US012386215B2

(12) **United States Patent**
Kang et al.

(10) **Patent No.: US 12,386,215 B2**
(45) **Date of Patent: Aug. 12, 2025**

(54) **DISPLAY DEVICE WITH A MULTI-PART COVER**

(71) Applicant: **LG Display Co., Ltd.**, Seoul (KR)

(72) Inventors: **ChounSung Kang**, Gimpo-si (KR); **Daeyun Kim**, Seoul (KR); **GeunChang Park**, Goyang-si (KR)

(73) Assignee: **LG Display Co., Ltd.**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **18/473,031**

(22) Filed: **Sep. 22, 2023**

(65) **Prior Publication Data**

US 2024/0192535 A1 Jun. 13, 2024

(30) **Foreign Application Priority Data**

Dec. 9, 2022 (KR) 10-2022-0171716

(51) **Int. Cl.**
G02F 1/1333 (2006.01)
G06F 1/16 (2006.01)

(52) **U.S. Cl.**
CPC .. ***G02F 1/133305*** (2013.01); ***G02F 1/133314*** (2021.01); ***G06F 1/1652*** (2013.01)

(58) **Field of Classification Search**
CPC G02F 1/133305; G02F 1/133308; G02F 1/133314; G06F 1/1652
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

11,170,671	B1	11/2021	Han et al.	
2018/0130974	A1 *	5/2018	Koo	G02F 1/133308
2020/0103741	A1	4/2020	Song et al.	
2020/0159288	A1 *	5/2020	Song	G09F 9/301
2021/0068276	A1 *	3/2021	Kim	H05K 5/0017
2021/0327311	A1 *	10/2021	Han	G06F 1/1601

FOREIGN PATENT DOCUMENTS

CN	107342018	A	11/2017
CN	110580859	A	12/2019
CN	112967609	A	6/2021
KR	2021-0078242	*	6/2021
KR	20210078242	A	6/2021
TW	202110301	A	3/2021

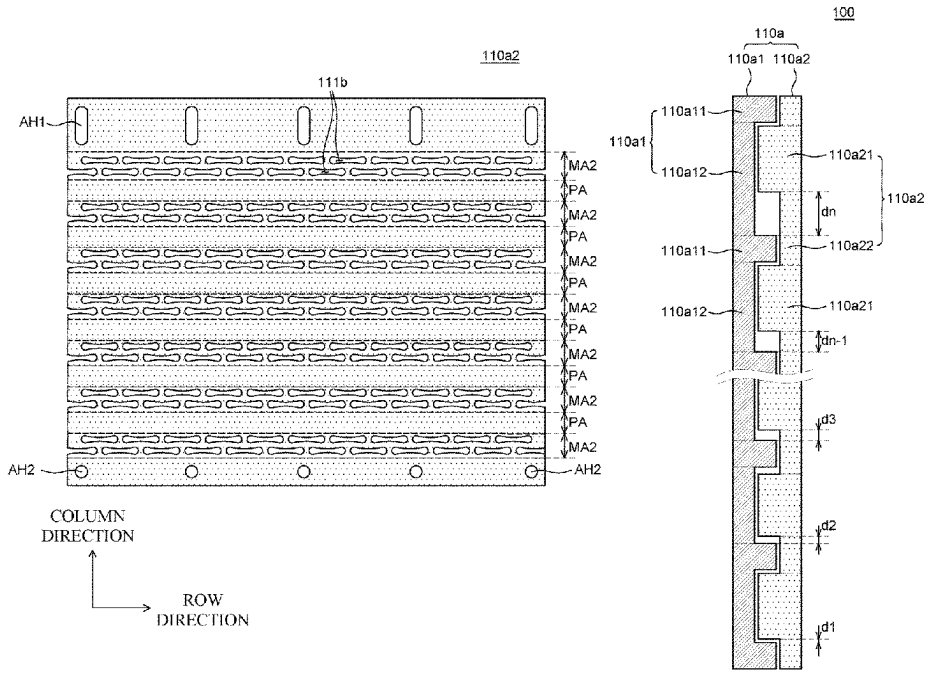
* cited by examiner

Primary Examiner — Paisley L Wilson
(74) *Attorney, Agent, or Firm* — Seed IP Law Group LLP

(57) **ABSTRACT**

A display device includes a display panel, a cover configured to support a rear surface of the display panel, and a roller configured to wind or unwind the display panel and the cover. The cover includes an upper cover bonded to the display panel, and the upper cover includes a first upper cover and a second upper cover. The second upper cover includes a plurality of concave portions and a plurality of convex portions, and the first upper cover is disposed between the display panel and the second upper cover. The first upper cover is disposed to engage with the plurality of concave portions and the plurality of convex portions of the second upper cover.

19 Claims, 25 Drawing Sheets



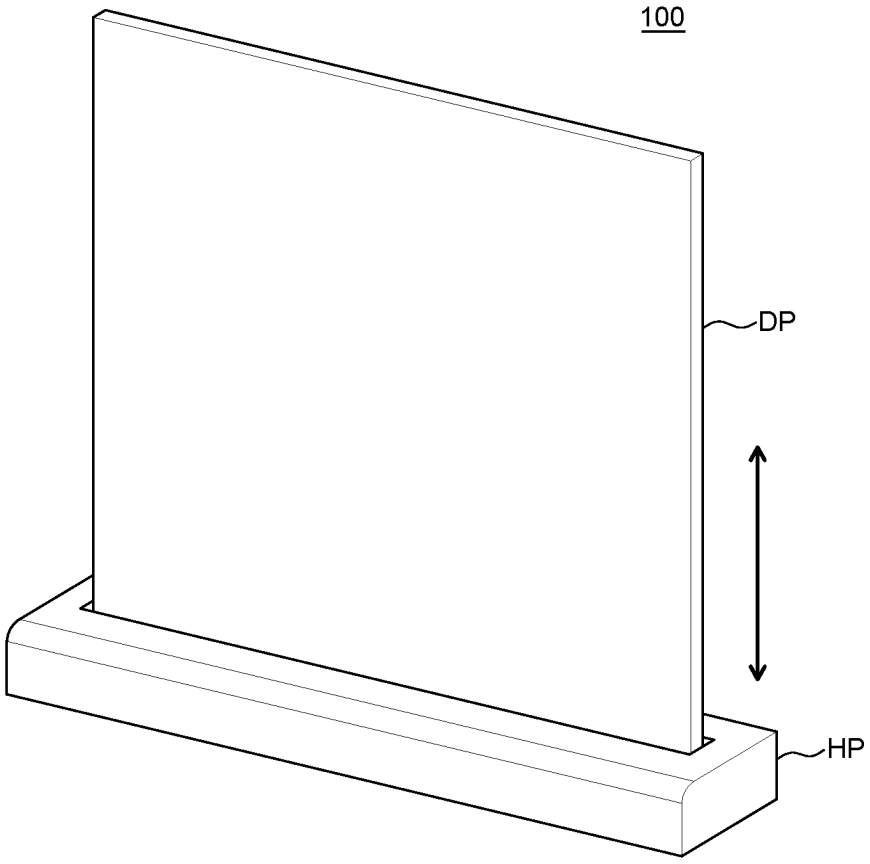


FIG. 1A

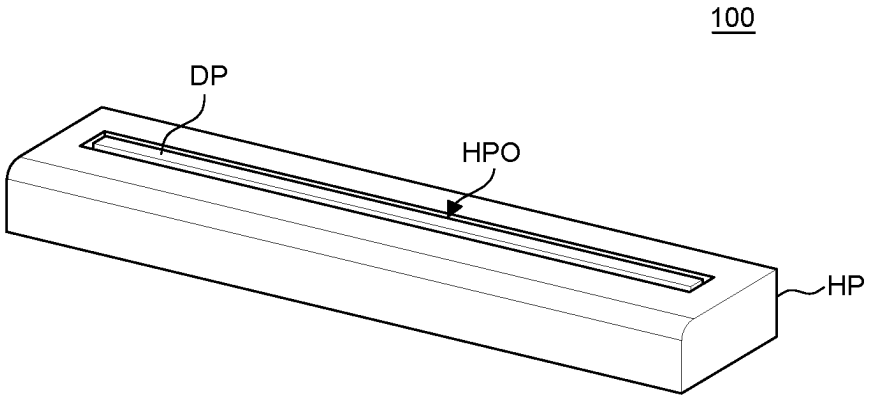


FIG. 1B

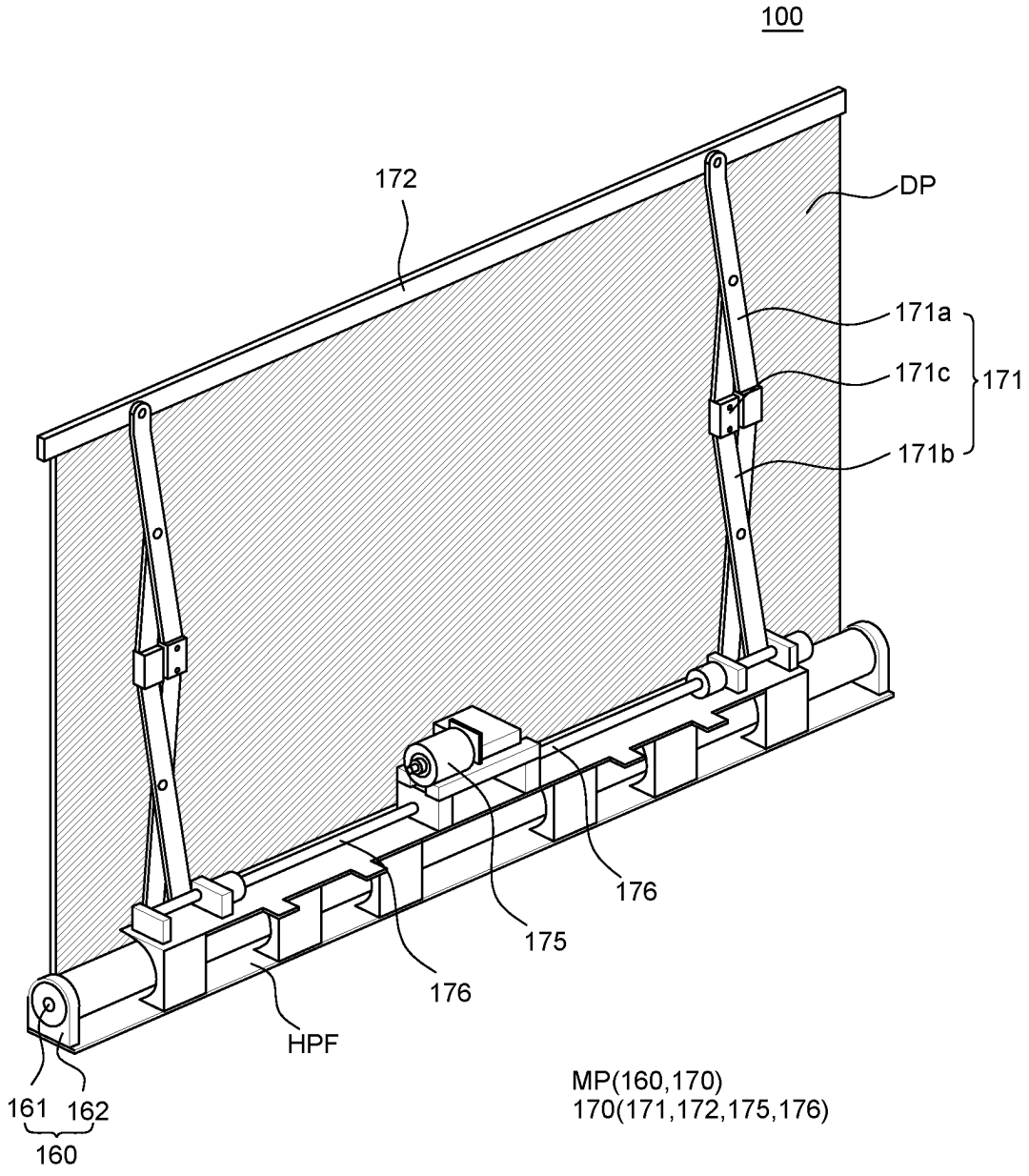

100
172
DP
171a
171c
171
171b
176
175
176
HPF
161
162
160
MP(160,170)
170(171,172,175,176)

