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(54) **LIQUID CRYSTAL DISPLAY APPARATUS**

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G02F 1/1335 (2006.01)

(52) **U.S. Cl.**
CPC ***G02F 1/13394*** (2013.01)
USPC **349/155**; 349/106; 349/107; 349/114

(58) **Field of Classification Search**
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USPC 349/106–109, 114, 155–157
See application file for complete search history.

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(57) **ABSTRACT**

A liquid crystal display apparatus is disclosed. The liquid crystal display apparatus includes: a plurality of sub-pixels, a first substrate on which at least one first thin film is disposed, a second substrate facing the first substrate and on which at least one second thin film is disposed, a liquid crystal layer disposed between the first substrate and the second substrate, and a spacer unit disposed between the first substrate and the second substrate to maintain a space where the liquid crystal layer is disposed, and continuously formed across at least two sub-pixels from among the plurality of sub-pixels, where the spacer unit includes a contact unit and an isolation unit including a plurality isolation sub-units, where the contact unit is formed to contact the first thin film closest to the liquid crystal layer and the second thin film closest to the liquid crystal layer, where the isolation unit is formed to be spaced apart from the first thin film closest to the liquid crystal layer and to contact the second thin film closest to the liquid crystal layer, and where a distance between the plurality of isolation sub-units and the first thin film closest to the liquid crystal layer is not uniform.

3 Claims, 12 Drawing Sheets

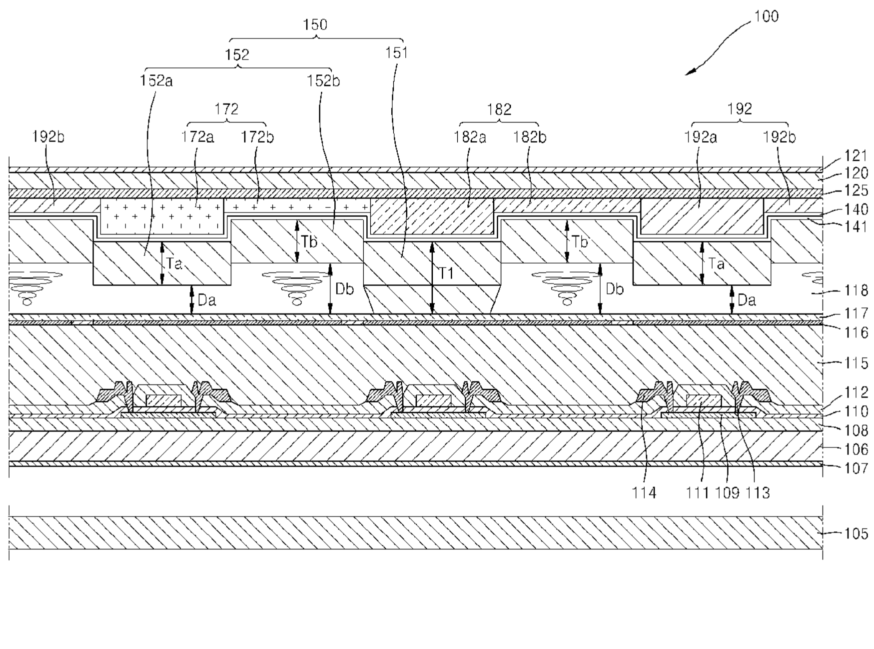
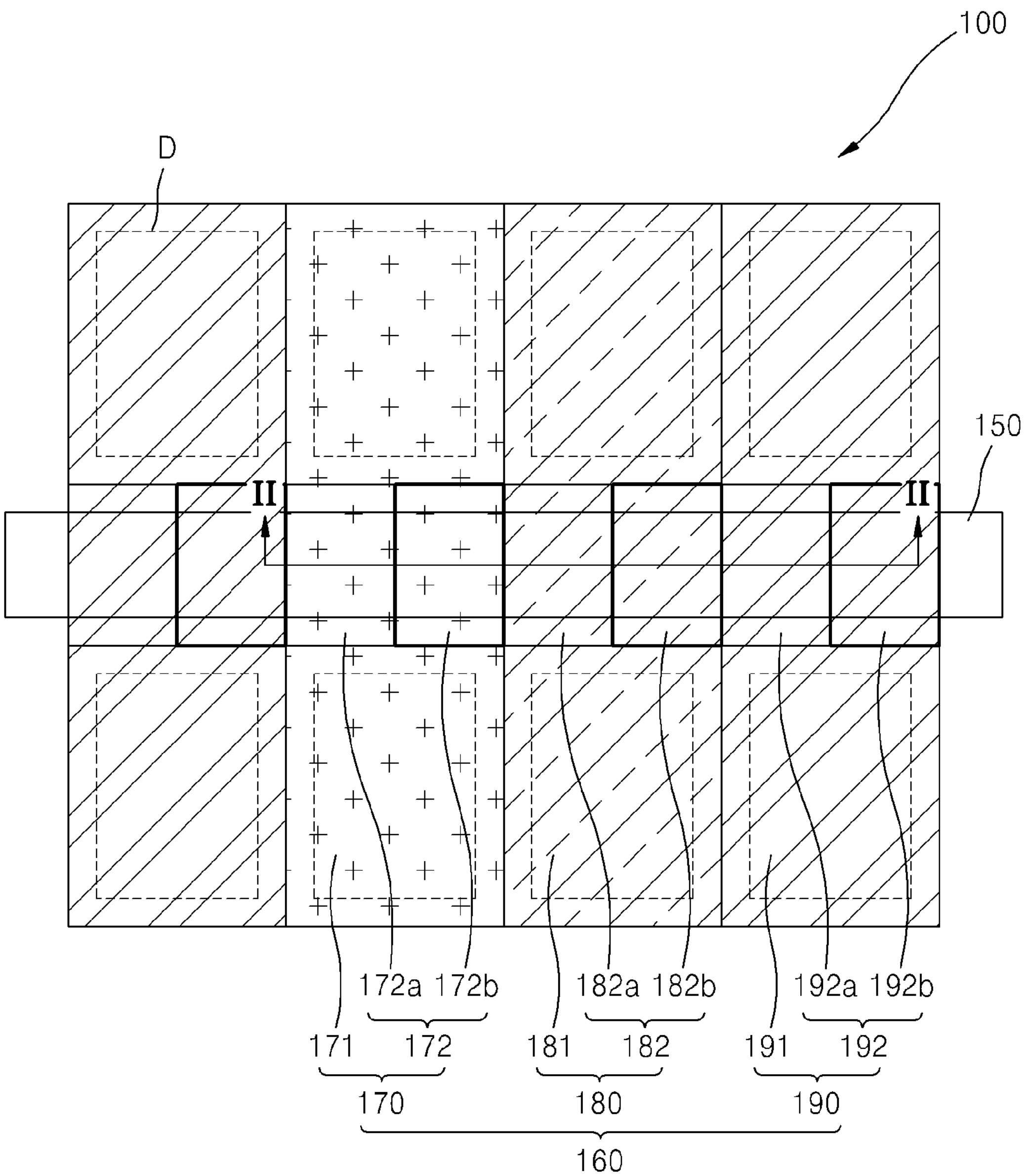


FIG. 1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D
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II
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182a 182b
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171
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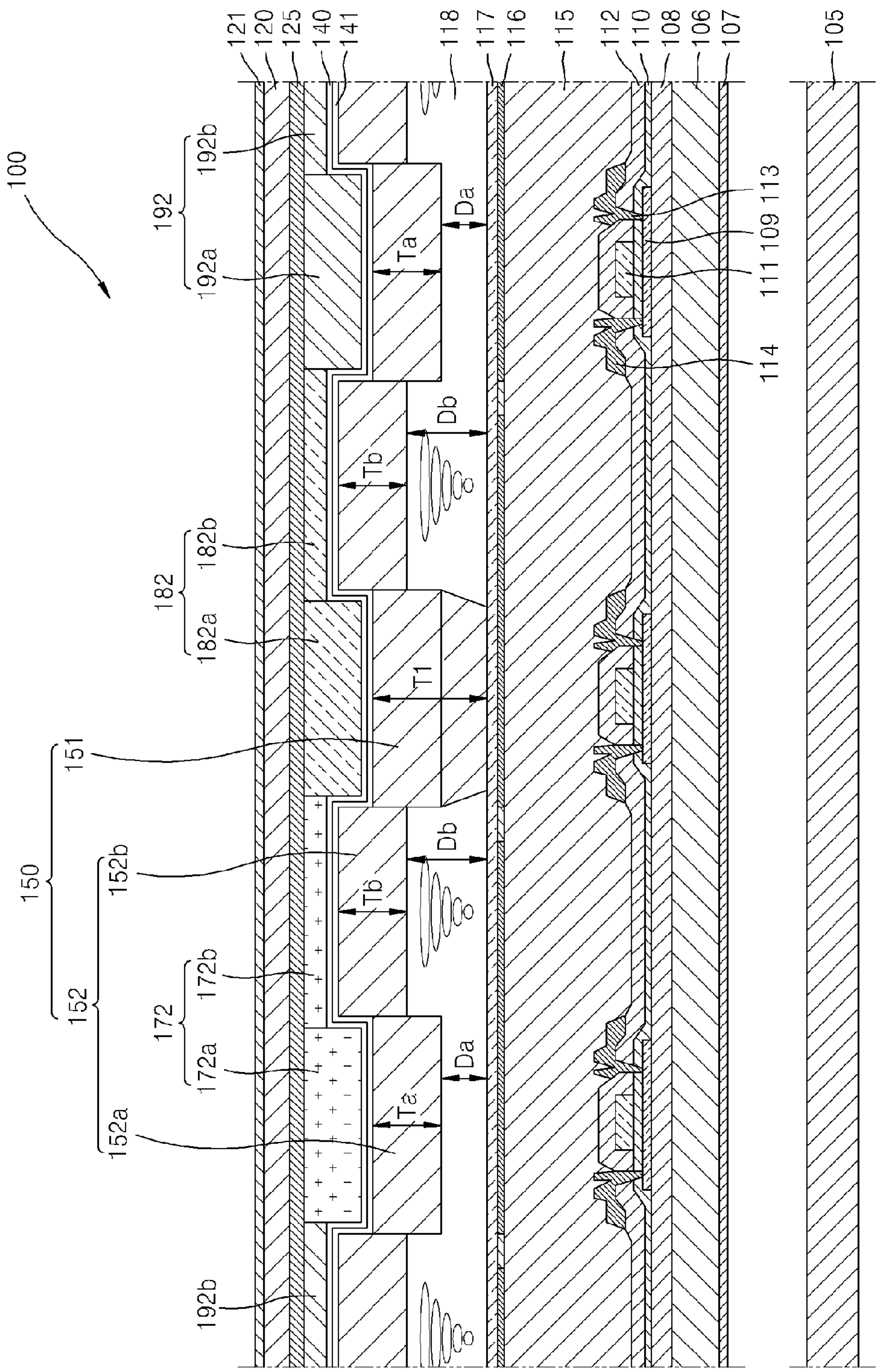
FIG. 2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182b
172
172a
172b
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151
152
152a
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Da
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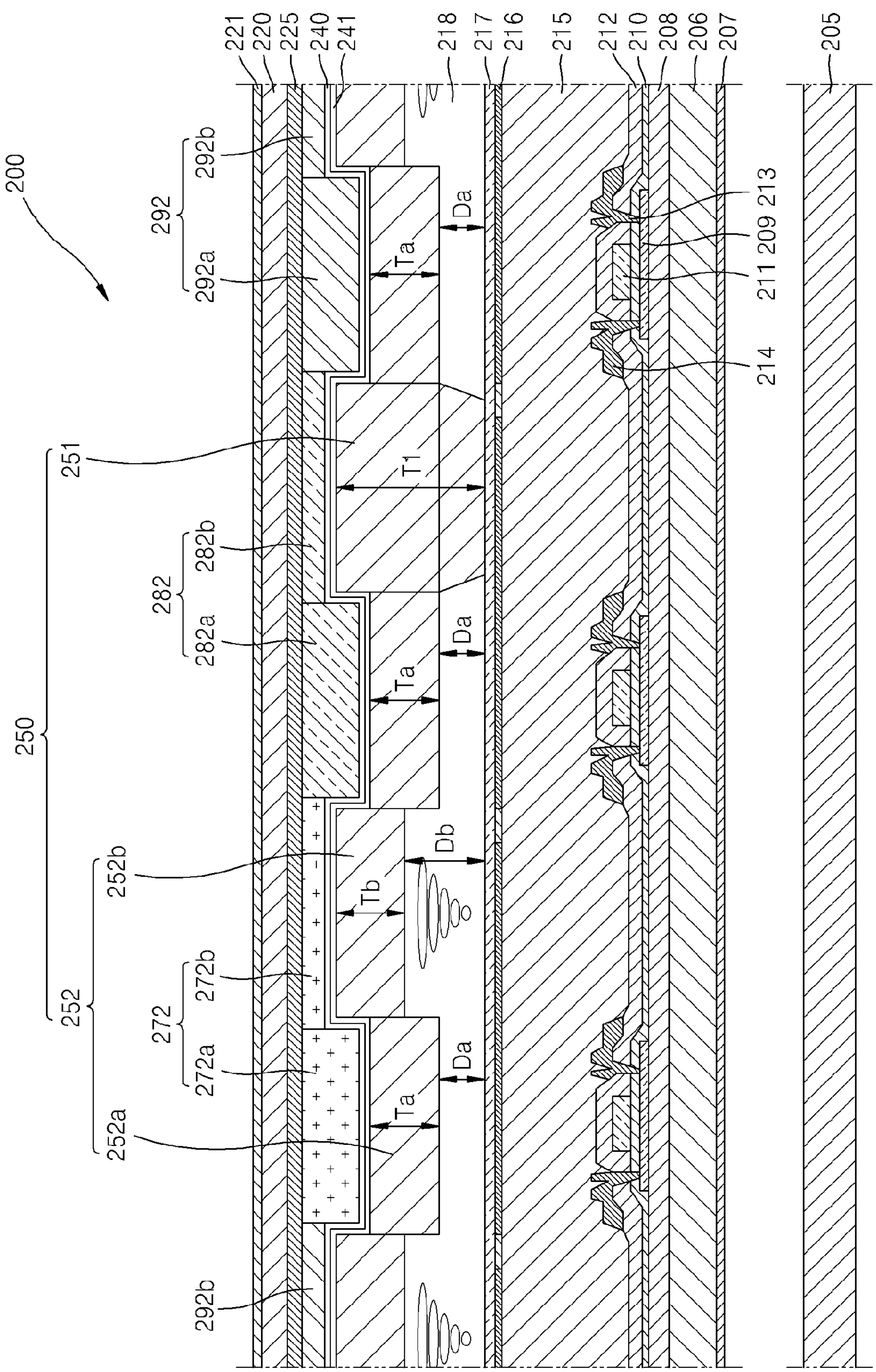
Ta
Tb
T1
113
109
111
114

