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(54) REFLECTIVE LIQUID CRYSTAL DISPLAY DEVICE AND FABRICATING METHOD THEREOF

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(57) **ABSTRACT**

A reflective liquid crystal display device and a fabricating method thereof are disclosed in the present invention. The reflective liquid crystal display device includes a substrate having a pixel region, a gate line on the substrate, a thin film transistor connected to the gate line and the data line, the thin film transistor having a gate electrode, an active layer, and source and drain electrodes, first and second reflective electrodes connected to the drain electrode, the first and second reflective electrodes completely covering the data line and separated by a gap, and a data line crossing the gate line, wherein the data line has a bent shape including first, second, and third portions, and the first portion parallel to the gate line connects the second and third portions, and the second and third portions are formed under the first and second reflective electrodes, respectively.

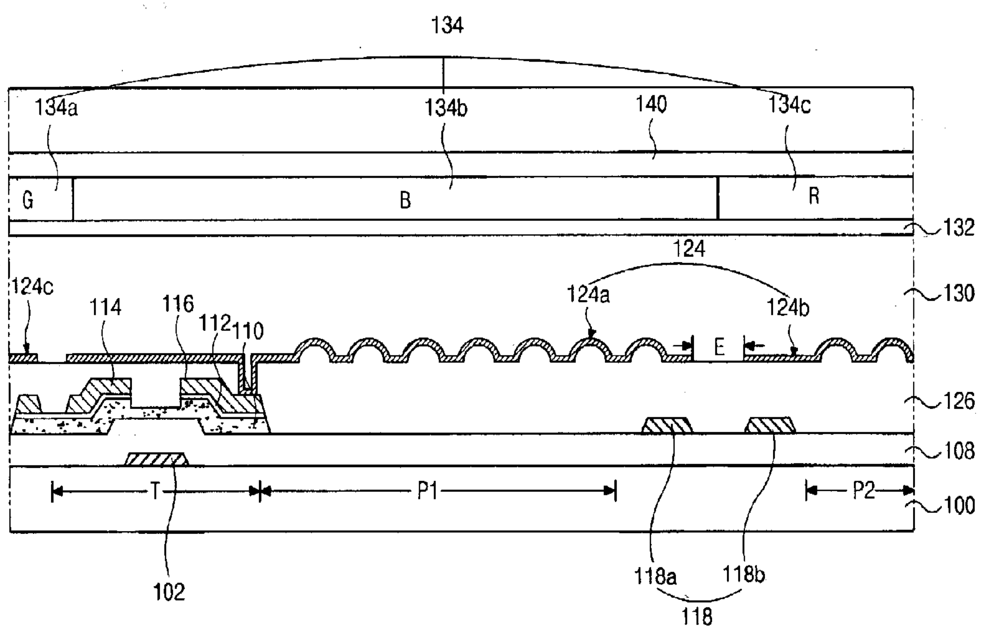


FIG. 1

Related Art

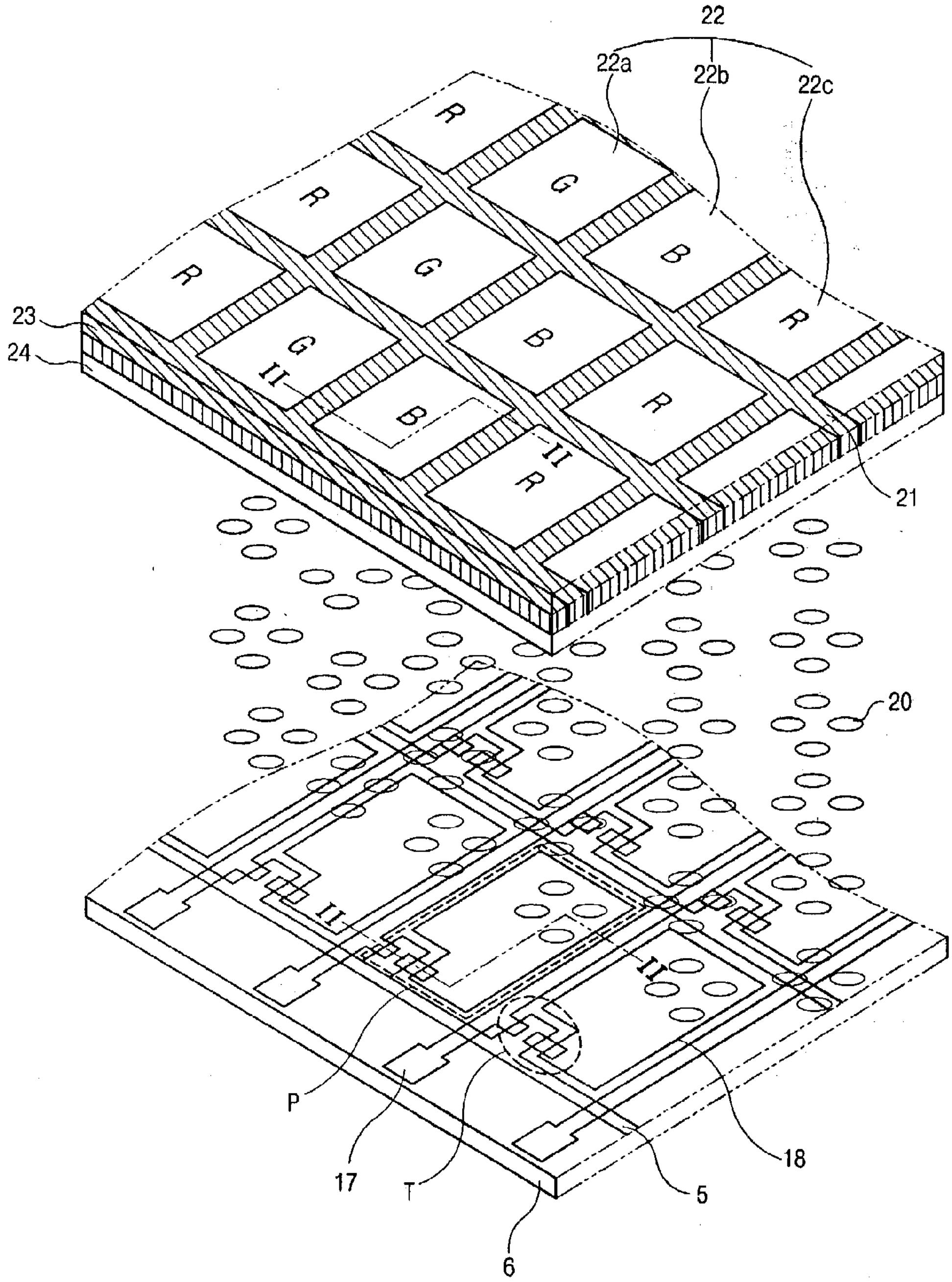


FIG. 2

Related Art

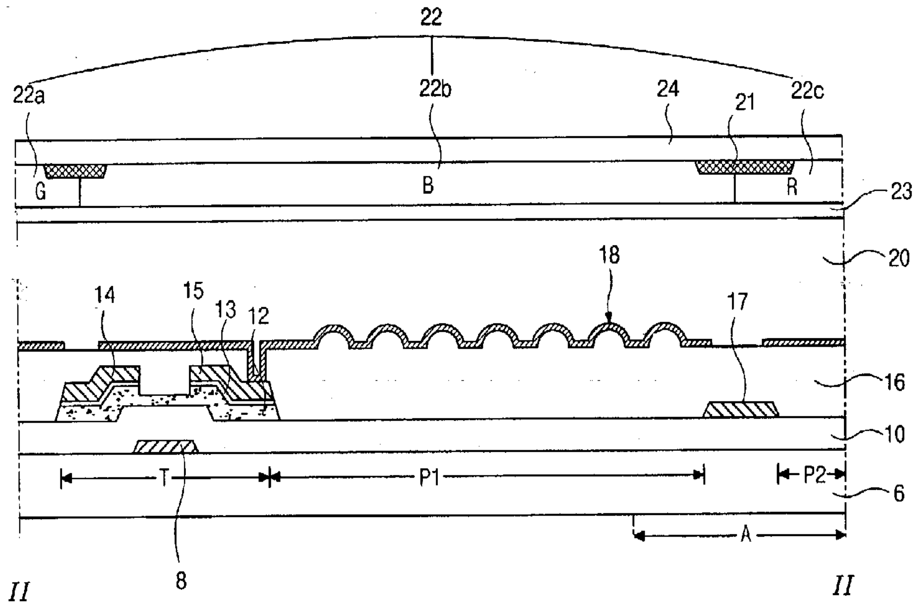


FIG. 3

Related Art

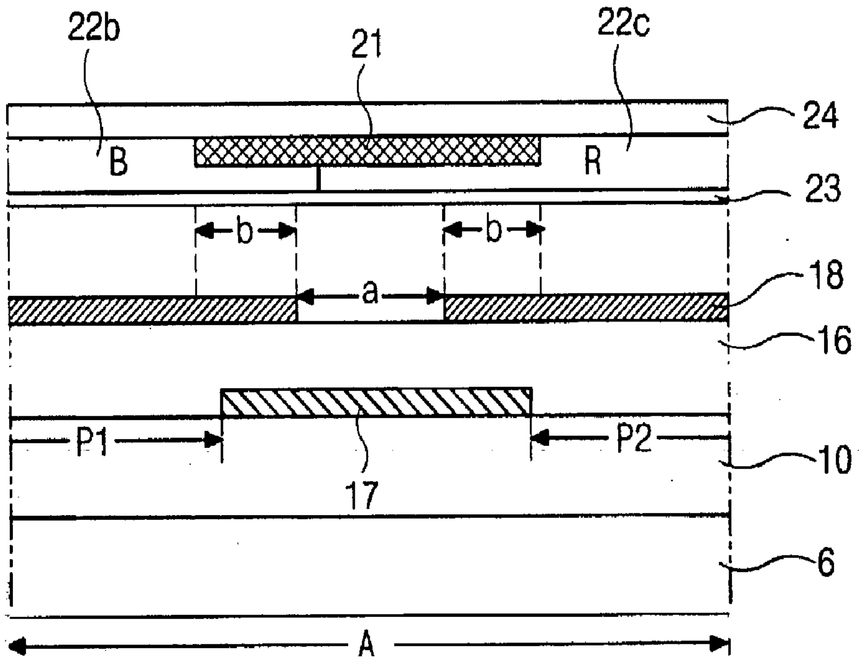
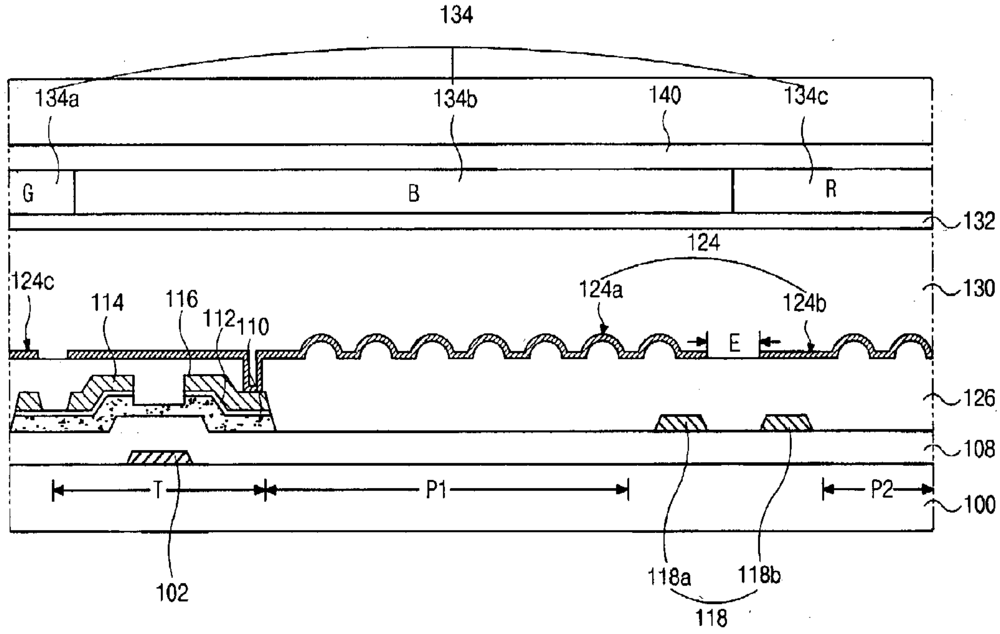