FIG. 2

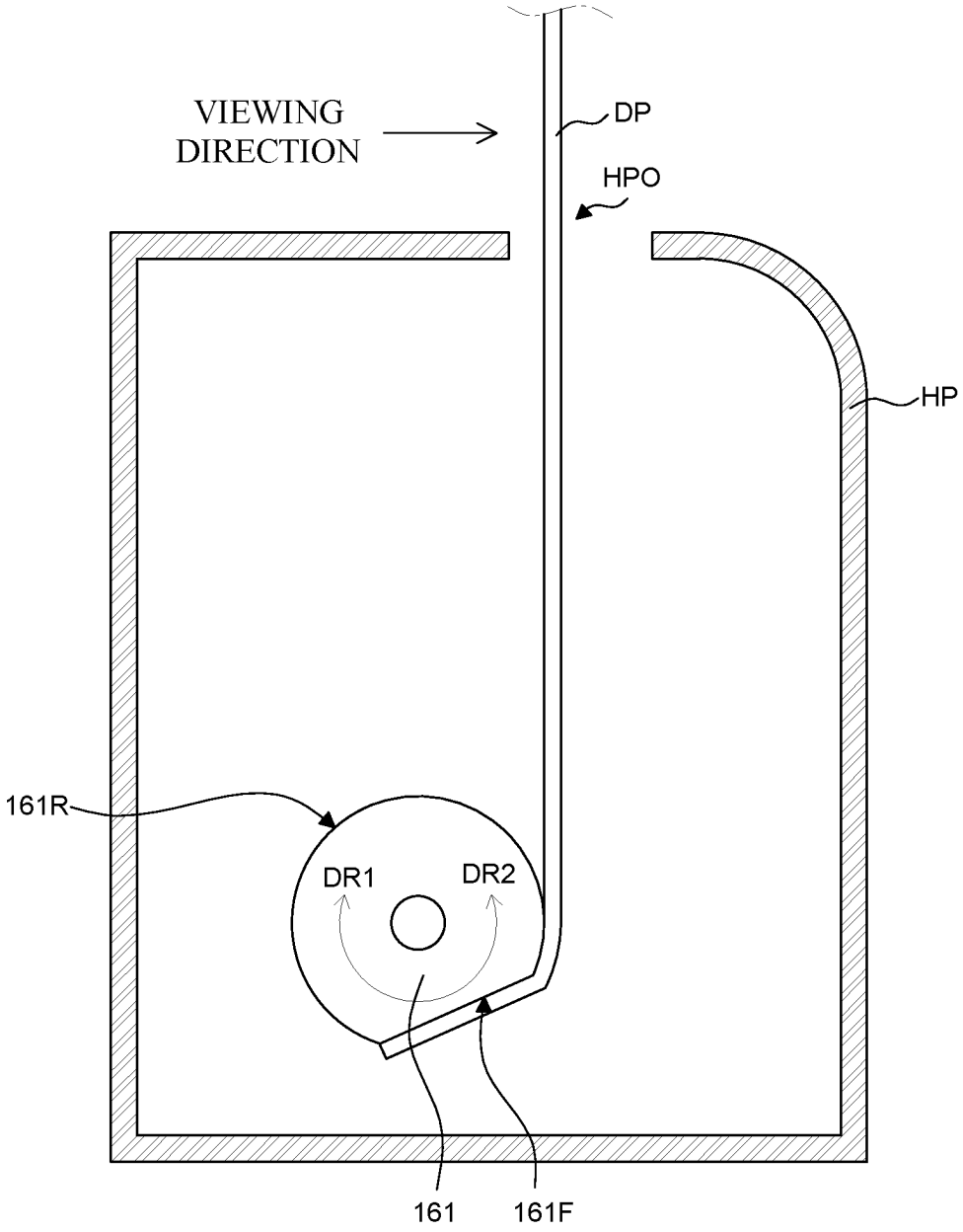


FIG. 3

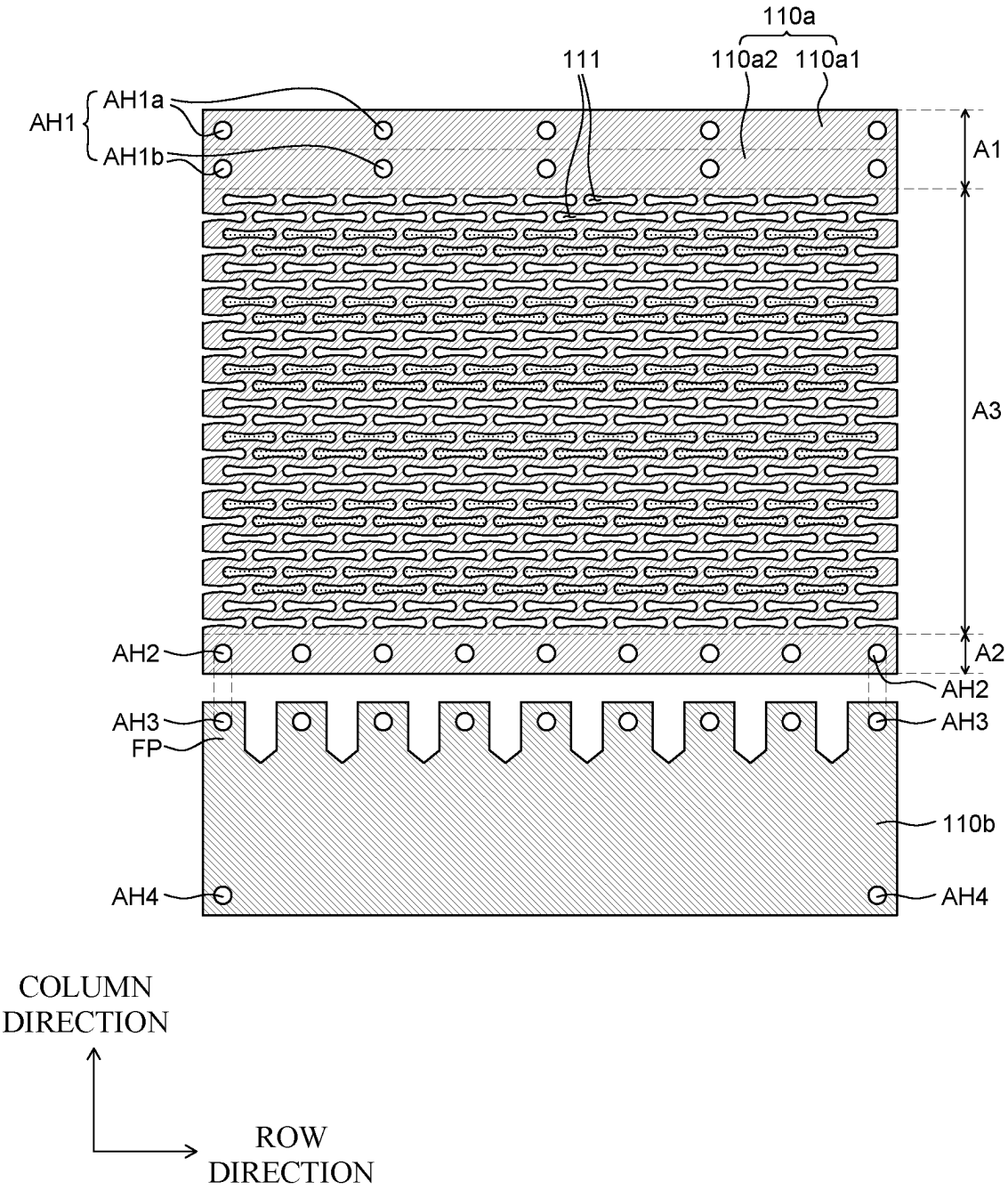

110a
111
110a2
110a1
AH1
AH1a
AH1b
A1
A3
AH2
A2
AH2
AH3
FP
AH3
110b
AH4
AH4
COLUMN DIRECTION
ROW DIRECTION

FIG. 4A

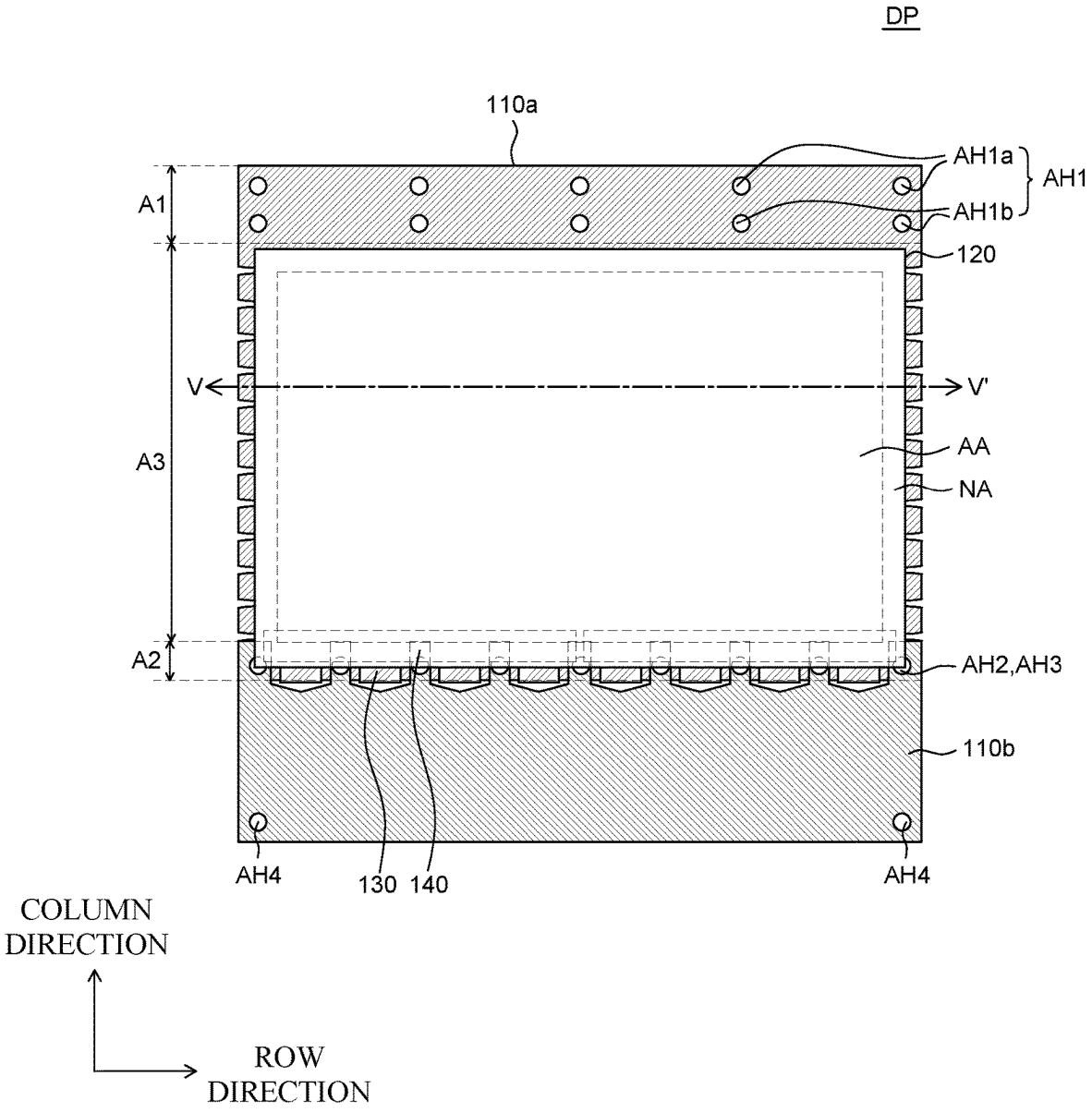

DP
110a
AH1a
AH1
AH1b
A1
120
V
V'
A3
AA
NA
A2
AH2,AH3
110b
AH4
130
140
AH4
COLUMN DIRECTION
ROW DIRECTION

FIG. 4B

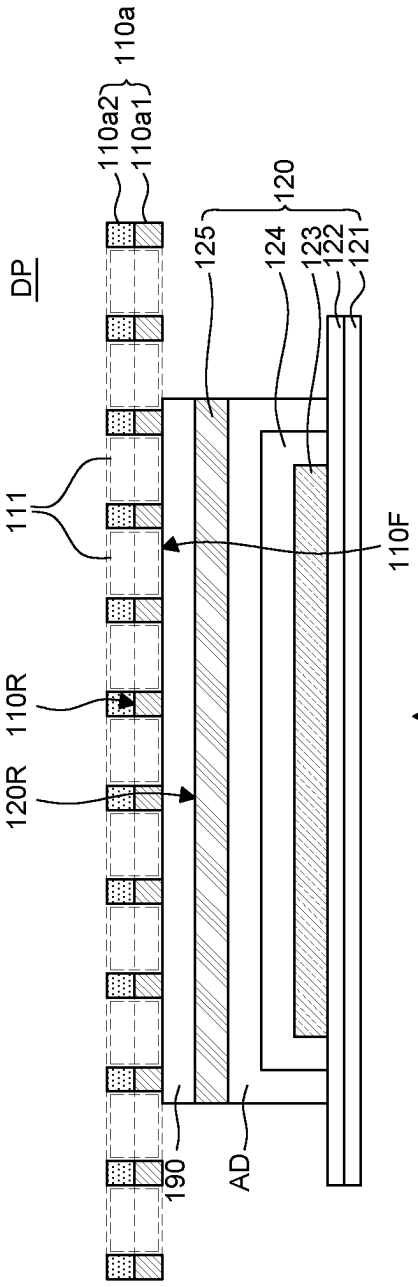

DP
110a
110a2
110a1
120
125
124
123
122
121
111
110F
110R
120R
190
AD
VIEWING DIRECTION

FIG. 5

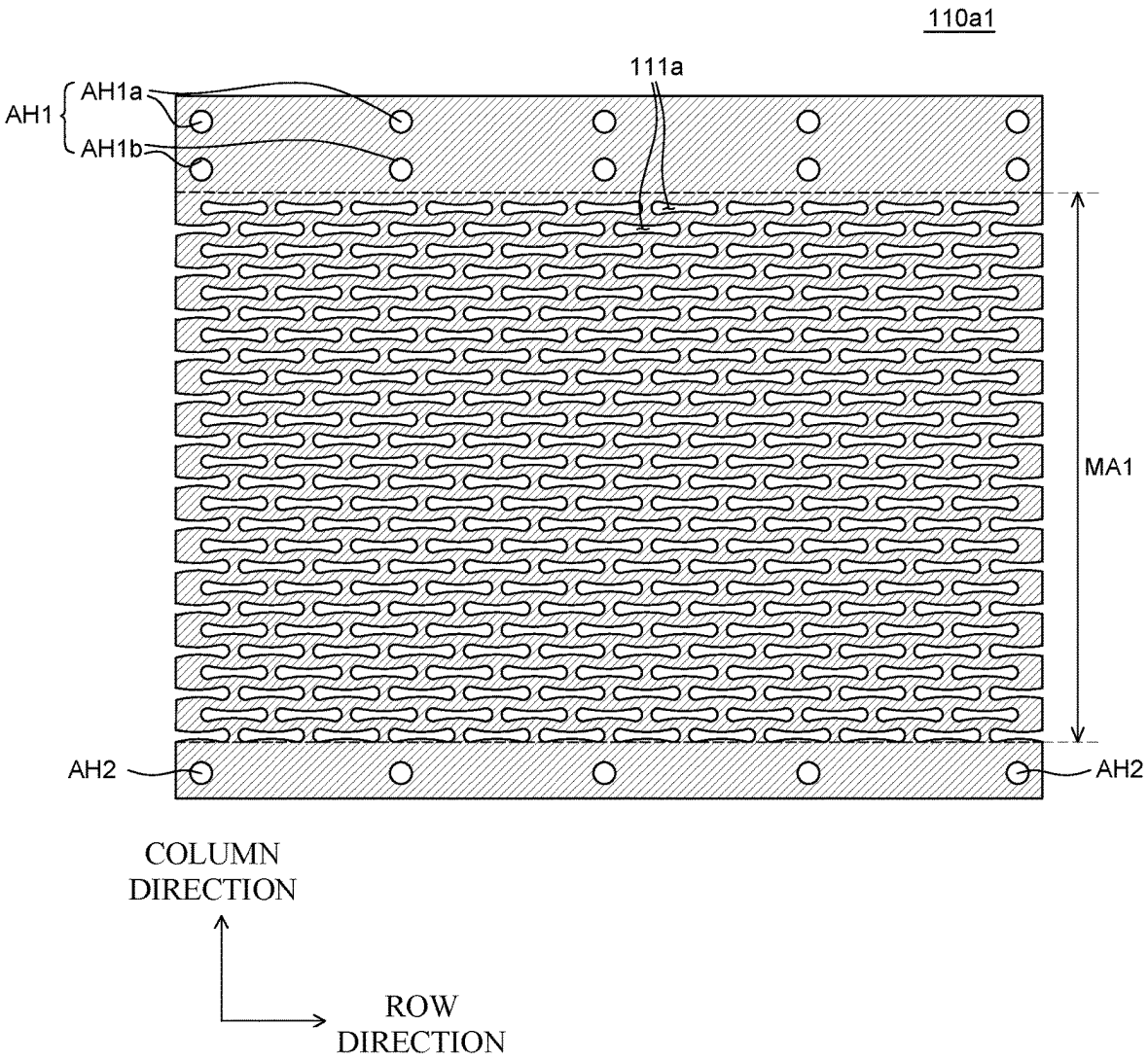

110a1
111a
AH1
AH1a
AH1b
MA1
AH2
AH2
COLUMN DIRECTION
ROW DIRECTION

FIG. 6A

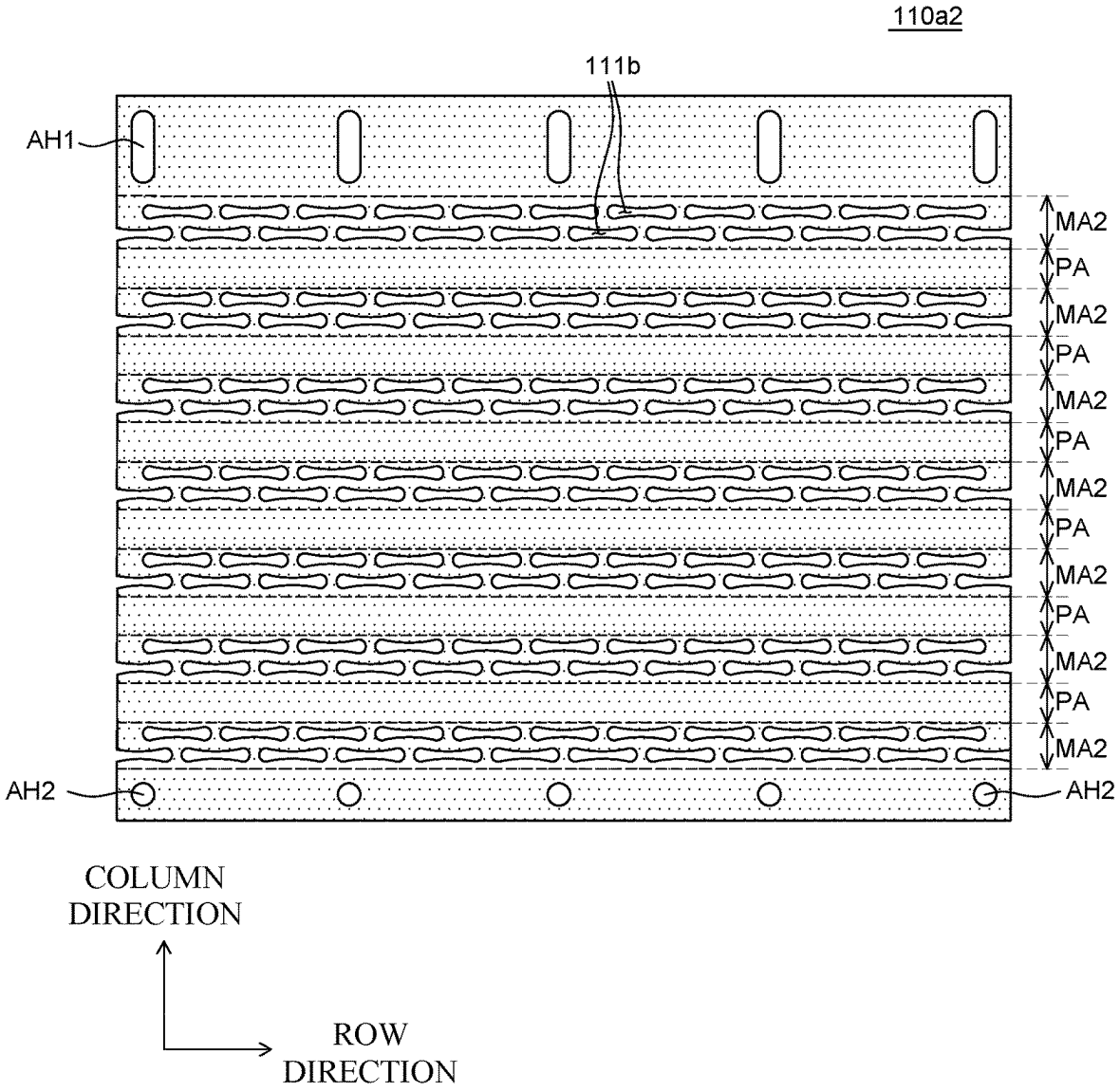

110a2
111b
AH1
AH2
AH2
MA2