FIG. 3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208
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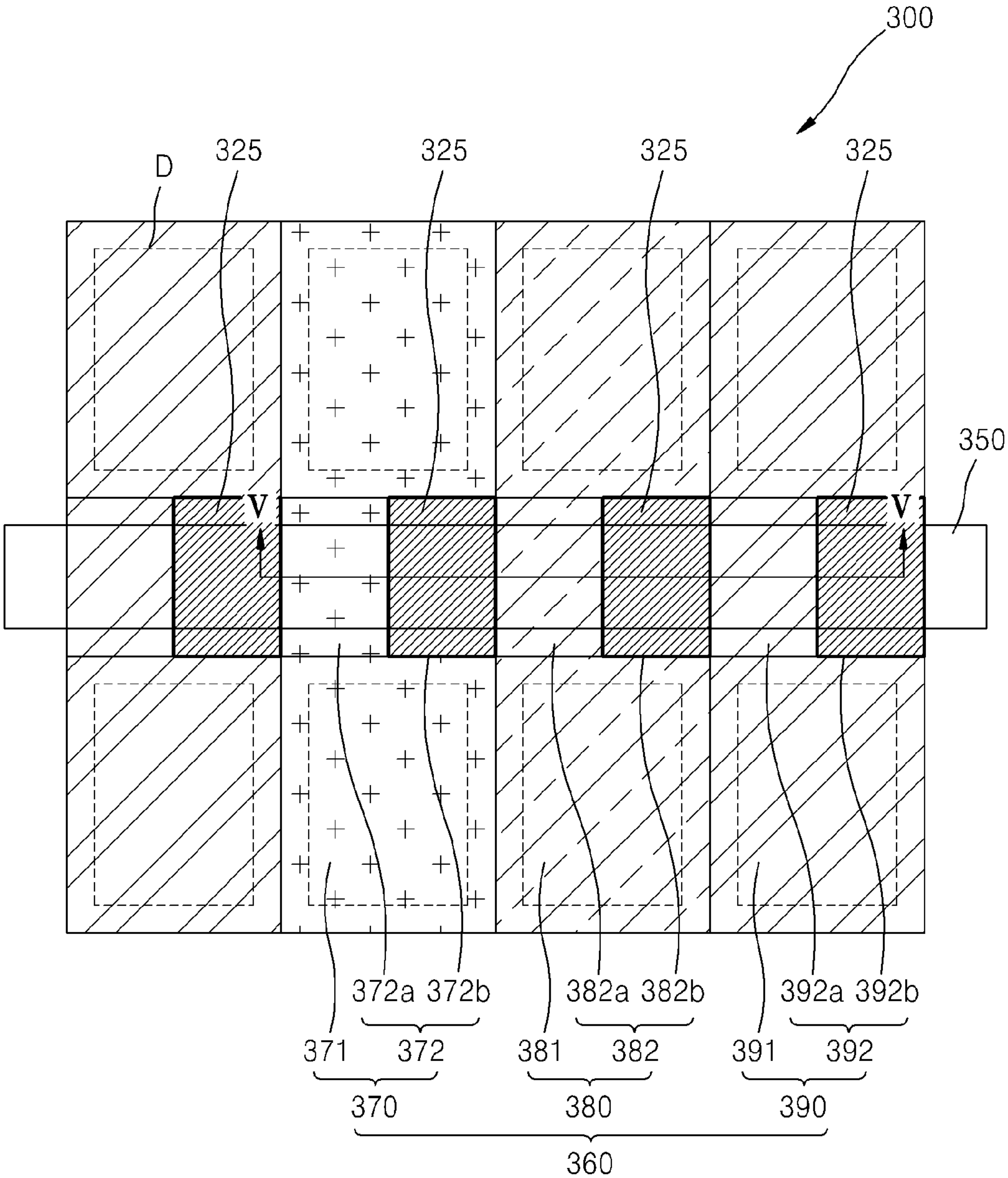
213
209
211
214
Da
Ta
251
T1
250
282
282a
282b
252
252a
252b
272
272a
272b
Db
Tb

FIG. 4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382b
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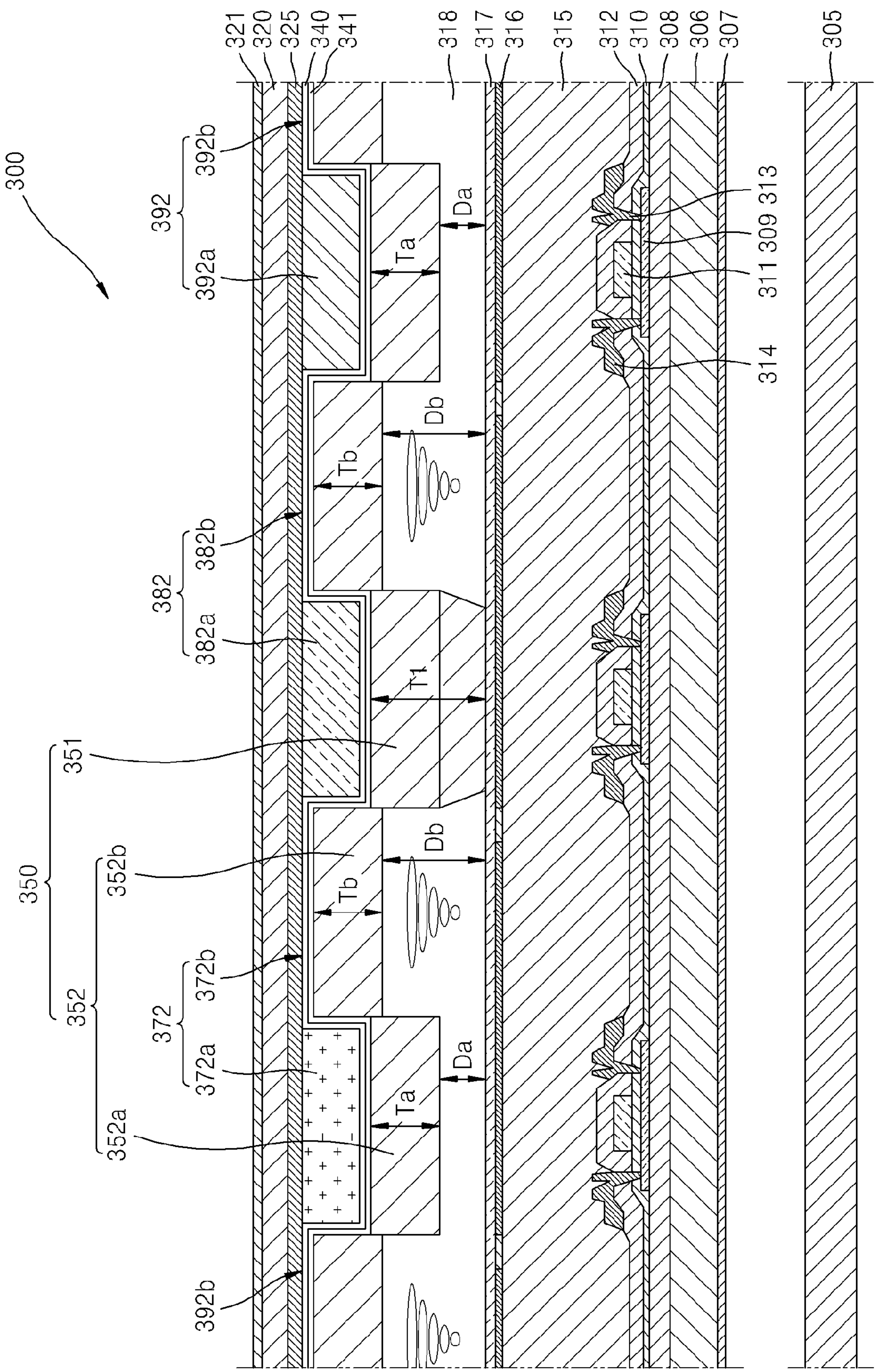
392a
392b
392
390
360

