US 20180275437A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2018/0275437 A1**

NISHIWAKI et al.

(43) **Pub. Date: Sep. 27, 2018**

(54) **DISPLAY PANEL AND METHOD OF PRODUCING DISPLAY PANEL**

(71) Applicant: **SHARP KABUSHIKI KAISHA**, Sakai City, Osaka (JP)

(72) Inventors: **SHOGO NISHIWAKI**, Sakai City (JP); **MASAHIKO KONDOH**, Sakai City (JP)

(21) Appl. No.: **15/755,554**

(22) PCT Filed: **Aug. 26, 2016**

(86) PCT No.: **PCT/JP2016/074945**

§ 371 (c)(1),
(2) Date: **Feb. 27, 2018**

(30) **Foreign Application Priority Data**

Aug. 31, 2015 (JP) 2015-170391

Publication Classification

(51) **Int. Cl.**

G02F 1/1339 (2006.01)

G02F 1/1335 (2006.01)

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

CPC ***G02F 1/1339*** (2013.01); *G02F 2001/133357* (2013.01); ***G02F 1/133512*** (2013.01)

(57) **ABSTRACT**

A method of producing a liquid crystal panel **11** (a display panel) includes: a sealing member forming process of forming a sealing member **11***q;* a board bonding process of bonding an array board **11***b* (a second board) to the CF board **11***a* with a liquid crystal layer **11***c* (a medium layer) between the array board **11***b* and the CF board **11***a;* and a sealing member fixing process of fixing the sealing member **11***q* to the array board **11***b.* The sealing member forming process includes disposing a sealing material S on the CF board **11***a* and curing the sealing member **11***q* without any uncured section.

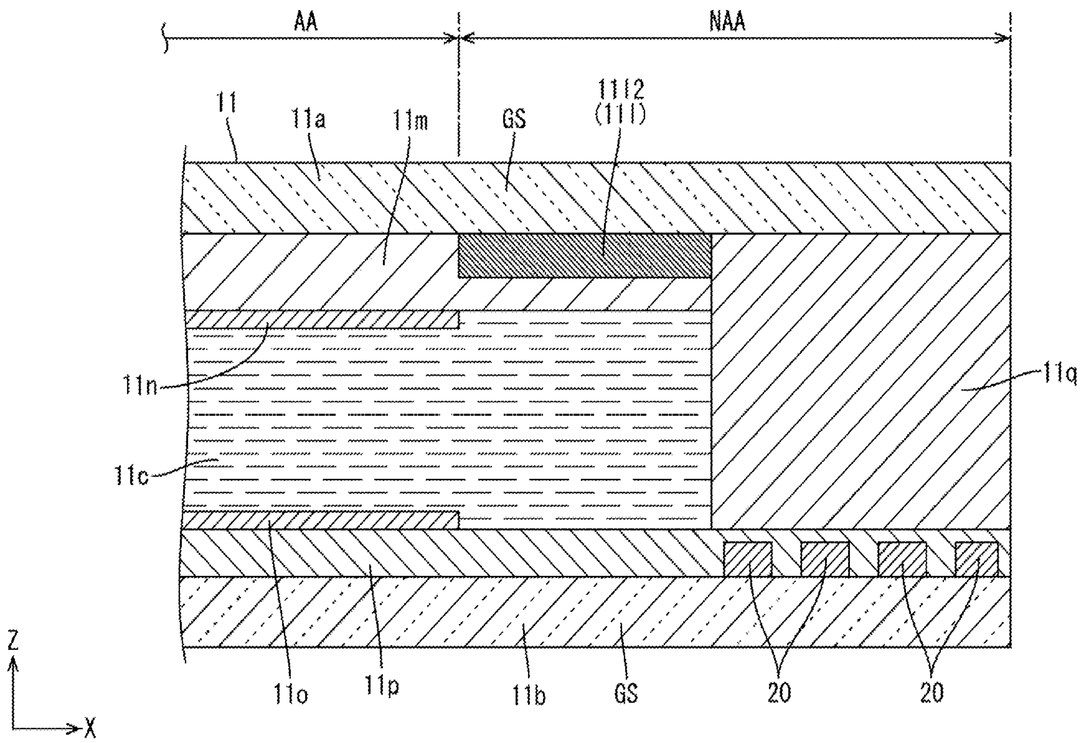


FIG.1

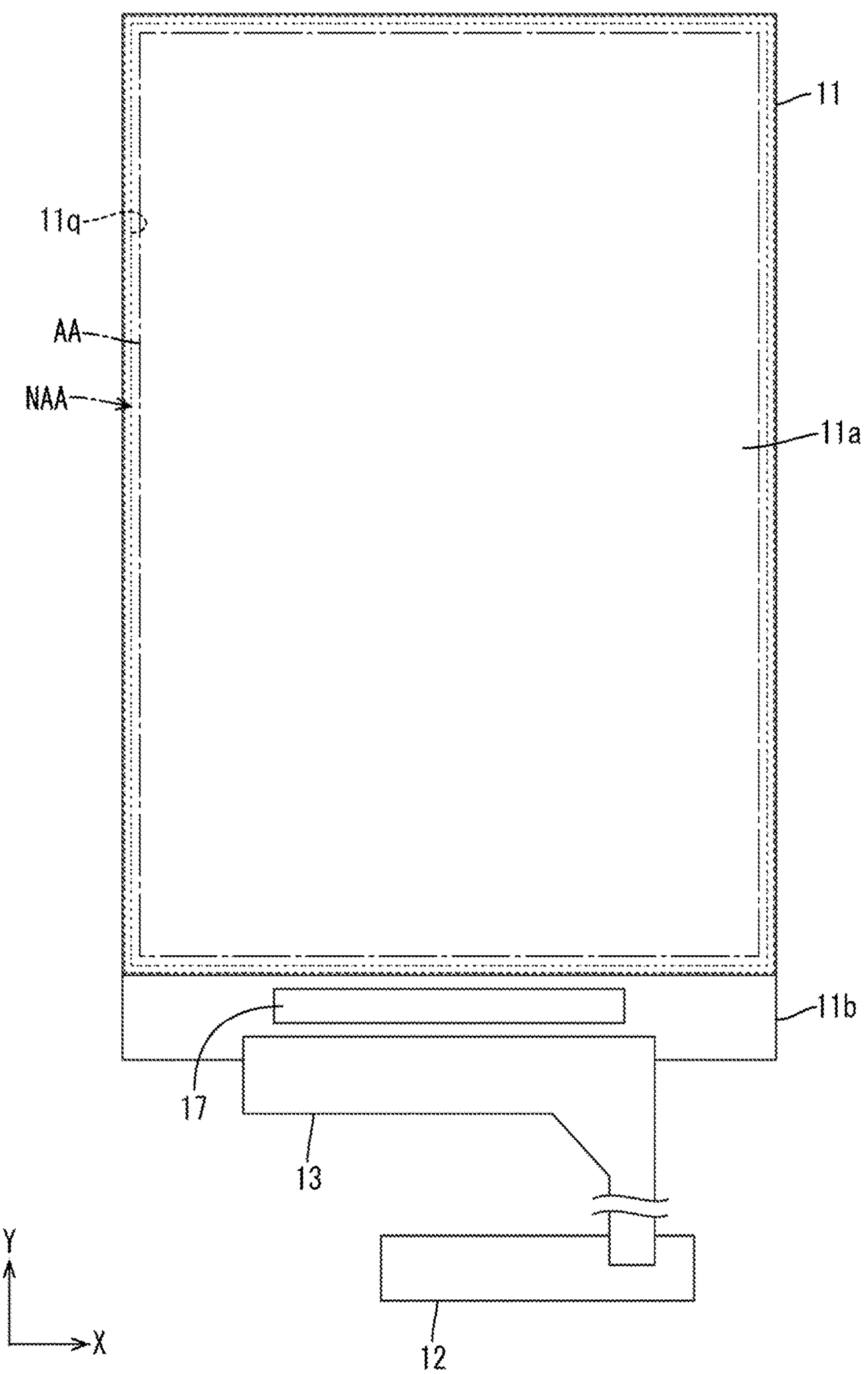


FIG.2

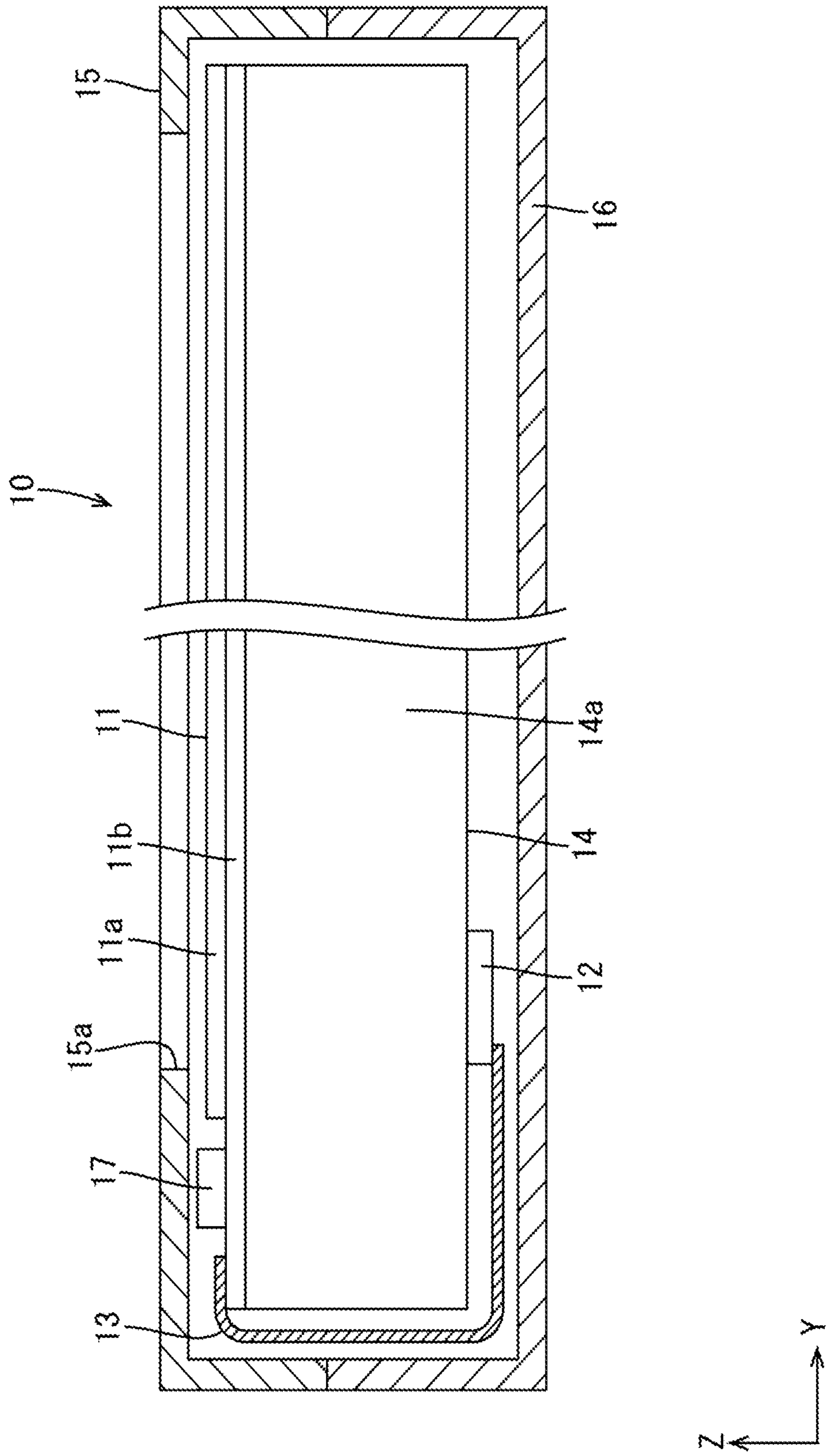


FIG.3

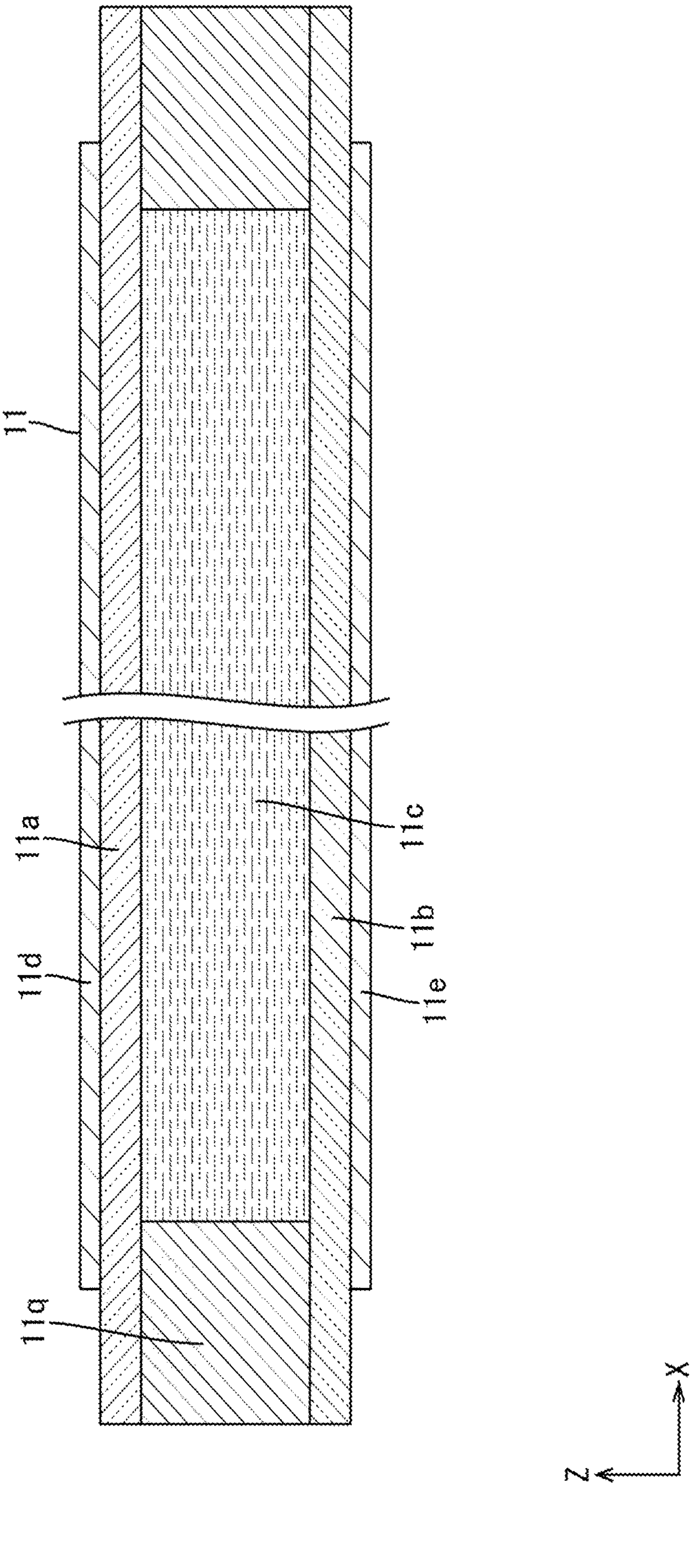
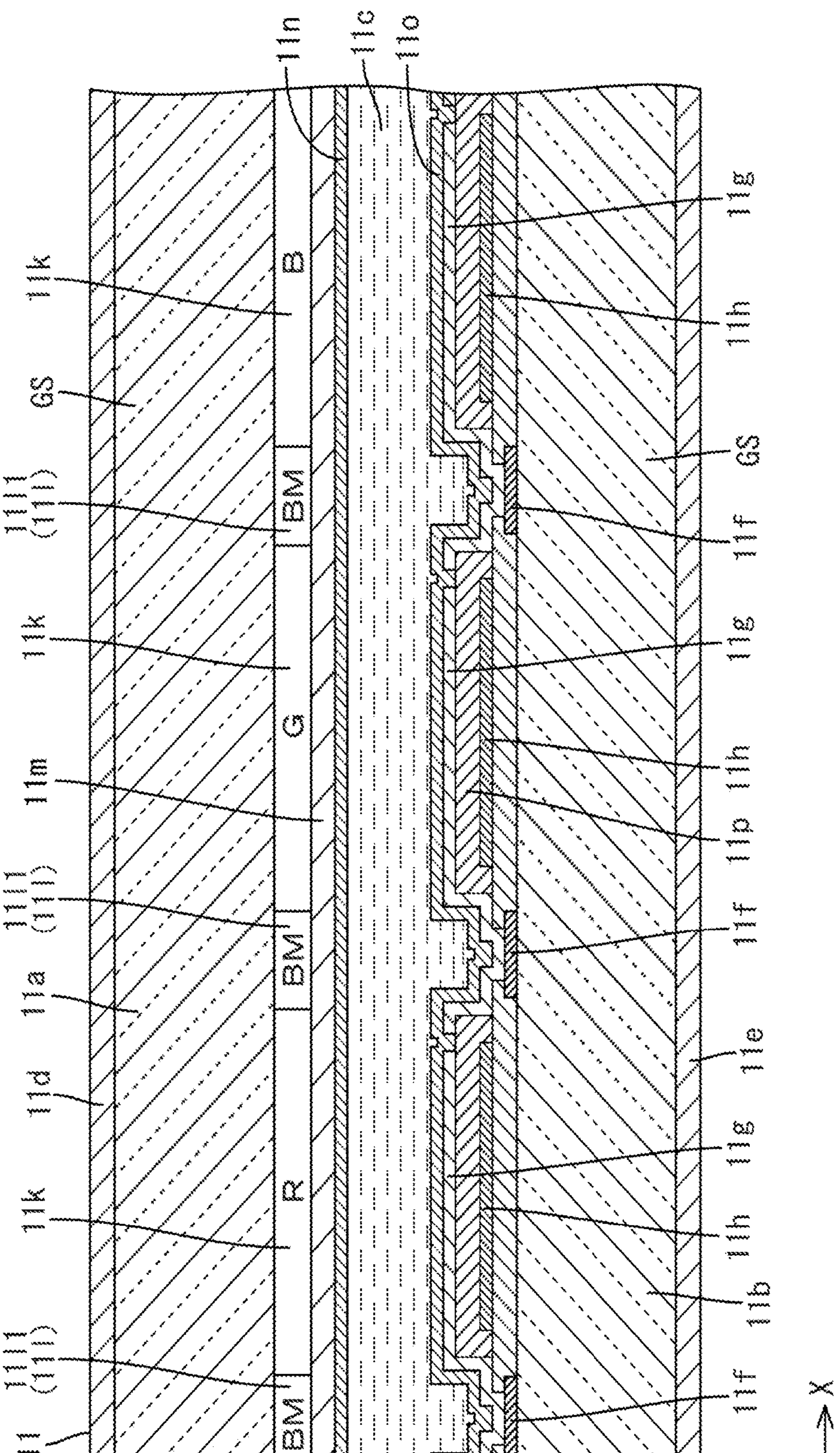


FIG.4



11
11l1
(11l)
BM
11k
R
11d
11a
11l1
(11l)
BM
11m
G
11k
11l1
(11l)
BM
GS
11k
B
11n
11c
11o
11g
11h
GS
11f
11g
11h
11p
11f
11e
11g
11h
11b
11f
X
Z