PA
MA2
PA
MA2
PA
MA2
PA
MA2
PA
MA2
PA
MA2
COLUMN DIRECTION
ROW DIRECTION

FIG. 6B

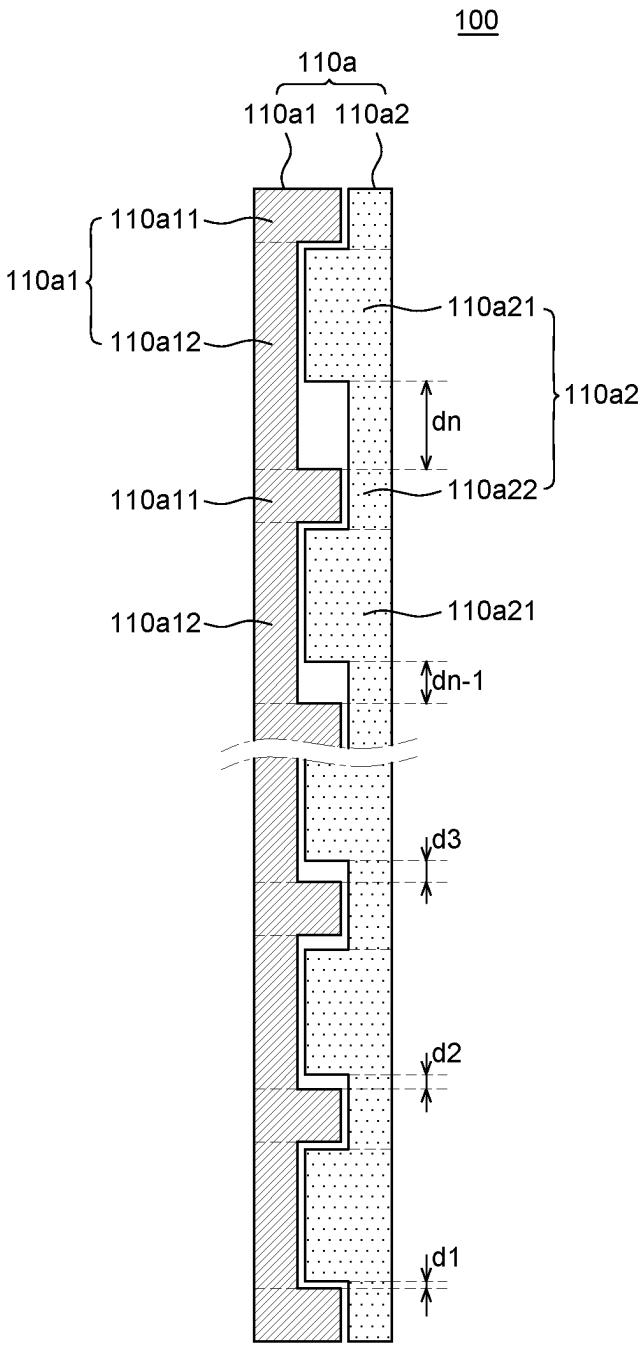

100
110a
110a1
110a2
110a11
110a1
110a12
110a21
110a2
dn
110a11
110a22
110a12
110a21
dn-1
d3
d2
d1

FIG. 6C

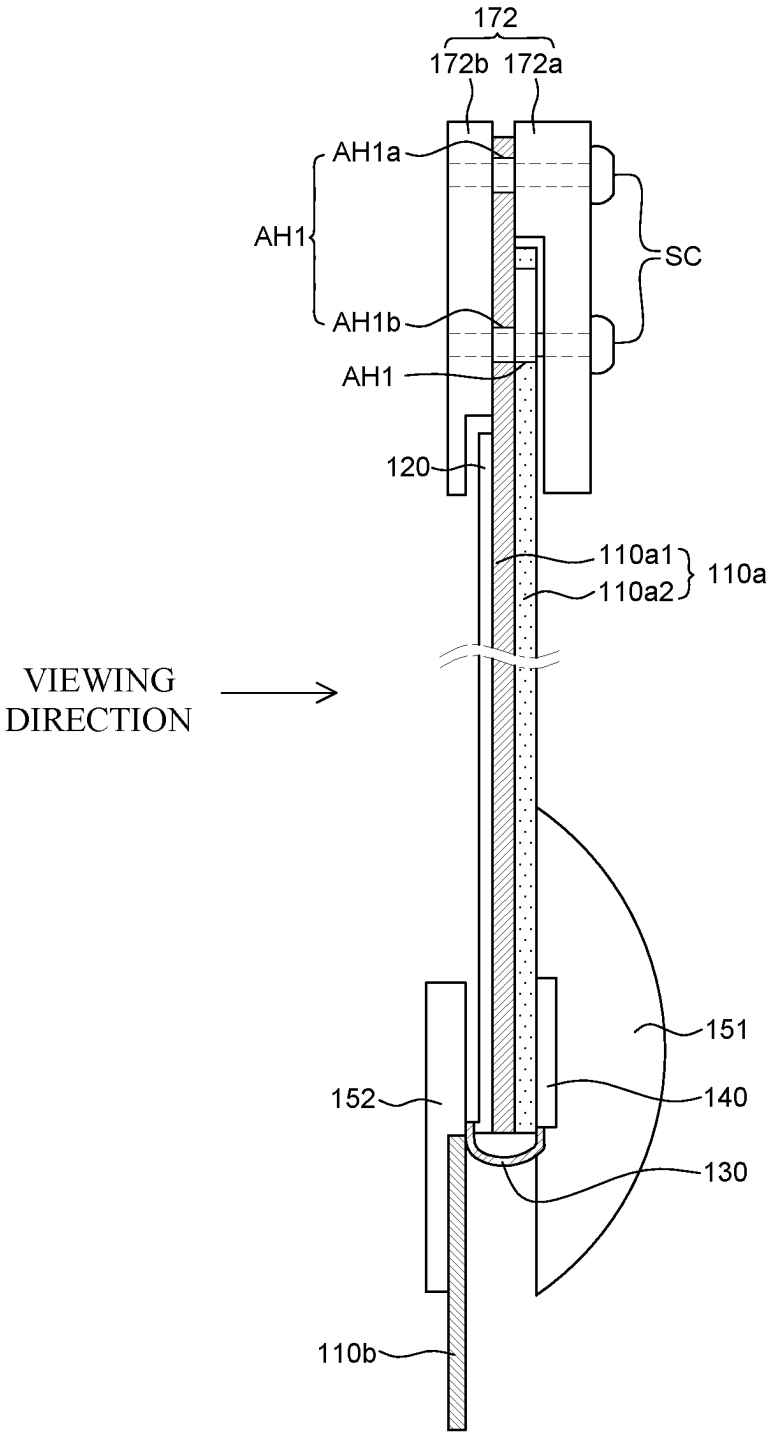

172
172b
172a
AH1a
AH1
AH1b
SC
AH1
120
110a1
110a2
110a
VIEWING DIRECTION
151
152
140
130
110b

FIG. 7

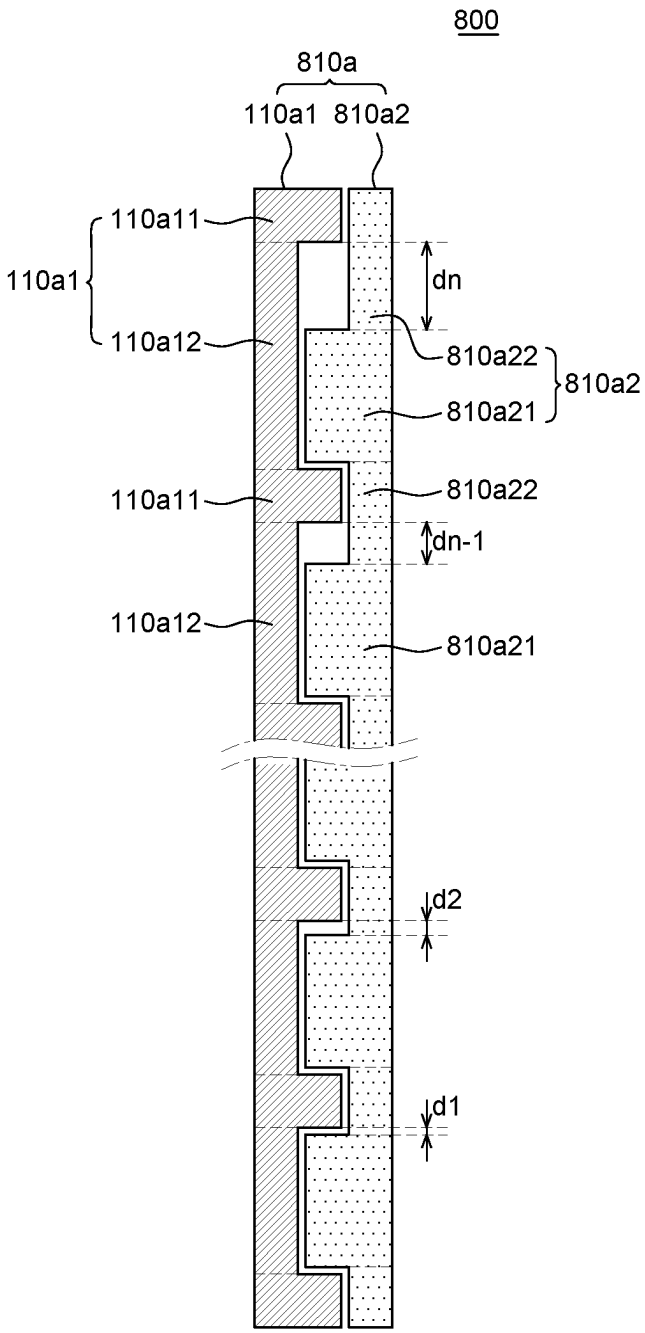

800
810a
110a1
810a2
110a11
110a1
110a12
dn
810a22
810a2
810a21
110a11
810a22
dn-1
110a12
810a21
d2
d1

FIG. 8

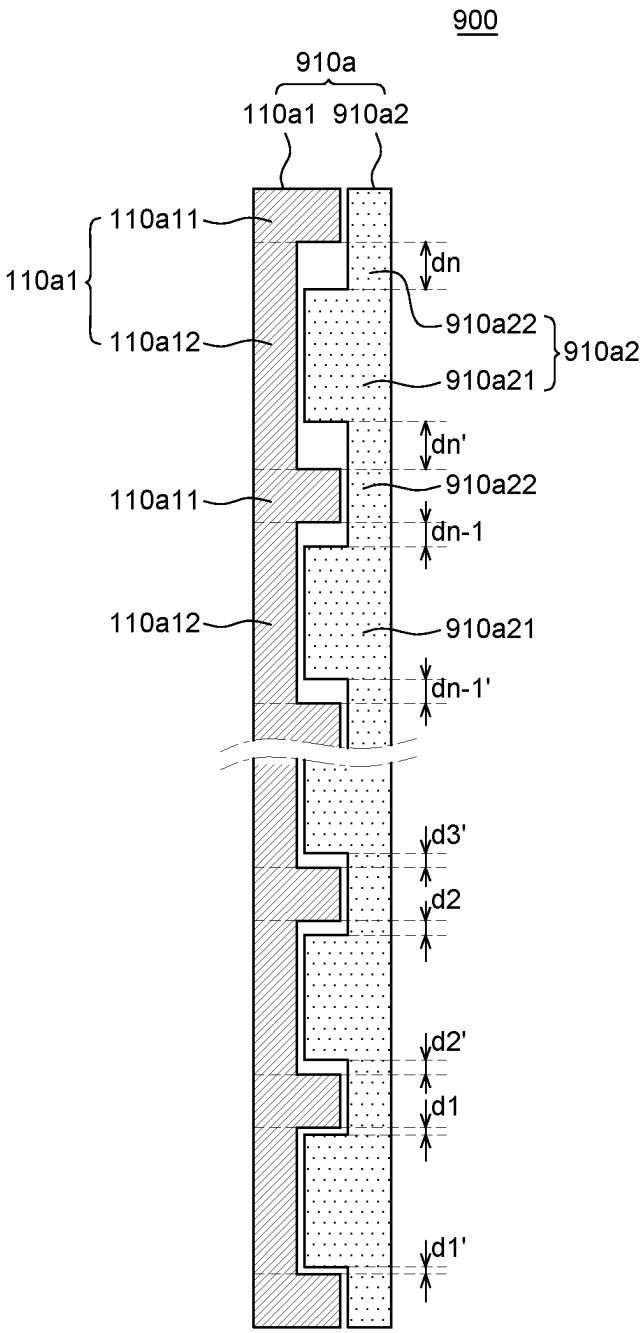

900
910a
110a1
910a2
110a11
110a1
110a12
dn
910a22
910a2
910a21
dn'
110a11
910a22
dn-1
110a12
910a21
dn-1'
d3'
d2
d2'
d1
d1'

