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Jang et al.

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(54) **LIQUID CRYSTAL DISPLAY COMPRISING THE SPACERS DISPOSED NEAR THE LIQUID CRYSTAL INLET, WHEREIN THE SPACERS HAVE PRISM SHAPES OR ELLIPTICAL COLUMN SHAPES**

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G02F 1/1339 (2006.01)

(52) **U.S. Cl.** **349/155; 349/156; 349/157; 349/189**

(58) **Field of Classification Search** 349/155, 349/156, 189, 190, 157
See application file for complete search history.

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(57) **ABSTRACT**

A liquid crystal display apparatus includes first and second substrates, a liquid crystal layer, a sealing member, and first and second spacers. The first substrate includes a first display part having a pixel electrode formed thereon. The second substrate includes a second display part having a common electrode. The liquid crystal layer is interposed between the first and second substrates. The seal line includes a liquid crystal inlet. The first spacer is disposed between the first and second display parts. The second spacer is disposed near the liquid crystal inlet. The second and third spacers prevent the cell gap of the liquid crystal inlet from being narrowed, so that a liquid crystal material may be injected easily completely. Thus, the liquid crystal material is completely filled to enhance the display quality.

33 Claims, 24 Drawing Sheets

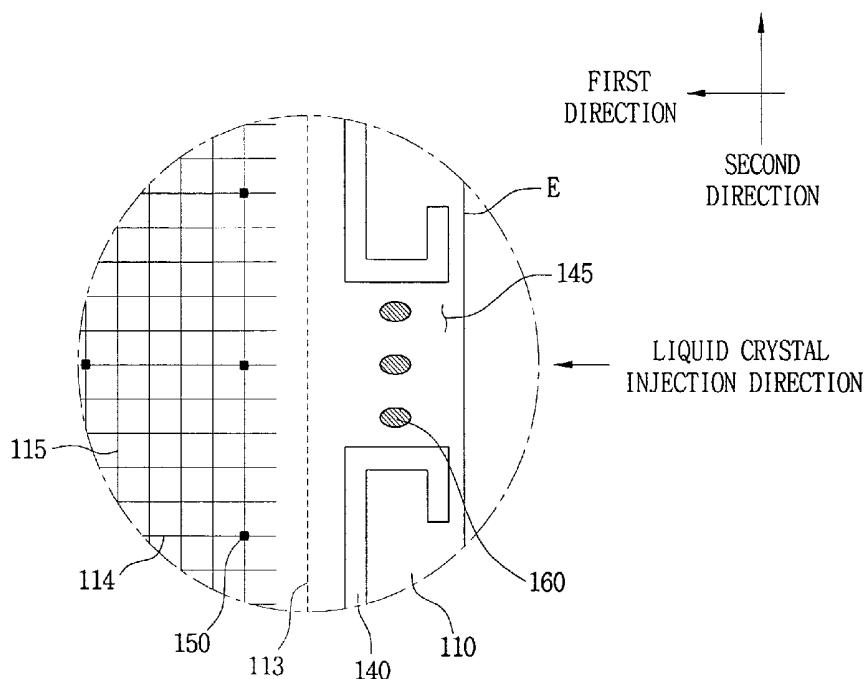


FIG. 1

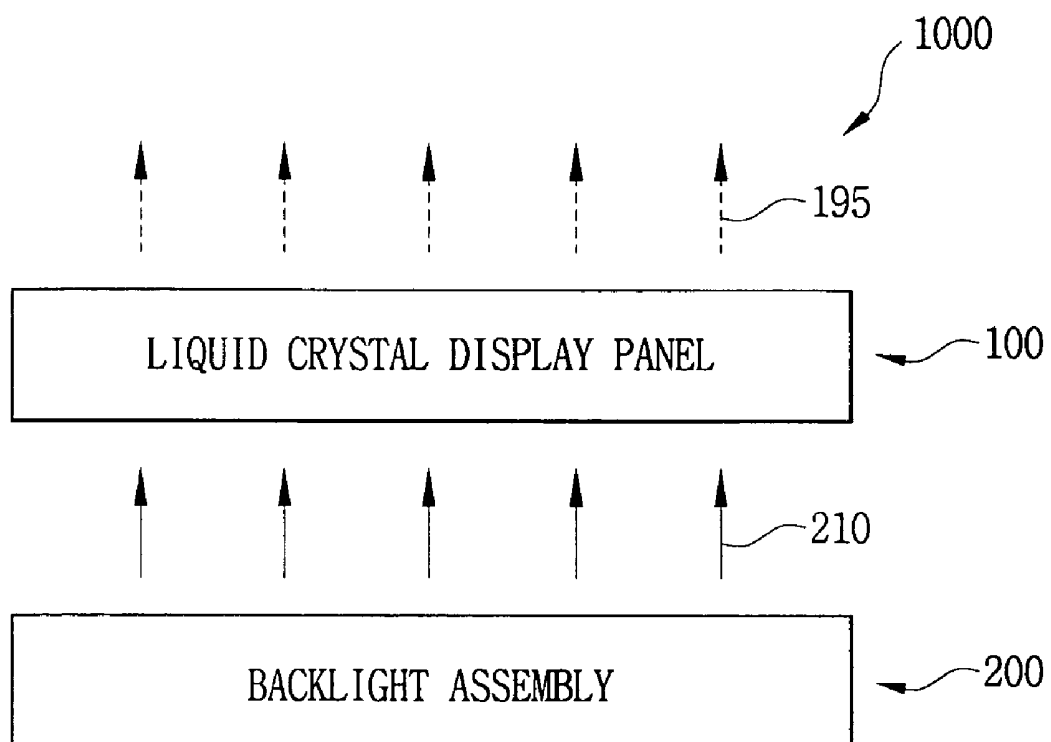


FIG. 2

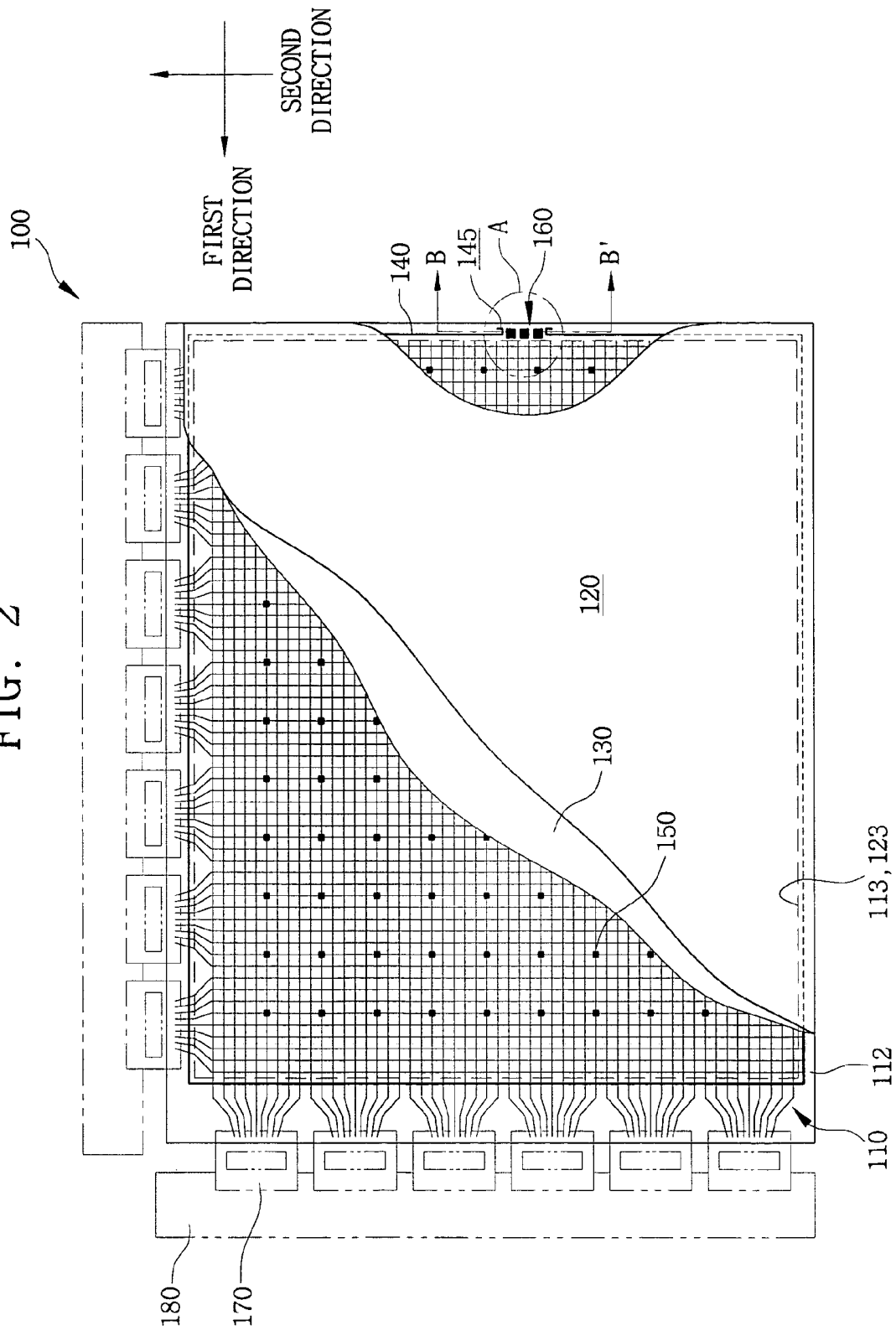


FIG. 3

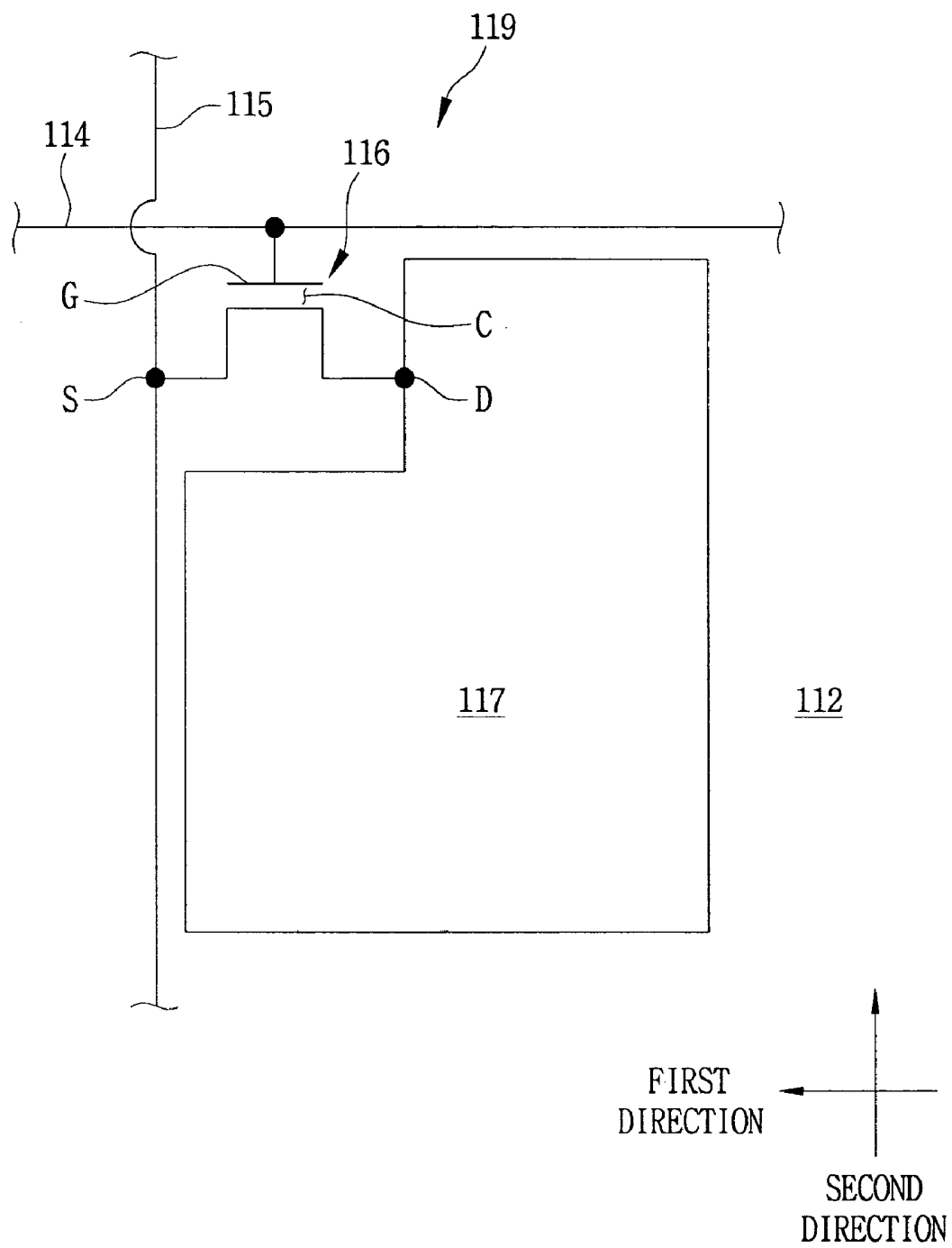


FIG. 4

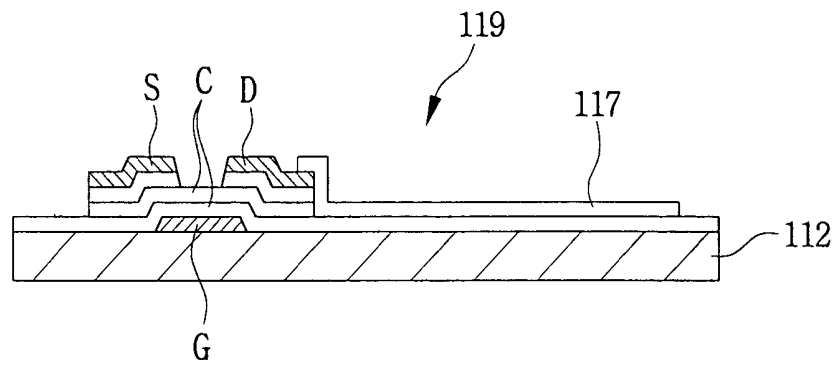


FIG. 5

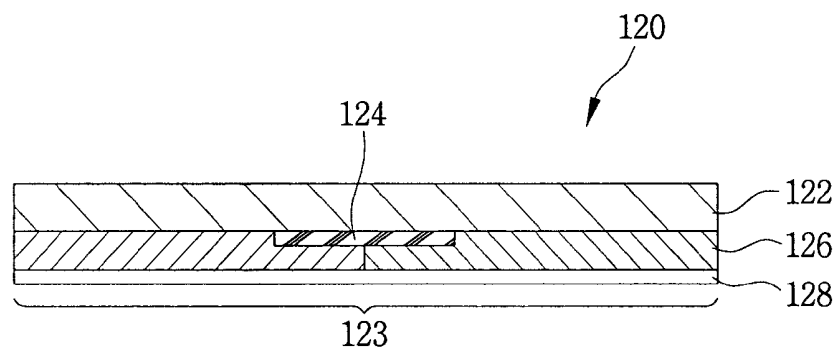
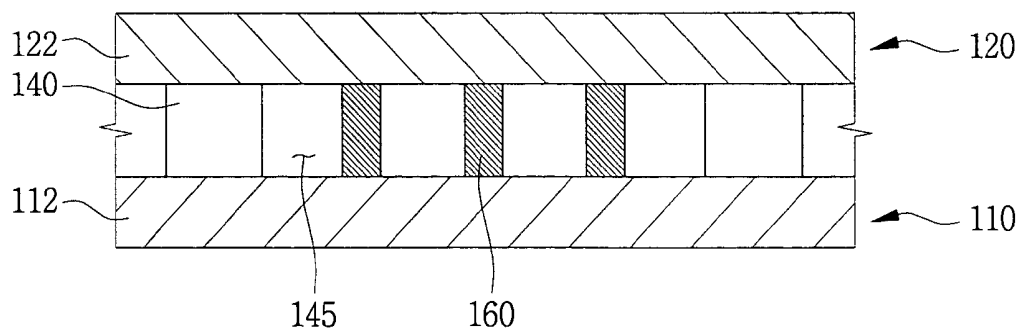