FIG. 5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392b
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382a
382b
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372a
372b
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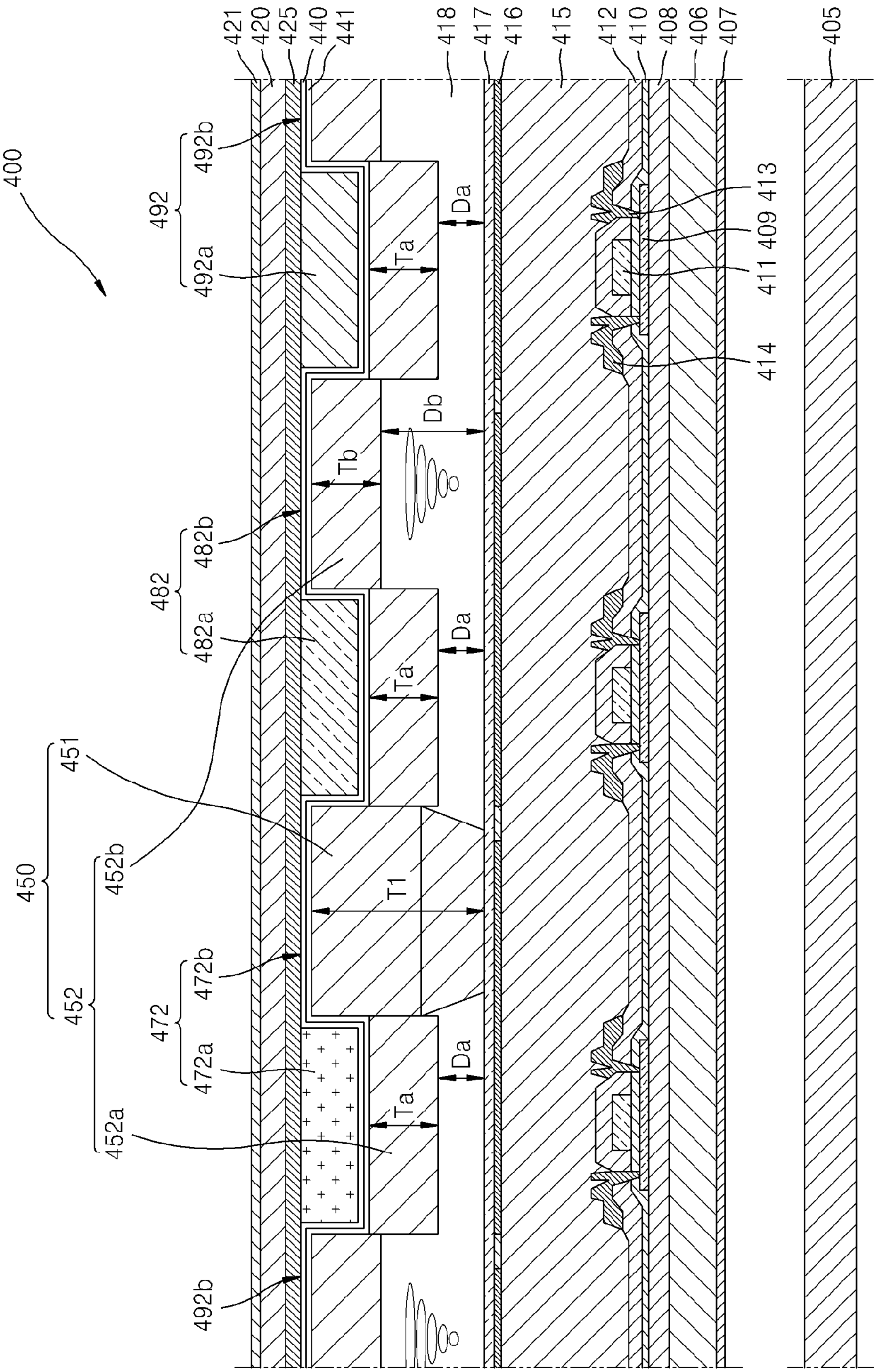
351
352
352a
352b
311 309 313
314
Ta
Tb
Da
Db
T1

FIG. 6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414
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Db
Tb
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482a
482b
451
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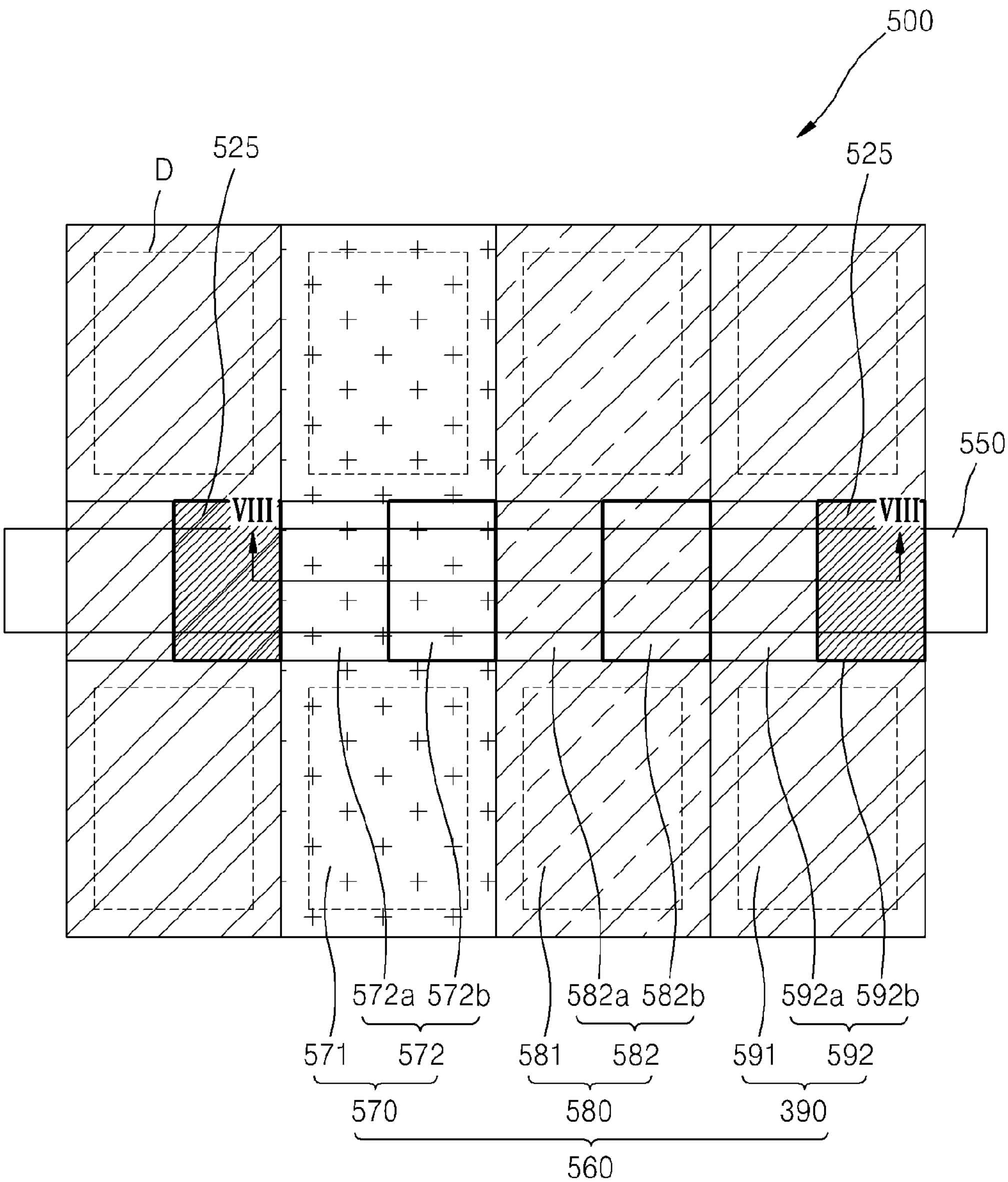
452
452a
452b
T1
472
472a
472b

FIG. 7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D
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VIII
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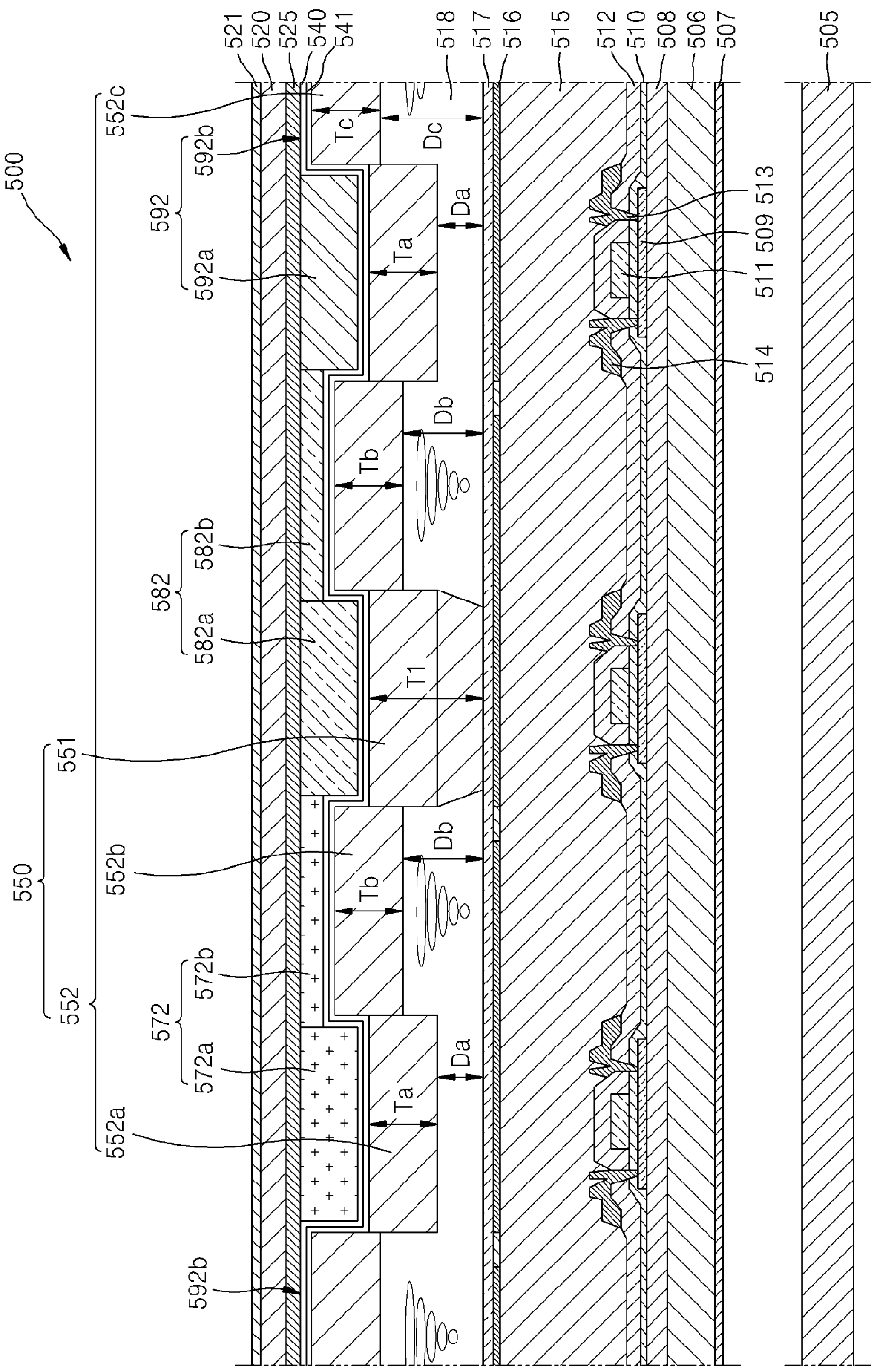
591
592
570
580
390
560

