19**A and FIG. **19**B, in the electrode missing part **210** of the counter-electrode **173**, the transmittance decreases from the edge portion of the electrode missing part **210** toward the central portion of the electrode missing part **210**. Thus, if the part, where the electrode missing part **210** and contact hole **134** do not overlap, increases, the part with low transmittance increases in the display area **110** of the liquid crystal display panel **100**.

[0145] Next, a second comparative example of the liquid crystal display device according to the present embodiment is described with reference to the accompanying drawings. As shown in FIG. **20**, FIG. **21**A and FIG. **21**B, the liquid crystal display device according to the present comparative example is the same as the liquid crystal display device according to the second example, except for the position of the contact hole **134**.

[0146] Specifically, in the liquid crystal display device according to the present comparative example, the width of the contact hole **134** is greater than the width of the electrode missing part **210**. Thus, there is a part where the contact hole **134** does not overlap the electrode missing part **210**, and the part where the contact hole **134** overlaps the electrode missing part **210** decreases.

[0147] FIG. **22** shows a result of evaluation of the above-described liquid crystal display device. As shown in FIG. **22**, in the liquid crystal display device of the second comparative example, the reflectance and contrast ratio at the time of reflective display deteriorated, and the liquid crystal alignment state in the reflective display region **10** was relatively unstable.

[0148] Specifically, in the liquid crystal display devices of the first example and the second example, the contact hole **134** is disposed in the reflective display region and the contact hole **134** is disposed so as to overlap the electrode missing part **210** of the counter-electrode **173**. Thereby, compared to the prior art, the loss of emitted light can be reduced. This advantageous effect becomes greater as the fineness of images increases. In addition, it is possible to prevent degradation in quality of a screen image, such as persistence or roughness, which occurs due to the phenomenon that the contact hole part, where the alignment is unstable, becomes an optically dark part.

[0149] Therefore, the present invention can provide a liquid crystal display device which can prevent occurrence of abnormality in color and gradation in the reflective display region **10**, and can suppress degradation in optical characteristics and deterioration in display screen quality.

[0150] The present invention is not limited directly to the above-described embodiments. In practice, the structural elements can be modified without departing from the spirit of the invention. For example, in the liquid crystal display device according to the embodiments, the pitch of pixel electrodes in the direction substantially parallel to the short side of the display pixel is about 50 μm. However, if the width of the short side of the pixel electrode **131** is 50 μm or less, when the voltage is applied to the liquid crystal **104**, the electric force lines, which are generated near edges of the display pixel PX, are also tilted by the influence of the electrode missing part **210**. Thus, the invention is effectively applicable to the liquid crystal display device in which the short-side width of the pixel electrode **131** is 50 μm or less.

[0151] In the first and second examples of the liquid crystal display device **1** of the second embodiment, the contact hole **134** is disposed at the central part of the electrode missing part **210**. However, the position of the contact hole **134** is not limited to this, and may be disposed at other positions if the contact hole **134** is opposed to the electrode missing part **210** and is disposed within the electrode missing part **210**. In this case, too, the degradation in display quality of the liquid crystal display device can be suppressed.

[0152] In addition, in the first and second examples of the liquid crystal display device **1** of the second embodiment, the contact hole **134** is opposed to the electrode missing part **210**. However, owing to restrictions in design, there may be a case in which the entire contact hole **134** cannot be disposed to be opposed to the electrode missing part **210** because the region where the electrode missing part **210** is disposed in small, for example, as in the case of the second comparative example.

[0153] In such a case, the degradation in display quality of the liquid crystal display device can be suppressed by increasing as much as possible the area of the part where the contact hole **134** is opposed to the electrode missing part **210**.

[0154] In the liquid crystal display device according to the embodiment, the contact hole **134**, which connects the pixel electrode **131** and storage capacitance electrode **151**, and the electrode missing part **210** are configured to be opposed to each other. Alternatively, the contact hole **117**, which connects the pixel electrode **131** and the switching element, and the electrode missing part **210** may be configured to be opposed to each other. Besides, in the case where a common contact hole (not shown) is used to connect the pixel electrode **131** and the storage capacitance electrode **151** and to connect the pixel electrode **131** and the switching element, this common contact hole and the electrode missing part **210** may be configured to be opposed to each other. In these cases, too, the same advantageous effects as with the liquid crystal display devices of the above-described embodiments can be obtained.

[0155] Various inventions can be made by properly combining the structural elements disclosed in the embodiments. For example, some structural elements may be omitted from all the structural elements disclosed in the embodiments. Furthermore, structural elements in different embodiments may properly be combined.