FIG. 6



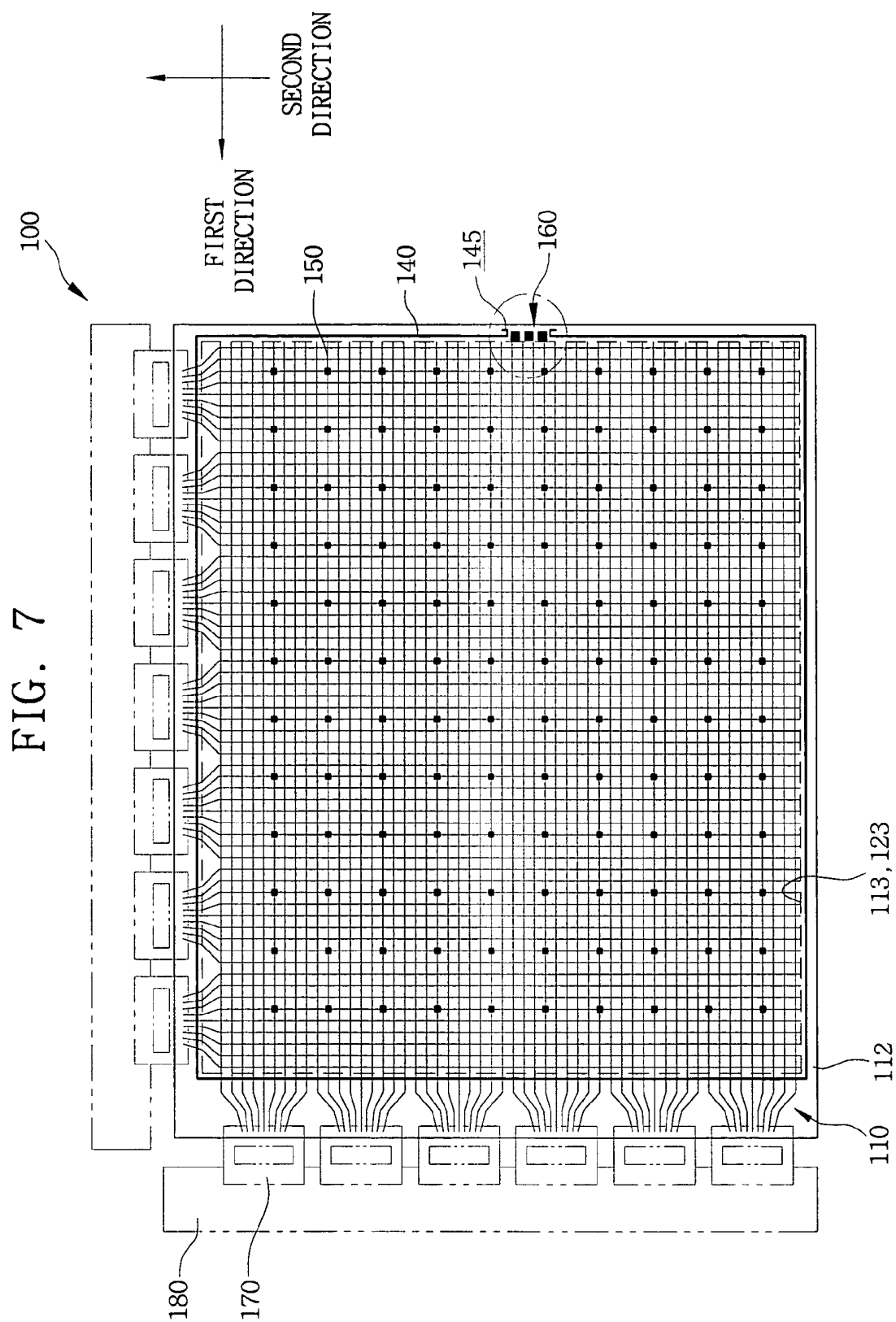


FIG. 10

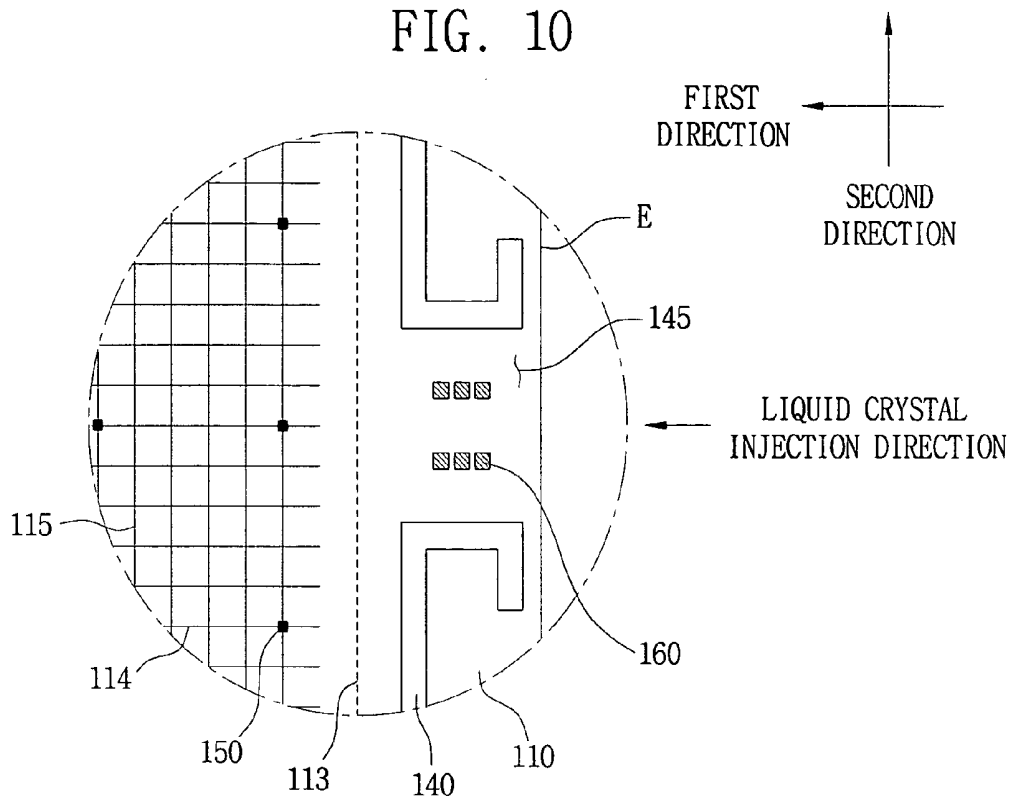


FIG. 11

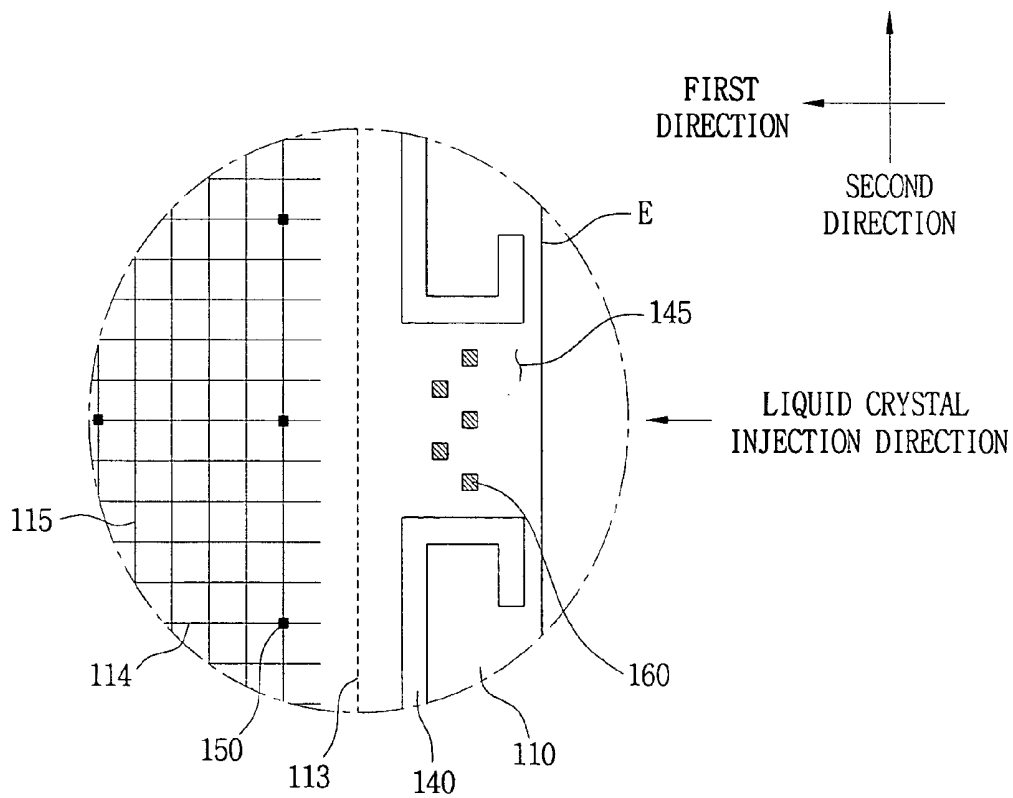


FIG. 12

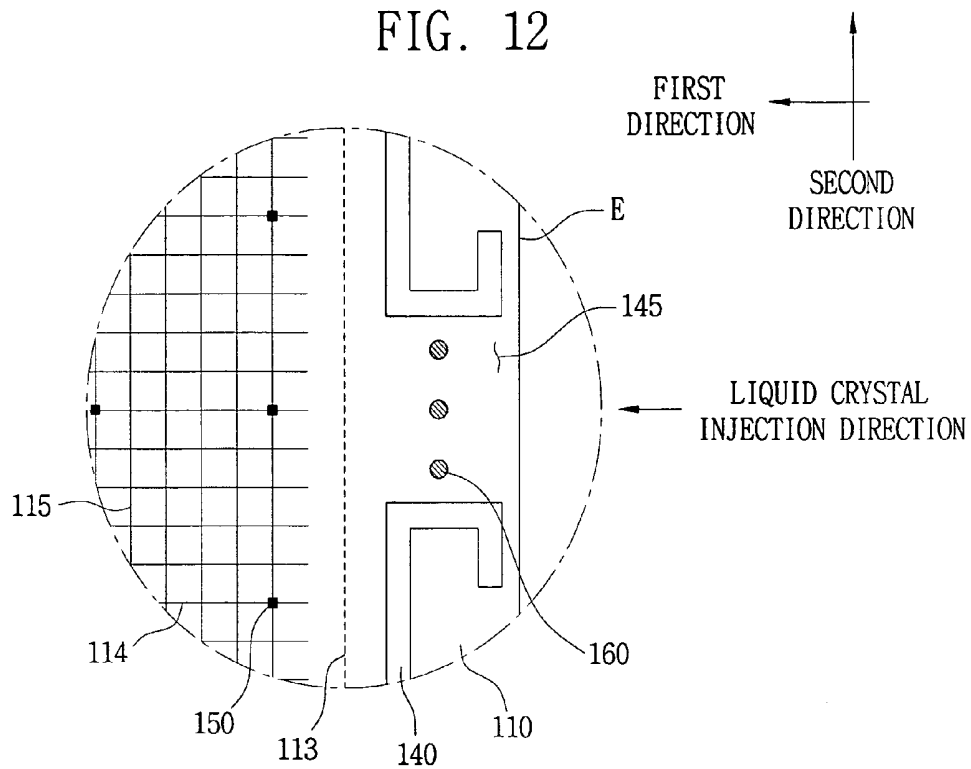


FIG. 13

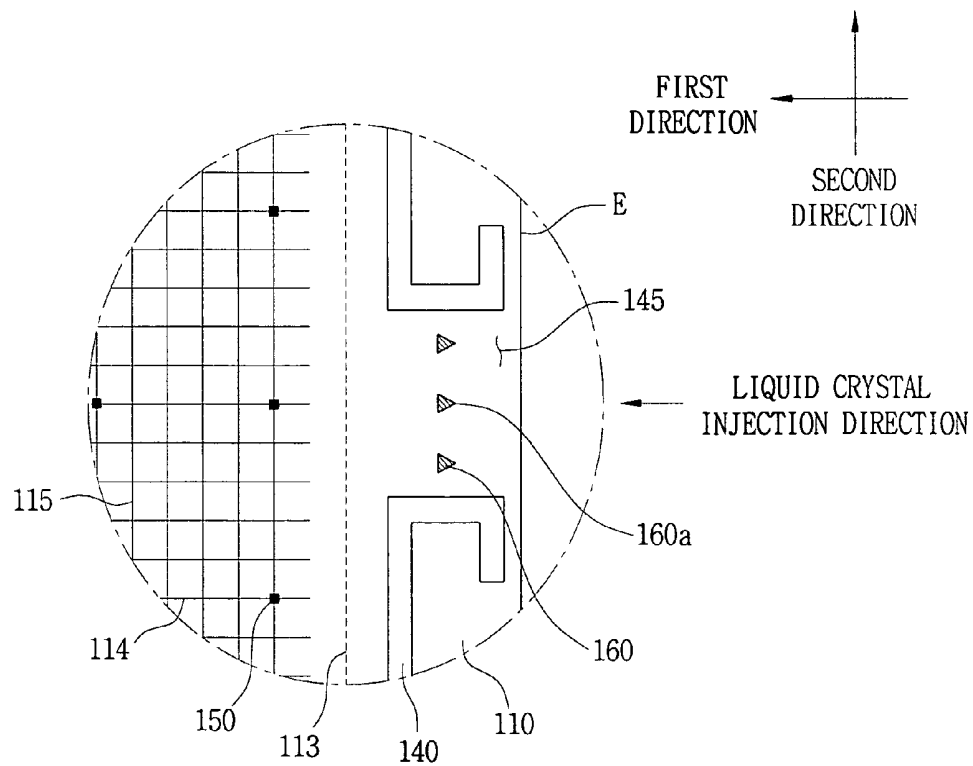


FIG. 14

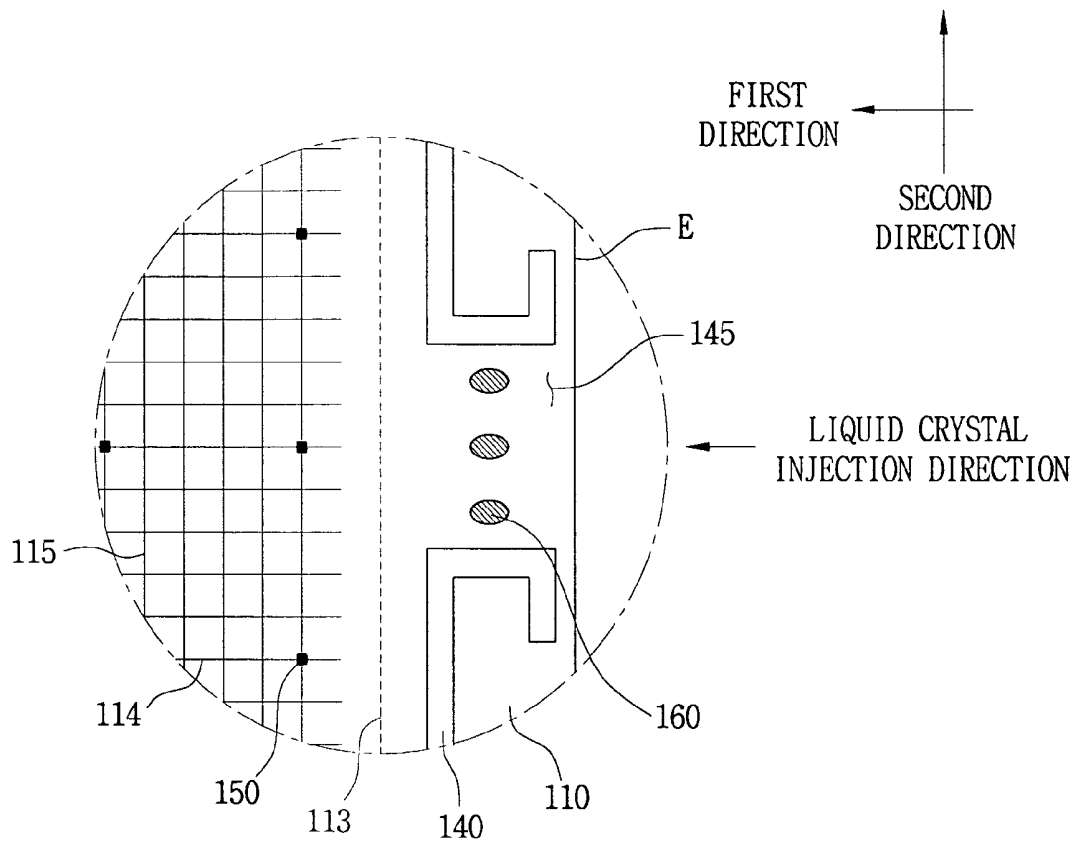


