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Lee et al.

(10) **Patent No.: US 10,203,567 B2**
(45) **Date of Patent: Feb. 12, 2019**

(54) **LIQUID CRYSTAL DISPLAY DEVICE COMPRISING A PIXEL ELECTRODE HAVING A FIRST EDGE ELECTRODE CONNECTED TO ONE DISTAL END OF A STEM ELECTRODE**

(71) Applicant: **SAMSUNG DISPLAY CO., LTD.**, Yongin-si, Gyeonggi-do (KR)

(72) Inventors: **Se Hyun Lee**, Seoul (KR); **Hak Sun Chang**, Yongin-si (KR); **Cheol Shin**, Hwaseong-si (KR)

(73) Assignee: **Samsung Display Co., Ltd.**, Yongin-Si, Gyeonggi-do (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 242 days.

(21) Appl. No.: **15/351,694**

(22) Filed: **Nov. 15, 2016**

(65) **Prior Publication Data**

US 2017/0322462 A1 Nov. 9, 2017

(30) **Foreign Application Priority Data**

May 3, 2016 (KR) 10-2016-0054473

(51) **Int. Cl.**
G02F 1/1343 (2006.01)
G02F 1/1333 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***G02F 1/134309*** (2013.01); ***G02F 1/1368*** (2013.01); ***G02F 1/13394*** (2013.01); ***G02F 1/13439*** (2013.01); ***G02F 1/133345*** (2013.01); ***G02F 1/133512*** (2013.01); ***G02F 1/133514*** (2013.01); ***G02F 1/133707*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC G02F 2001/133357; G02F 2201/121
See application file for complete search history.

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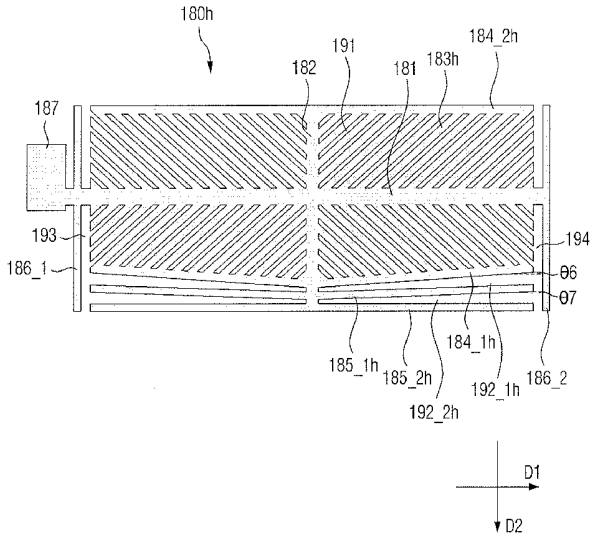
Primary Examiner — Paul Lee
(74) *Attorney, Agent, or Firm* — Lee & Morse, P.C.

(57) **ABSTRACT**

A liquid crystal display device includes a substrate, and a pixel electrode disposed on the substrate, the pixel electrode including a first stem electrode that extends in a first direction, a second stem electrode that extends in a second direction perpendicular to the first direction and intersects with the first stem electrode, a plurality of branch electrodes, the branch electrodes extending obliquely to the first direction and the second direction from the first stem electrode and the second stem electrode, a first connection electrode that connects distal ends of some of the branch electrodes to each other, extends in the first direction and intersects with the second stem electrode, and a first edge electrode that is connected to one distal end of the second stem electrode and extends in the first direction.

20 Claims, 25 Drawing Sheets



(51) **Int. Cl.**

G02F 1/1335	(2006.01)
G02F 1/1337	(2006.01)
G02F 1/1339	(2006.01)
G02F 1/1368	(2006.01)
H01L 27/12	(2006.01)
G02F 1/1362	(2006.01)

(52) **U.S. Cl.**

CPC ***G02F 1/136286*** (2013.01); ***H01L 27/124*** (2013.01); *G02F 2001/133357* (2013.01); *G02F 2201/121* (2013.01); *G02F 2201/123* (2013.01)

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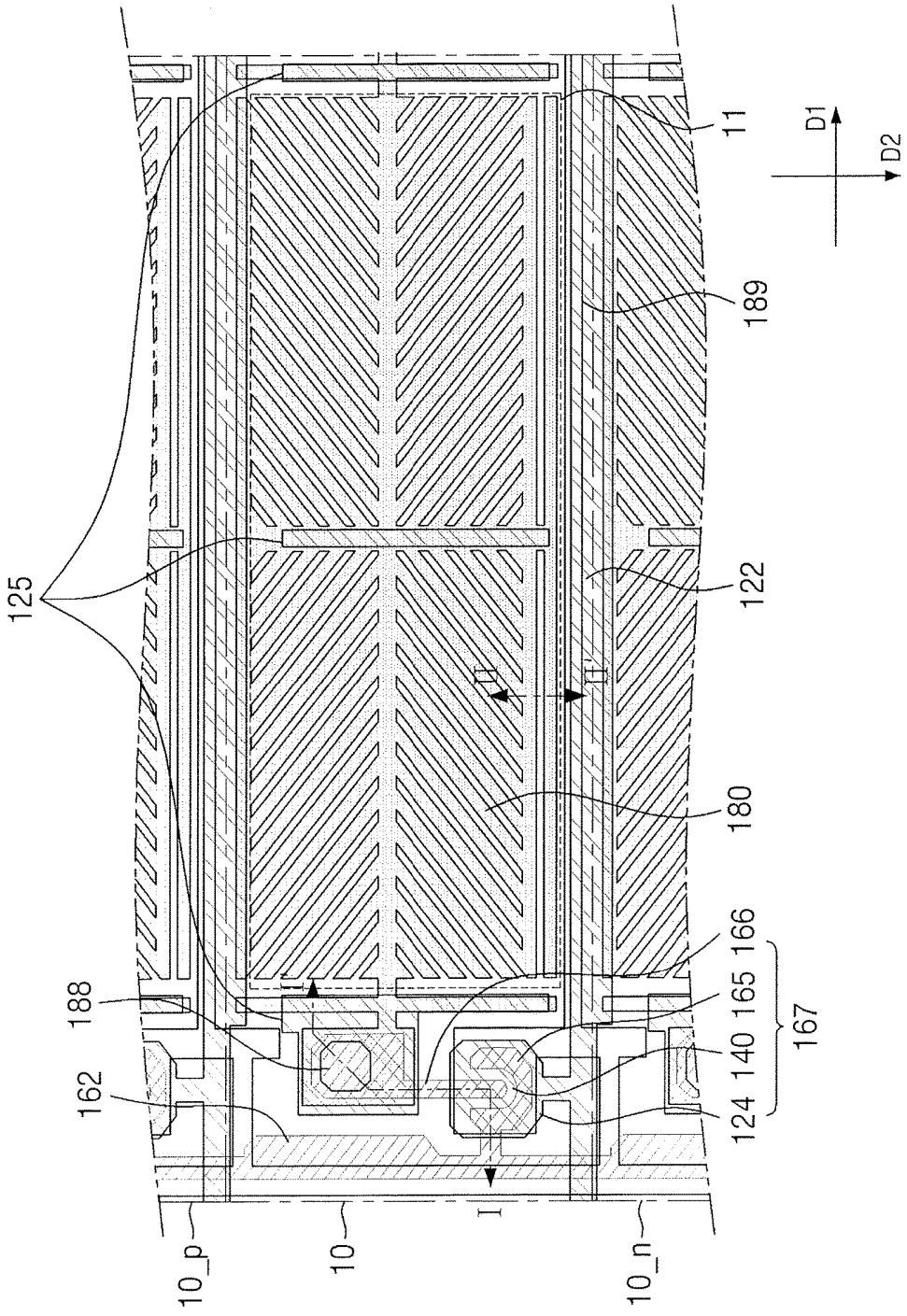
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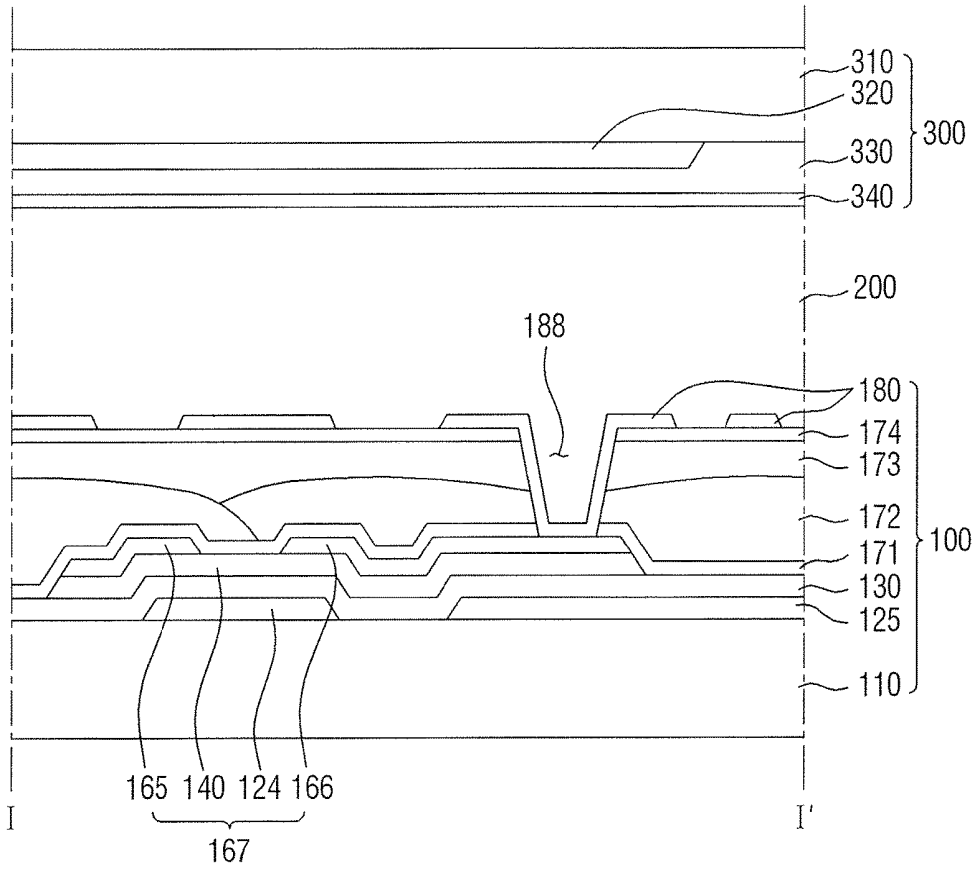
D1
D2
189
125
122
II
II'
180
166
165
140
124
167
188
162
I
I'
10_p
10
10_n

FIG. 1

FIG. 2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320
330
340
300
200
188
180
174
173
172
171
130
125
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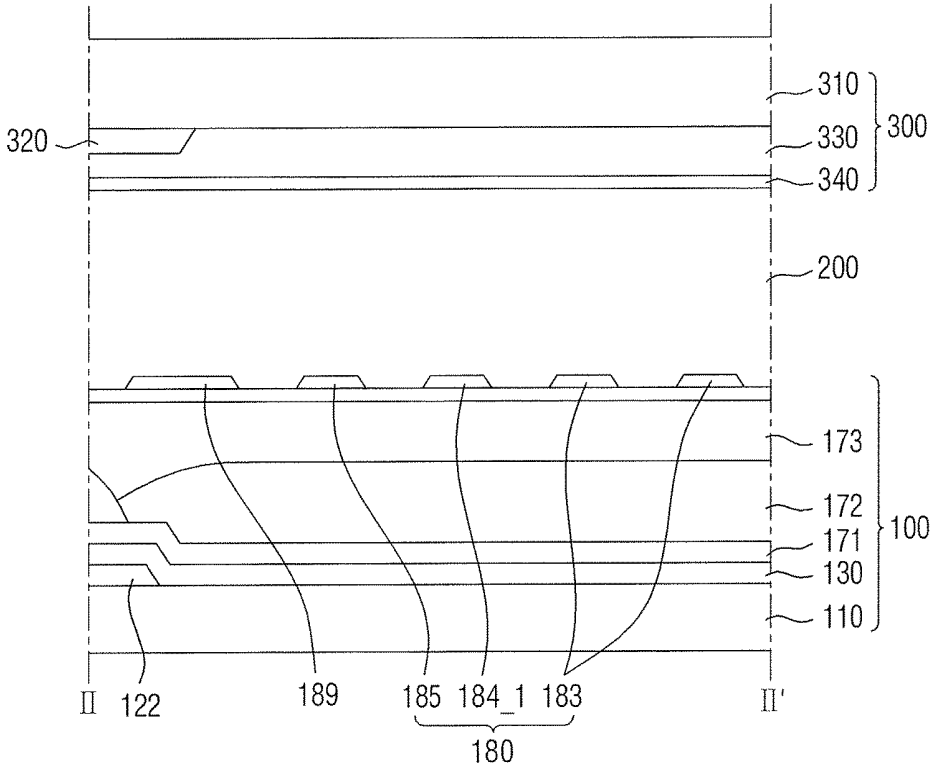
100
165 140 124 166
167
I
I'

FIG. 3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320
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340
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172
171
100
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110
II
122
189
185
184_1
183
II'
180