FIG. 9

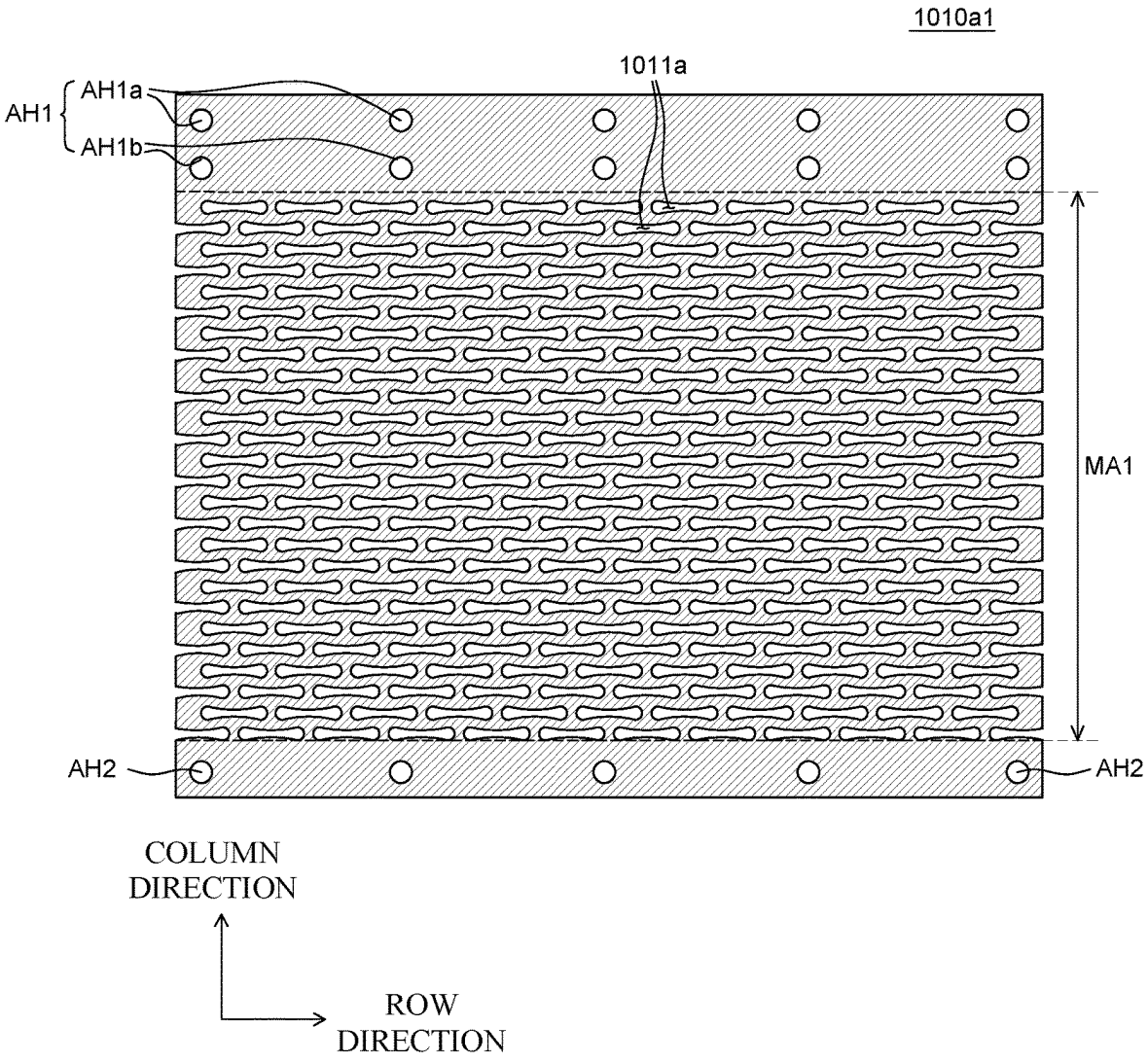

1010a1
1011a
AH1
AH1a
AH1b
MA1
AH2
AH2
COLUMN DIRECTION
ROW DIRECTION

FIG. 10A

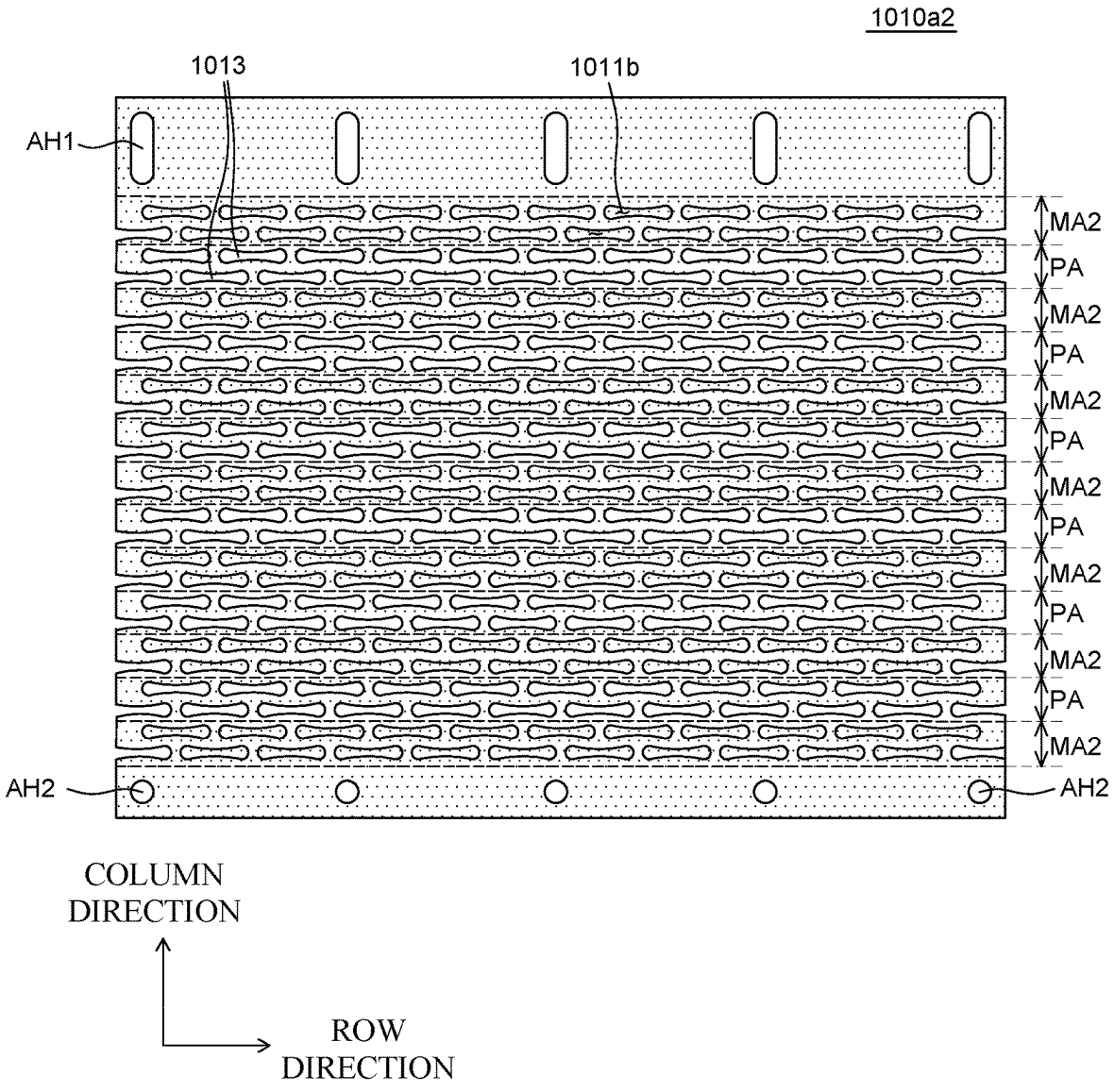

1010a2
1013
1011b
AH1
MA2
PA
MA2
PA
MA2
PA
MA2
PA
MA2
PA
MA2
PA
MA2
AH2
AH2
COLUMN DIRECTION
ROW DIRECTION

FIG. 10B

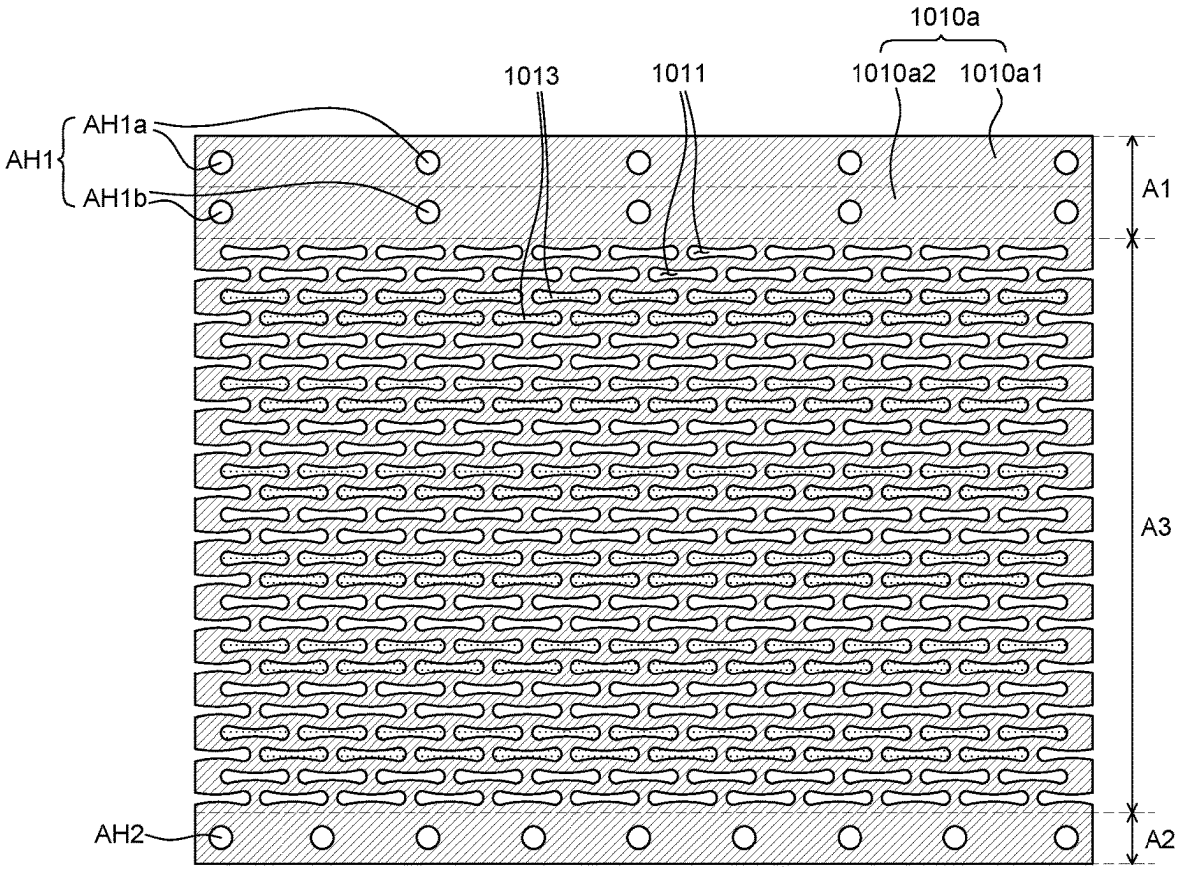


FIG. 10C

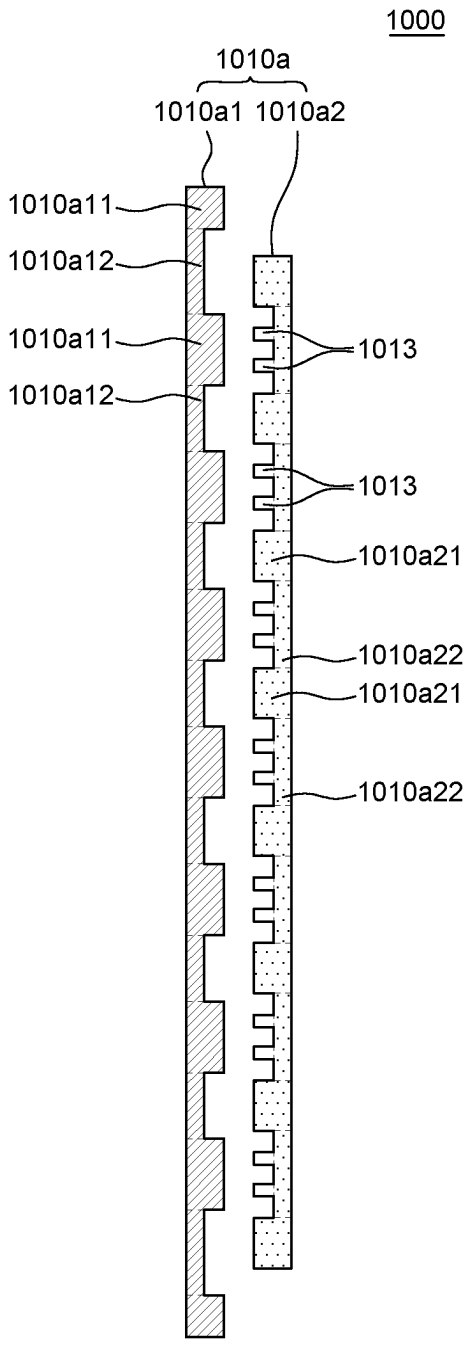

1000
1010a
1010a1
1010a2
1010a11
1010a12
1010a11
1010a12
1013
1013
1010a21
1010a22
1010a21
1010a22