FIG.5

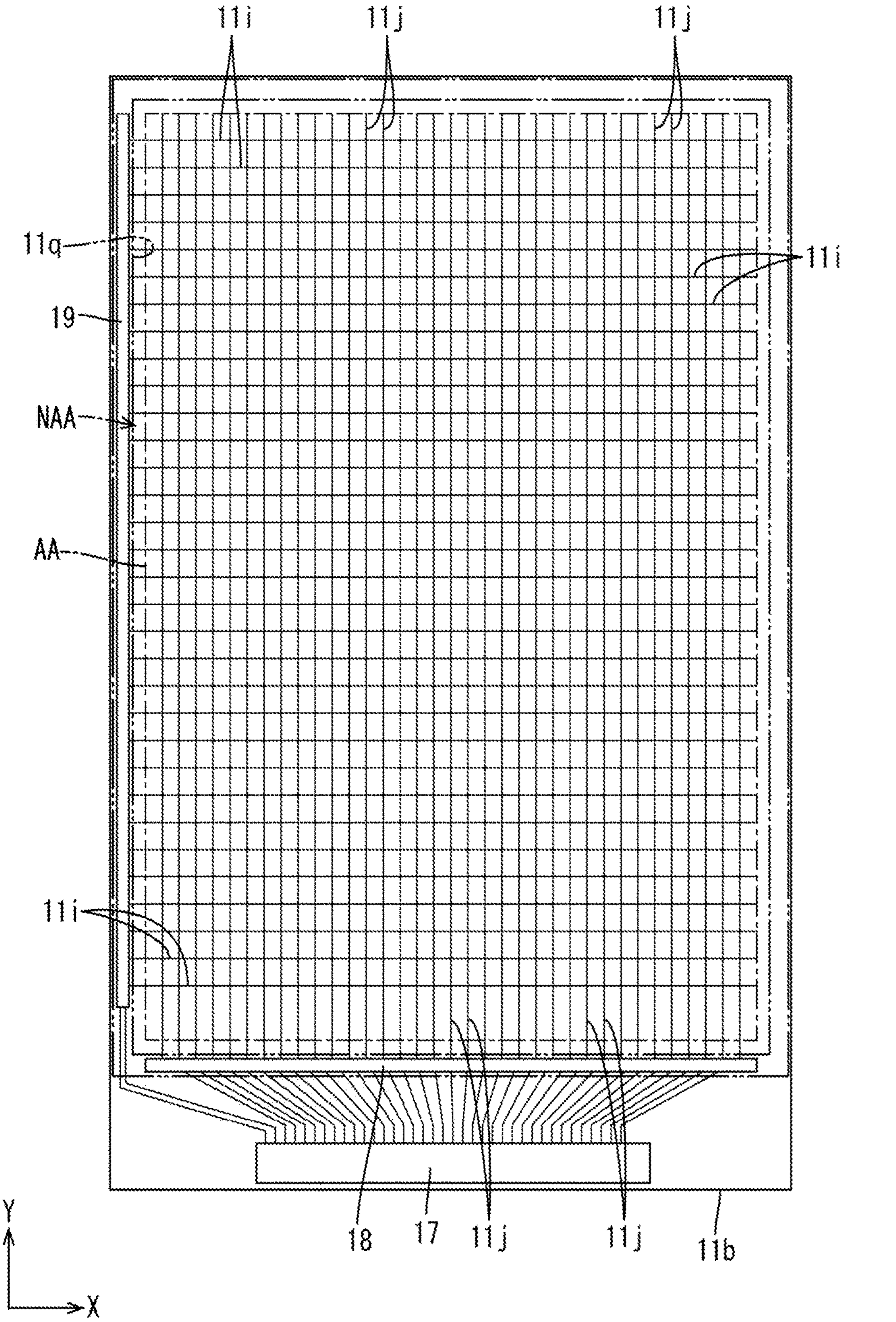


FIG.6

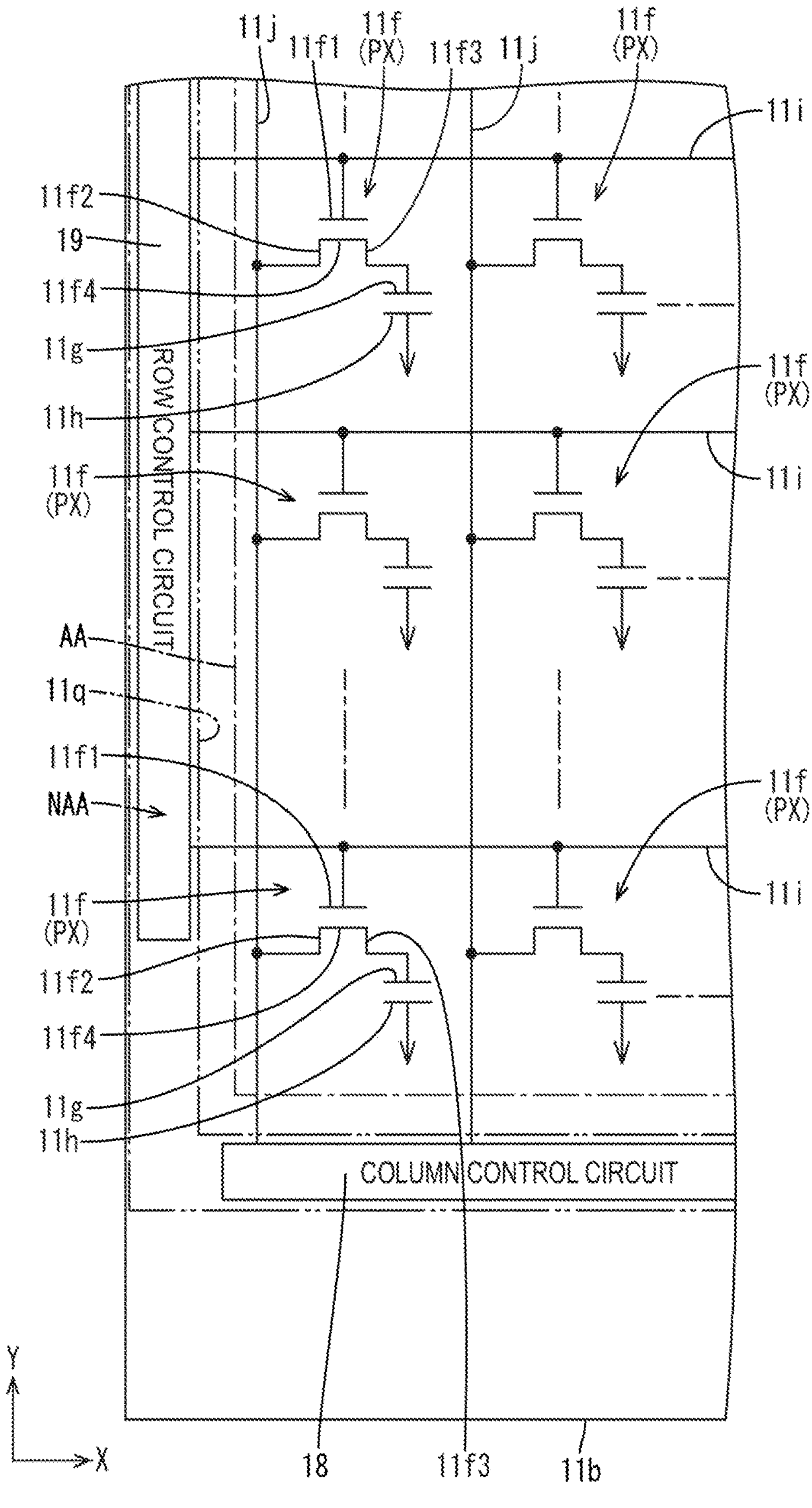

11j
11f1
11f
(PX)
11f3
11j
11f
(PX)
11i
11f2
19
11f4
11g
11h
ROW CONTROL CIRCUIT
11f
(PX)
11i
11f
(PX)
AA
11q
11f1
NAA
11f
(PX)
11f
(PX)
11i
11f2
11f4
11g
11h
COLUMN CONTROL CIRCUIT
Y
X
18
11f3
11b

