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(54) MULTI-DOMAIN TRANSFLECTIVE TYPE FRINGE FIELD SWITCHING LIQUID CRYSTAL DISPLAY

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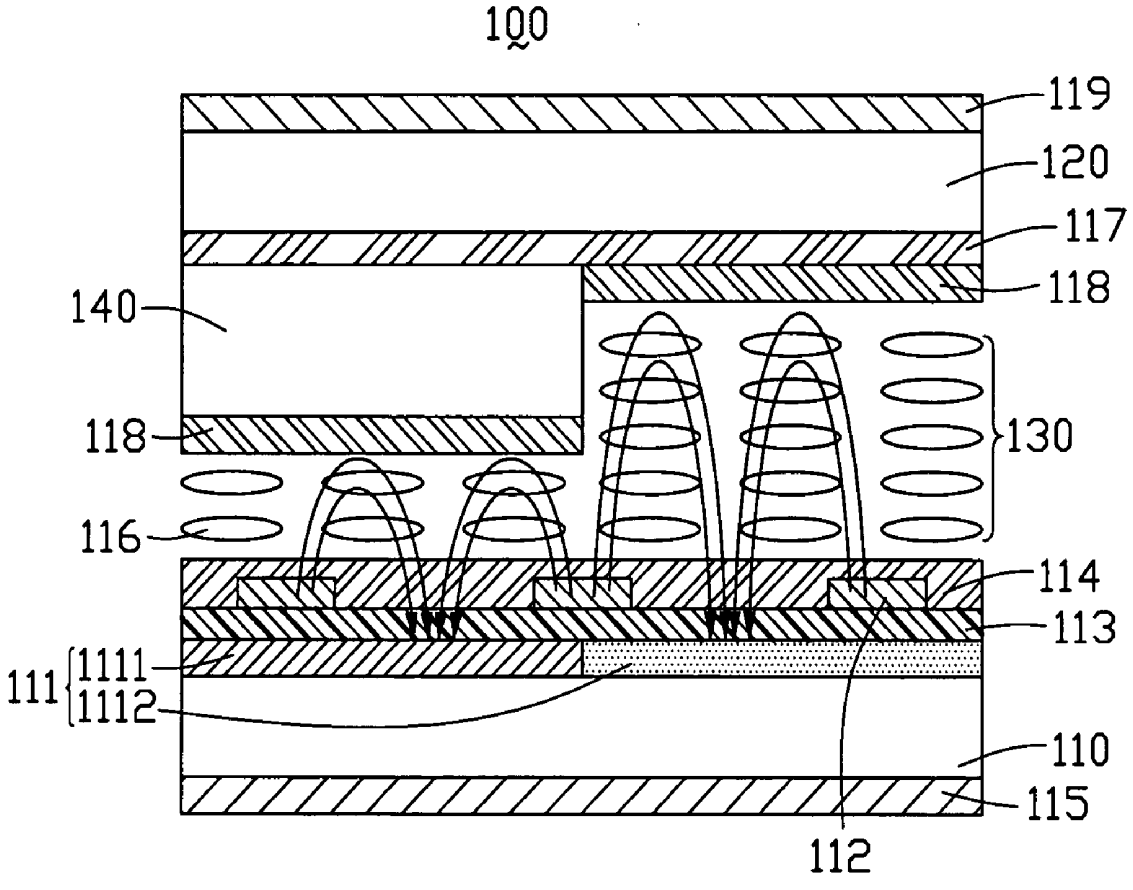
(57) **ABSTRACT**

A transflective type fringe field switching liquid crystal display (**100**), includes a first and a second substrates (**110, 120**) facing each other, a liquid crystal layer (**130**) contained between the first and second substrates, a plurality of gate lines (**121**) and a plurality of data lines (**122**) associated with the first substrate, thereby defining a plurality of pixel regions. Each pixel region includes a transmissive region and a reflective region, a counter electrode (**111**) and a plurality of pixel electrodes (**112**) overlying the counter electrode are arranged on each pixel region in order to form one or more fringe electric fields, and each of the pixel electrodes has a bent portion. In each pixel region of the FFS LCD, an electric field in at least two directions is generated between the pixel and counter electrodes so as to form at least two domains. Accordingly, the FFS LCD has a high quality, reliable display.