FIG. 4



134
134a
134b
140
134c
G
B
R
132
124
124c
114
116
112
110
124a
124b
130
E
126
108
T
P1
P2
100
102
118a
118b
118

FIG. 5

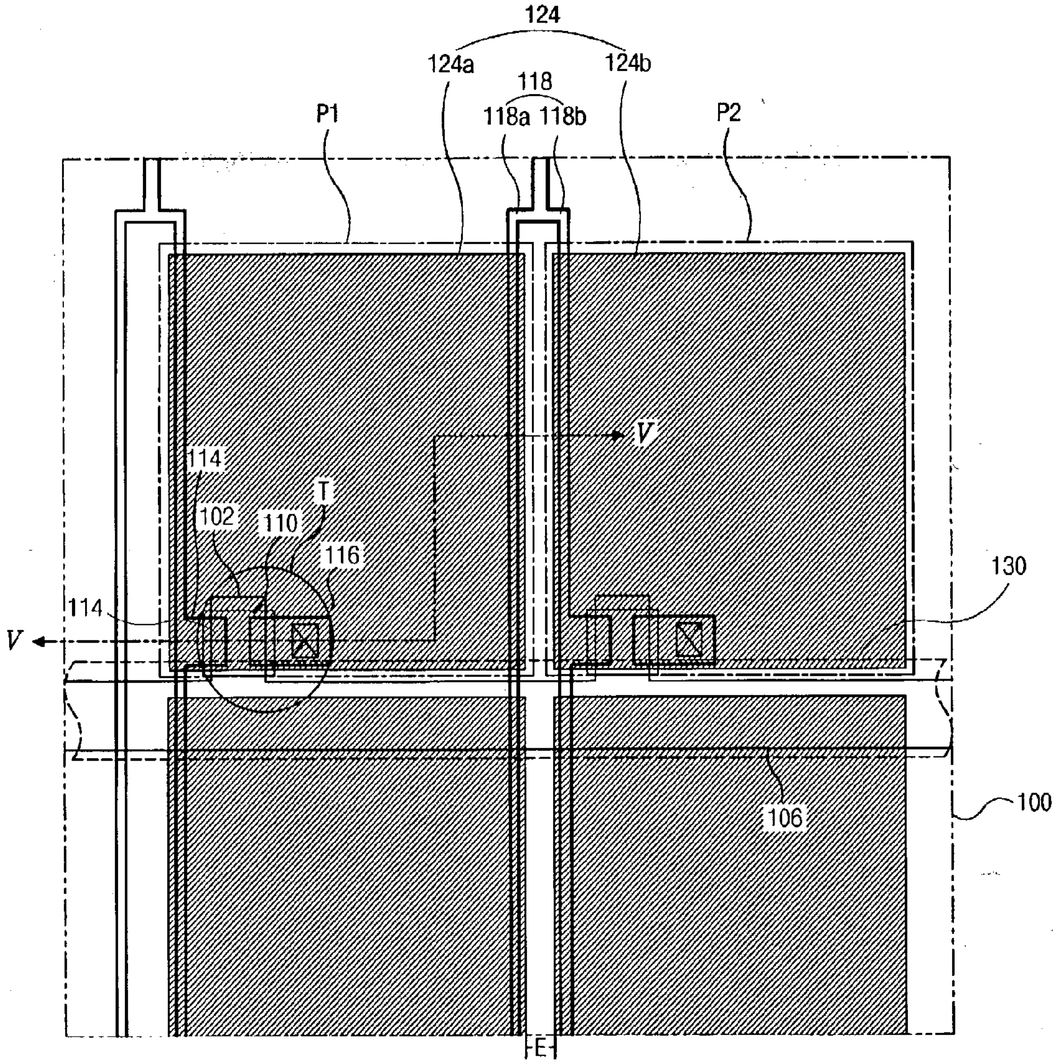

124
124a
124b
118
118a 118b
P1
P2
V
114
102
110
T
116
114
V
130
100
106
E

FIG. 6A

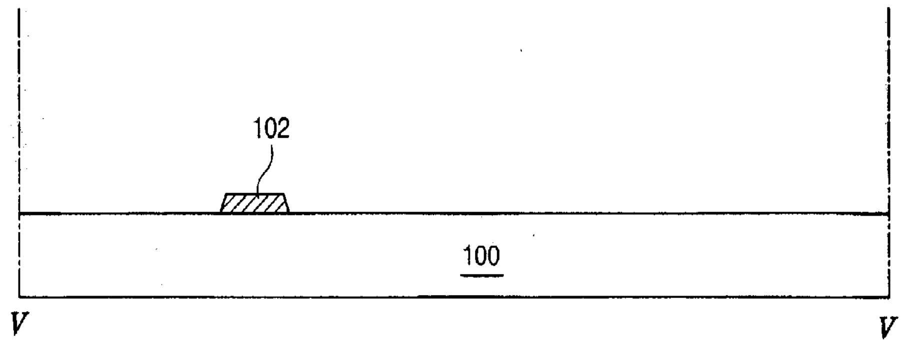


FIG. 6B

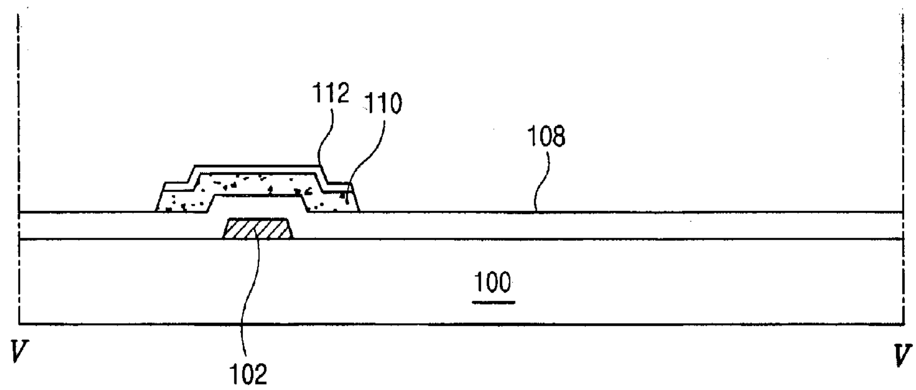
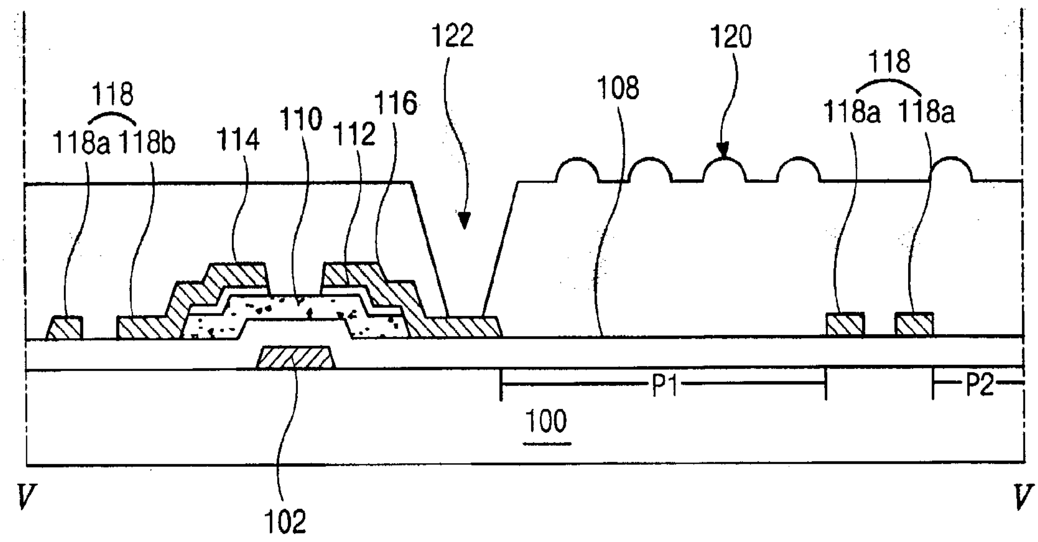
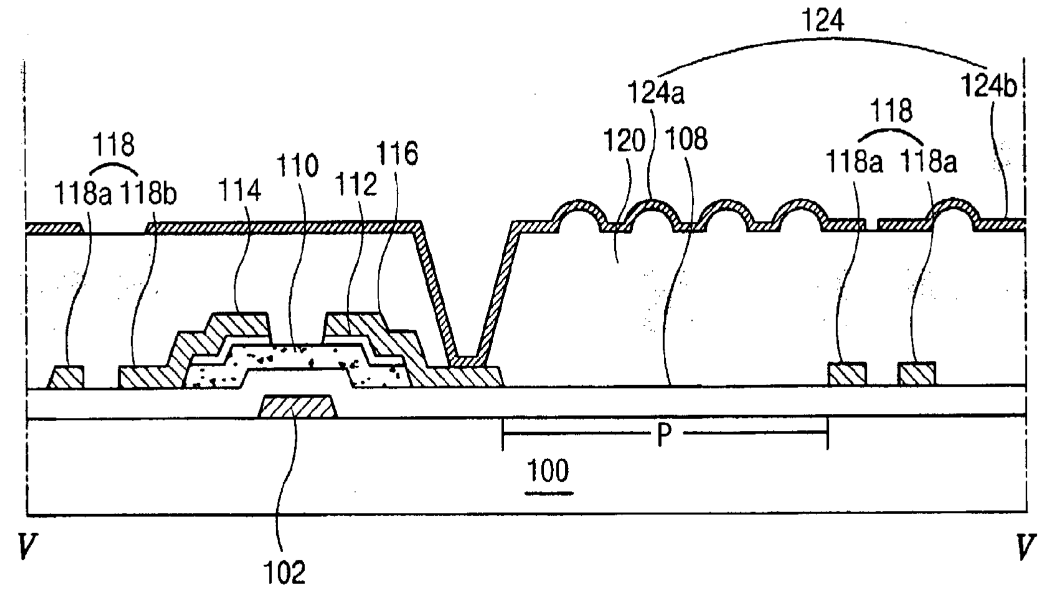