FIG.7

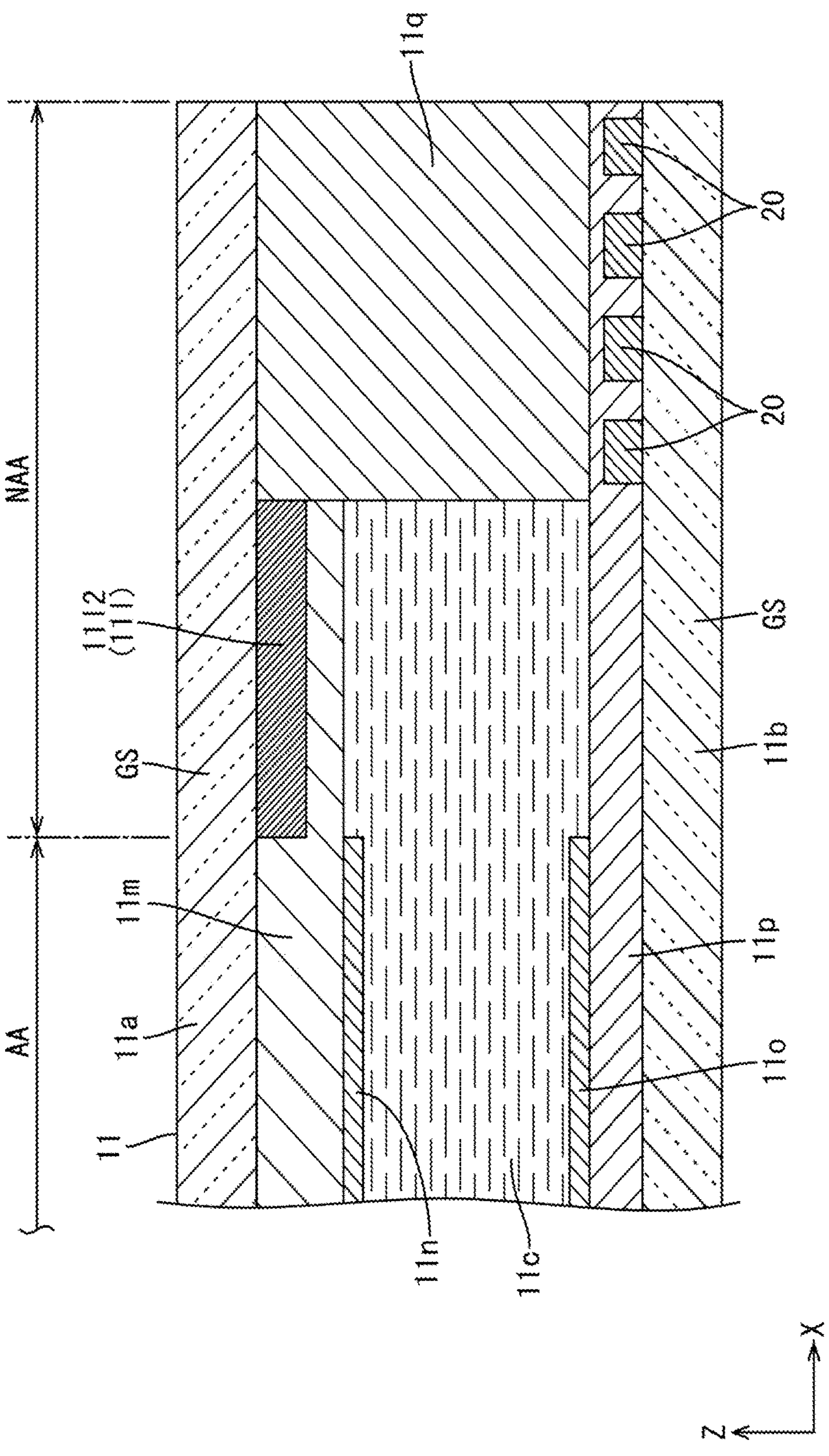


FIG.8

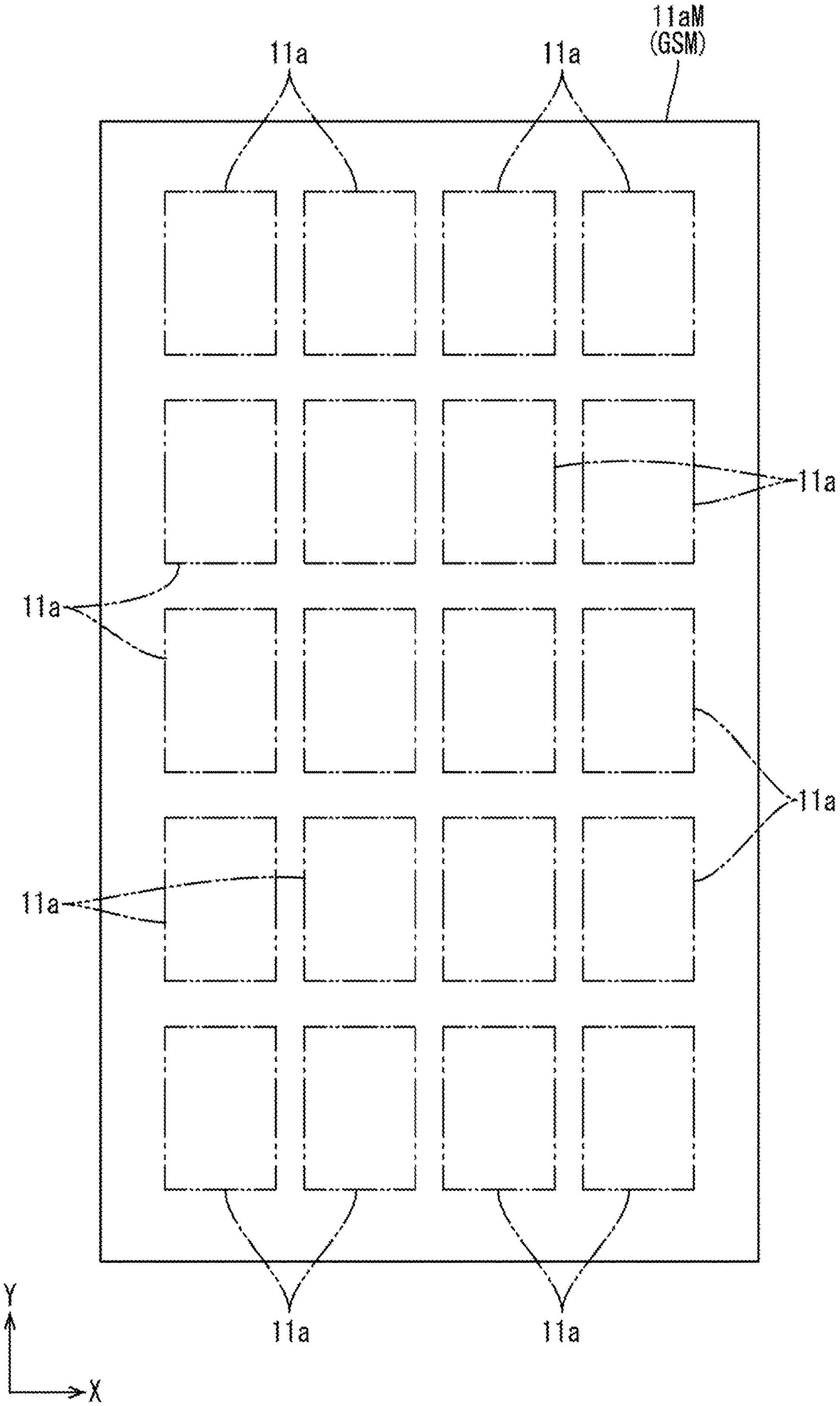


FIG.9

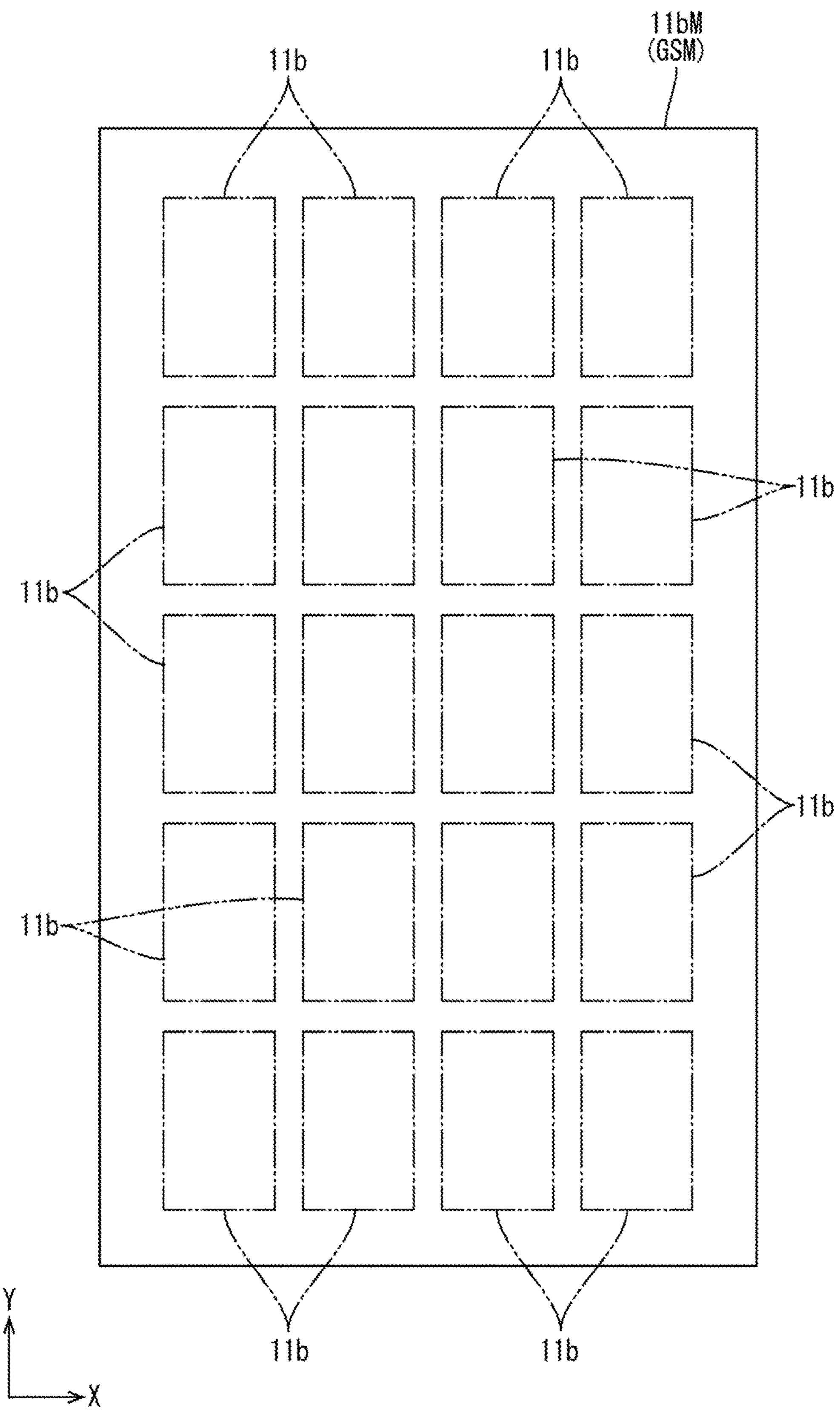


FIG.10

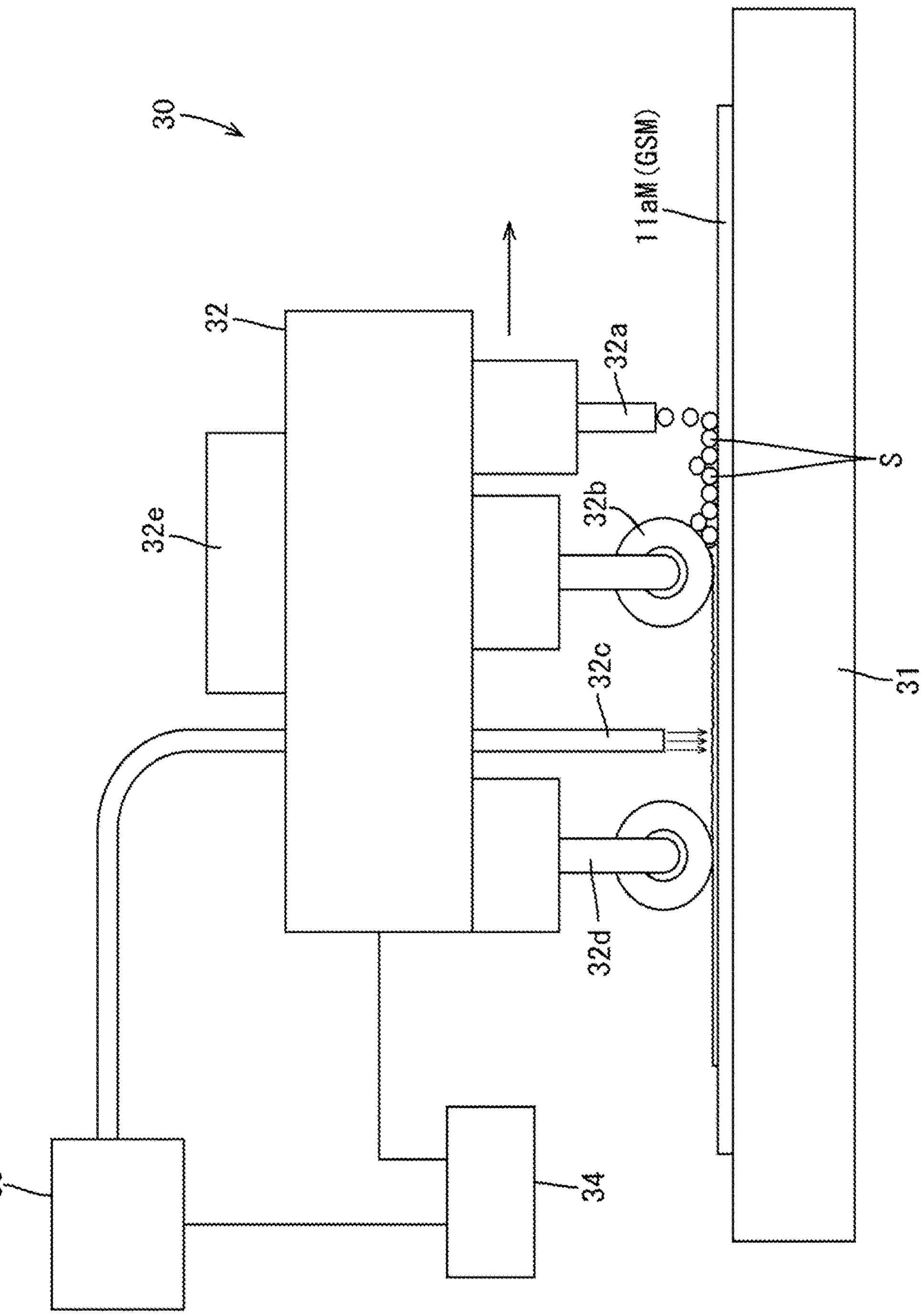


FIG.11

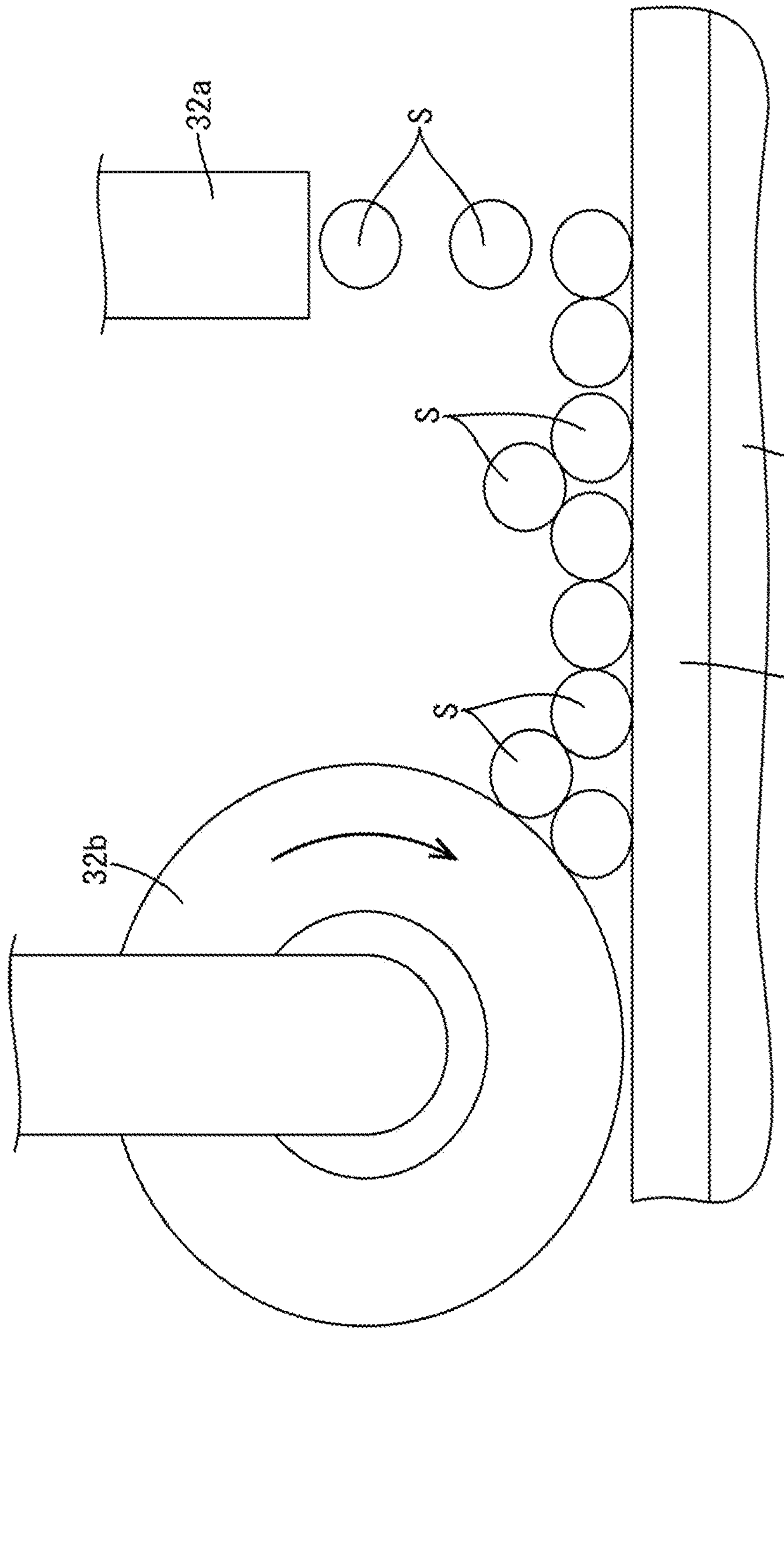


FIG.12

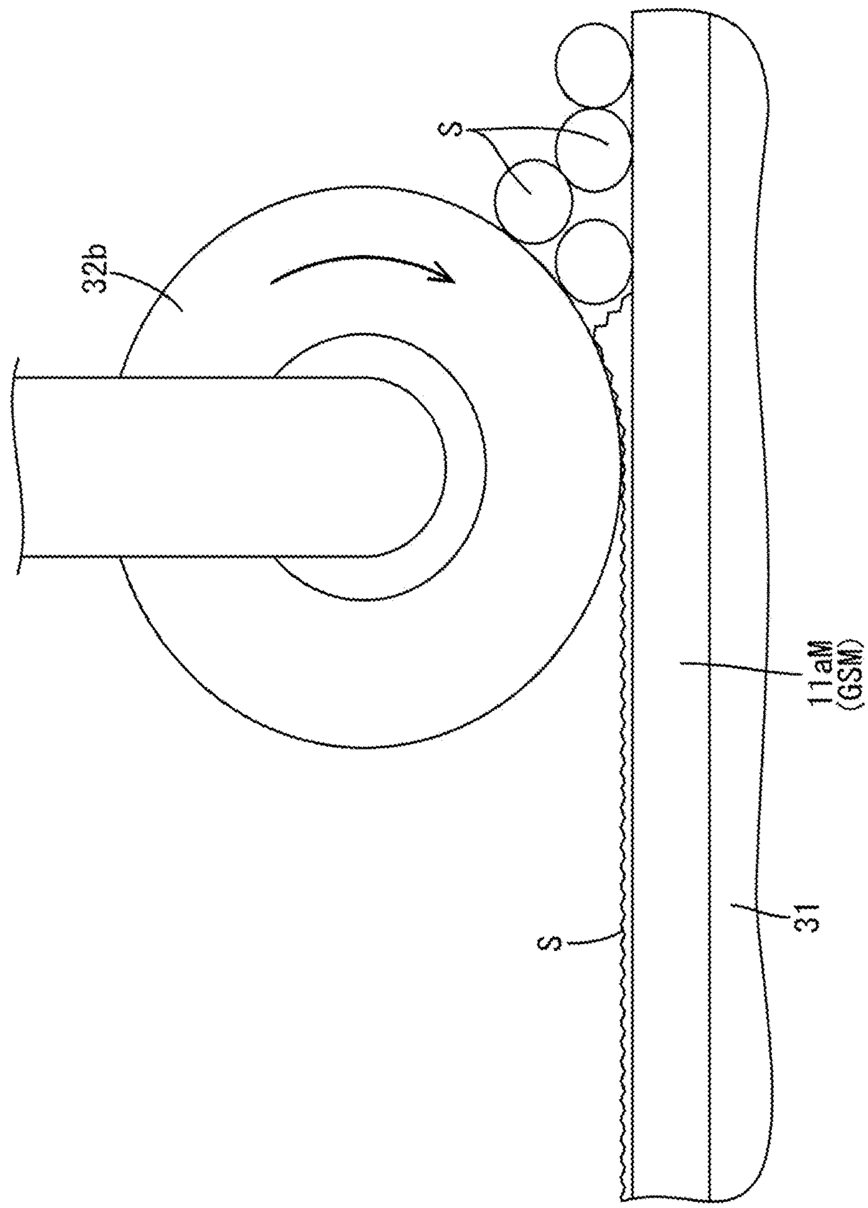


FIG.13

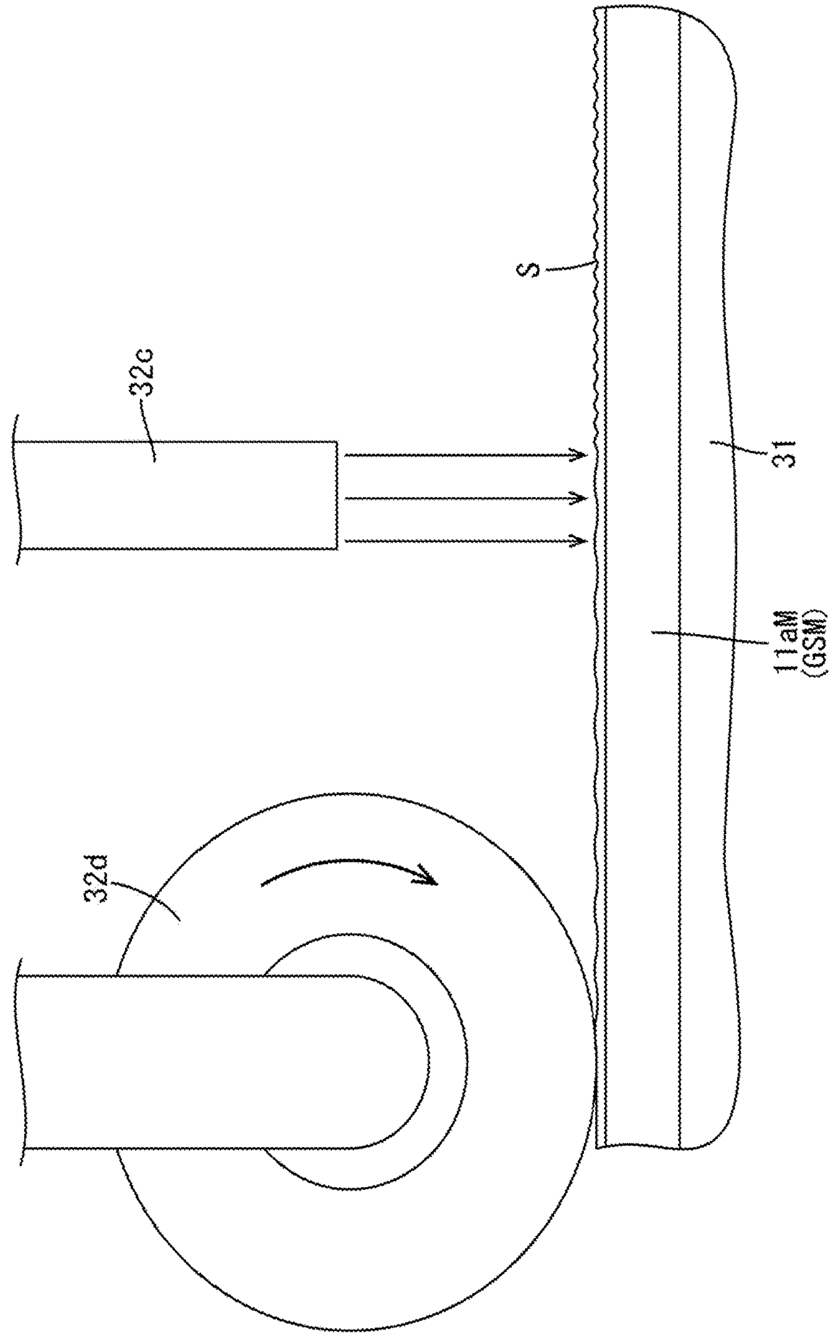


FIG.14

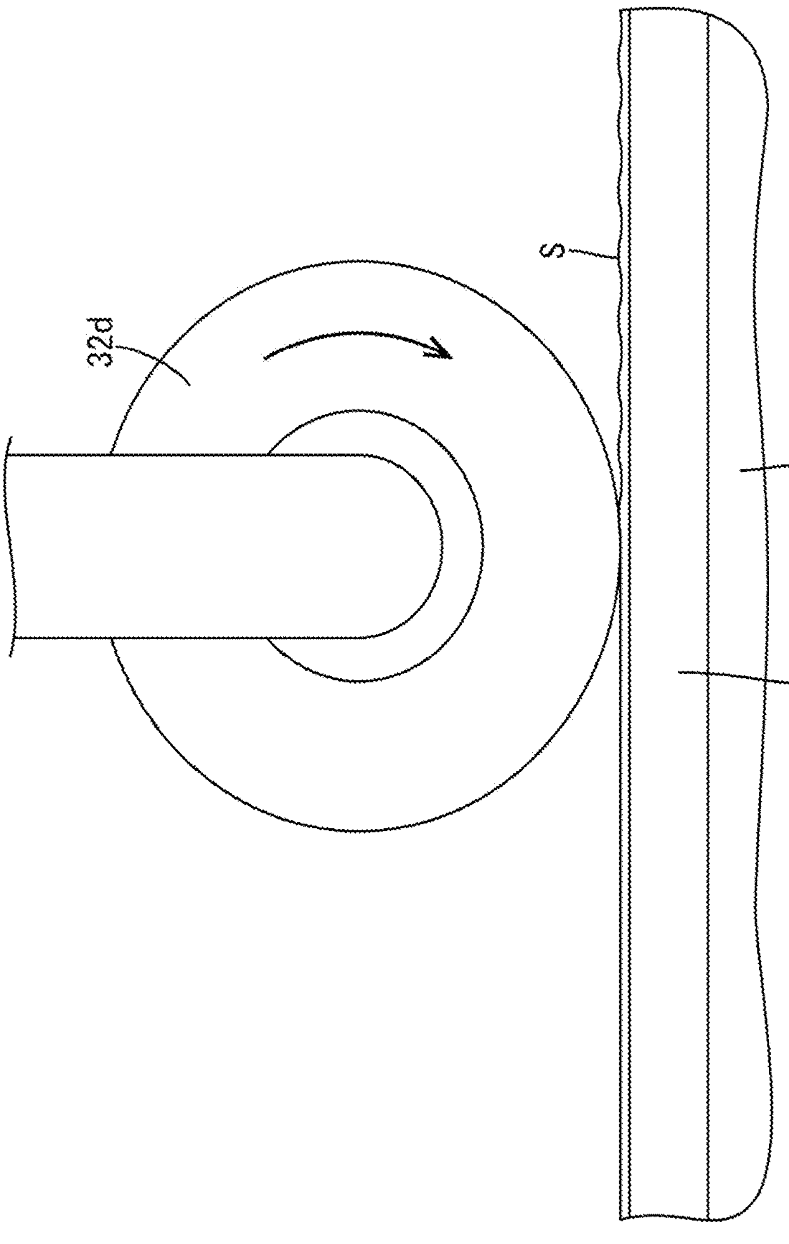


FIG.15

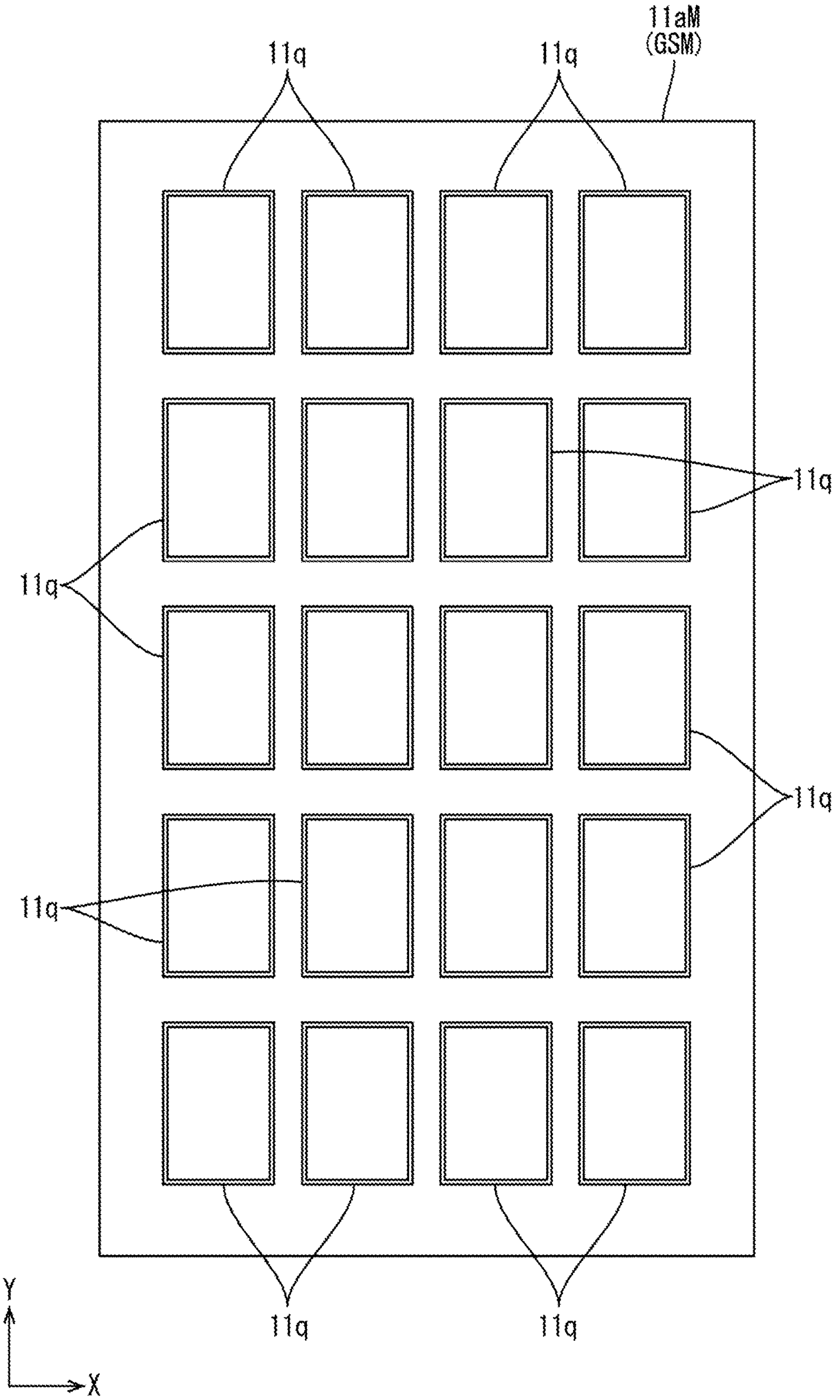


FIG.16

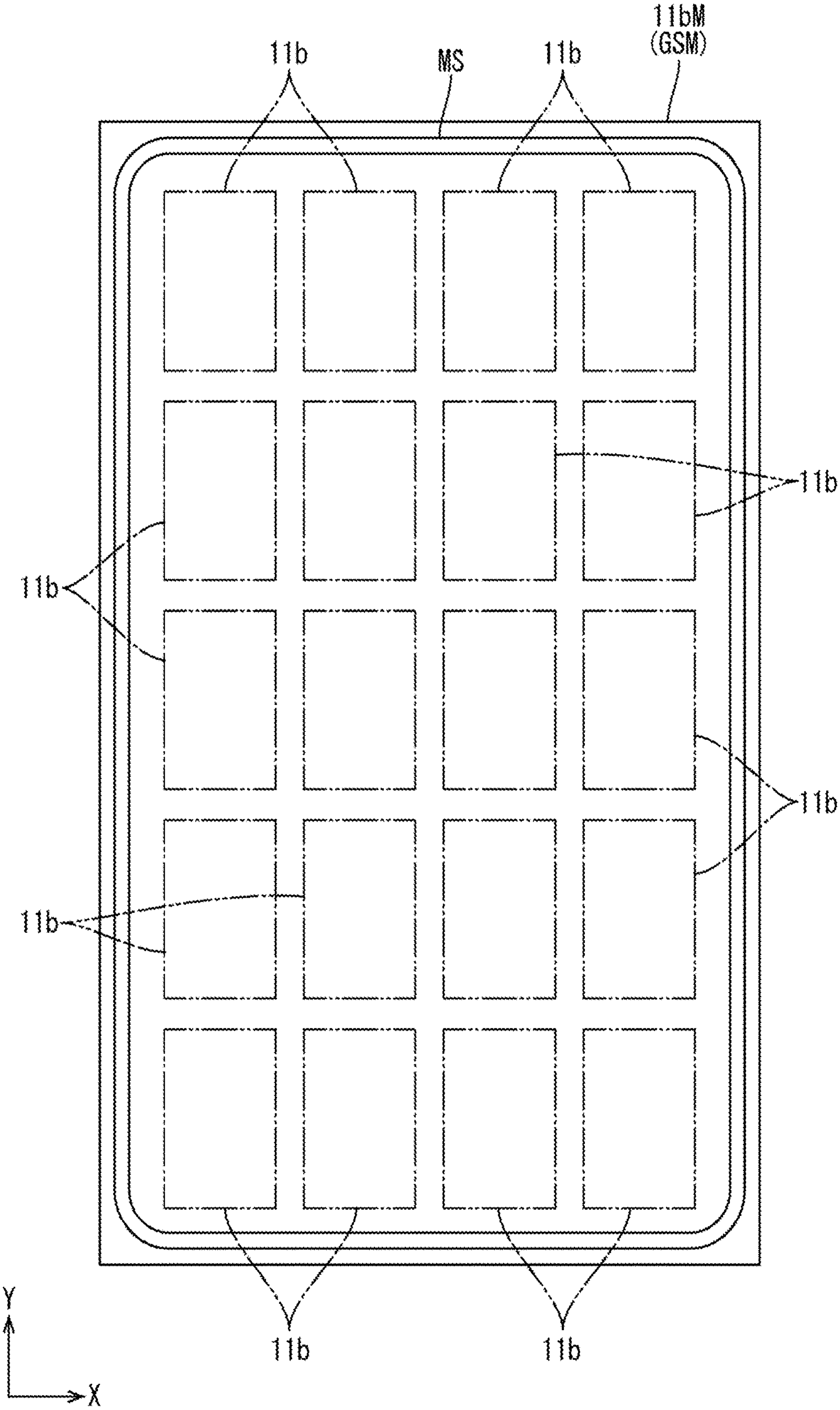


FIG.17

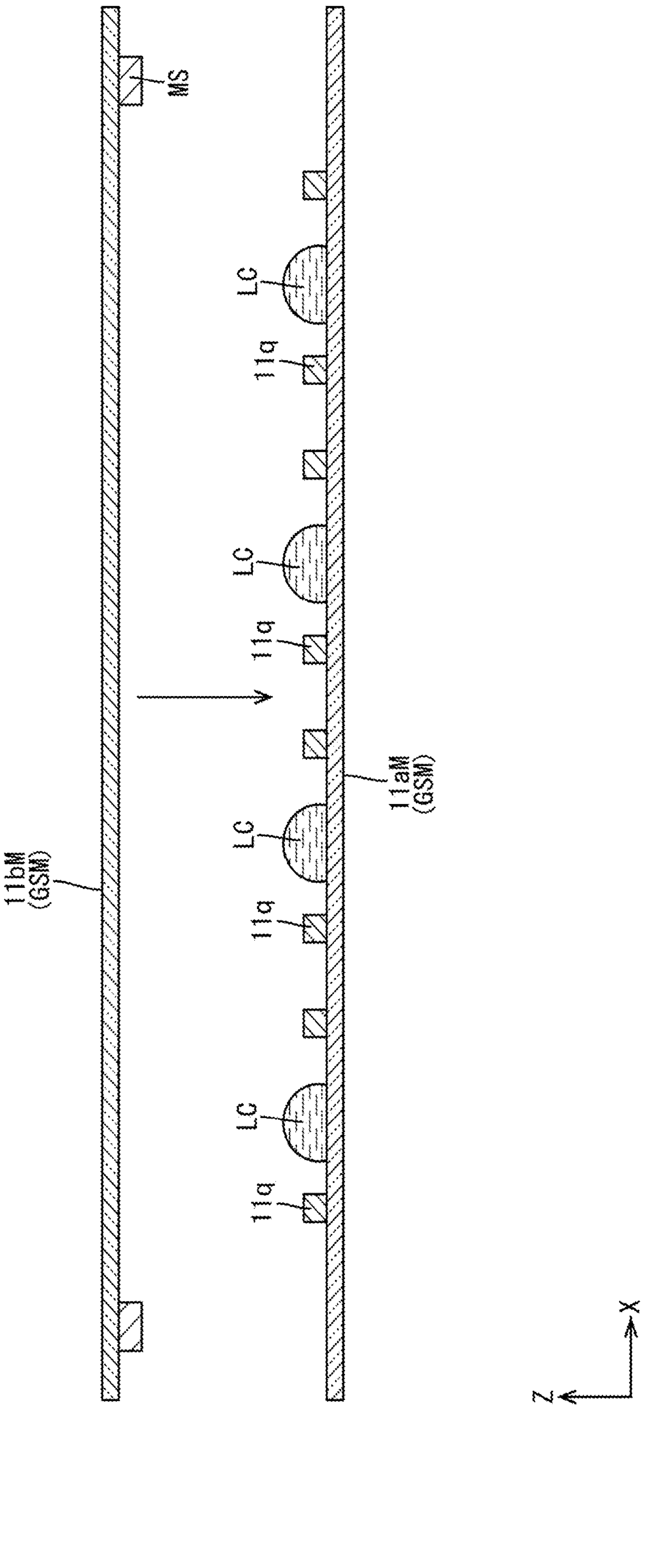


FIG.18

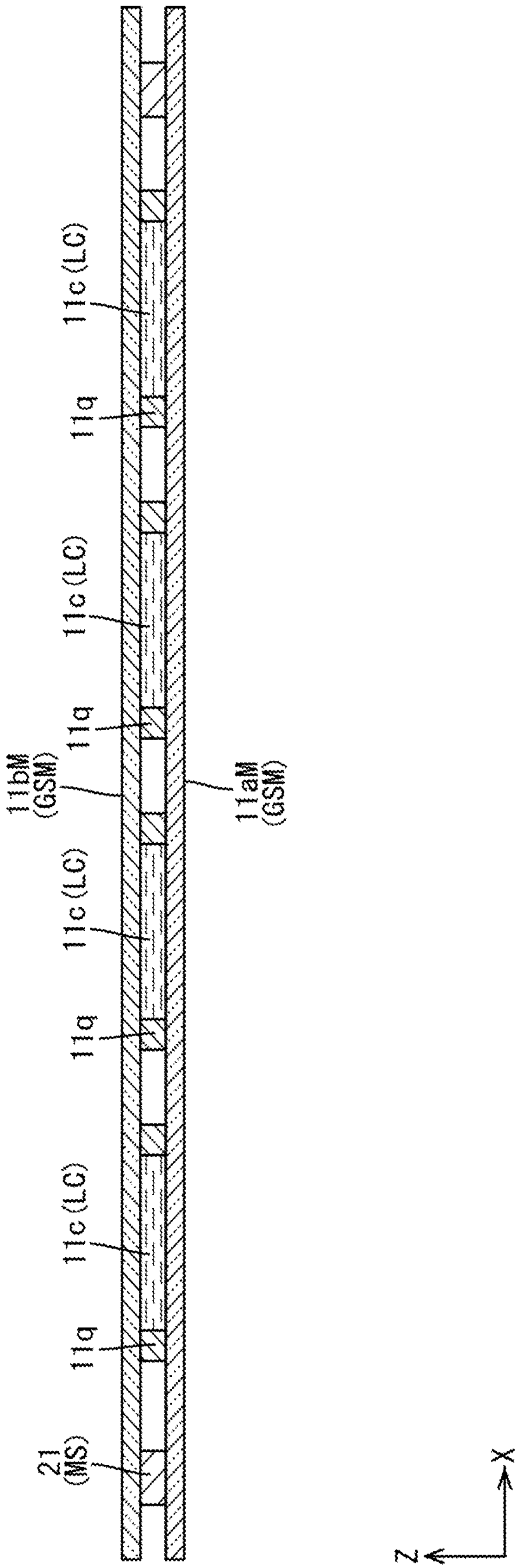

11c (LC)
11q
11c (LC)
11q
11bM (GSM)
11aM (GSM)
11c (LC)
11q
11c (LC)
11q
21 (MS)
X
Z