FIG. 4

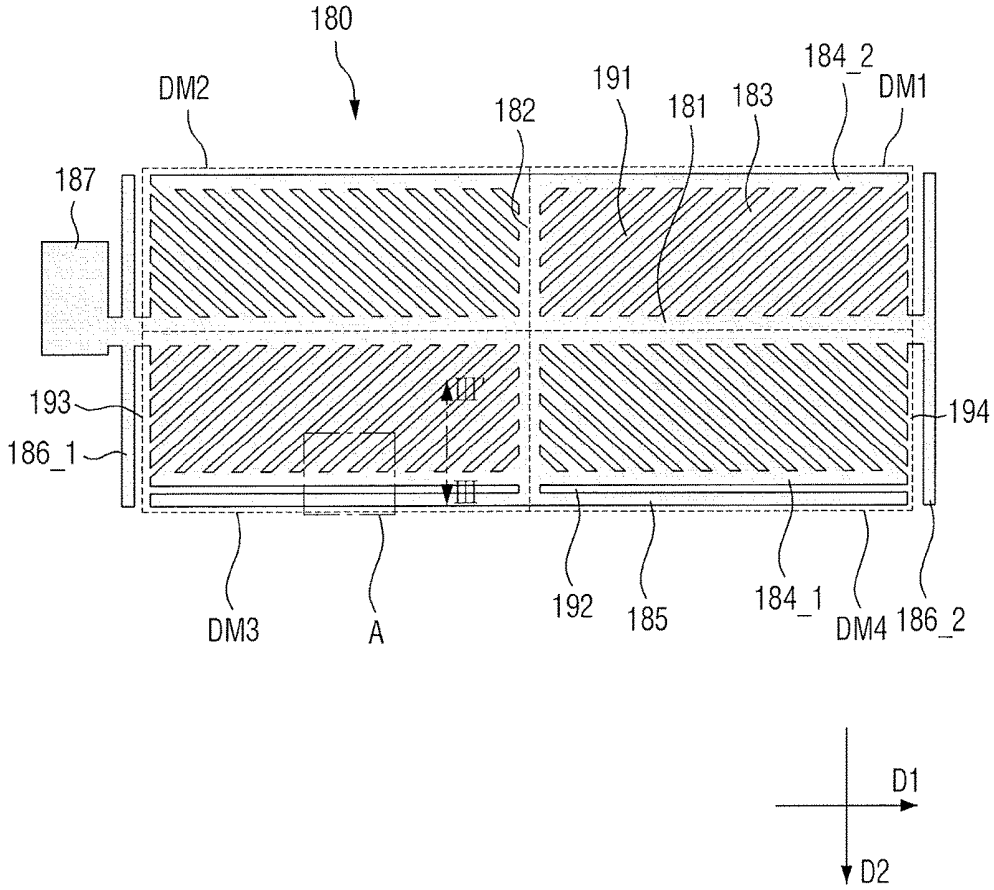

180
DM2
182
191
181
183
184_2
DM1
187
193
186_1
III
III'
194
DM3
A
192
185
184_1
DM4
186_2
D1
D2

FIG. 5

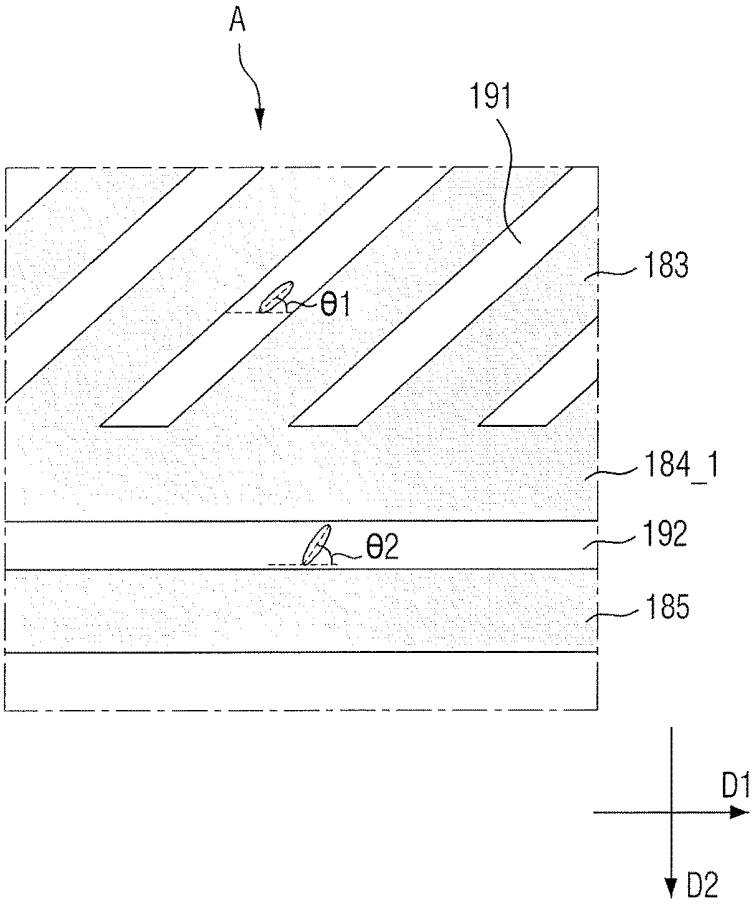


FIG. 6

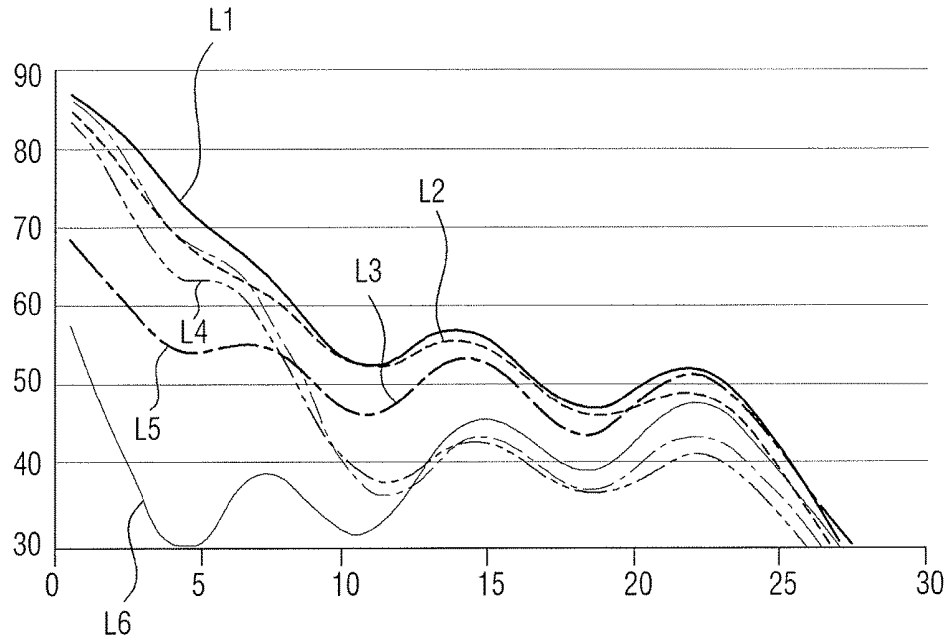

L1
L2
L3
L4
L5
L6
90
80
70
60
50
40
30
0
5
10
15
20
25
30

FIG. 7

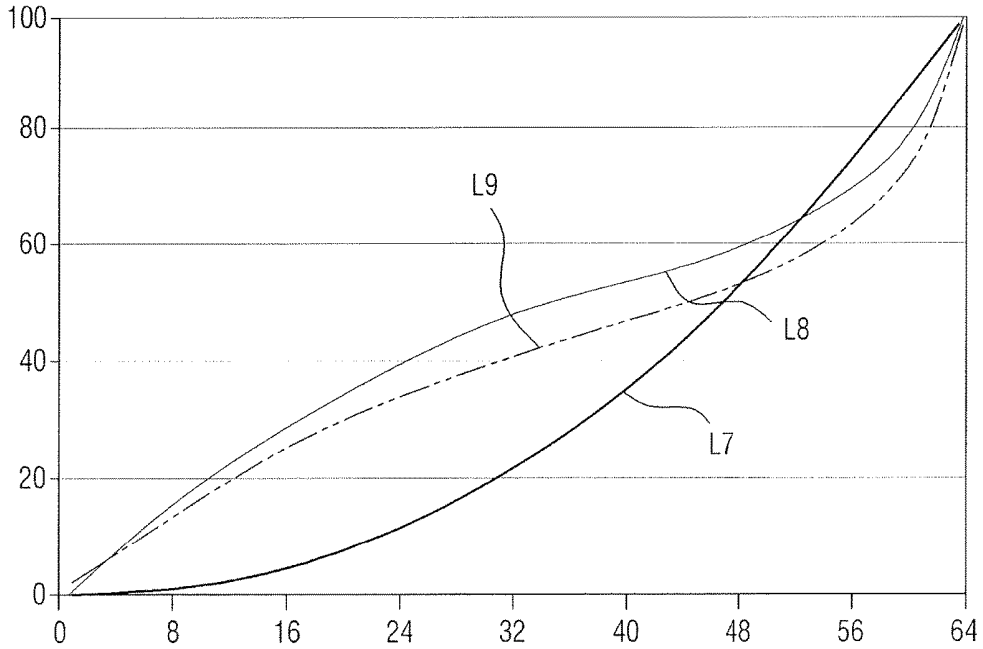
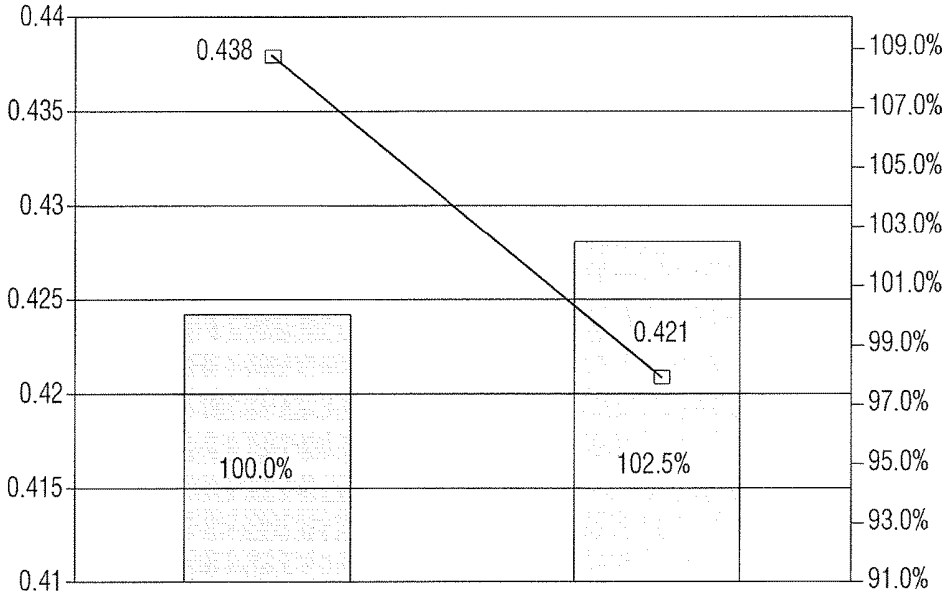

L9
L8
L7
100
80
60
40
20
0
0
8
16
24
32
40
48
56
64

FIG. 8


0.44
0.435
0.43
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0.42
0.415
0.41
0.438
0.421
100.0%
102.5%
109.0%
107.0%
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95.0%
93.0%
91.0%

FIG. 9

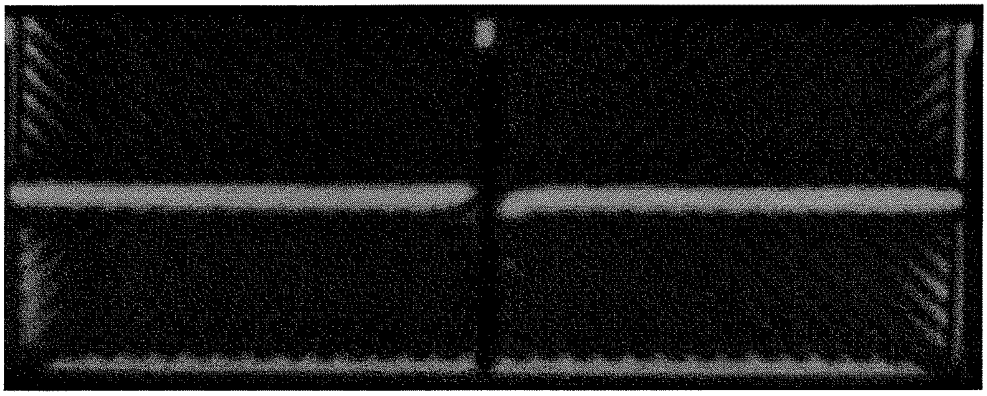


FIG. 10

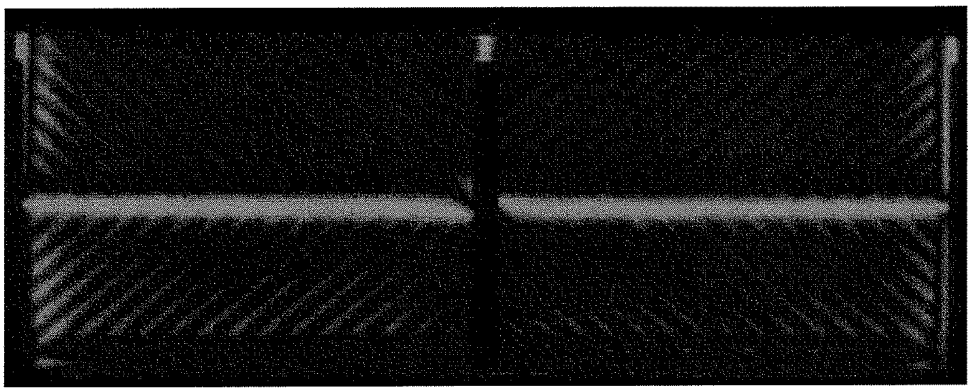


FIG. 11

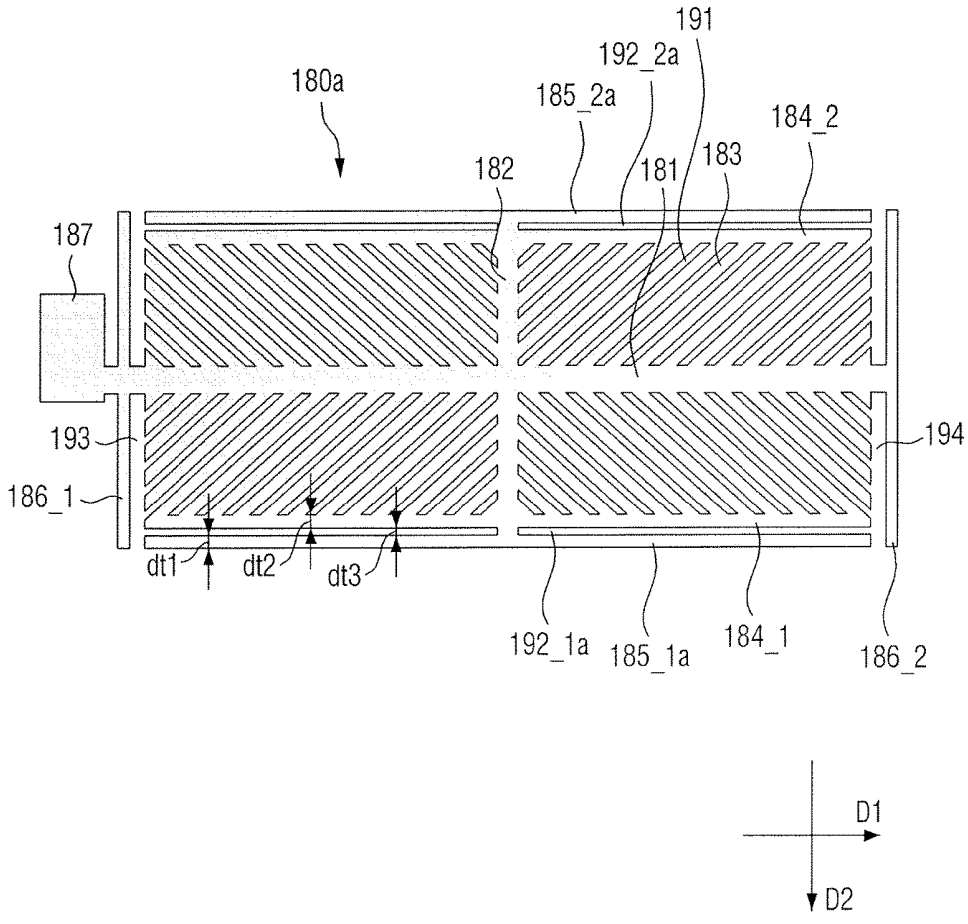

191
192_2a
180a
185_2a
184_2
182
181
183
187
193
194
186_1
dt1
dt2
dt3
192_1a
185_1a
184_1
186_2
D1
D2

FIG. 12

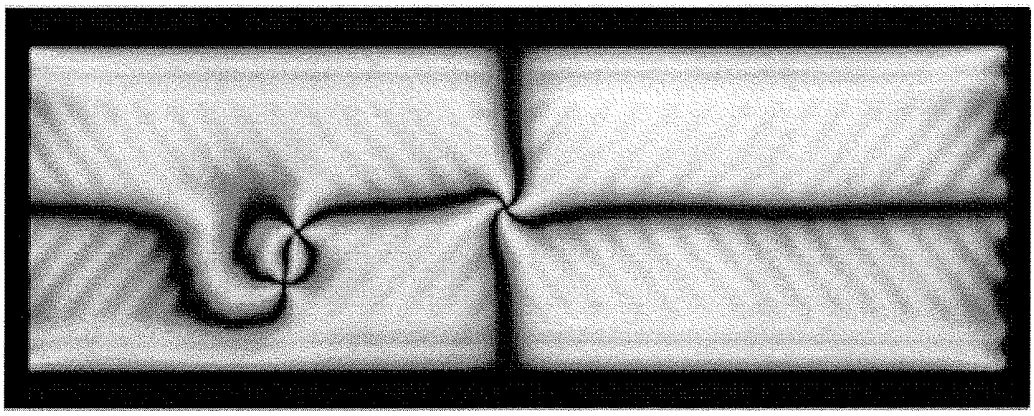
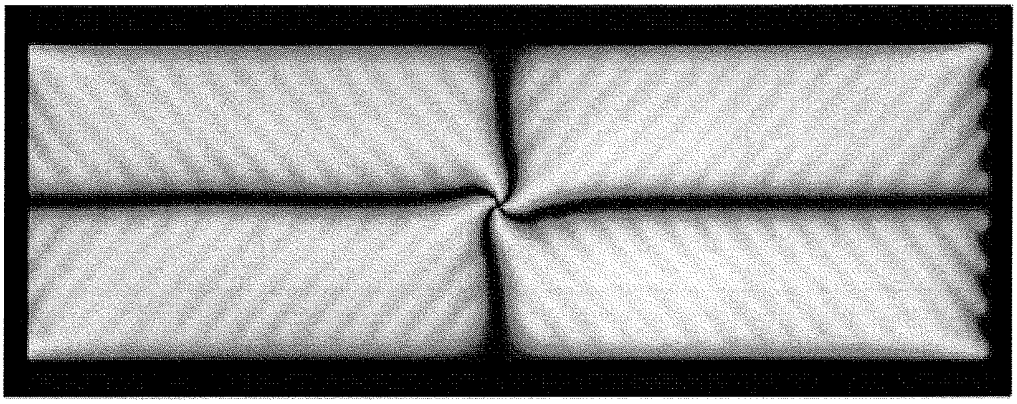


FIG. 13



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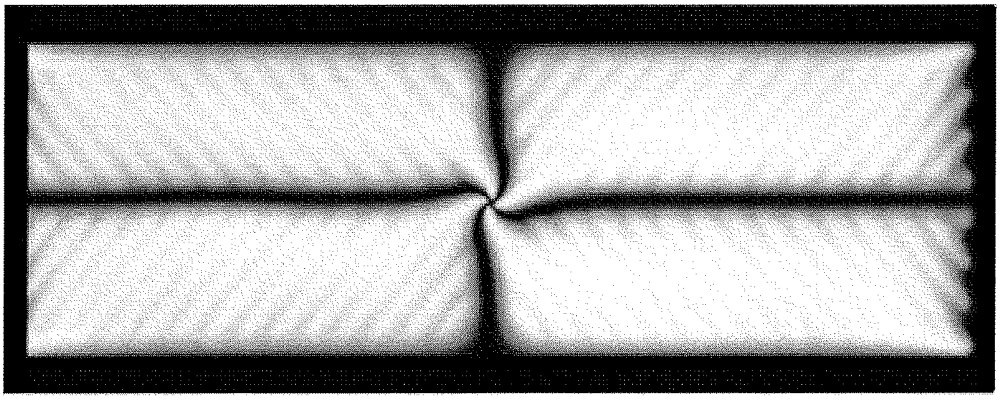

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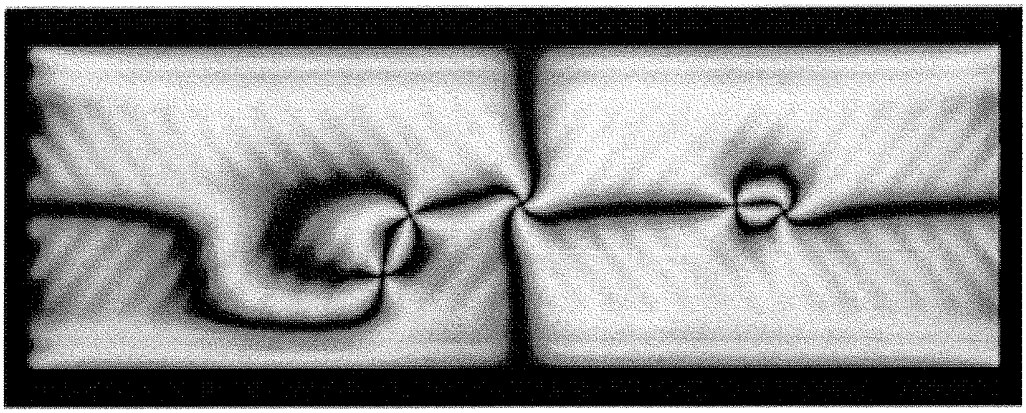

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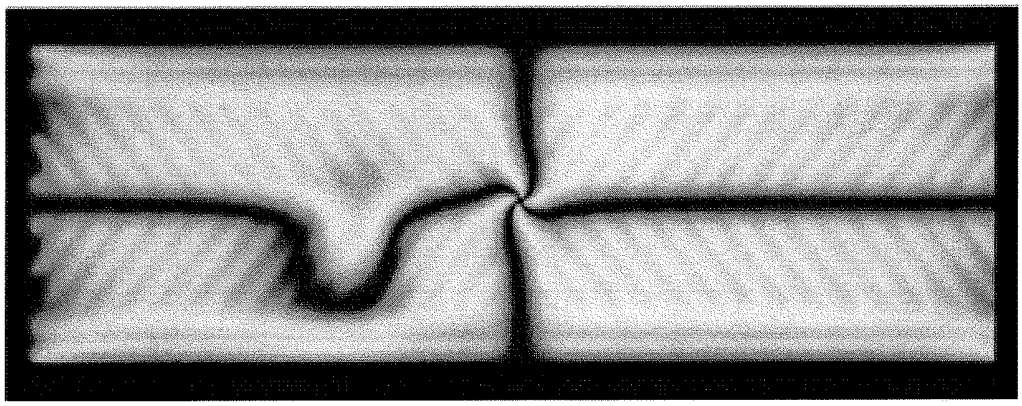

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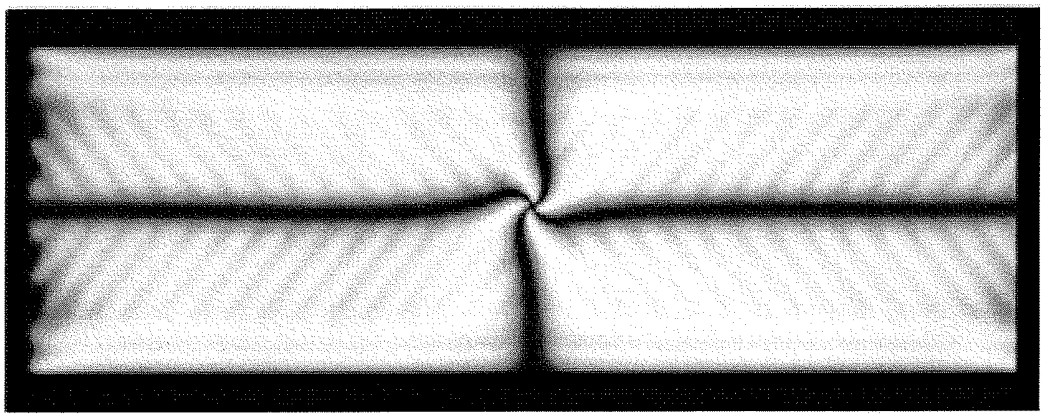