FIG. 6C



122
120
118
108
118a 118a
118
118a 118b
114
110
112
116
P1
P2
100
V
V
102

FIG. 6D



124
124a
124b
118
120
108
118a 118a
118
118a 118b
114
110
112
116
P
100
V
V
102

FIG. 7A

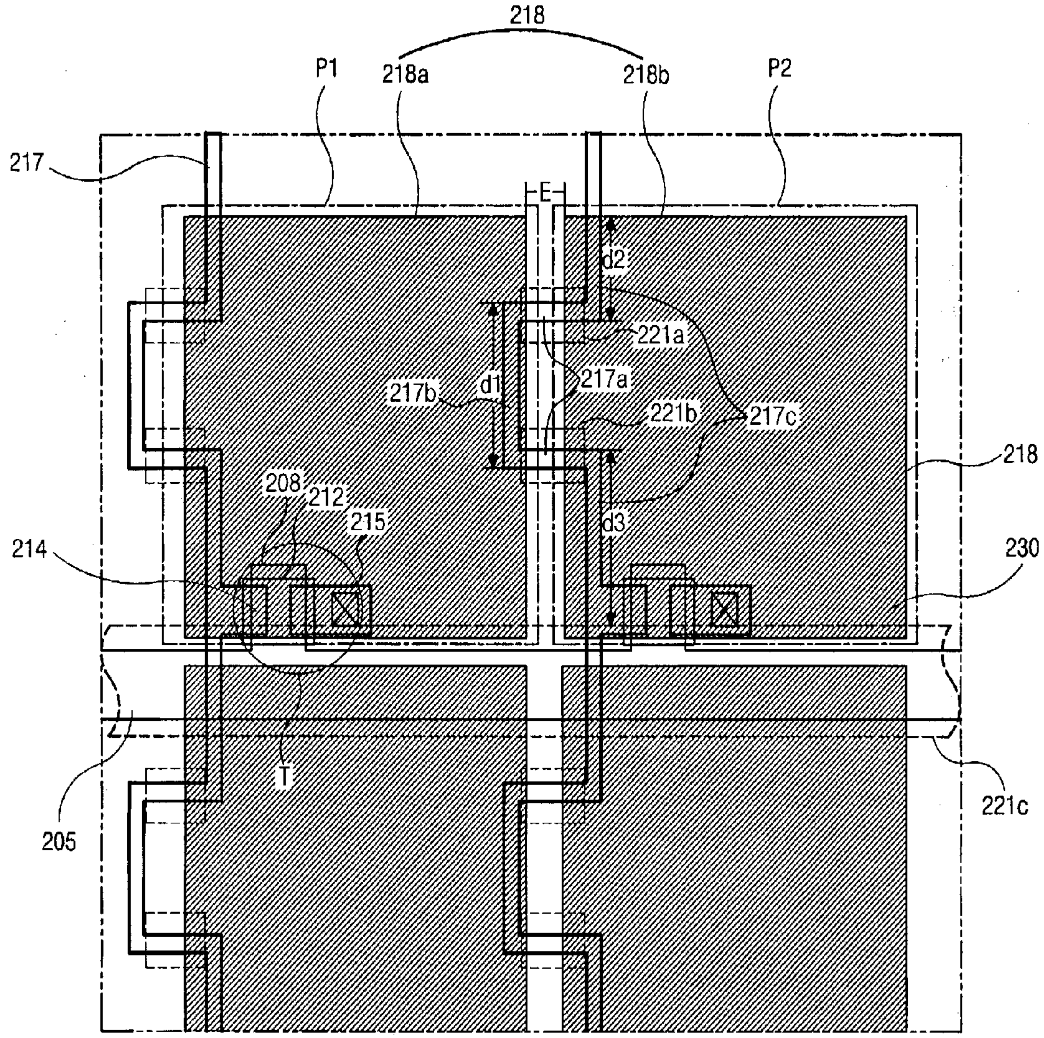
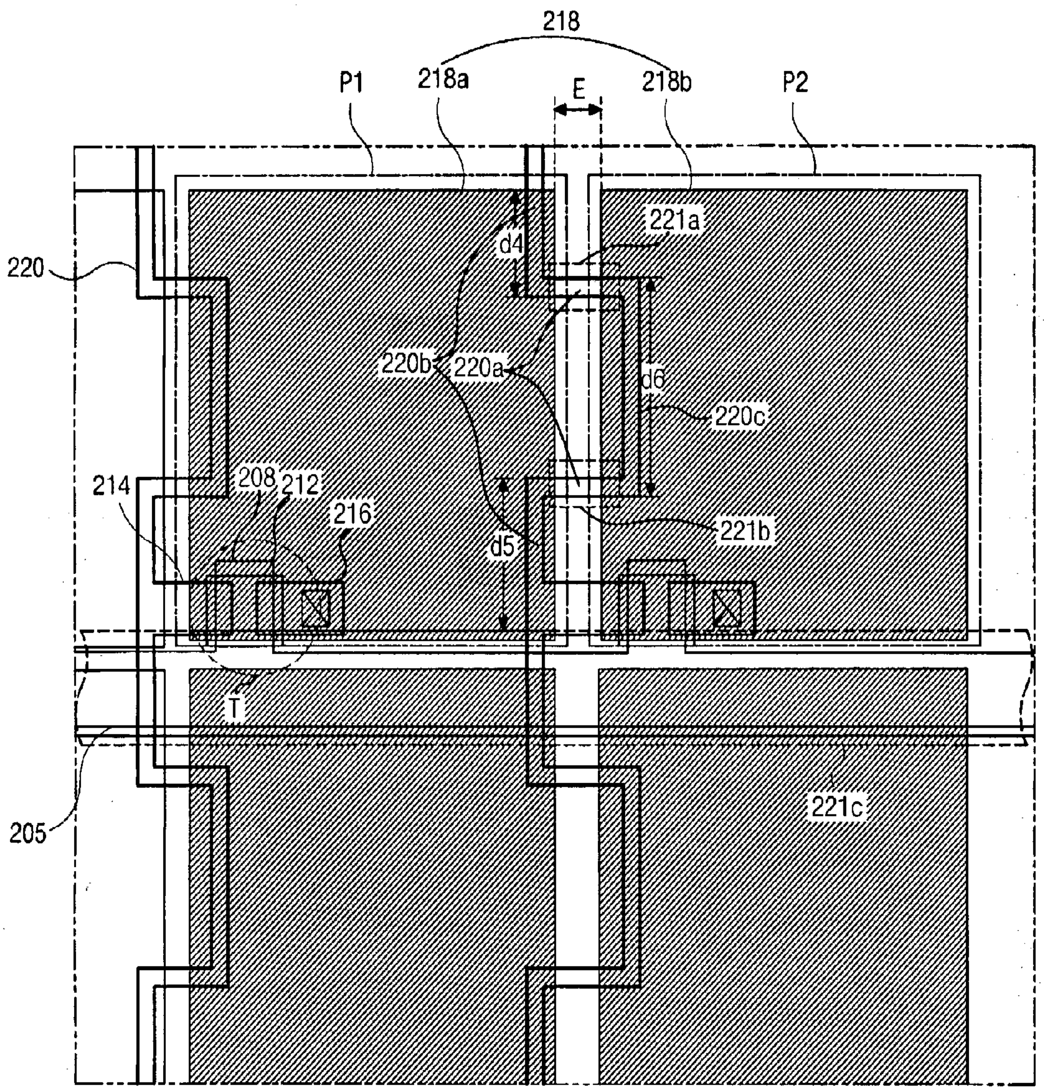