FIG.19

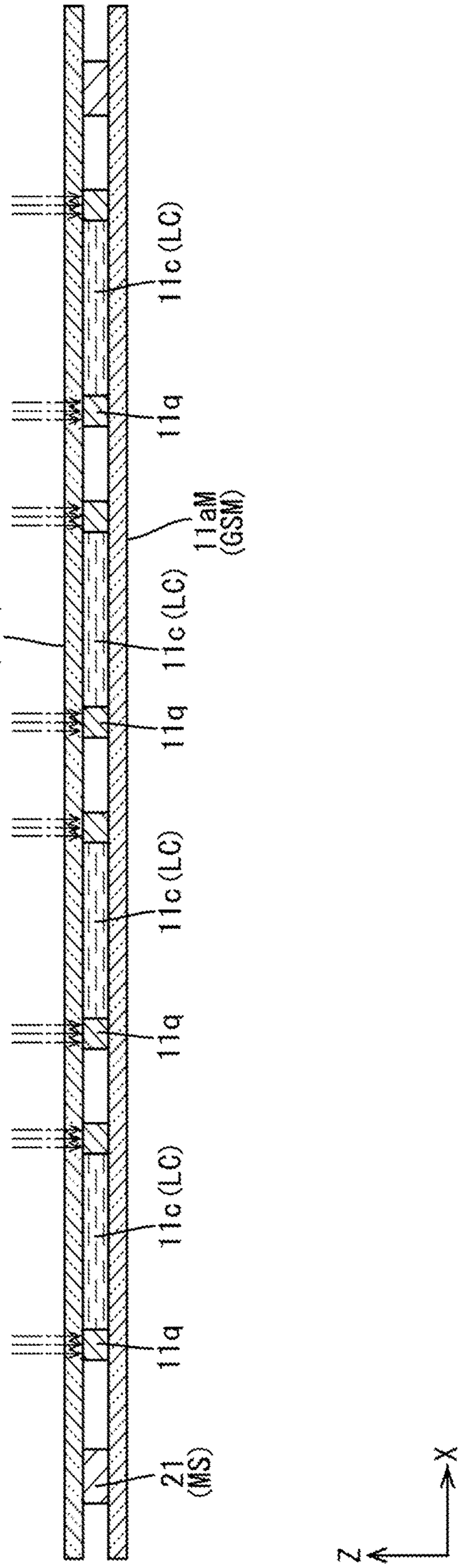

11c (LC)
11q
11aM (GSM)
11bM (GSM)
11c (LC)
11q
11c (LC)
11q
11c (LC)
11q
21 (MS)
X
Z