FIG. 8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592a
Tc
Dc
Da
Ta
513
509
511
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Db
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582b
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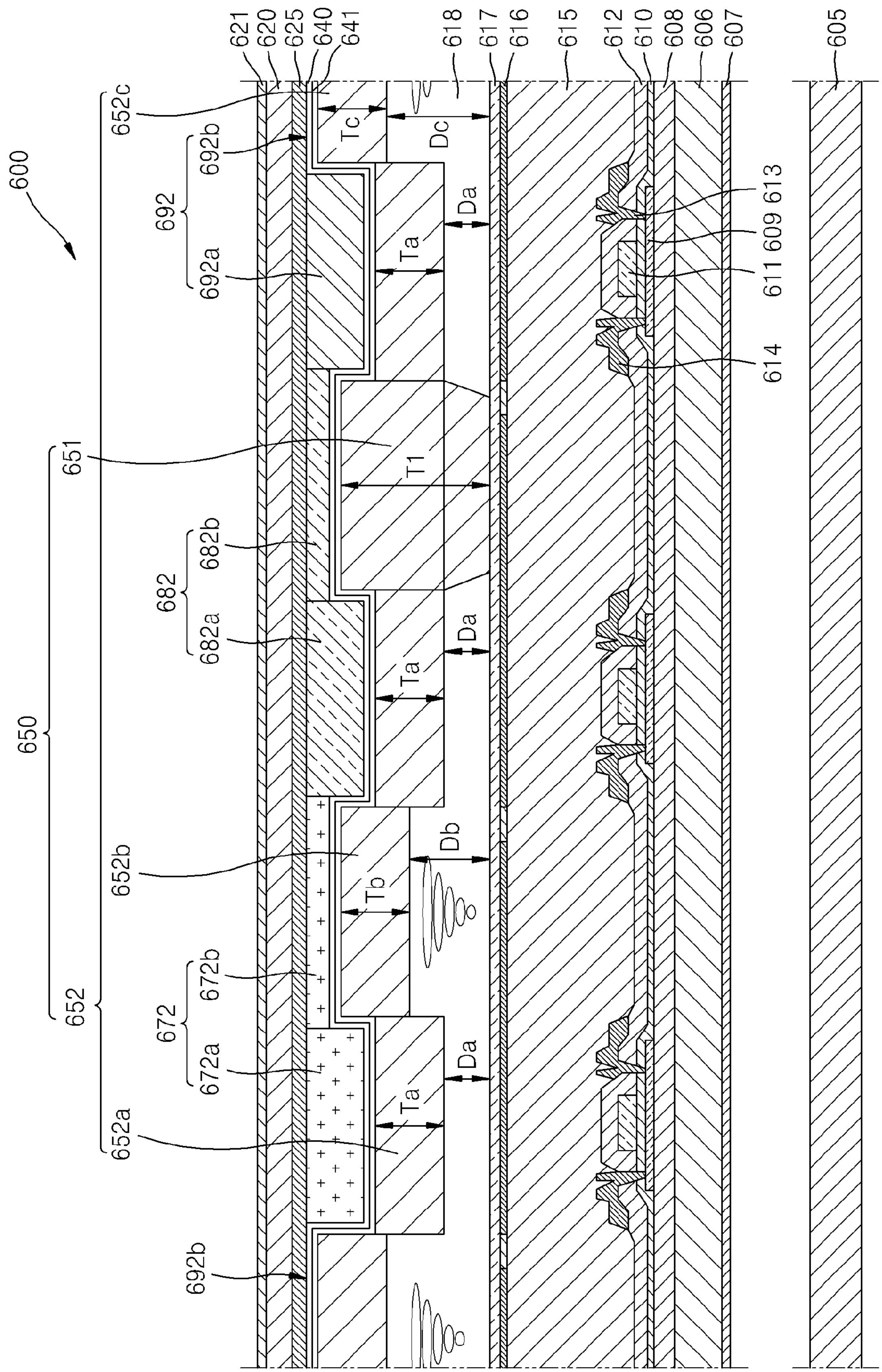
T1
551
550
552
552b
572
572b
572a
552a

FIG. 9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650
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692b
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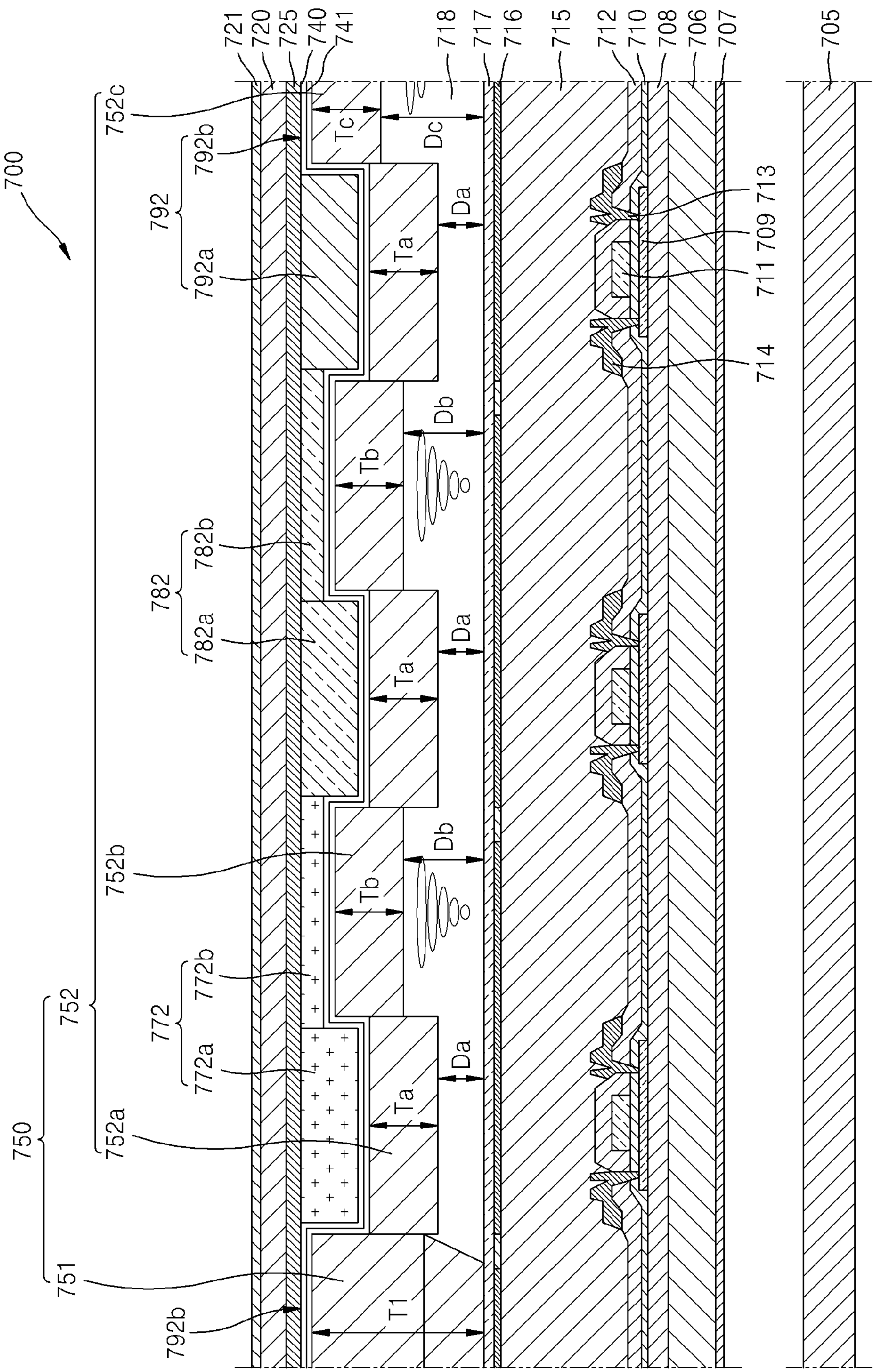
625
640
641
618
617
616
615
612
610
608
606
607
605
613
609
611
614
Tc
Dc
Ta
Da
T1
Tb
Db

FIG. 10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Tc
Dc
Da
Ta
713
709
711
714
Db
Tb
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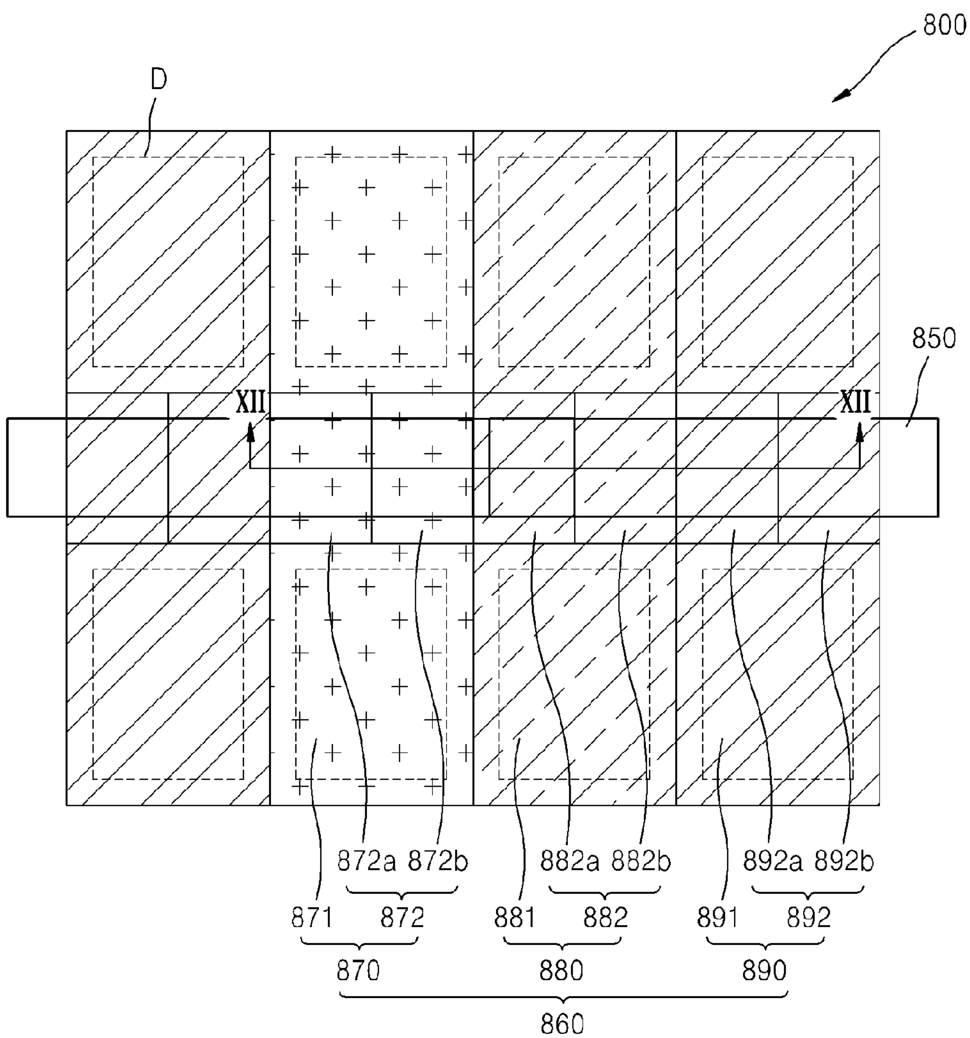
782
782a
752b
772b
772
772a
752
750
752a
751
T1

FIG. 11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XII
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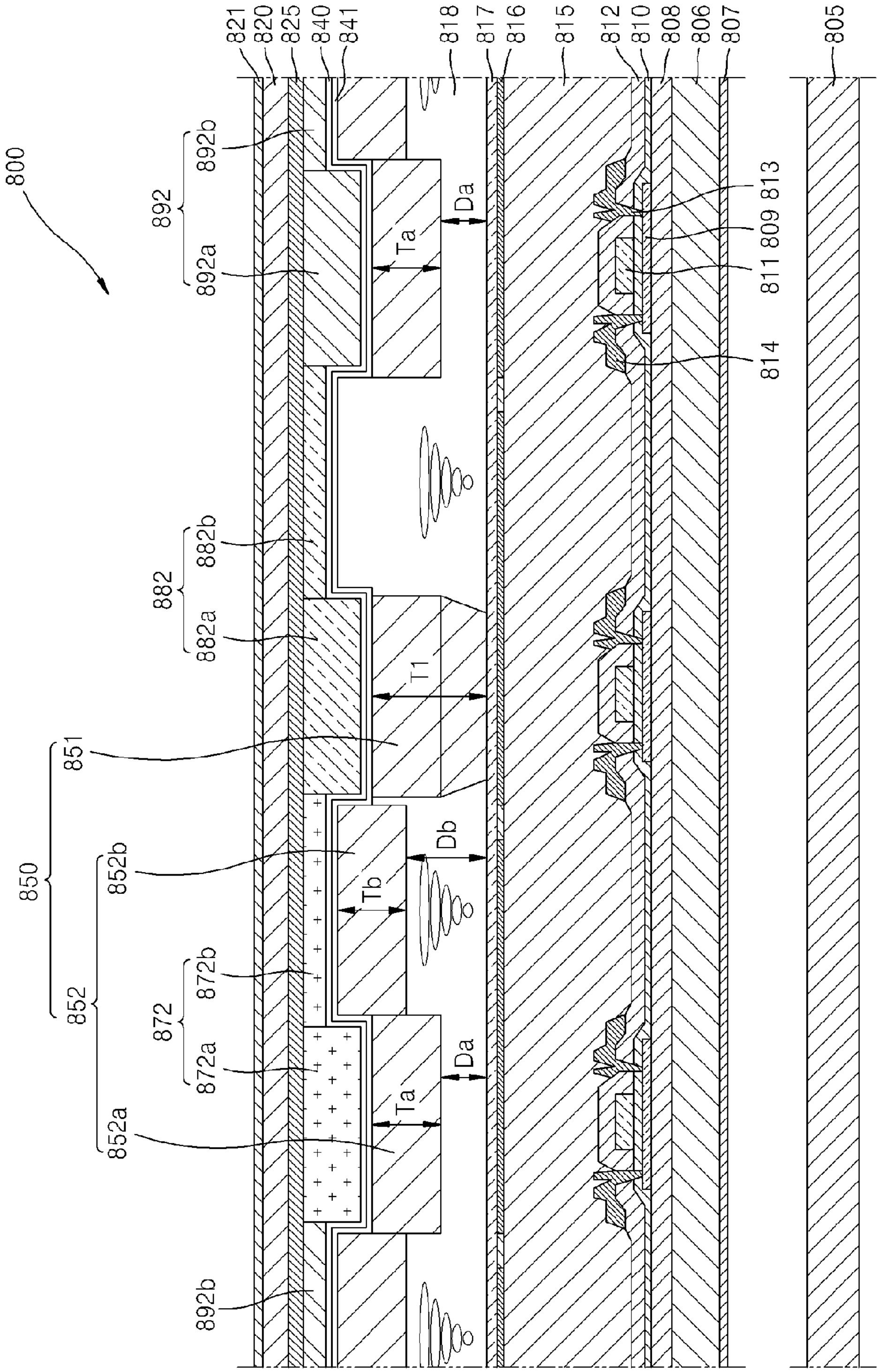
860