218
P1
218a
218b
P2
217
E
d2
221a
217b
d1
217a
221b
217c
218
208
212
215
d3
214
230
T
205
221c

FIG. 7B



218
P1
218a
E
218b
P2
221a
220
d4
220b
220a
d6
220c
214
208
212
216
221b
d5
T
205
221c

FIG. 8

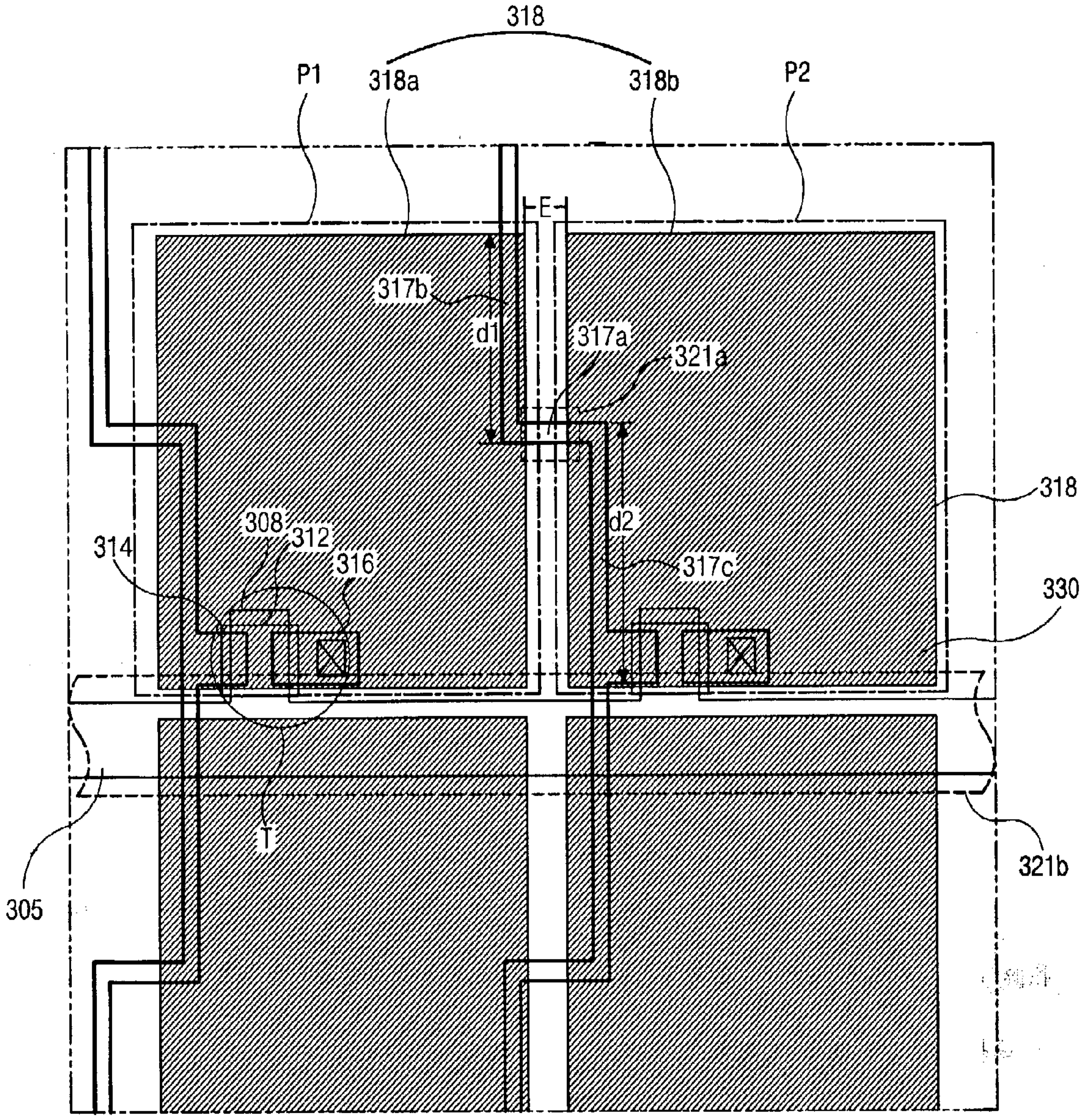

318
P1
318a
318b
P2
E
317b
d1
317a
321a
318
308
312
314
316
d2
317c
330
T
305
321b

FIG. 9

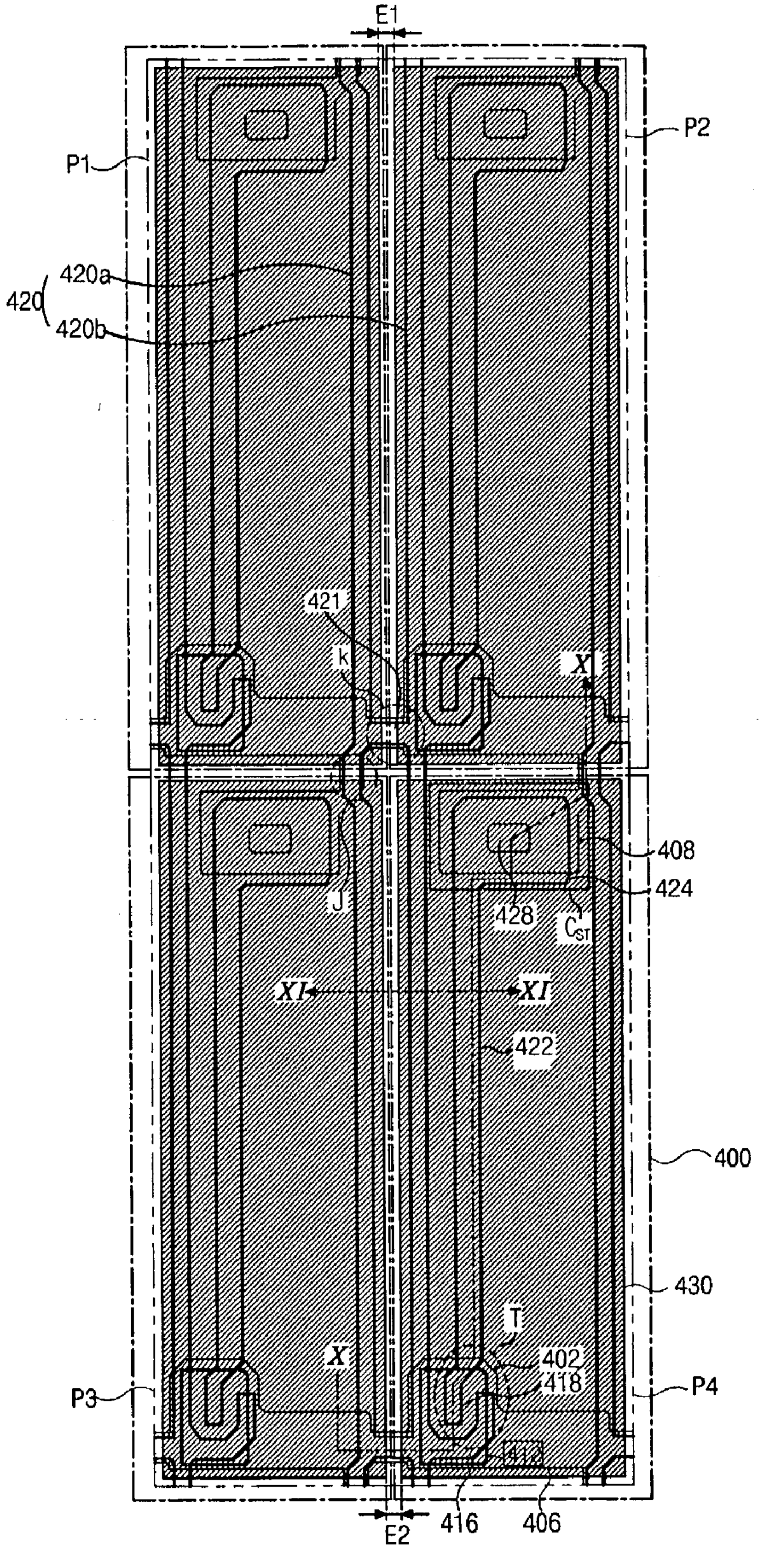

E1
P1
P2
420
420a
420b
421
k
X
J
408
424
428
C_{ST}
XI
XI
422
400
430
T
402
418
X
P3
P4
E2
416
406

FIG. 10A

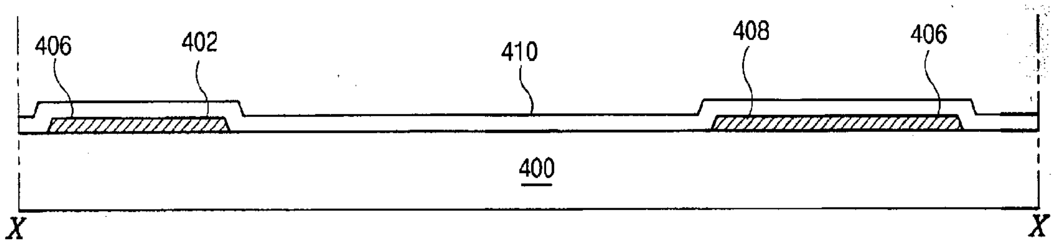


FIG. 10B

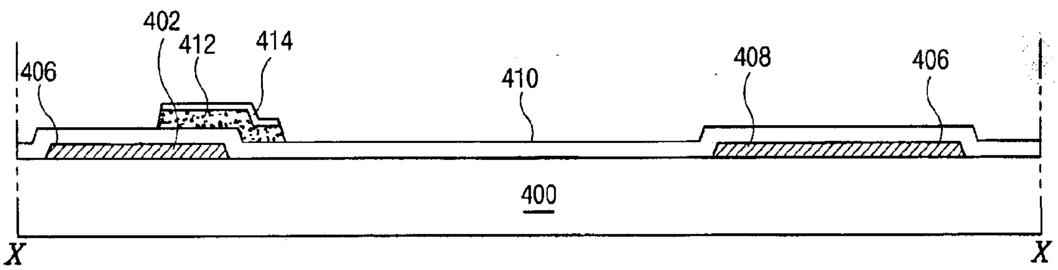


FIG. 10C

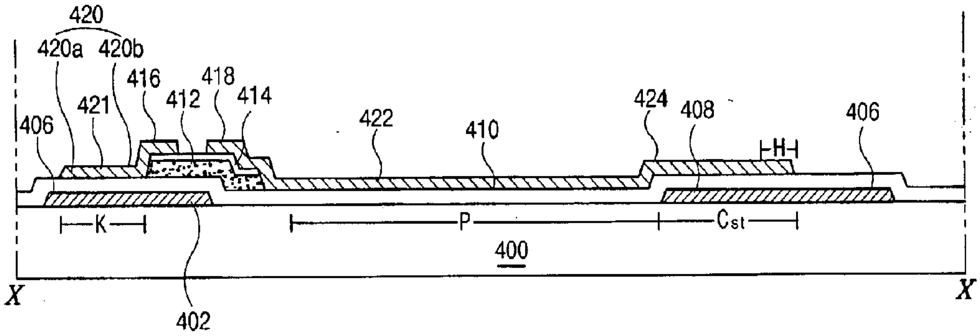


FIG. 10D

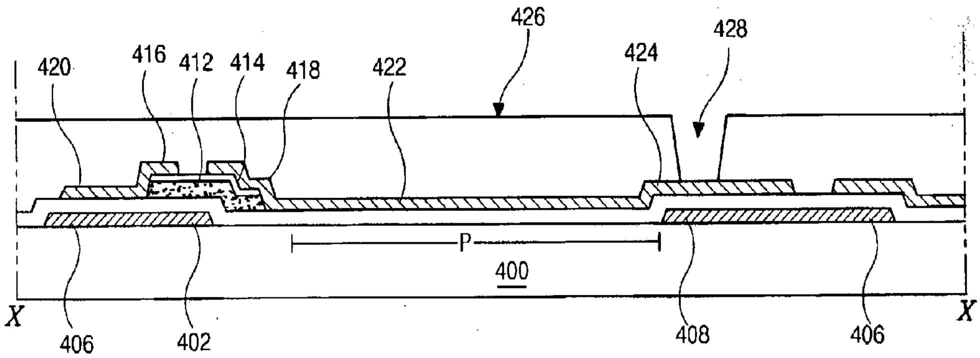


FIG. 10E

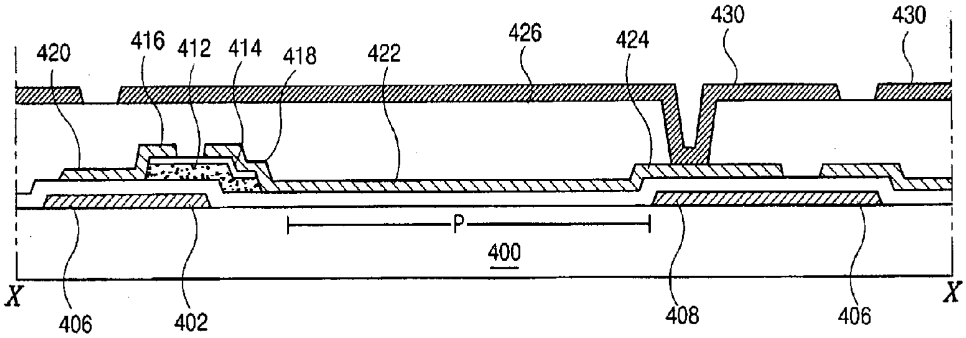


FIG. 11A

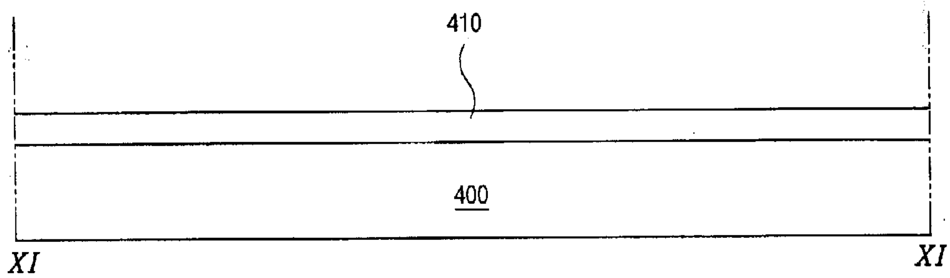


FIG. 11B

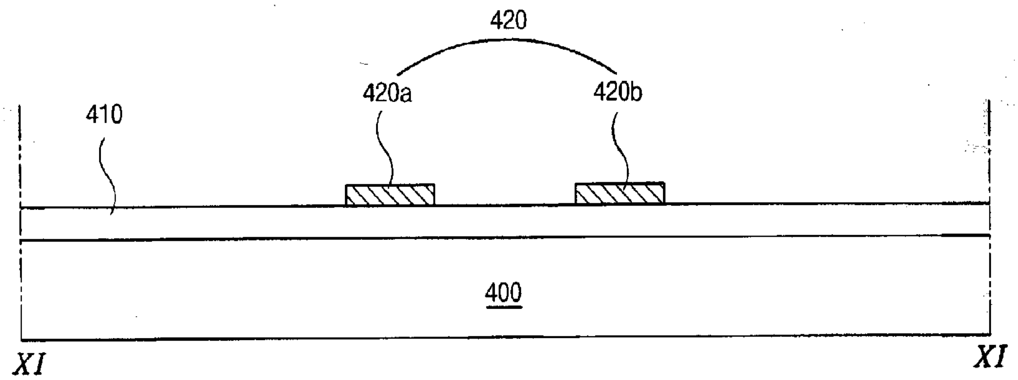


FIG. 11C

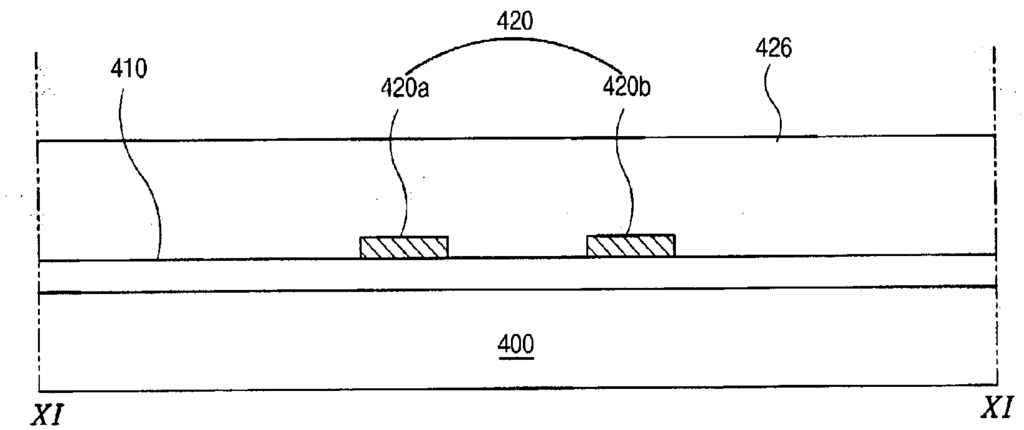
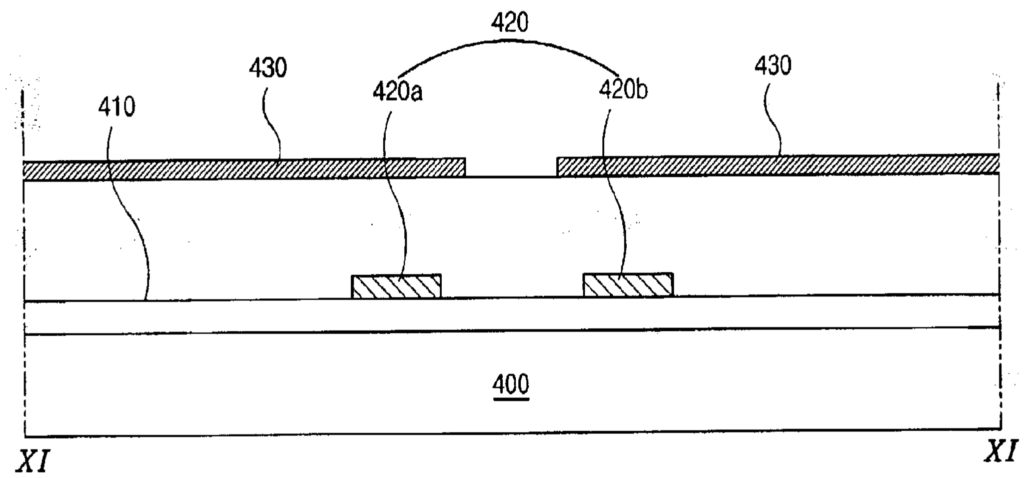


FIG. 11D



REFLECTIVE LIQUID CRYSTAL DISPLAY DEVICE AND FABRICATING METHOD THEREOF

[0001] This application claims the benefit of the Korean Application No. P2002-045132 filed on Jul. 31, 2002, which is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a liquid crystal display device, and more particularly, to a reflective liquid crystal display device and a fabricating method thereof. Although the present invention is suitable for a wide scope of applications, it is particularly suitable for improving a contrast ratio of a liquid crystal display device.

[0004] 2. Discussion of the Related Art

[0005] Generally, liquid crystal display (LCD) devices are classified into two types depending upon the usage of a light source: a transmissive LCD device using a backlight and a reflective LCD device using an external natural and/or artificial light source. More than about two thirds of a total power are consumed for the backlight in the transmissive LCD device, whereas the power consumption is improved in the reflective LCD devices due to the absence of the backlight.

[0006] In the reflective LCD device, a black matrix is used to improve a contrast ratio. However, a contrast ratio is reduced as a black matrix reduces a reflective portion.

[0007] **FIG. 1** is an expanded perspective view of a reflective liquid crystal display device according to a related art. In **FIG. 1**, first and second substrates **6** and **23** face into and are spaced apart from each other. A data line **17** and a gate line **5** are formed on the inner surface of the first substrate **6**. Each of the data line **17** and the gate line **5** crosses each other and defines a pixel region "P". A thin film transistor (TFT) "T" is formed at each intersection between the data line **17** and the gate line **5**. A pixel electrode (i.e., a reflective electrode **18**) is formed at the pixel region "P". The reflective electrode **18** is formed of a conductive material such as aluminum (Al) having an excellent conductivity and reflectance, and an Al alloy. A black matrix **21** is formed on the inner surface of the second substrate **23** in a matrix form. A color filter layer **22** including sub-color filters **22***a*, **22***b*, and **22***c* is formed at an inner portion of the matrix corresponding to the pixel region "P". A transparent common electrode **24** is formed on the entire surface of the second substrate **23**. A liquid crystal layer **20** is interposed between the first and second substrates **6** and **23**.