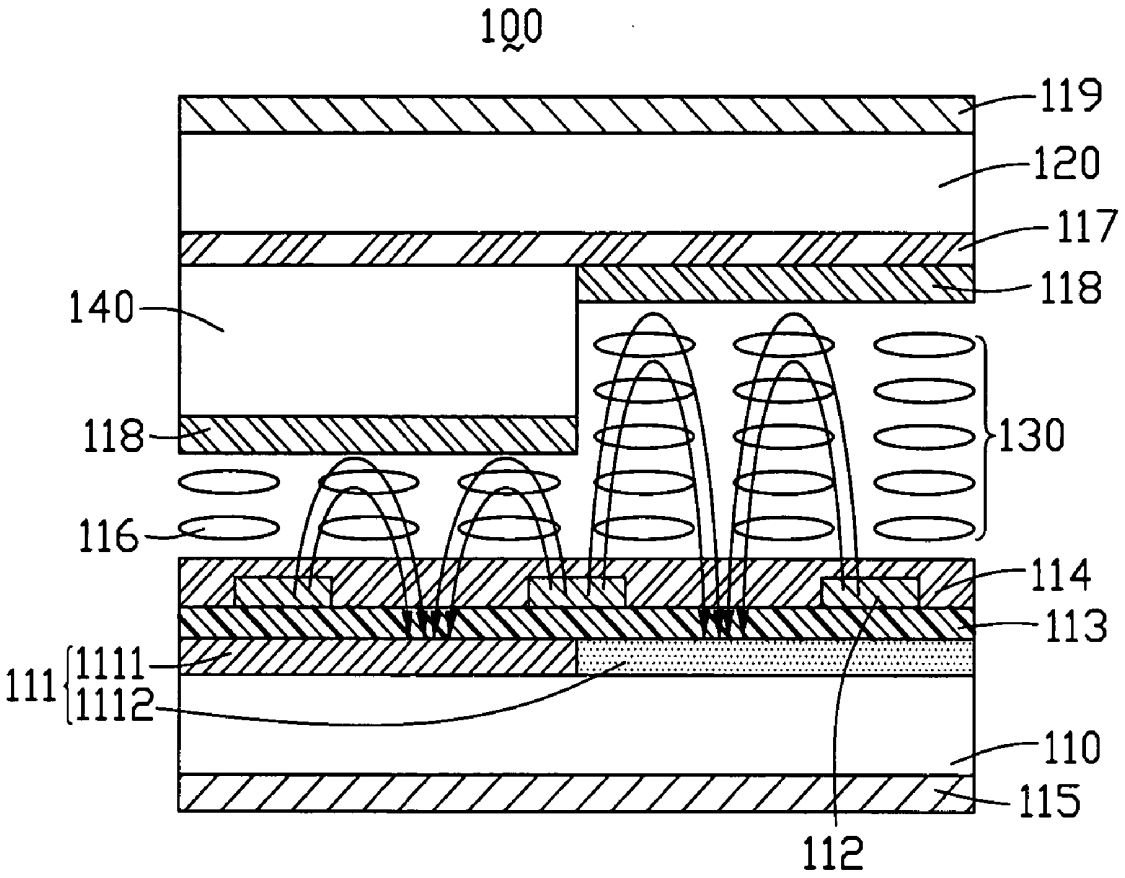

100
119
120
117
118
140
118
130
116
114
113
111
1111
1112
110
115
112

FIG. 1

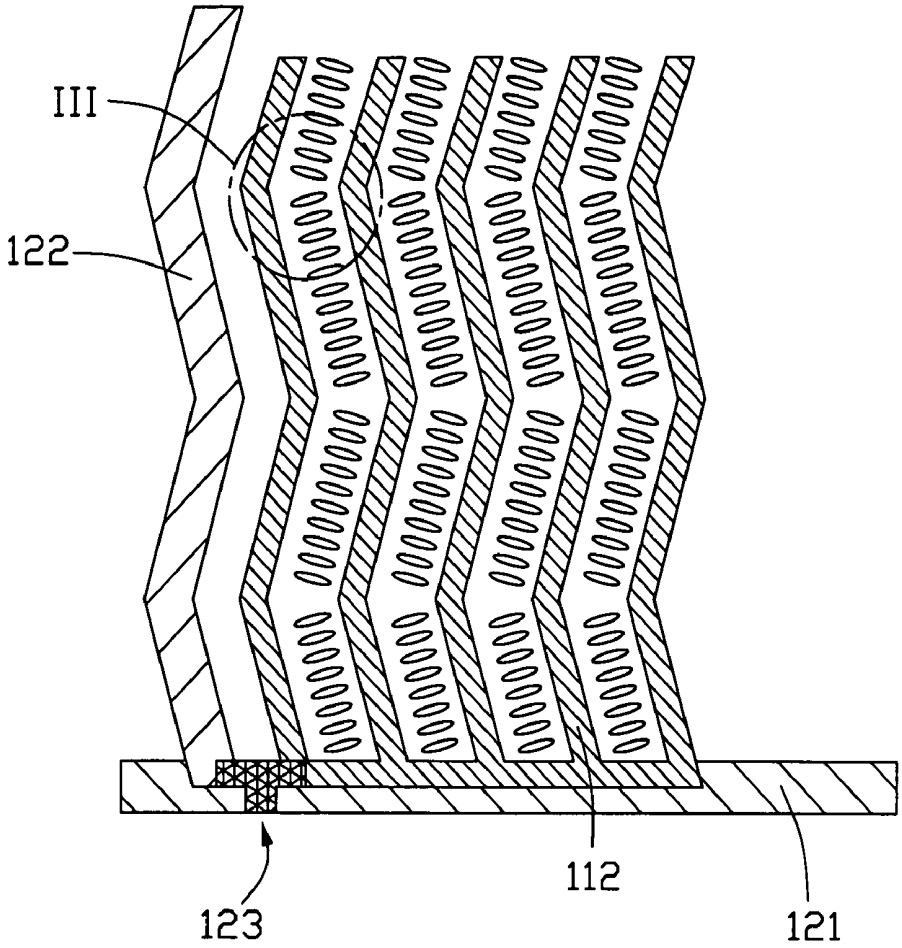


FIG. 2

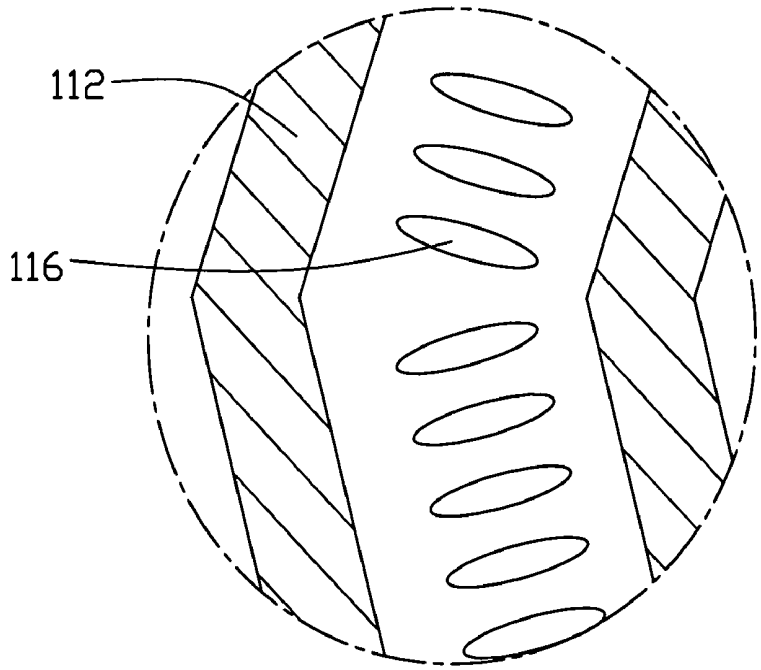


FIG. 3

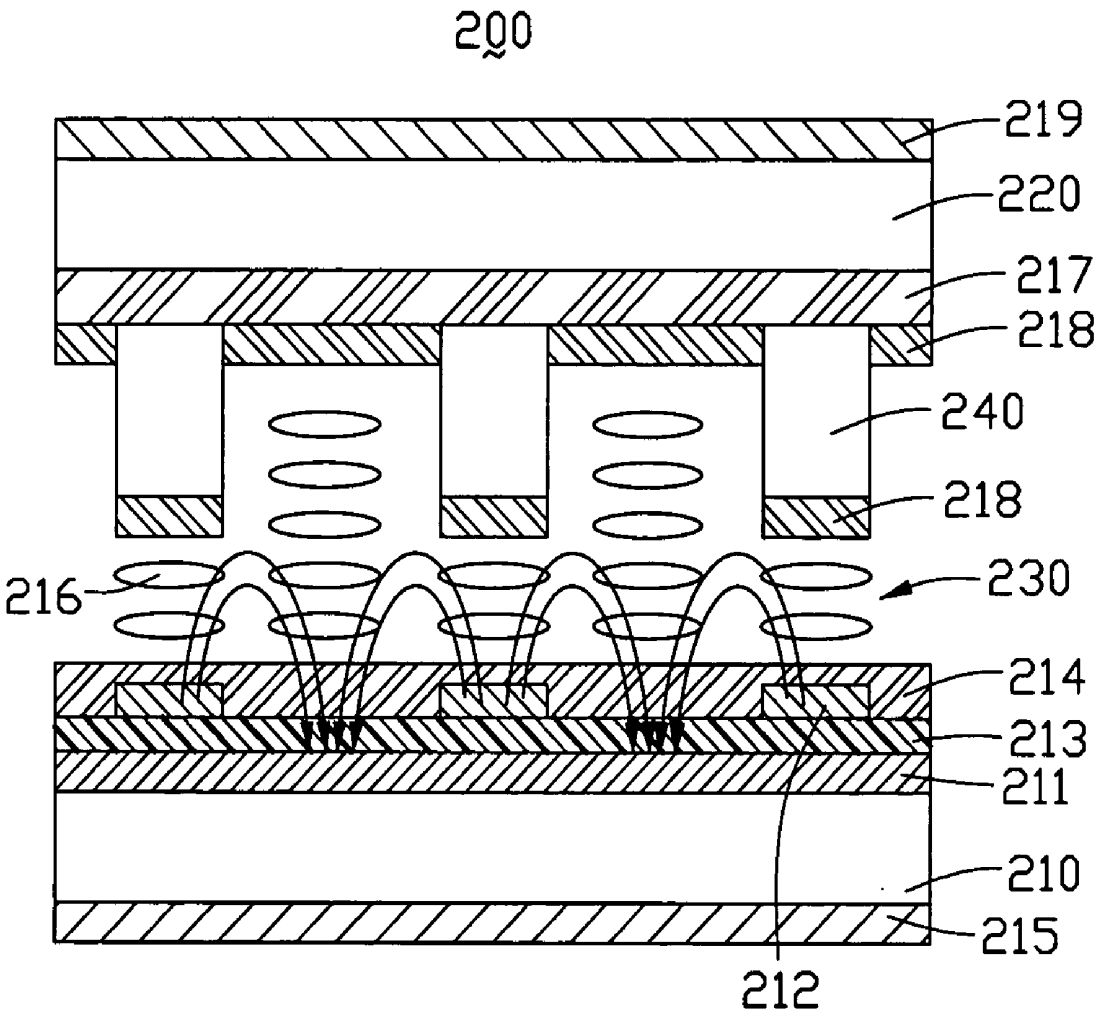


FIG. 4

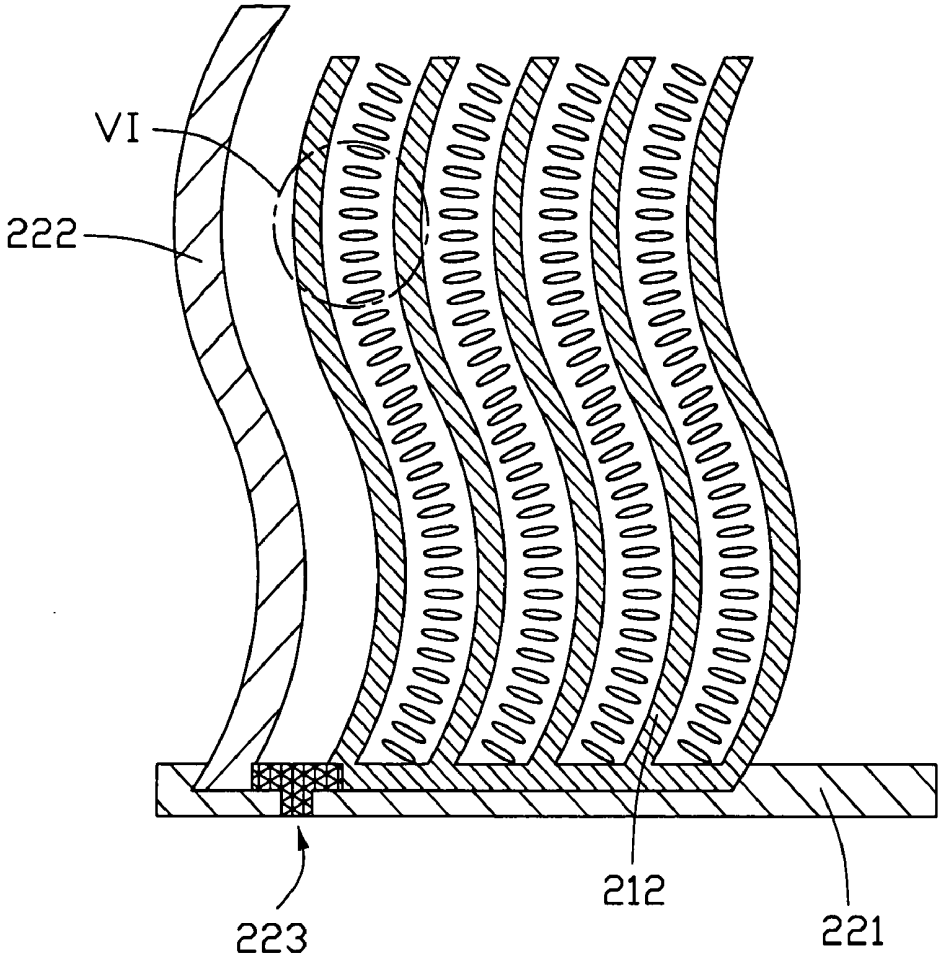


FIG. 5

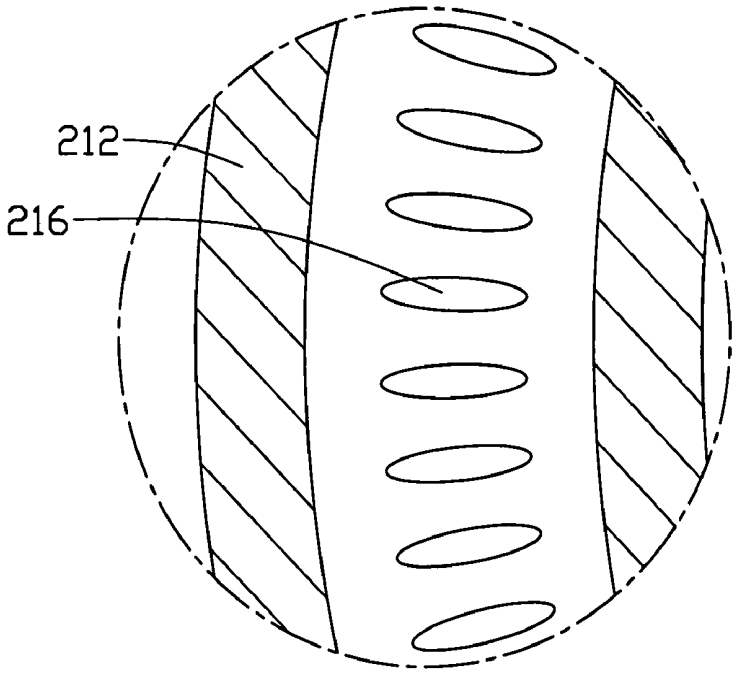


FIG. 6

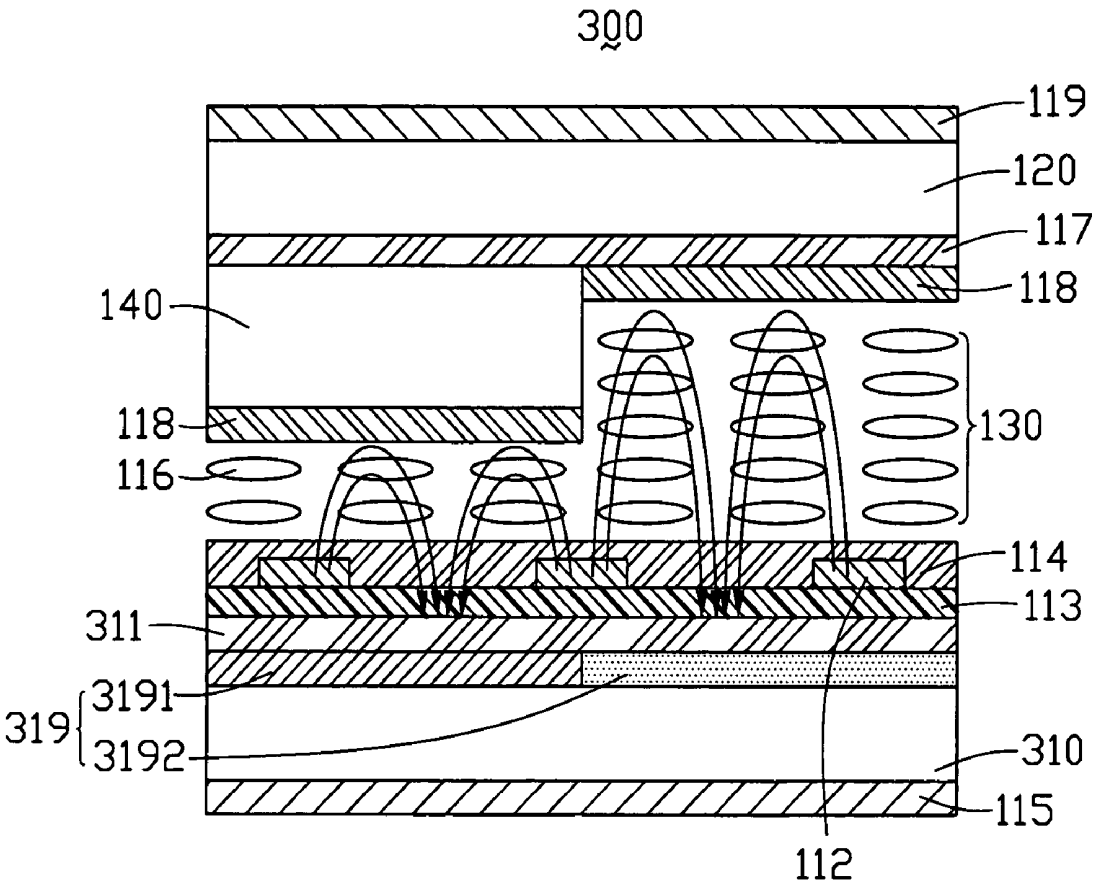

300
119
120
117