FIG.20

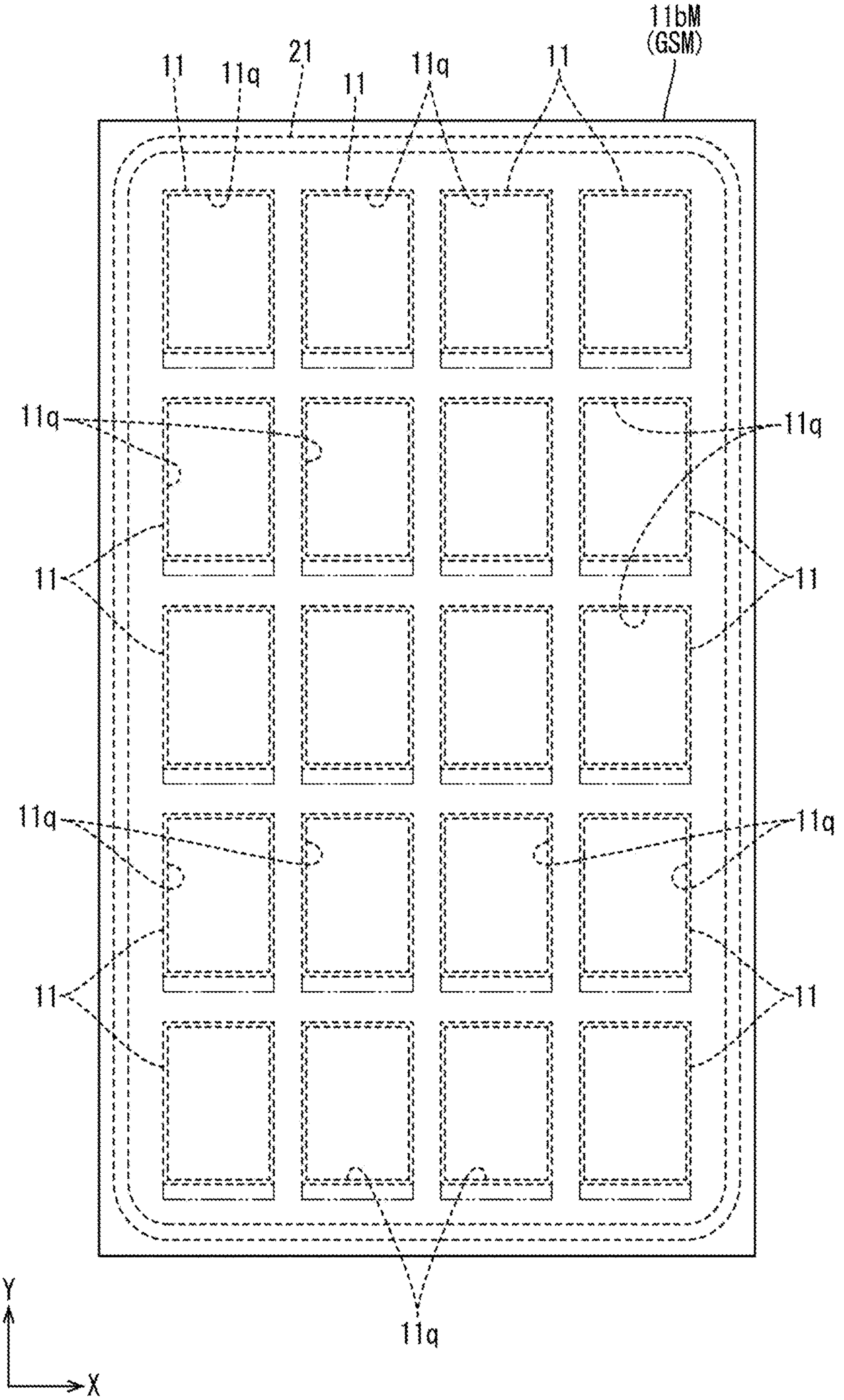


FIG.21

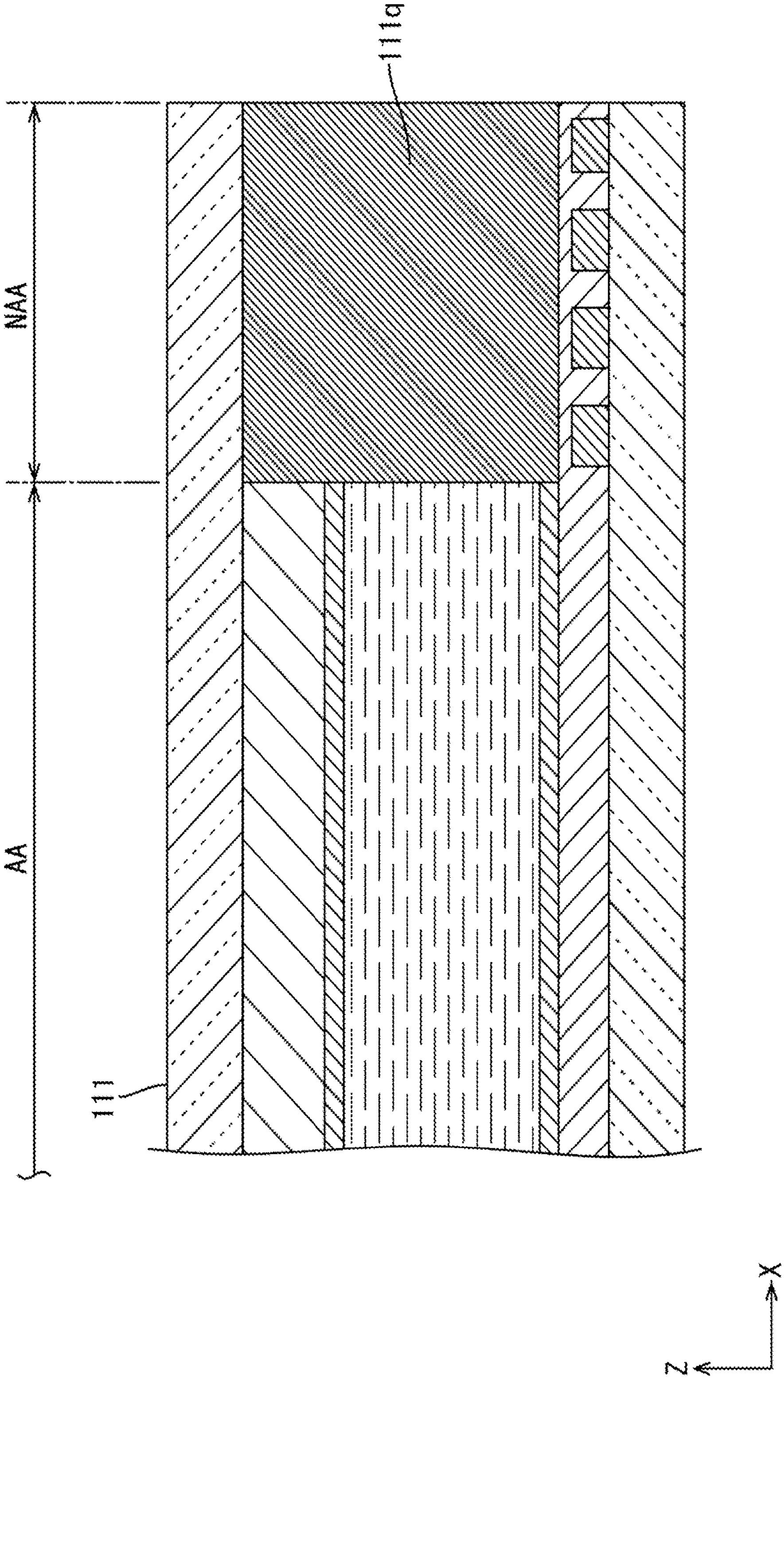


FIG.22

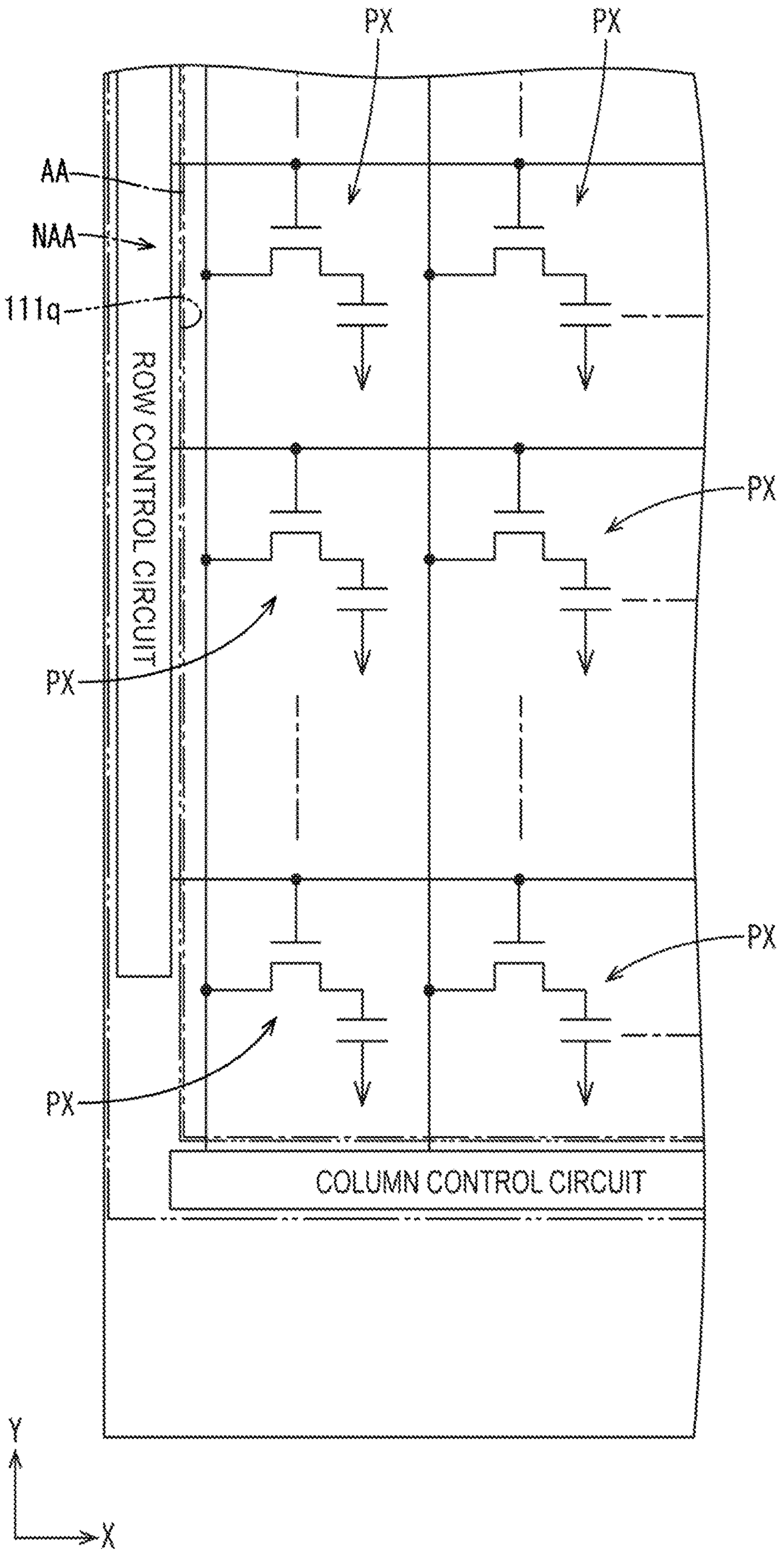

PX
PX
AA
NAA
111q
ROW CONTROL CIRCUIT
PX
PX
PX
PX
COLUMN CONTROL CIRCUIT
Y
X

FIG.23

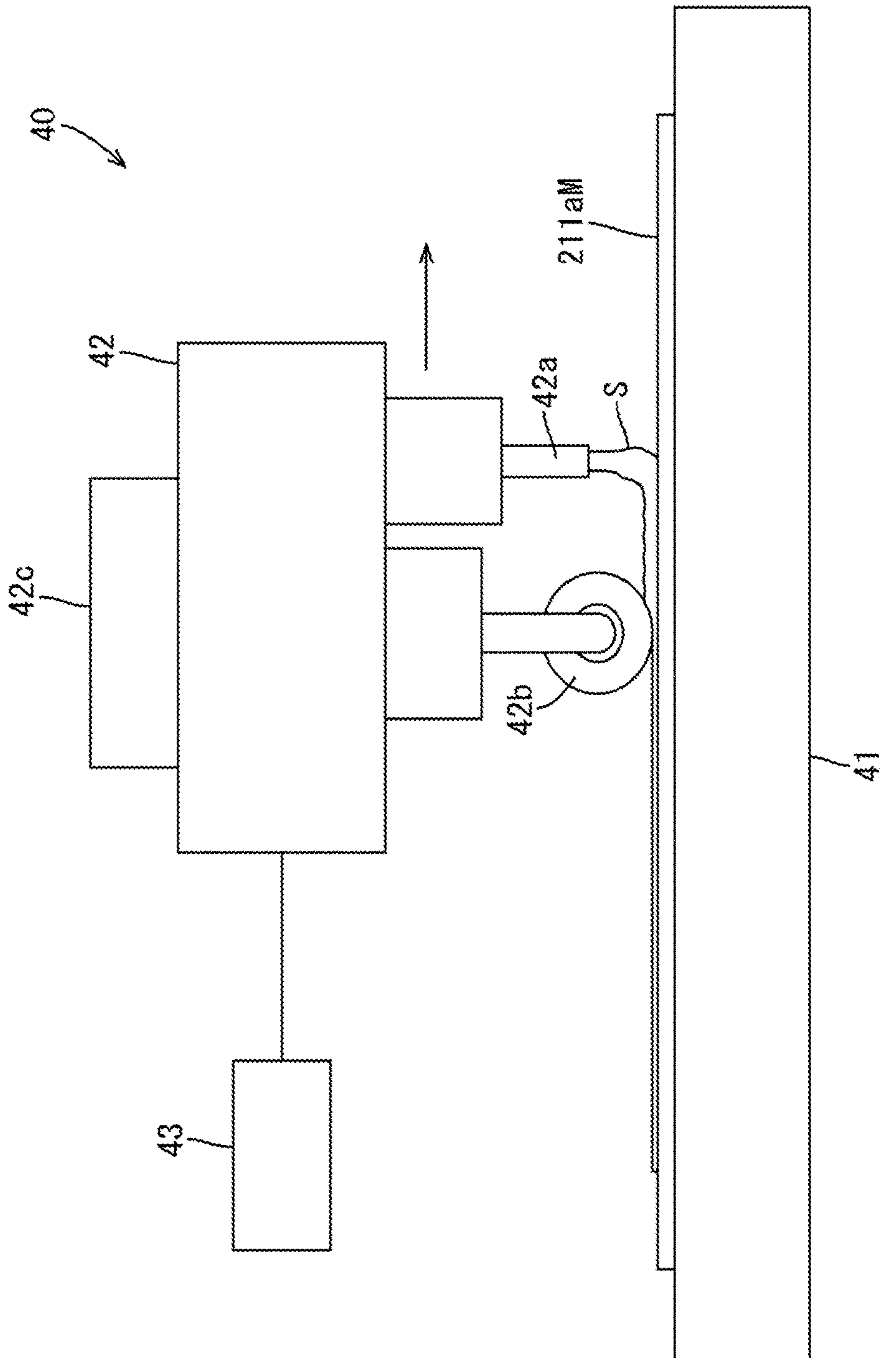


FIG.24

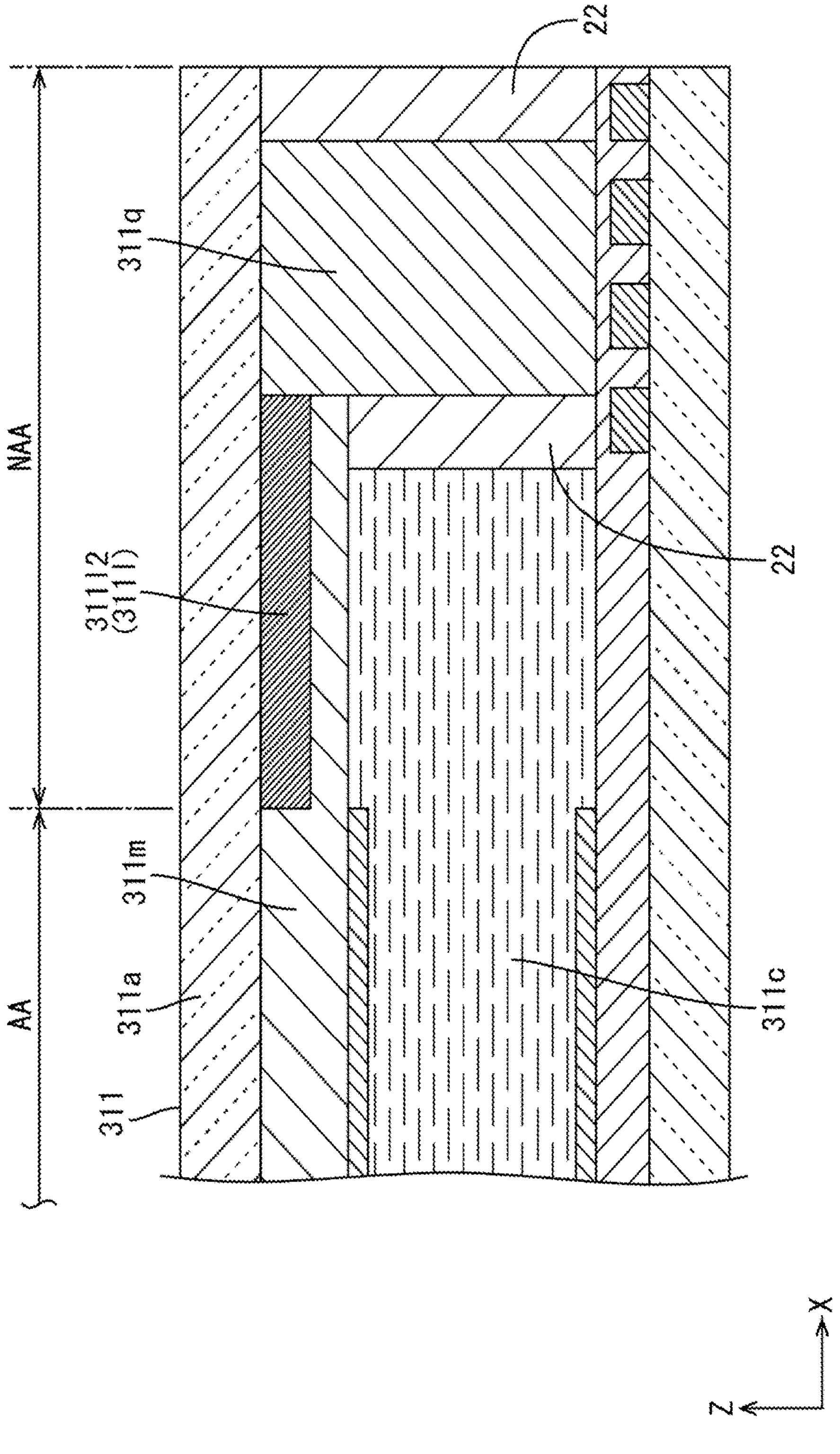


FIG.25

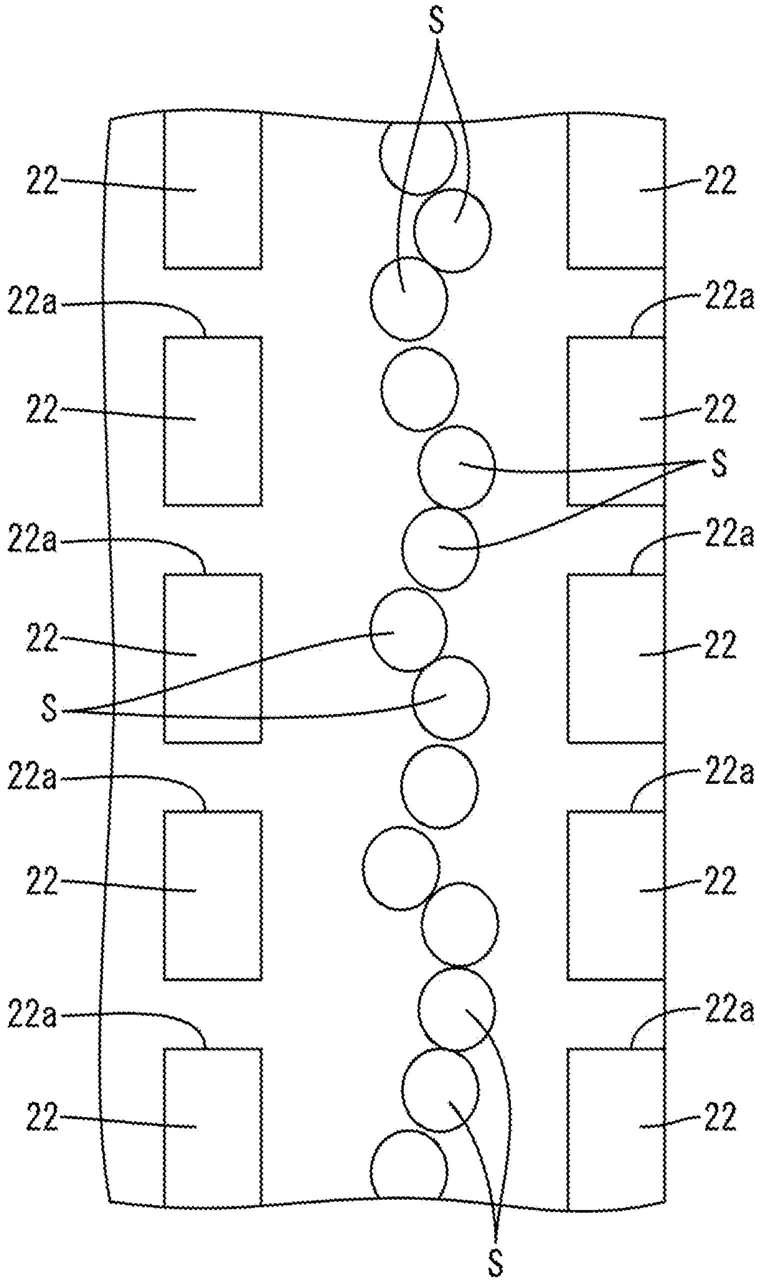
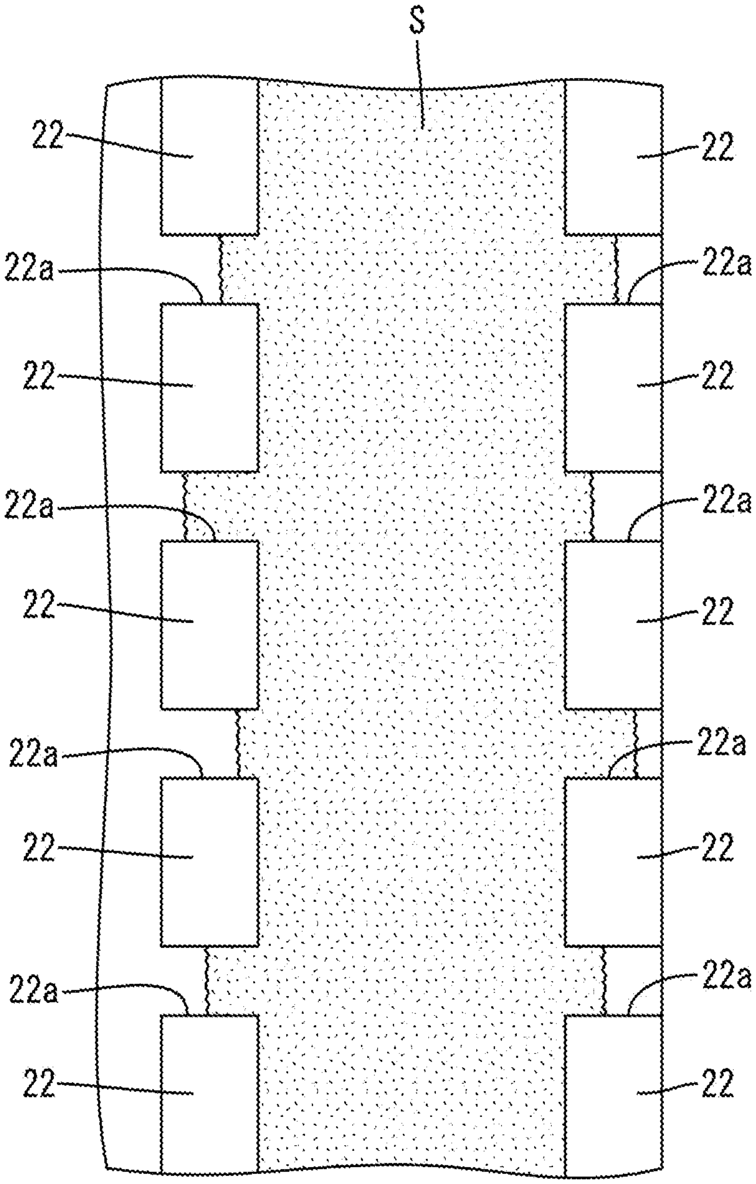


FIG.26



DISPLAY PANEL AND METHOD OF PRODUCING DISPLAY PANEL

TECHNICAL FIELD

[0001] The present invention relates to a display panel and a method of producing a display panel.

BACKGROUND ART

[0002] A method of producing a liquid crystal panel of a liquid crystal display device disclosed in Patent Document 1 has been known as an example of a method of producing a liquid crystal panel. According to the method of producing the liquid crystal panel disclosed in Patent Document 1, a recess is formed for an entire peripheral area of an alignment film forming area on a substrate. A first application liquid is applied on the recess to form a bank portion in a frame shape. A second application liquid is discharged to the alignment film forming area through an inkjet method to form an alignment film. A sealing member is disposed on one of the substrates including the substrate on which the alignment film is formed. The substrates are bonded together with the sealing member. A liquid crystal layer is sandwiched between the substrates. An outer edge of the sealing member is located closer to an outer edge of the substrate relative to the bank portion.

RELATED ART DOCUMENT

Patent Document

[0003] Patent Document 1: Unexamined Japanese Patent Application Publication No. 2014-174432

Problem to be Solved by the Invention

[0004] Patent Document 1 includes two problems described below. A first problem will be described. In Patent Document 1, bonding of boards is performed after a sealant that has not been cured is applied and then the sealant is cured. During the bonding of the boards, a liquid crystal material is pressed and spread between the boards. The sealant receives a force that is applied to the sealant by the liquid crystal material to push the sealant. If the frame size of the liquid crystal panel is further reduced and a width of the sealant is reduced, the sealant may not be able to withstand the force and the liquid crystal material may partially enter the sealant. Furthermore, if the frame size of the liquid crystal panel is further reduced and a width of a seal member is reduced, external moisture may passes through an uncured section of the sealant and tend to diffused in a liquid crystal layer.

[0005] Next, a second problem will bP described. In Patent Document 1, the sealant is disposed to overlap a peripheral light blocking portion. To cure and fix the sealant to a common board, ultraviolet rays are applied from the array board side to cure the sealant. In recent years, a number of traces are disposed in a frame area of the array board. The traces may overlap the sealant. In such a case, the ultraviolet rays are applied to the sealant through spaces between the traces. If the frame size of the liquid crystal panel is further reduced, an arrangement area of the traces is reduced. Therefore, arrangement density of the traces increases and the spaces between the traces decreases. During curing of the sealant, the ultraviolet rays may be blocked by the traces and thus curing of the sealant may become difficult or a longer period of time may be required for curing the sealant.

DISCLOSURE OF THE PRESENT INVENTION

[0006] The present invention was made in view of the above circumstances. An object is to provide a liquid crystal panel and a method of producing the liquid crystal panel preferable for a reduction in frame size.

Means for Solving the Problem

[0007] A method of producing a display panel according to the present invention includes a sealing member forming process of forming a sealing member, a board bonding process of bonding a second board to a first board with a medium layer between the first board and the second board, and a sealing member fixing process of fixing the sealing member to the second board. The sealing member forming process includes disposing a sealing material on the first board and curing the sealing material without any uncured section.

[0008] In the sealing member forming process, the sealing material is disposed on the first board and the sealing material is cured without any uncured section. Through the process, the sealing member is formed. In the board bonding process that is subsequently performed, the second board is bonded to the first board with the medium layer between the first board and the second board. In the sealing member fixing process that is subsequently performed, the sealing member is fixed to the second board. Through the process, the medium layer is sealed. In the board bonding process, the medium layer is pressed and spread between the boards in accordance with the bonding of the boards. The sealing member receives a force that may be applied by the medium layer to push the sealing member. If the frame size is further reduced and the width of the sealing member is reduced, the sealing member may not be able to withstand the force and the medium layer may partially enter into the sealing member. In the sealing member forming process that is preformed prior to the board bonding process, the sealing material is cured without any uncured section to form the sealing member. Therefore, even if the frame size is further reduced, the medium layer is less likely to partially enter into the sealing member. If the width of the sealing member is reduced in accordance with the further reduction in the frame size, external moisture may pass through the uncured section of the sealing member and diffuse in the medium layer. In the sealing member forming process that is preformed prior to the board bonding process, the sealing material is cured without any uncured section to form the sealing member. Therefore, even if the frame size is further reduced, the external moisture is less likely to pass through the sealing member and thus the moisture is less likely to diffuse in the medium layer. As described above, this method is preferable for reducing the frame size of the display panel.

[0009] Preferable embodiments of the method of producing the display panel according to the present invention may include the following features.

[0010] (1) The method may further include a first base board producing process, a second base board producing process, a base sealing material disposing process, and a base sealing material curing process. The first base board producing process includes producing a first base board including first boards within a plate surface of the first base board. The second base board producing process includes producing a second base board including second boards within a plate surface of the second base board. The base sealing material disposing process includes disposing a base sealing material on any one of the first base board and the second base board to surround either the first boards or the second boards and to include an uncured section. The base sealing material curing process includes curing the base sealing material without any uncured section to form a base sealing member. The base sealing material curing process is performed after at least the board bonding process. In the base sealing material disposing process, the base sealing material that includes the uncured section is disposed on any one of the first base board that is produced through the first base board producing process and the second base board that is produced through the second base board producing process to surround either the first board or the second boards. In the board bonding process that is subsequently performed, the boards are bonded together. The base sealing material that includes the uncured section closely contacts the other one of the first base board and the second base board. The boards are maintained under negative pressure. Therefore, the boards are less likely to be displaced or removed. In the base sealing material curing process that is subsequently performed, the base sealing material is cured without any uncured section. Through the process, the base sealing member is formed.

[0011] (2) The base sealing material disposing process may include disposing the base sealing material on the second base board. The base sealing material disposing process is performed to dispose the base sealing material on the second base board that is not the first base board on which the sealing member forming process is performed. Therefore, the sealing member forming process and the base sealing material disposing process can be performed in parallel. In comparison to the method in which the sealing member forming process and the base sealing material disposing process are performed on the first base board, time that is required for the production of the display panel can be reduced.

[0012] (3) The medium layer in the board bonding process may be a liquid crystal layer. The base sealing material disposing process may include disposing a thermosetting resin material as the base sealing material. The base sealing curing process may include heating processing that is performed until a temperature reaches at least a curing temperature of the thermosetting resin material. When the heating processing is performed until the temperature reaches at least the curing temperature of the thermosetting resin material in the base sealing material curing process, the thermosetting resin material is cured and the base sealing member is formed. Furthermore, reorientation of liquid crystal molecules included in the liquid crystal layer that is the medium layer is accelerated. Therefore, the liquid crystal molecules included in the liquid crystal layer are properly orientated.

[0013] (4) The sealing member forming process may include discharging the sealing material by a dispenser and disposing the sealing material along an area to form the sealing member. In comparison to a method in which the sealing material is layered in an entire area of the plate surface of the first board and the sealing material is selectively cured, an amount of the sealing material can be reduced. This method is preferable for reducing the production cost.

[0014] (5) The sealing member forming process may include a sealing material disposing process and a sealing material curing process. The sealing material disposing process may include disposing the sealing material that is in a powdered form on the first board. The sealing material curing process may include applying a laser beam to a section of the sealing material and selectively curing the section of the sealing material without any cured area. In the sealing material disposing process, the sealing material that is in the powder form is disposed on the first board. In the sealing material curing process that is subsequently performed, the laser beam is applied to the sealing material that is disposed on the first board and the section to which the laser beam is applied is selectively cured without any uncured area. Through the processes, the sealing member is formed.

[0015] (6) The sealing member forming process may include heating and fusing the sealing material that is the thermosetting resin material, applying the sealing material to the first board, and curing the sealing material without any uncured section. In the sealing member forming process, after the sealing material is heated and fused, the fused sealing material is applied to the first board. The sealing material that is applied to the first board is cured without any uncured section as the temperature decreases. Through the process, the sealing member is formed.

[0016] A display panel according to the present invention includes pixels, an array board, a common board, a medium layer, and a sealing member. The pixels are arranged in a matrix in a display area in which an image is displayed. The array board includes at least traces that are disposed in a non-display area outside the display area. The common board is disposed opposite the array board. The common board includes a light blocking portion. The light blocking portion includes sections that are disposed to separate at least the pixels from one another. The medium layer is sandwiched between the array board and the common board. The sealing member is disposed between the array board and the common board to overlap the traces in the non-display area to surround the medium layer. The sealing member is made of a material having a light blocking property and disposed not to overlap the light blocking portion.

[0017] Because the pixels that are arranged in the matrix in the display area are separated from one another by the light blocking portion, color mixture is less likely to occur. The medium layer that is sandwiched between the array board and the common board is sealed with the sealing member that is disposed between the array board and the common board in the non-display area to surround the medium layer.

[0018] The sealing member is disposed to overlap the traces that are included in the array board in the non-display area. To accelerate the fixation of the sealing member to the common board with light applied from the array board side, the light may be blocked by the traces. If the arrangement density of the traces is increased in accordance with the reduction in the frame size, the fixation of the sealing member to the common board may become insufficient or timer that is required for the fixation may become longer. The sealing member is disposed not to overlap the light blocking portion that is included in the common board. By applying the light to the sealing member from the common board side to fix the sealing member to the array board, the light is less likely to be blocked by the light blocking portion. Therefore, the fixation of the sealing member to the array board can be properly accelerated. Even if the arrangement density of the traces is increased in accordance with the reduction in the frame size, the fixation of the sealing member to the array board can be properly accelerated regardless of the arrangement density of the traces. Furthermore, the sealing member has the light blocking property. Although the sealing member is disposed not to overlap the light blocking portion, leakage of light is less likely to occur in the non-display area. This configuration is preferable for reducing the frame size.

[0019] Preferable embodiments of the display panel according to the present invention may include the following configurations.

[0020] (1) The common board may include a planarization layer that is layered on a medium layer side relative to the light blocking portion. The planarization layer may be disposed in an area not to overlap the sealing member. According to the configuration, the sealing member is fixed to the common board with direct contact. Because the planarization layer is not disposed between the sealing member and the common board, the sealing member is more strongly fixed to the common board. Furthermore, only an interface between the sealing member and the common board is exposed to the outside. In comparison to a configuration in which the planarization layer is disposed between the sealing member and the common board, an area of the interface exposed to the outside is reduced. Therefore, external moisture is less likely to pass through the interface and enter into the medium layer.

[0021] (2) The sealing member may include an outer surface on an opposite side from the medium layer side. The outer surface maybe flush with at least an end surface of the common board. In comparison to a configuration in which the outer surface of the sealing member is located inner than the end surface of the common board, the frame size can be further reduced.

[0022] (3) The sealing member may be made of synthetic resin material with a light blocking compound contained in the synthetic resin material. According to the configuration, the light blocking compounds can be easily disposed in the synthetic resin material when mixing the light blocking compounds into the synthetic resin material. Therefore, the sealing member that delivers even light blocking performance can be easily provided. In comparison to a configuration in which the sealing member is made of metal material, the sealing member can be fixed to the common board at a lower temperature.

[0023] (4) The display panel may include sealing member control portions that are disposed to sandwich the sealing member from the medium layer side and an opposite side from the medium layer side. According to the configuration, the width of the sealing member can be controlled during the formation of the sealing member. Therefore, the width of frame of the display panel can be set with high accuracy. This configuration is further preferable for reducing the frame size.

[0024] (5) The sealing member control portions may extend parallel to the sealing member and include holes in the middle. According to the configuration, a material in an uncured state can be released through the holes of the sealing member control portions during the formation of the sealing member. Therefore, the sealing member has a constant height.

[0025] (6) The sealing member may contain spacer particles. This configuration is preferable for maintain the height of the sealing member constant.

[0026] (7) The sealing member maybe disposed to separate the pixels from one another together with the light blocking portion. In comparison to a configuration, in which the light blocking portion has a frame section along the sealing member and the pixels are separated from one another only by the light blocking portion, this configuration is further preferable for reducing the frame size.

Advantageous Effect of the Invention

[0027] According to the present invention, the liquid crystal panel and the method of producing the liquid crystal panel preferable for reducing the frame size.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] FIG. **1** is a schematic plan view illustrating connection among a liquid crystal panel that includes a drive according to a first embodiment of the present invention, a flexible circuit board, and a control circuit board.

[0029] FIG. **2** is a schematic cross-sectional view illustrating a cross-sectional configuration along a short direction of a liquid crystal display device.

[0030] FIG. **3** is a schematic cross-sectional view illustrating an overall cross-sectional configuration of the liquid crystal panel.

[0031] FIG. **4** is a schematic cross-sectional view illustrating a cross sectional configuration of a section of the liquid crystal panel in a display area.

[0032] FIG. **5** is a plan view schematically illustrating a wiring configuration of an array board included in the liquid crystal panel.

[0033] FIG. **6** is a plan view illustrating a wiring configuration of TFTs in a peripheral section of the liquid crystal panel and positional relation between a sealing member and the display area.

[0034] FIG. **7** is a cross-sectional view illustrating a cross-sectional configuration of the peripheral section of the liquid crystal panel.

[0035] FIG. **8** is a plan view of a CF base board that is produced through a CF base board producing process.

[0036] FIG. **9** is a plan view of an array base board that is produced through an array base board producing process.

[0037] FIG. **10** is a side view illustrating a schematic configuration of a sealing member forming device used in a sealing member forming process.

[0038] FIG. **11** is a side view illustrating a side view illustrating a sealing material discharged by a dispenser in a sealing material disposing process included in the sealing member forming process.

[0039] FIG. **12** is a side view illustrating rolling and compressing of the sealing material by a first roller in the sealing member forming process.

[0040] FIG. **13** is a side view illustrating output of laser beams by a laser beam output port in a sealing material curing process included in the sealing member forming process.

[0041] FIG. **14** is a side view illustrating rolling and compressing of the sealing material by a second roller in the sealing member forming process.

[0042] FIG. **15** is a plan view of an array base board on which a sealing member is formed through the sealing member forming process.

[0043] FIG. **16** is a plan view of a CF base board on which a base sealing material is disposed through a base sealing material disposing process.

[0044] FIG. **17** is a cross-sectional view illustrating the CF base board on which a liquid crystal material is dropped and the array base board before the array base board is bonded to the CF board in a board bonding process.

[0045] FIG. **18** is a cross-sectional view illustrating the base boards that are bonded together in the board bonding process.

[0046] FIG. **19** is a cross-sectional view illustrating application of laser beams onto the sealing member in the sealing member fixing process.

[0047] FIG. **20** is a plan view illustrating the base boards with a base sealing member formed through a base sealing material curing process.

[0048] FIG. **21** is a cross-sectional view illustrating a cross-sectional configuration of an outer edge section of a liquid crystal panel according to a second embodiment of the present invention.

[0049] FIG. **22** is a plan view illustrating a wiring configuration of TFTs and a positional relation between a sealing member and a display area in the outer edge section of the liquid crystal panel.

[0050] FIG. **23** is a side view illustrating a schematic configuration of a sealing member forming device used in a sealing member forming process according to a third embodiment of the present invention.

[0051] FIG. **24** is a cross-sectional view illustrating a cross-sectional configuration of an outer edge section of a liquid crystal panel according to a fourth embodiment of the present invention.

[0052] FIG. **25** is a plan view illustrating a sealing material disposed between sealing member control portions in a sealing member forming process.

[0053] FIG. **26** is a plan view illustrating rolling and compressing of the sealing material by a first roller in the sealing member forming process.

MODE FOR CARRYING OUT THE INVENTION

First Embodiment

[0054] A first embodiment of the present invention will be described with reference to FIGS. **1** to **20**. In this section, a liquid crystal display device **10** will be described. X-axes, Y-axes, and Z-axes may be present in drawings. The axes in each drawing correspond to the respective axes in other drawings to indicate the respective directions. A vertical direction of the liquid crystal display device **10** is defined based on FIGS. **2** to **4**. Upper sides and lower sides in in FIGS. **2** to **4** correspond to a front side and a rear side of the liquid crystal display device **10**, respectively.

[0055] As illustrated in FIGS. **1** and **2**, the liquid crystal display device **10** includes a liquid crystal panel **11** (a display panel), a driver **17** (a panel driver), a control circuit board **12** (an external signal source), a flexible circuit board **13** (an external connecting component), and a backlight unit **14** (a lighting device). The liquid crystal panel **11** is configured to display images. The liquid crystal panel **11** includes a display area AA and a non-display area NAA. The display area AA is an inner area configured to display images. The non-display area NAA is an outer area to surround the display area AA. The driver **17** is configured to drive the liquid crystal panel **11**. The control circuit board **12** is configured to supply various kinds of signals from outside to the driver **17**. The flexible circuit board **13** electrically connects the liquid crystal panel **11** to the control circuit board **12** that is provided outside. The backlight unit **14** is an external light source for supplying light to the liquid crystal panel **11**. The liquid crystal display device **10** includes a front exterior component **15** and a rear exterior component **16** provided as a pair to hold the liquid crystal panel **11** and the backlight unit **14** that are assemble together. The front exterior component **15** includes an opening **15***a* through which images displayed in the display area AA of the liquid crystal panel **11** can be viewed from the outside. The liquid crystal display device **10** according to this embodiment may be used in, but not limited to, an electronic device (not illustrated). Examples of the electronic device include mobile phones (including smart phones), laptop computers (including tablet-type laptop computers), wearable terminals (including smartwatches), mobile information terminals (including electronic books and PDAs), portable video game players, and digital photo frames. Therefore, a screen size of the liquid crystal panel **11** included in the liquid crystal display device **10** may be from several inches to a ten and several inches, which is usually classified as a small or a small-to-medium screen size.

[0056] The backlight unit **14** will be briefly described. As illustrated in FIG. **2**, the backlight unit **14** includes a chassis **14***a*, alight source (e.g. cold cathode fluorescent tubes, LEDs, organic ELs), which are not illustrated, and an optical member, which is not illustrated. The chassis **14***a* has a box-like shape. The light sources are disposed inside the chassis **14***a*. The optical member is disposed to cover an opening of the chassis **14***a*. The optical member is configured to convert light emitted by the light sources into planar light.