[0008] The black matrix **21** is formed at regions corresponding to the data line **17**, the gate line **5**, and the thin film transistor "T". The black matrix **21** is designed in consideration of a misaligned margin during the attachment process of the first and second substrates **6** and **23**. Accordingly, the area of the black matrix **21** is increased.

[0009] **FIG. 2** is a schematic cross-sectional view taken along line II-II of **FIG. 1**. **FIG. 3** is a magnified cross-sectional view of a portion "A" of **FIG. 2**.

[0010] As shown in **FIGS. 2 and 3**, a data line **17** is formed between adjacent pixel regions "P1" and "P2" on the inner surface of a first substrate **6**. A black matrix **21** corresponding to the data line **17** and a color filter layer **22** including sub-color filters **22***a*, **22***b*, and **22***c* corresponding to the pixel regions "P1" and "P2" are formed on the inner surface of a second substrate **23**. When a first distance between adjacent reflective electrodes **18** over the data line **17** is "a" and a second distance of the portion of the reflective electrodes **18** overlapping the data line **17** is "b", a width of the black matrix **21** becomes "a+2b". Since a uniform electric field is not sufficiently applied to a liquid crystal layer (not shown) corresponding to the first distance "a" unlike on the reflective electrode **18**, light is leaked through the liquid crystal layer corresponding to the first distance "a" even when a voltage corresponding to a black state of the pixel region "P" is applied in a normally white mode. Therefore, the black matrix **21** should shield the region corresponding to the first distance "a". Furthermore, a value of "2b" corresponds to a misaligned margin during the attachment process of the first and second substrates **6** and **23**. Therefore, the area of the black matrix **21** is increased, thereby decreasing an effective reflection area, which is not suitable for a reflective liquid crystal display device requiring high luminance.

[0011] In the reflective LCD device, as mentioned above, it is important to improve brightness and a contrast ratio because the ambient light reflected at the reflective electrode is used instead of the backlight to display images. The black matrix improving a contrast ratio may prevent the light leakage in the region corresponding to the data line. However, an overlapping region of the black matrix and the data line reduces an effective reflection area, thereby reducing the brightness.

SUMMARY OF THE INVENTION

[0012] Accordingly, the present invention is directed to a reflective liquid crystal display device and a fabricating method thereof that substantially obviate one or more of problems due to limitations and disadvantages of the related art.

[0013] Another object of the present invention is to provide a reflective liquid crystal display device for improving reduction in an effective reflection area due to a black matrix and for increasing brightness.