FIG. 12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882a
882b
872
872a
872b
850
851
852
852a
852b
811 809 813
814
Da
Db
Ta
Tb
T1

LIQUID CRYSTAL DISPLAY APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of Korean Patent Application No. 10-2010-0060131, filed on Jun. 24, 2010, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein in its entirety by reference.

BACKGROUND

1. Field

The present disclosure relates to a liquid crystal display apparatus, and more particularly, to a liquid crystal display apparatus having improved image quality.

2. Description of the Related Technology

Display apparatuses have been recently replaced with portable flat panel display apparatuses. Liquid crystal display apparatuses, among the portable flat panel display apparatuses, have recently been highlighted due to relatively low power consumption and relatively low generation of electromagnetic waves.

A liquid crystal display apparatus typically includes a liquid crystal layer disposed in a space between two substrates. The space is called a cell gap, and significantly affects driving of the liquid crystal layer and image quality of the liquid crystal display apparatus.

It is generally difficult to control mobility of a liquid crystal layer while maintaining such a cell gap, and thus improvement of image quality of liquid crystal display apparatuses is generally limited.

SUMMARY OF CERTAIN INVENTIVE ASPECTS

A liquid crystal display apparatus including: a plurality of sub-pixels, a first substrate on which at least one first thin film is disposed, a second substrate facing the first substrate and on which at least one second thin film is disposed, a liquid crystal layer disposed between the first substrate and the second substrate, and a spacer unit disposed between the first substrate and the second substrate to maintain a space where the liquid crystal layer is disposed, and continuously formed across at least two sub-pixels from among the plurality of sub-pixels, where the spacer unit includes a contact unit and an isolation unit including a plurality isolation sub-units, where the contact unit is formed to contact the first thin film closest to the liquid crystal layer and the second thin film closest to the liquid crystal layer, where the isolation unit is formed to be spaced apart from the first thin film closest to the liquid crystal layer and to contact the second thin film closest to the liquid crystal layer, and where a distance between the plurality of isolation sub-units and the first thin film closest to the liquid crystal layer is not uniform.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other features and advantages will become more apparent by describing in detail certain embodiments with reference to the attached drawings in which:

FIG. **1** is a plan view of an embodiment of a liquid crystal display apparatus;

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

FIG. **3** is s a cross-sectional view of another embodiment of a liquid crystal display apparatus;

FIG. **4** is a plan view of another embodiment of a liquid crystal display apparatus;

FIG. **5** is a cross-sectional view taken along line V-V of FIG. **4**;

FIG. **6** is a cross-sectional view of another embodiment of a liquid crystal display apparatus;

FIG. **7** is a plan view of another embodiment of a liquid crystal display apparatus;

FIG. **8** is a cross-sectional view taken along line VIII-VIII of FIG. **7**;

FIG. **9** is a cross-sectional view of another embodiment of a liquid crystal display apparatus;

FIG. **10** is a cross-sectional view of another embodiment of a liquid crystal display apparatus;

FIG. **11** is a plan view of another embodiment of a liquid crystal display apparatus; and

FIG. **12** is a cross-sectional view taken along line XII-XII of FIG. **11**.

DETAILED DESCRIPTION OF CERTAIN INVENTIVE EMBODIMENTS

Hereinafter, certain embodiments will be described more fully with reference to the accompanying drawings.

FIG. **1** is a plan view of an embodiment of a liquid crystal display apparatus **100**, and FIG. **2** is a cross-sectional view taken along line II-II of FIG. **1**.

Referring to FIGS. **1** and **2**, the liquid crystal display apparatus **100** includes a first substrate **106**, a second substrate **120**, a liquid crystal layer **118**, and a spacer unit **150**.

The first substrate **106** is disposed above a backlight **105**. The backlight **105** includes various types of optical sources and emits light toward the liquid crystal layer **118**. The first substrate **106** is formed of a transparent substrate. The first substrate **106** can include a transparent glass material, such as SiO2, or a transparent plastic material.

A first polarization layer **107** is formed on the surface of the first substrate **106** facing the backlight **105**. A buffer layer **108** is formed on the upper surface of the first substrate **106**, which is opposite to the surface facing the backlight **105**. The buffer layer **108** provides a smooth surface and prevents impurities from flowing into the first substrate **106**. The buffer layer **108** may be formed of SiO2 and/or SiNx.

A plurality of active layers **109**, each having a predetermined pattern, is formed on portions of the buffer layer **108**. A gate insulating layer **110** is formed on the active layers **109**, and a plurality of gate electrodes **111**, each having a predetermined pattern, is formed on the gate insulating layer **110**. An interlayer insulating layer **112** is formed on the gate electrodes **111** to cover the gate electrodes **111**. The gate insulating layer **110** and the interlayer insulating layer **112** are etched to expose predetermined areas of the active layers **109**. A plurality of source electrodes **113** and a plurality of drain electrodes **114** are respectively formed to be electrically connected to the exposed areas of the active layers **109**.

A passivation layer **115** is formed to cover the source electrodes **113** and the drain electrodes **114**. A first electrode **116** having a predetermined pattern is formed on the passivation layer **115**. Although not illustrated in FIG. **2**, the first electrode **116** is formed to be electrically connected to the source electrodes **113** or the drain electrodes **114**.

The second substrate **120** is disposed facing the first substrate **106**. Similar to the first substrate **106**, the second substrate **120** is formed of a transparent material. The liquid crystal layer **118** is disposed between the first substrate **106** and the second substrate **120**. A black matrix layer **125** having a predetermined pattern is formed on the lower surface of the second substrate **120**, and a color filter unit **160** is formed on the lower surface of the black matrix layer **125**.

A second electrode **140** is formed on the lower surface of the color filter unit **160**. A first alignment layer **117** and a second alignment layer **141**, which help orient the liquid crystal layer **118**, are respectively formed on surfaces of the first electrode **116** and the second electrode **140** facing each other.

A second polarization layer **121** is formed on the upper surface of the second substrate **120** facing the outside. A protection layer (not illustrated) may be formed on the second polarization layer **121** in order to prevent breakage due to a force applied from the outside.

The spacer unit **150** is formed in the space between the first substrate **106** and the second substrate **120** where the liquid crystal layer **118** is disposed. The spacer unit **150** includes a contact unit **151** and an isolation unit **152**.

The contact unit **151** contacts both the uppermost surface formed on the first substrate **106**, the first alignment layer **117**, and the lowermost surface formed on the second substrate **120**, the second alignment layer **141**. The isolation unit **152** is spaced apart from the first alignment layer **117** and contacts only the second alignment layer **141**.

Referring to FIG. **1**, in some embodiments, the color filter unit **160** includes a first color filter **170**, a second color filter **180**, and a third color filter **190**. The first color filter **170** has a first color, the second color filter **180** has a second color, and the third color filter **190** has a third color.

The liquid crystal display apparatus **100** includes a plurality of sub-pixels. The first color filter **170**, the second color filter **180**, and the third color filter **190** are formed to each correspond to a subset of sub-pixels among the plurality of sub-pixels. The first color filter **170** corresponds to the sub-pixels that realize the first color, the second color filter **180** corresponds to the sub-pixels that realize the second color, and the third color filter **190** corresponds to the sub-pixels that realize the third color.

The black matrix layer **125** is formed between the second substrate **120** and the color filter unit **160** in order to prevent colors from being mixed, and to improve contrast. Visible rays are not realized in the area covered by the black matrix layer **125**. In FIG. **1**, area D illustrated represents an area where visible rays are realized, where the black matrix layer **125** is not disposed.

The first color filter **170** includes a plurality of first area units **171**, and a first connecting unit **172**. The first connecting unit **172** is formed to connect two adjacent first area units **171** among the plurality of first area units **171** to each other, and includes a connecting unit **172*a*** and a connecting unit **172*b***. The connecting unit **172*b*** has a smaller thickness than that of the connecting unit **172*a***.

The second color filter **180** includes a plurality of second area units **181**, and a second connecting unit **182**. The second connecting unit **182** is formed to connect two adjacent second area units **181** among the plurality of second area units **181** to each other, and includes a connecting unit **182*a*** and a connecting unit **182*b***. The connecting unit **182*b*** has a smaller thickness than that of the connecting unit **182*a***.

The third color filter **190** includes a plurality of third area units **191**, and a third connecting unit **192**. The third connecting unit **192** is formed to connect two adjacent third area units **191** among the plurality of third area units **191** to each other, and includes a connecting unit **192*a*** and a connecting unit **192*b***. The connecting unit **192*b*** has a smaller thickness than that of the connecting unit **192*a***.

In the embodiment of FIG. **1**, the first area unit **171**, the second area unit **181**, and the third area unit **191** are arranged to each correspond to the area D.

Referring again to FIG. **2**, the contact unit **151** of the spacer unit **150** is formed to correspond to the connecting unit **182*a*** of the second color filter **180**.

The isolation unit **152** of the spacer unit **150** includes a plurality of isolation sub-units. More specifically, the plurality of isolation sub-units includes first isolation sub-units **152*a*** and second isolation sub-units **152*b***.

The first isolation sub-units **152*a*** are formed to correspond to the connecting unit **172*a*** of the first color filter **170** and the connecting unit **192*a*** of the third color filter **190**, respectively. The second isolation sub-units **152*b*** are formed to correspond to the connecting unit **172*b***, the connecting unit **182*b***, and the connecting unit **192*b***, respectively.

The contact unit **151** of the spacer unit **150** has a thickness T1, and contacts the first alignment layer **117** and the second alignment layer **141**. The first isolation sub-units **152*a*** each have a thickness Ta, contact the second alignment layer **141**, and are spaced apart from the first alignment layer **117** by a predetermined distance Da. The second isolation sub-units **152*b*** each have a thickness Tb, contact the second alignment layer **141**, and are spaced apart from the first alignment layer **117** by a predetermined distance Db.

In some embodiments, the distance Da is less than the distance Db. In such embodiments, the first isolation sub-units **152*a*** are disposed closer to the first alignment layer **117** than the second isolation sub-units **152*b***.