118
140
118
130
116
114
113
311
3191
319
3192
310
115
112

FIG. 7

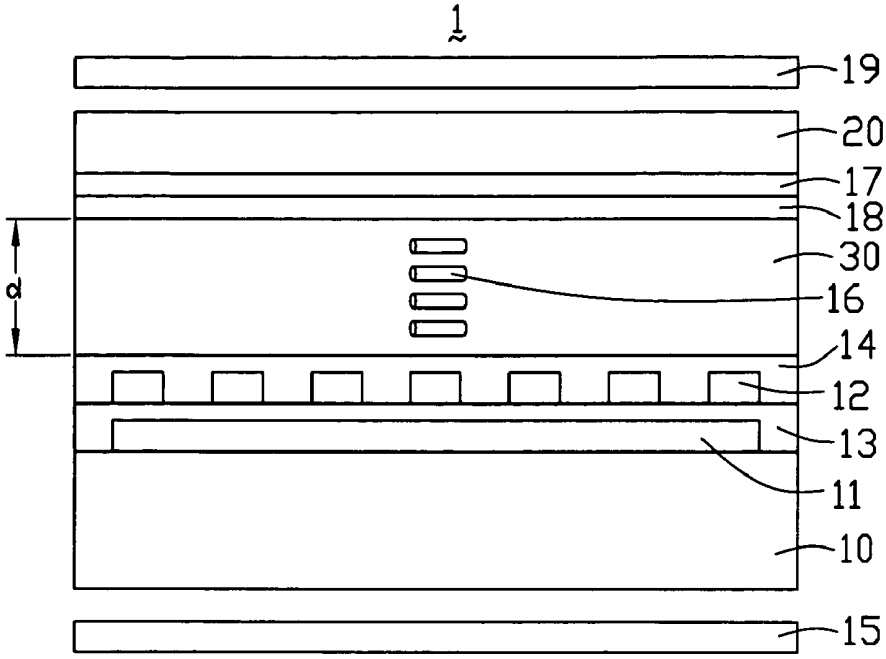


FIG. 8
(PRIOR ART)

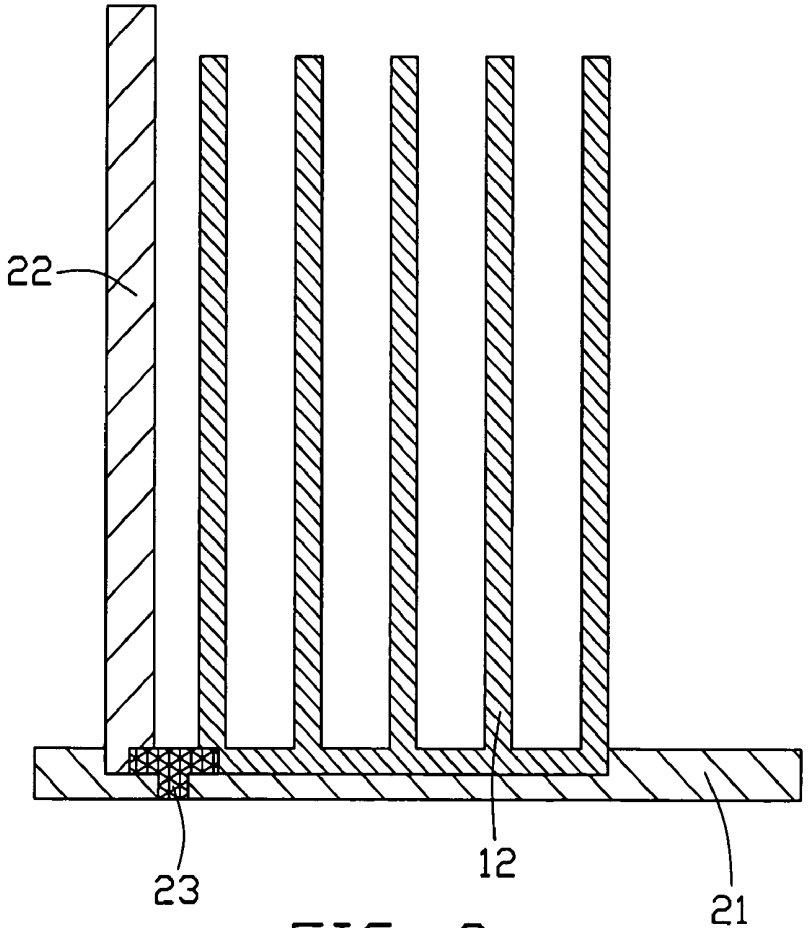


FIG. 9
(PRIOR ART)

MULTI-DOMAIN TRANSFLECTIVE TYPE FRINGE FIELD SWITCHING LIQUID CRYSTAL DISPLAY

FIELD OF THE INVENTION

[0001] The present invention relates to liquid crystal displays (LCDs), and more particularly to a multi-domain transflective type fringe field switching (FFS) LCD.

BACKGROUND

[0002] An LCD utilizes the optical and electrical anisotropy of liquid crystal molecules thereof in order to produce an image. The liquid crystal molecules have a particular passive orientation when no voltage is applied thereto. However, when a voltage is applied and the LCD is in a driven state, the liquid crystal molecules change their orientation according to the strength and direction of the driving electric field. A polarization state of incident light changes when the light transmits through the liquid crystal molecules, due to the optical anisotropy of the liquid crystal molecules. The extent of the change depends on the orientation of the liquid crystal molecules. Thus, by properly controlling the driving electric field, an orientation of the liquid crystal molecules is changed and a desired image can be produced.