[0014] Additional features and advantages of the invention will be set forth in the description which follows and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages of the invention will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0015] To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described, a reflective liquid crystal display device includes a substrate having a pixel region, a gate line on the substrate, a thin film transistor connected to the gate line and the data line, the thin film transistor having a gate electrode, an active layer, and source and drain electrodes, first and second reflective electrodes connected to the drain electrode, the first and second reflective electrodes completely covering the data line and separated by a gap, and a data line crossing the gate line, wherein the data line has a bent shape including first, second, and third portions, and the first portion parallel to the gate line connects the second and third portions, and the second and third portions are formed under the first and second reflective electrodes, respectively.

[0016] In another aspect of the present invention, a method for fabricating a reflective liquid crystal display device includes forming a gate line on a substrate, forming a data line crossing the gate line to define a pixel region, wherein the data line has a bent shape including first, second, and third portions, and the first portion parallel to the gate line connects the second and third portions, and the second and third portions are formed under the first and second reflective electrodes, respectively, forming a thin film transistor connected to the gate line and the data line, the thin film transistor comprising a gate electrode, an active layer, and source and drain electrodes, and forming first and second reflective electrodes connected to the drain electrode, the first and second reflective electrodes completely covering the data line and having a gap between the first and second reflective electrodes.

[0017] In another aspect of the present invention, a reflective liquid crystal display device includes a substrate including a pixel region, a gate line on the substrate, a thin film transistor connected to the gate line and the data line, the thin film transistor including a gate electrode, an active layer, and source and drain electrodes, first and second reflective electrodes electrically connected to the drain electrode, the first and second reflective electrodes completely covering the data line and having a first gap between the first and second reflective electrodes, and a data line crossing the gate line, the data line comprising first and second branch lines separated by a second gap formed under the first and second reflective electrodes, respectively.

[0018] In a further aspect of the present invention, a method for fabricating a reflective liquid crystal display device includes forming a gate line on a substrate, forming a data line on the substrate crossing the gate line and defining a pixel region, the data line comprising first and second branch lines separated by a first gap, forming a thin film transistor connected to the gate line and the data line, the thin film transistor comprising a gate electrode, an active layer, and source and drain electrodes, and forming first and second reflective electrodes connected to the drain electrode, the first and second reflective electrodes completely covering the data line and having a second gap between the first and second reflective electrodes.

[0019] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

[0020] BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiments of the invention and together with the description serve to explain the principle of the invention.

[0022] In the drawings

[0023] **FIG. 1** is an expanded perspective view of a reflective liquid crystal display device according to a related art;

[0024] **FIG. 2** is a schematic cross-sectional view taken along line II-II of **FIG. 1**;

[0025] **FIG. 3** is a magnified cross-sectional view of portion “A” of **FIG. 2**;

[0026] **FIG. 4** is a schematic cross-sectional view of a reflective liquid crystal display device according to a first embodiment of the present invention;

[0027] **FIG. 5** is a schematic plane view illustrating an array substrate for the reflective liquid crystal display device according to the first embodiment of the present invention;

[0028] **FIGS. 6A** to **6D** are schematic cross-sectional views taken along line VI-VI of **FIG. 5** to illustrate the process steps of fabricating the array substrate for the reflective liquid crystal display device according to the first embodiment of the present invention;

[0029] **FIGS. 7A and 7B** are schematic plane views showing an array substrate for a reflective liquid crystal display device according to a second embodiment of the present invention;

[0030] **FIG. 8** is a schematic plane view showing an array substrate for a reflective liquid crystal display device according to a third embodiment of the present invention;

[0031] **FIG. 9** is a schematic plane view showing an array substrate for a reflective liquid crystal display device according to a fourth embodiment of the present invention;

[0032] **FIGS. 10A** to **10**E are schematic cross-sectional views taken along line X-X of **FIG. 9** to illustrate the process steps of fabricating the array substrate for the reflective liquid crystal display device according to the fourth embodiment of the present invention; and

[0033] **FIGS. 11A** to **11**D are schematic cross-sectional views taken along line XI-XI of **FIG. 9** to illustrate the process steps of fabricating the array substrate for the reflective liquid crystal display device according to the fourth embodiment of the present invention.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

[0034] Reference will now be made in detail to the illustrated embodiments of the present invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

[0035] In a reflective liquid crystal display (LCD) device according to the present invention, a black matrix is eliminated or reduced by modifying a data line to minimize a reduction in an effective reflection area due to an overlapping portion of the black matrix and the data line.

[0036] **FIG. 4** is a schematic cross-sectional view of a reflective liquid crystal display device according to a first embodiment of the present invention.

[0037] In **FIG. 4**, first and second substrates **100** and **140** face into and spaced apart from each other. A thin film transistor (TFT) “T”, a data line **118**, and a gate line (not shown) are formed on the inner surface of the first substrate **100**. The thin film transistor “T” has a gate electrode **102**, an active layer **110**, and source and drain electrodes **114** and **116**. The data line **118** and the gate line are connected to the source electrode **114** and the gate electrode **102**, respectively. A plurality of pixel regions "P1" and "P2" are defined by the gate line and the data line **118** crossing each other. A passivation layer **126** is formed on the thin film transistor "T" and the data line **118**. Adjacent reflective electrodes **124***a* and **124***b* are formed on the passivation layer **126** at the adjacent pixel regions "P1" and "P2", respectively. The reflective electrode **124***a* is connected to the drain electrode **116**. The reflective electrode **124***a* may have an uneven shape in order to increase the brightness. Generally, an uneven pattern is formed on the upper surface of the passivation layer **126**, and the reflective electrode **124***a* have the uneven shape due to the uneven pattern of the passivation layer **126**. In the above structure, the data line **118** is divided into first and second branch lines **118***a* and **118***b* at one end of the lower substrate **100**. The first and second branch lines **118***a* and **118***b* are formed and extended under the adjacent reflective electrodes **124***a* and **124***b*, respectively.

[**0038**] A color filter layer **134** including red, green, and blue sub-color filters **134***a*, **134***b*, and **134***c* is formed on the inner surface of the second substrate **140** facing into the lower substrate **100**. Each sub-color filter **134***a*, **134***b*, and **134***c* corresponds to each pixel region "P1" and "P2". A transparent common electrode **132** is formed on the color filter layer **134**.

[**0039**] In the above-described reflective liquid crystal display device, the ambient light is reflected at the adjacent reflective electrodes **124***a* and **124***b* and, at the same time, transmitted through a space between the first and second branch lines **118***a* and **118***b*. Unlike the related art structure, light leakage does not occur at region "E" between the adjacent reflective electrodes **124***a* and **124***b* (region "E"). Accordingly, a black matrix (not shown) is not required to be formed on the portion corresponding to the adjacent reflective electrodes **124***a* and **124***b*. Consequently, since a black matrix is formed only at a portion corresponding to the gate line, an effective area of the black matrix can be reduced, and high brightness and a high contrast ratio can be obtained.

[**0040**] **FIG. 5** is a schematic plane view illustrating the array substrate for the reflective liquid crystal display device according to the first embodiment of the present invention.

[**0041**] As shown in **FIG. 5, a** gate line **106** and a data line **118** cross each other defining adjacent pixel regions "P1" and "P2". A thin film transistor (TFT) "T" including a gate electrode **102**, an active layer **110**, and source and drain electrodes **114** and **116** is disposed at the intersection of the gate line **106** and the data line **118**. The gate electrode **102** and the source electrode **114** are connected to the gate line **106** and the data line **118**, respectively. Herein, the source and drain electrodes **114** and **116** are spaced apart from each other. Adjacent reflective electrodes **124***a* and **124***b* connected to the drain electrode **116** are formed in the adjacent pixel regions "P1" and "P2", respectively.

[**0042**] The data line **118** is divided into a first branch line **118***a* and a second branch line **118***b* at one end of the first substrate **100**. The first and second branch lines **118***a* and **118***b* are formed and extended under the adjacent reflective electrodes **124***a* and **124***b*, respectively. Considering electrical resistance, the data line is designed to have the total of widths of the first and second branch lines **118***a* and **118***b* to be the same as the width of the data line of the related art reflective LCD device.

[**0043**] Since there is no data line in the region "E" between the adjacent reflective electrodes **124***a* and **124***b*, it is not required to form a black matrix on a portion corresponding to the region "E" between the adjacent reflective electrodes **124***a* and **124***b* on a second substrate (not shown). Accordingly, a black matrix **130** is formed only on a second portion of the gate line **106** on the second substrate.

[**0044**] **FIGS. 6A** to 6D, which are taken along line VI-VI of **FIG. 5**, are cross-sectional views illustrating the process steps of fabricating the array substrate for the reflective liquid crystal display device of **FIG. 5**.

[**0045**] In **FIG. 6A, a** gate electrode **102** and a gate line **106** (shown in **FIG. 5**) are formed on a substrate **100**. The gate electrode **102** and the gate line **106** (shown in **FIG. 5**) are formed of aluminum (Al) having a low electrical resistance in order to reduce a resistance-capacitance (RC) delay. Pure aluminum has a low chemical resistance and causes line defects due to a hillock phenomenon during a later high-temperature process. Thus, a multi-layered structure including an aluminum layer such as aluminum/molybdenum (Al/Mo) can be used as the gate electrode **102** and the gate line **106** (shown in **FIG. 5**).

[**0046**] As shown in **FIG. 6B, a** gate insulating layer **108** is formed on the gate electrode **102** and the gate line **106** (shown in **FIG. 5**), which are formed on the entire surface of the substrate **100**, by depositing an inorganic insulating material, such as silicon nitride (SiN_x) and silicon oxide (SiO_2). Subsequently, an active layer **110** formed of amorphous silicon (a-Si:H) and an ohmic contact layer **112** formed of impurity-doped amorphous silicon (n+a-Si:H) are sequentially formed on the gate insulating layer **108** over the gate electrode **102**.

[**0047**] In **FIG. 6C, a** source electrode **114** and a drain electrode **116** are formed on the ohmic contact layer **112** by depositing and patterning a conductive metallic material, such as chromium (Cr), molybdenum (Mo), antimony (Sb), and titanium (Ti). At the same time, a data line **118** connected to the source electrode **114** is formed on the gate insulating layer **108**. Crossing over a gate line **106** (shown in **FIG. 5**), the data line **118** defines adjacent pixel regions "P1" and "P2". Moreover, the data line **118** is divided into first and second branch lines **118***a* and **118***b* at one end of the substrate **100**. The first and second branch lines **118***a* and **118***b* are formed at the adjacent pixel regions "P1" and "P2", respectively, to be extended in the perpendicular direction.

[**0048**] A passivation layer **120** is formed on the source and drain electrodes **114** and **116**, and the data line **118** by depositing an organic insulating material, such as benzocyclobutene (BCB) and acrylic resin. Sequentially, a drain contact hole **122** exposing a portion of the drain electrode **116** is formed by etching the passivation layer **120**. The upper surface of the passivation layer **120** has an uneven top surface having concave and convex structures.