FIG. 15

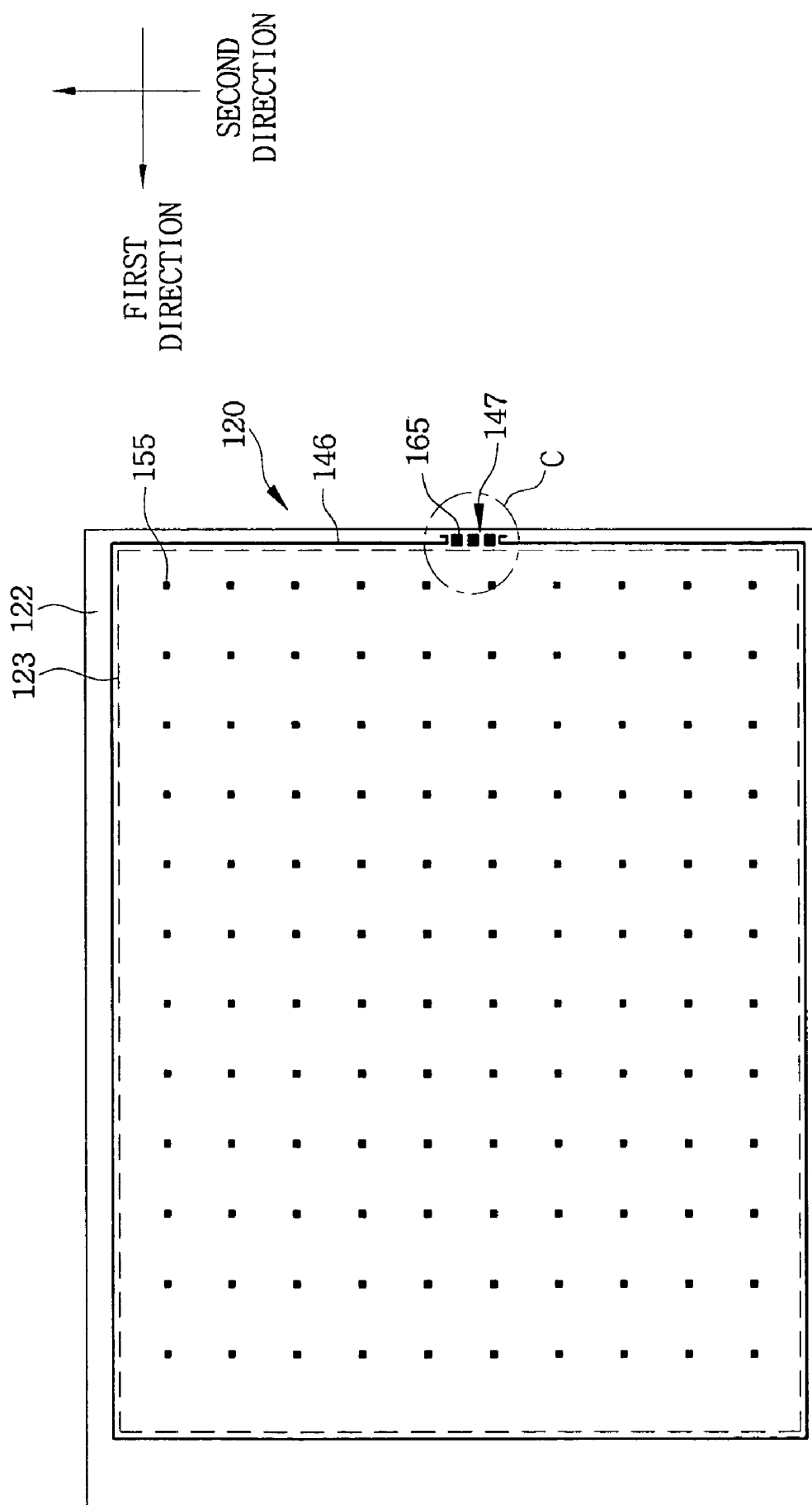


FIG. 16

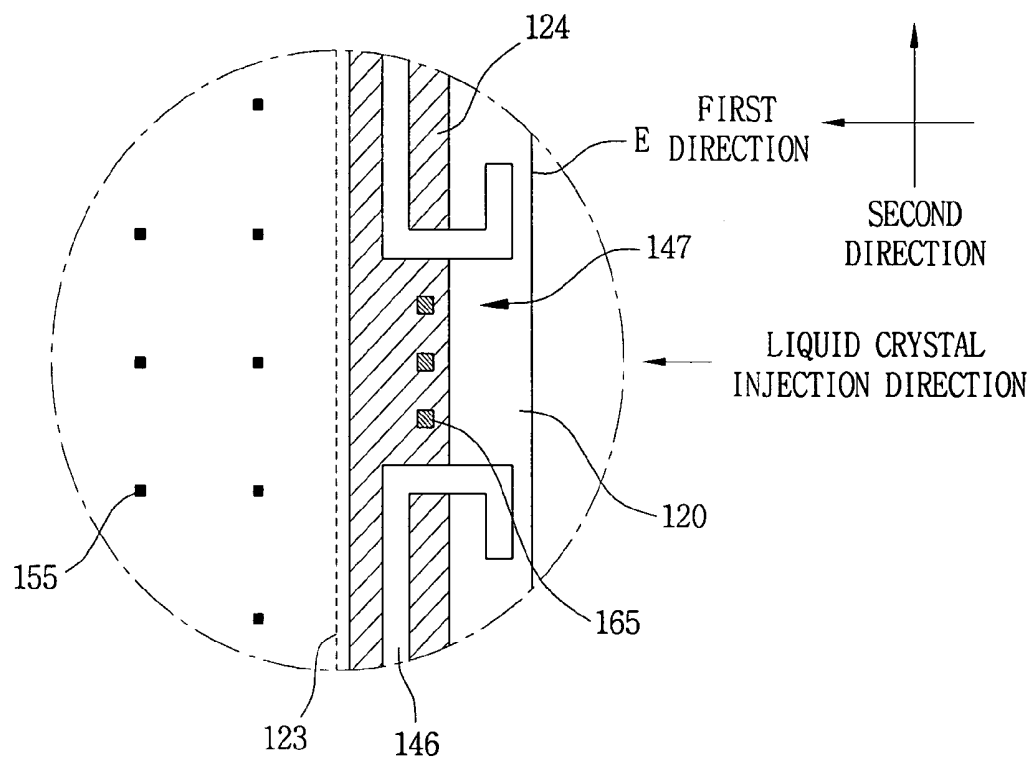


FIG. 17

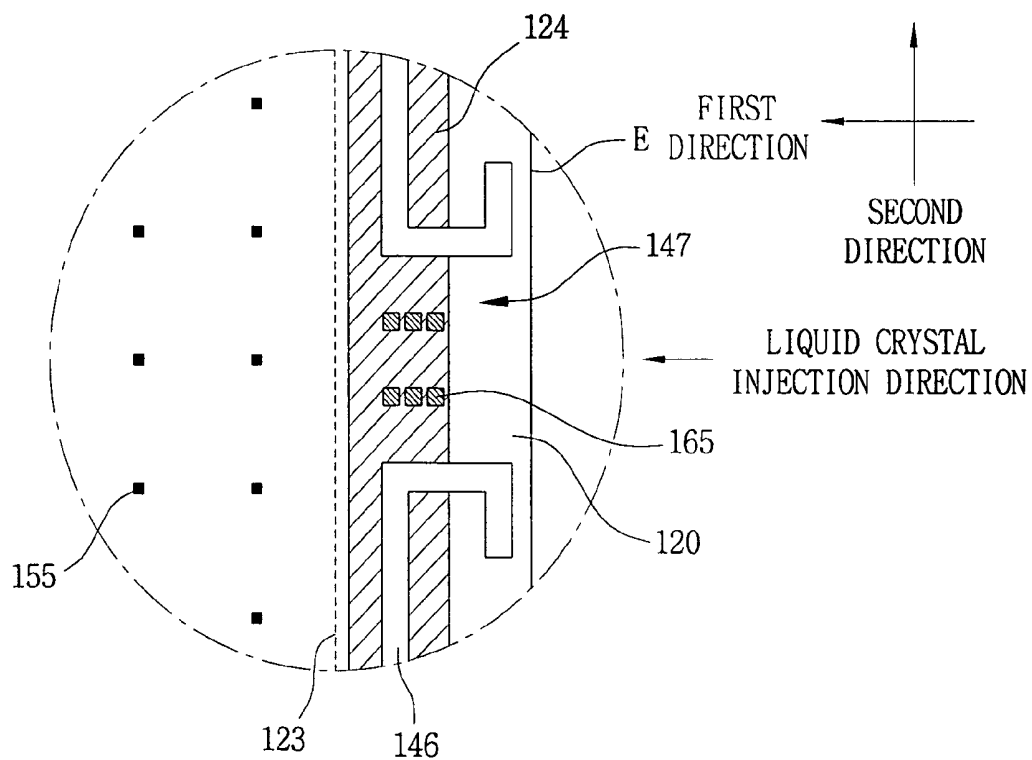


FIG. 18

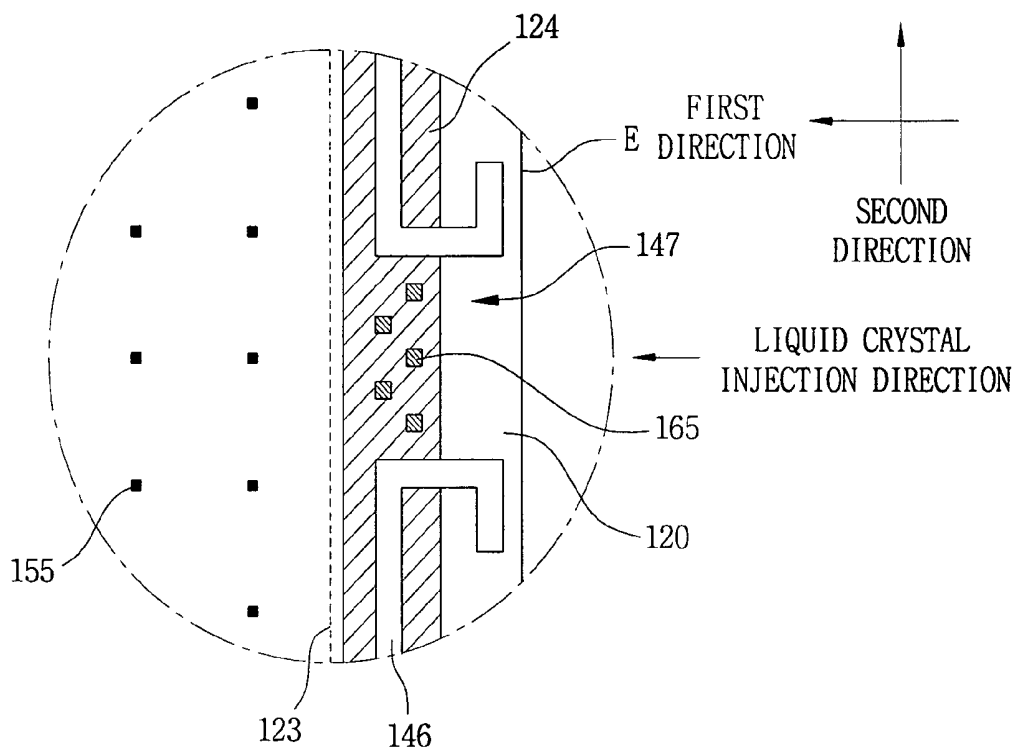


FIG. 19

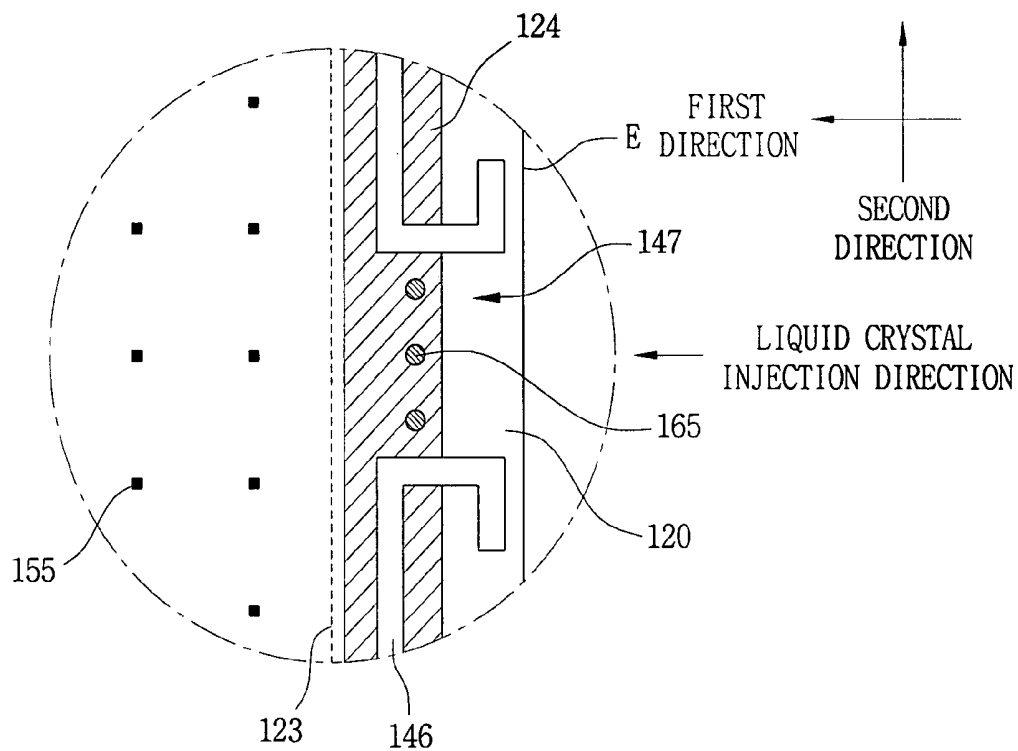


FIG. 20

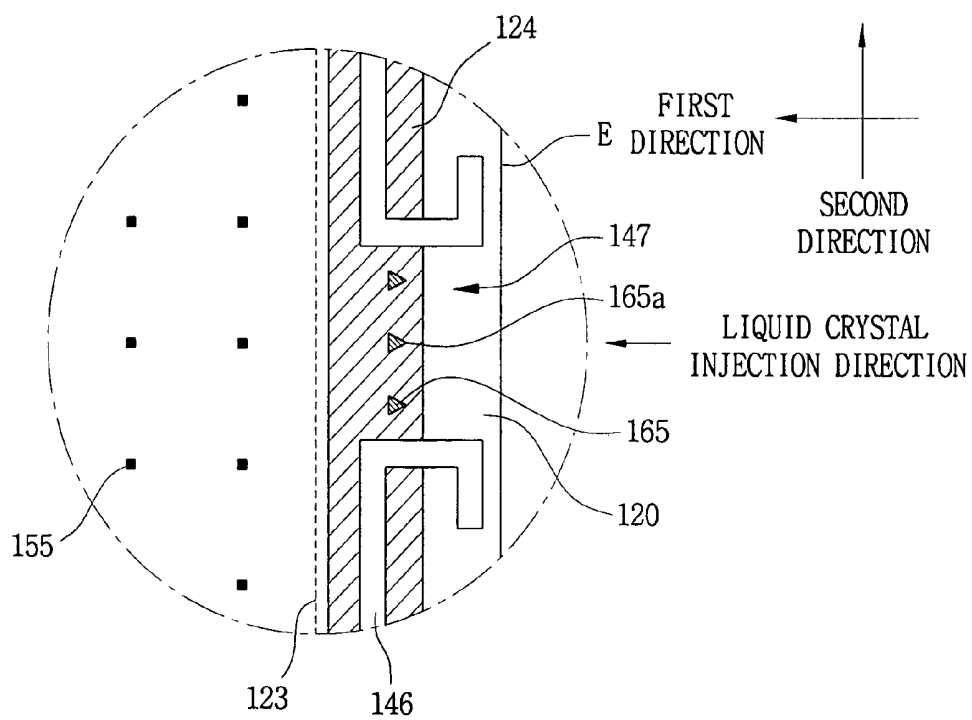