What is claimed is:

1. A liquid crystal display device comprising:

an array substrate on which a plurality of signal lines and a plurality of scanning lines, which are perpendicular to the plurality of signal lines, are provided;

switching elements which are provided at intersection portions between the signal lines and the scanning lines and are connected to the signal lines and the scanning lines;

pixel electrodes and storage capacitance electrodes which are disposed in a matrix on the array substrate;

an insulation film which is formed on the switching element and the storage capacitance electrode;

a contact hole which penetrates the insulation film and connects the pixel electrode and the switching element, or the switching element and the storage capacitance electrode;

a counter-substrate which is disposed to be opposed to the array substrate, with a gap being formed therebetween;

a counter-electrode which is formed on the counter-substrate; and

a liquid crystal layer which is held between the array substrate and the counter-substrate and is formed of a liquid crystal with a negative dielectric constant anisotropy, the counter-electrode having an electrode missing part which is disposed at a position that is opposed to the contact hole.

2. The liquid crystal display device according to claim **1**, wherein the contact hole which connects the switching element and the pixel electrode and the contact hole which connects the switching element and the storage capacitance electrode are the same contact hole, and the counter-electrode has the electrode missing part which is disposed at a position that is opposed to the contact hole.

3. The liquid crystal display device according to claim **1** or **2**, wherein the pixel electrode comprises a transmissive electrode and a reflective electrode, and the electrode missing part is opposed to the reflective electrode.

4. The liquid crystal display device according to claim **3**, wherein one of the array substrate and the counter-substrate includes an insulation layer which varies a thickness of the liquid crystal layer, and

the reflective electrode is disposed to overlap a region where the insulation layer is disposed.

5. The liquid crystal display device according to claim **1** or **2**, wherein the pixel electrode has a substantially rectangular shape, and a width of a short side of the pixel electrode is 50 μm or less.

6. The liquid crystal display device according to claim **1** or **2**, wherein the pixel electrode has a substantially rectangular shape, and

the electrode missing part and the storage capacitance electrode are disposed at a central part in a long side of the pixel electrode and extend substantially in parallel to a short-side direction of the pixel electrode.

7. The liquid crystal display device according to claim **1** or **2**, wherein a longitudinal direction of the electrode missing part is substantially parallel to a short-side direction of the pixel electrode.

8. The liquid crystal display device according to claim **1**, wherein the contact hole is a contact hole which connects the switching element and the pixel electrode, and the counter-electrode has the electrode missing part which is disposed at a position that is opposed to the contact hole.

9. The liquid crystal display device according to claim **1**, wherein the contact hole is a contact hole which connects the switching element and the storage capacitance electrode, and the counter-electrode has the electrode missing part which is disposed at a position that is opposed to the contact hole.

* * * * *

专利名称(译)	液晶显示装置		
公开(公告)号	US20080192160A1	公开(公告)日	2008-08-14
申请号	US12/028526	申请日	2008-02-08
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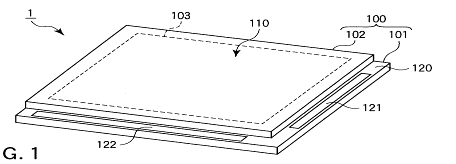
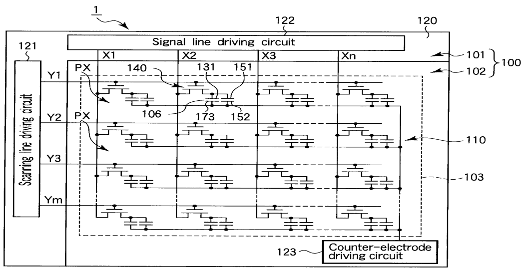
IPC分类号	G02F1/1335 G02F1/1343		
CPC分类号	G02F1/136227 G02F2201/121 G02F2001/13712		
优先权	2007034003 2007-02-14 JP		
外部链接	Espacenet USPTO		

摘要(译)

一种液晶显示装置，包括基板，设置在基板上的信号线，垂直于信号线的扫描线，设置在信号线，像素电极和存储电容电极之间的交叉部分的开关元件。基板上的矩阵，连接像素电极和开关元件的接触孔，或者开关元件和存储电容电极，设置成与基板相对的对置基板，形成在基板上的对电极对置基板和保持在基板之间并由具有负介电常数各向异性的液晶形成的液晶层，该对电极具有设置在与其相对的位置的电极缺失部分。接触孔。



F I G. 1



F I G. 2