In some embodiments, the thickness Ta of each of the first isolation sub-units **152*a*** may be different from the thickness Tb of each of the second isolation sub-units **152*b***. In other embodiments, Ta and Tb may be the same for convenience of a manufacturing process. To pattern the spacer unit **150**, an exposing process may be performed once by using a half-tone mask. In embodiments where the thicknesses of the first isolation sub-units **152*a*** and the second isolation sub-units **152*b*** are the same, the same amount of light may penetrate half-tone mask areas for forming patterns of the first isolation sub-units **152*a*** and the second isolation sub-units **152*b***.

As illustrated in the embodiment of FIG. **1**, the spacer unit **150** is formed to extend across the plurality of sub-pixels. Accordingly, the space between the first substrate **106** and the second substrate **120** in which the liquid crystal layer **118** is disposed, the cell gap, can be easily maintained. The spacer unit **150** includes the contact unit **151** formed to contact the first alignment layer **117** and the second alignment layer **141** to constantly maintain the cell gap.

The spacer unit **150** includes the first isolation sub-units **152*a*** and the second isolation sub-units **152*b*** that are each spaced apart from the first alignment layer **117** by a predetermined distance, and thus the spacer unit **150** facilitates movement of the liquid crystal layer **118**.

The liquid crystal display apparatus **100** may be pressurized while in use. Pressure may be applied in the direction of the first substrate **106** or of the second substrate **120**. In those circumstances, the cell gap may be reduced so that movement of the liquid crystal layer **118** may be affected and image quality of the liquid crystal display apparatus may deteriorate.

In some embodiments, the first isolation sub-units **152*a*** and the second isolation sub-units **152*b*** sequentially contact the first alignment layer **117** according to the amount of pressure applied to the liquid crystal display apparatus **100**. When relatively less pressure is applied, the first isolation sub-units **152*a*** contact the first alignment layer **117**, and when relatively greater pressure is applied, the second isolation sub-units **152*b*** contact the first alignment layer **117**.

Accordingly, the first isolation sub-units **152***a* and the second isolation sub-units **152***b* may easily maintain the cell gap, along with the contact unit **151**.

The cell gap in which the liquid crystal layer **118** is disposed can thus be easily maintained without reduction in the mobility of the liquid crystal layer **118**. Consequently, image quality of the liquid crystal display apparatus **100** can be prevented from deteriorating and thus better image quality can be secured.

The first color filter **170** of the color filter unit **160** includes the first connecting unit **172**, wherein the first connecting unit **172** includes the connecting unit **172***a* and the connecting unit **172***b* having different thicknesses. The second color filter **180** and the third color filter **190** also each include connecting units having different thicknesses. Accordingly, although the first isolation sub-units **152***a* and the second isolation sub-units **152***b* are patterned to have the same thickness, the first isolation sub-units **152***a* and the second isolation sub-units **152***b* can be formed to have different distances, Da and Db, to the first alignment layer **117**.

The color filter unit **160** is patterned to form the first color filter **170**, the second color filter **180**, and the third color filter **190** by using, for example, photolithography. Using photolithography, a material used to form any one of the first color filter **170**, the second color filter **180**, and the third color filter **190** is firstly formed as a thin film by using spin coating. Then, the thin film is patterned to form one color filter, for example, the first color filter **170**. Next, a material used to form the second color filter **180** is formed as a thin film by using spin coating. With the first color filter **170** already formed, the material used to form the second color filter **180** may not be uniformly disposed on the entire substrate. In some embodiments, the first color filter **170** includes the connecting unit **172***b* and the thickness of the connecting unit **172***b* is relatively small so that it may function as an effective path through which the material used to form the second color filter **180** passes. Thus, the material used to form the second color filter **180** may be uniformly diffused on the substrate. The second color filter **180** is thus easily patterned. Similarly, when the third color filter **190** is formed, it is easy to precisely pattern the third color filter **190** due to the connecting unit **172***b* of the first color filter **170** and the connecting unit **182***b* of the second color filter **180**.

The embodiment of FIG. **2** illustrates a TFT-LCD. However, the liquid crystal display apparatus **100** to such embodiments. A potential difference between the first electrode **116** and the second electrode **140** is formed by an external signal controlled by the gate electrodes **111**, the source electrodes **113**, and the drain electrodes **114**. An arrangement of the liquid crystal layer **118** is determined by the potential difference, and visible rays from the backlight **105** are blocked or passed according to the arrangement of the liquid crystal layer **118**. The passed light passes the color filter unit **160** and a color appears, thereby forming an image.

FIG. **3** is a cross-sectional view of another embodiment of a liquid crystal display apparatus **200**. Referring to FIG. **3**, the liquid crystal display apparatus **200** includes a first substrate **206**, a second substrate **220**, a liquid crystal layer **218**, and a spacer unit **250**. Descriptions of elements which are common to the different embodiments and which have already been described in relation to FIG. **2** will not be repeated. Like reference numerals generally denote like elements.

In this embodiment, the contact unit **251** of the spacer unit **250** is formed to correspond to the connecting unit **282***b* of the second color filter.

The first isolation sub-units **252***a* are formed to correspond to the connecting unit **272***a* of the first color filter **270**, the connecting unit **282***a* of the second color filter **280**, and the connecting unit **292***a* of the third color filter **290**, respectively. The second isolation sub-units **252***b* are formed to correspond to the connecting unit **272***b* of the first color filter **270** and the connecting unit **292***b* of the third color filter **290**, respectively.

In the embodiment of FIG. **3**, the spacer unit **250** is formed to extend across the plurality of sub-pixels and includes the contact unit **251** so as to stably maintain a cell gap. Also, the spacer unit **250** includes the first isolation sub-units **252***a* and the second isolation sub-units **252***b* and thus facilitates movement of the liquid crystal layer **218**.

Although pressure is applied to the liquid crystal display apparatus **200** while being used, the cell gap may be easily maintained while not reducing the mobility of the liquid crystal layer **218**. Consequently, image quality of the liquid crystal display apparatus **200** may be prevented from deteriorating and thus excellent image quality may be secured.

In particular, the first isolation sub-units **252***a* are disposed to be close to the contact unit **251**. The first isolation sub-units **252***a* are disposed to be closer to the first alignment layer **217** than the second isolation sub-units **252***b*. That is, a step difference between the contact unit **251** and the first isolation sub-unit **252***a* is smaller than a step difference between the contact unit **251** and the second isolation sub-unit **252***b*. The step difference between the contact unit **251** and the first isolation sub-unit **252***a* is a difference in height of a bottom surface of the contact unit **251** and a bottom surface of the first isolation sub-unit **252***a*. The step difference between the contact unit **251** and the second isolation sub-unit **252***b* is a difference in height of a bottom surface of the contact unit **251** and a bottom surface of the second isolation sub-unit **252***b*.

With the first isolation sub-units **252***a* close to the contact unit **251**, when pressure is applied to the liquid crystal display apparatus **200**, a load provided to the contact unit **251** may be more easily shared with the first isolation sub-units **252***a*, relative to when the first isolation sub-units **252***a* are far from the contact unit **251**. Excessive pressure is prevented from being applied to the contact unit **251** so that the contact unit **251** and the spacer unit **250** including the contact unit **251** may be prevented from being damaged. Consequently, the ability to maintain a cell gap may be improved and durability of the spacer unit **250** may be improved.

FIG. **4** is a plan view of another embodiment of a liquid crystal display apparatus **300**, and FIG. **5** is a cross-sectional view taken along line V-V of FIG. **4**.

Referring to FIGS. **4** and **5**, the liquid crystal display apparatus **300** includes a first substrate **306**, second substrate **320**, a liquid crystal layer **318**, and a spacer unit **350**. Descriptions of elements which are common to the different embodiments and which have already been described in relation to FIGS. **1** and **2** will not be repeated. Like reference numerals generally denote like elements.

In the embodiment of FIGS. **4** and **5**, the first color filter **370** includes a plurality of first area units **371** and a first connecting unit **372**. The first connecting unit **372** is formed to connect two adjacent first area units **371** among the plurality of first area units **371** to each other and includes a connecting unit **372***a* and a penetration unit **372***b*. The penetration unit **372***b* is disposed to be close to the connecting unit **372***a* and to expose the black matrix layer **325**.

The second color filter **380** includes a plurality of second area units **381** and a second connecting unit **382**. The second connecting unit **382** is formed to connect two adjacent second area units **381** among the plurality of second area units **381** to each other and includes a connecting unit **382***a* and a penetration unit **382***b*. The penetration unit **382***b* is disposed to be close to the connecting unit **382***a* and to expose the black matrix layer **325**.

The third color filter **390** includes a plurality of third area units **391** and a third connecting unit **392**. The third connecting unit **392** is formed to connect two adjacent third area units **391** among the plurality of third area units **391** to each other and includes a connecting unit **392***a* and a penetration unit **392***b*. The penetration unit **392***b* is disposed to be close to the connecting unit **392***a* and to expose the black matrix layer **325**.

The contact unit **351** of the spacer unit **350** is formed to correspond to the connecting unit **382***a* of the second color filter **380**.

The isolation unit **352** of the spacer unit **350** includes a plurality of isolation sub-units. More specifically, the plurality of isolation sub-units include first isolation sub-units **352***a* and second isolation sub-units **352***b*.

The first isolation sub-units **352***a* are formed to correspond to the connecting unit **372***a* of the first color filter **370** and the connecting unit **392***a* of the third color filter **390**, respectively. The second isolation sub-units **352***b* are formed to correspond to the penetration unit **372***b* of the first color filter **370**, the penetration unit **382***b* of the second color filter **380**, and the penetration unit **392***b* of the third color filter **390**, respectively.

The spacer unit **350** is formed to extend across the plurality of sub-pixels and includes the contact unit **351** so as to stably maintain a cell gap. Also, the spacer unit **350** includes the first isolation sub-units **352***a* and the second isolation sub-units **352***b* and thus facilitates movement of the liquid crystal layer **318**. The second isolation sub-units **352***b* are formed to correspond to the penetration unit **372***b* of the first color filter **370**, the penetration unit **382***b* of the second color filter **380**, and the penetration unit **392***b* of the third color filter **390**, respectively, and the distance Db between the second isolation sub-units **352***b* and the first alignment layer **317** is sufficiently increased and thus mobility of the liquid crystal layer **318** is improved.

Even if pressure is applied to the liquid crystal display apparatus **300** during use, the cell gap may be easily maintained without reducing the mobility of the liquid crystal layer **318**. Consequently, image quality of the liquid crystal display apparatus **300** may be prevented from deteriorating and thus excellent image quality may be secured.

A difference between the distance Da and the distance Db can be sufficiently increased. A part of a load provided to the contact unit **351** while pressure is applied to the liquid crystal display apparatus **300** can be sequentially shared with the first isolation sub-units **352***a* and the second isolation sub-units **352***b* by controlling the difference in time when the first isolation sub-units **352***a* and the second isolation sub-units **352***b* contact the first alignment layer **317**, respectively.

FIG. **6** is a cross-sectional view of another embodiment of a liquid crystal display apparatus **400**.

Referring to FIG. **6**, the liquid crystal display apparatus **400** includes a first substrate **406**, a second substrate **420**, a liquid crystal layer **418**, and a spacer unit **450**. Descriptions of elements which are common to the different embodiments and which have already been described will not be repeated. Like reference numerals generally denote like elements.

In the embodiment of FIG. **6**, the color filter unit includes a first color filter, a second color filter, and a third color filter, as illustrated in and described in relation to FIGS. **4** and **5**.

In the embodiment of FIG. **6**, the contact unit **451** of the spacer unit **450** is formed to correspond to the penetration unit **472***b* of the first color filter **470**.

The isolation unit **452** of the spacer unit **450** includes a plurality of isolation sub-units. More specifically, the plurality of isolation sub-units include first isolation sub-units **452***a* and second isolation sub-units **452***b*.

The first isolation sub-units **452***a* are formed to correspond to the connecting unit **472***a* of the first color filter **470**, the connecting unit **482***a* of the second color filter **480**, and the connecting unit **492***a* of the third color filter **490**, respectively. The second isolation sub-units **452***b* are formed to correspond to the penetration unit **482***b* of the second color filter **480** and the penetration unit **492***b* of the third color filter **490**, respectively.