[0057] Next, the liquid crystal panel **11** will be described. As illustrated in FIG. **1**, the liquid crystal panel **11** has a vertically-long rectangular overall shape. At a position closer to a first end of the liquid crystal panel **11** with respect to a long direction of the liquid crystal panel **11** (the upper side in FIG. **1**), the display area AA (an active area) is provided. The driver **17** and the flexible circuit board **13** are mounted at positions closer to a second end of the liquid crystal panel **11** with respect to the long direction of the liquid crystal panel **11** (the lower side in FIG. **1**). In the liquid crystal panel **11**, the area outside the display area AA is the non-display area NAA (a non-active area) in which images are not displayed. The non-display area NAA includes a frame-shaped region that surrounds the display area AA (a frame-shaped section of a CF board **11***a*, which will be described later) and a region that is provided at the second end with respect to the long direction (a section of an array board **11***b* which is exposed without overlapping the CF board **11***a*, which will be described later). The region provided at the second end with respect to the long direction includes a mounting region (an attachment region) in which the driver **17** and the flexible circuit board **13** are mounted. A width of three sections (non-mounting edge sections) other than the mounting area in which the driver **17** and the flexible circuit board **13** are located, more specifically, a linear distance between an outer edge of an glass substrate GS and an outer edge of the display area AA (a frame width) is 0.5 mm or less. Namely, the liquid crystal panel **11** has a significantly narrow frame configuration in which the frame size is significantly small. The short direction of the liquid crystal panel **11** corresponds with the X-axis direction in the drawings and the long direction of the liquid crystal panel **11** corresponds with the Y-axis direction in the drawings. In FIGS. **1**, **5**, and **6**, a chain line slightly smaller than the CF board **11***a* in a frame shape indicates an outline of the display area AA and an area outside the chain line is the non-display area NAA.

[0058] Next, the components connected to the liquid crystal panel **11** will be described. As illustrated in FIGS. **1** and **2**, the control circuit board **12** is mounted to a back surface of the chassis **14***a* of the backlight unit **14** (an outer surface on an opposite side from the liquid crystal panel **11** side) with screws. The control circuit board **12** includes a substrate made of paper phenol or glass epoxy resin. Electronic components for supplying various signals to the driver **17** are mounted on the substrate and traces (conductive lines), which are not illustrated, are formed and routed. One of ends (a first end) of the flexible circuit board **13** is electrically and mechanically connected to the control circuit board **12** via an anisotropic conductive film (ACF), which is not illustrated.

[0059] As illustrated in FIG. **2**, the flexible circuit board **13** includes a base member made of synthetic resin material (e.g., polyimide-based resin) having an insulating property and flexibility. A number of traces, which are not illustrated, are formed on the base member. As described earlier, the first end of the flexible circuit board **13** with respect to the long direction is connected to the control circuit board **12** disposed on the back surface of the chassis **14***a*. The other one of the ends (a second end) of the flexible circuit board **13** connected to the array board **11***b* of the liquid crystal panel **11**. The flexible circuit board **13** is folded to turn back and to have a U-shaped cross section in the liquid crystal display device **10**. At the ends of the flexible circuit board **13** with respect to the long direction, sections of the traces are exposed and configured as terminals (not illustrated). The terminals are electrically connected to the control circuit board **12** and the liquid crystal panel **11**. According to the configuration, the signals supplied by the control circuit board **12** are transmitted to the liquid crystal panel **11**.

[0060] As illustrated in FIG. **1**, the driver **17** is an LSI chip that includes a drive circuit therein. The driver **17** is configured to operate based on the signals supplied by the control circuit board **12**, which is a signal source. The driver **17** is configured to process the signals supplied by the control circuit board **12**, which is a signal source, to generate output signals, and output the output signals to the display area AA of the liquid crystal panel **11**. The driver **17** has a horizontally-long rectangular shape (an elongated shape along a short edge of the liquid crystal panel **11**) in a plan view. The driver **17** is directly mounted in the non-display area NAA of the liquid crystal panel **11** (on the array board **11***b*, which will be described later). Namely, the driver **17** is mounted with the chip-on-glass (COG) technology. The long direction of the driver **17** corresponds with the X-axis direction (the short direction of the liquid crystal panel **11**) and the short direction of the driver **17** corresponds with the Y-axis direction (the long direction of the liquid crystal panel **11**).

[0061] The liquid crystal panel **11** will be described. As illustrated in FIG. **3**, the liquid crystal panel **11** includes at least a pair of the boards **11***a* and **11***b*, a liquid crystal layer **11***c* (a medium layer), and a sealing member **11***q*. The liquid crystal layer **11***c* is sandwiched between the boards **11***a* and **11***b*. The liquid crystal layer **11***c* includes liquid crystal molecules that are substances having optical characteristics that vary according to application of an electric field. The sealing member **11***q* is disposed between the boards **11***a* and **11***b* to surround the liquid crystal layer **11***c*. The sealing member **11***q* seals the liquid crystal layer **11***c* while maintaining a cell gap in a size that corresponds with a thickness of the liquid crystal layer **11***c*. Although the cell gap in the liquid crystal panel **11** in this embodiment is set to about 3 to 4 μm, the size of the cell gap can be altered where appropriate. One of the boards **11***a* and **11***b* on the front side is the CF board a (a second board, a common board). The other one of the boards **11***a* and **11***b* on the rear side (the back side) is the array board **11***b* (a first board, an active matrix board). The CF board **11***a* and the array board **11***b* include glass substrates GS that are made of glass and various films that are formed in layers on inner surfaces of the glass substrates GS. The sealing member **11***q* is disposed in the non-display area NAA of the liquid crystal panel **11**. The sealing member **11***q* has a vertically-long frame shape along the non-display area NAA in the plan view (the view in a normal direction to a plate surface of the array board **11***b*) (FIG. **2**). The sealing member **11***q* has a width of about 400 μm in the significantly narrow frame configuration in which the frame width of the liquid crystal panel **11** is 0.5 min or less. Sections of the sealing member **11***q* disposed in three edge areas (non-mounting edge areas) other than the mounting area in which the driver **17** and the flexible circuit board **13** are located at the outermost in the non-display area NAA (FIG. **2**). Polarizing plates **11***d* and **11***e* are attached to outer surfaces of the boards **11***a* and **11***b*, respectively.

[0062] On an inner surface of the array board **11***b* (on a liquid crystal layer **11***c* side, an opposed surface that is opposed to the CF board **11***a*), as illustrated in FIGS. **4** and **6**, thin film transistors (TFTs, display components) **11***f* which are switching components and pixel electrodes **11***g* are arranged in rows and columns (in a matrix). Gate lines **11***i* (scan lines) and source lines **11***j* (data lines, signal lines) are routed in a grid to surround the TFTs **11***f* and the pixel electrodes **11***g*. The gate lines **11***i* and the source lines **11***j* are connected to gate electrodes **11***f***1** and source electrodes **11***f***2** of the TFTs **11***f*, respectively. The pixel electrodes **11***g* are connected to drain electrodes **11***f***3** of the TFTs **11***f*. The TFTs **11***f* are driven based on signals supplied to the gate lines **11***i* and the source lines **11***j*. The TFTs **11***f* are driven based on various signals supplied to the gate lines **11***i* and the source lines **11***j*. Application of voltages to the pixel electrodes **11***g* is controlled in accordance with the driving of the TFTs **11***f*. The TFTs **11***f* include channels **11***f***4** that connect the drain electrodes **11***f***3** to the source electrodes **11***f***2**. An oxide semiconductor film is used to form the channels **11***f***4**. The oxide semiconductor film of the channels **11***f***4** has electron mobility 20 to 50 times higher in comparison to an amorphous silicon thin material. Therefore, the TFTs **11***f* can be easily reduced in size to obtain an optimal amount of transmitted light through the pixel electrodes **11***g* (an aperture rate of display pixels). This configuration is preferable for increasing the definition and reducing the power consumption. The pixel electrodes **11***g* are disposed in quadrilateral areas defined by the gate lines **11***i* and the source lines **11***j*. The pixel electrodes **11***g* are formed from a transparent electrode film (an upper layer-side transparent electrode film) made of indium tin oxide (ITO) or zinc oxide (ZnO). The pixel electrodes **11***g* are layered on an insulating film lip on an upper layer side relative to the insulating film **11***p*. Common electrodes **11***h* are layered under the insulating film **11***p* on a lower layer side relative to the insulating film **11***p*. The common electrodes **11***h* are formed from the transparent electrode film (the lower layer-side transparent electrode film) similarly to the pixel electrodes **11***g*. The common electrodes **11***h* are formed as a solid pattern. The array board **11***b* includes the pixel electrodes **11***g* and the common electrodes **11***h*. When a potential difference is created between the electrodes **11***g* and **11***h*, a fringe electric field (an oblique electric field) including a component along the plate surface of the array board **11***b* and a component in the normal direction to the plate surface of the array board **11***b*. The liquid crystal panel **11** operates in fringe field switching (FFS) mode that is an improved version of in-plane switching (IPS) mode. In this embodiment, an extending direction in which the gate lines **11***i* extend and an extending direction in which the source lines **11***j* extend correspond with the X-axis direction and Y-axis direction in the drawings, respectively.

[0063] As illustrated in FIG. **4**, on the inner surface of the CF board **11***a* in the display area AA, color filters **11***k* are arranged at positions opposed to the pixel electrodes **11***g* on the array board **11***b*. The color filters **11***k* include red (R), green (G), and blue (B) color portions in three colors. The R color portions, the G color portions, and the B color portion are repeatedly arranged to form a matrix. The color portions (the pixels PX) of the color filters ilk arranged in the matrix are separated from one another with a light blocking portion **11***l* (a black matrix). With the light blocking portion **11***l*, color mixture of different colors of light rays that pass through the color portions is less likely to occur. The light blocking portion **11***l* is formed in a grid in the plan view. The light blocking portion **11***l* includes dividing sections **1111** and a frame section **1112**. The dividing sections **1111** a grid shape in the plan view and separate the color port ions from one another. The frame portion **1112** has a frame shape (a picture frame shape) in the plan view and surrounds the dividing sections **1111** from the peripheral sides. The dividing sections **1111** are disposed to overlap the gate lines **11***i* and the source lines **11***j* in the plan view. The frame section **1112** extends along the sealing member **11***q* and has a vertically-long rectangular shape in the plan view. A planarization layer **11***m* (an overcoat layer) is layered on the color filters **11***k* and the light blocking portion **11***l*. In the liquid crystal panel **11**, each color potion of the color filter **11***k* and the pixel electrode **11***g* that is opposed to the color potion form a single pixel PX. The pixels PX include red pixels, green pixels, and blue pixels. The red pixels include the R color portions of the color filters **11***k*. The green pixels include the G color portions of the color filters **11***k*. The blue pixels include the B color portions of the color filters **11***k*. The pixels PX in three colors are repeatedly arranged along the row direction (the X-axis direction) on the plate surface of the liquid crystal panel **11** to form pixel lines. A number of the pixel lines are arranged along the column direction (the Y-axis direction). Namely, a number of the pixels PX are arranged in a matrix in the display area AA of the liquid crystal panel **11**.

[0064] Next, the configuration of the array board **11***b* in the non-display area NAA will be described in detail. As illustrated in FIG. **5**, in the non-display area NAA, a column control circuit **18** is disposed in a section of the array board **11***b* adjacent to a short edge of the display area AA and a row control circuit **19** is disposed in a section of the array board **11***b* adjacent to a long edge of the display area AA. The column control circuit **18** and the row control circuit **19** are configured to perform control for supplying the signals that are output by the driver **17** to the TFTs **11***f*. The column control circuit **18** and the row control circuit **19** are monolithically fabricated on the array board **11***b* with the oxide semiconductor film, which are the same semiconductor film of the channels **11***f***4** of the TFTs **11***f*, as a base. The column control circuit **18** and the row control circuit **19** include control circuits for controlling the supply of the output signals to the TFTs **11***f*. The control circuits in the column control circuit **18** and the row control circuit **19** include at least control TFTs and traces **20** that are connected to the control TFTs. As illustrated in FIGS. **5** and **6**, the column control circuit **18** and the row control circuit **19** are disposed in sections of the CF board **11***a* closer to the outer edges of the non-display area. Namely, the column control circuit **18** and the row control circuit **19** are disposed to overlap the sealing member **11***q*. As illustrated in FIG. **7**, the sealing member **11***q* overlaps the traces **20** that are including in the control circuits of the column control circuit **18** and the row control circuit **19**. In FIGS. **5** and **6**, the sealing member **11***q* is indicated by two-dashed chain lines. The outer edges of the sealing member **11***q* substantially correspond with the outer edges of the CF board **11***a*. The inner edges of the sealing member **11***q* are disposed on inner side (closer to the display area AA) than the inner edges of the control circuits **18** and **19**. In a production process of the array board **11***b*, the control circuits of the column control circuit **18** and the row control circuit **19** are patterned on the array board **11***b* simultaneously with the patterning of the TFTs **11***f* by a known photolithography method.

[0065] As illustrated in FIG. **5**, the column control circuit **18** is disposed adjacent to the short edge of the display area AA on the lower side in FIG. **5**, that is, between the display area AA and the driver **17** with respect to the Y-axis direction. The column control circuit **18** overlaps one of the short sections of the sealing member **11***q* which extends along the X-axis direction in the plan view. The column control circuit **18** is disposed in a horizontally-long rectangular area that extends in the X-axis direction. The column control circuit **18** is connected to the source lines **11***j* disposed in the display area AA. The column control circuit **18** includes a switching circuit (an RGB switching circuit) for distributing image signals that are included in the output signals from the driver **17** to the source lines **11***j*. Specifically, a large number of the source lines **11***j* are disposed on the array board **11***b* in the display area AA along the X-axis direction. The source lines **11***j* are connected to the respective TFTs **11***f* that are connected to the respective pixel electrodes **11***g* that form the R (red) pixels PX, the G (green) pixels PX, and the B (blue) pixels PX. The column control circuit **18** is configured to distribute the image signals from the driver **17** to the source lines **11***j* of R, G, and B through the switching circuit. The column control circuit **18** may include an auxiliary circuit such as a level shifter circuit and an ESD protection circuit.

[0066] As illustrated in FIG. **5**, the row control circuit **19** is disposed adjacent to the long edge of the display area AA on the left side in FIG. **5**. The row control circuit **19** is disposed in a vertically-long rectangular area that extends along the Y-axis direction. The row control circuit **19** overlaps one of the long sections of the sealing member **11***q* which extends along the Y-axis direction in the plan view. The row control circuit **19** is connected to the gate lines **11***i* that are disposed in the display area AA. The row control circuit **19** includes a scanning circuit that is configured to supply scan singles included in the output signals from the driver **17** to the gate lines **11***i* at predefined timing to scan the gate lines in sequence. Specifically, a large number of the gate lines **11***i* are arranged on the array board **11***b* in the display area AA along the Y-axis direction. The row control circuit **19** is configured to scan the gate lines **11***i* by supplying the control signals (scan signals) from the driver **17** to the gate lines from the gate line **11***i* at the uppermost to the gate line **11***i* at the lowermost in FIG. **5** in the display area AA through the scanning circuit. The row control circuit **19** includes a buffer circuit for amplifying the scan signals. The row control circuit **19** may include an auxiliary circuit such as a level shifter circuit and an ESD protection circuit. The column control circuit **18** and the row control circuit **19** are connected to the driver **17** via connecting traces, which are not illustrated, formed on the array board **11***b*.

[0067] In the liquid crystal panel **11** in this embodiment, the sealing member **11***q* is formed on a CF board **11***a* side by curing the material through application of laser beams and fixed to the array board **11***b* through application of the laser beams during bonding of the boards **11***a* and **11***b* in the production process of the liquid crystal panel **11**. The sealing member **11***q* is made of the material having the light blocking property. As illustrated in FIG. **7**, the sealing member **11***q* is disposed to overlap the traces **20** of the control circuits **18** and **19** in the non-display area NAA but not overlap the light blocking portion **11***l*. In this embodiment, the liquid crystal panel **11** has the narrow frame design. Therefore, the sealing member **11***q* is disposed to overlap traces **20** that included in the array board **11***b* in the non-display area NAA. When the fixation of the sealing member **11***q* to the CF board **11***a* is accelerated by the laser beams that are applied from the array board **11***b* side, the laser beams may be blocked by the traces **20**. Especially, if arrangement density of the traces **20** is increased and intervals between the traces **20** is reduced in accordance with the reduction in the frame size, the fixation of the sealing member **11***q* to the CF board **11***a* may become insufficient or a longer period of time may be required for the fixation of the sealing member **11***q*. Because the sealing member **11***q* is disposed not to overlap the light blocking portion **11***l* of the CF board **11***a*, the laser beams are less likely to be blocked by the light blocking portion **11***l* by applying the laser beams from the CF board **11***a* side for the fixation the sealing member **11***q* to the array board **11***b*. According to the configuration, the fixation of the sealing member **11***q* to the array board **11***b* can be properly accelerated. Even if the arrangement density of the traces **20** is increased in accordance with a reduction in the frame size, the fixation of the sealing member **11***q* to the array board **11***b* can be properly accelerated regardless of the arrangement density of the traces **20**. Because the sealing member **11***q* has the light blocking property, even if the sealing member **11***q* is disposed not to overlap the light blocking portion **11***l*, a leakage of light is less likely to occur in the non-display area NAA.

[0068] Specifically, a sealing material S of the sealing member **11***q* includes synthetic resin material (e.g., nylon powder made of nylon (polyamide)) and black light blocking compounds (e.g., carbon powder (carbon black)) dispersed in the synthetic resin material. The sealing member **11***q* is formed by sintering and curing the sealing material S with the laser beams. More specifically, to form the sealing member **11***q*, the sealing material S that is in the powdered form is disposed on the CF board **11***a* and the laser beams are applied to the sealing material S. A section of the sealing material S to which the laser beams are applied is selectively sintered and cured. Namely, by adjusting an area of the sealing material S to which the laser beams are applied, a forming area (e.g., a width) to form the sealing member can be set with high accuracy. The light blocking compounds are evenly disposed in the synthetic resin material of the sealing member **11***q* prepared by curing the sealing material S and fixed. According to the configuration, the sealing member **11***q* can deliver light blocking performance at the same level as the light blocking portion **11***l* and even light blocking performance. As illustrated in FIG. **7**, the sealing member **11***q* is disposed such that an inner peripheral surface of the sealing member **11***q* contacts the outer peripheral surface of a frame section **1112** of the light blocking portion **11***l*. Therefore, the sealing member **11***q* can block a leakage of light from the non-display area together with the frame section **1112**. The outer peripheral surface of the sealing member **11***q* on the opposite side from the liquid crystal layer **11***c* side (the light blocking portion **11***l* side) is flush with an outer end surface of the CF board **11***a*. This configuration is preferable for further reducing the frame size. Furthermore, the sealing material S of the sealing member **11***q* contains spacer particles. The spacer particles contained in the sealing material S may be silica beads. A diameter of each particle is about equal to the cell gap of the liquid crystal panel **11** (the thickness of the liquid crystal layer **11**). With the spacer particles, the height of the sealing member **11***q* can be maintained constant with a value about equal to the cell gap for the entire periphery. Other than the spacer particles, inorganic filler, auxiliary agent, and additive agent may be added to the sealing material S where appropriate.

[0069] As illustrated in FIG. **7**, the sealing member **11***q* is disposed not to overlap the planarization layer **11***m* formed on the CF board **11***a*. The planarization layer **11***m* is layered on the color filters **11***k* and the light blocking portion **11***l* with in the plane of the CF board **11***a* on the liquid crystal layer **11***c* side. Within the plane of the CF board **11***a*, the planarization layer **11***m* is solid. However, an outer peripheral section of the planarization layer **11***m* which may overlap the sealing member **11***q* is removed. Namely, the planarization layer **11***m* is selectively formed in the section of the inner peripheral surface of the CF board **11***a* which does not overlap the sealing member **11***q*. An outer peripheral surface of the planarization layer **11***m* is disposed to contact the inner peripheral surface of the sealing member **11***q* and flush with the outer peripheral surface of the frame section **1112** of the light blocking portion **11***l*. According to the configuration, the sealing member **11***q* is fixed to the glass substrate GS of the CF board **11***a* with direct contact.

The planarization layer **11***m* and the light blocking portion **11***l* do not exist between the sealing member **11***q* and the CF board **11***a*. Therefore, the sealing member **11***q* is more strongly bonded to the CF board **11***a*. Because only an interface between the sealing member **11***q* and the CF board **11***a* is exposed to the outside, in comparison to a configuration in which the planarization layer **11***m* is disposed between the sealing member **11***q* and the CF board **11***a*, a size of the interface that is exposed to the outside can be reduced and thus moisture that exists the outside is less likely to enter into the liquid crystal layer **11***c* via the interface.

[0070] The liquid crystal panel **11** in this embodiment has the configuration described above. Next, the method of producing the liquid crystal panel **11** will be described. The method of producing the liquid crystal panel **11** in this embodiment includes a CF base board producing process (a first base board producing process), an array base board producing process (a second base board producing process), a sealing member forming process, a base sealing material disposing process, a board bonding process, a sealing member fixing process, a base sealing material curing process, and a cutting process. The CF base board producing process includes producing a CF base board **11***a*M (a first base board) which includes CF boards **11***a* within a plate surface thereof. The array base board producing process includes producing an array base board **11***b*M (a second base board) which includes array boards **11***b* within a plate surface thereof. The sealing member forming process includes forming the sealing member **11***q* by curing the sealing material S on the CF board **11***a* without any uncured sections. The base sealing material disposing process includes disposing a base sealing material MS that includes uncured sections on any one of the CF base board **11***a*M and the array base board **11***b*M to surround either the CF boards **11***a* or the array boards **11***b*. The board bonding process includes bonding the CF board **11***a* and the array board **11***b* with the liquid crystal layer **11***c* between the CF board **11***a* and the array board **11***b*. The sealing member fixing process includes fixing the sealing member **11***q* to the array board **11***b*. The base sealing material curing process includes curing the base sealing material MS without any uncured sections to form a base sealing member **21**. The cutting process includes cutting the cutting the base boards **11***a*M and **11***b*M to obtain the liquid crystal panels **11**. In the sealing member forming process, the expression "the sealing material S is cured without any uncured section" does not mean that the extent of curing is 100%. The extent of curing lower than 100% may be included.

[0071] As illustrated in FIG. **8**, in the CF base board producing process, various films are formed on a plate surface of a large-sized glass base substrate GSM by a known photolithography method and the films are processed through patterning to form components of the CF boards **11***a* in layers. Through the process, the CF base board **11***a*M is produced. As illustrated in FIG. **9**, in the array base board producing process, various films are formed on a plate surface of a large-sized glass base substrate GSM by a known photolithography method and the films are processed through patterning to form components of the array boards **11***b* in layers. Through the process, the array base board **11***b*M is produced. In FIGS. **8** and **9**, the CF boards **11***a* and the array boards **11***b* within the respective glass base substrates GSM are indicated by two-dashed chain lines. The CF boards **11***a* are arranged in a matrix within the plate surface of the glass base substrate GSM and the array boards **11***b* are arranged in a matrix within the plate surface of the glass base substrate GSM. Specifically, four along the X-axis direction by five along the Y-axis direction of those are arranged. The number of the CF boards **11***a* or the array boards **11***b* arranged within the plate surface of each glass base substrate GSM can be altered from the number described above where appropriate. Short dimensions and long dimensions of the CF base board **11***a*M and the array base board **11***b*M may be about in a range from 660 to 1500 mm and a range from 880 to 1800 mm, respectively. The dimensions may be altered where appropriate.