FIG. 10D

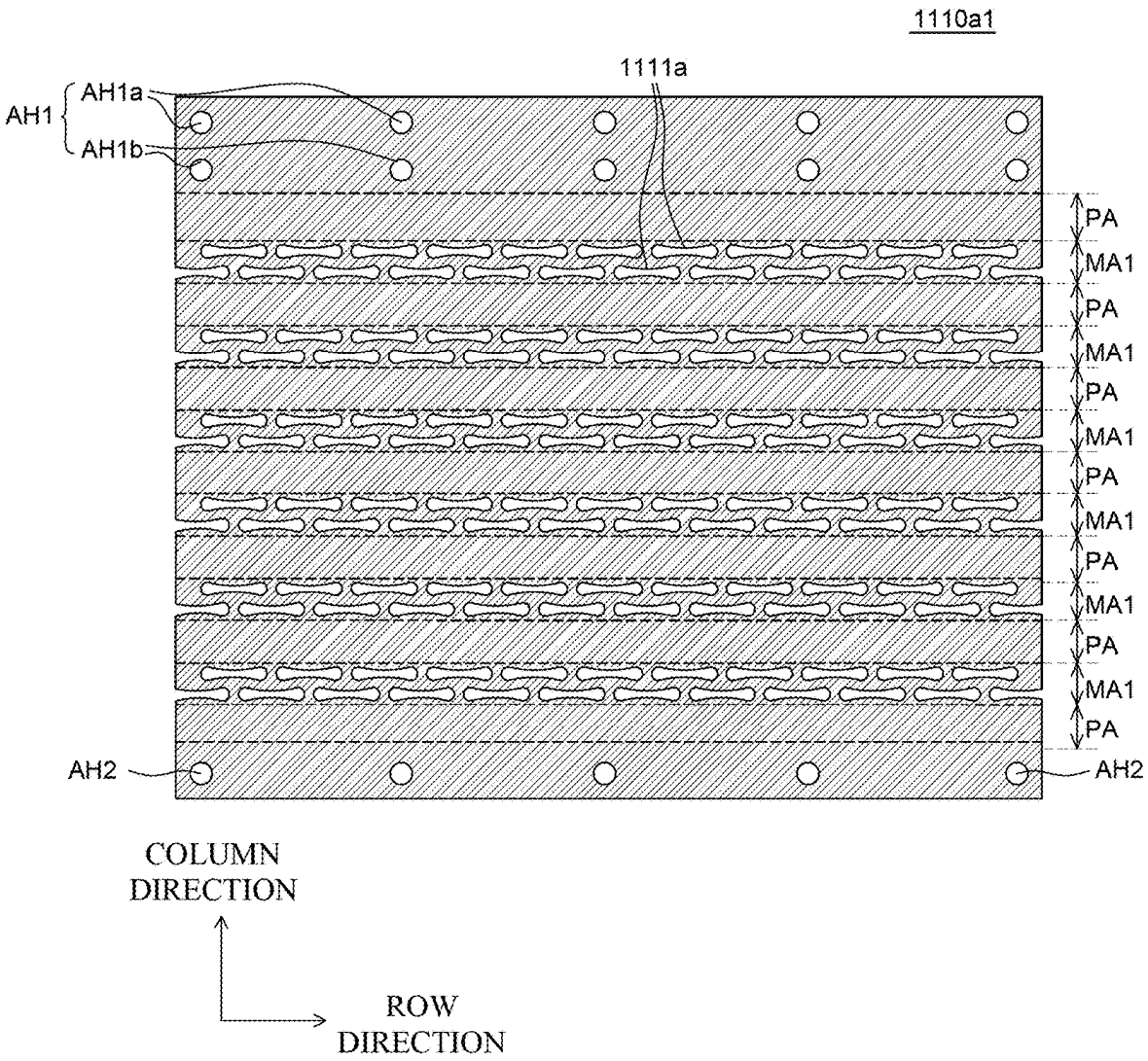

1110a1
1111a
AH1
AH1a
AH1b
PA
MA1
PA
MA1
PA
MA1
PA
MA1
PA
MA1
PA
AH2
AH2
COLUMN DIRECTION
ROW DIRECTION

FIG. 11A

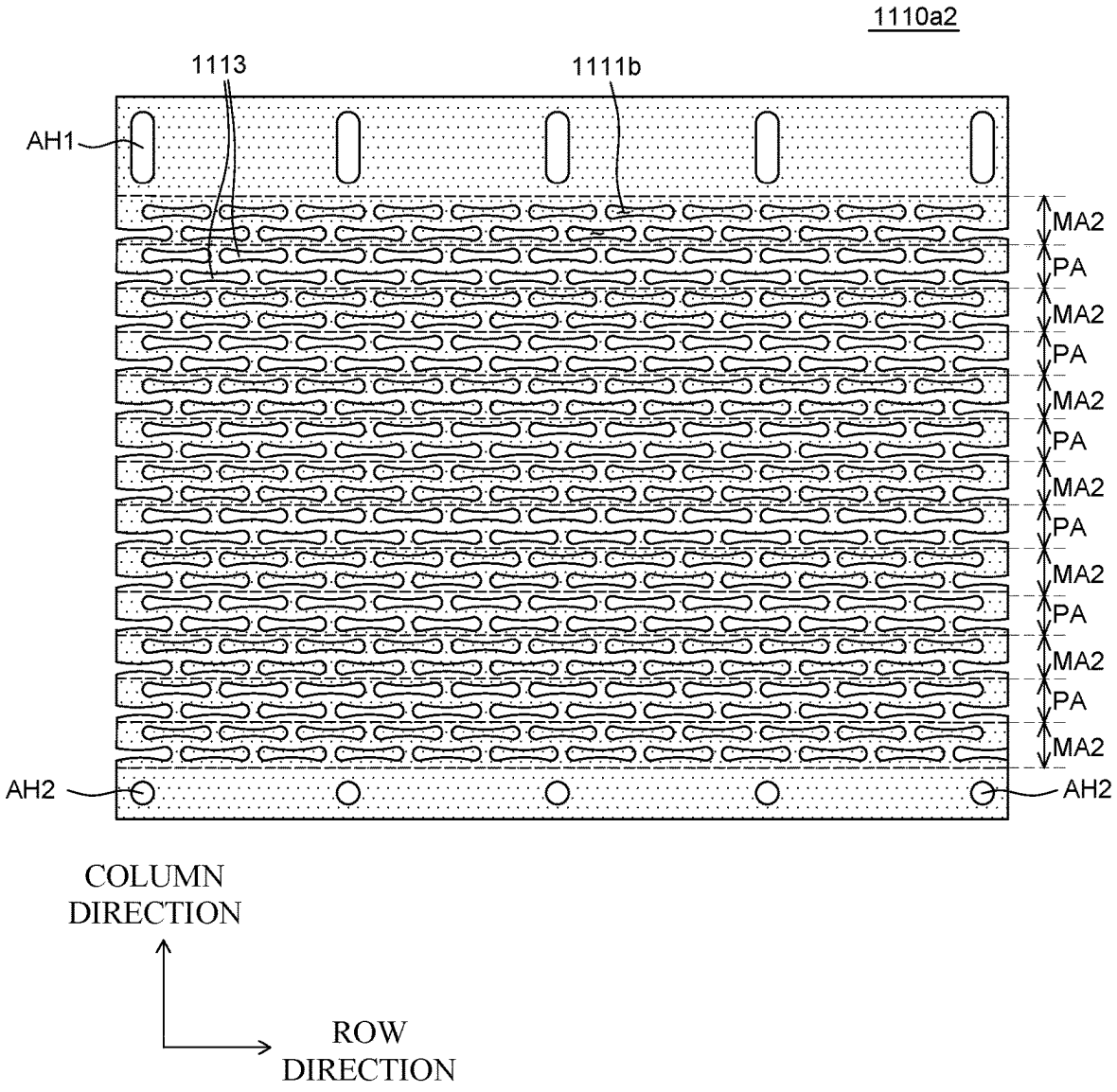

1110a2
1113
1111b
AH1
MA2
PA
MA2
PA
MA2
PA
MA2
PA
MA2
PA
MA2
PA
MA2
AH2
AH2
COLUMN DIRECTION
ROW DIRECTION

FIG. 11B

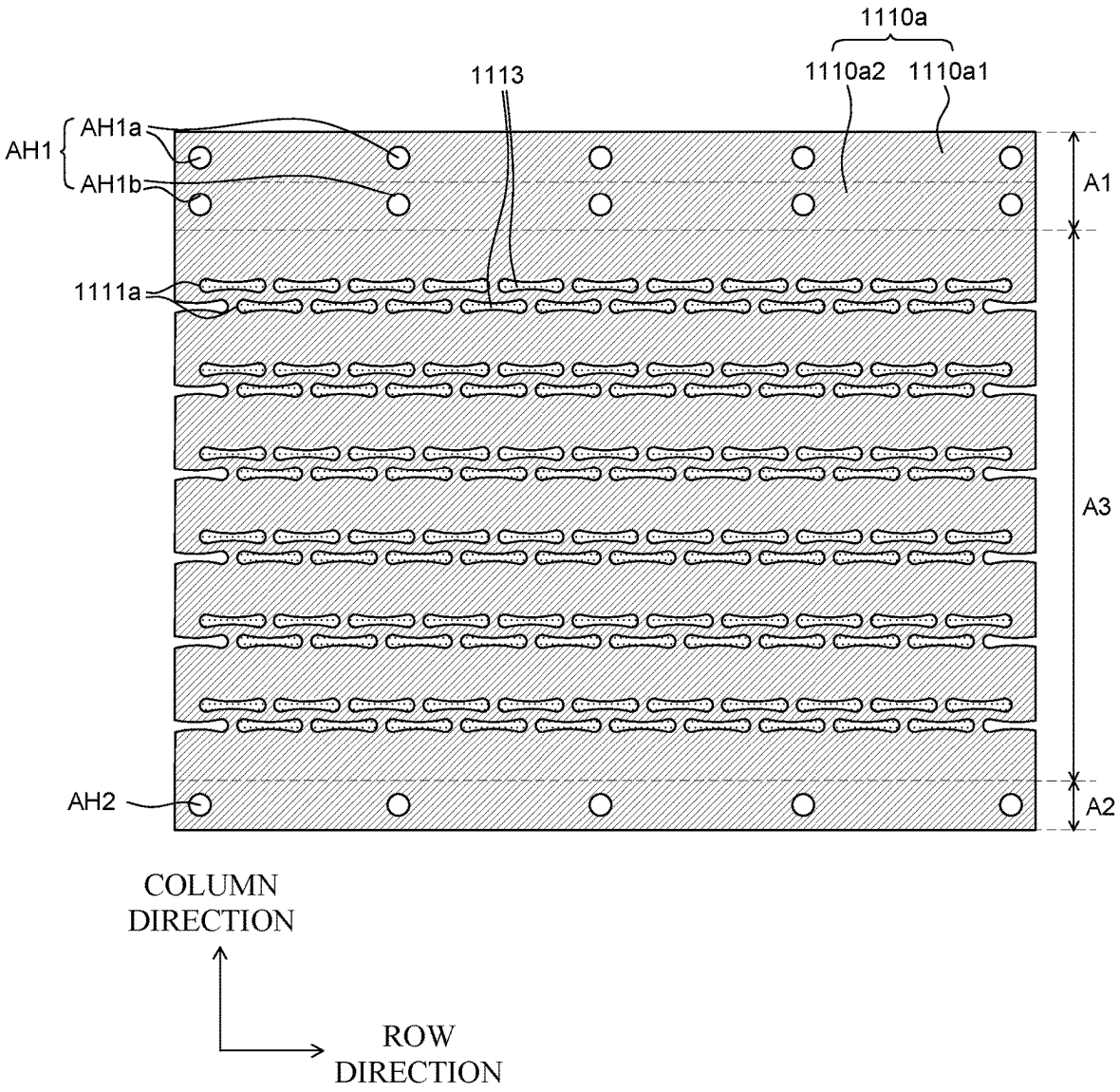

1110a
1110a2
1110a1
1113
AH1
AH1a
AH1b
1111a
A1
A3
AH2
A2
COLUMN DIRECTION
ROW DIRECTION

FIG. 11C

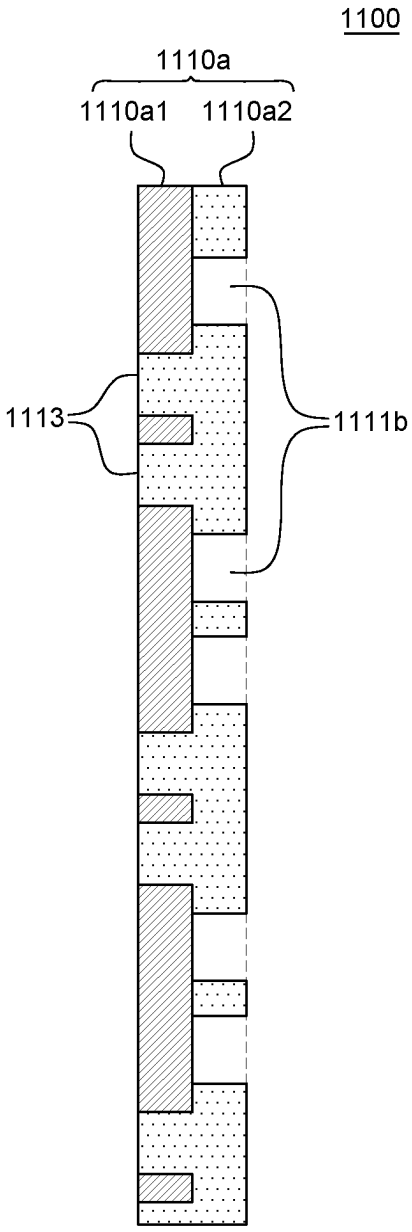


FIG. 11D

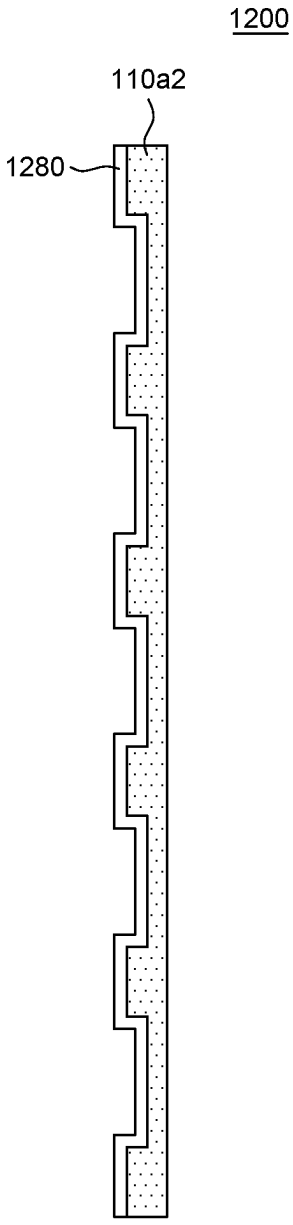


FIG. 12

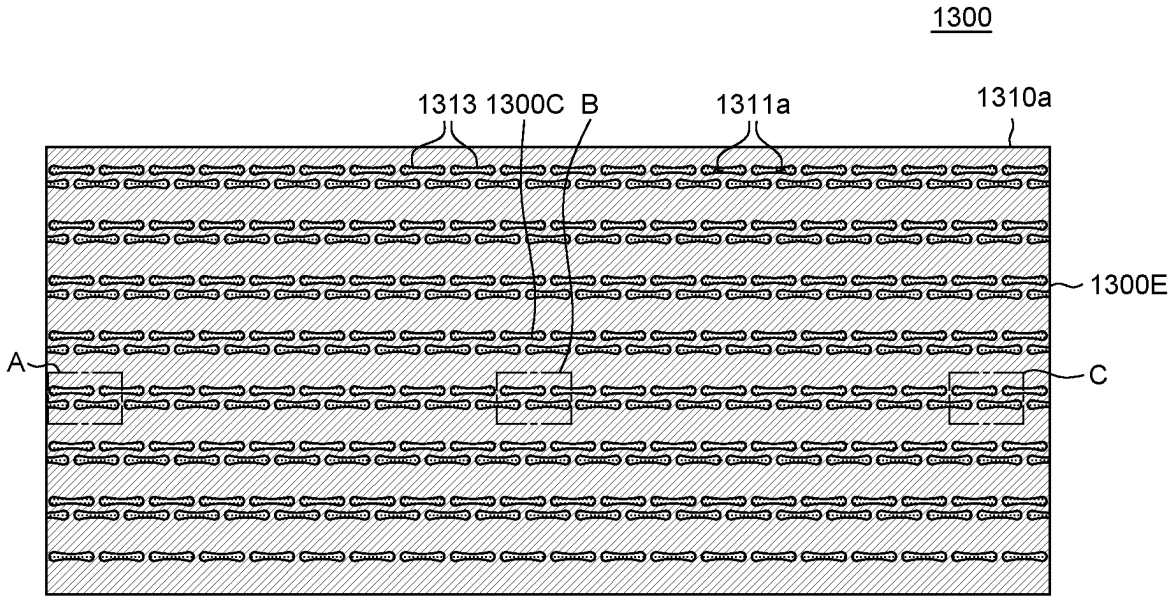


FIG. 13

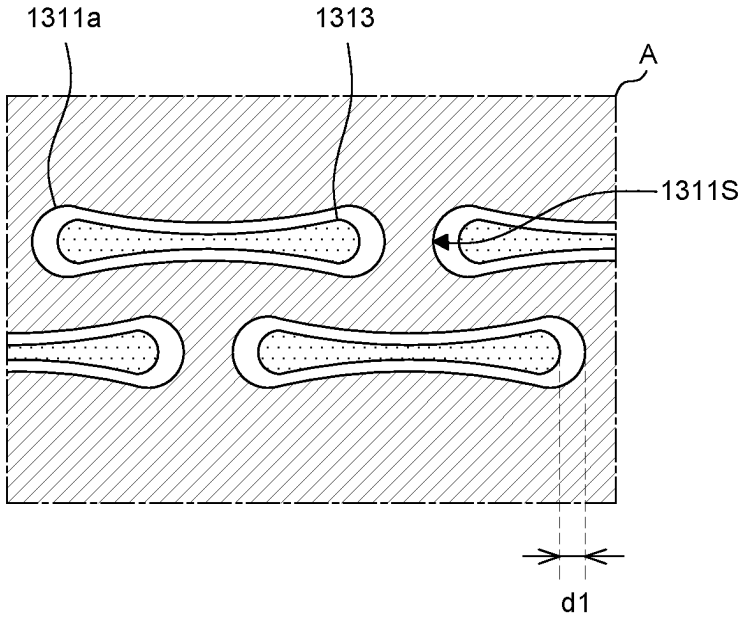


FIG. 14A

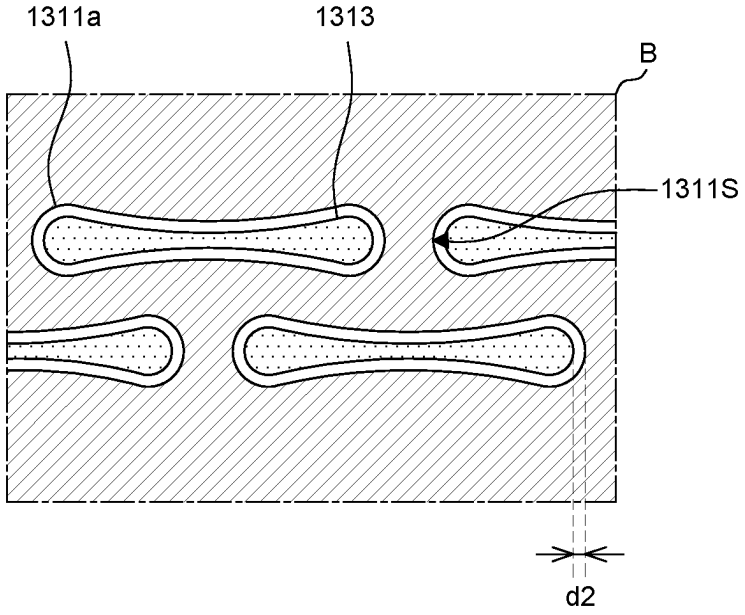


FIG. 14B

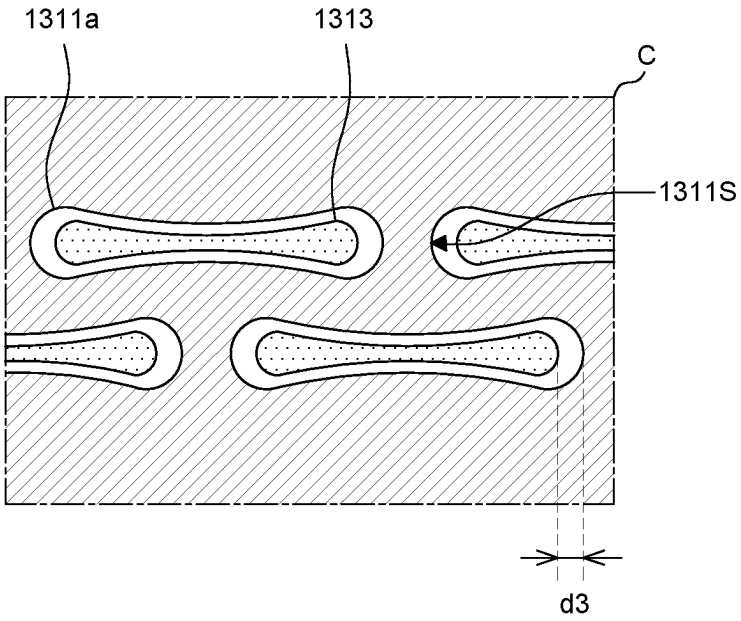


FIG. 14C

DISPLAY DEVICE WITH A MULTI-PART COVER

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the priority of Korean Patent Application No. 10-2022-0171716 filed on Dec. 9, 2022, in the Korean Intellectual Property Office, the entire contents of which are incorporated herein by reference.