The spacer unit **450** in the embodiment of FIG. **6** is formed to extend across the plurality of sub-pixels and includes the contact unit **451** so as to stably maintain a cell gap. Also, the spacer unit **450** includes the first isolation sub-units **452***a* and the second isolation sub-units **452***b* and thus facilitates movement of the liquid crystal layer **418**. In particular, the second isolation sub-units **452***b* are formed to correspond to the penetration unit **482***b* of the second color filter **480** and the penetration unit **492***b* of the third color filter **490**, respectively, and the distance Db between the second isolation sub-units **452***b* and the first alignment layer **417** is increased and thus mobility of the liquid crystal layer **418** is improved.

FIG. **7** is a plan view of another embodiment of a liquid crystal display apparatus **500**, and FIG. **8** is a cross-sectional view of the liquid crystal display apparatus **500** of FIG. **7** taken along line VIII-VIII of FIG. **7**.

Referring to FIGS. **7** and **8**, the liquid crystal display apparatus **500** includes a first substrate **506**, a second substrate **520**, a liquid crystal layer **518** and a spacer unit **550**. Descriptions of elements which are common to the different embodiments and which have already been described will not be repeated. Like reference numerals generally denote like elements.

The color filter unit **560** of the embodiment of FIG. **8** includes a first color filter **570**, a second color filter **580**, and a third color filter **590**. The first color filter **570** includes a plurality of first area units **571**, and a first connecting unit **572**. The first connecting unit **572** is formed to connect two adjacent first area units **571** among the plurality of first area units **571** to each other, and includes a connecting unit **572***a* and a penetration unit **572***b*. The connecting unit **572***b* is disposed to be close to the connecting unit **572***a* and has a smaller thickness than that of the connecting unit **572***a*.

The second color filter **580** includes a plurality of second area units **581**, and a second connecting unit **582**. The second connecting unit **582** is formed to connect two adjacent second area units **581** among the plurality of second area units **581** to each other, and includes a connecting unit **582***a* and a connecting unit **582***b*. The connecting unit **582***b* is disposed to be close to the connecting unit **582***a* and has a smaller thickness than that of the connecting unit **582***a*.

The third color filter **590** includes a plurality of third area units **591**, and a third connecting unit **592**. The third connecting unit **592** is formed to connect two adjacent third area units **591** among the plurality of third area units **591** to each other, and includes a connecting unit **592***a* and a penetration unit **592***b*. The penetration unit **592***b* is disposed to be close to the connecting unit **592***a* and to expose the black matrix layer **525**.

The contact unit **551** of the spacer unit **550** is formed to correspond to the connecting unit **582***a* of the second color filter **580**.

The isolation unit **552** of the spacer unit **550** includes a plurality of isolation sub-units. More specifically, the plurality of isolation sub-units include first isolation sub-units **552***a*, second isolation sub-units **552***b*, and third isolation sub-units **552***c*.

The first isolation sub-units **552***a* are formed to correspond to the connecting unit **572***a* of the first color filter **570** and the connecting unit **592***a* of the third color filter **590**, respectively. The second isolation sub-units **552***b* are formed to correspond to the connecting unit **572***b* of the first color filter and the connecting unit **582***b* of the second color filter **580**, respectively. The third isolation sub-units **552***c* are formed to correspond to the penetration unit **592***b* of the third color filter **590**.

The contact unit **551** of the spacer unit **550** has a thickness T**1**, and contacts the first alignment layer **517** and the second alignment layer **541**. The first isolation sub-units **552***a* each have a thickness Ta, contact the second alignment layer **541**, and are spaced apart from the first alignment layer **517** by a predetermined distance Da. The second isolation sub-units **552***b* each have a thickness Tb, contact the second alignment layer **541**, and are spaced apart from the first alignment layer **517** by a predetermined distance Db. The third isolation sub-units **552***c* each have a thickness Tc, contact the second alignment layer **541**, and are spaced apart from the first alignment layer **517** by a predetermined distance Dc.

The distance Da is less than the distance Db, and the distance Dc is greater than the distance Db. The first isolation sub-units **552***a* are disposed to be closer to the first alignment layer **517**, compared with the second isolation sub-units **552***b*, and the second isolation sub-units **552***b* are disposed to be closer to the first alignment layer **517**, compared with third isolation sub-units **552***c*.

The thickness Ta of each of the first isolation sub-units **552***a*, the thickness Tb of each of the second isolation sub-units **552***b*, and the thickness Tc of each of the third isolation sub-units **552***c* may be different from each other. In some embodiments, the three thicknesses may be the same for convenience of a manufacturing process.

The spacer unit **550** is formed to extend across the plurality of sub-pixels and includes the contact unit **551** so as to stably maintain a cell gap.

Also, the spacer unit **550** includes the first isolation sub-units **552***a*, the second isolation sub-units **552***b*, and the third isolation sub-units **552***c* and thus facilitates movement of the liquid crystal layer **518**. The third isolation sub-units **552***c* are formed to correspond to the penetration unit **592***b* of the third color filter so that the distance Dc between the third isolation sub-units **552***c* and the first alignment layer **517** is increased and thus mobility of the liquid crystal layer **518** is improved.

Although pressure is applied to the liquid crystal display apparatus **500** while being used, the cell gap may be easily maintained while not reducing the mobility of the liquid crystal layer **518**. Consequently, image quality of the liquid crystal display apparatus **500** may be prevented from deteriorating and thus excellent image quality may be secured.

In particular, when pressure is applied to the liquid crystal display apparatus **500**, a part of a load provided to the contact unit **551** may be sequentially shared with the first isolation sub-units **552***a*, the second isolation sub-units **552***b*, and the third isolation sub-units **552***c* and thus a cell gap may be efficiently maintained according to a pressure condition.

FIG. **9** is a cross-sectional view of another embodiment of a liquid crystal display apparatus **600**.

Referring to FIG. **9**, the liquid crystal display apparatus **600** includes a first substrate **606**, a second substrate **620**, a liquid crystal layer **618**, and a spacer unit **650**. Descriptions of elements which are common to the different embodiments and which have already been described will not be repeated. Like reference numerals generally denote like elements.

The color filter unit according to the embodiment of FIG. **9** includes a first color filter, a second color filter, and a third color filter. The first color filter includes first area units (not illustrated) and a first connecting unit **672**. The first connecting unit **672** is formed to connect two adjacent first area units (not illustrated) to each other and includes a connecting unit **672***a* and a connecting unit **672***b*. The connecting unit **672***b* is disposed to be close to the connecting unit **672***a* and is formed to have a smaller thickness than that of the connecting unit **672***a*.

The second color filter includes second area units (not illustrated) and a second connecting unit **682**. The second connecting unit **682** is formed to connect two adjacent second area units (not illustrated) to each other and includes a connecting unit **682***a* and a connecting unit **682***b*. The connecting unit **682***b* is disposed to be close to the connecting unit **682***a* and is formed to have a smaller thickness than that of the connecting unit **682***a*.

The third color filter includes third area units (not illustrated) and a third connecting unit **692**. The third connecting unit **692** is formed to connect two adjacent third area units (not illustrated) to each other and includes a connecting unit **692***a* and a penetration unit **692***b*. The penetration unit **692***b* is disposed to be close to the connecting unit **692***a* and to expose the black matrix layer **625**.

The contact unit **651** of the spacer unit **650** is formed to correspond to the connecting unit **682***b*.

The isolation unit **652** of the spacer unit **650** includes a plurality of isolation sub-units. More specifically, the plurality of isolation sub-units include first isolation sub-units **652***a*, second isolation sub-units **652***b*, and third isolation sub-units **652***c*.

The first isolation sub-units **652***a* are formed to correspond to the connecting unit **672***a*, the connecting unit **682***a*, and the connecting unit **692***a*, respectively. The second isolation sub-units **652***b* are formed to correspond to the connecting unit **672***b*. The third isolation sub-units **652***c* are formed to correspond to the penetration unit **692***b*.

The contact unit **651** of the spacer unit **650** has a thickness T**1**, and contacts the first alignment layer **617** and the second alignment layer **641**. The first isolation sub-units **652***a* each have a thickness Ta, contact the second alignment layer **641**, and are spaced apart from the first alignment layer **617** by a predetermined distance Da. The second isolation sub-units **652***b* each have a thickness Tb, contact the second alignment layer **641**, and are spaced apart from the first alignment layer **617** by a predetermined distance Db. The third isolation sub-units **652***c* have a thickness Tc, contact the second alignment layer **641**, and are spaced apart from the first alignment layer **617** by a predetermined distance Dc.

The distance Da is less than the distance Db, and the distance Dc is greater than the distance Db. That is, the first isolation sub-units **652***a* are disposed to be closer to the first alignment layer **617**, compared with the second isolation sub-units **652***b*, and the second isolation sub-units **652***b* are disposed to be closer to the first alignment layer **617**, compared with third isolation sub-units **652***c*.

The thickness Ta of each of the first isolation sub-units **652***a*, the thickness Tb of each of the second isolation sub-units **652***b*, and the thickness Tc of each of the third isolation sub-units **652***c* may be different from each other; however, in some embodiments, may be the same for convenience of a manufacturing process.

The spacer unit **650** is formed to extend across the plurality of sub-pixels and includes the contact unit **651** so as to stably maintain a cell gap. Also, the spacer unit **650** includes the first isolation sub-units **652***a*, the second isolation sub-units **652***b*, and the third isolation sub-units **652***c* and thus facilitates movement of the liquid crystal layer **618**. The third isolation sub-units **652***c* are formed to correspond to the penetration unit **692***b* so that the distance Dc between the third isolation sub-units **652***c* and the first alignment layer **617** is increased and thus mobility of the liquid crystal layer **618** is improved.

Although pressure is applied to the liquid crystal display apparatus **600** while being used, the cell gap may be easily maintained while not reducing the mobility of the liquid crystal layer **618**. Consequently, image quality of the liquid crystal display apparatus **600** may be prevented from deteriorating and thus excellent image quality may be secured.

When pressure is applied to the liquid crystal display apparatus **600**, a part of a load provided to the contact unit **651** may be sequentially shared with the first isolation sub-units **652***a*, the second isolation sub-units **652***b*, and the third isolation sub-units **652***c* and thus a cell gap may be efficiently maintained according to a pressure condition.

In addition, the first isolation sub-units **652***a* are disposed to be close to the contact unit **651**. The first isolation sub-units **652***a* are disposed to be closer to the first alignment layer **617**, compared with the second isolation sub-units **652***b* and the third isolation sub-units **652***c*. That is, a step difference between the contact unit **651** and the first isolation sub-unit **652***a* is smaller than a step difference between the contact unit **651** and the second isolation sub-unit **652***b* and a step difference between the contact unit **651** and the third isolation sub-units **652***c*. As the first isolation sub-units **652***a* having the smallest step difference with the contact unit **651** are disposed to be close to the contact unit **651**, a load provided to the contact unit **651** may be easily shared with the first isolation sub-units **652***a* that are close to the contact unit **651** when pressure is applied to the liquid crystal display apparatus **600**. Thus, the ability to maintain a cell gap may be improved and durability of the spacer unit **650** may be improved.

FIG. **10** is a cross-sectional view of another embodiment of a liquid crystal display apparatus **700**.

Referring to FIG. **10**, the liquid crystal display apparatus **700** includes a first substrate **706**, a second substrate **720**, a liquid crystal layer **718**, and a spacer unit **750**. Descriptions of elements which are common to the different embodiments and which have already been described will not be repeated. Like reference numerals generally denote like elements.

The color filter unit according to the embodiment of FIG. **10** includes a first color filter, a second color filter, and a third color filter. The first color filter includes first area units (not illustrated) and a connecting unit **772**. The first connecting unit **772** is formed to connect two adjacent first area units (not illustrated) to each other and includes a connecting unit **772***a* and a connection unit **772***b*. The connecting unit **772***b* is disposed to be close to the connecting unit **772***a* and has a smaller thickness than that of the connecting unit **772***a*.