FIG. 21

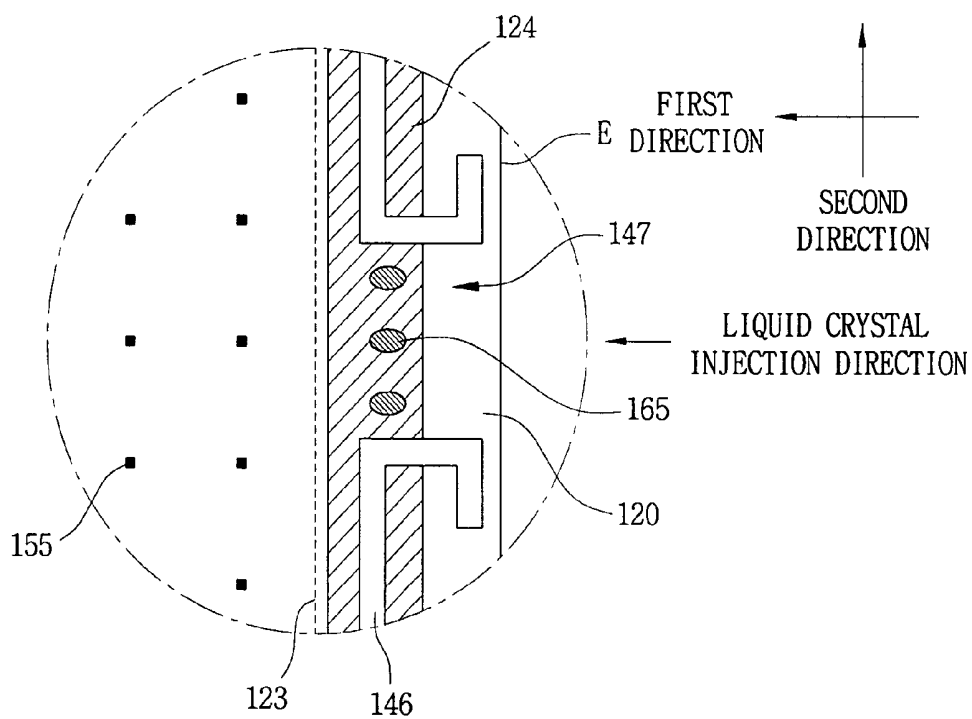


FIG. 22

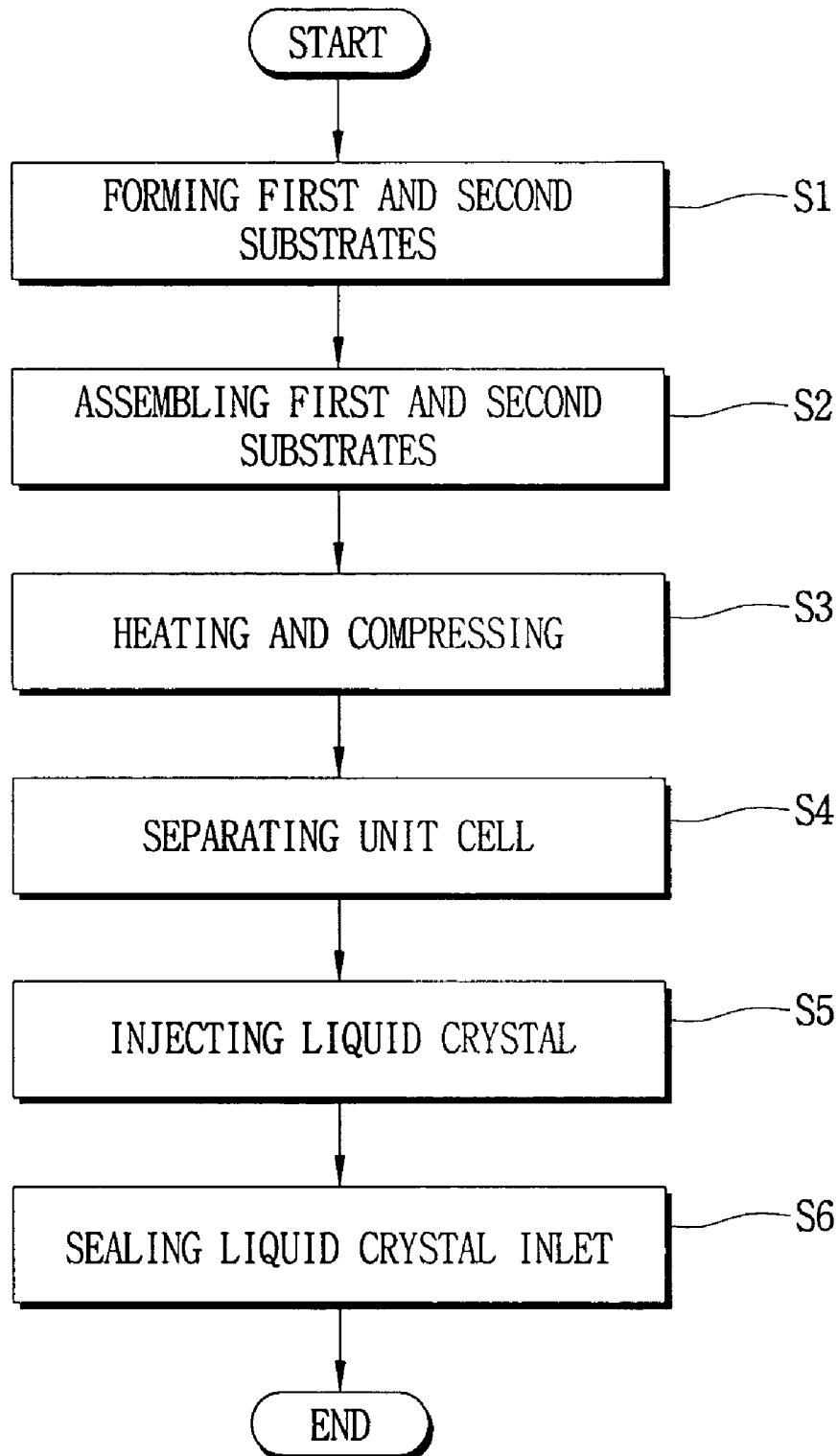


FIG. 23

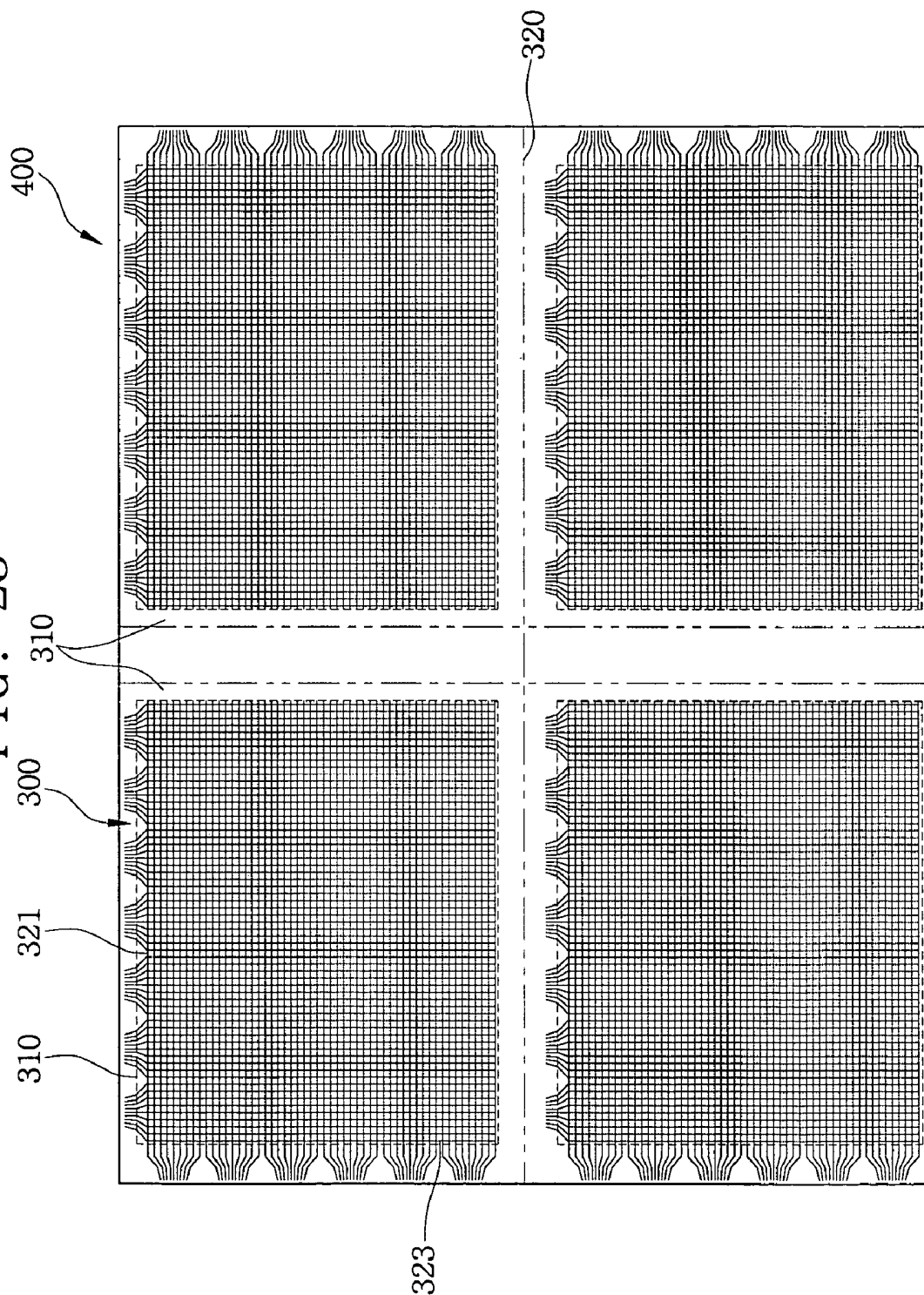


FIG. 26

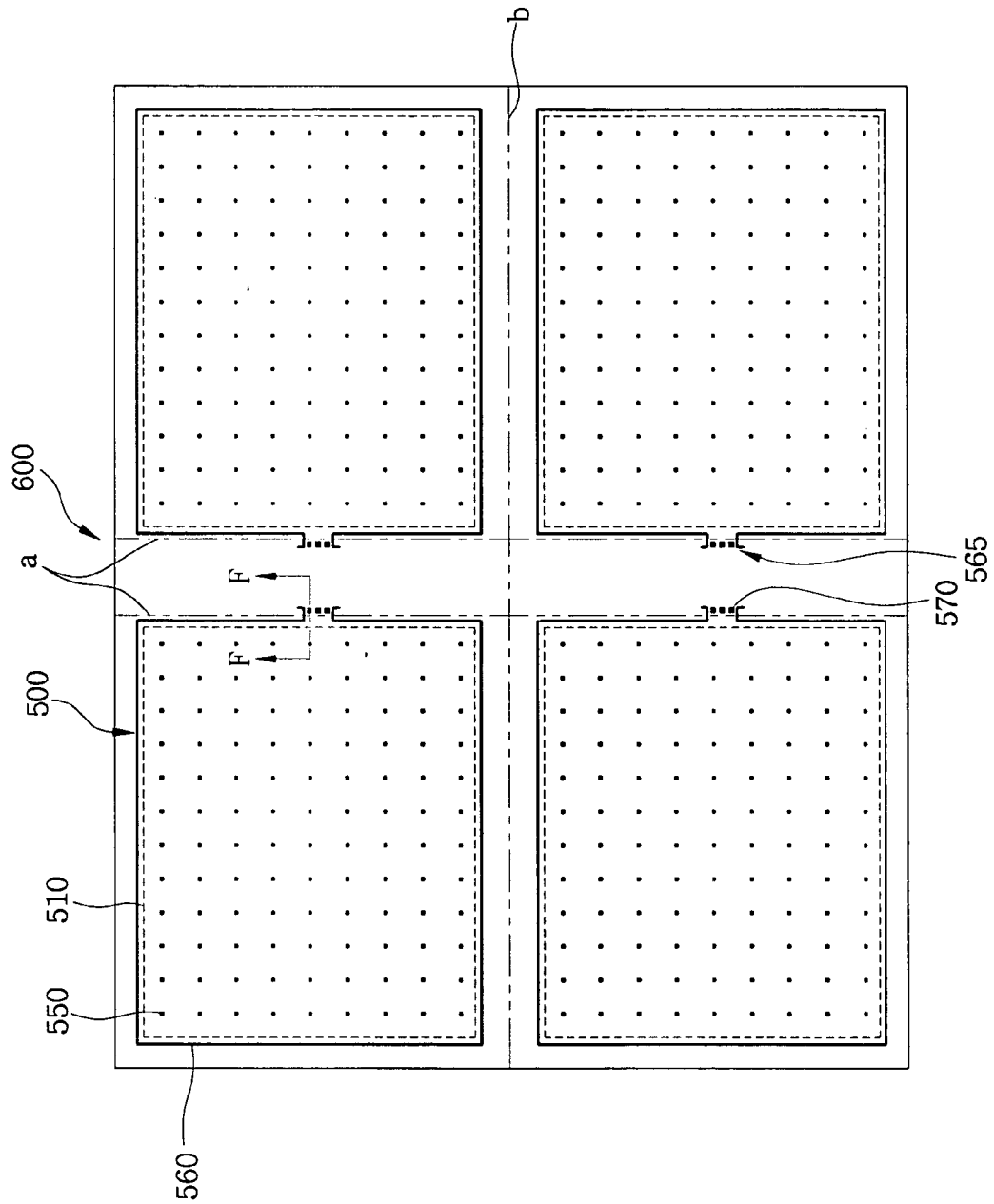


FIG. 27

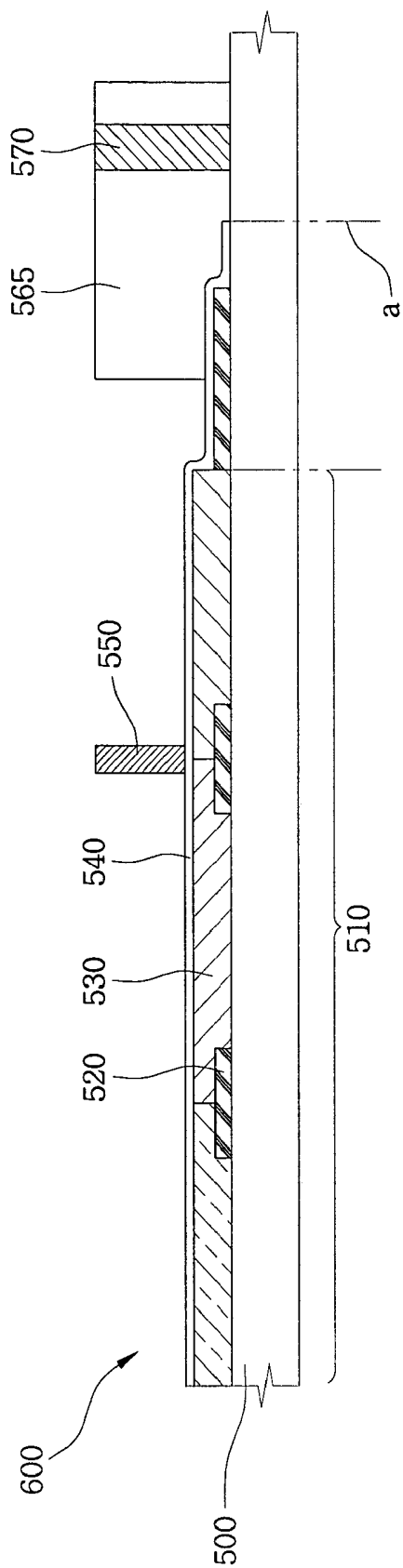
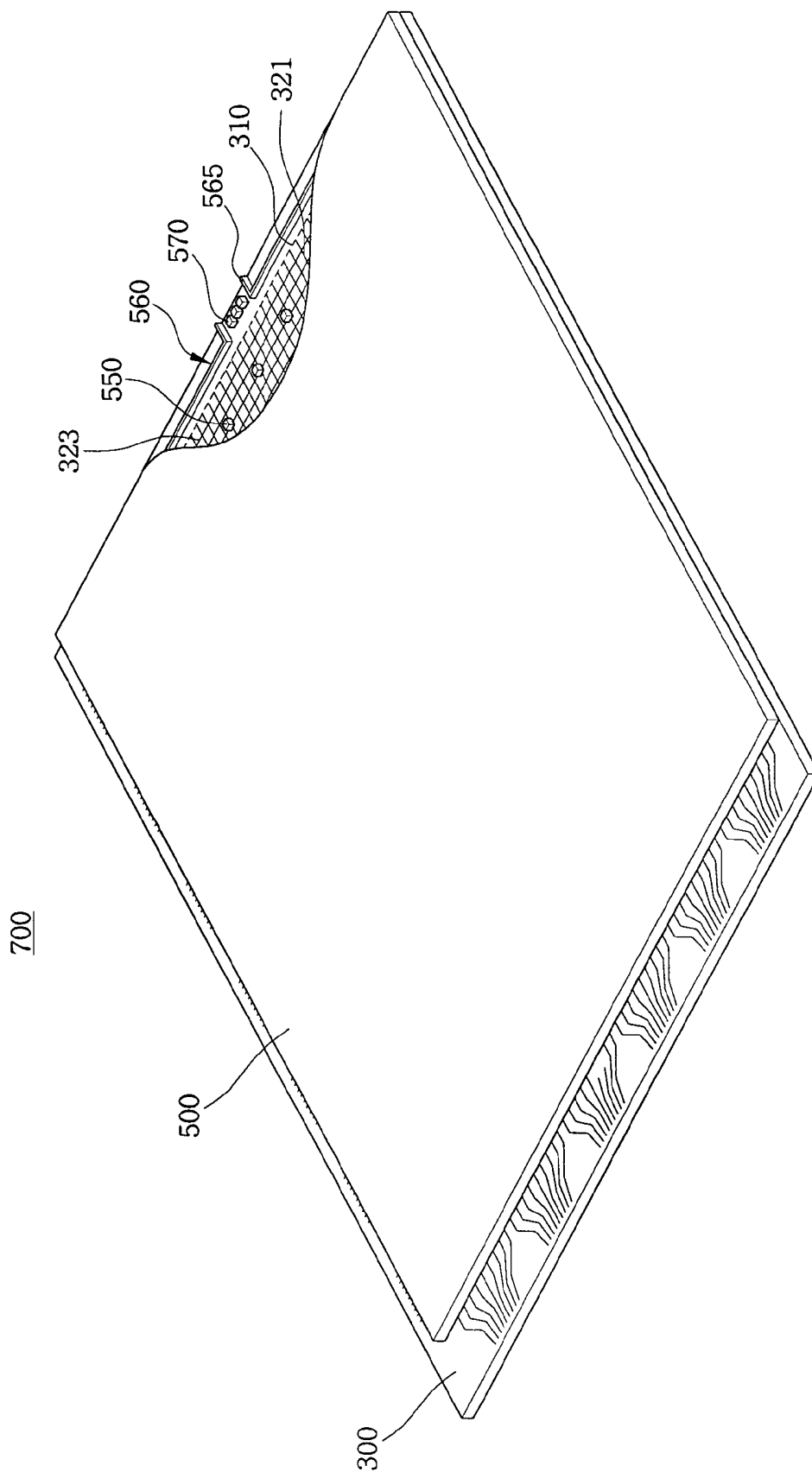