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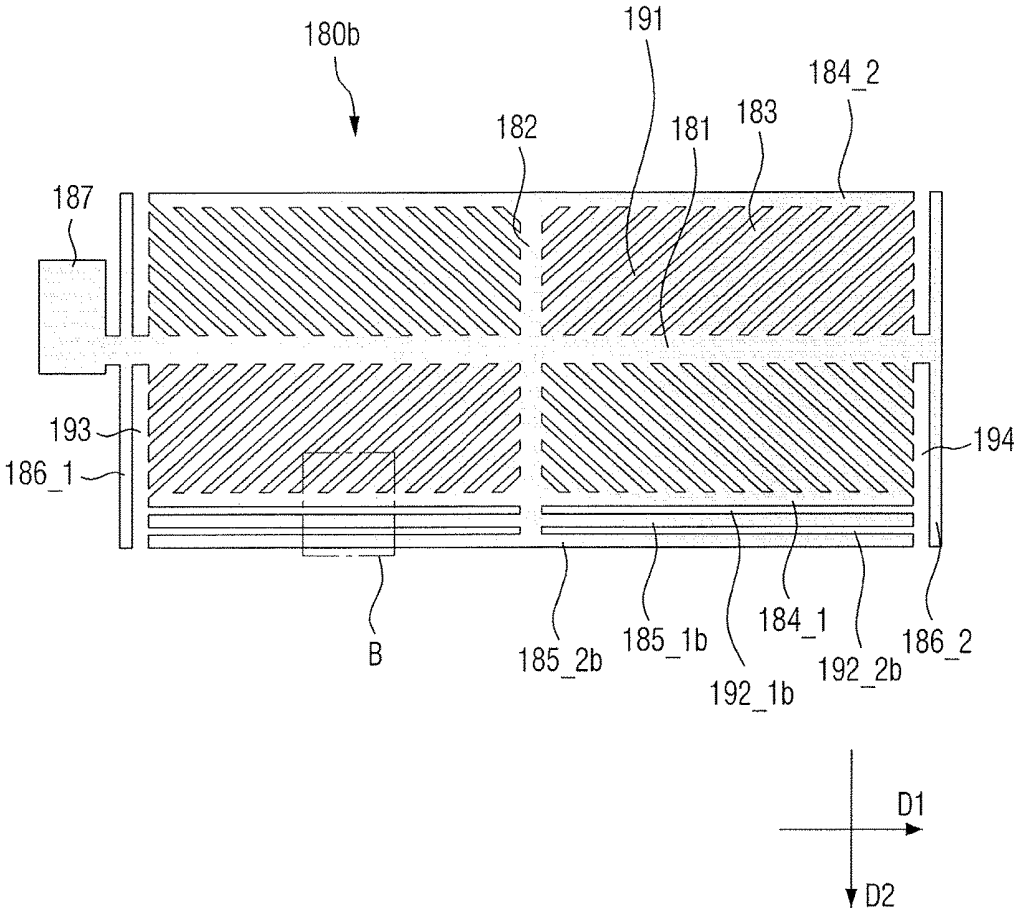
180b
191
184_2
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186_1
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B
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184_1
192_2b
186_2
D1
D2

FIG. 19

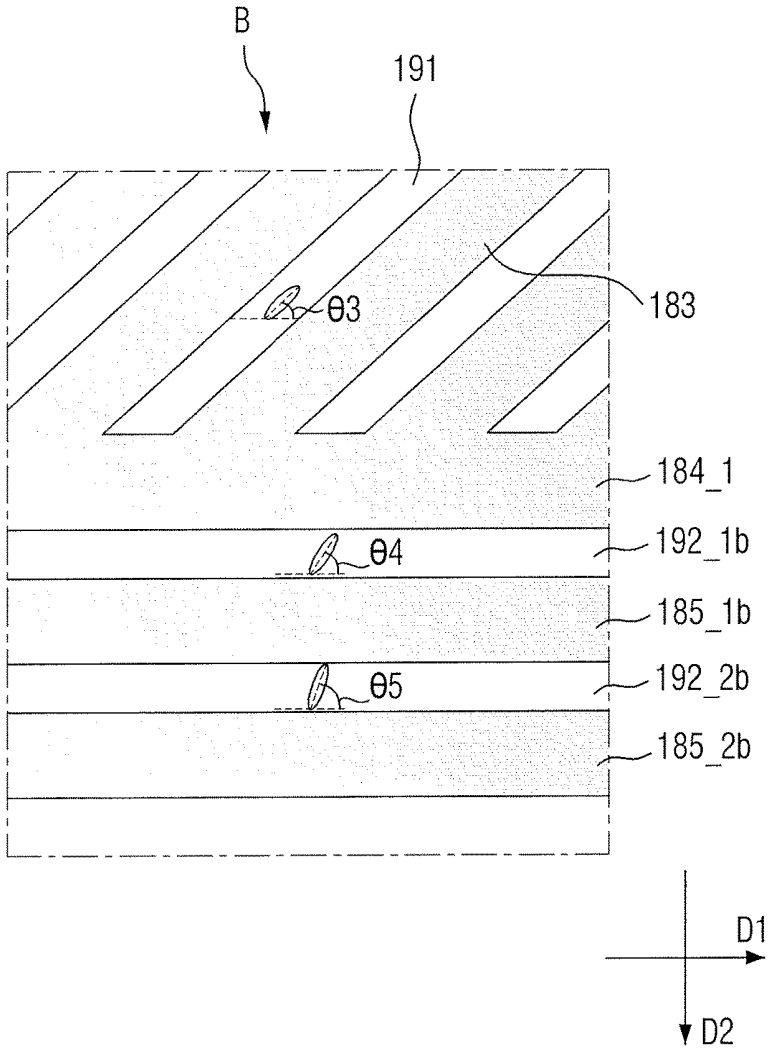


FIG. 20

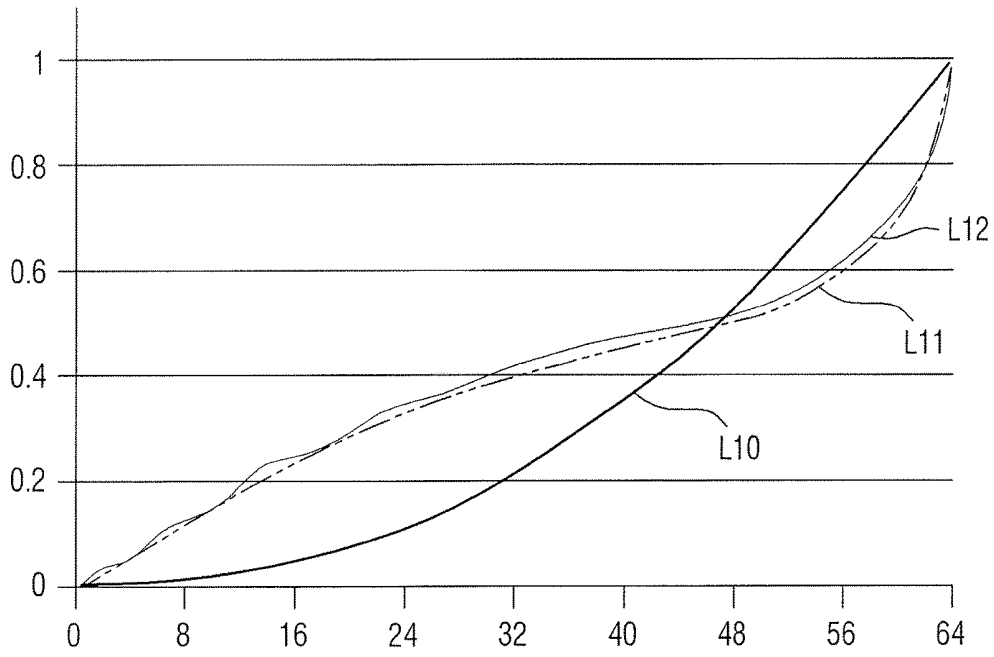
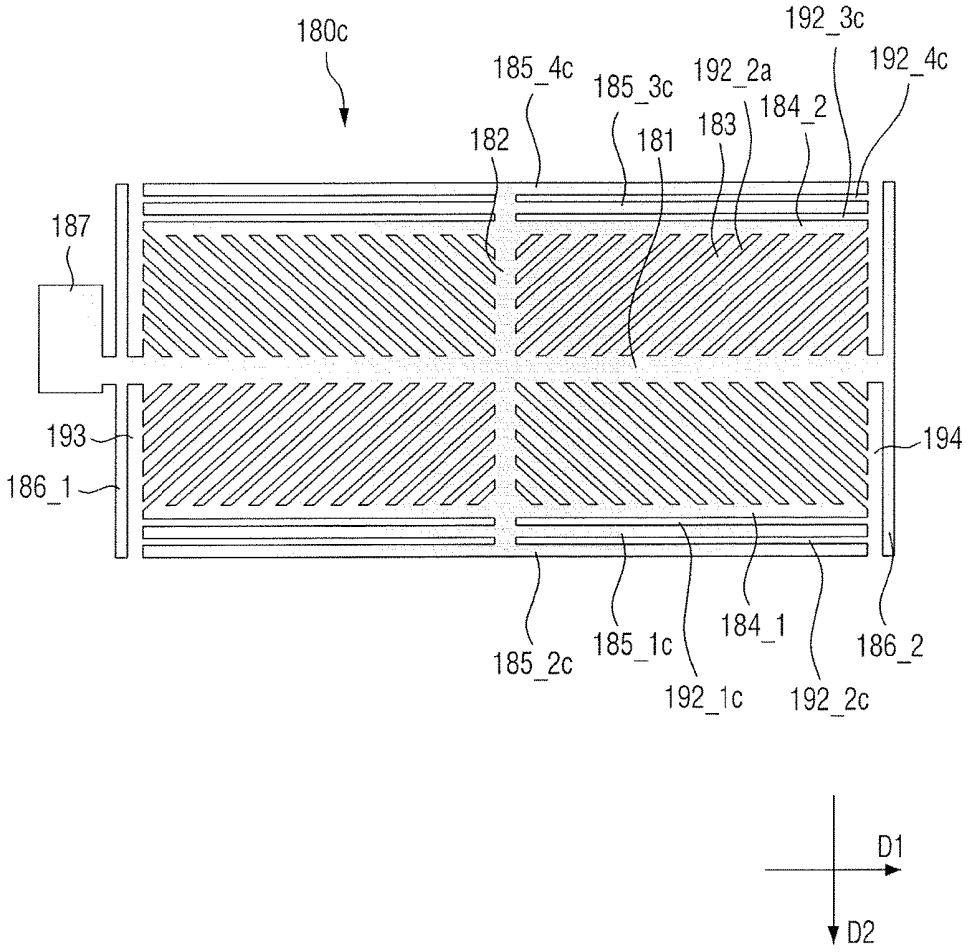


FIG. 21


180c
192_3c
192_4c
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185_3c
192_2a
184_2
183
182
181
187
193
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185_2c
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186_2
192_1c
192_2c
D1
D2

FIG. 22

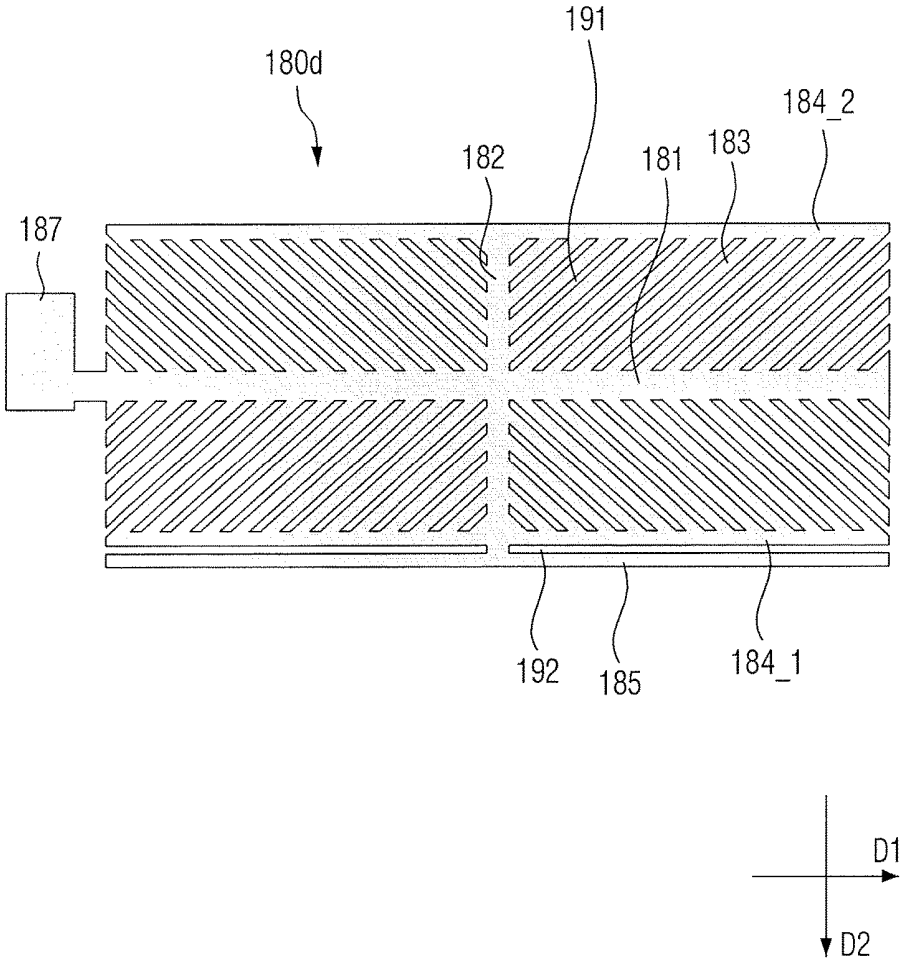
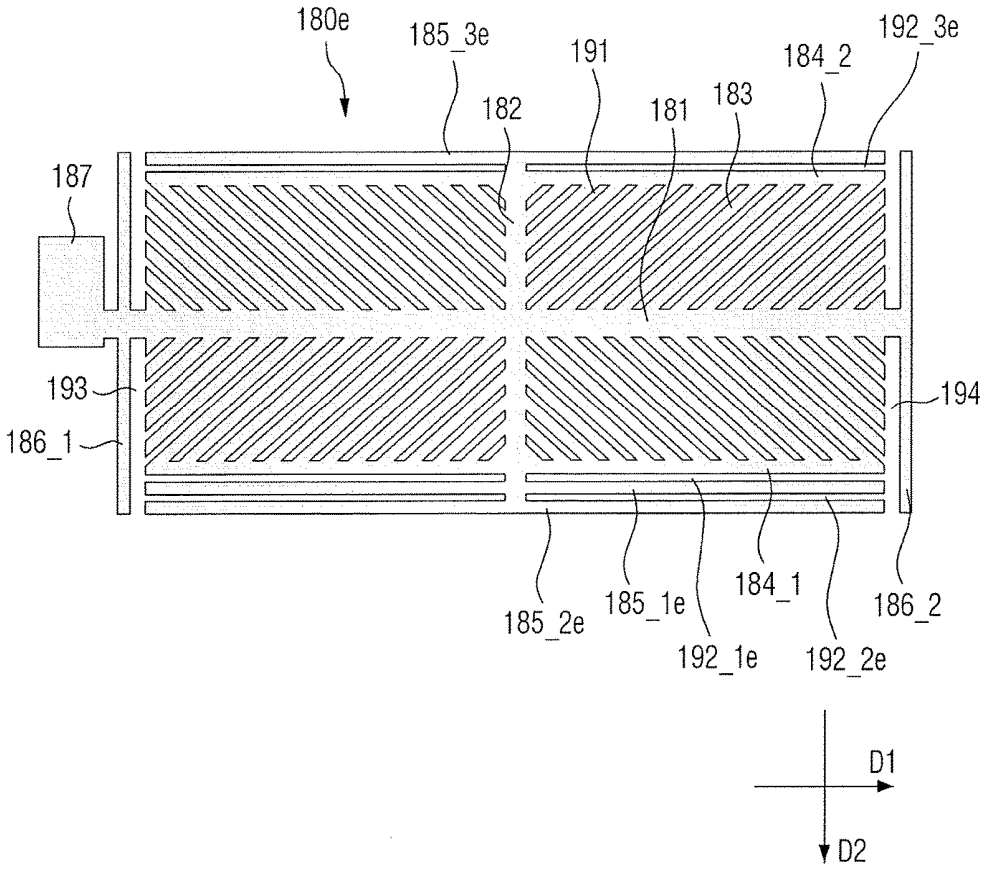


FIG. 23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185_3e
191
184_2
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182
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183
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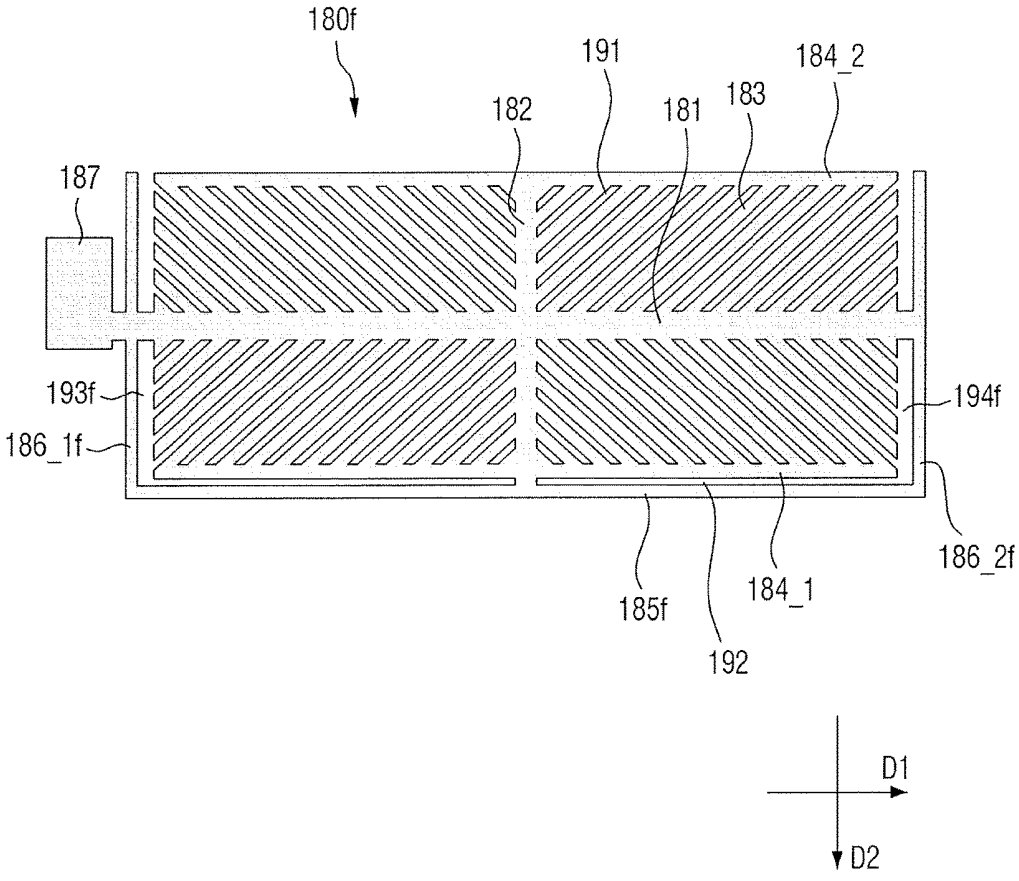
184_1
186_2
192_1e
192_2e
D1
D2