[0072] In the sealing member forming process, the sealing member **11***q* is formed on each CF board **11***a* of the CF base board **11***a*M using a sealing member forming device **30** that is a powder sintering type forming device described below. As illustrated in FIG. **10**, the sealing member forming device **30** includes at least a stage **31**, a head **32**, a light source **33**, and a controller **34**. The CF base board **11***a*M is placed on the stage **31**. The head **32** is disposed opposite the CF base board **11***a*M on the stage **31**. The light source **33** is connected to the head **32** and configured to emit the laser beam toward the CF base board **11***a*M. The controller **34** is connected to the head **32** and the light source **33** and configured to control the head **32** and the light source **33**. The stage **31** can move the CF base board **11***a*M along the X-axis direction, the Y-axis direction, and the θ direction (the rotational direction) which are parallel to the plate surface of the CF base board **11***a*M. The head **32** includes at least a dispenser **32***a*, a first roller **32***b*, a laser beam output port **32***c*, a second roller **32***d*, and a driver **32***e*. The dispenser **32***a* is configured to supply the sealing material S onto the CF base board **11***a*M. The first roller **32***b* is disposed adjacent to the dispenser **32***a* to roll and compress the sealing material S. The laser beam output port **32***c* is configured to apply the laser beam to the CF base board **11***a*M. The second roller **32***d* is disposed adjacent to the laser beam output port **32***c* to roll and compress the sealing material S to which the laser beam has been applied. The driver **32***e* is configured to drive the dispenser **32***a*, the first roller **32***b*, the laser beam output port **32***c*, and the second roller **32***d*. The light source **33** may include a carbon dioxide laser unit that is configured to emit an oscillating carbon dioxide laser beam (CO_2 laser beam). The light source **33** is connected to the head **32** via optical fibers to supply the carbon dioxide laser beam to the laser beam output port **32***c* that is included in the head **32**. The controller **34** is configured to control the oscillation of the carbon dioxide laser beam by the light source **33**. The controller **34** is configured to control the components **32***a* to **32***e* that are included in the head **32**.

[0073] The configuration of the head **32** will be described in detail. The dispenser **32***a* is configured to discharge the sealing material S in the powdered form to form the sealing member. The dispenser **32***a* is configured to discharge the sealing material S in the powdered form in line in an area of the CF base board **11***a*M with a width smaller than the width of the sealing member **11***q*. The amount of the sealing material S discharged by the dispenser **32***a* is controlled by the driver **32***e*. The nylon powder that is the synthetic resin material to form the sealing material S and discharged by the dispenser **32***a* has a mean particle diameter of about 50 μm. A mean particle diameter of the spacer particles that are contained in the sealing material S is about 3 to 4 μm. By adding the organic filler, auxiliary agent, and additive agent to the sealing material S, flowability of the sealing material S during the rolling and compressing them by the first roller **32***b* can be improved. The first roller **32***b* can be move down to be set closer to the CF baseboard **11***a*M and up to be set away from the CF base board **11***a*M by the driver **32***e*. Specifically, when the sealing material S is not discharged by the dispenser **32***a*, the first roller **32***b* is set at a position away from the CF base board **11***a*M. During the discharge of the sealing material S by the dispenser **32***a*, the first roller **32***b* is set at a position closer to the CF base board **11***a*M. The first roller **32***b* is configured to grind the nylon powder to form the sealing material S between the first roller **32***b* and the CF baes board **11***a*M to reduce the particle diameters about equal to the cell gap or less and to spread them in the width direction of the sealing member **11***q*.

[0074] The laser beam output port **32***c* is disposed on an opposite side from the dispenser **32***a* relative to the first roller **32***b* with a distance larger than a distance between the first roller **32***b* and the dispenser **32***a*. The laser beam output port **32***c* is configured to apply the laser beam that is supplied by the light source to the sealing material S on the CF base board **11***a*M. It is preferable that the carbon dioxide laser beam output from the laser beam output port **32***c* has a wavelength of about 9.2 to 10.8 μm and an intensity of about 25 kW. When the laser beam is applied to the sealing material S, the nylon powder that is a main component of the sealing material S is sintered. The second roller **32***d* is configured to move down to be set closer to the CF base board **11***a*M and up to be set away from the CF base board **11***a*M by the driver **32***e*. Specifically, when the laser beam is not output from the laser beam output port **32***c*, the second roller **32***d* is set at a position away from the CF base board **11***a*M. During the output of the laser beam from the laser beam output port **32***c*, the second roller **32***d* is set at a position closer to the CF base board **11***a*M. The second roller **32***d* may include a heater, which is not illustrated. The second roller **32***d* may be heated to about 160° C. According to the configuration, the sealing material S that is in a condition immediately after the laser beam is applied can be softened during the rolling and compressing of the sealing material S.

[0075] The sealing member forming process will be described in detail. The sealing member forming process includes the sealing material disposing process and the sealing material curing process. The sealing material disposing process includes disposing the sealing material S that is in the powdered form on the CF board **11***a*. The sealing material curing process includes applying the laser beam to the sealing material S and selectively curing the section of the sealing material S to which the laser beam is applied without any uncured areas. In the sealing member forming process, the CF base board **11***a*M is placed on the stage **31** of the sealing member forming device **30**. In the sealing material disposing process that is included in the sealing member forming process, the stage **31** is moved in the X-axis direction, the Y-axis direction, and the θ direction that are parallel to the plate surface of the CF base board **11***a*M relative to the head **32**. During the movement, the sealing material S is discharged by the dispenser **32***a*. As illustrated in FIG. **11**, the sealing material S is disposed in line along the area of the CF base board **11***a*M to form the sealing member **11***q*. The sealing material S is selectively disposed in the area to form the sealing member **11***q*. In comparison to a configuration in which the sealing material S is disposed in an entire area within the plate surface of the CF board **11***a* and the sealing material S is selectively cured, the amount of sealing material S to be used is smaller. This is preferable for reducing the production cost. The sealing material S disposed on the CF base board **11***a*M is rolled and compressed by the first roller **32***b* that is disposed at the position closer to the CF base board **11***a*M. As a result, the sealing material S is ground. The sealing material S that is ground by the first roller **32***b* has the particle diameter equal to the cell gap or less as illustrated in FIG. **12** and spread in the width direction of the sealing member **11***q* (a first rolling and compressing process). As illustrated in FIG. **13**, in the sealing material curing process that is included in the sealing member forming process, the laser beam that is output from the laser beam output port **32***c* is applied to the sealing material S that has been rolled and compressed by the first roller **32***b*. The nylon powder that is exit in the laser applied section is instantaneously heated and sintered. In sections of the sealing material to which the laser beam is not applied (non-laser applied sections), the nylon powder is not sintered and thus not cured. As illustrated in FIG. **14**, the sealing material S to which the laser beam is applied is rolled and compressed by the second roller **32***d* that is disposed at the position closer to the CF base board **11***a*M (a second rolling and compressing process). The second roller **32***d* is heated by the heater and thus the sealing material S is softened. According to the configuration, the rolling and compressing can be accelerated while the flowability of the sealing material S is ensured. The sealing material S is spread by the second roller **32***d* to have a thickness that is about equal to the cell gap and cured without any uncured sections (completely cured). As a result, the sealing member **11***q* is formed. The above-described sealing member forming process is performed for every CF board **11***a* that is within the plate surface of the CF base board **11***a*M. As illustrated in FIG. **15**, the sealing member **11***q* is formed on each CF board **11***a*.

[0076] As illustrated in FIG. **16**, in the base sealing material disposing process, the base sealing material MS that includes an uncured section is disposed on the array base board **11***b*M to collectively surround the array boards **11***b*. The base sealing material MS is disposed in an outer edge section of the array base board **11***b*M in a vertically-long frame shape in a plan view. The base sealing material MS is made of thermosetting resin material. When the base sealing material MS is heated to a predefined curing temperature, the base sealing material MS is cured and formed into the base sealing member **21**. In the base sealing material disposing process, an interim curing processing is performed to heat the base sealing material MS for a short period of time to cure a surface thereof. Most of inner section of the base sealing material MS on which the interim curing processing has been performed is uncured although the surface of the base sealing material MS is cured. The base sealing material disposing process is performed on the array base board **11***b*M but not on the CF base board **11***a*M on which the sealing member forming process is performed. Therefore, the sealing member forming process and the base sealing material disposing process can be performed in parallel. In comparison to a method in which the sealing member forming process and the base sealing material disposing process area performed on the CF base board **11***a*M, the time required for producing the liquid crystal panel **11** can be reduced.

[0077] As illustrated in FIG. **17**, in the board bonding process, a liquid crystal material LC is dropped into a section of each CF board **11***a* surrounded by the sealing member **11***q* on the CF base board **11***a*M and then the array base board **11***b*M is bonded to the CF base board **11***a*M. The board bonding process is performed in the vacuum environment. As illustrated in FIG. **18**, when the base boards **11***a*M and **11***b*M are bonded together, the liquid crystal material LC to form the liquid crystal layer **11***c* is pressed and spread between the base boards **11***a*M and **11***b*M and thus a space surrounded by the sealing member **11***q* is filled with the liquid crystal material LC. The sealing member **11***q* receives a force that is applied by the liquid crystal layer **11***c* to squeeze the sealing member **11***q*. When the frame size is further reduced and the width of the sealing member **11***q* is reduced, the sealing member **11***q* may not be able to withstand the force and the liquid crystal layer **11***c* may partially enter the sealing member **11***q*. In the sealing member forming process that is performed prior to the board bonding process, the sealing material S is cured without any uncured sections (completely cured) and the sealing member **11***q* is formed. Even if the frame size is further reduced, the liquid crystal layer **11***c* is less likely to partially enter into the sealing member **11***q*. Because the entrance of the liquid crystal layer into the sealing member **11***q* is less likely to occur, a decrease in fixing strength of the sealing member **11***q* relative to the boards **11***a* and **11***b* is less likely to occur. Furthermore, the sealing member **11***q* is less likely to have bubbles and thus removal of the boards **11***a* and **11***b* is less likely to occur. Other than the above, when the width of the sealing member **11***q* is reduced according to the reduction in the frame size, external moisture may pass through the uncured section of the sealing member **11***q* and diffuse in the liquid crystal layer **11***c*. In the sealing member forming process that is performed prior to the board bonding process, the sealing material is cured without any uncured section (completely cured) and the sealing member **11***q* is formed. Even if the frame size is further reduced, the external moisture is less likely to pass through the sealing member **11***q*. Therefore, the moisture is less likely to diffuse in the liquid crystal layer **11***c*. When the board bonding process is performed, the base sealing material MS that includes the uncured sections tightly contact the CF base board **11***a*M. Therefore, a space between the base boards **11***a*M and **11***b*M is maintained under negative pressure. After the board bonding process that is performed in the vacuum environment is completed, the base boards **11***a*M and **11***b*M are placed in the atmospheric pressure environment. When the base boards **11***a*M and **11***b*M are placed in the atmospheric pressure environment, displacement or removal of the base boards **11***a*M and **11***b*M is less likely to occur.

[0078] In the sealing member fixing process, the sealing member **11***q* is fixed to each array board **11***b* of the array base board **11***b*M of the bonded base boards **11***a*M and **11***b*M to seal the liquid crystal layer **11***c*. To fix the sealing member **11***q* to the array board **11***b*, as illustrated in FIG. **19**, the laser beam is applied to the sealing member **11***q* from the CF board **11***a* side to melt a section of the sealing member **11***q* which contacts the CF board **11***a*. Immediately after that, the melted section of the sealing member **11***q* is cured and thus the sealing member **11***q* is fixed to the CF board **11***a*. The laser beam that is applied to the sealing member **11***q* is less likely to be blocked by the light blocking portion **11***l* because the sealing member **11***q* does not overlap the light blocking portion **11***i* of the CF board **11***a* and by the traces **20** of the array board **11***b* (see FIG. **7**). Even if the frame size of the liquid crystal panel **11** is further reduced and the arrangement density of the traces **20** on the array board **11***b* is increased, that is, the intervals of the traces **20** are reduced, the fixation of the sealing member **11***q* to the CF board **11***a* can be properly improved regardless of the reduction in the intervals of the traces **20**. In FIG. **19**, the laser beams that are applied to the sealing members **11***q* in the sealing member fixing process are indicated with chain-line arrows. The laser beams may be separately applied to the sealing members **11***q* in sequence or collectively applied to all sealing members **11***q* at a time.

[0079] In the base sealing material curing process, the thermosetting resin material that is the base sealing material MS is heated to the curing temperature. Through the heating, the base sealing material MS is cured without any uncured sections (completely cured). As illustrated in FIG. **20**, the base sealing member **21** is formed. In association with the heating, reorientation of the liquid crystal molecules that are included in the liquid crystal layer **11***c* is accelerated. Therefore, the liquid crystal molecules that are included in the liquid crystal layer **11***c* are properly orientated. The base sealing material curing process may be performed prior to the sealing member fixing process. In the cutting process, the base boards **11***a*M and **11***b*M are cut along a predefined scribe line to obtain the liquid crystal panel **11**.

[0080] As described above, the method of producing the liquid crystal panel **11** in this embodiment (the display panel) includes the sealing member forming process, the board bonding process, and the sealing member fixing process. The sealing member forming process includes forming the sealing member **11***q* by curing the sealing material S disposed on the CF board **11***a* (the first board) without any uncured section. The board bonding process includes bonding the array board **11***b* (the second board) to the CF board **11***a* with the liquid crystal layer **11***c* (the medium layer) therebetween. The sealing member fixing process includes fixing the sealing member **11***q* to the array board **11***b*.

[0081] In the sealing member forming process, the sealing material S is disposed on the CF board **11***a* and the sealing material S is cured without any uncured sections. Through the process, the sealing member **11***q* is formed. In the board bonding process that is subsequently performed, the array board **11***b* is bonded to the CF board **11***a* with the liquid crystal layer **11***c* therebetween. In the sealing member fixing process that is subsequently performed, the sealing member **11***q* is fixed to the array board **11***b*. Through the process, the liquid crystal layer **11***c* is sealed. In the board bonding process, the liquid crystal layer **11***c* is pressed and spread between the boards **11***a* and **11***b* in association with bonding of the boards **11***a* and **11***b*. The sealing member **11***q* may receive the force that is applied by the liquid crystal layer **11***c* to squeeze the sealing member **11***q*. If the frame size is further reduced and the width of the sealing member **11***q* is reduced, the sealing member **11***q* may withstand the force and thus the liquid crystal layer **11***c* may partially enter into the sealing member **11***q*. In the sealing member forming process that is performed prior to the board bonding process, the sealing material S is cured without any uncured sections and the sealing member **11***q* is formed. Even if the frame size is further reduced, the liquid crystal layer **11***c* is less likely to partially enter into the sealing member **11***q*. If the width of the sealing member **11***q* is reduced when the frame size is further reduced, external moisture may pass through the uncured section of the sealing member **11***q* and diffuse in the liquid crystal layer **11***c*. In the sealing member forming process that is performed prior to the board bonding process, the sealing material S is cured without any uncured sections and the sealing member **11***q* is formed. Even if the frame size is further reduced, the external moisture is less likely to pass the sealing member **11***q* and thus the moisture is less likely to diffuse in the liquid crystal layer **11***c*. This is preferable for reducing the frame size of the liquid crystal panel **11**.

[0082] The method of producing the liquid crystal panel **11** includes the CF base board producing process (the first base board producing process), the array base board producing process (the second base board producing process), the base sealing material disposing process, and the base sealing material curing process. The CF base board producing process includes producing the CF base board **11***a*M (the first base board) which includes the CF boards **11***a* within the plate surface. The array base board producing process includes producing the array base board **11***b*M (the second base board) which includes the array boards **11***b* within the plate surface. The base sealing material disposing process includes disposing the base sealing material MS that includes the uncured section on any one of the CF base board **11***a*M and the array base board **11***b*M to surround either the CF boards **11***a* or the array boards **11***b*. The base sealing material curing process is performed at least after the board bonding process for curing the base sealing material MS without any uncured sections to form the base sealing member **11***q*. In the base sealing material disposing process, the base sealing material MS that includes the uncured section is disposed on either the CF base board **11***a*M that is produced through the CF base board producing process or the array base board **11***b*M that is produced through the array base board producing process to surround either the CF boards **11***a* or the array boards **11***b*. When the CF base board **11***a*M and the array base board **11***b*M are bonded together in the board bonding process that is subsequently performed, the base sealing material MS that includes the uncured section closely contact the other one of the CF base board **11***a*M and the array base board **11***b*M. The space between the base boards **11***a*M and **11***b*M is maintained under the negative pressure. Therefore, the base boards **11***a*M and **11***b*M are less likely to be displaced or removed. In the base sealing material curing process that is subsequently performed, the base sealing material MS is cured without any uncured sections and the base sealing member **11***q* is formed.

[0083] In the base sealing material disposing process of the method of producing the liquid crystal panel **11**, the base sealing material MS is disposed on the array base board **11***b*M. The base sealing material disposing process is performed to dispose the base sealing material MS on the array base board **11***b*M that is different from the CF base board **11***a*M on which the sealing material forming process is performed. According to the method, the sealing member forming process and the base sealing material disposing process can be performed in parallel. In comparison to a method in which the sealing member forming process and the base sealing material disposing process are performed on the CF base board **11***a*M, the time that is required for the production of the liquid crystal panel **11** can be reduced.

[0084] In the board bonding process of the method of producing the liquid crystal panel **11**, the medium layer is the liquid crystal layer **11***c*. In the base sealing material disposing process, the thermosetting resin material is disposed for the base sealing material MS. In the base sealing material curing process, the heating is performed until the temperature reaches at least the curing temperature of the thermosetting resin material. When the heating is performed until the temperature reaches at least the curing temperature of the thermosetting resin material of the base sealing material MS in the base sealing material curing process, the thermosetting resin material is cured and the base sealing member **11***q* is formed. The reorientation of the liquid crystal molecules in the liquid crystal layer **11***c* that is the medium layer is accelerated. Therefore, the liquid crystal molecules in the liquid crystal layer **11***c* are properly orientated.

[0085] In the sealing member forming process of the method of producing the liquid crystal panel **11**, the sealing material S is discharged by the dispenser **32***a* to dispose the sealing material S along the area to form the sealing member **11***q*. In comparison to a method in which the sealing material S is disposed over an entire are of the CF board **11***a* within the plate surface thereof and the sealing material S is selectively cured, the amount of the sealing material S to be used can be reduced. This method is preferable for reducing the production cost.

[0086] The sealing member forming process of the method of producing the liquid crystal panel **11** includes the sealing material disposing process and the sealing material curing process. The sealing material disposing process includes disposing the sealing material S that is in the powdered form on the CF board **11***a*. The sealing material curing process includes applying the laser beams to the sealing material S and selectively curing the sections to which the laser beams are applied without any uncured sections. In the sealing material disposing process, the sealing material S that is in the powdered form is disposed on the CF board **11***a*. In the sealing material curing process that is subsequently performed, the laser beams are applied to the sealing material S that is disposed on the CF board **11***a* and the sections to which the laser beams are applied are selectively cured without any uncured sections. Through the processes, the sealing member **11***q* is formed.

[0087] The liquid crystal panel **11** in this embodiment includes the array board **11***b*, the CF board **11***a* (the common board), the liquid crystal layer **11***c*, and the sealing member **11***q*. The array board **11***b* includes at least the pixels PX and the traces **20**. The pixels PX are arranged in the matrix in the display area AA in which images are displayed. The traces **20** are disposed in the non-display area NAA outside the display area AA. The CF board **11***a* that includes the light blocking portion **11***l* is disposed opposite the array board **11***b*. The light blocking portion **11***l* include at least the sections that are disposed to separate the pixels PX from one another. The liquid crystal layer **11***c* is sandwiched between the array board **11***b* and the CF board **11***a*. The sealing member **11***q* is disposed between the array board **11***b* and the CF board **11***a* to surround the liquid crystal layer **11***c* and to overlap the traces **20** in the non-display area NAA. The sealing member **11***q* is made of the material that has the light blocking property and disposed not to overlap the light blocking portion **11***l*.

[0088] According to the configuration, the pixels PX that are arranged in the matrix in the display area AA are separated from one another by the light blocking portion **11***l*. Therefore, color mixture is less likely to occur. The liquid crystal layer **11***c* that is sandwiched between the array board **11***b* and the CF board **11***a* is surrounded and sealed by the sealing member **11***q* that is disposed in the non-display area and between the array board **11***b* and the CF board **11***a*.

[0089] The sealing member **11***q* is disposed in the non-display area to overlap the traces **20** that are included in the array board **11***b*. To accelerate the fixation of the sealing member **11***q* to the CF board **11***a* with light that is applied from the array board **11***b* side, the light may be blocked by the traces **20**. If the arrangement density of the traces **20** is increased when the frame size is further reduced, the fixation of the sealing member **11***q* to the CF board **11***a* may become insufficient or takes a longer period of time. The sealing member **11***q* is disposed not to overlap the light blocking portion **11***l* that is includes in the CF board **11***a*. If light is applied to the sealing member **11***q* from the CF board **11***a* side to fix the sealing member **11***q* to the array board **11***b*, the light is less likely to be blocked by the light blocking portion **11***l*. Therefore, the fixation of the sealing member **11***q* can be properly accelerated. Even if the arrangement density of the traces **20** is increased when the frame size is further reduced, the fixation of the sealing member **11***q* to the array board **11***b* can be properly accelerated regardless of the arrangement density of the traces **20**. Furthermore, the sealing member **11***q* has the light blocking property. Therefore, although the sealing member **11***q* is disposed not to overlap the light blocking portion **11***l*, light leakage is less likely to occur in the non-display area NAA. This configuration is preferable for reducing the frame size.

[0090] The CF board **11***a* of the liquid crystal panel **11** includes the planarization layer **11***m* that is disposed at least over the light blocking portion **11***l* on the liquid crystal layer **11***c* side. The planarization layer **11***m* is disposed in the area not to overlap the sealing member **11***q*. According to the configuration, the sealing member **11***q* is fixed to the CF board **11***a* with direct contact. Namely, because the planarization layer **11***m* is not disposed between the sealing member **11***q* and the CF board **11***a*, the sealing member **11***q* is more strongly fixed to the CF board **11***a*. Only the interface between the sealing member **11***q* and the CF board **11***a* is exposed to the outside. In comparison to a configuration in which the planarization layer **11***m* is disposed between the sealing member **11***q* and the CF board **11***a*, the area of the interface that is exposed to the outside can be reduced. Therefore, the external moisture is less likely to pass through the interface and enter into the liquid crystal layer **11***c*.

[0091] In the liquid crystal panel **11**, the outer surface of the sealing member **11***q* on the opposite side from the liquid crystal layer **11***c* is flush with at least the end surface of the CF board **11***a*. In comparison to a configuration in which the outer surface of the sealing member **11***q* is located inner than the end surface of the CF board **11***a*, the frame size can be further reduced.

[0092] The sealing member **11***q* of the liquid crystal panel **11** is made of the synthetic resin material with the light blocking compounds mixed in the synthetic resin material. According to the configuration, the light blocking compounds can be easily dispersed in the synthetic resin material when mixing the light blocking compounds in the synthetic resin material. Therefore, the sealing member **11***q* that delivers even light blocking performance can be easily provided. In comparison to a configuration in which the sealing member **11***q* is made of metal, the sealing member **11***q* can be fixed to the CF board **11***a* with a lower temperature.