The second color filter includes second area units (not illustrated) and a second connecting unit **782**. The second connecting unit **782** is formed to connect two adjacent second area units (not illustrated) to each other and includes a connecting unit **782***a* and a connecting unit **782***b*. The connecting unit **782***b* is disposed to be close to the connecting unit **782***a* and has a smaller thickness than that of the connecting unit **782***a*.

The third color filter includes third area units (not illustrated) and a third connecting unit **792**. The third connecting unit **792** is formed to connect two adjacent third area units (not illustrated) to each other and includes connecting units **792***a* and penetration units **792***b*. The penetration units **792***b* are disposed to be close to the connecting units **792***a* and to expose the black matrix layer **725**.

The contact unit **751** of the spacer unit **750** is formed to correspond to at least one of the penetration units **792***b*.

The isolation unit **752** of the spacer unit **750** includes a plurality of isolation sub-units. More specifically, the plurality of isolation sub-units include first isolation sub-units **752***a*, second isolation sub-units **752***b*, and a third isolation sub-unit **752***c*.

The first isolation sub-units **752***a* are formed to correspond to the connecting unit **772***a*, the connecting unit **782***a*, and the connecting unit **792***a*, respectively. The second isolation sub-units **752***b* are formed to correspond to the connecting unit **772***b* and the connecting unit **782***b*. The third isolation sub-unit **752***c* is formed to correspond to at least one of the penetration units **792***b* on which the contact unit **751** is not formed from among the third penetration units **792***b*.

The contact unit **751** of the spacer unit **750** has a thickness T1, and contacts the first alignment layer **717** and the second alignment layer **741**. The first isolation sub-units **752***a* each have a thickness Ta, contact the second alignment layer **741**, and are spaced apart from the first alignment layer **717** by a predetermined distance Da. The second isolation sub-units **752***b* each have a thickness Tb, contact the second alignment layer **741**, and are spaced apart from the first alignment layer **717** by a predetermined distance Db. The third isolation sub-units **752***c* each have a thickness Tc, contact the second alignment layer **741**, and are spaced apart from the first alignment layer **717** by a predetermined distance Dc.

The distance Da is less than the distance Db, and the distance Dc is greater than the distance Db. The first isolation sub-units **752***a* are disposed to be to the first alignment layer **717** compared with the second isolation sub-units **752***b* and the second isolation sub-units **752***b* are disposed to be to the first alignment layer **717** compared with third isolation sub-units **752***c*.

The thickness Ta of the first isolation sub-units **752***a*, the thickness Tb of the second isolation sub-units **752***b*, and the thickness Tc of the third isolation sub-units **752***c* may be different from each other; however, in some embodiments, the thicknesses may be the same for convenience of a manufacturing process.

The spacer unit **750** according to the embodiment of FIG. **10** is formed to extend across the plurality of sub-pixels and includes the contact unit **751** so as to stably maintain a cell gap. Also, the spacer unit **750** includes the first isolation sub-units **752***a*, the second isolation sub-units **752***b*, and the third isolation sub-units **752***c* and thus facilitates movement of the liquid crystal layer **718**. In particular, the third isolation sub-units **752***c* are formed to correspond to the penetration unit **792***b* so that the distance Dc between the third isolation sub-units **752***c* and the first alignment layer **717** is increased and thus mobility of the liquid crystal layer **718** is improved.

Although pressure is applied to the liquid crystal display apparatus **700** during use, the cell gap may be easily maintained without reducing the mobility of the liquid crystal layer **718**. Consequently, image quality of the liquid crystal display apparatus **700** may be prevented from deteriorating and thus excellent image quality may be secured.

When pressure is applied to the liquid crystal display apparatus **700**, a part of a load provided to the contact unit **751** may be sequentially shared with the first isolation sub-units **752***a*, the second isolation sub-units **752***b*, and the third isolation sub-units **752***c* and thus a cell gap may be efficiently maintained according to a pressure condition.

In addition, the first isolation sub-units **752***a* are disposed to be close to the contact unit **751**. As the first isolation sub-units **752***a* having the smallest step difference with the contact unit **751** are disposed to be close to the contact unit **751**, a load provided to the contact unit **751** may be easily shared with the first isolation sub-units **752***a* that are close to the contact unit **751** when pressure is applied to the liquid crystal display apparatus **700**. Thus, the ability to maintain a cell gap may be improved and durability of the spacer unit **750** may be improved.

FIG. **11** is a plan view of another embodiment of a liquid crystal display apparatus **800**, and FIG. **12** is a cross-sectional view taken along line XII-XII of FIG. **11**. Descriptions of elements which are common to the different embodiments and which have already been described will not be repeated. Like reference numerals generally denote like elements.

Referring to FIGS. **11** and **12**, the liquid crystal display apparatus **800** includes a first substrate **806**, a second substrate **820**, a liquid crystal layer **818**, and a spacer unit **850**.

The contact unit **851** and the isolation unit **852** of the spacer unit **850** are disposed spaced apart from each other. In FIG. **11**, the spacer unit **850** is represented in a bold solid line and a separate square part is illustrated at the center area of the spacer unit **850**. The separate square part corresponds to the contact unit **851** of FIG. **12**. That is, in FIG. **12**, the contact unit **851** is spaced apart from a second isolation sub-unit **852***b* formed to correspond to a connecting unit **872***b*, and the contact unit **851** is spaced apart from a first isolation sub-unit **852***a* formed to correspond to a connecting unit **892***a*.

The color filter **860** includes a first color filter **870**, a second color filter **880**, and a third color filter **890**. The black matrix layer **825** is formed between the second substrate **820** and the color filter unit **860** in order to prevent colors from being mixed and to improve contrast. Here, visible rays are not realized in a part covered by the black matrix layer **825**.

The first color filter **870** includes first area units **871** and a first connecting unit **872**. The first connecting unit **872** is formed to connect two adjacent first area units **871** to each other and includes a connecting unit **872***a* and a connecting unit **872***b*. The connecting unit **872***b* has a smaller thickness than that of the connecting unit **872***a*.

The second color filter **880** includes second area units **881** and a second connecting unit **882**. The second connecting unit **882** is formed to connect two adjacent second area units **881** to each other and includes a connecting unit **882***a* and a connecting unit **882***b*. The connecting unit **882***b* has a smaller thickness than that of the connecting unit **882***a*.

The third color filter **890** includes third area units **891** and a third connecting unit **892**. The third connecting unit **892** is formed to connect two adjacent third area units **891** to each other and includes the connecting unit **892***a* and a connecting unit **892***b*. The connecting unit **892***b* has a smaller thickness than that of the connecting unit **892***a*.

The contact unit **851** of the spacer unit **850** is formed to correspond to the connecting unit **882***a* of the second color filter **880**.

The isolation unit **852** of the spacer unit **850** includes a plurality of isolation sub-units including first isolation sub-units **852***a* and the second isolation sub-units **852***b*.

The first isolation sub-units **852***a* are formed to correspond to the connecting unit **872***a* of the first color filter **870** and the connecting unit **892***a* of the third color filter **890**, respectively. The second isolation sub-units **852***b* are formed to correspond to the connecting unit **872***b* and the connecting unit **892***b*, respectively. The spacer unit **850** may not exist in the connecting unit **882***b* of the second color filter **880**. Accordingly, mobility of the liquid crystal layer **818** may be improved.

The contact unit **851** of the spacer unit **850** has a thickness T**1**, and contacts the first alignment layer **817** and the second alignment layer **841**. The first isolation sub-units **852***a* each have a thickness Ta, contact the second alignment layer **841**, and are spaced apart from the first alignment layer **817** by a predetermined distance Da. The second isolation sub-units **852***b* each have a thickness Tb, contact the second alignment layer **841**, and are spaced apart from the first alignment layer **817** by a predetermined distance Db.

The distance Da is less than the distance Db. That is, the first isolation sub-units **852***a* are disposed closer to the first alignment layer **817** than the second isolation sub-units **852***b*.

The thickness Ta of each of the first isolation sub-units **852***a* may be different from the thickness Tb of each of the second isolation sub-units **852***b*; however, may be the same for convenience of a manufacturing process.

The spacer unit **850** is formed to have an extended part and a part spaced apart from the extended part, as illustrated in FIG. **11**. Accordingly, a space between the first substrate **806** and the second substrate **820** in which the liquid crystal layer **818** is disposed, that is, a cell gap, may be easily maintained. In particular, the spacer unit **850** includes the contact unit **851** that is formed to contact the first alignment layer **817** and the second alignment layer **841** to stably maintain a cell gap.

Also, the spacer unit **850** includes the first isolation sub-units **852***a* and the second isolation sub-units **852***b* that are each spaced apart from the first alignment layer **817** by a predetermined distance and thus facilitates movement of the liquid crystal layer **818**.

If pressure is applied to the liquid crystal display apparatus **800** while in use, the first isolation sub-units **852***a* and the second isolation sub-units **852***b* may sequentially contact the first alignment layer **817** according to the pressure. If pressure is applied, the first isolation sub-units **852***a* and the second isolation sub-units **852***b* may maintain a cell gap, along with the contact unit **851**.

Accordingly, although pressure is applied to the liquid crystal display apparatus **800** while being used, the cell gap may be easily maintained while not reducing the mobility of the liquid crystal layer **818**. Consequently, image quality of the liquid crystal display apparatus **800** may be prevented from deteriorating and thus excellent image quality may be secured

The liquid crystal display apparatus according to embodiments described herein may have improved image quality.

While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the following claims.

What is claimed is:

1. A liquid crystal display apparatus, comprising:

a plurality of sub-pixels;

a first substrate on which at least one first thin film is disposed;

a second substrate facing the first substrate and on which at least one second thin film is disposed;

a liquid crystal layer disposed between the first substrate and the second substrate; and

a spacer unit disposed between the first substrate and the second substrate to maintain a space where the liquid crystal layer is disposed, and continuously formed across at least two sub-pixels from among the plurality of sub-pixels,

wherein the spacer unit comprises a contact unit and an isolation unit comprising a plurality of isolation sub-units, wherein the contact unit is formed to contact the first thin film closest to the liquid crystal layer and the second thin film closest to the liquid crystal layer, wherein the isolation unit is formed to be spaced apart from the first thin film closest to the liquid crystal layer and to contact the second thin film closest to the liquid crystal layer, and wherein a distance between the plurality of isolation sub-units and the first thin film closest to the liquid crystal layer is not uniform,

wherein there are a plurality of second thin films, which together comprise a color filter unit comprising a first color filter, a second color filter, and a third color filter, wherein the first color filter comprises a plurality of first area units and a first connecting unit connecting the first area units that are adjacent to each other, wherein the second color filter comprises a plurality of second area units and a second connecting unit connecting the second area units that are adjacent to each other, wherein the third color filter comprises a plurality of third area units and a third connecting unit connecting the third area units that are adjacent to each other, wherein each of the first, second and third connecting units comprises two connecting sub-units with different thicknesses from one another, and

wherein the contact unit of the spacer unit is formed to correspond to the thicker of the connecting sub-units of each of the three color filters, and wherein the isolation sub-units of the spacer unit comprise first isolation sub-units and second isolation sub-units, the first isolation sub-unit is formed to correspond to the thicker of the connecting sub-units of the three color filters, in each of which the contact unit is not formed, and the second isolation sub-unit is formed to correspond to the thinner of the connection sub-units of the three color filters.

2. The apparatus of claim **1**, wherein a distance between the first isolation sub-unit and the first thin film closest to the liquid crystal layer is less than a distance between the second isolation sub-unit and the second thin film closest to the liquid crystal layer.

3. The apparatus of claim **1**, wherein the first isolation sub-unit and the second isolation sub-unit have the same thickness.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 8,908,139 B2
APPLICATION NO. : 13/077436
DATED : December 9, 2014
INVENTOR(S) : Dong-Yoon So et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Title page, item 57, line 13, please delete “plurality”, and insert -- plurality of --, therefor.

Specification

At column 1, line 47, please delete “plurality”, and insert -- plurality of --, therefor.

At column 14, line 41, please delete “secured”, and insert -- secured. --, therefor.

Signed and Sealed this
Twentieth Day of October, 2015

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office