FIG. 28



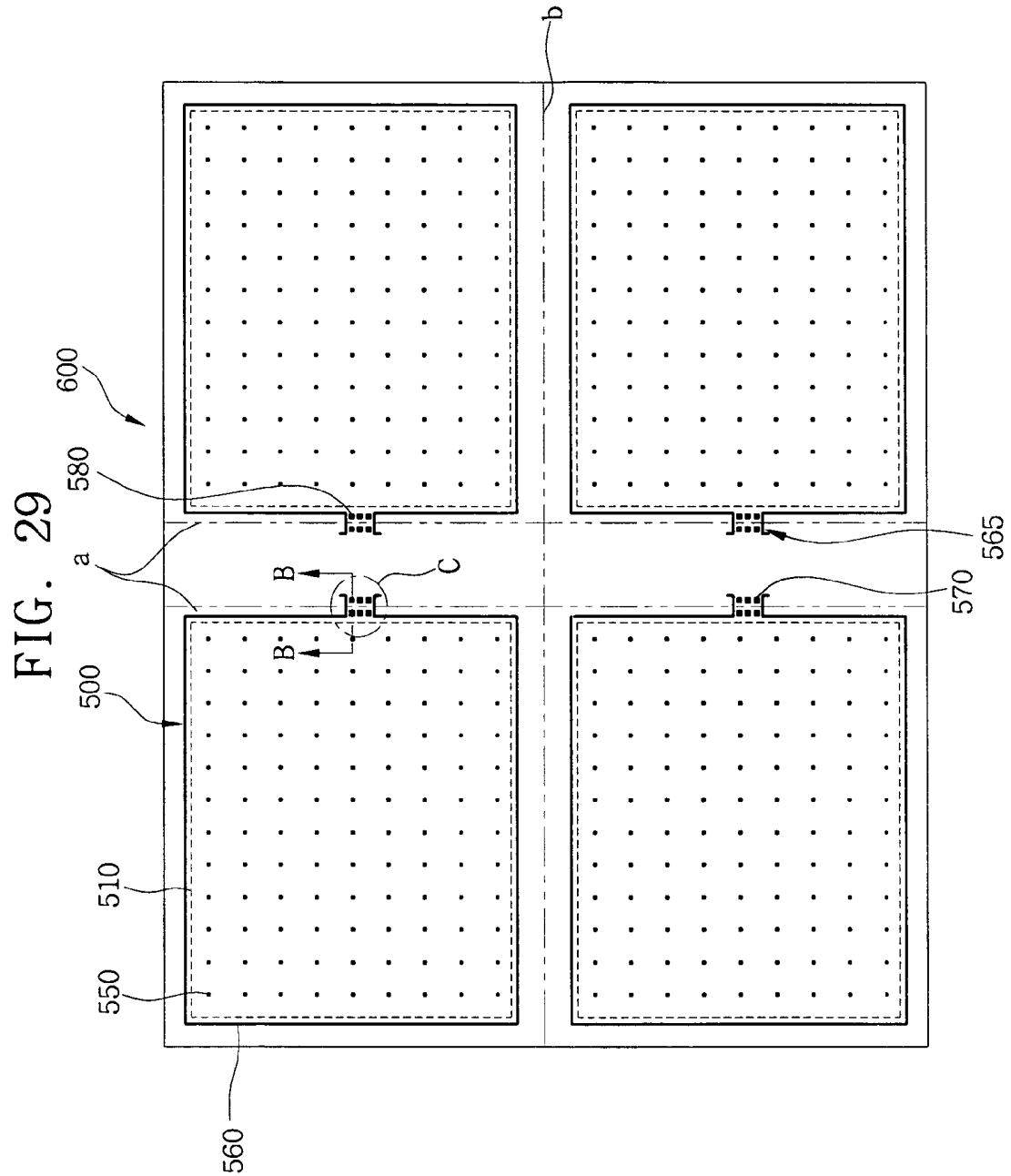


FIG. 30

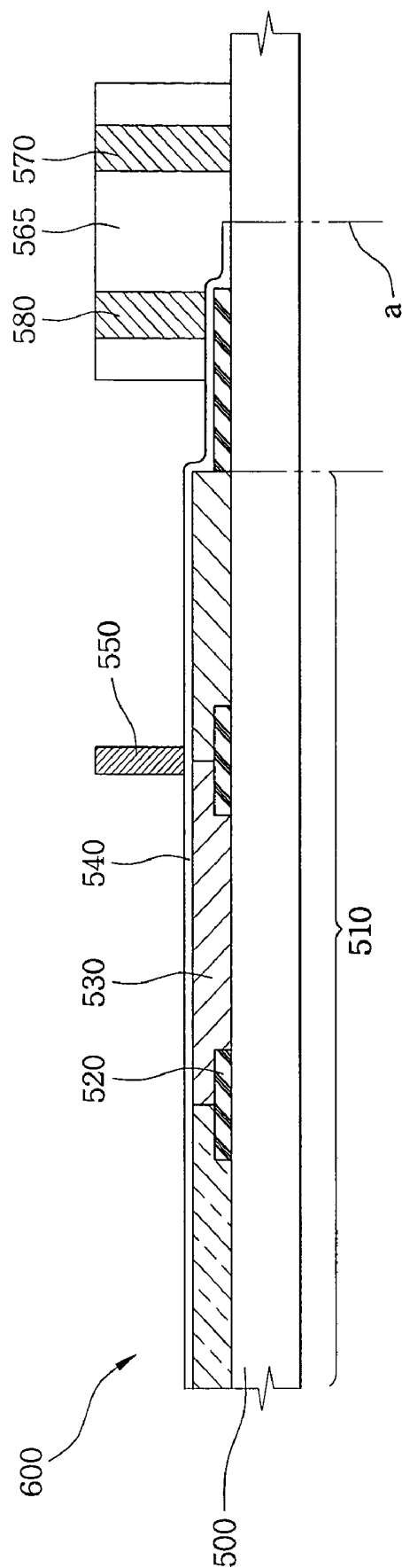


FIG. 31

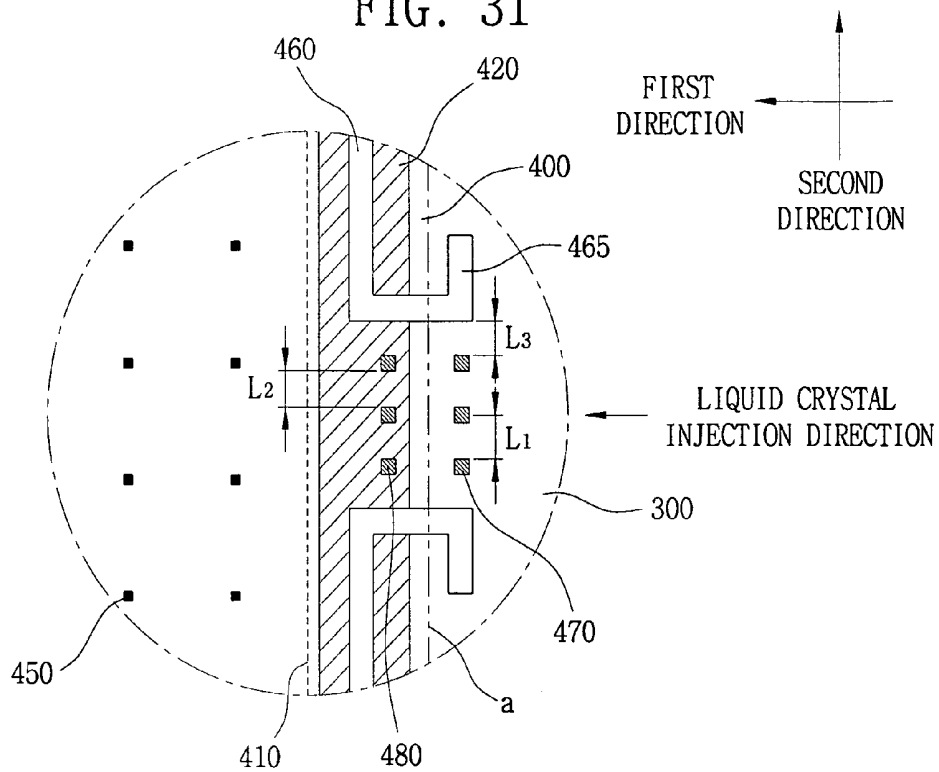


FIG. 32

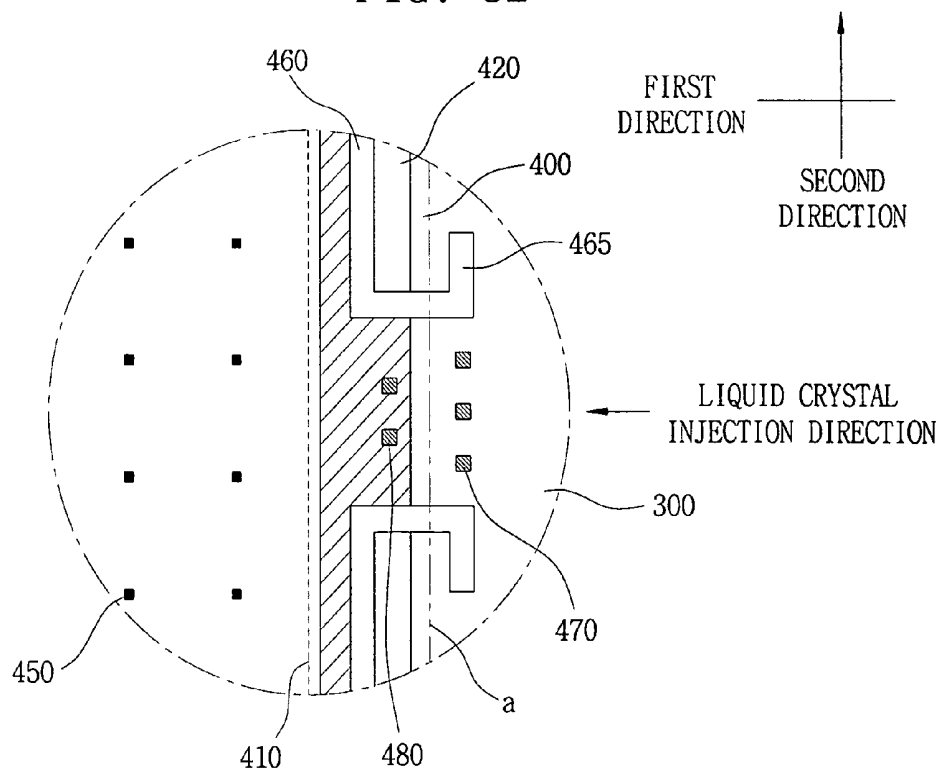


FIG. 33

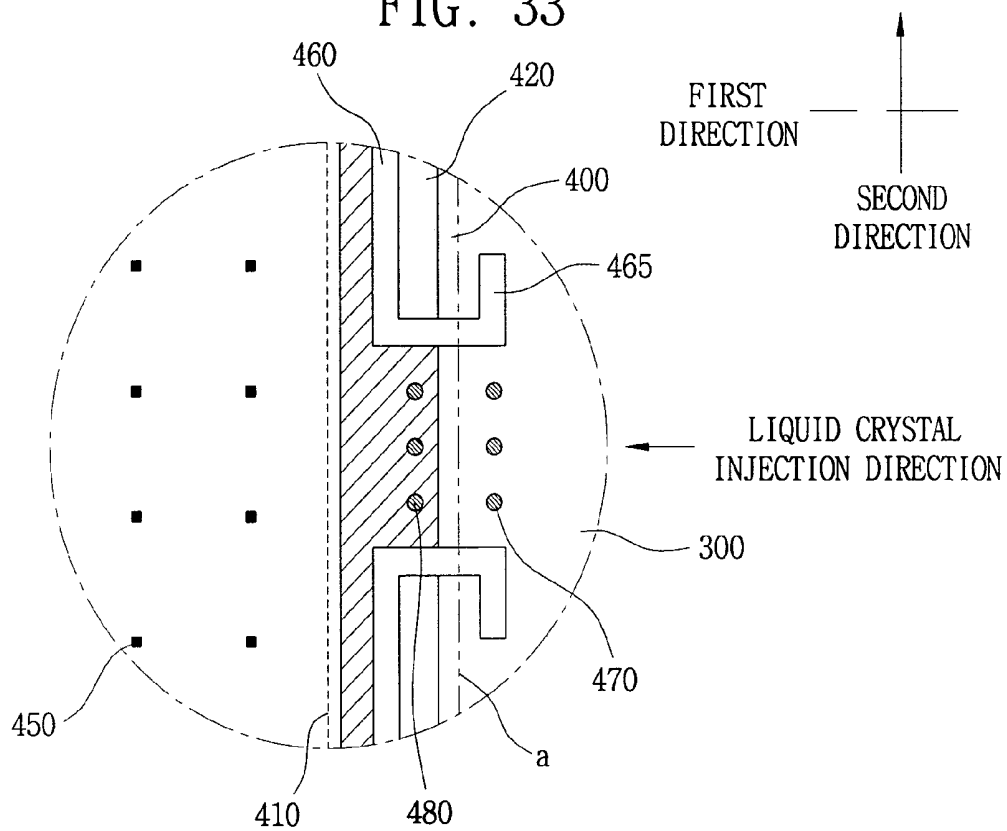


FIG. 34

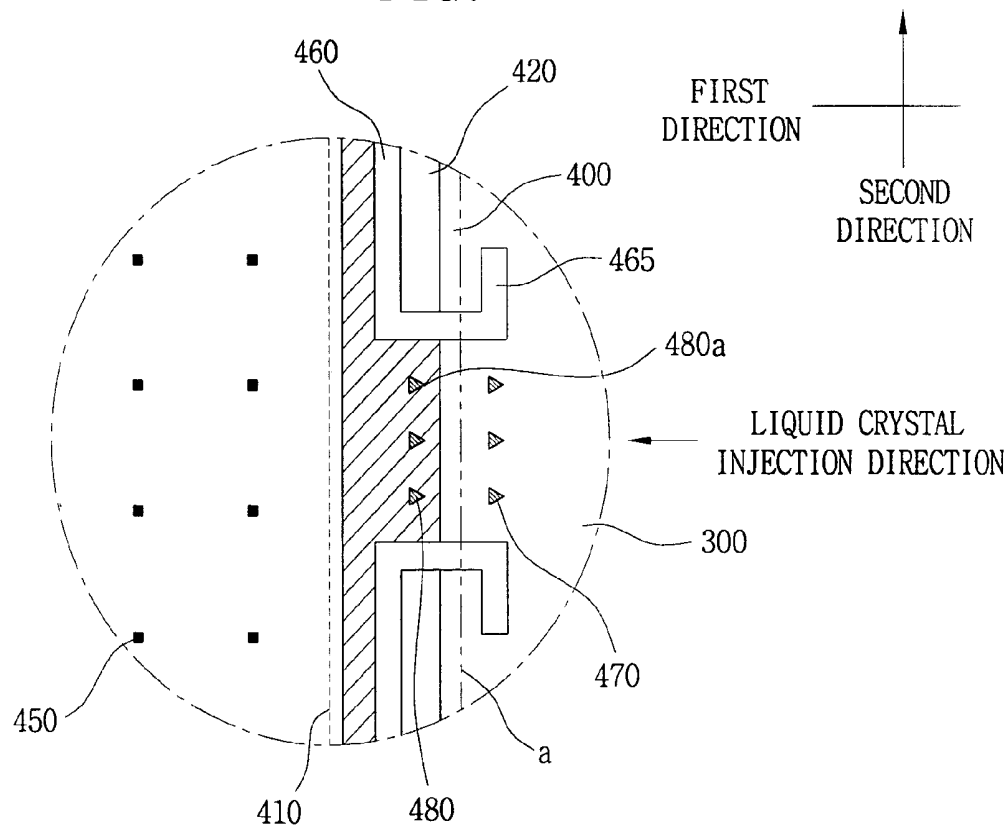
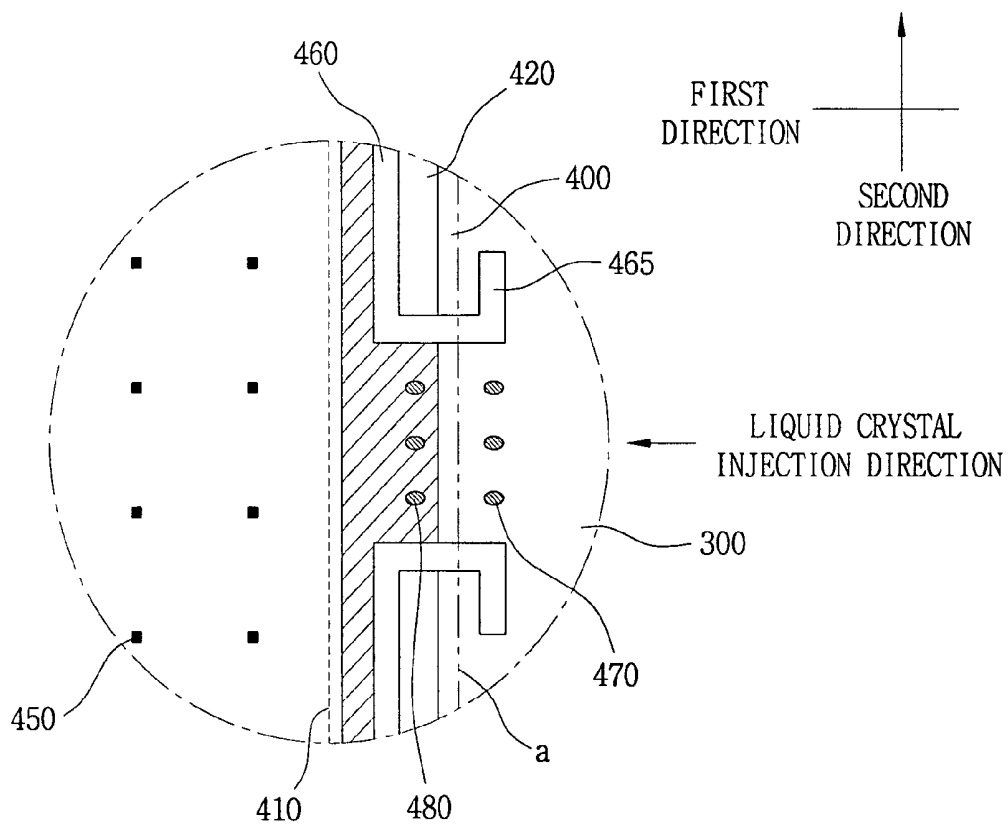


FIG. 35



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**LIQUID CRYSTAL DISPLAY COMPRISING
THE SPACERS DISPOSED NEAR THE
LIQUID CRYSTAL INLET, WHEREIN THE
SPACERS HAVE PRISM SHAPES OR
ELLIPTICAL COLUMN SHAPES**

**CROSS-REFERENCE TO RELATED
APPLICATIONS**

This application relies for priority upon Korean Patent Application No. 2003-39240 filed on Jun. 17, 2003, and Korean Patent Application No. 2003-51929 filed on Jul. 28, 2003, the contents of which are herein incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a liquid crystal display apparatus and a method of manufacturing the liquid crystal display apparatus, and more particularly to a liquid crystal display apparatus with completely filled liquid crystal material and a method of manufacturing the liquid crystal display apparatus.

2. Description of the Related Art

An arrangement of liquid crystal molecules is adjusted in accordance with electric fields applied to the liquid crystal molecules, so that optical characters are adjusted. A liquid crystal display apparatus uses liquid crystal molecules so as to display an image. The liquid crystal display apparatus includes a liquid crystal display panel. The liquid crystal display panel includes a thin film transistor substrate, a color filter substrate and a liquid crystal layer interposed between the thin film transistor substrate and the color filter substrate.

Generally, a thickness of the liquid crystal layer is in a range of a few μm .

A liquid crystal material is injected into between the thin film transistor substrate and the color filter substrate via a vacuum injection method to form the liquid crystal layer. In order to inject the liquid crystal material into between the thin film transistor substrate and the color filter substrate via vacuum injection method, a seal line is formed along an edge of the thin film transistor substrate or the color filter substrate. However, the seal line is not a closed curve. That is, a portion of the seal line is opened to form a liquid crystal inlet. Then, the color filter substrate and the thin film transistor substrate are assembled together via the seal line, so that a liquid crystal receiving space defined by the seal line is formed between the thin film transistor substrate and the color filter substrate.

In a chamber having a vacuum pressure, the liquid crystal inlet is dipped in the liquid crystal material. Then, a pressure of the chamber increases, so that the liquid crystal material is injected into the liquid crystal receiving space, because a pressure of the liquid crystal receiving space is lower than the an environmental pressure. Then, a sealing member seals the liquid crystal inlet.

However, according to the general vacuum injection method, the liquid crystal receiving space may not be completely filled because the liquid crystal inlet may be narrowed in an assembling process of the thin film transistor substrate and the color filter substrate.

When the liquid crystal receiving space is not completely filled, a display quality is deteriorated.

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SUMMARY OF THE INVENTION

Accordingly, the present invention is provided to substantially obviate one or more problems due to limitations and disadvantages of the related art.

It is a feature of the present invention to provide a liquid crystal display apparatus with a completely injected liquid crystal material.

It is another feature of the present invention to provide a method of manufacturing the liquid crystal display apparatus.

In one aspect of the liquid crystal display apparatus, the liquid crystal display apparatus includes first and second substrates, a liquid crystal layer, a sealing member, and first and second spacers. The first substrate includes a first display part having a pixel electrode formed thereon. The second substrate includes a second display part having a common electrode that faces the pixel electrode. The liquid crystal layer is interposed between the first and second substrates. The seal line includes a liquid crystal inlet. The seal line defines the first and second display parts. The first spacer is disposed between the first and second display parts. The first spacer maintains a cell gap formed between the first and second substrates. The second spacer is disposed near the liquid crystal inlet. The second spacer also maintains the cell gap.

In another aspect of the method of manufacturing a liquid crystal display apparatus, a first display part is formed on a first mother substrate. A second display part is formed on a second mother substrate, such that the second display part faces the first display part. A seal line having a liquid crystal inlet is formed along a boundary of the first display part. First and second spacers are formed on the first display part and outside of the first display part corresponding to the liquid crystal inlet respectively. The first and second mother substrates are assembled together. The first and second display parts are separated from the first and second mother substrates. A liquid crystal material is injected into between the first and second display parts via the liquid crystal inlet. Then, the liquid crystal inlet is sealed.

In another aspect of the method of manufacturing a liquid crystal display apparatus, a first display part is formed on a first mother substrate. A second display part is formed on a second mother substrate, such that the second display part faces the first display part. A seal line having a liquid crystal inlet is formed along a boundary of the second display part. First and second spacers are formed on the second display part and outside of the first display part corresponding to the liquid crystal inlet respectively. The first and second mother substrates are assembled together. The first and second display parts are separated from the first and second mother substrates. A liquid crystal material is injected into between the first and second display parts via the liquid crystal inlet. Then, the liquid crystal inlet is sealed.