[0003] The twisted nematic (TN) mode LCD was the first main type of LCD developed. Even though TN mode LCDs have been put into use in many applications, they have an inherent drawback that cannot be eliminated; namely, a very narrow viewing angle. By adding compensation films on TN mode LCDs, this problem can be mitigated to some extent. However, the cost of the TN mode LCD is increased. Therefore, an LCD with a totally different driving means has been developed. The LCD is called a fringe field switching (FFS) LCD. The FFS LCD has pixel and counter electrodes usually arranged on two different layers of a same substrate. The distance between the electrodes is narrow, in order to form a fringe electric field about the electrodes.

[0004] Usually an LCD needs a planar light source, such as a backlight module, to display images. This kind of LCD is called a transmissive type LCD. In general, the backlight module is the main power consuming component of the transmissive type LCD. In order to reduce power consumption, reflective type LCDs have been developed. A reflective type LCD generally utilizes natural ambient light beams to provide a planar light source. Importantly, the reflective type LCD cannot operate without some kind of external light source. In order to overcome the drawbacks of the two above-described types of LCDs, a transflective type LCD that can operate as both a reflective type LCD and a transmissive type LCD has been developed.

[0005] **FIG. 8** shows a schematic, side cross-sectional view of part of a conventional FFS LCD. The FFS LCD **1** includes a lower substrate **10**, an upper substrate **20** facing the lower substrate **10**, and a liquid crystal layer **30** interposed between the substrates **10**, **20**.

[0006] A counter electrode **11**, an isolating layer **13**, a plurality of parallel pixel electrodes **12**, and a lower alignment layer **14** are sequentially arranged on an inner surface of the lower substrate **10**. A lower polarizer **15** is arranged on an outer surface of the lower substrate **10**.

[0007] A color filter **17** and an upper alignment layer **18** are sequentially arranged on an inner surface of the upper substrate **20**. An upper polarizer **19** is arranged on an outer surface of the upper substrate **20**.

[0008] When a voltage is applied to the FFS LCD **1**, the FFS LCD **1** is in a driven state. The pixel electrodes **12** and the counter electrode **11** form a fringe electric field to drive liquid crystal molecules **16** of the liquid crystal layer **30**, and to thus make the LCD **1** display desired images.

[0009] Also referring to **FIG. 9**, a schematic, cross-sectional top view of pixel electrodes **12** of the FFS LCD **1** is shown. A gate line **21** and a data line **22** are arranged on the lower substrate **10**, and cross each other. A thin film transistor (TFT) **23** is disposed in the vicinity of the crossing of the gate line **21** and the data line **22**. The pixel electrodes **12** connect to the TFT **23**. Each pixel electrode **12** is a linear electrode that is aligned along a single direction.

[0010] In summary, the FFS LCD **1** is a conventional single-domain FFS LCD. When a voltage is applied between the pixel and counter electrodes **12** and **11**, a single-domain electric field is established between the pixel and counter electrodes **12** and **11**. The liquid crystal molecules **16** are twisted so as to align according to the electric field. That is, long axes of the liquid crystal molecules **16** are oriented in a single direction only. This means that an associated display screen exhibits color shift when the display screen is obliquely viewed while displaying white.

[0011] What is needed, therefore, is a transflective type FFS LCD which has more than a single domain.

SUMMARY

[0012] In a preferred embodiment of the multi-domain transflective type FFS LCD includes a first and a second substrates facing each other, a liquid crystal layer contained between the first and second substrates, a plurality of gate lines and a plurality of data lines associated with the first substrate, thereby defining a plurality of pixel regions. Each pixel region includes a transmissive region and a reflective region; a counter electrode and a plurality of pixel electrodes overlying the counter electrode are disposed on each pixel region in order to form one or more fringe electric fields, and each of the pixel electrodes has a bent portion.

[0013] In a second embodiment of the multi-domain transflective type FFS LCD includes a first and a second substrates facing each other, a liquid crystal layer contained between the first and second substrates, a plurality of gate lines and a plurality of data lines associated with the first substrate, thereby defining a plurality of pixel regions. Each pixel region includes a transmissive region and a reflective region; a counter electrode and a plurality of pixel electrodes overlying with the counter electrode are disposed on each pixel region in order to form at least one fringe electric field, at least one of the pixel electrodes in each pixel region has a bent portion in order to establish an electric field in at least two directions between the pixel electrodes and the counter electrode in the pixel region.

[0014] Thus, in each pixel region of the FFS LCD, an electric field in at least two directions is generated between the pixel and counter electrodes so as to form at least two domains. Accordingly, the FFS LCD has a high quality, reliable display.

[0015] Other objects, advantages, and novel features will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] **FIG. 1** is a schematic, side cross-sectional view of part of an FFS LCD according to a first embodiment of the present invention;

[0017] **FIG. 2** is a schematic, cross-sectional top elevation of parts of a pixel region of the FFS LCD of **FIG. 1**, showing a configuration of pixel electrodes;

[0018] **FIG. 3** is an enlarged view of a circled portion III of **FIG. 2**;

[0019] **FIG. 4** is a schematic, side cross-sectional view of part of an FFS LCD according to a second embodiment of the present invention;

[0020] **FIG. 5** is a schematic, cross-sectional top elevation of parts of a pixel region of the FFS LCD of **FIG. 4**, showing a configuration of pixel electrodes;

[0021] **FIG. 6** is an enlarged view of a circled portion VI of **FIG. 5**;

[0022] **FIG. 7** is a schematic, side cross-sectional view of part of an FFS LCD according to a third embodiment of the present invention;

[0023] **FIG. 8** is a schematic, side cross-sectional view of part of a conventional FFS LCD; and

[0024] **FIG. 9** is a schematic, cross-sectional top elevation of parts of a pixel region of the FFS LCD of **FIG. 8**, showing a configuration of a pixel electrode.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0025] Referring to **FIG. 1**, an FFS LCD **100** according to a first embodiment of the present invention includes a lower substrate **110**, an upper substrate **120** facing the lower substrate **110**, and a liquid crystal layer **130** interposed between the lower and upper substrates **110**, **120**.