FIG. 24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194f
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186_2f
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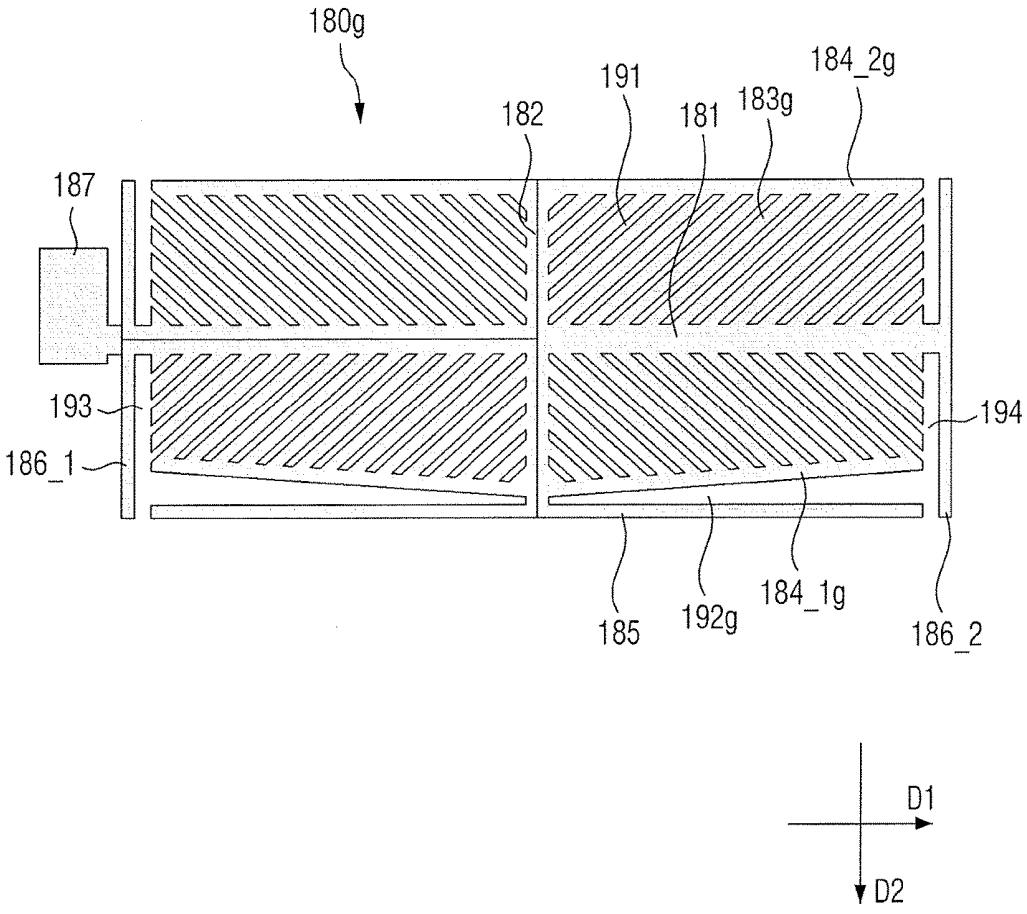
192
D1
D2

FIG. 25


180g
184_2g
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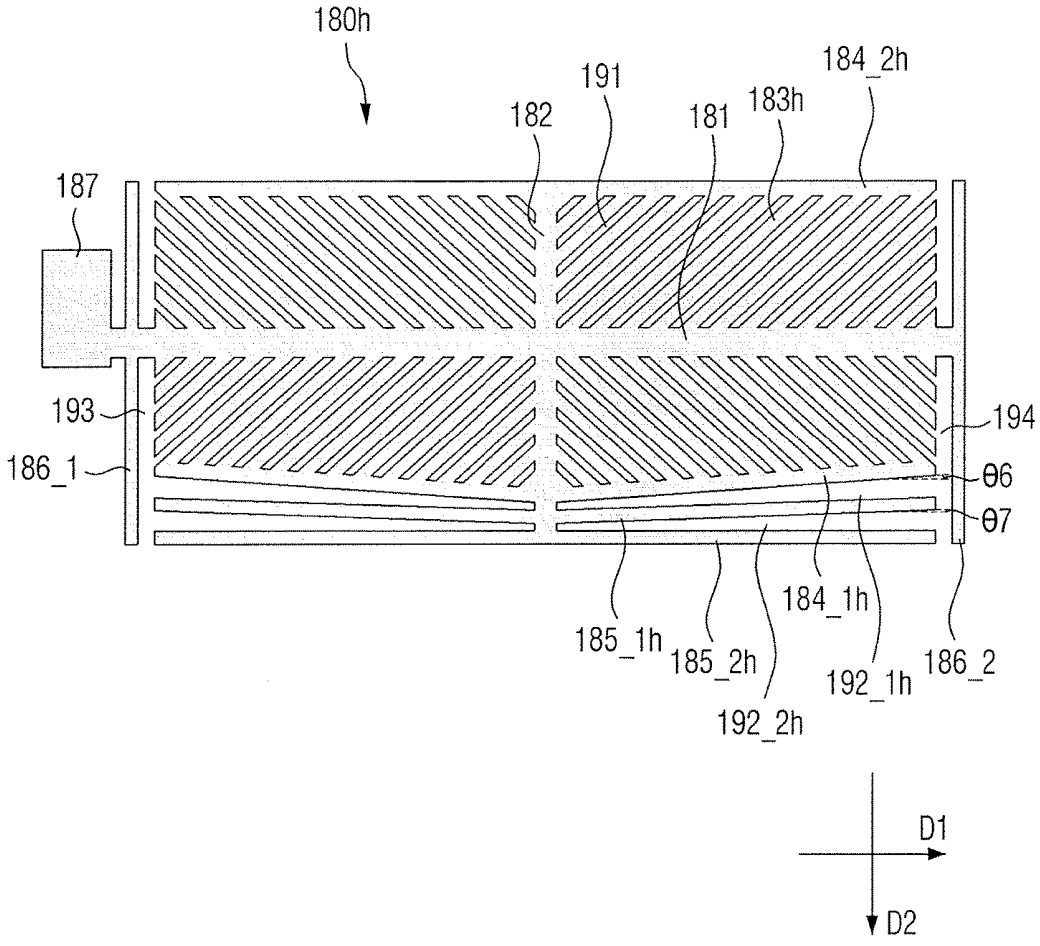
185
192g
184_1g
186_2
D1
D2

FIG. 26


180h
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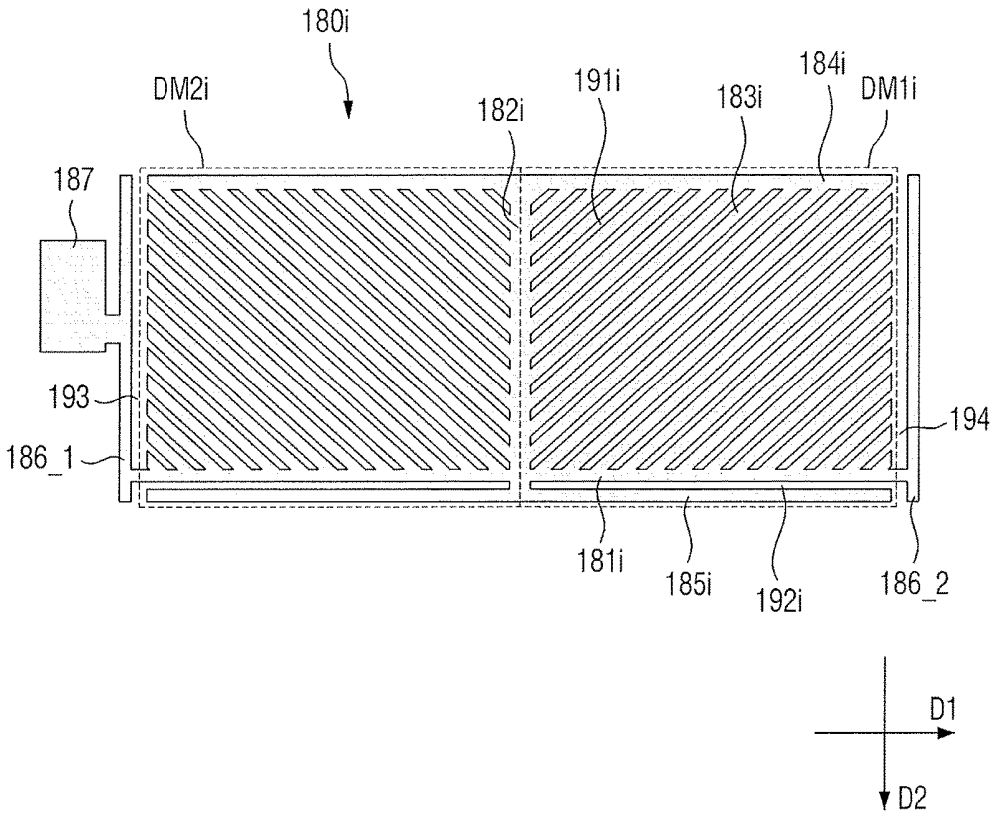
186_2
192_1h
192_2h
D1
D2

FIG. 27


180i
DM2i
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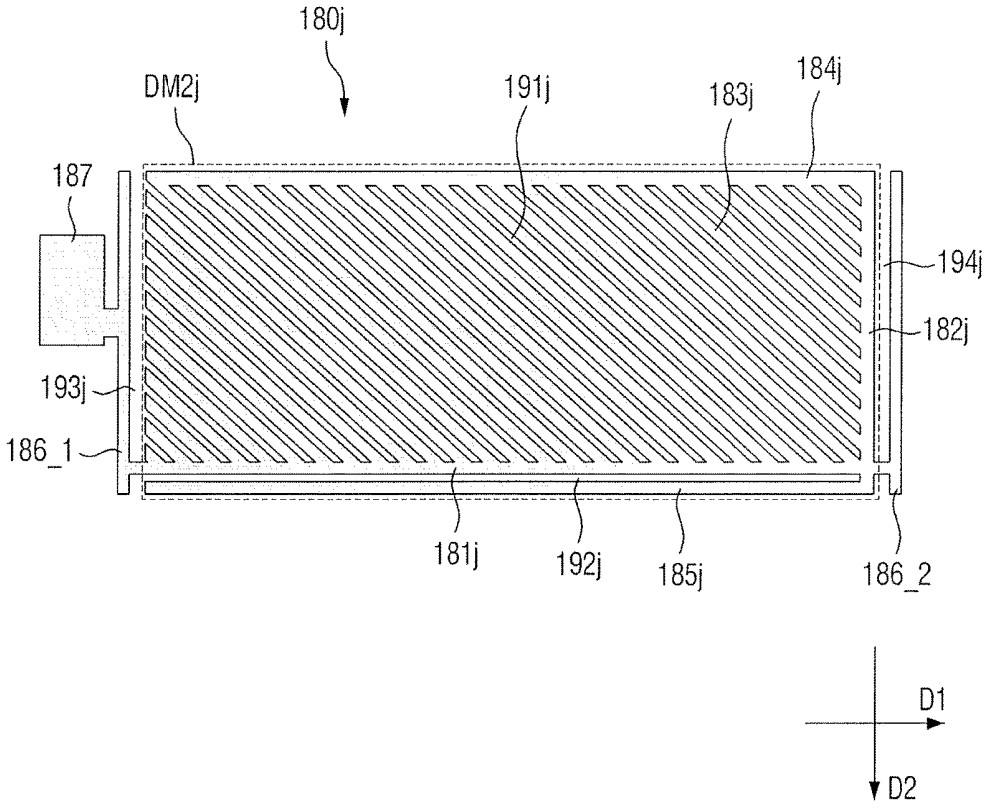
D1
D2

FIG. 28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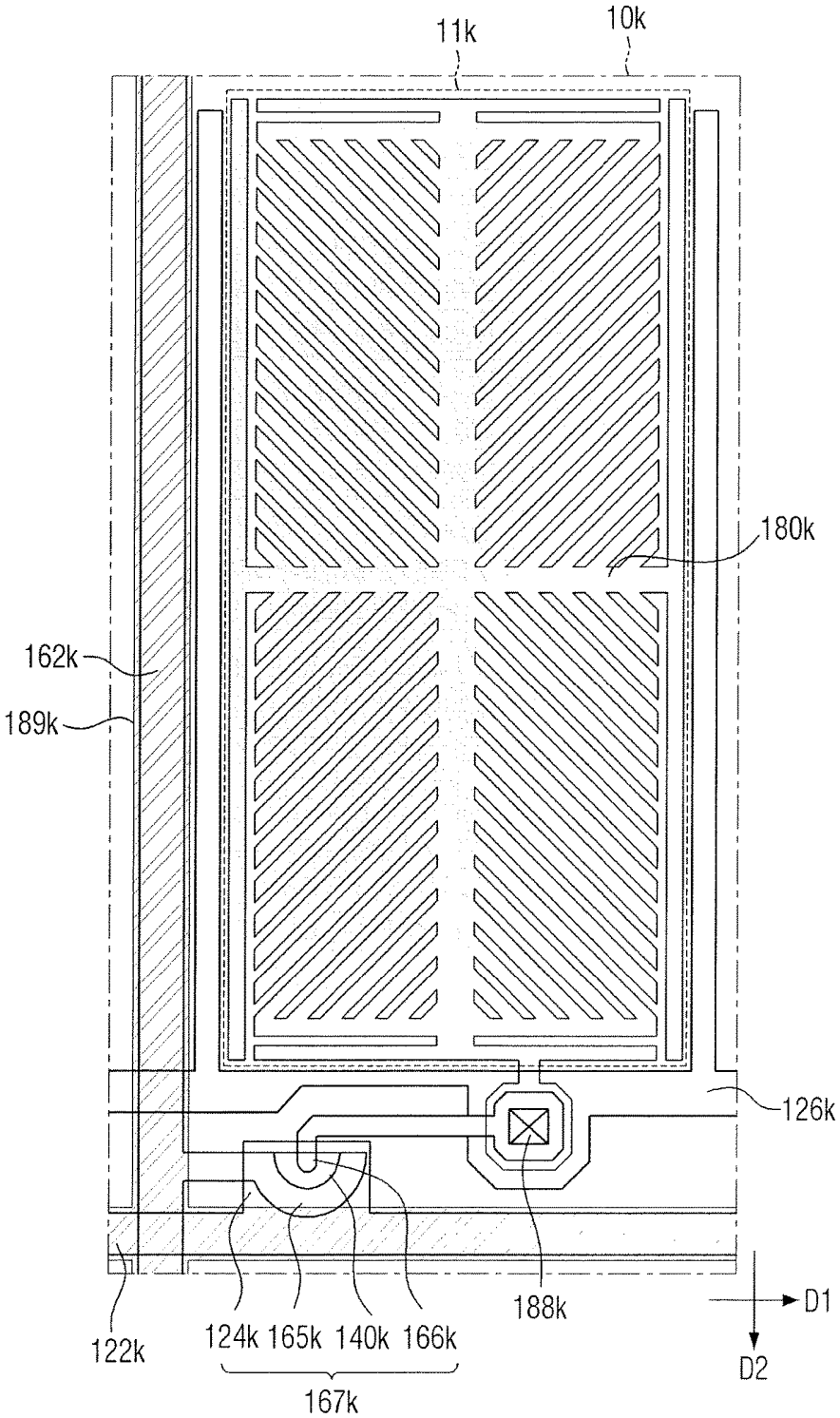
D1
D2

FIG. 29


11k
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D1
D2
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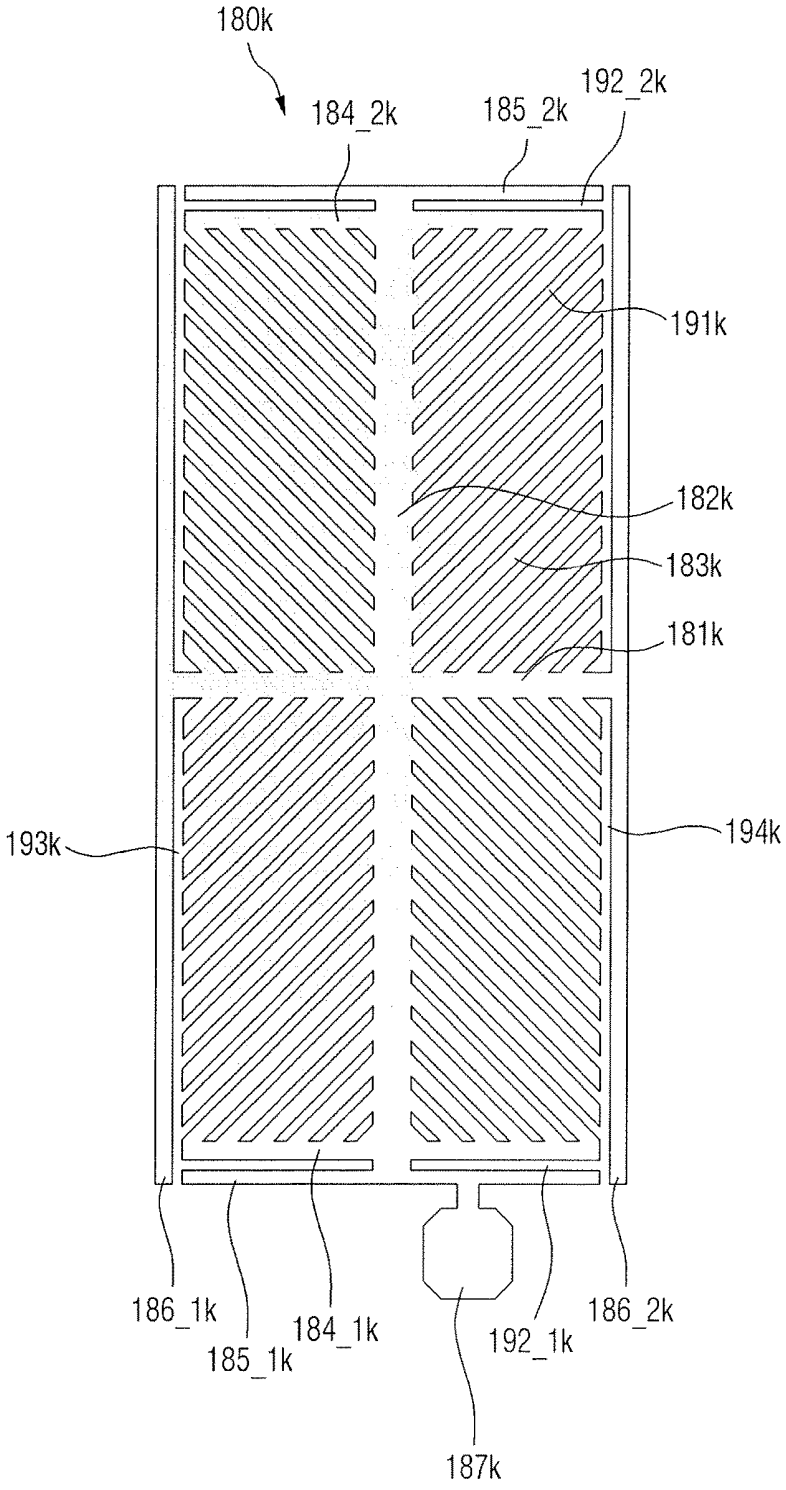
165k
140k
166k
167k