BACKGROUND

Technical Field

The present disclosure relates to a display device, and more particularly, but not exclusively to a rollable display device capable of displaying images even in a case in which the display device is rolled up.

Description of the Related Art

As display devices used for a monitor of a computer, a TV set, a mobile phone, and the like, there are an organic light-emitting display (OLED) configured to autonomously emit, and a liquid crystal display (LCD) that requires a separate light source.

The range of application of the display devices is diversified from the monitor of the computer and the TV set to personal mobile devices, and studies are being conducted on the display devices having wide display areas and having reduced volumes and weights.

In addition, recently, a rollable display device, which is made by forming display elements, lines, and the like on a substrate made of a flexible plastic material having flexibility and thus may display images even in a case in which the rollable display device is rolled up, has attracted attention as a next-generation display device.

BRIEF SUMMARY

In an embodiment of the present disclosure, a display device is provided that is capable of improving the bending of the display panel.

In an embodiment of the present disclosure, a display device is provided that is capable of improving rigidity of the display panel while reducing a thickness of the display device.

In an embodiment of the present disclosure, a display device is provided that is capable of reducing a problem in which an opening portion of an upper cover is visually recognized.

In an embodiment of the present disclosure, a display device is provided that is capable of reducing the occurrence of flexure on a display part at the time of winding the display part.

According to one or more embodiments of the present disclosure, a display device includes: a display panel; a cover configured to support a rear surface of the display panel; and a roller configured to wind or unwind the display panel and the cover, in which the cover includes an upper cover bonded to the display panel, in which the upper cover includes a first upper cover, and a second upper cover including a plurality of concave portions and a plurality of convex portions, in which the first upper cover is disposed between the display panel and the second upper cover, and in which the first upper cover is disposed to engage with the plurality of concave portions and the plurality of convex portions of the second upper cover.

According to one or more embodiments of the present disclosure, a display device includes: a plate for a display device includes: a first plate including a plurality of first opening portions; and a second plate disposed on a rear surface of the first plate and including a plurality of protruding patterns, in which the plurality of protruding patterns of the second plate is inserted into the plurality of first opening portions of the first plate, and in which a spacing distance between each of the plurality of protruding patterns and a side surface of each of the plurality of first opening portions increases in a direction from a central portion to an edge of the plate.

According to the present disclosure, the plurality of back covers having different thicknesses are disposed to engage with one another, thereby maintaining rigidity of the display device and reducing a thickness of the display device.

According to the present disclosure, it is possible to suppress bending of the display device.

According to the present disclosure, it is possible to minimize a situation in which the opening portion is visually recognized from the front surface of the display device.

According to the present disclosure, it is possible to reduce the occurrence of flexure on the display part caused by a slip of the upper cover during a winding process.

Embodiments of the present disclosure are not limited to the above-mentioned embodiments, and other embodiments, which are not mentioned above, can be clearly understood by those skilled in the art from the following descriptions.

Other details of the embodiments are provided in the detailed description with reference to the accompanying drawings.

The benefits and advantages according to the present disclosure are not limited to the contents exemplified above, and more various benefits and advantages are included in the present specification.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The above and other aspects, features and advantages of the present disclosure will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIGS. **1**A and **1**B are front perspective views of a display device in an unrolled and a rolled configuration, respectively, according to an embodiment of the present disclosure;

FIG. **2** is a rear perspective view of the display device of FIG. **1**A;

FIG. **3** is a schematic cross-sectional view of the display device FIG. **1**A;

FIG. **4**A is an exploded elevational view of an upper cover and a lower cover of the display device of FIG. **1**A;

FIG. **4**B is an elevational view of a display of the display device of FIG. **1**A;

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

FIG. **6**A is an elevational view of a first upper cover of the display device of FIG. **1**A;

FIG. **6**B is an elevational view of a second upper cover of the display device of FIG. **1**A;

FIG. **6**C is a schematic cross-sectional view of the upper cover of the display device of FIG. **4**A;

FIG. **7** is a schematic cross-sectional view of a head bar and a display panel of the display device of FIG. **1**A;

FIG. **8** is a schematic cross-sectional view of an upper cover of a display device according to an embodiment of the present disclosure;

FIG. **9** is a schematic cross-sectional view of an upper cover of a display device according to an embodiment of the present disclosure;

FIG. **10**A is an elevational view of a first upper cover of a display device according to an embodiment of the present disclosure;

FIG. **10**B is a an elevational view of a second upper cover of the display device of FIG. **10**A;

FIG. **10**C is a schematic elevational view of an upper cover of the display device of FIG. **10**A;

FIG. **10**D is a schematic cross-sectional view of the upper cover of the display device of FIG. **10**C;

FIG. **11**A is an elevational view of a first upper cover of a display device according to an embodiment of the present disclosure;

FIG. **11**B is an elevational view of a second upper cover of the display device of FIG. **11**A;

FIG. **11**C is a schematic elevational view of an upper cover of the display device of FIG. **11**A;

FIG. **11**D is a schematic cross-sectional view of the upper cover of the display device of FIG. **11**C;

FIG. **12** is a schematic cross-sectional view of a second upper cover of a display device according to an embodiment of the present disclosure;

FIG. **13** is a schematic elevational view of a plate of a display device according to an embodiment of the present disclosure; and

FIGS. **14**A to **14**C are enlarged views of areas A, B, and C, respectively, of the plate of FIG. **13**.

DETAILED DESCRIPTION

Advantages and characteristics of the present disclosure and a method of achieving the advantages and characteristics will be clear by referring to the embodiments described below in detail together with the accompanying drawings. However, the present disclosure is not limited to the embodiments disclosed herein but will be implemented in various forms. The embodiments are provided by way of example only so that those skilled in the art can fully understand the disclosures of the present disclosure and the scope of the present disclosure.

The shapes, sizes, ratios, angles, numbers, and the like illustrated in the accompanying drawings for describing the embodiments of the present disclosure are merely examples, and the present disclosure is not limited thereto. Like reference numerals generally denote like elements throughout the specification. Further, in the following description of the present disclosure, a detailed explanation of known related technologies may be omitted to avoid unnecessarily obscuring the subject matter of the present disclosure. The terms such as "including," "having," and "consist of" used herein are generally intended to allow other components to be added unless the terms are used with the term "only". Any references to singular may include plural unless expressly stated otherwise.

Components are interpreted to include an ordinary error range even if not expressly stated.

When the position relation between two parts is described using the terms such as "on", "above", "below", and "next", one or more parts may be positioned between the two parts unless the terms are used with the term "immediately" or "directly".

When an element or layer is disposed "on" another element or layer, another layer or another element may be interposed directly on the other element or therebetween.

Although the terms "first", "second", and the like are used for describing various components, these components are not confined by these terms. These terms are merely used for distinguishing one component from the other components. Therefore, a first component to be mentioned below may be a second component in a technical concept of the present disclosure.

A size and a thickness of each component illustrated in the drawing are illustrated for convenience of description, and the present disclosure is not limited to the size and the thickness of the component illustrated.

The features of various embodiments of the present disclosure can be partially or entirely adhered to or combined with each other and can be interlocked and operated in technically various ways, and the embodiments can be carried out independently of or in association with each other.

Hereinafter, various embodiments of the present disclosure will be described in detail with reference to the accompanying drawings.

Display Device—Rollable Display Device

A rollable display device refers to a display device capable of displaying images even in a case in which the rollable display device is rolled up. The rollable display device may have higher flexibility than a general display device in the related art. A shape of the rollable display device may be freely changed depending on whether the rollable display device is used. Specifically, when the rollable display device is not in use, the rollable display device may be rolled up and stored with a reduced volume. On the contrary, when the rollable display device is in use, the rolled-up rollable display device may be unrolled again and used.

FIGS. **1**A and **1**B are perspective views of a display device **100** according to an embodiment of the present disclosure. With reference to FIGS. **1**A and **1**B, a display device according to an embodiment of the present disclosure includes a display part DP (which may also be referred to herein as a display assembly DP) and a housing part HP (which may also be referred to herein as a housing HP).

The display part DP is configured to display images to a user. For example, display elements and circuits, lines, and components for operating the display elements may be disposed on the display part DP. In this case, because the display device **100** according to the embodiment of the present disclosure is a rollable display device, the display part DP may be configured to be wound or unwound. For example, the display part DP may include a display panel **120** (see FIG. **4**B) and an upper cover **110***a* (see FIG. **4**A) that have flexibility so as to be wound or unwound. The display part DP, including the display panel **120** and upper cover **110***a*, will be described below in more detail with reference to FIGS. **4**A to **5**.

The housing part HP is a casing capable of accommodating the display part DP.

The housing part HP may have an opening portion HPO (which may also be referred to herein as an opening HPO) through which the display part DP may move to the outside or the inside of the housing part HP.

Meanwhile, the display part DP of the display device **100** may switch from a fully unwound state illustrated in FIG. **1**A with the display part DP extending from the housing part HP through the opening portion HPO to a fully wound state illustrated in FIG. **1**B in which the display part DP is

received completely internal to the housing part HP through the opening portion HPO, or may switch from the fully wound state to the fully unwound state at the selection of a user.

A drive part MP (which may also be referred to herein as a drive assembly MP) is disposed in the housing part HP to wind or unwind the display part DP to switch the display part DP to the fully unwound state or the fully wound state, as described further below.

Drive Part

FIG. **2** is a perspective view of the display device **100**. FIG. **3** is a schematic cross-sectional view of the display device **100**. FIG. **3** illustrates a roller **161** and the display part DP of the display device **100** according to one or more embodiments of the present disclosure in more detail. For the convenience of description, FIG. **3** illustrates only the housing part HP, the roller **161**, and the display part DP.

First, with reference to FIG. **2**, the drive part MP includes a roller part **160** and a lifting part **170**.

The roller part **160** winds or unwinds the display part DP fixed to the roller part **160** while rotating clockwise or counterclockwise. The roller part **160** includes the roller **161** and roller support parts **162** (which may also be referred to herein as roller supports **162**).

The roller **161** refers to a member around which the display part DP is wound. For example, the roller **161** may have a cylindrical shape. A lower edge of the display part DP may be fixed to the roller **161**. When the roller **161** rotates, the display part DP having the lower edge fixed to the roller **161** may be wound around the roller **161**. In contrast, when the roller **161** rotates in the reverse direction, the display part DP wound around the roller **161** may be unwound from the roller **161**.

With reference to FIG. **3**, the roller **161** may have a cylindrical shape in which at least a portion of an outer peripheral surface of the roller **161** has a flat surface, and the remaining portion of the outer peripheral surface has a curved surface. The roller **161** may have a cylindrical shape as a whole, but a part of the roller **161** may have a flat surface. That is, a portion of the outer peripheral surface of the roller **161** is flat, and the remaining portion of the outer peripheral surface is curved. For example, the roller **161** may include a curved surface portion **161**R and a flat surface portion **161**F. The flat surface portion **161**F of the roller **161** may be a portion on which a plurality of flexible films and a printed circuit board of the display part DP are seated or disposed. However, the roller **161** may have a complete cylindrical shape or any shape around which the display part DP may be wound. Thus, the present disclosure is not limited to the particular shape or shapes shown and described herein.

With reference back to FIG. **2**, the roller support parts **162** support the roller **161** at two opposite sides of the roller **161**. Specifically, the roller support part **162** is disposed on a bottom surface HPF of the housing part HP. Further, side surfaces of upper ends of the roller support parts **162** are coupled to two opposite ends of the roller **161**. Therefore, the roller support parts **162** may support the roller **161** so that the roller **161** is spaced apart from the bottom surface HPF of the housing part HP. In an embodiment, the roller **161** may be rotatably coupled to the roller support parts **162**.

The lifting part **170** moves the display part DP in an upward or downward direction in conjunction with an operation of the roller part **160**. The lifting part **170** includes link parts **171** (which may also be referred to herein as links **171**), a head bar **172**, a motor **175**, and rotary parts **176** (which may also be referred to herein as an axle **176**).

The link part **171** of the lifting part **170** includes a plurality of links **171***a* and **171***b*, and a hinge **171***c* configured to connect the plurality of links **171***a* and **171***b*. Specifically, the plurality of links **171***a* and **171***b* include a first link **171***a* and a second link **171***b*. The first link **171***a* and the second link **171***b* are rotatably fastened by means of the hinge **171***c* while intersecting each other in a scissors shape. Therefore, when the link part **171** moves in the upward or downward direction, the plurality of links **171***a* and **171***b* may rotate in a direction toward or away from one another. The link part **171** may include the plurality of links **171***a* and **171***b* that intersect each other. However, the present disclosure is not limited thereto. The link part **161** may include a single link that does not intersect.

The head bar **172** of the lifting part **170** is fixed to an uppermost end of the display part DP. The head bar **172** may be connected to the link parts **171** and move the display part DP in the upward or downward direction via rotation or movement of the plurality of links **171***a* and **171***b* of the link parts **171**. That is, the display part DP may be moved in the upward or downward direction by the head bar **172** and the link part **171**.

The head bar **172** covers only a part of the display part DP adjacent to the edge of the uppermost end of the display part DP so as not to cover an image displayed on a front or viewing surface of the display part DP. The display part DP and the head bar **172** may be fixed by a screw. However, the present disclosure is not limited thereto.

The motor **175** may be connected to a power generator, such as a separate external power source or an embedded battery, and supplied with power from the power generator. The motor **175** generates a rotational force and provides driving power to the rotary parts **176**.

The rotary part **176** is connected to the motor **175** and configured to convert a rotational motion provided from the motor **175** into a rectilinear reciprocating motion. That is, the rotational motion of the motor **175** may be converted into the rectilinear reciprocating motion of a structure fixed to the rotary part **176**. For example, the rotary part **176** may be implemented as a ball-screw mechanism including a shaft and a nut fastened to the shaft. The motor **175** may be operable to rotate a drive shaft in communication with the shaft of the rotary part **176**. The rotation of the rotary part **176** moves the nut in a linear direction along the shaft of the rotary part **176**. Because the link parts **171** are mechanically connected to the nut of the rotary part **176**, the movement of the nut results in movement or rotation of the link parts **171**. However, the present disclosure is not limited thereto.

The motor **175** and the rotary part **176** may operate in conjunction with the link part **171**, thereby moving the display part DP upward or downward. The link parts **171** may each have a link structure and be repeatedly folded or unfolded by receiving the driving power from the motor **175** and the rotary parts **176**.

Specifically, to wind the display part DP, the motor **175** may operate, and the structure of the rotary part **176** may rectilinearly move. That is, a part of the rotary part **176** to which one end of the second link **171***b* is connected may rectilinearly move. Therefore, one end of the second link **171***b* may move toward the motor **175**, and the plurality of links **171***a* and **171***b* are folded, such that a height of the link part **171** may decrease. In addition, during the process of folding the plurality of links **171***a* and **171***b*, the head bar **172** connected to the first link **171***a* also moves downward, and one end of the display part DP connected to the head bar **172** also moves downward.

To unwind the display part DP, the motor **175** may operate, and the structure of the rotary part **176** may rectilinearly move. That is, a part of the rotary part **176** to which one end of the second link **171***b* is connected may rectilinearly move. Therefore, one end of the second link **171***b* may move away from the motor **175**, and the plurality of links **171***a* and **171***b* may be unfolded, such that the height of the link part **171** may increase. In addition, during the process of unfolding the plurality of links **171***a* and **171***b*, the head bar **172** connected to the first link **171***a* also moves upward, and the display part DP connected to the head bar **172** also moves upward.

Therefore, when the display part DP is fully wound around the roller **161**, the link part **171** of the lifting part **170** is kept folded. That is, when the display part DP is fully wound around the roller **161**, the lifting part **170** may have the lowest height. In contrast, when the display part DP is fully unwound, the link part **171** of the lifting part **170** is kept unfolded. That is, when the display part DP is fully unwound, the lifting part **170** may have the highest height.