According to the present invention, the second and third spacers prevent the cell gap of the liquid crystal inlet from being narrowed, so that a liquid crystal material may be easily injected completely. Thus, the liquid crystal material is completely filled to enhance the display quality.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other features and advantage points of the present invention will become more apparent by describing in detailed exemplary embodiments thereof with reference to the accompanying drawings, in which:

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FIG. 1 is a schematic view showing a liquid crystal display apparatus according to a first exemplary embodiment of the present invention;

FIG. 2 is a partially cut out plan view showing a liquid crystal display panel of FIG. 1;

FIG. 3 is a schematic view showing a pixel of the liquid crystal display panel of FIG. 2;

FIG. 4 is a cross-sectional view showing a thin film transistor and a pixel electrode formed on the first substrate of FIG. 2;

FIG. 5 is a cross-sectional view showing a second substrate of the liquid crystal display panel of FIG. 2;

FIG. 6 is a cross-sectional view taken along the line B-B' of FIG. 2;

FIG. 7 is plan view showing first and second spacers formed on a first substrate according to a second exemplary embodiment of the present invention;

FIG. 8 is a partially enlarged view showing a portion 'B' of FIG. 7;

FIG. 9 is a cross-sectional view taken along a line C-C';

FIG. 10 is an enlarged view showing a second spacer according to a third exemplary embodiment of the present invention;

FIG. 11 is an enlarged view showing a second spacer according to a fourth exemplary embodiment of the present invention;

FIG. 12 is an enlarged view showing a second spacer according to a fifth exemplary embodiment of the present invention;

FIG. 13 is an enlarged view showing a second spacer according to a sixth exemplary embodiment of the present invention;

FIG. 14 is an enlarged view showing a second spacer according to a seventh exemplary embodiment of the present invention;

FIG. 15 is a plan view showing first and second spaces formed on a second substrate according to an eighth exemplary embodiment of the present invention;

FIG. 16 is a partially enlarged view showing a portion 'C' of FIG. 15;

FIG. 17 is an enlarged view showing a second spacer according to a ninth exemplary embodiment of the present invention;

FIG. 18 is an enlarged view showing a second spacer according to a tenth exemplary embodiment of the present invention;

FIG. 19 is an enlarged view showing a second spacer according to an eleventh exemplary embodiment of the present invention;

FIG. 20 is an enlarged view showing a second spacer according to a twelfth exemplary embodiment of the present invention;

FIG. 21 is an enlarged view showing a second spacer according to a thirteenth exemplary embodiment of the present invention;

FIG. 22 is a flow chart showing a method of manufacturing the liquid crystal display panel of FIG. 1 according to a fourteenth exemplary embodiment of the present invention;

FIG. 23 is a plan view showing a process of manufacturing the first substrate of FIG. 22;

FIG. 24 is a schematic view showing a unit pixel of a liquid crystal display panel of FIG. 23;

FIG. 25 is a cross-sectional view showing a thin film transistor and a pixel electrode formed on the first substrate of FIG. 23;

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FIG. 26 is a plan view showing a process of manufacturing the second substrate of FIG. 22;

FIG. 27 is a cross-sectional view taken along the line F-F' of FIG. 26;

FIG. 28 is a partially cut out perspective view showing a unit cell that is separated from a mother substrate according to a fourth step of FIG. 22;

FIG. 29 is a plan view showing first, second and third spacers formed on a second substrate according to a fifteenth exemplary embodiment of the present invention;

FIG. 30 is a cross-sectional view taken along the line G-G';

FIG. 31 is an enlarged view showing the second and third spacers of FIG. 29;

FIG. 32 is an enlarged view showing second and third spacers according to a sixteenth exemplary embodiment of the present invention;

FIG. 33 is an enlarged view showing second and third spacers according to a seventeenth exemplary embodiment of the present invention;

FIG. 34 is an enlarged view showing second and third spacers according to an eighteenth exemplary embodiment of the present invention; and

FIG. 35 is an enlarged view showing second and third spacers according to a nineteenth exemplary embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Hereinafter, the preferred embodiments of the present invention will be described in detail with reference to the accompanied drawings.

Embodiment 1

FIG. 1 is a schematic view showing a liquid crystal display apparatus according to a first exemplary embodiment of the present invention.

Referring to FIG. 1, a liquid crystal display apparatus 1000 according to a first exemplary embodiment of the present invention includes a liquid crystal display panel 100 and a backlight assembly 200.

The backlight assembly 200 provides the liquid crystal display panel 100 with a light 210 that contains no information. The liquid crystal display panel 100 transforms the light 210 into an image light 195 that contains image information.

FIG. 2 is a partially cut-out plan view showing a liquid crystal display panel of FIG. 1.

Referring to FIG. 2, a liquid crystal display panel 100 includes first and second substrates 110 and 120, a seal line 140, and first and second spacers 150 and 160.

FIG. 3 is a schematic view showing a pixel of the liquid crystal display panel of FIG. 2.

Referring to FIGS. 2 and 3, the first substrate 110 includes a first transparent substrate 112 and a pixel 119.

The first transparent substrate 112 has a rectangular plate shape. A light transmittance of the first transparent 112 may be substantially same as a glass. For example, the first transparent substrate 112 comprises glass. The first transparent substrate 112 includes a first display part 113. A pixel 119 is disposed on the first display part 113.

FIG. 4 is a cross-sectional view showing a thin film transistor and a pixel electrode formed on the first substrate of FIG. 2.

Referring to FIGS. 3 and 4, a plurality of pixels 119 is disposed in the first display part 113. The pixels 119 are arranged in a matrix shape. For example, when a liquid

crystal display apparatus has a resolution that is 1024×768, and displays a full color, 1024×768×3 number of pixels **119** are formed on the first display part **113**.

Each of the pixels **119** includes a gate line **114**, a data line **115**, a thin film transistor **116** and a pixel electrode **117**. The gate line **114** extends in a first direction. 768 number of gate lines are arranged in parallel. The gate line **114** comprises a material that has good electric property, for example, such as aluminum or aluminum alloy.

The data line **115** is electrically insulated from the gate line **114**. The data line **115** extends in a second direction that is substantially perpendicular to the first direction.

1024×3 number of data lines **115** are arranged in parallel. The data line **115** also comprises a material that has good electric property, for example, such as aluminum or aluminum alloy.

The thin film transistor **116** is electrically connected to the gate line **114** and the data line **115**. The thin film transistor **116** includes a gate electrode G, a source electrode S, a channel layer C and a drain electrode D.

The gate line **114** that extends in the first direction protrudes in the second direction to form the gate electrode G. 1024×3 number of gate electrode G is formed spaced apart per gate line.

The channel layer C is formed on the gate electrode G, such that the electrically insulated from the gate electrode G. The channel layer comprises amorphous silicon or n+ amorphous silicon.

The source electrode S is electrically connected to the data line **115**. 768 number of source electrodes are formed per data line **115**. The source electrode S is formed on the channel layer C.

The drain electrode D is electrically insulated from the source electrode S. The drain electrode D is also formed on the channel layer C.

The pixel electrode **117** comprises a material that is optically transparent and electrically conductive, for example, such as indium tin oxide (ITO) and indium zinc oxide (IZO).

The pixel electrode **117** is formed on a pixel region defined by the gate line **114** and the data line **115**. The pixel electrode **117** is electrically connected to the drain electrode D of the thin film transistor **116**.

FIG. 5 is a cross-sectional view showing a second substrate of the liquid crystal display panel of FIG. 2.

Referring to FIGS. 1, 4 and 5, the second substrate **120** includes a second transparent substrate **122**, a light blocking layer **124**, a color filter **126** and a common electrode **128**. The second substrate **120** is disposed, such that the common electrode **128** faces the pixel electrode **117**.

The second transparent substrate **122** has a rectangular plate shape. A transmittance of the second transparent substrate **122** is substantially same as glass. For example, the second transparent substrate **122** comprises the glass. The second transparent substrate **122** includes a second display part **123**. The light blocking layer **124**, the color filter **126** and the common electrode **128** are formed in the second display part **123**. The second display part **123** faces the first display part **113** of the first substrate **110**, and the first and second display parts **113** and **123** are substantially same as in area and shape.

The light blocking layer **124** comprises a metal such as chromium (Cr) or chromium oxide (CrO₂), or an organic material. The light blocking layer **124** has openings corresponding to the pixel electrode **117** of the first substrate **110**. Thus, the light blocking layer **124** allows a first light that penetrates the pixel electrode **117** to pass through the

openings, and the light blocking layer **124** blocks a second light that penetrates through between the pixel electrodes **117** so as to enhance a display quality.

The color filter **126** is formed on the second transparent substrate **122**, such that the color filter **126** faces the pixel electrode **117**. The color filter **126** includes a red color filter, a green color filter and a blue color filter. The red color filter allows only a light that has a wavelength corresponding to a red color to pass through the red color filter. The green color filter allows only a light that has a wavelength corresponding to a green color to pass through the green color filter. The blue color filter allows only a light that has a wavelength corresponding to a blue color to pass through the blue color filter.

The common electrode **128** is formed on the color filter **126** covering all region of the second transparent substrate **122**. The common electrode **128** comprises a material that is optically transparent and electrically conductive, for example, such as indium tin oxide (ITO) and indium zinc oxide (IZO).

Referring again to FIGS. 1 to 5, the liquid crystal layer **130** is interposed between the first and second substrates **110** and **120**. A thickness of the liquid crystal layer **130** is in the range from about 3 μm to about 5 μm. A pixel voltage is applied to the pixel electrode **117**, and a reference voltage is applied to the common electrode **128**. Then, an arrangement of liquid crystal molecules of the liquid crystal layer **130** is adjusted according to electric fields formed between the pixel electrode **117** and the common electrode **128**, so that an optical transmittance of the liquid crystal layer is adjusted.

The seal line **140** comprises a thermosetting material and adhesive. The seal line **140** surrounds the first display part **113** of the first substrate **110** or the second display part **123** of the second substrate **120** to define a space between the first and second display parts **113** and **123**.

The seal line **140** combines the first and second substrates **110** and **120**. Further, the seal line **140** confines the liquid crystal material. The seal line **140** also forms a cell gap that corresponds to a distance between the first and second substrates **110** and **120**.

The seal line **140** surrounds the first display part **113** or the second display part **123**. However, the seal line **140** does not form a closed curve. That is, the seal line **140** has an opening portion corresponding to a liquid crystal inlet **145**. A width of the liquid crystal inlet is in the range from about 11 mm to about 20 mm.

Referring again to FIG. 2, an organic layer comprising an organic material is patterned to form the first spacer **150** in the first and second display parts **113** and **123**.

The seal line **140** forms the cell gap between the first and second substrates **110** and **120**, and the first spacer **150** maintains the cell gap.

FIG. 6 is a cross-sectional view taken along the line B-B' of FIG. 2.

Referring to FIG. 6, at least one second spacer **160** is formed at circumference of the liquid crystal inlet **145** of the seal line **140** surrounding the first and second display parts **113** and **123**. The second spacer **160** prevents the liquid crystal inlet **145** from being narrowed, so that a liquid crystal material may be injected easily into a liquid crystal receiving space that is formed between the first and second substrates **110** and **120** via the liquid crystal inlet **145**.

Then, a sealing member seals the liquid crystal inlet. The sealing member prevents the liquid crystal material from flowing out via the liquid crystal inlet **145**.

The sealing member comprises a material that is hardened, when an ultraviolet light is irradiated onto the material.

A tape carrier package and a driver printed circuit board are attached on the first substrate **100**. A pixel voltage and a reference voltage are applied to the first substrate **100** via the tape carrier package and the driver printed circuit board.

According to the present embodiment, a first spacer **150** is formed in the first and second display parts **113** and **123**, and a second spacer **160** is formed at a circumference of a liquid crystal inlet **145**, so that the liquid crystal inlet **145** is not narrowed. Thus, a liquid crystal material may be injected easily into a liquid crystal receiving space, so that deterioration of a display quality is prevented.

Embodiment 2

FIG. **7** is plan view showing first and second spacers formed on a first substrate according to a second exemplary embodiment of the present invention. FIG. **8** is a partially enlarged view showing a portion 'B' of FIG. **7**, and FIG. **9** is a cross-sectional view taken along a line C-C'. The first substrate is same as in Embodiment 1 except for a shape and arrangement of second spacers. Thus, the same reference numerals will be used to refer to the same or like parts as those described in Embodiment 1 and any further explanation will be omitted.

Referring to FIGS. **7** to **9**, first and second spacers **150** and **160** are formed on a first substrate **110** of a liquid crystal display panel **100**. The first spacer **150** is formed in a first display part **113**, and the second spacer **160** is formed at a circumference of a liquid crystal inlet **145**.

The second spacer **160** is disposed at the circumference of the liquid crystal inlet **145** so as to prevent the liquid crystal inlet **145** from being narrowed. That is, the second spacer **160** prevents a cell gap of the liquid crystal inlet **145**, which is formed between first and second substrates, from being narrowed.

According to the present embodiment, a plurality of the second spacers **160** is formed in the liquid crystal inlet **145**. In detail, when a liquid crystal material is injected in a first direction, the second spacers **160** are disposed in parallel with a second direction that is substantially perpendicular to the first direction.

The second spacers **160** may be disposed between an edge 'E' of the first substrate **110** and the first display part **113**. An arrangement of the second spacers **160** is determined according to a force applied to the first substrate **110** or the second substrate **120**.

In the present embodiment, the second spacers **160** is larger than the first spacers **150** in volume, and the second spacers **160** is denser than the first spacers **150** (or a number of the second spacers **160** per unit area is greater than a number of the first spacers **150** per unit area), so that a liquid crystal material may be injected via the liquid crystal inlet **145** easily.

A first distance L1 between the second spacers **160** is in the range from about 1.5 mm to about 2.0 mm. For example, when the first distance L1 is smaller than 1.5 mm, the second spacers **160** may block the liquid crystal material that flows into between the first and second substrates via the liquid crystal inlet **145**. On the contrary, when the first distance L1 is greater than 2.0 mm, the second spacers **160** may not prevent the liquid crystal inlet **145** from being narrowed. Thus, the liquid crystal material may not be injected easily via the liquid crystal inlet **145**.

A second distance L2 between an edge of the liquid crystal inlet **145** and the second spacer **160** is in the range from about 0.5 mm to about 1.5 mm. For example, when the

second distance L2 is smaller than 0.5 mm, an apparatus of forming the seal line **140** may not detect an exact position on which the seal line is formed. Thus, the seal line **140** may not be exactly formed. On the contrary, when the second distance L2 is greater than 1.5 mm, a cell gap between the first and second substrates **110** and **120** may be narrowed, so that the liquid crystal material may be easily injected.

In the present embodiment of the present invention, the second spacer **160** is formed on the first substrate **110**, so that the liquid crystal material may be easily injected.

Embodiment 3

FIG. **10** is an enlarged view showing a second spacer according to a third exemplary embodiment of the present invention. The liquid crystal display apparatus is same as in Embodiment 2 except for an arrangement of second spacers. Thus, the same reference numerals will be used to refer to the same or like parts as those described in Embodiment 2 and any further explanation will be omitted.

Referring to FIG. **10**, when a liquid crystal material is injected in a first direction, a plurality of second spacers **160** are arranged in the first direction. For example, in the present embodiment, two columns of the second spacers **160** are formed along the second direction. Each of columns includes a plurality of the second spacers **160** in the first direction. Then, the second spacers **160** maintain a cell gap formed between the first and second substrates, while it minimizes a blocking of a liquid crystal material. Thus, the liquid crystal material may be easily injected via the liquid crystal inlet **145**.

According to the present embodiment, a plurality of the second spacers **160** is arranged in a liquid crystal injecting direction of a liquid crystal material. Thus, the second spacers **160** may not block the liquid crystal material, so that the liquid crystal material may be easily injected, while preventing the liquid crystal inlet **145** from being narrowed.

Embodiment 4

FIG. **11** is an enlarged view showing a second spacer according to a fourth exemplary embodiment of the present invention. The liquid crystal display apparatus is same as in Embodiment 2 except for an arrangement of second spacers. Thus, the same reference numerals will be used to refer to the same or like parts as those described in Embodiment 2 and any further explanation will be omitted.

Referring to FIG. **11**, second spacers **160** are arranged in a zigzag form, so that the second spacers **160** maintain a cell gap between first and second substrates, while the second spacers **160** are not blocking a liquid crystal material. Further, the second spacer **160** is disposed widely between the first and second substrate so that even when an excessive force is applied, the second spacer **160** may maintain the cell gap.

According to the present embodiment, a plurality of the second spacers **160** is arranged in a zigzag form in the liquid crystal inlet **145** so as to maintain the cell gap between the first and second substrates. Thus, the liquid crystal material may be easily injected into between the first and second substrates.

Embodiment 5

FIG. **12** is an enlarged view showing a second spacer according to a fifth exemplary embodiment of the present invention. The liquid crystal display apparatus is same as in Embodiment 2 except for a shape of second spacers. Thus, the same reference numerals will be used to refer to the same or like parts as those described in Embodiment 2 and any further explanation will be omitted.

Referring to FIG. **12**, second spacers **160** formed in a liquid crystal inlet **145** has a cylindrical shape. The second

spacers **160** may have a truncated cone shape. When the second spacers **160** has the cylindrical shape or the truncated cone shape, a friction between the second spacers **160** and a liquid crystal material that is to be injected into between first and second substrates is reduced. Thus, the liquid crystal may be easily injected, while preventing the liquid crystal inlet **145** from being narrowed.

According to the present embodiment, each of the second spacers **160** has the cylindrical shape, or the truncated cone shape, so that the liquid crystal material may be easily injected into between the first and second substrates.

Embodiment 6

FIG. **13** is an enlarged view showing a second spacer according to a sixth exemplary embodiment of the present invention. The liquid crystal display apparatus is same as in Embodiment 2 except for a shape of second spacers. Thus, the same reference numerals will be used to refer to the same or like parts as those described in Embodiment 2 and any further explanation will be omitted.

Referring to FIG. **13**, second spacers **160** formed in a liquid crystal inlet **145** has a triangular prism shape, such that an edge of the triangular prism extends outward. Thus, a liquid crystal material may be injected easily via a liquid crystal inlet **145**, because a friction between the second spacers **160** and the liquid crystal material is reduced.

However, the friction between the second spacers **160** and the liquid crystal material increases when the liquid crystal material flows out. Thus, the second spacers **160** prevent the liquid crystal material from being leaked.

According to the present embodiment, the second spacers **160** have a triangular shape of which edge faces an injection direction of a liquid crystal molecule. Thus, a friction between the liquid crystal material and the second spacers **160** is reduced.