FIG. 30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192_2k
191k
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181k
193k
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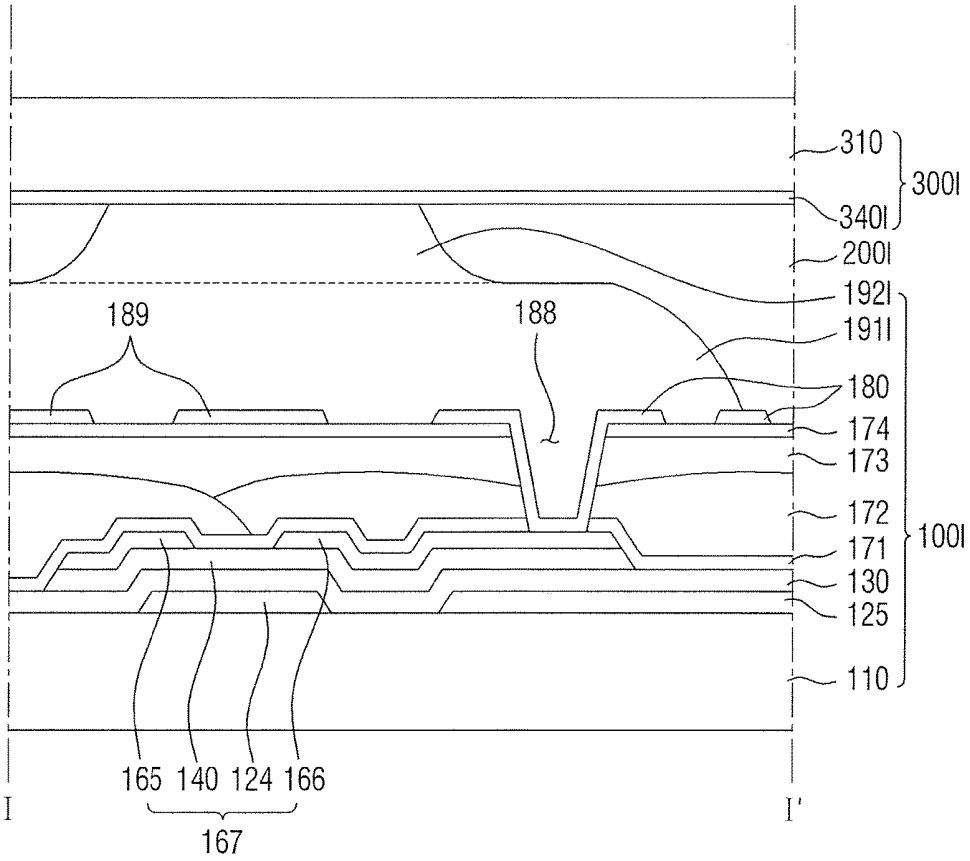
184_1k
192_1k
186_2k
187k

FIG. 31


310
300I
340I
200I
192I
191I
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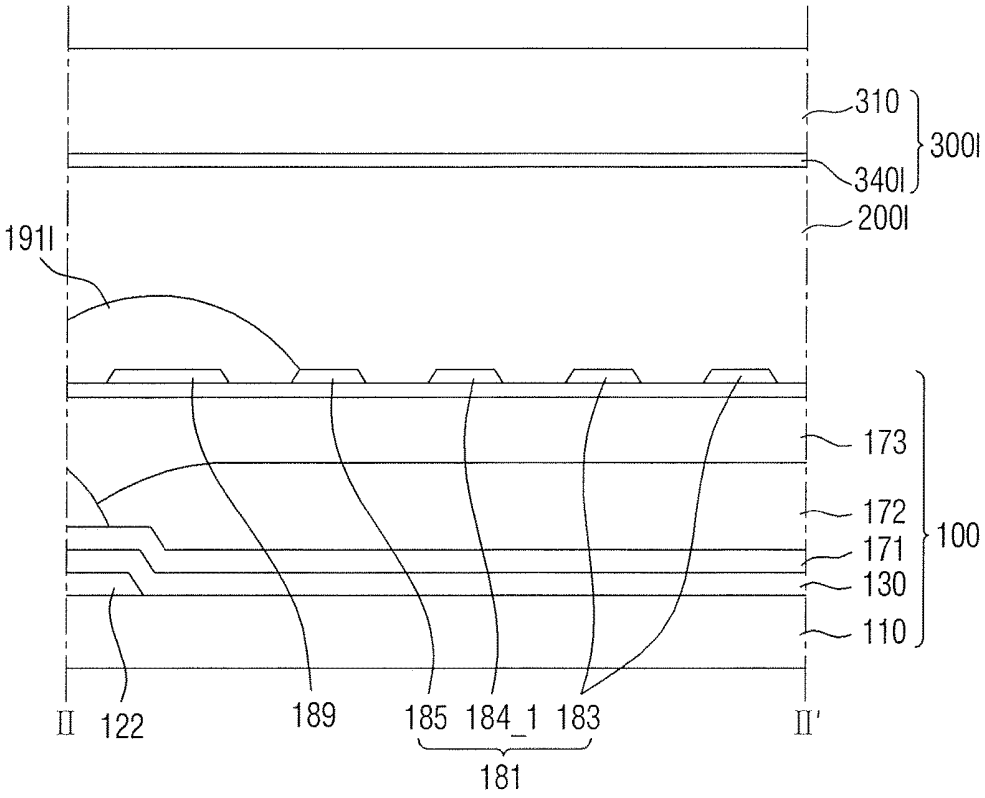
171
130
125
100I
110
165 140 124 166
167
I
I'

FIG. 32


310
300I
340I
200I
191I
173
172
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130
110
100
II
122
189
185
184_1
183
II'
181

LIQUID CRYSTAL DISPLAY DEVICE COMPRISING A PIXEL ELECTRODE HAVING A FIRST EDGE ELECTRODE CONNECTED TO ONE DISTAL END OF A STEM ELECTRODE

CROSS-REFERENCE TO RELATED APPLICATION

Korean Patent Application No. 10-2016-0054473, filed on May 3, 2016, in the Korean Intellectual Property Office, and entitled: "Liquid Crystal Display Device," is incorporated by reference herein in its entirety.

BACKGROUND

1. Field

Embodiments relate to a liquid crystal display device

2. Description of the Related Art

The liquid crystal display device is one of display devices that are most widely used at present. The liquid crystal display device includes two substrates formed with field-generating electrodes such as a pixel electrode and a common electrode, and a liquid crystal layer injected therebetween, and displays an image, by applying a voltage to the field-generating electrodes to form the electric field in the liquid crystal layer, and by determining the alignment of the liquid crystal of the liquid crystal layer and controlling the polarization of incident light.

SUMMARY

Embodiments are directed to a liquid crystal display device including a substrate, and a pixel electrode disposed on the substrate, the pixel electrode including a first stem electrode that extends in a first direction, a second stem electrode that extends in a second direction perpendicular to the first direction and intersects with the first stem electrode, a plurality of branch electrodes, the branch electrodes extending obliquely to the first direction and the second direction from the first stem electrode and the second stem electrode, a first connection electrode that connects distal ends of some of the branch electrodes to each other, extends in the first direction and intersects with the second stem electrode, and a first edge electrode that is connected to one distal end of the second stem electrode and extends in the first direction.

Embodiments are also directed to a liquid crystal display device including a substrate, a first gate line and a second gate line that are disposed on the substrate, extend in a first direction, and are insulated from each other, a data line that is disposed on the first gate line, is insulated from the first gate line and the second gate line, and extends in a second direction perpendicular to the first direction, and a pixel electrode that is disposed on the data line and is insulated from the first gate line, the second gate line, and the data line, the pixel electrode including a first stem electrode that extends in a first direction, a second stem electrode that extends in the second direction and intersects with the first stem electrode, a plurality of branch electrodes, the branch electrodes extending obliquely to the first direction and the second direction from the first stem electrode and the second stem electrode, a first connection electrode that connects distal ends of some of the branch electrodes to each other, extends in the first direction, and intersects with the second stern electrode, a second connection electrode that connects the distal ends of the remaining branch electrodes to each other, extends in the first direction, and intersects with the second stem electrode on an opposite side of the first connection electrode, and a first edge electrode that is connected to one distal end of the second stem electrode and extends in the first direction. The first edge electrode may be disposed between the first connection electrode and the first gate line, and the second connection electrode may be disposed to overlap the second gate line.

BRIEF DESCRIPTION OF THE DRAWINGS

Features will become apparent to those of skill in the art by describing in detail example embodiments with reference to the attached drawings in which:

FIG. **1** illustrates a layout diagram of a first display substrate that is included in a liquid crystal display device according to an example embodiment, more specifically, illustrating a partial structure of a single pixel and two pixels adjacent thereto;

FIG. **2** illustrates a cross-sectional view of the liquid crystal display device including the first display substrate of FIG. **1** taken along line I-I' of FIG. **1**;

FIG. **3** illustrates a cross-sectional view of the liquid crystal display device including the first display substrate of FIG. **1** taken along the line II-II' of FIG. **1**;

FIG. **4** illustrates a plan view of a pixel electrode of a single pixel of the liquid crystal display device including the first display substrate of FIG. **1**;

FIG. **5** illustrates an enlarged plan view illustrating a region A of FIG. **4**;

FIG. **6** illustrates a graph of the direction in which the liquid crystal is tilted along III-III' of FIG. **4** through measurement;

FIG. **7** illustrates a graph of the degree of improvement in visibility of the liquid crystal display device according to the embodiment illustrated in FIG. **1**;

FIG. **8** illustrates a graph of the degrees of improvement in transmittance and visibility of the liquid crystal display device according to the embodiment illustrated in FIG. **1**;

FIG. **9** illustrates a photograph obtained in the case of viewing a region corresponding to an active region of the liquid crystal display device according to the embodiment illustrated in FIG. **1** from the front, in a liquid crystal display device according to a comparative example;

FIG. **10** illustrates a photograph obtained in the case of viewing the active region of the liquid crystal display device according to the embodiment illustrated in FIG. **1** from the front;

FIG. **11** illustrates a plan view of a pixel electrode of a liquid crystal display device according to another example embodiment;

FIGS. **12** to **14** illustrate photographs of an active region for each time period in a case where a width of a first connection electrode is 2.6 μm;

FIGS. **15** to **17** illustrate photographs of an active region for each time period in a case where the width of the first connection electrode is 3 μm;

FIG. **18** illustrates a plan view of a pixel electrode of a liquid crystal display device according to another example embodiment;

FIG. **19** illustrates an enlarged plan view illustrating a region B of FIG. **18**;

FIG. **20** illustrates a graph of the degree of improvement in visibility of the liquid crystal display device according to the embodiment illustrated in FIG. **18**;

FIG. **21** illustrates a plan view of a pixel electrode of a liquid crystal display device according to still another example embodiment;

FIG. **22** illustrates a plan view of the pixel electrode of the liquid crystal display device according to still another example embodiment;

FIG. **23** illustrates a plan view of the pixel electrode of the liquid crystal display device according to still another example embodiment;

FIG. **24** illustrates a plan view of the pixel electrode of the liquid crystal display device according to still another example embodiment;

FIG. **25** illustrates a plan view of the pixel electrode of the liquid crystal display device according to still another example embodiment;

FIG. **26** illustrates a plan view of the pixel electrode of the liquid crystal display device according to still another example embodiment;

FIG. **27** illustrates a plan view of the pixel electrode of the liquid crystal display device according to still another example embodiment;

FIG. **28** illustrates a plan view of the pixel electrode of the liquid crystal display device according to still another example embodiment;

FIG. **29** illustrates a layout diagram of a single pixel of the liquid crystal display device according to still another example embodiment;

FIG. **30** illustrates an enlarged plan view illustrating the pixel electrode of FIG. **29**;

FIG. **31** illustrates a cross-sectional view taken along a line corresponding to the line I-I' illustrated in FIG. **1** in a liquid crystal display device according to still another example embodiment; and

FIG. **32** illustrates a cross-sectional view taken along a line corresponding to the line I-I' illustrated in FIG. **1** in the liquid crystal display device according to the embodiment illustrated in FIG. **31**.

DETAILED DESCRIPTION

Example embodiments will now be described more fully hereinafter with reference to the accompanying drawings; however, they may be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey example implementations to those skilled in the art.

In the drawing figures, the dimensions of layers and regions may be exaggerated for clarity of illustration. Like reference numerals refer to like elements throughout.

It will be understood that, although the terms first, second, third, etc., may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another element. Thus, a first element discussed below could be termed a second element without departing from the teachings of the invention.

The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting. As used herein, the singular forms "a," "an," and "the" are intended to include the plural forms, including "at least one," unless the content clearly indicates otherwise. "Or" means "and/or." As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items. It will be further understood that the terms "comprises" and/or "comprising," or "includes" and/or "including" when used in this specification, specify the presence of stated features, regions, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, regions, integers, steps, operations, elements, components, and/or groups thereof.

Spatially relative terms, such as "beneath," "below," "lower," "above," "upper" and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. It will be understood that the spatially relative terms are intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements described as "below" or "beneath" other elements or features would then be oriented "above" the other elements or features. Thus, the example term "below" can encompass both an orientation of above and below. The device may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein interpreted accordingly.

FIG. **1** is a layout diagram of a first display substrate that is included in a liquid crystal display device according to an example embodiment, more specifically, illustrating a partial structure of a single pixel and two pixels adjacent thereto. FIG. **2** is a cross-sectional view of the liquid crystal display device including the first display substrate of FIG. **1** taken along line I-I' of FIG. **1**. FIG. **3** is a cross-sectional view of the liquid crystal display device including the first display substrate of FIG. **1** taken along the line II-II' of FIG. **1**. FIG. **4** is a plan view illustrating a pixel electrode of a single pixel of the liquid crystal display device including the first display substrate of FIG. **1**. FIG. **5** is an enlarged plan view illustrating a region A of FIG. **4**.

Referring to FIGS. **1** through **5**, a liquid crystal display device according to an example embodiment includes a first display substrate **100**, a second display substrate **300**, and a liquid crystal layer **200**. Furthermore, the liquid crystal display device may further include a pair of polarizers attached to the outside surfaces of the first display substrate **100** and the second display substrate **300**.

A switching element for driving the liquid crystal **210** of the liquid crystal layer **200**, for example, a thin film transistor **167**, is disposed on the first display substrate **100**. The second display substrate **300** is a substrate which is disposed to face the first display substrate **100**.

The liquid crystal layer **200** is interposed between the first display substrate **100** and the second display substrate **300**, and may include a plurality of liquid crystals **210** having dielectric constant anisotropy. When the electric field is applied between the first display substrate **100** and the second display substrate **300**, the liquid crystal **210** may transmit or cut off light by rotating in a particular direction between the first display substrate **100** and the second display substrate **300**. Here, the term "rotation" may include the meaning that the alignment of the liquid crystal **210** changes by the electric field, as well as the actual rotation of the liquid crystal **210**.

The liquid crystal display device includes a plurality of pixels **10** arranged in the form of a matrix. The gradations of each pixel **10** can be independently controlled, and each pixel may be a basic unit for displaying a particular color. As shown in FIG. **2**, each pixel **10** includes an active region **11**, which is a region in which colors are actually displayed by transmitting the light incident on the bottom of the first display substrate **100** to the top of the second display substrate **300**. A total of three pixels **10**_*p*, **10**, and **10**_*n* are illustrated in FIG. **1** as an example. For convenience, on the

basis of FIG. **1**, the pixel **10** arranged at the top is referred to as a previous pixel **10**_*p* and a pixel **10** arranged at the bottom is referred to as a next pixel **10**_*n*. Further, a pixel **10** referred to without a special and additional description will be referred to as a pixel **10** disposed at the center of FIG. **1**.

Hereinafter, the first display substrate **100** will be described.

Referring to FIG. **2**, the first display substrate **100** includes a first base substrate **110**. The first base substrate **110** may be a transparent insulating substrate. For example, the first base substrate **110** may be made of a glass substrate, a quartz substrate, a transparent resin substrate, or the like.

In some embodiments, the first base substrate **110** may also be curved along one direction. In some other embodiments, the first base substrate **110** may also have flexibility. For example, the first base substrate **110** may be deformed by rolling, folding, bending, or the like.

A gate line **122**, a gate electrode **124**, and a light-shielding pattern **125** are disposed on the first base substrate **110**.

The gate line **122** transmits a gate signal that controls the thin film transistor **167**, as described further below. The gate line **122** may have a shape extending in a first direction D**1**.

Here, the first direction D**1** corresponds to a direction extending in parallel with one side of the first base substrate **110** on the plane in which the first base substrate **110** is disposed, and may be defined as a direction indicated by an arbitrary straight line that extends from left to right as illustrated in FIG. **1**. However, the first direction does not need to be parallel to the one side of the first base substrate **110** and may also be a direction indicated by an arbitrary straight line extending in a specific direction on the first base substrate **110**.

The gate signal may be a signal having a varying voltage value provided from the outside, and turning on/off of the thin film transistor **167** may be controlled to correspond to the voltage value of the gate signal.

The gate line **122** may extend along the first direction D**1** for each pixel **10**, and may be disposed over a boundary between the previous pixel **10**_*p* and the pixel **10** or over a boundary the pixel **10** and the next pixel **10**_*n*.

The gate electrode **124** may be formed as a protrusion from the gate line **122**, and may be physically connected to the gate line **122**. The gate electrode **124** may be a single component that makes up the thin film transistor **167**, as described further below.

The light-shielding pattern **125** may cut off the transmission of the light through the first display substrate **100** and the second display substrate **300** in the region in which the light-shielding pattern **125** is disposed, and may help minimize a deterioration of display quality caused by scattering and reflection of light due to each constituent element, as described further below. The light shielding pattern **125** may be disposed on the first base substrate **110**. The light-shielding pattern **125** may be disposed to be physically spaced apart from the gate line **122** and the gate electrode **124**, and may be a conductor that is maintained in a floating state, i.e., a state in which a voltage is not directly applied.

The light-shielding pattern **125** may be disposed to overlap a contact hole **188**, as described further below, or a second stem electrode **182**, as described further below, and the arrangement thereof will be described below.

The gate line **122**, the gate electrode **124**, and the light-shielding pattern **125** may be made of the same material. As an example, the gate line **122**, the gate electrode **124** and the light-shielding pattern **125** may contain an aluminum-based metal such as aluminum (Al) and aluminum alloy, a silver-based metal such as silver (Ag) and silver alloy, a copper-based metal such as copper (Cu) or copper alloy, a molybdenum-based metal such as molybdenum (Mo) and molybdenum alloy, chromium (Cr), tantalum (Ta) and titanium (Ti). The gate line **122**, the gate electrode **124**, and the light-shielding pattern **125** may have a single layer structure or may also have a multilayer structure that includes at least two conductive films with physical properties different from each other.

The gate insulating film **130** is disposed on the gate line **122**, the gate electrode **124**, and the light-shielding pattern **125**. The gate insulating film **130** may be made of an insulating material, and as an example, it may be made of silicon nitride or silicon oxide. The gate insulating film **130** may be made of a single layer structure, or may have a multilayer structure including two insulating layers with physical properties different from each other.

A semiconductor layer **140** may be disposed on the gate insulating film **130**. The semiconductor layer **140** may at least partially overlap the gate electrode **124**. The semiconductor layer **140** may be formed of amorphous silicon, polycrystalline silicon, or an oxide semiconductor, etc.

The semiconductor layer **140** may overlap the gate electrode **124** and may also be disposed to overlap at least a part or all of a data line **162**, a source electrode **165**, and a drain electrode **166**, as described further below, depending on the process procedure.

In some embodiments, an ohmic contact member may be additionally disposed on the semiconductor layer **140**. The ohmic contact member may be formed of, for example, n+ hydrogenated amorphous silicon doped with n-type impurities at high concentration or may be formed of silicide. The ohmic contact members may be disposed in pairs on the semiconductor layer **140**. The ohmic contact member may be disposed among the source electrode **165**, the drain electrode **166**, and the semiconductor layer **140** to allow them to have ohmic contact characteristics. In an implementation, the semiconductor layer **140** includes an oxide semiconductor and the ohmic contact member is omitted.

The data line **162**, the source electrode **165**, and the drain electrode **166** may be disposed on the semiconductor layer **140** and the gate insulating film **130**.

The data line **162** may extend in the second direction D**2** and may intersect with the gate line **122**.

Here, the second direction D**2** may be a direction intersecting with the first direction D**1** on the plane in which the first base substrate **110** is disposed, and as illustrated in FIG. **1**, the second direction may be a direction indicated by an arbitrary straight line extending from the lower side to the upper side. In some embodiments, the first direction D**1** and the second direction D**2** may perpendicularly intersect with each other.

The data line **162** may be insulated from the gate line **122**, the gate electrode **124**, and a sustain line by the gate insulating film **130**.