[0026] A counter electrode **111**, an isolating layer **113**, a plurality of pixel electrodes **112**, and a lower alignment layer **114** are sequentially arranged on an inner surface of the lower substrate **110**. A lower polarizer **115** is arranged on an outer surface of the lower substrate **110**. The counter electrode **111** includes a transmissive portion **1112** and a reflective portion **1111**. The transmissive portion **1112** has a transmissive display function, and the reflective portion **1111** has a reflective display function. Thus a pixel region is divided into a transmissive region and a reflective region.

[0027] A color filter layer **117** and an upper alignment layer **118** are sequentially arranged on an inner surface of the upper substrate **120**. An upper polarizer **119** is arranged on an outer surface of the upper substrate **120**. An overcoat layer **140** is interposed between the color filter layer **117** and the upper alignment layer **118** in the reflective region. Thus, a thickness of the liquid crystal layer **130** in the reflective region is less than a thickness of the liquid crystal layer **130** in the transmissive region.

[0028] Referring to **FIG. 2** and **FIG. 3**, a gate line **121** and a data line **122** cross each other and define the pixel region. A thin film transistor (TFT) **123** is disposed in the vicinity of the crossing of the gate line **121** and the data line **122**. The pixel electrodes **112** connect to the TFT **123**. Each pixel electrode **112** has a generally zigzagged configuration, with the pixel electrodes **112** being parallel to each other. The data line **122** may also have a zigzagged configuration, whereby the data line **122** is parallel to the pixel electrodes **112**.

[0029] When a voltage is applied to the FFS LCD **100**, the FFS LCD **100** is in an on state. A fringe electric field distributing in at least two directions is generated between the pixel electrodes **112** and the counter electrode **111** so as to form at least two domains. Liquid crystal molecules **116** are twisted so as to align according to the fringe electric field. That is, long axes of the liquid crystal molecules **116** are oriented in at least two directions. Accordingly, the FFS LCD **100** has a high quality, reliable display.

[0030] Referring to **FIG. 4**, an FFS LCD **200** according to a second embodiment of the present invention includes a lower substrate **210**, an upper substrate **220** facing the lower substrate **210**, and a liquid crystal layer **230** interposed between the lower and upper substrates **210**, **220**.

[0031] A counter electrode **211**, an isolating layer **213**, a plurality of pixel electrodes **212**, and a lower alignment layer **214** are sequentially arranged on an inner surface of the lower substrate **210**. A lower polarizer **215** is arranged on an outer surface of the lower substrate **210**. The counter electrode **211** is made of a transmissive material, so that it constitutes a transmissive electrode and has a transmissive display function. The pixel electrodes **212** are made of a reflective material, so that they constitute reflective electrodes and have a reflective display function. Thus a pixel region is divided into transmissive regions and reflective regions.

[0032] A color filter layer **217** and an upper alignment layer **218** are sequentially arranged on an inner surface of the upper substrate **220**. An upper polarizer **219** is arranged on an outer surface of the upper substrate **220**. An overcoat layer **240** is interposed between the color filter layer **217** and the upper alignment layer **218** in the reflective regions. Thus, a thickness of the liquid crystal layer **230** in the reflective regions is less than a thickness of the liquid crystal layer **230** in the transmissive regions.

[0033] Referring to **FIG. 5** and **FIG. 6**, a gate line **221** and a data line **222** cross each other and define the pixel region. A TFT **223** is disposed in the vicinity of the crossing of the gate line **221** and the data line **222**. The pixel electrodes **212** connect to the TFT **223**. Each pixel electrode **212** has a wave-shaped configuration, with the pixel electrodes **212** being parallel to each other. The data line **222** may also have a wave-shaped configuration, whereby the data line **222** is parallel to the pixel electrodes **212**.

[0034] When a voltage is applied to the FFS LCD **200**, the FFS LCD **200** is in an on state. A fringe electric field distributing in multi-directions is generated between the pixel electrodes **212** and the counter electrode **211** so as to form multi-domains. Liquid crystal molecules **216** are twisted so as to align according to the fringe electric field. That is, long axes of the liquid crystal molecules **216** are oriented in multi directions. Accordingly, the FFS LCD **200** has a high quality, reliable display.

[0035] Referring to **FIG. 7**, an FFS LCD **300** according to a third embodiment of the present invention is similar to the FFS LCD **100** of the first embodiment. However, in the FFS LCD **300**, a counter electrode **311** is made of a transmissive material so that it constitutes a transmissive electrode, and a

transflector **319** is interposed between a lower substrate **310** and the counter electrode **311**. The transflector **319** includes a transmissive portion **3192** and a reflective portion **3191**. The transmissive portion **3192** has a transmissive display function, and the reflective portion **3191** has a reflective display function. Thus a pixel region is divided into a transmissive region and a reflective region.

[**0036**] In summary, all the above-described configurations of an FFS LCD provide the following structure, function and advantages. In each pixel region, an electric field in at least two directions is generated between the pixel and counter electrodes so as to form at least two domains. Accordingly, the FFS LCD has a high quality, reliable display.

[**0037**] It is to be understood, however, that even though numerous characteristics and advantages of embodiments of the present invention have been set forth in the foregoing description, together with details of the structure and function of the embodiments, the disclosure is illustrative only, and changes may be made in detail to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

What is claimed is:

1. A transflective type fringe field switching liquid crystal display, comprising:

a first and a second substrates facing each other;

a liquid crystal layer contained between the first and second substrates;

a plurality of gate lines and a plurality of data lines associated with the first substrate, thereby defining a plurality of pixel regions, each pixel region comprising a transmissive region and a reflective region; and

a counter electrode and a plurality of pixel electrodes overlying the counter electrode disposed in the pixel regions in order to form one or more fringe electric fields, each of the pixel electrodes having a bent portion.