[**0049**] In **FIG. 6D**, adjacent reflective electrodes **124***a* and **124***b* connected to the drain electrode **116** are formed at the adjacent pixel regions "P1" and "P2", respectively. The reflective electrode **124** may be formed of a conductive and reflective metallic material, such as aluminum and an aluminum alloy. The reflective electrode **124** has an uneven shape because it is formed on the uneven structure of the passivation layer **120** so as to obtain a high reflectance.

[0050] **FIGS. 7A and 7B** are schematic plane views showing an array substrate for a reflective liquid crystal display device according to a second embodiment of the present invention.

[0051] In **FIG. 7A, a** gate line **205** and a data line **217** cross each other defining adjacent pixel regions "P1" and "P2". A thin film transistor (TFT) "T" having a gate electrode **208**, an active layer **212**, and source and drain electrodes **214** and **215** is disposed at the intersection of the gate line **205** and the data line **217**. The gate electrode **208** and the source electrode **214** are connected to the gate line **205** and the data line **217**, respectively. Herein, the source and drain electrodes **214** and **215** are spaced apart from each other. Adjacent reflective electrodes **218***a* and **218***b* connected to the drain electrode **215** are formed in the adjacent pixel regions "P1" and "P2", respectively.

[0052] The data line **217** has a bent shape including first, second, and third portions **217***a*, **217***b*, and **217***c*. The first portion **217***a* parallel to the gate line **205** connects the second and third portions **217***b* and **217***c*. The second and third portions **217***b* and **217***c* are formed under the adjacent reflective electrodes **218***a* and **218***b*, respectively. The second portion **217***b* has the same area as the third portion **217***c* to disperse and minimize an effect on the reflective electrode **218** by a polarity ("+" or "−") of a signal flowing through the data line **217**. Since the second portion **217***b* has the same width as the third portion **217***c*, a length "d_1" of the second portion **217***b* is equal to a length "d_2+d_3" of the third portion **217***c*. A black matrix **221***a*, **221***b*, and **221***c* is formed to cover the first portion **217***a* at region "E" between the adjacent reflective electrodes **218***a* and **218***b* and the gate line **205**. Since the first portion **217***a* at the region "E" between the adjacent reflective electrodes **218***a* and **218***b* has a small area, the black matrix **221***a* and **221***b* over the first portion **217***a* can be eliminated. Therefore, an area of the black matrix is reduced so that an effective reflection area can be enlarged.

[0053] **FIG. 7B** is a schematic plane view illustrating an array substrate for a reflective liquid crystal display device according to a variation of the second embodiment of the present invention.

[0054] In **FIG. 7B, a** gate line **205** and a data line **220** cross each other defining adjacent pixel regions "P1" and "P2". A thin film transistor (TFT) "T" having a gate electrode **208**, an active layer **212**, and source and drain electrodes **214** and **216** is disposed at the intersection of the gate line **205** and the data line **220**. The gate electrode **208** and the source electrode **214** are connected to the gate line **205** and the data line **220**, respectively. The source and drain electrodes **214** and **216** are spaced apart from each other. Adjacent reflective electrodes **218***a* and **218***b* connected to the drain electrode **216** are formed at the adjacent pixel regions "P1" and "P2", respectively.

[0055] The data line **220** has a bent shape including first, second and third portions **220***a*, **220***b*, and **220***c*, wherein the bent portion forms a right angle (90°). The first portion **220***a* parallel to the gate line **205** connects the second and third portions **220***b* and **220***c*. The second and third portions **220***b* and **220***c* are formed under the adjacent reflective electrodes **218***a* and **218***b*, respectively. The second portion **220***b* has the same area as the third portion **220***c* to disperse and minimize an effect on the reflective electrode **218** by a polarity ("+" or "−") of a signal flowing through the data line **220**. Since the second portion **220***b* has the same width as the third portion **220***c*, a length "d_4+d_5" of the second portion **220***b* is equal to a length "d_6" of the third portion **220***c*. A black matrix **221***a*, **221***b*, and **221***c* is formed to cover the first portion **220***a* at region "E" between the adjacent reflective electrodes **218***a* and **218***b* and the gate line **205**. Since the first portion **220***a* at the region "E" between the adjacent reflective electrodes **218***a* and **218***b* has a small area, the black matrix **221***a* and **221***b* over the first portion **220***a* can be eliminated. Therefore, an area of the black matrix is reduced so that an effective reflection area can be enlarged.

[0056] Alternatively, the data line can be alternately formed at a plurality of pixel regions. In this case, the data line has first, second, and third portions and the number of each of the first, second, and third portions is one.

[0057] **FIG. 8** is a schematic plane view illustrating an array substrate for a reflective liquid crystal display device according to a third embodiment of the present invention.

[0058] In **FIG. 8, a** gate line **305** and a data line **317** cross each other defining adjacent pixel regions "P1" and "P2". A thin film transistor (TFT) "T" having a gate electrode **308**, an active layer **312**, and source and drain electrodes **314** and **316** is disposed at the intersection of the gate line **305** and the data line **317**. The gate electrode **308** and the source electrode **314** are connected to the gate line **305** and the data line **317**, respectively. The source and drain electrodes **314** and **316** are spaced apart from each other. Adjacent reflective electrodes **318***a* and **318***b* connected to the drain electrode **316** are formed at the adjacent pixel regions "P1" and "P2", respectively.

[0059] The data line **317** has a bent shape including first, second, and third portions **317***a*, **317***b*, and **317***c*, wherein the bent portion forms a right angle (90°). The first portion **317***a* parallel to the gate line **305** connects the second and third portions **317***b* and **317***c*. The second and third portions **317***b* and **317***c* are formed under the adjacent reflective electrodes **318***a* and **318***b*, respectively. The second portion **317***b* has the same area as the third portion **317***c* to disperse and minimize an effect on the reflective electrode **318** by a polarity ("+" or "−") of a signal flowing through the data line **317**. Since the second portion **317***b* has the same width as the third portion **317***c*, a length "d_1" of the second portion **317***b* is equal to a length "d_2" of the third portion **317***c*. A black matrix **321***a* and **321***b* is formed to cover the first portion **317***a* at region "E" between the adjacent reflective electrodes **318***a* and **318***b* and the gate line **305**. Since the first portion **317***a* at the region "E" between the adjacent reflective electrodes **318***a* and **318***b* has a small area, the black matrix **321***a* over the first portion **317***a* can be eliminated. Therefore, an area of the black matrix is reduced so that an effective reflection area can be enlarged.

[0060] Alternatively, the data line can be alternately formed at a plurality of pixel regions. In this case, the data line has first, second, and third portions and the number of each of the first, second, and third portions is one.

[0061] **FIG. 9** is a schematic plane view showing an array substrate for a reflective liquid crystal display device according to a fourth embodiment of the present invention.

[0062] In **FIG. 9, a** gate line **406** and a data line **420** are formed on a first substrate **400**. The gate line **406** and the data line **420** cross each other defining first, second, third, and fourth pixel regions "P1", "P2", "P3", and "P4". The widths of a first region "E1" between the first and second pixel regions "P1" and "P2" and a second region "E2" between the third and fourth pixel regions "P3" and "P4" are minimized. The data line **420** is divided into first and second branch lines **420***a* and **420***b* at one end of the first substrate **400**. The first branch line **420***a* is disposed at the first and third pixel regions "P1" and "P3", and the second branch line **420***b* is disposed at the second and fourth pixel regions "P2" and "P4". The first and second branch lines **420***a* and **420***b* are connected to each other through a connection pattern **421**. The connection pattern **421** is formed over the gate line **406** at the intersecting region "K" of the gate line **406** and the data line **420**. The gate line **406** may have a minimum width at the intersecting region "K".

[0063] The gate line **406** has first and second protrusions **402** and **408**. The first protrusion **402** extending to the first and second pixel regions "P1" and "P2" is used as a gate electrode, and the second protrusion **408** extending to the third and fourth pixel regions "P3" and "P4" is used as a first capacitor electrode of a storage capacitor "C_{ST}". The first branch line **420***a* is disposed to pass over a connecting region "J" between the gate line **406** and the first capacitor electrode **408**.

[0064] A thin film transistor (TFT) "T" including the gate electrode **402**, an active layer **412**, and source and drain electrodes **416** and **418** is disposed at the intersection of the gate line **406** and the second branch line **420***b*. The source electrode **416** connected to the second branch line **420***b* is spaced apart from the drain electrode **418**. The drain electrode **418** has a third protrusion **424** extending over the first capacitor electrode **408** through an extended portion **422** at each pixel region "P1", "P2", "P3", and "P4". The third protrusion **424** is used as a second capacitor electrode of a storage capacitor. Accordingly, the first and second capacitor electrodes **408** and **424** form the storage capacitor "C_{ST}" with an insulating layer (not shown) interposed between the first and second capacitor electrodes **408** and **424**.

[0065] A reflective electrode **430** is formed at each pixel region "P1", "P2", "P3", and "P4". Since the reflective electrode **430** is connected to the second capacitor electrode **424**, image signals are supplied to the reflective electrode **430** from the drain electrode **418**. The reflective electrode **430** completely covers the data line **420**, the gate line **406**, and the gate electrode **402**. Since the data line **420** is formed under the reflective electrode **430** spaced apart at each pixel region, the black matrix covering the light reflected from the data line is not required. If the first branch line **420***a* is not disposed at the connecting region "J" between the gate line **406** and the data line **420** and the connection pattern **421** is not disposed at the intersecting region "K" of the gate line **406** and the data line **420**, an additional black matrix corresponding to the exposed first branch line **420***a* and the exposed connection pattern **421** should be formed on a second substrate (not shown) to prevent light leakage. The first branch line **420***a* at the connecting region "J" and the connecting pattern **421** at the intersecting region "K" are exposed. However, the exposed areas of the first branch line **420***a* and the connection pattern **421** are small, so that a black matrix corresponding to the exposed first branch line **420***a* and the exposed connection pattern **421** is not required. Accordingly, high luminance and a high aperture ratio can be obtained. Although an overlapping portion of the first branch line **420***a* and the first capacitor electrode **408** at the connecting region "J" may vary a capacitance of the storage capacitor "C_{ST}", the variation of the capacitance can be minimized in a small-sized reflective liquid crystal display device.

[0066] **FIGS. 10A** to **10**E, which are taken along line X-X of **FIG. 9**. **FIGS. 11A** to **11**D, which are taken along line XI-XI of **FIG. 9**, are cross-sectional views illustrating the process steps of fabricating the array substrate for the reflective liquid crystal display device according to the fourth embodiment of the present invention.