The data line **162** may provide a data signal to the source electrode **165**. Here, the data signal may be a signal having a varying voltage value provided from the outside, and the gradation of each pixel **10** may be controlled to correspond to the data signal.

The source electrode **165** may branch from the data line **162** and may at least partially overlap the gate electrode **124**.

The drain electrode **166** may be disposed to be spaced apart from the source electrode **165** with the semiconductor layer **140** interposed therebetween on the basis of the viewing point of FIG. **1**, and may at least partially overlap the gate electrode **124**.

As illustrated in FIG. **1**, the source electrode **165** may be formed in the form of surrounding the drain electrode **166** in a "U" shape at fixed intervals. However, the source electrode **165** may extend in a rod shape, and may also be disposed to be spaced apart from the drain electrode **166** in parallel at regular intervals, etc.

The semiconductor layer **140** may also be disposed in a region between the source electrode **165** and the drain electrode **166** formed by the source electrode **165** and the drain electrode **166** being spaced apart from each other. For example, the source electrode **165** and the drain electrode **166** partially overlap the semiconductor layer **140** or are in contact with the semiconductor layer **140**, and may be disposed to face each other with the semiconductor layer **140** interposed therebetween.

The data line **162**, the source electrode **165**, and the drain electrode **166** may be made of the same material. As an example, the data line **162**, the source electrode **165**, and the drain electrode **166** may be made of aluminum, copper, silver, molybdenum, chromium, titanium, tantalum, or an alloy thereof. Further, the data line **162**, the source electrode **165**, and the drain electrode **166** may also have, for example, a multilayer structure having a lower film such as a refractory metal and a low-resistance upper film formed thereon.

The gate electrode **124**, the semiconductor layer **140**, the source electrode **165**, and the drain electrode **166** may constitute the thin film transistor **167**. The thin film transistor **167** may be disposed in a region other than the active region **11**.

A first passivation film **171** may be disposed on the gate insulating film **130** and the thin film transistor **167**. The first passivation film **171** may be made of an inorganic insulating material and may be disposed to cover the thin film transistor **167**. The first passivation film **171** may protect the thin film transistor **167**, and may prevent a substance contained in a color filter layer **172** and a planarization film **173** (to be described below) from flowing into the semiconductor layer **140**.

A color filter layer **172** may be disposed on the first passivation film **171**. The color filter layer **172** may be a photosensitive organic composition that contains a pigment for providing a color, and may include, for example, any one of red, green, and blue pigments. As an example, the color filter layer **172** may include a plurality of color filters. As an example, any one of the plurality of color filters may display one of primary colors such as three primary colors of red, green, and blue. In an implementation, the plurality of color filters may display any one of cyan, magenta, yellow, and white colors.

The planarization film **173** may be disposed on the color filter layer **172**. The planarization film **173** may flatten a local step generated by components located between the planarization film **173** and the first base substrate **110**. Thus, the upper surface of the planarization film **173** may be substantially flat.

A second passivation film **174** may be disposed on the planarization film **173**. The second passivation film **174** may be made of an inorganic insulating material such as silicon oxide, silicon nitride, or silicon oxynitride, etc. The second passivation film **174** may help prevent the liquid crystal layer **200** from being contaminated by organic matter, such as solvent introduced from the planarization film **173** and the color filter layer **172**. Thus, it may be possible to prevent a defect such as a residual image that may be generated at the time of driving the liquid crystal display device. In some embodiments, the second passivation film **174** may be omitted.

A contact hole **188** may be formed in the first passivation film **171**, the color filter layer **172** the planarization film **173**, and the second passivation film **174**. The contact hole **188** may expose some of the thin film transistor **167** and, for example, some of the drain electrode **166** to the top along the direction perpendicular to the first base substrate **110**. Some of the drain electrode **166** and the pixel electrode **180**, as described further below, disposed at the top of the second passivation film **174** may be physically and electrically connected to each other through the contact hole **188**.

The pixel electrode **180** and the shielding electrode **189** may be disposed on the second passivation film **174**.

The pixel electrode **180** may receive the data signal from the drain electrode **166** by being physically and electrically connected to the drain electrode **166** through the contact hole **188**.

The pixel electrode **180** may be made of a transparent conductive material such as indium tin oxide (ITO), indium zinc oxide (IZO), indium tin zinc oxide (ITZO), or Al-doped zinc oxide (AZO), etc.

The pixel electrodes **180**, **180** may include an opening portion on which an electrically conductive material is not disposed. A pattern is formed on the pixel electrode **180** by the opening portion, and a tilted direction of the liquid crystal **210** disposed to overlap the pixel electrode **180** may be controlled depending on the shape and pattern of the pixel electrode **180**.

The pixel electrode **180** includes a first stem electrode **181**, a second stem electrode **182**, a plurality of branch electrodes **183**, a first connection electrode **184_1**, a second connection electrode **184_2**, a first edge electrode **185**, a first auxiliary electrode **186_1**, a second auxiliary electrode **186_2**, and a protrusion **187**.

Most of the components constituting the pixel electrode **180** are disposed in the active region **11**, but some components, for example, the second connection electrode **184_2**. the first auxiliary electrode **186_1**, the second auxiliary electrode **186_2**, and the protrusion **187**, may be located outside the active region **11**.

The first stem electrode **181** may extend along the first direction D**1**, and the second stem electrode **182** may extend along the second direction D**2**. The first stem electrode **181** and the second stem electrode **182** may intersect with each other in a cross shape, and may be physically connected to each other at the point of intersection.

The first stem electrode **181** and the second stem electrode **182** may be disposed in the active region **11** to form a cross shape. Thus, the active region **11** may be divided into four regions. Here, a region disposed at the right top from the intersection between the first stem electrode **181** and the second stern electrode **182** will be defined as a first domain region DM**1**, a region disposed at the left top will be defined as a second domain region DM**2**, a region disposed at the left bottom will be defined as a third domain region DM**3**, and a region disposed at the right bottom will be defined as a fourth domain region DM**4**.

A plurality of branch electrodes **183** may be provided. The branch electrodes **183** may extend in an oblique direction that is not parallel to the first direction D**1** or the second direction D**2** from the first stem electrode **181** and the second stem electrode **182**. The branch electrodes **183** may extend in the same direction within each domain region. For example, the branch electrodes **183** may extend to face the right top in the first domain region DM**1**, may extend to face the left top in the second domain region DM**2**, may extend

to face the left bottom in the third domain region DM3, and may extend to face the right bottom in the fourth domain region DM4.

An absolute value of an included angle formed between the branch electrode **183** and the first direction D1 may be, for example, 30° to 60° in each of the first to fourth domain regions DM1, DM2, DM3, and DM4. For example, the absolute value of the included angle formed between each first branch electrode **183** and the first direction D1 may be about 45°.

First fine slits **191** are disposed between the branch electrodes **183** disposed in parallel with each other. The first fine slits **191** may be opening portions in which a transparent conductive material is not disposed. Because the first fine slits **191** are disposed between the two branch electrodes **183** disposed in parallel with each other, the first fine slits **191** may extend along the same direction as the extending direction of the branch electrodes **183** adjacent to each other in each domain region.

The first connection electrode **184_1** and the second connection electrode **184_2** connect the distal ends of the branch electrodes **183** to each other, extend along the first direction D1, and are disposed to intersect with the second stern electrode **182**. For example, the first connection electrode **184_1** may connect the distal ends of the branch electrodes **183** disposed in the third domain region DM3 and the fourth domain region DM4 to each other. The second connection electrode **184_2** may connect the distal ends of the branch electrodes **183** disposed in the first domain region DM1 and the second domain region DM2 to each other. Consequentially, the first connection electrode **184_1** extends in parallel with the first stem electrode **181** and is disposed at the bottom of the first stem electrode **181**, and the second connection electrode **184_2** extends in parallel with the first stem electrode **181** and may be disposed at the top of the first stem electrode **181**.

Because the first connection electrode **184_1** and the second connection electrode **184_2** connect the distal ends of the branch electrodes **183** in which the electric field formed in the liquid crystal layer **200** is likely to be irregularly formed, it is possible to prevent the misalignment of the liquid crystal **210** and a decrease in transmittance at the distal ends of the branch electrodes **183**.

The first edge electrode **185** extends along the first direction D1 and is disposed to be connected to one distal end of the second stem electrode **182**. The first edge electrode **185** may be connected to the distal end close to the gate line **122** connected to the control terminal of the thin film transistor **167**, of the two distal ends of the second stem electrode **182**. Thus, the first edge electrode **185** is disposed adjacent to the first connection electrode **184_1** and in parallel with the first connection electrode **184_1** at intervals, and the first edge electrode **185** may be disposed to form a 180° rotation shape of a "T" shape with the second stem electrode **182**. Further, as illustrated in FIG. **1**, from the viewing point of viewing the first base substrate **110**, the first edge electrode **185** is disposed adjacent to the gate line **122** and in parallel with the gate line **122** at intervals, and may be disposed in parallel with the gate line **122** at intervals. Consequentially, the first connection electrode **184_1**, the first edge electrode **185**, and the gate line **122** extend in parallel with one another along the first direction D1, and the first edge electrode **185** may be disposed between the first connection electrode **184_1** and the gate line **122**.

A second fine slit **192** is disposed between the first connection electrode **184_1** and the first edge electrode **185**. The second fine slit **192** may be an opening portion in which a transparent conductive material is not disposed. Because the second fine slit **192** is disposed between the first connection electrode **184_1** and the first edge electrode **185** extending in the first direction D1 and disposed in parallel with each other, the second fine slit **192** may extend along the first direction D1 similarly to the first connection electrode **184_1** and the first edge electrode **185**.

With the arrangement of the aforementioned first edge electrode **185**, the effect of improving the visibility and improving the transmittance can be maximized in the region in which the first edge electrode **185** and the second fine slit **192** are disposed.

For example, the display qualities of the pixel electrode **180** and the gate line **122** for controlling the same may be degraded due to a kick-back phenomenon when overlapping. Here, when the kick-back phenomenon is a phenomenon in which, when the gate signal provided to the gate line **122** changes from an on-level voltage value to an off-level voltage value, the voltage charged to the pixel electrode **180** drops under its influence. Because this reduces the charging rate of the pixel electrode **180** and causes a user to recognize blinking, or the like, there is a risk of a degradation of display quality. Accordingly, the pixel electrode **180** and the gate line **122** for controlling the same are disposed at a fixed interval to minimize the kickback phenomenon. Thus, the control of the liquid crystal **210** may be incomplete in the region between the pixel electrode **180** and the gate lines **122**, and the first edge electrode **185** may be disposed adjacent to the gate line **122** and in parallel with the gate line **122** and may suppress the degradation of the visibility and the decrease in transmittance due to the gate line **122**. The specific description of the principles of improvement in the visibility and improvement in the transmittance of the first edge electrode **185** will be described later with reference to FIG. **5**.

The second connection electrode **184_2** may be disposed to overlap the gate line **122** of the previous pixel **10**_*p*. The reason is that the gate line **122** of the previous pixel **10**_*p* does not induce a kickback phenomenon in the pixel electrode **180** because it is a pixel in which the operation is already finished. For example, as the gate line **122** of the previous pixel **10**_*p* and the pixel electrode **180** are disposed close to each other to such an extent that the second connection electrode **184_2** overlaps the gate line **122** of the previous pixel **10**_*p*. an arrangement region of the pixel electrode **180** may be maximized. Accordingly, the transmittance may be maximized.

Each of the first auxiliary electrode **186_1** and the second auxiliary electrode **186_2** extends along the second direction D2 and is disposed so as to be connected to both distal ends of the first stem electrode **181**. The first auxiliary electrode **186_1** and the second auxiliary electrode **186_2** may be disposed to be spaced apart from the distal end of the adjacent branch electrode **183**.

A third fine slit **193** as an opening portion extending along the second direction D2 is formed between the first auxiliary electrode **186_1** and the branch electrode **183** adjacent thereto, and a fourth fine slit **194** as an opening portion extending along the second direction D2 may be formed between the second auxiliary electrode **186_2** and the branch electrode **183** adjacent thereto.

Some of a region in which the first auxiliary electrode **186_1** and the second auxiliary electrodes **186_2** are disposed may overlap the light-shielding pattern **125**, and may not transmit the light accordingly. However, the first auxiliary electrode **186_1** and the second auxiliary electrode **186_2** may improve the visibility of the region in which the

third fine slit **193** and the fourth fine slit **194** are disposed by interaction with the adjacent branch electrode **183** and may improve the transmittance.

The protrusion **187** is for connection with another layer, and protrudes from the first stem electrode **181**. However, the protrusion **187** may also protrude from the second stem electrode **182** in some embodiments, without being limited to protruding from the first stem electrode **181**, and the protrusion **187** may also protrude from one of the branch electrode **183**, the first connection electrodes **184_1**, the second connection electrode **184_2**, the first edge electrode **185**, the first auxiliary electrode **186_1** and the second auxiliary electrode **186_2**. The protrusions **187** may be electrically connected to the drain electrode **166** through the contact hole **188**.

The extended length of the first stem electrode **181** may be longer than the extended length of the second stem electrode **182**. For example, the extension width of the active region **11** along the first direction D**1** may be greater than the extension width along the second direction D**2**. In this case, the previous pixel **10**_*p*, the pixel **10**, and the next pixel **10**_*n* that are consecutively arranged along the second direction D**2** may be different from one another in the color of the color filter layer **172**. For example, the previous pixel **10**_*p*, the pixel **10** and the next pixel **10**_*n* that are consecutively arranged along the second direction D**2** may be each of a red pixel **10** for displaying red, a green pixel **10** for displaying green, and a blue pixel **10** for displaying blue. Thus, the red pixel **10**, the green pixel **10**, and the blue pixel **10** that are consecutively arranged along the second direction D**2** are gathered one by one, and may become a basic unit which is recognized as a single color.

In this ways, when the extended length of the first stem electrode **181** is longer than the extended length of the second stem electrode **182**, the number of pixels **10** arranged along the second direction D**2** increases, but the number of pixels **10** arranged along the first direction D**1** decreases accordingly. Consequentially, the number of gate lines **122** extending along the first direction D**1** increases, but the number of data lines **162** extending along the second direction D**2** decreases accordingly. Therefore, the required number of gate drivers for providing the gate signal to the gate line **122** increases, but the required number of data drivers for providing the data signal to the data line **162** decreases accordingly. In general, because the manufacturing cost of the gate drivers is lower than the manufacturing cost of the data drivers, the manufacturing cost of the liquid crystal display device can be reduced accordingly.

The shielding electrode **189** is disposed on the same layer as the pixel electrode **180** and is formed of the same material, but the shielding electrode **189** is physically spaced apart from and is electrically insulated from the pixel electrode **180**. The shielding electrode **189** may be made of a transparent conductive material, and the shielding electrode **189** and the pixel electrode **180** may be simultaneously formed in the same process using a single optical mask.

The shielding electrode **189** may be disposed in a portion corresponding to the gate line **122** and the data line **162**, of the top of the second passivation film **174**. For example, the shielding electrode **189** is disposed on the upper side of the gate line **122** and the data line **162** to be insulated from the gate line **122** and the data line **162**, and may extend along the extension direction of each of the gate line **122** and the data line **162**.

A voltage having the same level as the common signal provided to a common electrode **340**, as described further below may be provided to the shielding electrode **189**. However, the shielding electrode **189** may also maintain a floating state that is a state in which the voltage is not intentionally provided, without being limited thereto. Thus, it is possible to minimize a phenomenon in which the liquid crystal layer **200** disposed in the upper direction of the shielding electrode **189** is affected depending on the change in the voltage values of the gate line **122** and the data line **162** arranged in the lower direction of the shielding electrode **189**, thereby improving the display quality.

Meanwhile, a first alignment film may be further arranged on the pixel electrode **180**. The first alignment film may control an initial alignment angle of the liquid crystal **210** injected into the liquid crystal layer **200**.

Hereinafter, the second display substrate **300** will be described.

The second display substrate **300** includes a second base substrate **310**, a light-shielding member **320**, an overcoat layer **330**, and a common electrode **340**.

The second base substrate **310** is disposed to face the first base substrate **110**. The second base substrate **310** may have durability capable of withstanding an external impact. The second base substrate **310** may be a transparent insulating substrate. For example, the second base substrate **310** may be made of a glass substrate, a quartz substrate, a transparent resin substrate, or the like. The second base substrate **310** may be a flat plate type but may also be curved in a particular direction.

The light-shielding member **320** is disposed on a surface of the second base substrate **310** that faces the first display substrate **100**. The light-shielding member **320** may be disposed to overlap the gate line **122**, the data line **162**, the thin film transistor **167**, and the contact hole **188**, for example, to overlap the regions other than the active region **11**, and may cut off the transmission of light in the regions other than the active region **11**.

The overcoat layer **330** is disposed on a surface of the light-shielding member **320** that faces the first display substrate **100**. The overcoat layer **330** may alleviate a step caused by the light-shielding member **320**. In some embodiments, the overcoat layer **330** may be omitted.

The common electrode **340** is disposed on a surface of the overcoat layer **330** that faces the first display substrate **100**. The common electrode **340** may be made of a transparent conductive material such as indium tin oxide (ITO), indium zinc oxide (IZO), indium tin zinc oxide (ITZO) and Al-doped zinc oxide (AZO). The common electrode **340** may be formed by a single board over the entire surface of the second base substrate **310**. The common signal provided from the outside is provided to the common electrode **340** and may form an electric field to the liquid crystal layer **200** with the pixel electrode **180**.

Meanwhile, a second alignment film may be disposed on a surface of the common electrode **340** that faces the first display substrate **100**. The second alignment film may control an initial alignment angle of the liquid crystal **210** injected into the liquid crystal layer **200**, similarly to the first alignment film.

The liquid crystal layer **200** will be described below.

The liquid crystal layer **200** includes a plurality of liquid crystals **210** having dielectric anisotropy and refractive index anisotropy. The liquid crystals **210** may be aligned in the direction perpendicular to the first display substrate **100** and the second display substrate **300**, in a state in which the electric field is not formed on the liquid crystal layer **200**. When an electric field is formed between the first display substrate **100** and the second display substrate **300**, the liquid crystals **210** may change the polarization of light by

rotating or tilting in a particular direction between the first display substrate **100** and the second display substrate **300**.

The effect of improving the visibility will be more specifically described below.

FIG. **5** illustrates a direction in which the liquid crystal **210** disposed in the region A of FIG. **5** is tilted in a state in which a predetermined voltage is provided to the pixel electrode **180**. FIG. **5** illustrates a state in which the predetermined electric field is formed in the liquid crystal layer **200** and the liquid crystals **210** are tilted when the first display substrate **100** is viewed from the top, and an extension direction of the long axis of the liquid crystals **210** means a direction in which the liquid crystals **210** are tilted.

Referring to FIG. **5**, the liquid crystal **210** overlapping the first fine slit **191** may be tilted to form a first included angle (θ**1**) with the first direction D**1**. Further, the liquid crystal **210** overlapping the second fine slit **192** may be tilted to form a second included angle (θ**2**) with the first direction D**1**. However, because there are a very large number of liquid crystals **210** disposed to overlap the first fine slits **191**, it is a matter of course that the long axis of the liquid crystal **210** and the first direction D**1** may form an angle other than the first included angle (θ**1**). However, because most of the liquid crystals **210** form an angle close to the first included angle (θ**1**), this will be mainly described for convenience. This may also be applied to the liquid crystal **210** disposed to overlap the second fine slit **192**.