2. The transflective type fringe field switching liquid crystal display as claimed in claim 1, wherein the bent portion of each of the pixel electrodes has a generally zigzagged configuration.

3. The transflective type fringe field switching liquid crystal display as claimed in claim 1, wherein the bent portion of each of the pixel electrodes is wave-shaped.

4. The transflective type fringe field switching liquid crystal display as claimed in claim 1, further comprising an isolating layer disposed between the counter and pixel electrodes.

5. The transflective type fringe field switching liquid crystal display as claimed in claim 4, wherein the counter electrode defines a transmissive portion and a reflective portion in each pixel region, the transmissive portion and the reflective portion respectively corresponding to the transmissive region and the reflective region.

6. The transflective type fringe field switching liquid crystal display as claimed in claim 5, further comprising an overcoat layer disposing at an inner surface of the second substrate corresponding to the reflective region in each pixel region.

7. The transflective type fringe field switching liquid crystal display as claimed in claim 4, wherein the pixel electrodes are reflective electrodes and the counter electrode is a transmissive electrode.

8. The transflective type fringe field switching liquid crystal display as claimed in claim 7, further comprising an overcoat layer disposing at an inner surface of the second substrate corresponding to the reflective electrodes in each pixel region.

9. The transflective type fringe field switching liquid crystal display as claimed in claim 4, further comprising a transflector defining transmissive portions and reflective portions disposing between the counter electrode and the first substrate, and wherein the counter electrode constitutes a transmissive electrode.

10. The transflective type fringe field switching liquid crystal display as claimed in claim 9, further comprising an overcoat layer disposing at an inner surface of the second substrate corresponding to the reflective portions of each pixel region.

11. The transflective type fringe field switching liquid crystal display as claimed in claim 1, further comprising a color filter layer and an upper alignment layer disposed at an inner surface of the second substrate.

12. The transflective type fringe field switching liquid crystal display as claimed in claim 11, further comprising an overcoat layer disposing between the color filter layer and the upper alignment layer in locations corresponding to the reflective regions.

13. The transflective type fringe field switching liquid crystal display as claimed in claim 12, wherein a thickness of the liquid crystal layer corresponding to the reflective regions is less than a thickness of the liquid crystal layer corresponding to the transmissive regions.

14. A transflective type fringe field switching liquid crystal display, comprising:

a first and a second substrates facing each other;

a liquid crystal layer contained between the first and second substrates;

a plurality of gate lines and a plurality of data lines associated with the first substrate, thereby defining a plurality of pixel regions, each pixel region comprising a transmissive region and a reflective region; and

a counter electrode and a plurality of pixel electrodes overlying the counter electrode disposing in the pixel regions in order to form at least one fringe electric field, at least one of the pixel electrodes in each pixel region having a bent portion in order to establish an electric field in at least two directions between the pixel electrodes and the counter electrode in the pixel region.

15. The transflective type fringe field switching liquid crystal display as claimed in claim 14, wherein liquid crystal molecules in the liquid crystal layer can be simultaneously twisted in at least two different directions in each pixel region.

16. The transflective type fringe field switching liquid crystal display as claimed in claim 14, wherein the bent portion of each of the pixel electrodes has a generally zigzagged configuration.

17. The transflective type fringe field switching liquid crystal display as claimed in claim 14, wherein the bent portion of each of the pixel electrodes is wave-shaped.

18. The transflective type fringe field switching liquid crystal display as claimed in claim 14, wherein the counter electrode defines a transmissive portion and a reflective portion in each pixel region, the transmissive portion and the reflective portion respectively corresponding to the transmissive region and the reflective region.

19. The transflective type fringe field switching liquid crystal display as claimed in claim 14, wherein the pixel electrodes are reflective electrodes and the counter electrode is a transmissive electrode.

20. The transflective type fringe field switching liquid crystal display as claimed in claim 14, further comprising a transflector defining a transmissive portion and a reflective portion disposed between the counter electrode and the first substrate, and wherein the counter electrode constitutes a transmissive electrode.

21. The transflective type fringe field switching liquid crystal display as claimed in claim 14, further comprising a color filter layer, an overcoat layer and an upper alignment layer disposed at an inner surface of the second substrate, and the overcoat layer is disposed between the color filter layer and the upper alignment layer in locations corresponding to the reflective regions.

22. The transflective type fringe field switching liquid crystal display as claimed in claim 21, wherein a thickness of the liquid crystal layer corresponding to the reflective regions is less than a thickness of the liquid crystal layer corresponding to the transmissive regions.

* * * * *

专利名称(译)	多畴透反型边缘场切换液晶显示器		
公开(公告)号	US20060256264A1	公开(公告)日	2006-11-16
申请号	US11/130612	申请日	2005-05-16
[标]申请(专利权)人(译)	群创光电股份有限公司		
申请(专利权)人(译)	群创光电股份有限公司.		
当前申请(专利权)人(译)	群创光电		
[标]发明人	YANG CHIU LIEN PANG JIA PANG		
发明人	YANG, CHIU-LIEN PANG, JIA-PANG		
IPC分类号	G02F1/1335 G02F1/1343		
CPC分类号	G02F1/133555 G02F2001/133757 G02F1/134363 G02F1/133753		
优先权	093113615 2004-05-14 TW		
外部链接	Espacenet USPTO		

摘要(译)

透反射型边缘场切换液晶显示器（100），包括彼此面对的第一和第二基板（110,120），包含在第一和第二基板之间的液晶层（130），多个栅极线（ 121）和与第一基板相关联的多条数据线（122），从而限定多个像素区域。每个像素区域包括透射区域和反射区域，对电极（111）和覆盖对电极的多个像素电极（112）布置在每个像素区域上，以形成一个或多个边缘电场，并且每个像素电极像素电极的一部分具有弯曲部分。在FFS LCD的每个像素区域中，在像素电极和对电极之间产生至少两个方向上的电场，以便形成至少两个畴。因此，FFS LCD具有高质量，可靠的显示器。