[0067] In **FIGS. 10A and 11A**, a gate line **406**, a gate electrode **402**, and a first capacitor electrode **408** are formed on a first substrate **400**. The gate electrode **402** is a first protrusion extending from the gate line **406**, and the first capacitor electrode **408** is a second protrusion extending from the gate line **406**. The gate line **406**, the gate electrode **402**, and the first capacitor electrode **408** are formed of aluminum (Al) having a low electrical resistance in order to reduce a resistance-capacitance (RC) delay. Pure aluminum has a low chemical resistance and causes line defects due to a hillock phenomenon during a later high-temperature process. Thus, a multi-layered structure including aluminum layer such as aluminum/molybdenum (Al/Mo) can be used as the gate line **406**, the gate electrode **402**, and the first capacitor electrode **408**. As shown in **FIG. 10A, a** gate insulating layer **410** is formed on the gate line **406**, the gate electrode **402**, and the first capacitor electrode **408** by depositing an inorganic insulating material, such as silicon nitride (SiN_x) and silicon oxide (SiO_2)

[0068] In FIGS. **10**B, an active layer **412** of amorphous silicon (a-Si:H) and an ohmic contact layer **414** of impurity-doped amorphous silicon (n+a-Si:H) are sequentially formed on the gate insulating layer **410** over the gate electrode **402**.

[0069] In **FIG. 10C and 11B**, source and drain electrodes **416** and **418** are formed on the ohmic contact layer **414** by depositing and patterning a conductive metallic material, such as chromium (Cr), molybdenum (Mo), antimony (Sb), and titanium (Ti). At the same time, a data line **420** connected to the source electrode **416** is formed on the gate insulating layer **410**. The data line **420** defines adjacent pixel regions "P3" and "P4" with the gate line **406**. Moreover, an extended portion **422** and a second capacitor electrode **424** are formed on the gate insulating layer **410**. The second capacitor electrode **424** is formed over the first capacitor electrode **408**, and the extended portion **422** connects the second capacitor electrode **424** and the drain electrode **418**. The first and second capacitor electrodes **408** and **424** form a storage capacitor "C_{ST}" with an insulating layer **410** interposed between the first and second capacitor electrodes **408** and **424**.

[0070] The data line **420** is divided into first and second branch lines **420***a* and **420***b* at one end of the substrate **400**. The first and second branch lines **420***a* and **420***b* are connected to each other through a connection pattern **421** at an intersecting region "K" of the gate line **406** and the data line **420**. The connection pattern **421** is formed to overlap the gate line **406**. The first branch line **420***a* is disposed at a connecting region "J" between the gate line **406** and the first capacitor electrode **408**. Since the area of the first branch line **420***a* at the connecting region "J" and the connection pattern **421** at the intersecting region "K" is small, a black matrix corresponding to the first branch line **420***a* and the connection pattern **421** is not required.

[0071] In **FIGS. 10D and 11C**, a passivation layer **426** is formed on the source electrode **416**, the drain electrode **418**, the data line **420**, and the second capacitor electrode **424** by depositing an organic insulating material, such as benzocyclobutene (BCB) and acrylic resin. Sequentially, a capacitor contact hole **428** exposing a portion of the second capacitor electrode **424** is formed by etching the passivation layer **426**.

[0072] In **FIGS. 10E and 11D**, a reflective electrode **430** is formed on the passivation layer **426**. The reflective electrode **430** is located in the pixel region "P4" and connected to the second capacitor electrode **424** through the contact hole **428**. The reflective electrode **430** is formed of a reflective metallic material, such as aluminum and an aluminum alloy. Alternatively, an array substrate has a structure such that a floating reflective plate is formed at the pixel region and a transparent electrode connected to the second capacitor electrode is formed over or under the floating reflective plate.

[0073] Since a black matrix corresponding to a space between the adjacent reflective electrodes is not required, the total area of the black matrix can be reduced and luminance can be improved. Moreover, since the ambient light passes through the space between the adjacent reflective electrodes without reflection, a color-mixing phenomenon between the adjacent reflective electrodes can be prevented and a high contrast ratio can be obtained.

[0074] Consequently, in the array substrate according to the present invention, since the data line is formed under the reflective electrode, light leakage caused by a scattering of ambient light at the data line is prevented. Moreover, since ambient light passes through the space between the adjacent reflective electrodes without reflection, an additional black matrix corresponding to the region is not required. Therefore, an aperture ratio is improved, and high luminance and a high contrast ratio can be obtained.

[0075] It will be apparent to those skilled in the art that various modifications and variations can be made in the reflective liquid crystal display device and the fabricating method thereof of the present invention without departing from the spirit or scope of the inventions. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. A reflective liquid crystal display device, comprising:

a substrate having a pixel region;

a gate line on the substrate;

a thin film transistor connected to the gate line and the data line, the thin film transistor having a gate electrode, an active layer, and source and drain electrodes;

first and second reflective electrodes connected to the drain electrode, the first and second reflective electrodes completely covering the data line and separated by a gap; and

a data line crossing the gate line, wherein the data line has a bent shape including first, second, and third portions, and the first portion parallel to the gate line connects the second and third portions, and the second and third portions are formed under the first and second reflective electrodes, respectively.

2. The reflective liquid crystal display device according to claim 1, wherein the second portion of the data line has the same area as the third portion.

3. The reflective liquid crystal display device according to claim 1, wherein the gate electrode and the source electrode are connected to the gate line and the data line, respectively.

4. The reflective liquid crystal display device according to claim 1, wherein the first and second reflective electrodes are formed of one of aluminum and an aluminum alloy.

5. The reflective liquid crystal display device according to claim 1, wherein the first and second reflective electrodes have an uneven shape.

6. The reflective liquid crystal display device of claim 1, wherein the gap between the first and second reflective electrodes is smaller than a length of the first portion of the data line.

7. A method for fabricating a reflective liquid crystal display device, comprising:

forming a gate line on a substrate;

forming a data line crossing the gate line to define a pixel region, wherein the data line has a bent shape including first, second, and third portions, and the first portion parallel to the gate line connects the second and third portions, and the second and third portions are formed under the first and second reflective electrodes, respectively;

forming a thin film transistor connected to the gate line and the data line, the thin film transistor comprising a gate electrode, an active layer, and source and drain electrodes; and

forming first and second reflective electrodes connected to the drain electrode, the first and second reflective electrodes completely covering the data line and having a gap between the first and second reflective electrodes.

8. The method according to claim 7, wherein the gap between the first and second reflective electrodes is smaller than a length of the first portion of the data line.

9. The method according to claim 7, wherein the second portion has the same area as the third portion.

10. The method according to claim 7, wherein the gate electrode and the source electrode are connected to the gate line and the data line, respectively.

11. The method according to claim 7, wherein the first and second reflective electrodes are formed of one of aluminum and an aluminum alloy.

12. The method according to claim 7, wherein the first and second reflective electrodes have an uneven shape.

13. A reflective liquid crystal display device, comprising:

a substrate including a pixel region;

a gate line on the substrate;

a thin film transistor connected to the gate line and the data line, the thin film transistor including a gate electrode, an active layer, and source and drain electrodes;

first and second reflective electrodes electrically connected to the drain electrode, the first and second reflective electrodes completely covering the data line and having a first gap between the first and second reflective electrodes; and

a data line crossing the gate line, the data line comprising first and second branch lines separated by a second gap formed under the first and second reflective electrodes, respectively.

14. The reflective liquid crystal display according to claim 13, wherein the first gap is equal to or smaller than the second gap.

15. The reflective liquid crystal display device according to claim 13, wherein the gate electrode and the source electrode are connected to the gate line and the second branch line, respectively.

16. The reflective liquid crystal display device according to claim 15, further comprising a first capacitor electrode extending from the gate line to the pixel region, and a second capacitor electrode extending from the drain electrode, the second capacitor electrode being formed over the first capacitor electrode.

17. The reflective liquid crystal display device according to claim 13, wherein the first and second reflective electrodes are formed of one of aluminum and an aluminum alloy.

18. The reflective liquid crystal display device according to claim 13, further comprising a connection pattern connecting the first and second branch lines, the connection pattern located over the gate line.

19. The reflective liquid crystal display device according to claim 13, wherein the first branch line is formed over the gate line and the first capacitor electrode.

20. The reflective liquid crystal display device according to claim 13, wherein the first and second capacitor electrodes form a storage capacitor.

21. The reflective liquid crystal display device according to claim 13, wherein the first and second branch lines have a width substantially the same as each other.

22. The reflective liquid crystal display device according to claim 13, wherein the first and second reflective electrodes completely cover the gate line.

23. A method for fabricating a reflective liquid crystal display device, comprising:

forming a gate line on a substrate;

forming a data line on the substrate crossing the gate line and defining a pixel region, the data line comprising first and second branch lines separated by a first gap;

forming a thin film transistor connected to the gate line and the data line, the thin film transistor comprising a gate electrode, an active layer, and source and drain electrodes; and

forming first and second reflective electrodes connected to the drain electrode, the first and second reflective electrodes completely covering the data line and having a second gap between the first and second reflective electrodes.

24. The method according to claim 23, further comprising forming first and second capacitor electrodes on the substrate, wherein the first capacitor electrode is extended from the gate line and the second capacitor electrode is extended from the drain electrode and located over the first capacitor electrode.

25. The method according to claim 23, wherein the gate electrode and the source electrode are connected to the gate line and the second branch line, respectively.

26. The method according to claim 23, wherein the first and second reflective electrodes are formed of one of aluminum and an aluminum alloy.

27. The method according to claim 23, further comprising forming a connection pattern connecting the first and second branch lines, the connection pattern located over the gate line.

28. The method according to claim 23, wherein the first branch line is formed over the gate line and the first capacitor electrode.

29. The method according to claim 24, wherein the first and second capacitor electrodes form a storage capacitor.

30. The method according to claim 23, wherein the first gap is equal to or greater than the second gap.

31. The method according to claim 23, wherein the first and second branch lines have a width substantially the same as each other.

32. The reflective liquid crystal display device according to claim 23, wherein the first and second reflective electrodes completely cover the gate line.

* * * * *

专利名称(译)	反射型液晶显示装置及其制造方法		
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摘要(译)

在本发明中公开了一种反射型液晶显示装置及其制造方法。反射型液晶显示装置包括具有像素区域的基板，基板上的栅极线，连接到栅极线和数据线的薄膜晶体管，薄膜晶体管具有栅电极，有源层和源极漏电极，连接到漏电极的第一和第二反射电极，完全覆盖数据线并由间隙分开的第一和第二反射电极，以及与栅线交叉的数据线，其中数据线具有包括弯曲形状的数据线第一，第二和第三部分，以及与栅极线平行的第一部分连接第二和第三部分，第二和第三部分分别形成在第一和第二反射电极下面。