[0093] The sealing member **11***q* of the liquid crystal panel **11** contains the spacer particles. This configuration is preferable for maintaining the height of the sealing member **11***q* constant.

Second Embodiment

[0094] A second embodiment of the present invention will be described with reference to FIGS. **21** and **22**. The second embodiment includes a light blocking portion without a frame section. Configurations, functions, and effects similar to those of the first embodiment will not be described.

[0095] As illustrated in FIGS. **21** and **22**, a liquid crystal panel **111** in this embodiment includes a sealing member **111***q* that is disposed for about entire width of the non-display area NAA. The light blocking portion, which is not illustrated, does not include the frame section. The sealing member **111***q* is disposed to separate the pixels PX from one another together with a grid section of the light blocking portion. The pixels PX that are disposed at the outermost among the pixels PX that are arranged in the matrix in the display area AA are separated by the outermost section of the grid section of the light blocking portion and the sealing member **111***q* that collectively surrounds them. Because the frame section is not included in the light blocking portion, the frame size of the liquid crystal panel **111** can be further reduced.

[0096] As described above, in the liquid crystal panel **111** in this embodiment, the sealing member **111***q* is disposed to separate the pixels PX from one another together with the light blocking portion. In comparison to a configuration in which the light blocking portion includes the frame section along the sealing member **111***q* and the pixels PX are separated from one another only by the light blocking portion, this configuration is more preferable for reducing the frame size.

Third Embodiment

[0097] A third embodiment of the present invention will be described with reference to FIG. **23**. The third embodiment includes a sealing member forming device **40** used in a sealing member forming process, which is different from the first embodiment. Configurations, functions, and effects similar to those of the first embodiment will not be described.

[0098] As illustrated in FIG. **23**, in the sealing member forming process in this embodiment, the fusion deposition type sealing member forming device **40** is used. The sealing member forming device **40** includes at least a stage **41**, a head **42**, and a controller **43**. A CF base board **211***a*M is placed on the stage **41**. The head **42** is disposed opposite the CF base board **211***a*M on the stage **41**. The controller **43** is connected to the head **42** and configured to control the head **42**. In comparison to the powder sintering type sealing member forming device **30** in the first embodiment (see FIG.

10), the fusion deposition type sealing member forming device **40** is provided with a lower facility cost because it does not include the light source **33** and the laser beam output port **32***c*. A major different of the sealing member forming device **90** from the sealing member forming device **30** in the first embodiment is the head **42**. Therefore, the head **42** will be described in detail and other configurations similar to those of the first embodiment will not be described.

[0099] The head **42** of the sealing member forming device **40** includes at least a dispenser **42***a*, a roller **42***b*, and a driver **42***c*. The dispenser **42***a* is configured to fuse the thermosetting resin material of the sealing material S (thermal fusion) and to discharge the sealing material S onto the CF base board **211***a*M. The roller **42***b* is configured to roll and compress the sealing material that is discharged by the dispenser **42***a*. The driver **42***c* is configured to drive the dispenser **42***a* and the roller **42***b*. The dispenser **42***a* includes a syringe and a heater. The syringe is filled with the thermosetting resin material of the sealing material S such as an ABS resin material and a nylon resin material. The heater is configured to heat the syringe to fuse the thermosetting resin material. It is preferable to add one to some percent of silica beads that have particle diameters about equal to the cell gap to the thermosetting resin material as spacer particles. The amount of the sealing material S that is discharged by the dispenser **42***a* is controlled by the driver **42***c*.

[0100] The roller **42***b* can be move down to be closer to the CF base board **211***a*M and up to be away from the CF base board **211***a*M by the driver **42***c*. Specifically, the roller **42***b* is set at a position away from the CF base board **211***a*M when the sealing material S is not discharged by the dispenser **42***a* and at a position closer to the CF base board **211***a*M when the sealing material S is discharged by the dispenser **42***a*. The roller **42***b* is configured to press and spread the sealing material S that is fused on the CF base board **211***a*M until the thickness of the sealing material S becomes about equal to the cell gap. The sealing material S that is pressed and spread by the roller **42***b* is cured without any uncured sections (completely cured) as the temperature decreases (cool down) and the sealing member is formed. The sealing member that is formed as described above is fixed to an array base board, which is not illustrated, through pressing and heating of the base boards **211***a*M in a sealing material fixing process that is performed after a board bonding process. It is preferable that the roller **42***b* or the stage **41** includes a heater to maintain flowability of the sealing material S before the rolling and the compression of the sealing material S that is discharged onto the CF base board **211***a*M by the dispenser **42***a* by the roller **42***b* starts.

[0101] As described above, according to the method of producing the liquid crystal panel in this embodiment, the sealing material S that is the thermosetting resin material is heated and fused, applied to the CF base board **211***a*M (the CF board), and cured without any uncured sections in the sealing member forming process. In the sealing member forming process, after the sealing material S that is the thermosetting resin material is heated and fused, the fused sealing material S is applied to the CF base board **211***a*M. The sealing material S that is applied to the CF base board **211***a*M is cured without any uncured sections as the temperature decreases. Through the process, the sealing member is formed.

Fourth Embodiment

[0102] A fourth embodiment will be described with reference to FIGS. **24** to **26**. The fourth embodiment includes sealing member control portions **22** to control a width of a sealing member **311***q*, which is different from the first embodiment. Configurations, functions, and effects similar to those of the first embodiment will not be described.

[0103] As illustrated in FIG. **24**, a liquid crystal panel **311** in this embodiment includes the sealing member control portions **22**. The sealing member control portions **22** are disposed to sandwich the sealing member **311***q* from an inner side (a liquid crystal layer **311***c* side) and an outer side (an opposite side from the liquid crystal layer **311***c* side). The sealing member control portions **22** extend along the sealing member **311***q* (parallel to the sealing member **311***q*) to form a frame shape in a plan view. One of the sealing member control portions **22** is disposed adjacent to the sealing member **311***q* on the inner side. The other sealing member control portion **22** is disposed adjacent to the sealing member **311***q* on the outer side. With the sealing member control portions **22**, the width of the sealing member **311***q* can be controlled constant. The sealing member control portions **22** have widths in a range from 20 to 50 μm, which are smaller than the width of the sealing member **311***q*. When a CF board **311***a* is produced, that is, in the CF base board producing process, the sealing member control portions **22** are formed during formation of photo spacers on a surface of a planarization layer **311***m*. The sealing member control portions **22** are made of the same material as that of the photo spacers. It is preferable that the sealing member control portion **22** adjacent to the sealing member **311***q* on the inner side is disposed to overlap a frame section **311***l***2** of a light blocking portion **311***l* and the planarization layer **311***m* in a plan view.

[0104] The sealing member control portions **22** fulfills its function in the sealing member forming process that is performed after the CF base board producing process. In a sealing material disposing process that is included in the sealing member forming process, when the sealing material S is discharged onto the CF board **311***a* by the dispenser (see FIGS. **10** and **11**) of the sealing member forming device, the sealing material S is disposed in line in an area between the sealing member control portions **22** as illustrated in FIG. **25**. The sealing member control portions **22** include holes **22***a* in the middle with respect to the extending direction thereof. The holes **22***a* are through holes that extend in the width direction of the sealing member control portions **22**. An opening width of each hole **22***a* is smaller than the particle diameter (e.g., 50 μm) of the nylon powder in the sealing material S. The sealing material S that is disposed in the area between the sealing member control portions **22** cannot pass through the holes **22***a* of the sealing member control portions **22** and thus remain in the area between the sealing member control portions **22**. The sealing material S that is disposed as described above are rolled and compressed by the first roller (see FIGS. **10** and **12**) of the sealing member forming device. As a result, the sealing material S are ground and pressed to spread. An area in which the sealing material S is pressed to spread tends to depend on distribution density of the nylon powder that is disposed in the sealing material disposing process. If the distribution density of the nylon powder is high at a point, the area in which the sealing material S is pressed to spread may become locally large at the high distribution density point. In such a case, the area in which the sealing material S is pressed to spread is controlled by the sealing member control portions **22** that are disposed to sandwich the sealing material S. Therefore, the width of the sealing member **311**q that is formed through the sealing material curing process is substantially constant for the entire length. If the distribution density of the nylon powder is high at a point, an excess of the sealing material S which may be produced during the rolling and the compressing of the sealing material S is released to the outside through the holes **22**a of the sealing member control portions **22**. Therefore, unevenness in height of the sealing member **311**q resulting from the excess of the sealing material S is less likely to occur.

[0105] As described above, the liquid crystal panel **311** in this embodiment includes the sealing member control portions **22** that are disposed to sandwich the sealing member **311**q from the liquid crystal layer **311**c side and from the opposite side from the liquid crystal layer **311**c. With the sealing member control portions **22**, the width of the sealing member **311**q can be controlled during the formation of the sealing member **311**q. Therefore, the frame width of the liquid crystal panel **311** can be set with high accuracy. This configuration is preferable for reducing the frame size.

[0106] The sealing member control portions **22** of the liquid crystal panel **311** extend parallel to the sealing member **311**q and include the holes **22**a in the middle. According to the configuration, an uncured material can be released through the holes **22**a of the sealing member control portions **22** during the formation of the sealing member **311**q. Therefore, the sealing member **311**q has the constant height.

Other Embodiments

[0107] The present invention is not limited to the above embodiments described in the above sections and the drawings. For example, the following embodiments may be included in technical scopes of the present invention.

[0108] (1) In each of the above embodiment sections, the method of producing the liquid crystal panel that includes the sealing member that is disposed not to overlap the light blocking portion and has the light blocking property is described. According to the method, the board bonding process is performed after the sealing member forming process in which the sealing material is cured without any uncured sections to form the sealing member. Then, the sealing material fixing process is performed to fix the sealing member to the array board. However, the method of producing the liquid crystal panel may be modified. For example, the board bonding process may be performed after a sealing material temporarily curing process in which the sealing material is temporarily cured similar to the know method. Then, a sealing material permanently curing process may be performed to permanently cure the sealing material. Alternatively, the configuration of the liquid crystal panel may be modified. For example, the sealing member may not have the light blocking property similar to the known configuration and may be disposed to overlap the light blocking portion.

[0109] (2) in each of the above embodiments, the nylon powder that contains nylon (polyamide) is used for the main component of the sealing material. However, a material other than nylon may be used. Examples of the main component of the sealing material include a polyarnide resin hot-melt adhesive (an adhesive that contains a polyamide (nylon) resin as a main component), polypropylene (PP), polylactic acid, polyethylene (PE), polyethylene terephthalate (PET), polystyrene (PS), acrylonitrile butadiene styrene copolymer (ABS), ethylene vinyl acetate copolymer (EVA), styrene acrylonitrile copolymer (SAN), and polycaprolactone.

[0110] (3) In each of the above embodiments, the sealing material is the synthetic resin material. However, the sealing material may be a metal material. The metal material may be titanium particles made of titanium.

[0111] (4) in the first embodiment, the carbon dioxide laser beams are used for curing the sealing material. However, gas laser beams other than the carbon dioxide laser beams may be used. Examples of the gas laser beams include excimer laser beams (ArF, KrF, XeCl, or XeF may be used as a medium), ion laser beams (argon ions, krypton ions, or mixture of those may be used as a medium), nitrogen laser beams that include nitrogen as a medium, mixed gas laser beams (mixed gas such as He—Ne and TEA-CO_2 is used as a medium), metal vapor laser beams (Cu or He—Cd may be used as a medium), and chemical laser beams (HF may be used as a medium). For the excimer laser beams, if ArF is used as a medium, it is preferable to use excimer laser beams with a wavelength of 193 nm and a radiation intensity of 500 mJ. If KrF is used as a medium, it is preferable to use excimer laser beams with a wavelength of 248 nm and a radiation intensity of 1 J.

[0112] (5) Other than the gas laser beams described in the above (4), solid-state laser beams or liquid laser beams may be sued for curing the sealing material. Examples of the solid-state laser beams include YAG laser beams (Nd^{3+}:$Y_3Al_3O_{12}$ may be used as a medium), Q-switched YAG laser beams, ruby laser beams (Cr^{3+}:Al_2O_3 may be used as a medium), glass laser beams, titanium sapphire laser beams (Ti^{4+}:Al_2O_3 may be used as a medium), alexandrite laser beams (Cr^{3+}:$BeAl_2O_4$ may be used as a medium), YLF laser beams (Er^{3+}:YLi may be used as a medium), and semiconductor laser beams (GaAlAs or GaAlAs array may be used as a medium). For the semiconductor laser beams, if GaAlAs is used as a medium, it is preferable to use semiconductor beams with a wavelength of 750 to 905 nm and radiation intensity of 1 W.

[0113] (6) In each of the above embodiments, the sealing material is sintered and cured by the laser beams (powder sintering) or the thermosetting resin material used for the sealing material is cooled and cured after fusion through heating (thermal dissolution). However, an ultraviolet curable resin material may be used for the sealing material and cured with ultraviolet rays. In this case, the ultraviolet curable resin material may be applied to a target board with an ink-jet technology.

[0114] (7) Other than the above (6), powder adhesion may be used. Powder such as gypsum may be used for the sealing material. The powered may be disposed on a target board and a binder such as an adhesive may be sprayed to the powder to cure the powder.

[0115] (8) In each of the above embodiments, the sealing member is formed on the CF board (the CF base board) in the sealing member forming process, and the sealing member is fixed to the array board (the array base board) in the sealing member fixing process. However, the sealing member may be formed on the array board (the array base board) in the sealing member forming process and the sealing member may be fixed to the CF board (the CF base board) in the sealing member fixing process.

[0116] (9) In each of the above embodiments, the base sealing member is disposed in the array board (the array base board) in the base sealing material disposing process. However, the base sealing member may be disposed on the CF board (the CF base board) in the base sealing material disposing process.

[0117] (10) In each of the above embodiments, the base sealing member is formed. However, the base sealing member may be omitted if the base boards are fixed together with other methods. For example, ultraviolet curable resin materials may be disposed in the edge area of either one of the base boards in dots at intervals along the sealing member, the boards may be bonded together, and the ultraviolet resin materials in dots may be fixed through application of ultraviolet rays.

[0118] (11) In each of the above embodiments, the sealing member is disposed to overlap the row control circuit and the column control circuit for the entire areas. However, the sealing member may partially overlap the row control circuit and the column control circuit.

[0119] (12) In each of the above embodiments, the sealing member overlaps the row control circuit and the column control circuit. However, the sealing member may be disposed to overlap the traces other than the row control circuit and the column control circuit.

[0120] (13) In each of the above embodiment sections, the liquid crystal panel that includes the row control circuit and the column control circuit (the monolithic circuits) and the method of producing the liquid crystal panel are described. However, the present invention can be applied to a liquid crystal panel that includes only one of the row control circuit and the column control circuit or do not include the row control circuit and the column control circuit and to a method of producing the liquid crystal panel.

[0121] (14) In each of the above embodiment sections, the liquid crystal panel having the rectangular plan-view shape and the method of producing the liquid crystal panel are described. However, the present invention may be applied to liquid crystal panels having a square plan-view shape, a round plan-view shape, and an oval plan-view shape and methods of producing the liquid crystal panels.

[0122] (15) In each of the above embodiments, the driver is COG-mounted on the array board of the liquid crystal panel. However, the driver may be chip-on-film (COF) mounted on the liquid crystal panel flexible circuit board.

[0123] (16) In each of the above embodiments, the semiconductor film of the channels of the TFT is made of the oxide semiconductor material. Other than that, continuous grain (OG) silicon, which is one kind of polysilicon or amorphous silicon may be used as a material for the semiconductor film.

[0124] (17) in each of the above embodiment sections, the liquid crystal panel that is configured to operate in FFS mode and the method of producing such a liquid crystal panel are described. However, the present invention may be applied to liquid crystal panels that are configured to operate in VA mode, IPS mode, and TN mode, respectively, and to methods of producing those liquid crystal panels.

[0125] (18) In each of the above embodiments, the color filters of the liquid crystal panel have the three-color configuration of red, green, and blue. However, the present invention may be applied to color filters have a four-color configuration including yellow color portions in addition to the red, the green, and the blue color portions.

[0126] (19) In each of the above embodiment sections, the liquid crystal panel in the size that is classified into small size or small-to-medium size is described. However, the present invention may be applied to a liquid crystal panel in medium size or large size (or extra-large size) having a screen size of 20 to 100 inches. In such a case, the liquid crystal panel may be used for an electronic device such as a television device, an electronic signboard (a digital signage), and an electrical blackboard.

[0127] (20) In each of the above embodiment sections, the liquid crystal panel that includes the liquid crystal layer that is sandwiched between the boards is described. However, the present invention may be applied to a display panel that includes functional organic molecules other than the liquid crystals sandwiched between the boards.

[0128] (21) In each of the above embodiment sections, the liquid crystal panel and the method of producing the liquid crystal panel are described. However, the present invention can be applied to an organic EL panel and a method of producing the organic EL panel. In the organic EL panel, a dehumidification member or air may be included as a medium layer inside a sealing member. When the dehumidification member or the air is pushed into the sealing member because of pressure that may be produced during bonding of the boards, the dehumidification member or the air may enter the sealing member. According to the present invention, such a problem, that is, the entrance of the dehumidification member or the air into the sealing member can be solved.

[0129] (22) In each of the above embodiments, the TFTs are used as the switching components of the liquid crystal panel. However, the present invention may be applied to a liquid crystal panel that includes switching components other than TFTs (e.g., thin film diodes (TFD)). The present invention may be applied to a liquid crystal panel that is configured to display black-and-white images other than the liquid crystal panel that is configured to display color images and a method of producing the liquid crystal panel.

EXPLANATION OF SYMBOLS

[0130] **11**, **111**, **311**: Liquid crystal panel (Display panel)
[0131] **11***a*, **311***a*: CF board (First board, Counter board)
[0132] **11***a*M, **211***a*M: CF base board (First base board)
[0133] **11***b*: Array board (Second board)
[0134] **11***b*M: Array base board (Second base board)
[0135] **11***c*, **311***c*: Liquid crystal layer (Medium layer)
[0136] **11***l*, **311***l*: Light blocking portion
[0137] **11***m*, **311***m*: Planarization layer
[0138] **11***q*, **111***q*, **311***q*: Sealing member
[0139] **20**: Trace
[0140] **21**: Base sealing member
[0141] **22**: Sealing member control portion
[0142] **22***a*: Hole
[0143] **32***a*: Dispenser
[0144] **42***a*: Dispenser
[0145] AA: Display area
[0146] MS: Base sealing material
[0147] NAA: Non-display area
[0148] PX: Pixel
[0149] S: Sealing material

1. A method of producing a display panel, the method comprising:

a sealing member forming process of forming a sealing member, the sealing member forming process including disposing a sealing material on a first board and curing the sealing material without any uncured section;

a board bonding process of bonding a second board to the first board with a medium layer between the first board and the second board; and

a sealing member fixing process of fixing the sealing member to the second board.

2. The method of producing a display panel according to claim **1**, further comprising:

a first base board producing process of producing a first base board including a plurality of first boards within a plate surface of the first base board;

a second base board producing process of producing a second base board including a plurality of second boards within a plate surface of the second base board;

a base sealing material disposing process of disposing a base sealing material on any one of the first base board and the second base board to surround either the plurality of first boards or the plurality of second boards and to include an uncured section; and

a base sealing material curing process of curing the base sealing material without any uncured section to form a base sealing member, the base sealing material curing process being performed after at least the board bonding process.

3. The method of producing a display panel according to claim **2**, wherein the base sealing material disposing process includes disposing the base sealing material on the second base board.

4. The method of producing a display panel according to claim **2**, wherein

the medium layer in the board bonding process is a liquid crystal layer,

the base sealing material disposing process includes disposing a thermosetting resin material as the base sealing material, and

the base sealing curing process includes heating processing performed until a temperature reaches at least a curing temperature of the thermosetting resin material.

5. The method of producing a display panel according to claim **1**, wherein the sealing member forming process includes discharging the sealing material by a dispenser and disposing the sealing material along an area to form the sealing member.

6. The method of producing a display panel according to claim **1**, wherein

the sealing member forming process includes:

a sealing material disposing process of disposing the sealing material in a powdered form on the first board; and

a sealing material curing process of applying a laser beam to a section of the sealing material and selectively curing the section of the sealing material without any cured area.

7. The method of producing a display panel according to claim **1**, wherein the sealing member forming process includes heating and fusing the sealing material that is the thermosetting resin material, applying the sealing material to the first board, and curing the sealing material without any uncured section.

8. A display panel comprising:

a plurality of pixels arranged in a matrix in a display area in which an image is displayed;

an array board including at least a plurality of traces disposed in a non-display area outside the display area;

a common board disposed opposite the array board, the common board including a light blocking portion including sections disposed to separate at least the plurality of pixels from one another;

a medium layer sandwiched between the array board and the common board; and

a sealing member disposed between the array board and the common board to overlap the plurality of traces in the non-display area to surround the medium layer, the sealing member being made of a material having a light blocking property and disposed not to overlap the light blocking portion.

9. The display panel according to claim **8**, wherein the common board includes a planarization layer layered on a medium layer side relative to the light blocking portion, the planarization layer being disposed in an area not to overlap the sealing member.

10. The display panel according to claim **9**, wherein the sealing member includes an outer surface on an opposite side from the medium layer side, the outer surface being flush with at least an end surface of the common board.

11. The display panel according to claim **8**, wherein the sealing member is made of synthetic resin material with light blocking compounds contained in the synthetic resin material.

12. The display panel according to claim **8**, further comprising sealing member control portions disposed to sandwich the sealing member from the medium layer side and an opposite side from the medium layer side.

13. The display panel according to claim **12**, wherein the sealing member control portions extend parallel to the sealing member and include holes in the middle.

14. The display panel according to claim **8**, wherein the sealing member contains spacer particles.

15. The display panel according to claim **8**, wherein the sealing member is disposed to separate the plurality of pixels from one another together with the light blocking portion.

* * * * *

专利名称(译)	显示面板和制造显示面板的方法		
公开(公告)号	US20180275437A1	公开(公告)日	2018-09-27
申请号	US15/755554	申请日	2016-08-26
[标]申请(专利权)人(译)	夏普株式会社		
申请(专利权)人(译)	夏普株式会社		
当前申请(专利权)人(译)	夏普株式会社		
[标]发明人	NISHIWAKI SHOGO KONDOH MASAHIKO		
发明人	NISHIWAKI, SHOGO KONDOH, MASAHIKO		
IPC分类号	G02F1/1339 G02F1/1335		
CPC分类号	G02F1/1339 G02F1/133512 G02F2001/133357 G02F2001/13415		
优先权	2015170391 2015-08-31 JP		
外部链接	Espacenet USPTO		

摘要(译)

制造液晶面板的方法 11 （ 显示面板 ）包括：形成密封构件的密封构件形成过程 11 ; 将阵列板 11 b （ 第二块板 ）粘接到CF板上的板粘接工艺 11 在阵列板 11 之间具有液晶层 11 （ 中间层 ）和CF板 11 a; 和将密封构件固定到阵列板上的密封构件固定过程 11 。 密封构件形成过程包括将密封材料S设置在CF板上，并使密封构件固化 11 q 没有任何未经处理的部分。