Here, the included angle formed with the first direction D**1** means an acute angle of the two included angles formed with the first direction D**1**. In a case where the included angle becomes a positive (+) value when measured in a clockwise direction from the first direction D**1**, the included angle is measured in the clockwise direction. In a case where the included angle becomes the positive value when measured in a counterclockwise direction from the first direction D**1**, the include angle indicates the value measured in the counterclockwise direction.

When a predetermined voltage is applied to the pixel electrode **180**, the liquid crystal **210** disposed in the first fine slit **191** may be tilted along a direction parallel to the extension direction of the branch electrode **183**. The extension direction of the first electrode **183** may form an included angle of about 45° with the first direction D**1**. Thus, the first included angle may also be about 45°.

Here, the included angle formed between the long axis of the liquid crystal **210** and the first direction D**1** is about 45°. Thus, it may be advantageous for the visibility by interaction with the pair of polarizers. Thus, the liquid crystal **210** disposed in the first fine slit **191** may be tilted in a direction that is advantageous for the visibility.

When a predetermined voltage is provided to the pixel electrode **180**, the liquid crystal **210** disposed in the second fine slit **192** may be tilted to form a second included angle θ**2** with the first direction D**1**. The first included angle θ**1** may be larger than the second included angle θ**2**. However, even if the second included angle θ**2** is larger than the first included angle θ**1**, the second included angle θ**2** may have an angle less than 90° by the first edge electrode **185**. For example, because the force in which the liquid crystal **210** attempts to tilt acts from the distal end of the first edge electrode **185** in the direction of the portion in which the first edge electrode **185** and the second stem electrode **182** intersect with each other, the second included angle θ**2** may have a value that is less than 90° and is about 45°, rather than having the value of 90°. Accordingly, the visibility of the region in which the second fine slit **192** is disposed may be improved by the arrangement of the first edge electrode **185**. Further, as the visibility of the arrangement region of the second fine slit **192** is improved, the liquid crystal **210** of the arrangement region of the first edge electrode **185** and the first connection electrode **184_1** as an adjacent region is also affected, and the visibility may be improved.

Improvements in visibility and transmittance will be described referring to FIGS. **6** to **10**.

FIG. **6** is a graph illustrating the direction in which the liquid crystal is tilted along the line III-III' of FIG. **4** through measurement.

An x-axis of the graph in FIG. **6** represents a distance measured in a direction in which a point indicated by III' is disposed on the basis of a point indicated by III in FIG. **4** as an origin point, and its unit may be μm. In the graph of FIG. **6**, a y-axis represents an included angle formed with the first direction D**1** of FIG. **4**.

In the graph of FIG. **6**, a first line L**1**, a second line L**2**, and a third line L**3** represent an included angle formed between the liquid crystal **210** tilted by the structure of the pixel electrode **180** of the liquid crystal display device according to a comparative example and the first direction D**1**. A fourth line L**4**, a fifth line L**5**, and a sixth line L**6** represent an included angle formed between the liquid crystal **210** inclined by the structure of the pixel electrode **180** illustrated in FIG. **4** and the first direction D**1**.

Here, the structure of the pixel electrode **180** of the liquid crystal display device according to a comparative example means a structure in which the first edge electrode **185** is omitted from of the pixel electrode **180** structure illustrated in FIG. **4**, the length of the branch electrode **183** is further extended, and the first connection electrode **184_1** is disposed at a location of the existing first edge electrode **185**. For example, it means a structure in which the first edge electrode **185** is omitted.

Further, the first line L**1** and the fourth line L**4** are measured values when the first voltage level is applied to the pixel electrode **180**, the second line L**2** and the fifth line L**5** are measured values when the second voltage level is applied to the pixel electrode **180**, and the third line L**3** and the sixth line L**6** are measured values when the third voltage level is applied to the pixel electrode **180**. Here, the second voltage level has a voltage value higher than the first voltage level, and the third voltage level may have a voltage value higher than the second voltage level.

Referring to FIG. **6**, the fourth line L**4** is illustrated on a lower side than the first line L**1**, the fifth line L**5** is illustrated on a lower side than the second line L**2**, and the sixth line L**6** is illustrated on a lower side than the third line L**3**. For example, in the case of the structure of the pixel electrode **180** according to an example embodiment including the first edge electrode **185**, the included angle formed between the liquid crystal **210** and the first direction D**1** may be about 45°, as compared to the case of the structure of the pixel electrode **180** according to the comparative example. For example, it is possible to check that the visibility is improved.

Further, as indicated in all of the first to third voltage levels, it is possible to check that the visibility is improved in most cases of the voltage level applied to the pixel electrode **180**.

FIG. **7** is a graph illustrating the degree of improvement in visibility of the liquid crystal display device according to the embodiment illustrated in FIG. **1**.

An x-axis of the graph of FIG. **7** represents the gradation of each pixel **10**, and a y-axis represents the brightness. A maximum value of brightness represented by the y-axis is **100**, and its unit is %. In this graph, the reference of the

maximum value of brightness will be defined as a case where the liquid crystal display device having a gradation of 64 is viewed from the front.

The seventh line L7 in the graph of FIG. **7** represents brightness for each gradation when the liquid crystal display device according to the comparative example is viewed from the front, the eighth line L**8** represents brightness for each gradation when the liquid crystal display device according to the comparative example is viewed from the side, and the ninth line L**9** represents brightness for each gradation when the liquid crystal display device according to the embodiment illustrated in FIG. **1** is viewed from the side.

Referring to FIG. **7**, in most of the gradations, for example, in the gradations in the range of 0 to 50, the ninth line L**9** may be relatively closer to the seventh line L7 than the eighth line L**8**. For example, in a certain gradation among the gradations in the range of 0 to 50, a difference in measured values along the ninth line L**9** and the seventh line L7 may be smaller than a difference in measured values along the eighth line L**8** and the seventh line L7. Consequentially, it is possible to understand that the liquid crystal display device according to the embodiment illustrated in FIG. **1** has a difference in front brightness smaller than that of the liquid crystal display device according to the comparative example in most gradation ranges. Accordingly, it is possible to check that the visibility is improved in the case of the liquid crystal display device according to the embodiment illustrated in FIG. **1**.

FIG. **8** is a graph illustrating the degree of improvements in transmittance and visibility of the liquid crystal display device according to the embodiment illustrated in FIG. **1**.

In the graph of FIG. **8**, both of a bar graph and a line graph are illustrated. Among them, the bar graph represents the value of the transmittance in unit of %, and the line graph represents the value of visibility. The values of y-axis recorded on the left represent the value of the visibility, and the values of y-axis recorded on the right represent the value of the transmittance.

Further, the values of the bars and lines described on the left represent the measured values of the case according to the comparative example, and bars and the lines described on the right represent the measured values of the case according to the embodiment illustrated in FIG. **1**.

Referring to FIG. **8**, in the case according to the comparative example described above, the transmittance is measured as 100%, and the visibility is measured as 0.438. Meanwhile, in the case according to the embodiment illustrated in FIG. **1**, the transmittance is measured as 102.5%, and the visibility is measured as 0.421. Here, as the value of the visibility is low, it means that a difference in brightness between the front and the side is small. As a result, it is possible to understand that the transmittance increases and the visibility is improved according to an example embodiment.

FIG. **9** is a photograph obtained when a region corresponding to an active region of the liquid crystal display device according to the embodiment illustrated in FIG. **1** is viewed from the front, in the liquid crystal display device according to the comparative example, and FIG. **10** is a photograph obtained when the active region of the liquid crystal display device according to the embodiment illustrated in FIG. **1** is viewed from the front.

Referring to FIGS. **9** and **10**, in the case of the liquid crystal display device according to the comparative example, it is possible to check that the lower end of the region corresponding to the active region **11** is viewed brightly but just above the brightly viewed lower end is viewed darkly. Meanwhile, in the case of the liquid crystal display device according to the embodiment illustrated in FIG. **1**, it is possible to check that the lower end portion of the active region **11** has a uniform brightness. Therefore, in the case of the liquid crystal display device according to the embodiment illustrated in FIG. **1**, since it represents a generally uniform brightness in the active region **11**, it is possible to check that the display quality is improved as compared to the liquid crystal display device according to the comparative example.

As described in detail below, the shape of the pixel electrode **180** may be variously modified.

FIG. **11** is a plan view illustrating the pixel electrode of the liquid crystal display device according to another example embodiment.

As one example, FIG. **11** illustrates a structure that further includes a second edge electrode **185_2***a* in addition to the first edge electrode **185_1***a*, as compared to FIG. **4**, and illustrates a structure that further includes a fifth fine slit **192_2***a* with the addition of the second edge electrode **185_2***a*.

Hereinafter, this structure will be described with reference to FIGS. **1** to **5** and **11**. The pixel electrode **180***a* according to the present example embodiment further includes a second edge electrode **185_2***a* disposed adjacent to the second connection electrodes **184_2** as well as the first edge electrode **185_1***a* disposed adjacent to the first connection electrode **184_1**. The second edge electrode **185_2***a* intersects with the distal end of the second stem electrode **182** and may extend along the first direction D**1**. Consequently, the pixel electrode **180***a* according to the present example embodiment may include the first edge electrode **185_1***a* and the second edge electrode **185_2***a* connected to both distal ends of the second stem electrode **182**. For example, the arrangement of the first edge electrode **185_1***a* is not limited to be arranged only on one distal end of the second stem electrode **182**.

The sum of a width dt**1** of the first edge electrode **185_1***a*, a width dt**2** of the first connection electrode **184_1** and a spaced distance dt**3** between the first connection electrode **184_1** and the first edge electrode **185_1***a* may be, for example. 10.5 μm or less, which may help maintain a relatively high response speed of the liquid crystal display device. Here, the width dt**1** of the first edge electrode **185_1***a*, the width dt**2** of the first connection electrode **184_1**, and the spaced distance dt**3** between the first connection electrode **184_1** and the first edge electrode **185_1***a* are based on a length measured along the second direction D**2**.

For example, the width dt**2** of the first connection electrode **184_1** may be less than 3 μm, and the spaced distance dt**3** between the first connection electrode **184_1** and the first edge electrode **185_1***a* may be 2 μm or more and 4 μm or less.

The response speed will be further specifically described with reference to FIGS. **12** through **17**.

FIGS. **12** to **14** are photographs of the active region for each time period when the width of the first connection electrode is 2.6 μm, and FIGS. **15** to **17** are photographs of the active region for each time period when the width of the first connection electrodes is 3 μm.

Here, FIGS. **12** and **15** are photographs of the time when 1800 ms has passed from the time when the data signal begins to be provided to the pixel electrode **180***a* , FIGS. **13** and **16** are photographs of the time when 3000 ms has passed from the time when the data signal begins to be provided to the pixel electrode **180***a* , and FIGS. **14** and **17** are photo-

graphs of the time when 3600 ms has passed from the time when the data signal begins to be provided to the pixel electrode **180***a*.

Referring to FIG. **12** through **17**, it is possible to check that the liquid crystal **210** is stabilized within 3600 ms in both of the case where the width dt**2** of the first connection electrode **184_1** is 3 μm and the case of 2.6 μm. However, it is possible to check that, when the width dt**2** of the first connection electrode **184_1** is 2.6 μm, the liquid crystal **210** is stabilized within 3000 ms, and meanwhile, when the width dt**2** of the first connection electrode **184_1** is 3 μm, even if the 3000 ms has passed, the liquid crystal **210** is not stabilized. For example, it is possible to check that, when the width dt**2** of the first connection electrode **184_1** is less than 3 μm, the liquid crystal **210** is further quickly stabilized, and the response speed is improved.

FIG. **18** is a plan view illustrating the pixel electrode of the liquid crystal display device according to still another example embodiment.

For example, FIG. **18** illustrates a structure that further includes a second edge electrode **185_2***b* in addition to the first edge electrode **185_1***b* as compared to FIG. **4**, and illustrates a structure that further includes a fifth fine slit **192_2***b* with the addition of the second edge electrode **185_2***b*.

Hereinafter, this structure will be described with reference to FIGS. **1** to **5** and **18**. The pixel electrode **180***b* according to the present example embodiment further includes a second edge electrode **185_2***b* disposed adjacent to the first edge electrode **185_1***b* on the outside of the first edge electrode **185_1***b*, as well as the first edge electrode **185_1***b* disposed adjacent to the first connection electrode **184_1**.

Thus, the first edge electrode **185_1***b* intersects with the second stem electrode **182** in a cross shape and extends along the first direction D**1**, and the second edge electrode **185_2***b* intersects with the distal end of the second stem electrode **182** and may extend along the first direction D**1**.

Further, the pixel electrode **180***b* may further include a fifth fine slit **192_2***b* disposed between the first edge electrode **185_1***b* and the second edge electrode **185_2***b*, as well as the second fine slit **192_1***b* disposed between the first connection electrodes **184_1** and the first edge electrode **185_1***b*.

FIG. **19** is an enlarged plan view illustrating a region B of FIG. **18**.

Referring to FIG. **19**, the liquid crystal **210** overlapping the first fine slit **191** may be tilted to form a third included angle θ**3** with the first direction D**1**. The liquid crystal **210** overlapping the second fine slit **192_1***b* may be tilted to form a fourth included angle θ**4** with the first direction D**1**. Further, the liquid crystal **210** overlapping the fifth fine slit **192_2***b* may be tilted to form a fifth included angle θ**5** with the first direction D**1**.

Here, the degree of improvement in visibility may be compared by comparing the relationship between the third included angle θ**3**, the fourth included angle θ**4** and the fifth included angle θ**5** illustrated in FIG. **19** and the first included angle θ**1** and the second included angle θ**2** illustrated in FIG. **5**. For example, the third included angle θ**3** may be the same as the first included angle θ**1**, the fourth included angle θ**4** may be the same as the second included angle θ**2**, and the fifth included angle θ**5** may be smaller than the second included angle θ**2**. Without being bound by theory, it is believed that the reason is that, because the second edge electrode **185_2***b* and the first edge electrode **185_1***b* are included, the force which acts from the distal ends of the first edge electrode **185_1***b* and the second edge electrode **185_2***b* in the arrangement direction of the second stem electrode **182** is enhanced. Thus, the degree of improvement in visibility may be maximized.

FIG. **20** is a graph illustrating the degree of improvement in visibility of the liquid crystal display device according to the embodiment illustrated in FIG. **18**.

The x-axis of the graph in FIG. **20** represents the gradation of each pixel **10**, and the y-axis represents the brightness. The maximum value of brightness represented by the y-axis is 100, and its unit is %. In this graph, the reference of the maximum value of brightness will be defined as a case where the liquid crystal display device having a gradation of 64 is viewed from the front.

A tenth line L**10** in the graph of FIG. **20** represents brightness for each gradation when the liquid crystal display device according to the embodiment illustrated in FIG. **1** is viewed from the front, an eleventh line L**11** represents brightness for each gradation when the liquid crystal display device according to the embodiment illustrated in FIG. **1** is viewed from the side, and a twelfth line L**12** represents brightness for each gradation when the liquid crystal display device including the pixel electrode **180***b* according to the embodiment illustrated in FIG. **1** is viewed from the side.

Referring to FIG. **20**, in most of the gradations, for example, in the gradations in the range of 0 to 48, the twelfth line L**12** may be relatively closer to the tenth line L**10** than the eleventh line L**11**. For example, in a certain gradation of the gradations in the range of 0 to 48, a difference in measured values along the twelfth line L**12** and the tenth line L**10** may be smaller than a difference in measured values along the eleventh line L**11** and the tenth line L**10**. Consequentially, it is possible to understand that the liquid crystal display device including the pixel electrode **180***b* according to the embodiment illustrated in FIG. **18** has a difference in front brightness smaller than that of the liquid crystal display device according to the embodiment illustrated in FIG. **1** in most gradation ranges. Accordingly, it is possible to check that the degree of improvement in the visibility of the liquid crystal display device including the pixel electrode **180***b* illustrated in FIG. **18** is maximized.

FIG. **21** is a plan view illustrating the pixel electrode of the liquid crystal display device according to another example embodiment.

For example, FIG. **21** illustrates a structure which further includes a second edge electrode **185_2***c*, a third edge electrode **185_3***c* and a fourth edge electrode **185_4***c* in addition to the first edge electrode **185_1***c*, as compared to FIG. **4**, and illustrates a structure which further includes a fifth fine slit **192_2***c*, a sixth fine slit **192_3***c* and a seventh fine slit **192_4***c* with the addition of the second to fourth edge electrodes **185_2***c*, **185_3***c* and **185_4***c*.

Hereinafter, this structure will be described with reference to FIGS. **1** to **5** and **21**. The pixel electrode **180***c* according to the present example embodiment further includes a second edge electrode **185_2***c* disposed adjacent to the first edge electrode **185_1***c* to be spaced apart therefrom on the outside of the first edge electrode **185_1***c*, as well as the first edge electrode **185_1***c* disposed adjacent to the first connection electrode **184_1**. Further, the pixel electrode **180***c* further includes a third edge electrode **185_3***c* disposed adjacent to the second connection electrode **184_2** to be spaced apart therefrom, and a fourth edge electrode of **185_4***c* disposed adjacent to the outer side of the third edge electrode **185_3***c* to be spaced apart therefrom.

All of the first to fourth edge electrodes **185_1***c*, **185_2***c*, **185_3***c*, and **185_4***c* intersect with the second stern electrode **182**, and may extend along the first direction D**1**. For

example, the first edge electrode **185_1**C and the second edge electrode **185_2***c* are disposed below the first stem electrode **181**, and the third edge electrode **185_3***c* and the fourth edge electrode **185_4***c* may be disposed above the first stem electrode **181**.

A second fine slit **192_1***c* as an opening portion extending in the first direction D**1** may be disposed between the first connection electrode **184_1** and the first edge electrode **185**. A fifth fine slit **192_2***c* as an opening portion extending in the first direction D**1** may be disposed between the first edge electrode **185_1***c* and the second edge electrode **185_2***c*. Furthermore, a sixth fine slit **192_3***c* as an opening portion extending in the first direction D**1** may be disposed between the second connection electrode **184_2** and the third edge electrode **185_3***c*, and a seventh fine slit **192_4***c* as an opening portion extending in the first direction D**1** may be disposed between the third edge electrode **185_3***c* and the fourth edge electrode **185_4***c*.

FIG. **22** is a plan view illustrating the pixel electrode of the liquid crystal display device according to still another example embodiment.

For example, FIG. **22** illustrates a structure in which the first auxiliary electrode **186_1** and the second auxiliary electrode **186_2** are removed as compared to FIG. **4** and illustrates a structure in which the third fine slit **193** and the fourth fine slit **194** are also removed with the removal of the first auxiliary electrode **186_1** and the second auxiliary electrode **186_2**.

Hereinafter, this structure will be described with reference to FIGS. **1** to **5** and **22**. The pixel electrode **180***d* according to the present example embodiment may be constituted to include only a first stem electrode **181**, a second stem electrode **182**, a branch electrode **183**, a first connection electrode **184_1**, a second connection electrode **184_2**, a first edge electrode **185**, and a protrusion **187**. For example, the first auxiliary electrode **186_1** and the second auxiliary electrode **186_2** as illustrated in FIG. **4** may be omitted.

FIG. **23** is a plan view illustrating the pixel electrode of the liquid crystal display device according to still another example embodiment.

For example, FIG. **23** illustrates a structure that further includes a second edge electrode **185_2***e* and a third edge electrode **185_3***e* in addition to the first edge electrode **185_1***e* as compared to FIG. **4**, and illustrates a structure that further includes a fifth fine slit **192_2***e* and a sixth fine slit **192_3***e* with the addition of the second edge electrode **185_2***e* and third edge electrode **185_3***e*.