Embodiment 7

FIG. **14** is an enlarged view showing a second spacer according to a seventh exemplary embodiment of the present invention. The liquid crystal display apparatus is same as in Embodiment 2 except for a shape of second spacers. Thus, the same reference numerals will be used to refer to the same or like parts as those described in Embodiment 2 and any further explanation will be omitted.

Referring to FIG. **14**, second spacers **160** formed in a liquid crystal inlet **145** have an elliptical column shape, so that a friction between the second spacers **160** and a liquid crystal material is reduced.

A long axis of an ellipse that is a cross-section of the second spacers **160** is substantially in parallel with a first direction that corresponds to a liquid crystal injection direction so as to reduce a friction between the second spacer **160** and the liquid crystal material. When the long axis is in parallel with a second direction that is substantially perpendicular to the first direction, the friction between the second spacers **160** and the liquid crystal material increases.

According to the present embodiment, each of the second spacers **160** has an elliptical column shape of which long axis is substantially in parallel with the liquid crystal injection direction. Thus, the liquid crystal material may be easily injected into between first and second substrates.

Embodiment 8

FIG. **15** is a plan view showing first and second spaces formed on a second substrate according to an eighth exemplary embodiment of the present invention, and FIG. **16** is a partially enlarged view showing a portion 'C' of FIG. **15**. The liquid crystal display apparatus is same as in Embodiment 1 except for an arrangement and a shape of second spacers. Thus, the same reference numerals will be used to

refer to the same or like parts as those described in Embodiment 2 and any further explanation will be omitted.

Referring to FIGS. **15** and **16**, first and second spacers **155** and **165** are formed on a second substrate **120** of a liquid crystal display apparatus. The first spacer **155** is formed in a second region **123**, and the second spacer **165** is formed near a liquid crystal inlet **147**.

The second spacer **165** is disposed near the liquid crystal inlet **147** so as to prevent a cell gap between first and second substrates from being narrowed (or so as to prevent the liquid crystal inlet **147** from being narrowed).

According to the present embodiment, a plurality of the second spacers **165** is formed in the liquid crystal inlet **147**. In detail, when a liquid crystal material is injected in a first direction, the second spacers **165** are disposed in parallel with a second direction that is substantially perpendicular to the first direction.

The second spacers **165** may be disposed between an edge 'E' of the second substrate **120** and the second display part **123**. An arrangement of the second spacers **165** is determined according to a force applied to the first substrate **110** or the second substrate **120**.

According to the present embodiment, the second spacers **165** are larger than the first spacers **155** in volume, and the second spacers **165** are denser than the first spacers **155** (or a number of the second spacers **165** per unit area is greater than a number of the first spacers **155** per unit area), so that a liquid crystal material may be injected via the liquid crystal inlet **147** easily.

A first distance **L1** between the second spacers **165** is in the range from about 1.5 mm to about 2.0 mm. For example, when the first distance **L1** is shorter than 1.5 mm, the second spacers **160** may block the liquid crystal material. On the contrary, when the first distance **L1** is greater than 2.0 mm, the second spacers **165** may not prevent the liquid crystal inlet **147** from being narrowed. Thus, the liquid crystal material may not be injected easily via the liquid crystal inlet **147**.

A second distance **L2** between an edge of the liquid crystal inlet **147** and the second spacer **165** is in the range from about 0.5 mm to about 1.5 mm. For example, when the second distance **L2** is shorter than 0.5 mm, an apparatus of forming the seal line **146** may not detect an exact position on which the seal line is formed. Thus, the seal line **146** may not be exactly formed. On the contrary, when the second distance **L2** is greater than 1.5 mm, a cell gap between the first and second substrates **110** and **120** may be narrowed, so that the liquid crystal material may be easily injected.

In the present embodiment of the present invention, the second spacer **165** is formed on the second substrate **120**, such that the liquid crystal material may be easily injected.

Embodiment 9

FIG. **17** is an enlarged view showing a second spacer according to a ninth exemplary embodiment of the present invention. The liquid crystal display apparatus is same as in Embodiment 8 except for an arrangement of second spacers. Thus, the same reference numerals will be used to refer to the same or like parts as those described in Embodiment 8 and any further explanation will be omitted.

Referring to FIG. **17**, when a liquid crystal material is injected in a first direction, a plurality of second spacers **165** are arranged in the first direction. For example, in the present embodiment, two columns of the second spacers **165** are formed along the second direction. Each of columns includes a plurality of the second spacers **165** in the first direction. Then, the second spacers **165** may support a cell gap formed between the first and second substrates, while

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the second spacers **165** minimize a blocking a liquid crystal material. Thus, the liquid crystal material may be easily injected via the liquid crystal inlet **147**.

According to the present embodiment, a plurality of the second spacers **165** is arranged in an injecting direction of a liquid crystal material. Thus, the second spacers **165** do not block the liquid crystal material, so that the liquid crystal material may be easily injected, while preventing the liquid crystal inlet **147** from being narrowed.

Embodiment 10

FIG. **18** is an enlarged view showing a second spacer according to a tenth exemplary embodiment of the present invention. The liquid crystal display apparatus is same as in Embodiment 8 except for an arrangement of second spacers. Thus, the same reference numerals will be used to refer to the same or like parts as those described in Embodiment 8 and any further explanation will be omitted.

Referring to FIG. **18**, second spacers **165** are arranged in a zigzag form, so that the second spacers **165** maintains a cell gap between first and second substrates, while the second spacers **165** are not blocking a liquid crystal material. Further, the second spacer **165** is disposed widely between the first and second substrates so that even when an excessive force is applied, the second spacer **165** may maintain the cell gap.

According to the present embodiment, a plurality of the second spacers **165** is arranged in a zigzag form in the liquid crystal inlet **147** so as to maintain the cell gap between the first and second substrates. Thus, the liquid crystal material may be easily injected into between the first and second substrates.

Embodiment 11

FIG. **19** is an enlarged view showing a second spacer according to an eleventh exemplary embodiment of the present invention. The liquid crystal display apparatus is same as in Embodiment 8 except for a shape of second spacers. Thus, the same reference numerals will be used to refer to the same or like parts as those described in Embodiment 8 and any further explanation will be omitted.

Referring to FIG. **19**, second spacers **165** formed in a liquid crystal inlet **147** have a cylindrical shape. The second spacers **165** may have a truncated cone shape. When the second spacers **165** has the cylindrical shape or the truncated cone shape, a friction between the second spacers **165** and a liquid crystal material that is to be injected into between first and second substrates is reduced. Thus, the liquid crystal may be easily injected, while preventing the liquid crystal inlet **147** from being narrowed.

According to the present embodiment, each of the second spacers **165** has the cylindrical shape or the truncated cone shape, so that the liquid crystal material may be easily injected into between the first and second substrates.

Embodiment 12

FIG. **20** is an enlarged view showing a second spacer according to a twelfth exemplary embodiment of the present invention. The liquid crystal display apparatus is same as in Embodiment 8 except for a shape of second spacers. Thus, the same reference numerals will be used to refer to the same or like parts as those described in Embodiment 8 and any further explanation will be omitted.

Referring to FIG. **20**, second spacers **165** formed in a liquid crystal inlet **147** has a triangular prism shape, such that an edge of the triangular prism extends outward. Thus, a liquid crystal material may be injected easily via a liquid crystal inlet **147**, because a friction between the second spacers **165** and the liquid crystal material is reduced.

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However, the friction between the second spacers **165** and the liquid crystal material increases, when the liquid crystal material flows out. Thus, the second spacers **165** prevent the liquid crystal material from being leaked.

According to the present embodiment, the second spacers **165** have a triangular shape of which edge faces an injection direction of a liquid crystal molecule. Thus, a friction between the liquid crystal material and the second spacers **165** is reduced.

Embodiment 13

FIG. **21** is an enlarged view showing a second spacer according to a thirteenth exemplary embodiment of the present invention. The liquid crystal display apparatus is same as in Embodiment 8 except for a shape of second spacers. Thus, the same reference numerals will be used to refer to the same or like parts as those described in Embodiment 8 and any further explanation will be omitted.

Referring to FIGS. **21**, second spacers **165** formed in a liquid crystal inlet **147** have an elliptical column shape, so that a friction between the second spacers **165** and a liquid crystal material is reduced.

A long axis of an ellipse that is a cross-section of the second spacers **165** is substantially in parallel with a first direction that corresponds to a liquid crystal injection direction, so as to reduce a friction between the second spacer **165** and the liquid crystal material. When the long axis is in parallel with a second direction that is substantially perpendicular to the first direction, the friction between the second spacers **165** and the liquid crystal material increases.

According to the present embodiment, each of the second spacers **165** has an elliptical column shape of which long axis is substantially in parallel with the liquid crystal injection direction. Thus, the liquid crystal material may be easily injected into between first and second substrates.

Embodiment 14

FIG. **22** is a flow chart showing a method of manufacturing the liquid crystal display panel of FIG. **1** according to a fourteenth exemplary embodiment of the present invention. Hereinafter, a method of manufacturing a liquid crystal display apparatus is explained.

Referring to FIG. **22**, in order to manufacture a liquid crystal display panel, a first substrate having a plurality of pixels and a second substrate having color filters are formed (step S1).

FIG. **23** is a plan view showing a process of manufacturing the first substrate of FIG. **22**. FIG. **24** is a schematic view showing a unit pixel of a liquid crystal display panel of FIG. **23**, and FIG. **25** is a cross-sectional view showing a thin film transistor and a pixel electrode formed on the first substrate of FIG. **23**.

Referring to FIG. **23**, a plurality of first substrates **300** is formed on a first mother substrate **400** so as to enhance productivity.

Referring to FIGS. **23** to **25**, each of the first substrate **300** includes a plurality of pixels **320** arranged in a matrix shape. The pixels **320** are formed in a first display part **310**. For example, when a liquid crystal display apparatus has a resolution is 1024×768, and displays a full color, 1024×768 number of pixels **320** are formed on the first display part **310**.

Referring to FIGS. **24** and **25**, each of the pixels **320** includes a gate line **321**, a data line **323**, a thin film transistor **325** and a pixel electrode **327**. The gate line **321** extends in a first direction. 768 number of gate lines are arranged in parallel. The gate line **321** comprises a material that has good electric property, for example, such as aluminum or aluminum alloy.

The data line **323** is insulated from the gate line **321**. The data line **323** extends in a second direction that is substantially perpendicular to the first direction.

1024×3 number of data lines **323** are arranged in parallel. The data line **323** also comprises a material that has a good electric property, for example, such as aluminum or aluminum alloy.

The thin film transistor **325** is electrically connected to the gate line **321** and the data line **323**. The thin film transistor **325** includes a gate electrode G, a source electrode S, a channel layer C and a drain electrode D.

The gate line **321** that extends in the first direction protrudes in the second direction to form the gate electrode G. 1024×3 number of gate electrodes G are formed spaced apart per gate line.

The channel layer C is formed on the gate electrode G, such that the electrically insulated from the gate electrode G. The channel layer comprises amorphous silicon or n+ amorphous silicon having dopants.

The source electrode S is electrically connected to the data line **323**. 768 number of source electrodes are formed per data line **323**. The source electrode S is formed on the channel layer C.

The drain electrode D is electrically insulated from the source electrode S. The drain electrode D is also formed on the channel layer C.

The pixel electrode **327** comprises a material that is optically transparent and electrically conductive, such as indium tin oxide (ITO) and indium zinc oxide (IZO).

The pixel electrode **327** is formed on a pixel region defined by the gate line **321** and the data line **323**. The pixel electrode **327** is electrically connected to the drain electrode D of the thin film transistor **325**.

FIG. 26 is a plan view showing a process of manufacturing the second substrate of FIG. 22. FIG. 27 is a cross-sectional view taken along the line F-F' of FIG. 26.

Referring to FIGS. 26 and 27, a plurality of second substrates **500** is formed on a second mother substrate **600** so as to enhance productivity.

Each of the second substrate **500** includes a second display part **510** for displaying an image. The second display part **510** has substantially same area as the first display part **310** of the first substrate **300**. The second display part **510** faces the first display region **310**. The second display part **510** includes a light blocking layer **520**, a color filter **530**, a common electrode **540** and a first spacer **550**. A seal line **560** and a second spacer **570** are formed on the second substrate **500** outside of the second display part **510**.

The light blocking layer **520** comprises a metal such as chromium (Cr) or chromium oxide (CrO₂), or an organic material. The light blocking layer **520** has opening corresponding to the pixel electrode **327** of the first substrate **300**. Thus, the light blocking layer **520** allows a first light that penetrates the pixel electrode **327** to pass through via the opening, and the light blocking layer **520** blocks a second light that penetrate between the pixel electrodes **327** so as to enhance a display quality. A portion of the light blocking layer **520** is formed a band shape along an edge of the second display part **510**.

The color filter **530** is formed on the second substrate **500**, such that the color filter **530** faces the pixel electrode **327**. The color filter **530** includes a red color filter, a green color filter and a blue color filter. The red color filter allows only a light that has a wavelength corresponding to a red color to pass through the red color filter. The green color filter allows only a light that has a wavelength corresponding to a green color to pass through the green color filter. The blue color

filter allows only a light that has a wavelength corresponding to a blue color to pass through the blue color filter.

The common electrode **540** is formed on the color filter **530** covering all region of the second substrate **500**. The common electrode **540** comprises a material that is optically transparent and electrically conductive, such as indium tin oxide (ITO) and indium zinc oxide (IZO).

An organic layer comprising an organic material is patterned to form a plurality of the first spacers **550** on the common electrode **540**.

The seal line **560** comprises a thermosetting material and adhesive. The seal line **560** combines the first and second substrates **300** and **500**. Further, the seal line **560** confines the liquid crystal material. The seal line **560** also forms a cell gap that corresponds to a distance between the first and second substrates **300** and **500**.

The seal line **560** surrounds the first display part **310** or the second display part **510**. However, the seal line **560** does not form a closed curve. That is, the seal line **560** has an opening that corresponds to a liquid crystal inlet **565**. A width of the liquid crystal **565** inlet is in the range from about 11 mm to about 20 mm.

The organic layer comprising the organic material is patterned to form the second spacers **570** at a circumference of the liquid crystal inlet **565**. The second spacer **570** is disposed outside of cutting line 'a'. The second spacer **570** may be on the cutting line 'a' or inside of the cutting line 'a'.

The second spacer **570** is formed simultaneously with the first spacer **550**. The second spacer **570** prevents the cell gap of the liquid crystal inlet **565** from being narrowed.

The first spacer **550**, the seal line **560** and the second spacer **570** may be formed on the first substrate **300**.

Referring again to FIG. 22, when the first and second substrates **300** and **500** including the first and second display parts **310** and **510** respectively are formed in step S1, the first and second substrates **300** and **500** are aligned such that the first and second display parts **310** and **510** may face with each other. Then, the first and second substrates **300** and **500** are assembled together in step S2).

When the first and second display parts **310** and **510** are exactly aligned, a color filter **530** is disposed over a pixel electrode **327**. The light blocking layer **520** is disposed over the data line **321** and the data line **323**, and the first spacers **550** are disposed between the pixels **320**.

Then, the first and second mother substrates **400** and **600** are heated and compressed, so that the first and second mother substrates **400** and **600** are combined together in step S3).

When the first and second mother substrates **400** and **600** are heated and compressed, the first spacers **550** disposed in the first and second display parts **310** and **510** maintain a cell gap between the first and second substrates **300** and **500**, and the second spacers **570** prevent a cell gap of the liquid crystal inlet **565** from being narrowed.

A seal line **560** between the first and second mother substrates **400** and **600** is hardened, so that the first and second mother substrates **400** and **600** are combined with each other. Hereinafter, the first and second substrates **300** and **500** combined with each other will be referred to as a unit cell **700**.

Then, the unit cell **700** are separated from the first and second mother substrates **400** and **600** by cutting a cutting lines 'a' and 'b' of the first and second mother substrates **400** and **600** (step S4).

FIG. 28 is a partially cut out perspective view showing a unit cell that is separated from a mother substrate according to a fourth step of FIG. 22.

When the unit cell is separated from the first and second mother substrates, the second spacer that is formed outside of the cutting line 'a' remains at the first and second mother substrates, but the second spacer **570** that is formed inside of the cutting line 'a' remains at the unit cell as shown in FIG. **28**.

Referring to FIGS. **22** and **28**, when the unit cell **700** is separated from the first and second mother substrates (step **S4**), the liquid crystal inlet **565** is dipped in a liquid crystal material in a chamber having vacuum pressure. Then, the pressure of the chamber increases, so that the liquid crystal material flows into the unit cell **700** (step **S5**).

The second spacer **570** maintains the cell gap. When the second spacer **570** is formed outside of the cutting line 'a', the second spacer is not formed at the unit cell **700**. Thus, the unit cell does not block the liquid crystal material that flows into the unit cell **700** via the liquid crystal inlet **565**. In case that the second spacer **570** is formed inside of the cutting line 'a', a friction between the second spacer that is one of the previous embodiments and the liquid crystal material is minimized, so that the liquid crystal material is injected into the unit cell **700** easily.

When the liquid crystal material is filled completely, a sealing member seals the liquid crystal inlet **565**, so that the liquid crystal material may not flow out via the liquid crystal inlet **565**. Thus, a liquid crystal display panel **800** is formed (step **S6**).

The sealing member comprises a material that is hardened when an ultraviolet light is irradiated onto the material. Thus, the sealing member is hardened, when the ultraviolet light is irradiated onto the seal member.

According to the present embodiment, the first spacer **550** is formed in the first and second display parts **310** and **510**. The second spacer **570** is formed outside or inside of the cutting line 'a' so as to maintain the cell gap of the liquid crystal inlet in assembling the first and second mother substrates. Thus, the second spacer **570** does not block the liquid crystal material that flows into the unit cell, or a friction between the second spacer **570** and the liquid crystal material is minimized, so that the liquid crystal material is injected easily. Thus, the liquid crystal material is completely filled to enhance the display quality.

Embodiment 15

FIG. **29** is a plan view showing first, second and third spacers formed on a second substrate according to a fifteenth exemplary embodiment of the present invention, and FIG. **30** is a cross-sectional view taken along the line G-G'. The liquid crystal display apparatus is same as in Embodiment 1 except for a third spacer. Thus, the same reference numerals will be used to refer to the same or like parts as those described in Embodiment 1 and any further explanation will be omitted.