Meanwhile, to wind the display part DP, the roller **161** may rotate, and the display part DP may be wound around the roller **161**. With reference to FIG. **3**, for example, a lower edge of the display part DP is connected to the roller **161**. Further, when the roller **161** rotates in a first direction DR**1**, i.e., clockwise, the display part DP may be wound so that a rear surface of the display part DP is in close contact with the surface of the roller **161**.

To unwind the display part DP, the roller **161** may rotate, and the display part DP may be unwound from the roller **161**. Referring to FIG. **3**, for example, when the roller **161** rotates in a second direction DR**2**, i.e., counterclockwise, the display part DP wound around the roller **161** may be unwound from the roller **161** and disposed outside the housing part HP.

In some embodiments, the drive part MP having other structures other than the above-mentioned drive part MP may be applied to the display device **100**. That is, the components of the roller part **160** and the lifting part **170** may be changed, some of the components may be eliminated, or other components may be added as long as the components may wind and unwind the display part DP.

Display Part

FIG. **4**A is an exploded elevational view of an upper cover **110***a* and a lower cover **110***b* of the display device **100** according to one or more embodiments of the present disclosure. FIG. **4**B is an elevational view of the display part DP of the display device **100** according to one or more embodiments of the present disclosure. FIG. **5** is a cross-sectional view taken along line V-V' in FIG. **4**B.

With reference to FIGS. **4**A and **4**B, the display part DP includes the upper cover **110***a*, the display panel **120**, a plurality of flexible films **130**, a printed circuit board **140**, and the lower cover **110***b*. However, the present disclosure is not limited thereto. The display part DP may include only the display panel **120**, the plurality of flexible films **130**, and the printed circuit board **140**, among other possible configurations.

With reference to FIGS. **4**A and **4**B, the upper cover **110***a* is disposed on a rear surface **120**R (see FIG. **5**) of the display panel **120** and supports the display panel **120**. Because the upper cover **110***a* is disposed on the rear surface **120**R of the display panel **120**, the upper cover **110***a* may also be called a back cover. A size of the upper cover **110***a* may be larger than a size of the display panel **120**. The upper cover **110***a* may protect the display part DP from the outside.

The upper cover **110***a* may be fastened to the head bar **172** and the lower cover **110***b*, such as with fasteners of the type described herein, or others.

The upper cover **110***a* includes a first area A**1**, a second area A**2**, and a third area A**3**. The first area A**1** and the second area A**2** are areas in which a plurality of opening portions **111** is not disposed. The third area A**3** is an area in which the plurality of opening portions **111** is disposed. Specifically, the upper cover **110***a* includes the first area A**1**, the second area A**2**, and the third area A**3**. The first area A**1**, the third area A**3**, and the second area A**2** are sequentially disposed from the uppermost end of the upper cover **110***a*, i.e., from top to bottom. In an embodiment, because the upper cover **110***a* is wound or unwound in the column direction, the first area A**1**, the second area A**2**, and the third area A**3** may be disposed in the column direction.

The first area A**1** of the upper cover **110***a* is an uppermost end area of the upper cover **110***a*, i.e., an area fastened to the head bar **172**. A plurality of first fastening holes AH**1** may be formed in the first area A**1** to enable the first area A**1** to be fastened to the head bar **172**. For example, fastening members may be disposed to penetrate the head bar **172** and the plurality of first fastening holes AH**1**, such that the head bar **172** and the first area A**1** may be fastened to each other. Further, because the first area A**1** is fastened to the head bar **172**, the upper cover **110***a* may also move upward or downward when the link part **171** fastened to the head bar **172** moves upward or downward. Further, the display panel **120** attached to the upper cover **110***a* may also move upward or downward.

The plurality of first fastening holes AH**1** may be disposed in a plurality of row directions. For example, the plurality of first fastening holes AH**1** may include a plurality of first upper fastening holes AH**1***a* disposed in the row direction, and a plurality of first lower fastening holes AH**1***b* provided below the plurality of first fastening holes AH**1***a* and disposed in the row direction. In other words, the first upper fastening holes AH**1***a* and the first lower fastening holes AH**1***b* may be provided in two parallel, spaced apart rows in the row direction with the first upper fastening holes AH**1***a* and first lower fastening holes AH**1***b* aligned with each other in the column direction in an embodiment.

FIGS. **4**A and **4**B illustrate ten first fastening holes AH**1**. However, the number of first fastening holes AH**1** is not limited thereto and the number of first fastening holes AH**1** may be selected according to design factors.

The second area A**2** of the upper cover **110***a* is a lowermost area of the upper cover **110***a*, i.e., an area extending from the third area A**3**. One end, such as a bottom end, of the display panel **120** is disposed in the second area A**2**. For example, a pad area, which is a non-display area disposed at one end or a bottom end of the display panel **120**, may be disposed in the second area A**2**. In an embodiment, the second area A**2** of the upper cover **110***a* is coupled to the flat portion **161**F of the roller **161**, as best shown in FIG. **3**.

The third area A**3** of the upper cover **110***a* is an area disposed between the first area A**1** and the second area A**2**. The third area A**3** is an area in which the plurality of opening portions **111** is disposed and to which the display panel **120** is attached. Specifically, the third area A**3** is an area wound around or unwound from the roller **161** together with the display panel **120**. The third area A**3** may at least overlap the display panel **120** among the other components of the display part DP. In an embodiment, the third area A**3** is a majority of an area of the upper cover **110***a* that generally corresponds to the display panel **120**. Because the first area A**1** is coupled to the head bar **172** and the second area A**2** is

coupled to the roller **161**, the third area A**3** may be the primary area of the upper cover **110***a* that is wound or unwound about the roller **161** in some embodiments.

With reference to FIG. **4**A, second fastening holes AH**2** are disposed in the second area A**2**. The second fastening holes AH**2** may be holes for fixing the lower cover **110***b* and the upper cover **110***a*. FIG. **4**A illustrates nine second fastening holes AH**2**. However, the number of second fastening holes AH**2** is a non-limiting example, and the present disclosure is not limited thereto. The number of second fastening holes AH**2** can generally be selected according to design factors.

Meanwhile, the plurality of opening portions **111**, which is formed in the third area A**3**, is not formed in the first area A**1** and the second area A**2**. Specifically, the first fastening holes AH**1** are formed in the first area A**1**, and the second fastening holes AH**2** are formed in the second area A**2**. However, the plurality of opening portions **111** formed in the third area A**3** are not formed in the first area A**1** and the second area A**2**. In addition, the first and second fastening holes AH**1** and AH**2** are different in shape and function from the plurality of opening portions **111**.

The first area A**1** is an area fixed to the head bar **172**. The second area A**2** is an area that supports one end of the display panel **120**, such as a bottom end of the display panel **120**, the plurality of flexible films **130**, and the printed circuit board **140**. The first and second areas may have higher rigidity than the third area A**3**. Further, because the first and second areas A**1** and A**2** have comparatively higher rigidity, the first and second areas A**1** and A**2** may be securely fixed to the head bar **172** and the lower cover **110***b* and also provide support to the display panel **120**. The second area A**2** may maintain the printed circuit board **140** and the pad area of one end, such as a bottom end, of the display panel **120** in a flat shape, thereby protecting the printed circuit board **140** and the pad area of the display panel **120**. The display part DP may be fixed to the head bar **172** of the drive part MP and moved to the inside or outside of the housing part HP by the operation of the drive part MP. The second area may protect the printed circuit board **140** and the pad area of one end or the bottom end of the display panel **120**.

Meanwhile, FIG. **4**A illustrates that the first area A**1**, the third area A**3**, and the second area A**2** of the upper cover **110***a* are sequentially disposed in the column direction. However, in case that the upper cover **110***a* is wound in the row direction, the first area A**1**, the third area A**3**, and the second area A**2** may be disposed in sequential order in the row direction.

The plurality of opening portions **111** disposed in the third area A**3** of the upper cover **110***a* may be deformed by stress applied to the display part DP while the display part DP is wound or unwound. Specifically, the third area A**3** of the upper cover **110***a* may be deformed as the plurality of opening portions **111** contract or expand while the display part DP is wound or unwound. Further, because the plurality of opening portions **111** contract or expand, a slip of the display panel **120** disposed on the third area A**3** of the upper cover **110***a* is minimized, such that stress to be applied to the display panel **120** may be minimized.

Meanwhile, with reference to FIGS. **4**A and **5**, the upper cover **110***a* includes a first upper cover **110***a***1**, and a second upper cover **110***a***2** disposed on a rear surface **110**R of the first upper cover **110***a***1**. The first upper cover **110***a***1** may be attached to the display panel **120**. The second upper cover **110***a***2** may be disposed to engage with the first upper cover **110***a***1**. In an embodiment, the upper cover **110***a* may instead be a plate **110***a* with the first upper cover **110***a***1** being a first plate **110***a***1** or a first upper plate **110***a***1** and the second upper cover **110***a***2** being a second plate **110***a***2** or a second upper plate **110***a***2**, as described further with reference to FIGS. **13**-**14**C.

The upper cover **110***a* will be described in detail with reference to FIGS. **6**A to **6**C.

The lower cover **110***b* may be fastened to the upper cover **110***a* and the roller **161** and connect the upper cover **110***a* and the roller **161**. As described above, the lower cover **110***b* may connect the upper cover **110***a* and the roller **161**, and connect the roller **161** and the display panel **120** disposed on the upper cover **110***a*. The shape of the lower cover **110***b* or the connection method may be variously changed in accordance with design as long as the lower cover **110***b* may be connected to the upper cover **110***a* and the roller **161**. Thus, the present disclosure is not limited thereto.

One end of the lower cover **110***b* is an uppermost end area of the lower cover **110***b* and may overlap one end, such as a bottom end, of the upper cover **110***a*. For example, one end of the lower cover **110***b* may overlap the second area A**2** of the upper cover **110***a*. One end of the lower cover **110***b* may be connected to and overlap a part of the upper cover **110***a* or connected to a part of the upper cover **110***a* by using a connection member, fastener, or the like. However, the present disclosure is not limited thereto.

The lower cover **110***b* may include a plurality of fastening parts FP that overlap the upper cover **110***a*. The plurality of fastening parts FP is disposed at one end, such as an upper end, of the lower cover **110***b*. In addition, a plurality of third fastening holes AH**3** may be respectively disposed in the plurality of fastening parts FP so as to be fastened to the upper cover **110***a*. The plurality of fastening parts FP having the plurality of third fastening holes AH**3** is spaced apart from one another, such that a space in which the plurality of flexible films **130** may be bent may be provided between the plurality of fastening parts FP. FIG. **4**A illustrates nine third fastening holes AH**3**. However, the number of third fastening holes AH**3** is a non-limiting example, and the present disclosure is not limited thereto. The number of third fastening holes AH**3** may generally be selected based on design factors.

FIG. **4**A illustrates that the second fastening holes AH**2** of the upper cover **110***a* and the third fastening holes AH**3** of the lower cover **110***b* for fastening the upper cover **110***a* and the lower cover **110***b* to each other are respectively disposed in the second area A**2** of the upper cover **110***a* and at one end, such as an upper end, of the lower cover **110***b*. However, the upper cover **110***a* and the lower cover **110***b* may be fixed to each other without a separate fastening hole.

An area from one end to the other end of the lower cover **110***b*, i.e., a height across an entirety of the lower cover **110***b* in the column direction, is an area extending so that a display area AA (see FIG. **4**B) of the display panel **120** may be disposed outside the housing part HP. For example, when the upper cover **110***a* and the display panel **120** are in the fully unwound state, the area from the other end, or bottom end, of the lower cover **110***b* fixed to the roller **161** to one end, or top end, of the lower cover **110***b* at which the plurality of flexible films **130** and the printed circuit board **140** are disposed may be disposed inside the housing part HP. The third area A**3** of the upper cover **110***a* in which the display area AA of the display panel **120** is disposed and the first area A**1** of the upper cover **110***a* may be disposed outside the housing part HP. That is, the area from the other end, or bottom end, of the lower cover **110***b* fixed to the roller **161** to the second area A**2** and at least a part of one end, or top end, of the lower cover **110***b* may be disposed inside the

housing part HP. In an embodiment where the display device **100** is wound or unwound in the row direction, i.e., horizontally, the top and bottom ends of the covers **110***a*, **110***b* may instead be left or right ends, respectively.

The other end, or bottom end, of the lower cover **110***b* is a lowermost end area of the lower cover **110***b* that is fastened to the roller **161**. Fourth fastening holes AH**4** may be formed at the other end, or bottom end, of the lower cover **110***b* so that the lower cover **110***b* can be fastened to the roller **161**. For example, fastening members are disposed to penetrate the roller **161** and the fourth fastening holes AH**4**, such that the roller **161** may be fastened to the other end of the lower cover **110***b*. Further, as the other end of the lower cover **110***b* is fastened to the roller **161**, the display panel **120**, the upper cover **110***a*, and the lower cover **110***b* may be wound around or unwound from the roller **161**. FIG. **4**A illustrates two fourth fastening holes AH**4**. However, the number of fourth fastening holes AH**4** is not limited thereto and may generally be selected based on design factors.

Meanwhile, the plurality of opening portions **111**, which is formed in the third area A**3** of the upper cover **110***a*, is not formed in the lower cover **110***b* in an embodiment. Specifically, the third fastening holes AH**3** and the fourth fastening holes AH**4** are formed at one end, such as a top end, and the other end, such as a bottom end, of the lower cover **110***b*. However, the plurality of opening portions **111**, which is formed in the third area A**3** of the upper cover **110***a*, is not formed in the lower cover **110***b*. In addition, the third fastening hole AH**3** and the fourth fastening hole AH**4** are different in shape from the plurality of opening portions **111**.

The lower cover **110***b* may be made of a material having flexibility so that the lower cover **110***b* may be wound around or unwound from the roller **161**. For example, the lower cover **110***b* may be made of a plastic material such as polyethylene terephthalate (PET). However, the material of the lower cover **110***b* may be variously changed in accordance with design as long as the material of the lower cover **110***b* satisfies physical property conditions such as a thermal deformation amount, a radius of curvature, rigidity, and the like. Thus, the present disclosure is not limited thereto.

In the present specification, the configuration has been described in which the upper cover **110***a* and the lower cover **110***b* are separately formed. However, the present disclosure is not limited thereto. The upper cover **110***a* and the lower cover **110***b* may be integrated as a single, unitary, integral structure.

With reference to FIGS. **4**B and **5**, the display panel **120** is disposed on one surface of the upper cover **110***a*, such as a front surface **110**F of the upper cover **110***a*. The display panel **120** is provided on one surface, or front surface **110**F, of the upper cover **110***a* and disposed in the third area A**3**. The display panel **120** is a panel configured to display images to a user. The display panel **120** may include a display element configured to display images, a driving element configured to operate the display element, and lines configured to transmit various types of signals to the display element and the driving element.

The display elements may have different configurations depending on the type of display panel **120**. For example, in a case in which the display panel **120** is an organic light-emitting display panel **120**, the display element may be an organic light-emitting element including an anode, an organic light-emitting layer, and a cathode. For example, in a case in which the display panel **120** is a liquid crystal display panel, the display element may be a liquid crystal display element. Hereinafter, the assumption is made that the display panel **120** is the organic light-emitting display panel. However, the display panel **120** is not limited to the organic light-emitting display panel. In addition, because the display device **100** according to one or more embodiments of the present disclosure is a rollable display device **100**, the display panel **120** may be implemented as a flexible display panel **120** so as to be wound around or unwound from the roller **161**.

The display panel **120** includes the display area AA and a non-display area NA.

The display area AA is an area of the display panel **120** in which images are displayed. The display area AA may include a plurality of subpixels constituting the plurality of pixels, and a drive circuit configured to operate the plurality of subpixels. The plurality of subpixels is minimum units constituting the display area AA. The display element may be disposed in each of the plurality of subpixels. For example, the plurality of subpixels may each include the light-emitting element including an anode, a light-emitting part, and a cathode. However, the present disclosure is not limited thereto. In addition, the drive circuit configured to operate the plurality of subpixels may include driving elements, lines, and the like. For example, the drive circuit may include, but not limited to, a thin-film transistor, a storage capacitor, a gate line, a data line, and the like.

The non-display area NA is an area in which no image is displayed. Various lines and circuits for operating the organic light-emitting element in the display area AA are disposed in the non-display area NA. For example, the non-display area NA may include, but not limited to, link lines for transmitting signals to the plurality of subpixels and the drive circuit in the display area AA. The non-display area NA may include a drive IC such as a gate driver IC and a data driver IC.