Hereinafter, this structure will be described with reference to FIGS. **1** to **5** and **23**. The pixel electrode **180***e* according to the present example embodiment includes the first edge electrode **185_1***e*, the second edge electrode **185_2***e*, and the third edge electrode **185_3***e*. Here, the first edge electrode **185_1***e* and the second edge electrode **185_2***e* are disposed below the first stem electrode **181**, and the third edge electrode **185_3***e* may be disposed above the first stem electrode **181**. For example, the number of edge electrodes disposed on both sides based on the first stem electrode **181** may be different.

FIG. **24** is a plan view illustrating the pixel electrode of the liquid crystal display device according to still another example embodiment.

For example, FIG. **24** differs from FIG. **4** in that the first edge electrode **185***f* is connected to the first auxiliary electrode **186_1***f* and the second auxiliary electrode **186_2***f*. Thus, the extended lengths of the third fine slit **193***f* and the fourth fine slit **194**F along the second direction D**2** may become relatively short.

Hereinafter, this structure will be described with reference to FIGS. **1** to **4** and **24**. The first edge electrode **185***f* of the pixel electrode **180***f* according to the present example embodiment is connected to the distal end of the second stem electrode **182**, and may be connected to the distal ends of the first auxiliary electrode **186_1***f* and the second auxiliary electrode **186_2***f*. Thus, controllability of the liquid crystal **210** disposed in a region in which the first edge electrode **185***f* and the first auxiliary electrode **186_1***f* are connected to each other and in a region in which the first edge electrode **185***f* and the second auxiliary electrode **186_2***f* are connected to each other is improved, and the effect of improving the visibility may be further maximized.

FIG. **25** is a plan view illustrating the pixel electrode of the liquid crystal display device according to still another example embodiment.

For example, FIG. **25** differs from FIG. **4** in that the first connection electrode **184_1***g* extends in an oblique direction to the first direction D**1**. Thus, the extended width of the second fine slit **192***g* in the second direction D**2** may also be different depending on the positions.

Hereinafter, this structure will be described with reference to FIGS. **1** to **4** and **25**. The first connection electrode **184_1***g* of the pixel electrode **180***g* according to the present example embodiment may extend obliquely in the first direction D**1**. The first connection electrode **184_1***g* may have an axisymmetric shape on the basis of the second stem electrode **182**. Thus, the extended width of the second fine slit **192***g* in the second direction D**2** may increase as it is away from the second stem electrode **182**. Thus, the spaced distance between the first edge electrode **185** and the first connection electrode **184_1***g* may increase as it is away from the second stem electrode **182**.

FIG. **26** is a plan view illustrating the pixel electrode of the liquid crystal display device according to still another example embodiment.

For example, FIG. **26** illustrates a structure that further includes a second edge electrode **185_2***h* in addition to the first edge electrode **185_1***h* as compared to FIG. **4**, and illustrates a structure that further includes a fifth fine slit **192_2***h* with the addition of the second edge electrode **185_2***h*. Furthermore, the first connection electrode **184_1***h* and the first edge electrode **185_1***h* may extend obliquely in the first direction D**1**.

Hereinafter, this structure will be described with reference to FIGS. **1** to **5** and **26**. The first connection electrode **184_1***h* and the first edge electrode **185_1***h* of the pixel electrode **180***h* according to the present example embodiment may extend obliquely in the first direction D**1**. For example, the first connection electrode **184_1***h* may extend to form a sixth included angle θ**6** with the first direction D**1**, and the first edge electrode **185_1***h* may extend to form a seventh included angle θ**7** with the first direction D**1**. Here, the seventh included angle θ**7** may be greater than the sixth included angle θ**6**. Thus, the extended width of the second fine slit **192_1***h* in the second direction D**2** and the extended width of the fifth fine slit **192_2***h* in the second direction D**2** may increase as both the extended widths are away from the second stem electrode **182**. Thus, the spaced distance between the first edge electrode **185_1***h* and the first connection electrode **184_1***h* may increase as it is farther away from the second stem electrode **182**, and the spaced distance between the first edge electrode **185_1***h* and the second edge electrode **185_2***h* may also increase as it is away from the second stem electrode **182**.

FIG. **27** is a plan view illustrating the pixel electrode of the liquid crystal display device according to still another example embodiment.

For example, FIG. **27** illustrates a structure in which the third domain region DM**3** and the fourth domain region DM**4** are removed and only a first domain region DM**1***i* and a second domain region DM**2***i* are included as compared to FIG. **4**.

Hereinafter, this structure will be described with reference to FIGS. **1** to **5** and **27**. The pixel electrode **180** according to the present example embodiment includes a first stem electrode **181***i* extending along the first direction D**1**, a second stem electrode **182***i* intersecting with the first stem electrode **181***i* and extending along the second direction D**2**, and a plurality of branch electrodes **183***i* extending in the oblique direction to the first direction D**1** and the second direction D**2** from the first stern electrode **181***i* and the second stem electrode **182***i*. The first connection electrode **184***i* is disposed to connect the distal ends of the branch electrodes **183***i* disposed in the first domain region DM**1***i* and the second domain region DM**2***i* with each other and may be disposed to intersect with the second stem electrode **182***i*.

The first edge electrode **185***i* is disposed adjacent to the first stem electrode **181***i* to be spaced apart therefrom, and is disposed parallel to the first stem electrodes **181***i*. Thus, a second fine slit **192***i* may be formed between the first stern electrode **181***i* and the first edge electrode **185***i*.

For example, even if some of the first to fourth domain regions DM**1**, DM**2**, DM**3**, and DM**4** of the embodiment illustrated in FIG. **4** are omitted, it is also possible to improve the visibility as in the pixel electrode **180***i* according to the embodiment illustrated in FIG. **27**.

FIG. **28** is a plan view illustrating the pixel electrode of the liquid crystal display device according to still another example embodiment.

For example, FIG. **28** illustrates a structure in which the first domain region DM**1**, the third domain region DM**3** and the fourth domain region DM**4** are removed and only the second domain region DM**2***j* is included as compared to FIG. **4**.

Hereinafter, this structure will be described with reference to FIGS. **1** to **5** and **28**. The pixel electrode **180***j* according to the present example embodiment includes a first stem electrode **181***j* extending along the first direction D**1**, a second stein electrode **182***j* intersecting with the first stem electrode **181***j* and extending along the second direction D**2**. and a plurality of branch electrodes **183***j* extending in an oblique direction to the first direction D**1** and the second direction D**2** from the first stem electrode **181***j* and the second stem electrode **182***j*. The first connection electrode **184***j* is disposed to connect the distal ends of the branch electrodes **183***j* disposed in the second domain region DM**2***j*, and may be disposed to intersect with the second stem electrode **182***j*. The branch electrodes **183***j* may be disposed only in the second domain region DM**2***j*.

The first edge electrode **185***j* is disposed adjacent to the first stem electrode **181***j* to be spaced apart therefrom, and is disposed parallel to the first stem electrodes **181***j*. Thus, a second fine slit **192***j* may be formed between the first stem electrode **181***j* and the first edge electrode **185***j*.

For example, even if all the rest except one domain region among the first to fourth domain regions DM**1**, DM**2**, DM**3**, and DM**4** of the embodiment illustrated in FIG. **4** are omitted, it is possible to improve the visibility as in the pixel electrode **180***j* according to the embodiment illustrated in FIG. **28**.

FIG. **29** is a layout diagram of a single pixel of a liquid crystal display device according to still another example embodiment, and FIG. **30** is an enlarged plan view illustrating the pixel electrode of FIG. **29**.

Referring to FIG. **29**, a single pixel **10***k* of the liquid crystal display device according to the present example embodiment includes an active region **11***k*, a gate line **122***k*, a gate electrode **124***k*, a sustain electrode **126***k*, a semiconductor layer **140***k*, a source electrode **165***k*, a drain electrode **166***k*, a pixel electrode **180***k*, a shielding electrode **189***k* and a contact hole **188***k*. Further, the pixel electrode **180***k* includes a first stem electrode **181***k*, a second stem electrode **182***k*, a branch electrode **183***k*, a first connection electrode **184_1***k*, a second connection electrode **184_2***k*, a first edge electrode **185_1***k*, a second edge electrode **185_2***k*, a first auxiliary electrode **186_1***k*, a second auxiliary electrode **186_2***k*, and a protrusion **187***k*, and includes a first fine slit **191***k*, a second fine slit **192***k*, a third fine slit **193***k* and a fourth fine slit **194***k* as opening portions according to the structure of the pixel electrode **180***k*.

Here, the related description may be applied to the configurations corresponding to the configurations according to the embodiments illustrated in FIGS. **1** and **4** among the respective configurations illustrated in FIGS. **29** and **30**, unless there is separate explanation. Thus, differences from the configurations illustrated in FIGS. **1** and **4** among the respective configurations illustrated in FIGS. **29** and **30** will be mainly described.

Referring to FIGS. **1**, **4**, **29**, and **30**, a single pixel **10***k* of the liquid crystal display device according to the present example embodiment may have the width extending along the second direction D**2** longer than the width extending along the first direction D**1**. Further, the length of the second stem electrode **182***k* extending along the second direction D**2** in the active region **11***k* may be longer than the length of the first stem electrode **181***k* extending along the first direction D**1** in the active region **11***k*. For example, the extension direction of the long axis of the pixel **10** in the embodiment illustrated in FIGS. **1** and **4** may be changed, and the relative length relationship between the first stem electrode **181** and the second stem electrode **182** may also be changed. However, according to the present example embodiment, since the extended lengths of the first electrode **183***k* and the second electrode **183***k* along the first direction D**1** become relatively short, the degree of improvement in visibility and the degree of improvement in transmittance may be partially reduced as compared to the degree of improvement in visibility and the degree of improvement in transmittance illustrated in FIGS. **1** and **4**.

FIG. **31** is a cross-sectional view taken along a line corresponding to the line I-I' illustrated in FIG. **1** in a liquid crystal display device according to still another example embodiment, and FIG. **32** is a cross-sectional view taken along a line corresponding to the line I-I' illustrated in FIG. **1** in the liquid crystal display device according to the embodiment illustrated in FIG. **31**.

For example, the embodiments according to FIGS. **31** and **32** illustrate a structure in which a column spacer **191***l* and a spacer **192***l* are further included and a light-shielding member **320** and an overcoat layer **330** are omitted as compared to FIGS. **2** and **3**.

Hereinafter, this structure will be described with reference to FIGS. **1** to **3** and **31** and **32**. The liquid crystal display device according to the present example embodiment includes a column spacer **191***l* which is disposed to correspond to a region in which the light-shielding member **320** of FIGS. **1** to **3** is disposed. The column spacer **191***l* may not

transmit light and may cut off light provided from the bottom. As the column spacer **191***l* cuts off the light, the light-shielding member **320** illustrated in FIGS. **1** through **3** may be omitted. As the light-shielding member **320** is omitted, the overcoat layer **330** illustrated in FIGS. **1** to **3** may also be omitted. Accordingly, the common electrode **340***l* may be directly disposed on a surface of the first base substrate **110**.

Also, the liquid crystal display device may further include a spacer **192***l* for maintaining a space in which the liquid crystal layer **200***l* is formed. The spacer **192***l* may be formed integrally with the column spacer **191***l*, and may be formed in a region on which the thin film transistor **167** is disposed.

The column spacer **191***l* may be disposed between the pixels **10** adjacent to each other to extend along the first direction D**1**. However, because the column spacer **191***l* may form a step, it may tilt the liquid crystal **210**. Therefore, in the case of the liquid crystal display device formed with the column spacer **191***l*, the visibility may be lowered along the edge which extends along the first direction D**1**, among the edges of the active region **11**. In this case, since the first electrode **183** is disposed, it is possible to maximize the effect of improving the visibility.

By way of summation and review, among the liquid crystal display devices, vertically alignment mode liquid crystal display devices have been developed in which a long axis of the liquid crystal is arrayed to be perpendicular to the upper and lower substrates in a state in which no electric field is applied.

The vertical alignment mode liquid crystal display devices may have poorer lateral visibility than front visibility. For example, the liquid crystal display device may be more brightly visible when viewed from the side than when viewed from the front, and as the brightness difference between the front and the side is large, the visibility gets worse.

As described above, embodiments may provide a liquid crystal display device with improved visibility.

Example embodiments have been disclosed herein, and although specific terms are employed, they are used and are to be interpreted in a generic and descriptive sense only and not for purpose of limitation. In some instances, as would be apparent to one of ordinary skill in the art as of the filing of the present application, features, characteristics, and/or elements described in connection with a particular embodiment may be used singly or in combination with features, characteristics, and/or elements described in connection with other embodiments unless otherwise specifically indicated. Accordingly, it will be understood by those of skill in the art that various changes in form and details may be made without departing from the spirit and scope of the present invention as set forth in the following claims.

What is claimed is:

1. A liquid crystal display device, comprising:

a substrate; and

a pixel electrode disposed on the substrate, the pixel electrode including:

a first stem electrode that extends in a first direction;

a second stem electrode that extends in a second direction perpendicular to the first direction and intersects with the first stem electrode;

a plurality of branch electrodes, the branch electrodes extending obliquely to the first direction and the second direction from the first stem electrode and the second stem electrode;

a first connection electrode that connects distal ends of some of the branch electrodes to each other, extends in the first direction, and intersects with the second stem electrode; and

a first edge electrode that is connected to one distal end of the second stem electrode and extends in the first direction.

2. The liquid crystal display device as claimed in claim **1**, further comprising:

a gate line that is disposed on the substrate, is insulated from the pixel electrode, and extends along the first direction; and

a data line that is disposed on the substrate, is insulated from the pixel electrode and the gate line, and extends along the second direction.

3. The liquid crystal display device as claimed in claim **2**, further comprising a thin film transistor that is disposed on the substrate, and has an input terminal connected to the data line, an output terminal connected to the pixel electrode, and a control terminal connected to the gate line.

4. The liquid crystal display device as claimed in claim **2**, wherein the first edge electrode is disposed between the first connection electrode and the gate line.

5. The liquid crystal display device as claimed in claim **2**, wherein an extended length of the first stem electrode is longer than an extended length of the second stem electrode.

6. The liquid crystal display device as claimed in claim **1**, wherein a sum of a width in the second direction of the first edge electrode, a width in the second direction of the first connection electrode, and a spaced distance between the first connection electrode and the first edge electrode is 10.5 μm or less.

7. The liquid crystal display device as claimed in claim **6**, wherein the width in the second direction of the first connection electrode is less than 3 μm.

8. The liquid crystal display device as claimed in claim **6**, wherein the spaced distance between the first connection electrode and the first edge electrode is 4 μm or more and 2 μm or less.

9. The liquid crystal display device as claimed in claim **1**, further comprising a second edge electrode that is disposed between the first connection electrode and the first edge electrode, extends along the first direction, and intersects with the second stem electrode.

10. The liquid crystal display device as claimed in claim **1**, further comprising a second connection electrode that connects the distal ends of some of the branch electrodes to each other, extends in the first direction, intersects with the second stem electrode, and is disposed on an opposite side of the first connection electrode in the second direction.

11. The liquid crystal display device as claimed in claim **10**, further comprising a third edge electrode that is connected the other distal end of the second stem electrode and extends in the first direction.

12. The liquid crystal display device as claimed in claim **11**, further comprising a fourth edge electrode that is disposed between the first connection electrode and the first edge electrode, extends along the first direction and intersects with the second stem electrode.

13. The liquid crystal display device as claimed in claim **1**, further comprising a second auxiliary electrode that is connected to one distal end of the first stem electrode, is connected to the other distal ends of the first auxiliary electrode and the first stem electrode extending in the second direction, and extends in the second direction.

14. The liquid crystal display device as claimed in claim **1**, wherein a spaced distance between the first edge electrode

and the first connection electrode increases as it is farther away from the second stem electrode.

15. The liquid crystal display device as claimed in claim **1**, wherein the first edge electrode is disposed adjacent to the first stem electrode to be spaced apart therefrom.

16. A liquid crystal display device, comprising:

a substrate;

a first gate line and a second gate line that are disposed on the substrate, extend in a first direction, and are insulated from each other;

a data line that is disposed on the first gate line, is insulated from the first gate line and the second gate line, and extends in a second direction perpendicular to the first direction; and

a pixel electrode that is disposed on the data line and is insulated from the first gate line, the second gate line, and the data line, the pixel electrode including:

a first stem electrode that extends in a first direction;

a second stem electrode that extends in the second direction and intersects with the first stem electrode;

a plurality of branch electrodes, the branch electrodes extending obliquely to the first direction and the second direction from the first stem electrode and the second stem electrode;

a first connection electrode that connects distal ends of some of the branch electrodes to each other, extends in the first direction, and intersects with the second stem electrode;

a second connection electrode that connects the distal ends of the remaining branch electrodes to each other, extends in the first direction, and intersects with the second stem electrode on an opposite side of the first connection electrode; and

a first edge electrode that is connected to one distal end of the second stem electrode and extends in the first direction,

wherein the first edge electrode is disposed between the first connection electrode and the first gate line, and

the second connection electrode is disposed to overlap the second gate line.

17. The liquid crystal display device as claimed in claim **16**, wherein the extended length of the first stem electrode is longer than the extended length of the second stem electrode.

18. The liquid crystal display device as claimed in claim **17**, further comprising a thin film transistor that is disposed on the substrate, and has an input terminal connected to the data line, an output terminal connected to the pixel electrode, and a control terminal connected to the first gate line.

19. The liquid crystal display device as claimed in claim **18**, wherein the second gate line is electrically insulated from the thin-film transistor.

20. The liquid crystal display device as claimed in claim **17**, further comprising a shielding electrode that is disposed on the same layer as the pixel electrode and spaced apart from the pixel electrode, and extends in the first direction to partially overlap the first gate line and the second gate line.

* * * * *

专利名称(译)	液晶显示装置包括像素电极，该像素电极具有连接到茎电极的一个远端的第一边缘电极		
公开(公告)号	US10203567	公开(公告)日	2019-02-12
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[标]申请(专利权)人(译)	三星显示有限公司		
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CPC分类号	G02F1/134309 G02F1/1368 G02F1/13394 G02F1/13439 G02F1/133345 G02F1/133512 G02F1/133707 G02F1/136286 H01L27/124 G02F1/133514 G02F2201/123 G02F2001/133357 G02F2201/121 G02F1/134336 G02F1/1362 G02F2001/136218		
审查员(译)	LEE，PAUL		
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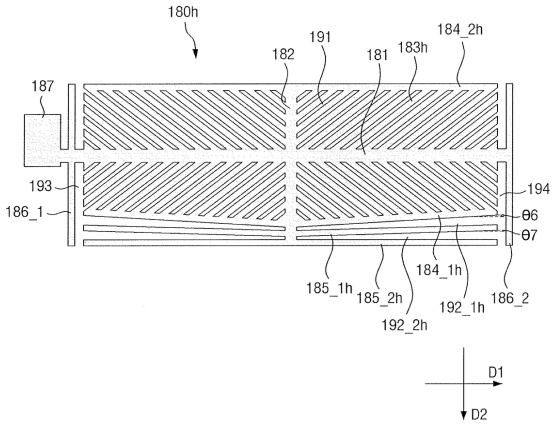
摘要(译)

一种液晶显示装置，包括基板和设置在基板上的像素电极，像素电极包括沿第一方向延伸的第一杆电极，第二杆电极，其沿垂直于第一方向的第二方向延伸并交叉具有第一杆电极，多个分支电极，分支电极从第一杆电极和第二杆电极倾斜于第一方向和第二方向延伸，第一连接电极连接一些分支电极的远端彼此沿第一方向延伸并与第二杆电极相交，并且第一边缘电极连接到第二杆电极的一个远端并沿第一方向延伸。