Referring to FIGS. **29** and **30**, first, second and third spacers **550**, **570** and **580** are formed on the second substrate **500**. The first spacer **550** is formed inside of a second display part **510**. The second and third spacers **570** and **580** are formed near a liquid crystal inlet **565**.

The second spacer **570** is formed on a cutting line 'a', or outside of the cutting line 'a'. The third spacer **580** is formed inside of the cutting line 'a' that passes the liquid crystal inlet **565**. The first, second and third spacers **550**, **570** and **580** are formed simultaneously. The second and third spacers **570** and **580** prevent the cell gap of the liquid crystal inlet from being narrowed.

FIG. **31** is an enlarged view showing the second and third spacers of FIG. **29**.

Referring to FIG. **31**, when a liquid crystal material is injected in a first direction, second and third spacers **570** and **580** are disposed in a second direction that is substantially perpendicular to the first direction. The second and third spacers **570** and **580** are parallel with each other in the first direction. A force applied to the first and second substrates **300** and **600** determines an arrangement of the second and third spacers **570** and **580**.

In the present embodiment, the second and third spacers **570** and **580** are larger than the first spacer **550** in volume, and the second and third spacers **570** and **580** are sparser than the first spacer **550** (or a number of the second and third spacers **570** and **580** per unit area is smaller than a number of the first spacer **550** per unit area), or the second and third spacers **570** and **580** are smaller than the first spacer **550** in volume, and the second and third spacers **570** and **580** are denser than the first spacer **550** (or a number of the second and third spacers **570** and **580** per unit area is greater than a number of the first spacer **550** per unit area). The number of the second spacer **570** is same as the number of the third spacer **580**.

Thus, a young's modulus of the first spacer **550** and a young's modulus of the second and third spacers **570** and **580** are substantially same with each other, so that a cell gap is maintained uniform during a process of heating and compressing so as to combine the first and second mother substrates.

In the present embodiment, a first distance **L1** between the second spacers **570**, and a second distance between the third spacers **580** are in the range from about 1.0 mm to about 3.0 mm. When the first and second distance **L1** and **L2** are smaller than 1.0 mm, the second and third spacer **570** and **580** may block a liquid crystal material that flows into between the first and second substrates. On the contrary, when first and second distances **L1** and **L2** are longer than 3.0 mm, a uniformity of the cell gap of the liquid crystal inlet **565** is lowered. Thus, the liquid crystal material may not be easily injected.

A third distance **L3** between the second spacer **570** and an edge of the liquid crystal inlet **565** or between the third spacer **580** and the edge of the liquid crystal inlet **565** is in the range from about 1.5 mm to about 3.0 mm. When the third distance **L3** is shorter than 1.5 mm, an apparatus of forming the seal line **560** may not detect an exact position on which the seal line **560** is formed. Thus, the seal line **560** may not be exactly formed. On the contrary, when the third distance **L3** is greater than 3.0 mm, a uniformity of the cell gap of the liquid crystal inlet **565** is lowered. Thus, the liquid crystal material may not be easily injected.

Each of the second and third spacers **570** and **580** has a rectangular prism.

The first and second mother substrates **400** and **600** having the first and second substrates **300** and **500** respectively are assemble together. Then, the first and second mother substrates **400** and **600** are heated and compressed to be combined with each other.

When the first and second mother substrates **400** and **600** are compressed, the first spacer **550** maintains a cell gap between the first and second substrates **300** and **500**, and the second and third spacers **570** and **580** prevent the liquid crystal inlet **565** from being narrowed.

Then, unit cell **700** is separated from the first and second mother substrates **400** and **600** by cutting both of cutting lines 'a' and 'b'. The second spacer **570** formed outside of the cutting line remains at the second mother substrate **600**. The third spacer **580** formed inside of the cutting line remains at the liquid crystal inlet **565** of the unit cell **700**.

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The liquid crystal inlet **565** is dipped in a liquid crystal material in a chamber having vacuum pressure. Then, the pressure of the chamber is enhanced, so that the liquid crystal material is injected into between the first and second substrates **300** and **500**.

The second and third spacers **570** and **580** maintain the cell gap of the liquid crystal inlet **565** during the assembling process of the first and second mother substrates. Thus, the liquid crystal material may be injected easily.

When the liquid crystal material is filled completely, a sealing member seals the liquid crystal inlet **565**, so that the liquid crystal panel is formed.

According to the present embodiment, the first spacer **550** is formed between the first and second display parts **310** and **510**, and the second and third spacers **570** and **580** are formed outside and inside of the cutting line 'a' respectively, so as to maintain the cell gap of the liquid crystal inlet uniformly. Thus, the uniformity of the cell gap is enhanced.

Embodiment 16

FIG. **32** is an enlarged view showing second and third spacers according to a sixteenth exemplary embodiment of the present invention. The liquid crystal display apparatus is same as in Embodiment 15 except for an arrangement of the third spacers. Thus, the same reference numerals will be used to refer to the same or like parts as those described in Embodiment 15 and any further explanation will be omitted.

Referring to FIG. **32**, a column of second spacers **570** is formed in parallel with a cutting line 'a'. A column of third spacers **580** is spaced apart from the second spacers **570**. Each of the third spacers **580** is disposed between the second spacers **570**, such that each of the second and third spacers **570** and **580** is disposed to form a zigzag shape. Thus, a liquid crystal material may be easily injected. Further, the second and third spacers **570** and **580** maintain a cell gap, even when the first and second mother substrates are excessively compressed.

According to the present embodiment, the second and third spacers **570** and **580** are disposed to form the zigzag form so as to maintain the cell gap of the liquid crystal inlet **565**. Thus, the liquid crystal material sprayed while passing trough between the second spacers **570** may easily pass through between the third spacers **580**.

Embodiment 17

FIG. **33** is an enlarged view showing second and third spacers according to a seventeenth exemplary embodiment of the present invention. The liquid crystal display apparatus is same as in Embodiment 15 except for a shape of third spacers. Thus, the same reference numerals will be used to refer to the same or like parts as those described in Embodiment 15 and any further explanation will be omitted.

Referring to FIG. **33**, third spacers **580** disposed inside of a cutting line 'a' has a cylindrical shape. The third spacers **580** may have a truncated cone shape. When the third spacers **580** have the cylindrical shape or the truncated cone shape, a friction between the third spacers **580** and a liquid crystal material that is to be injected into between first and second substrates is reduced. Thus, the liquid crystal may be easily injected, while preventing the liquid crystal inlet **565** from being narrowed.

A second spacer **570** disposed outside of the cutting line 'a' may have an arbitrary shape. When a unit cell is separated from the first and second mother substrates, the second spacer **570** is not disposed in the unit cell. Then, a liquid crystal material is injected. Thus, a shape of the second spacer **570** does not have any effect on injection of the liquid crystal material.

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According to the present embodiment, each of the third spacers **160** has the cylindrical shape, or the truncated cone shape, so that the liquid crystal material may be easily injected into between the first and second substrates.

Embodiment 18

FIG. **34** is an enlarged view showing second and third spacers according to an eighteenth exemplary embodiment of the present invention. The liquid crystal display apparatus is same as in Embodiment 15 except for a shape of third spacers. Thus, the same reference numerals will be used to refer to the same or like parts as those described in Embodiment 15 and any further explanation will be omitted.

Referring to FIG. **34**, third spacers **580** disposed inside of a cutting line 'a' has a triangular prism shape. An edge of the triangular prism extends outward. Thus, a liquid crystal material may be injected easily via a liquid crystal inlet **565** because a friction between the third spacers **580** and the liquid crystal material is reduced.

However, the friction between the third spacers **580** and the liquid crystal material increases when the liquid crystal material flows out. Thus, the third spacers **580** prevent the liquid crystal material from being leaked.

A second spacer **570** disposed outside of the cutting line 'a' may have an arbitrary shape. When a unit cell is separated from the first and second mother substrates, the second spacer **570** is not disposed in the unit cell. Then, a liquid crystal material is injected. Thus, a shape of the second spacer **570** does not have any effect on injection of the liquid crystal material.

According to the present embodiment, the third spacers **580** have a triangular shape of which edge faces an injection direction of a liquid crystal molecule. Thus, a friction between the liquid crystal material and the third spacers **580** is reduced.

Embodiment 19

FIG. **35** is an enlarged view showing second and third spacers according to a nineteenth exemplary embodiment of the present invention. The liquid crystal display apparatus is same as in Embodiment 15 except for a shape of third spacers. Thus, the same reference numerals will be used to refer to the same or like parts as those described in Embodiment 15 and any further explanation will be omitted.

Referring to FIG. **35**, third spacers **580** disposed inside of a cutting line 'a' have an elliptical column shape, so that a friction between the third spacers **580** and a liquid crystal material is reduced.

A long axis of an ellipse that is a cross-section of the third spacers **580** is substantially in parallel with a first direction that corresponds to a liquid crystal injection direction so as to reduce a friction between the third spacer **580** and the liquid crystal material. When the long axis is in parallel with a second direction that is substantially perpendicular to the first direction, the friction between the third spacers **580** and the liquid crystal material increases.

A second spacer **570** disposed outside of the cutting line 'a' may have an arbitrary shape. When a unit cell is separated from the first and second mother substrates, the second spacer **570** is not disposed in the unit cell. Then, a liquid crystal material is injected. Thus, a shape of the second spacer **570** does not have any effect on injection of the liquid crystal material.

According to the present embodiment, each of the second spacers **160** has an elliptical column shape of which long axis is substantially in parallel with the liquid crystal injection direction. Thus, the liquid crystal material may be easily injected into between first and second substrates.

Having described the exemplary embodiments of the present invention and its advantages, it is noted that various changes, substitutions and alterations can be made herein without departing from the spirit and scope of the invention as defined by appended claims.

What is claimed is:

1. A liquid crystal display apparatus comprising:

a first substrate including a first display part having a pixel electrode;

a second substrate including a second display part having a common electrode that faces the pixel electrode;

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

a seal line including a liquid crystal inlet, the seal line defining the first and second display parts;

a first spacer disposed between the first and second display parts, the first spacer maintaining a cell gap formed between the first and second substrates; and

a second spacer disposed near the liquid crystal inlet, the second spacer maintaining the cell gap,

wherein each of the second spacers has a prism shape or an elliptical column shape, the prism shape having an approximately triangular cross section with three surfaces wherein one of the three surfaces is substantially perpendicular to a liquid crystal injection direction, and the elliptical column shape having an elliptical cross section with a long axis that is parallel to the liquid crystal injection direction.

2. The liquid crystal display apparatus of claim 1, wherein the first and second spacers are formed on the first substrate.

3. The liquid crystal display apparatus of claim 2, wherein a number of the second spacer is plural, and the second spacers are arranged substantially in parallel to a liquid crystal injection direction.

4. The liquid crystal display apparatus of claim 2, wherein a number of the second spacer is plural and the second spacers are arranged in a zigzag form.

5. The liquid crystal display apparatus of claim 1, wherein the seal line is formed on the first substrate.

6. The liquid crystal display apparatus of claim 1, wherein a number of the second space is plural, and the second spacers are arranged in a line.

7. The liquid crystal display apparatus of claim 6, wherein the line is substantially perpendicular to a liquid crystal injection direction.

8. The liquid crystal display apparatus of claim 1, wherein a number of the first spacer is greater than a number of the second spacer, and a supporting force of the first spacer per unit area is substantially same as the supporting force of the second spacer per unit area.

9. The liquid crystal display apparatus of claim 1, further comprising a sealing member that seals the liquid crystal inlet, the sealing member being spaced apart from the second spacer.

10. The liquid crystal display apparatus of claim 9, wherein the sealing member comprises a material that is hardened when an ultraviolet light is irradiated.

11. The liquid crystal display apparatus of claim 1, wherein the first and second spacers are formed on the second substrate.

12. The liquid crystal display apparatus of claim 11, wherein the seal line is formed on the second substrate.

13. The liquid crystal display apparatus of claim 11, wherein a number of the second space is plural, and the second spacers are arranged in a line.

14. The liquid crystal display apparatus of claim 11, wherein the line is substantially perpendicular to a liquid crystal injection direction.

15. The liquid crystal display apparatus of claim 11, wherein a number of the first spacer is greater than a number of the second spacer, and a supporting force of the first spacer per unit area is substantially same as the supporting force of the second spacer per unit area.

16. The liquid crystal display apparatus of claim 11, wherein a width of the liquid crystal inlet is in a range from about 11 mm to about 20 mm, a number of the second spacer is plural, a first distance between the second spacers is in a range from about 1.5 mm to about 2.0 mm, and a second distance between the second spacer and an edge of the liquid crystal inlet is in a range from about 0.5 mm to about 1.5 mm.

17. The liquid crystal display apparatus of claim 11, further comprising a sealing member that seals the liquid crystal inlet, the sealing member being spaced apart from the second spacer.

18. The liquid crystal display apparatus of claim of claim 17, wherein the sealing member comprises a material that is hardened when an ultraviolet light is irradiated.

19. The liquid crystal display apparatus of claim 11, wherein a number of the second spacer is plural and the second spacers are arranged substantially in parallel to a liquid crystal injection direction.

20. The liquid crystal display apparatus of claim 11, wherein a number of the second spacer is plural and the second spacers are arranged in a zigzag form.

21. The liquid crystal display apparatus of claim 11, wherein the second spacer has a cylindrical shape, a triangular prism shape of which an edge facing a liquid crystal injection direction, or an elliptical column shape of which long axis is in parallel the liquid crystal injection direction.

22. A liquid crystal display apparatus comprising:

a first substrate including a first display part having a pixel electrode;

a second substrate including a second display part having a common electrode that faces the pixel electrode;

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

a seal line including a liquid crystal inlet, the seal line defining the first and second display parts;

a first spacer disposed between the first and second display parts, the first spacer maintaining a cell gap formed between the first and second substrates; and

a second spacer disposed near the liquid crystal inlet, the second spacer maintaining the cell gap,

wherein a width of the liquid crystal inlet is in a range of about 11 mm to about 20 mm, a number of the second spacer is plural, a first distance between the second spacers is in a range of about 1.5 mm to about 2.0 mm, and a second distance between the second spacer and an edge of the liquid crystal inlet is in a range of about 0.5 mm to about 1.5 mm.

23. A method of manufacturing a liquid crystal display apparatus, comprising:

forming a first display part on a first mother substrate;

forming a second display part on a second mother substrate, such that the second display part faces the first display part;

forming a seal line having a liquid crystal inlet along a boundary of the first display part;

forming first and second spacers on the first display part and outside of the first display part corresponding to the liquid crystal inlet respectively;

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assembling the first and second mother substrates together;

separating the first and second display parts from the first and second mother substrates;

injecting a liquid crystal material into between the first and second display parts via the liquid crystal inlet; and sealing the liquid crystal inlet, wherein each of the second spacers has a prism shape or an elliptical column shape, the prism shape having an approximately triangular cross section with three surfaces wherein one of the three surfaces is substantially perpendicular to a liquid crystal injection direction, and the an elliptical column shape having an elliptical cross section with a long axis that is parallel to the liquid crystal injection direction.

24. The method of claim 23, further comprising forming third spacers on the outside of the first display part so as to prevent a cell gap from being narrowed.

25. The method of claim 24, wherein a number of the second spacer and a number of the third spacer are plural respectively, and the second and third spacers are arranged in a line respectively.

26. The method of claim 25, wherein the line is substantially perpendicular to a liquid crystal injection direction.

27. The method of claim 24, wherein a number of the first spacer, a number of the second spacer and a number of the third spacer are plural respectively, the number of the first spacer is greater than the number of the second spacer and the number of the third spacer, and a supporting force of the first spacer per unit area is substantially same as the supporting force of the second and third spacers per unit area.

28. The method of claim 24, wherein a number of the second spacer and a number of the third spacer are plural respectively, and each of the second spacer and each of the third spacer are arranged in a line that is substantially perpendicular to a liquid crystal injection direction.

29. The method of claim 24, wherein a number of the second spacer and a number of the third spacer are plural respectively, and the second and third spacers are disposed alternately to form a zigzag shape.

30. The method of claim 24, wherein the liquid crystal inlet is sealed by a sealing member.

31. The method of claim 30, wherein the sealing member comprises a material that is hardened when an ultraviolet light is irradiated.

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32. The method of claim 24, wherein (a) the first display part includes i) a first electrode, ii) a switching device that is electrically connected to the first electrode, iii) a first wiring that is electrically connected to the switching device so as to apply a first voltage to the first electrode, and iv) a second wiring that is electrically connected to the switching device so as to determine a time for applying the first voltage to the first electrode, and (b) the second display part includes a second electrode facing the first electrode.

33. A method of manufacturing a liquid crystal display apparatus, comprising:

forming a first display part on a first mother substrate;

forming a second display part on a second mother substrate, such that the second display part faces the first display part;

forming a seal line having a liquid crystal inlet along a boundary of the first display part;

forming first and second spacers on the first display part and outside of the first display part corresponding to the liquid crystal inlet respectively;

forming third spacers on the outside of the first display part so as to prevent a cell gap from being narrowed;

assembling the first and second mother substrates together;

separating the first and second display parts from the first and second mother injecting a liquid crystal material into between the first and second display parts via the liquid crystal inlet; and

sealing the liquid crystal inlet, wherein a width of the liquid crystal inlet is in a range of about 11 mm to about 20 mm, a number of the second spacer and a number of the third spacer are plural, a first distance between the second spacers and between the third spacers is in a range of about 1.5 mm to about 2.0 mm, and a second distance between the second spacer and an edge of the liquid crystal inlet and between the third spacer and the edge of the liquid crystal inlet is in a range of about 0.5 mm to about 1.5 mm.

* * * * *

专利名称(译)	液晶显示器包括设置在液晶入口附近的间隔物，其中间隔物具有棱柱形状或椭圆柱形状		
公开(公告)号	US7133109	公开(公告)日	2006-11-07
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摘要(译)

一种液晶显示装置，包括第一和第二基板，液晶层，密封构件，以及第一和第二间隔物。第一基板包括第一显示部分，第一显示部分上形成有像素电极。第二基板包括具有公共电极的第二显示部分。液晶层介于第一和第二基板之间。密封线包括液晶入口。第一间隔物设置在第一和第二显示部分之间。第二间隔物设置在液晶入口附近。第二和第三隔离物防止液晶入口的单元间隙变窄，从而可以容易地完全注入液晶材料。因此，液晶材料被完全填充以提高显示质量。