Meanwhile, the non-display area NA includes a pad area.

The pad area is an area in which a plurality of pads is disposed. The plurality of pads is electrodes for electrically connecting the plurality of flexible films **130** and the display panel **120**. The plurality of flexible films **130** and the display panel **120** may be electrically connected through the plurality of pads. In the non-display area NA, the pad area may be the non-display area NA that overlaps the second area A**2** of the upper cover **110***a*. However, the pad area may be formed in another portion of the non-display area NA in accordance with the arrangement of the plurality of flexible films **130**. However, the present disclosure is not limited thereto. Certain features mentioned above are not illustrated to avoid obscuring the concepts of the disclosure.

With reference to FIG. **5**, the display panel **120** includes a substrate **121**, a buffer layer **122**, a pixel part **123**, a sealing layer **124**, and a sealing substrate **125**.

The substrate **121** is a base member for supporting various types of components of the display panel **120** and may be made of an insulating material. The substrate **121** may be made of a material having flexibility so that the display panel **120** can be wound or unwound. For example, the substrate **121** may be made of a plastic material such as polyimide (PI).

The buffer layer **122** is disposed on a top or front surface of the substrate **121**. The buffer layer **122** may inhibit moisture and/or oxygen penetrating from the outside of the substrate **121** from being diffused within the display panel **120**. The buffer layer **122** may be made of an inorganic material. For example, the buffer layer **122** may be configured as a single layer or multilayer made of silicon oxide (SiOx) or silicon nitride (SiNx), or any combination thereof. However, the present disclosure is not limited thereto.

The pixel part **123** is disposed on the top or front surface of the substrate **121** and a top or front surface of the buffer layer **122**. The pixel part **123** includes a plurality of organic light-emitting elements, and a circuit for operating the plurality of organic light-emitting elements. The pixel part **123** may be disposed to correspond to the display area AA.

Meanwhile, the display panel **120** may be a top-emission type display panel or a bottom-emission type display panel depending on a direction in which light is emitted from the organic light-emitting element.

The top-emission type display device allows the light emitted from the organic light-emitting element to propagate toward an upper side of the substrate **121** on which the organic light-emitting element is formed. The top-emission type display device may have a reflective layer formed on a lower portion of the anode in order to allow the light emitted from the organic light-emitting element to propagate toward the upper side of the substrate **121**, i.e., toward the cathode.

The bottom-emission type display device allows the light emitted from the organic light-emitting element to propagate toward a lower side of the substrate **121** on which the organic light-emitting element is formed. In the case of the bottom-emission type display device, the anode may be made of only a transparent electrically conductive material and the cathode may be made of a metallic material with high reflectance in order to allow the light emitted from the organic light-emitting element to propagate toward the lower side of the substrate **121**.

Hereinafter, for the convenience of description, the display device **100** according to the embodiment of the present disclosure will be described as being the bottom-emission type display device. However, the present disclosure is not limited thereto.

The sealing layer **124** is disposed to cover the pixel part **123**. The sealing layer **124** seals the organic light-emitting element of the pixel part **123**. The sealing layer **124** may protect the organic light-emitting element of the pixel part **123** from outside moisture, oxygen, impact, and the like. The sealing layer **124** may be formed by alternately stacking a plurality of inorganic layers and a plurality of organic layers. For example, the inorganic layer may be made of an inorganic material such as silicon nitride (SiNx), silicon oxide (SiOx), or aluminum oxide (AlOx). The organic layer may be made of epoxy-based polymer or acrylic polymer. However, the present disclosure is not limited thereto.

The sealing substrate **125** is disposed on the sealing layer **124**. Specifically, the sealing substrate **125** is disposed between the sealing layer **124** and the upper cover **110***a*. The sealing substrate **125**, together with the sealing layer **124**, may protect the organic light-emitting element of the pixel part **123**. The sealing substrate **125** may protect the organic light-emitting element of the pixel part **123** from outside moisture, oxygen, impact, and the like. For example, the sealing substrate **125** may be made of a material having a modulus of elasticity as high as about 200 to 900 MPa. The sealing substrate **125** may be made of a metallic material such as aluminum (Al), nickel (Ni), chromium (Cr), iron (Fe), and an alloy of nickel which is easily machined in the form of a foil or thin-film and has high corrosion resistance. Therefore, because the sealing substrate **125** is made of a metallic material in a preferred embodiment, the sealing substrate **125** may be implemented in the form of an ultrathin-film and have protection characteristics strong against outside impact and scratches.

A bonding layer AD is disposed between the sealing layer **124** and the sealing substrate **125**. The bonding layer AD may bond the sealing layer **124** and the sealing substrate **125**. The bonding layer AD may be made of a material having bondability or adhesive properties. The bonding layer AD may be a thermosetting or naturally curable bonding agent. For example, the bonding layer AD may be an optical clear adhesive (OCA), a pressure sensitive adhesive (PSA), or the like. However, the present disclosure is not limited thereto.

Meanwhile, the bonding layer AD may be disposed to surround the sealing layer **124** and the pixel part **123**. That is, the pixel part **123** may be sealed by the buffer layer **122** and the sealing layer **124**. The sealing layer **124** and the pixel part **123** may be sealed by the buffer layer **122** and the bonding layer AD. The bonding layer AD, together with the sealing layer **124** and the sealing substrate **125**, may protect the organic light-emitting element of the pixel part **123** from outside moisture, oxygen, impact, and the like. In this case, the bonding layer AD may further include a moisture absorbent. The moisture absorbent may include particles having hygroscopicity. The moisture absorbent may absorb moisture, oxygen, and the like from the outside, thereby minimizing a degree to which moisture and oxygen penetrate into the pixel part **123**.

With reference to FIG. **5**, a bonding part **190** is disposed to bond the display panel **120** and the upper cover **110***a*. The bonding part **190** may be disposed between the display panel **120** and the upper cover **110***a* and bond the display panel **120** and the upper cover **110***a*. The bonding part **190** may bond the display panel **120** and the upper cover **110***a* by bonding the scaling substrate **125** and the upper cover **110***a*. The bonding part **190** may be disposed between the scaling substrate **125** and the upper cover **110***a* and bond the sealing substrate **125** and the upper cover **110***a*.

Meanwhile, although not illustrated in the drawings, a polarizing plate may be disposed on the rear surface **120**R of the display panel **120**. The polarizing plate may selectively transmit light and reduce reflection of external light entering the display panel **120**. Specifically, the display panel **120** includes various metallic materials applied to semiconductor elements, lines, organic light-emitting elements, and the like. Therefore, the external light entering the display panel **120** may be reflected by the metallic material. The reflection of external light may decrease visibility of the display device **100**. However, in case that the polarizing plate is included in the display device **100**, the polarizing plate suppresses the reflection of external light, thereby improving outdoor visibility of the display device **100**. However, the polarizing plate may be excluded in accordance with one or more embodiments of the display device **100**.

With reference back to FIG. **4**B, the plurality of flexible films **130** is disposed at one end, or a bottom end, of the display panel **120**. The plurality of flexible films **130** are each a film having various types of components disposed on a base film having flexibility in order to supply signals to the plurality of subpixels constituting the plurality of pixels and to the drive circuit in the display area AA. The plurality of flexible films **130** may be electrically connected to the display panel **120**. The plurality of flexible films **130** is disposed at one end, such as a bottom end, of the non-display area NA of the display panel **120** and may supply power voltage, data voltage, and the like to the plurality of subpixels and the drive circuit in the display area AA. Meanwhile, FIG. **4**B illustrates eight flexible films **130**. However, the number of flexible films **130** may be variously changed in accordance with design and the present disclosure is not limited thereto.

The drive ICs such as gate driver ICs and data driver ICs may be disposed on base films of the plurality of flexible

films **130**. The drive IC is a component configured to process data for displaying the image and process a driving signal for processing the data. The drive IC may be disposed in ways such as a chip-on-glass (COG) method, a chip-on-film (COF) method, and a tape carrier package (TCP) method depending on how the drive IC is mounted.

Meanwhile, the plurality of flexible films **130** include components such as base films, the data drivers configured to display images on the base films, and the various types of drive ICs configured to control the data drivers. In other words, the plurality of flexible films **130** include components for displaying the images. The plurality of flexible films **130** is electrically connected to the pad area at one end of the display panel **120**, such as a bottom end of the display panel **120**, and bent toward the rear surface of the upper cover **110***a*. One end of each of the plurality of flexible films **130** may be connected to one end of the display panel **120** on one surface of the upper cover **110***a*, and the other end of each of the plurality of flexible films **130** may be disposed on a surface of the upper cover **110***a* opposite to one surface of the upper cover **110***a*.

With reference to FIG. **4**B, the printed circuit board **140** is disposed on the rear surface of the upper cover **110***a* and connected to the plurality of flexible films **130**. That is, the printed circuit board **140** disposed adjacent to the rear surface of the upper cover **110***a* and electrically connected to the plurality of flexible films **130**. The printed circuit board **140** is a component configured to supply a signal to the drive IC of each of the plurality of flexible films **130**. Various types of components for supplying the drive IC with various signals such as driving signals, data signals, and the like may be disposed on the printed circuit board **140**. Meanwhile, FIG. **4**B illustrates two printed circuit boards **140**. However, the number of printed circuit boards **140** may be variously changed in accordance with design. The present disclosure is not limited thereto.

Meanwhile, although not illustrated in FIG. **4**B, an additional printed circuit board connected to the printed circuit board **140** may be further disposed. For example, the printed circuit board **140** may be called a source printed circuit board (source PCB (S-PCB)) on which a data drive part is mounted. The additional printed circuit board connected to the printed circuit board **140** may be called a control printed circuit board (control PCB (C-PCB)) on which the timing controller and the like are mounted. The additional printed circuit board may be disposed in the roller **161**, disposed on the housing part HP outside the roller **161**, or disposed to directly adjoin the printed circuit board **140**.

Hereinafter, the upper cover **110***a* will be described in more detail with reference to FIGS. **6**A to **6**C.

Upper Cover

FIG. **6**A is an elevational view of the first upper cover **110***a***1** of the display device **100** according to one or more embodiments of the present disclosure. FIG. **6**B is an elevational view of the second upper cover **110***a***2** of the display device **100** according to one or more embodiments of the present disclosure. FIG. **6**C is a schematic cross-sectional view of the upper cover **110***a* of the display device **100** according to one or more embodiments of the present disclosure. For convenience of illustration, FIG. **6**C does not illustrate the opening portion **111**.

The upper cover **110***a* includes the first upper cover **110***a***1** and the second upper cover **110***a***2**.

The first upper cover **110***a***1** is disposed on the rear surface **120**R (FIG. **5**) of the display panel **120** and supports the display panel **120** or is configured to support the display panel **120**.

With reference to FIG. **6**A, the first upper cover **110***a***1** includes the plurality of first fastening holes AH**1** disposed in the area corresponding to the first area A**1** of the upper cover **110***a*. The plurality of first fastening holes AH**1** of the first upper cover **110***a***1** is disposed to fix the head bar **172**, the upper cover **110***a*, and the display panel **120**. Therefore, the plurality of first fastening holes AH**1** of the first upper cover **110***a***1** may be disposed at positions corresponding to a plurality of fastening members, which may be various fasteners, such as screws, bolts, and the like, that fixes the head bar **172**, the upper cover **110***a*, and the display panel **120**. For example, in case that the plurality of fastening members is disposed in first and second rows, the first fastening holes AH**1** of the first upper cover **110***a***1** may include the plurality of first upper fastening holes AH**1***a* disposed in the first row while corresponding to the positions of the plurality of fastening members, and the plurality of first lower fastening holes AH**1***b* disposed in the second row. In addition, when the plurality of fastening members each has a circular cross-sectional shape, the first fastening hole AH**1** of the first upper cover **110***a***1** may be disposed to have a circular shape corresponding to the cross-sectional shape of each of the plurality of fastening members.

Next, the first upper cover **110***a***1** includes the second fastening holes AH**2** disposed in the area corresponding to the second area A**2** of the upper cover **110***a*. The second fastening holes AH**2** of the first upper cover **110***a***1** may be holes for fixing the lower cover **110***b* and the upper cover **110***a*.

With reference to FIG. **6**A, the first upper cover **110***a***1** may include a first flexible area MA**1** in an area corresponding to the third area A**3** of the upper cover **110***a*. The first flexible area MA**1** of the first upper cover **110***a***1** includes a plurality of first opening portions **111***a*. The plurality of first opening portions **111***a* may be disposed in adjacent rows in a staggered manner. For example, the plurality of first opening portions **111***a* disposed in one or a first row and the plurality of first opening portions **111***a* disposed in a second row adjacent to the first row are disposed in a staggered manner. Specifically, centers of the plurality of first opening portions **111***a* disposed in odd-numbered rows and centers of the plurality of first opening portions **111***a* disposed in even-numbered rows may be disposed in a staggered manner. For example, the plurality of first opening portions **111***a* may be disposed to be staggered by ½ of a width of the first opening portion **111***a* in the row direction, although the disclosure is not limited thereto.

When the first upper cover **110***a***1** is wound, the first upper cover **110***a***1** may be curved in the column direction of the upper cover **110***a*, and stress may be applied so that the plurality of first opening portions **111***a* is stretched in the column direction. A width of each of the plurality of first opening portions **111***a* in the row direction may be increased to allow the third area A**3** of the upper cover **110***a* to be easily wound or unwound, thereby mitigating stress applied to the third area A**3**. Therefore, the third area A**3** of the first upper cover **110***a***1** may be referred to as a flexible area.

However, the arrangement of the plurality of first opening portions **111***a* illustrated in FIG. **6**A is an example, and the present disclosure is not limited thereto. For example, FIG. **6**A illustrates that the plurality of first opening portions **111***a* each has a dumbbell shape. However, the present disclosure is not limited thereto. The plurality of first opening portions **111***a* may have various shapes such as a polygonal shape or an elliptical shape.

The first upper cover **110***a***1** may be made of a material having rigidity. However, at least a part of the first upper

cover **110***a***1** may have flexibility so as to be wound or unwound together with the display panel **120**. For example, the first upper cover **110***a***1** may be made of a metallic material such as stainless steel (steel use stainless (SUS)) or Invar or a plastic material. However, the material of the first upper cover **110***a***1** may be variously changed in accordance with design as long as the material of the first upper cover **110***a***1** satisfies physical property conditions such as a thermal deformation amount, a radius of curvature, rigidity, and the like. However, the present disclosure is not limited thereto.

The second upper cover **110***a***2** is disposed on a rear surface **110**R (FIG. **5**) of the first upper cover **110***a***1** and supports the display panel **120** and the first upper cover **110***a***1**.

The second upper cover **110***a***2** may be disposed in the area corresponding to the first area A**1** of the upper cover **110***a* and have a smaller size than the first upper cover **110***a***1**. For example, a length of the second upper cover **110***a***2** in the column direction may be shorter than a length of the first upper cover **110***a***1** in the column direction. Therefore, an upper end of the second upper cover **110***a***2** may be disposed below an upper end of the first upper cover **110***a***1**.

With reference to FIG. **6**B, the second upper cover **110***a***2** includes the first fastening holes AH**1** disposed in the area corresponding to the first area A**1** of the upper cover **110***a*. The first fastening holes AH**1** of the second upper cover **110***a***2** may be disposed in an area corresponding to some of the first fastening holes AH**1** of the first upper cover **110***a***1**. For example, the first fastening holes AH**1** of the second upper cover **110***a***2** may be disposed only in the area corresponding to the first lower fastening holes AH**1** of the first upper cover **110***a***1**.

The first fastening hole AH**1** of the second upper cover **110***a***2** may be different in shape from the first fastening hole AH**1** of the first upper cover **110***a***1**. For example, as illustrated in FIG. **6**B, the first fastening hole AH**1** of the second upper cover **110***a***2** may have a shape having a width in the upward and downward direction larger than a width in the leftward and rightward direction. In other words, the first fastening hole AH**1** or first fastening holes AH**1** of the second upper cover **110***a***2** may have a height in the column direction that is greater than a width in the row direction according to the orientation of FIG. **6**B. That is, the first fastening hole **110***a***1** may have a shape having a relatively large width in a direction in which the display panel **120** is wound. The first fastening hole AH**1** of the second upper cover **110***a***2** will be described below in detail with reference to FIG. **7**.

Meanwhile, FIG. **6**B illustrates that the first fastening hole AH**1** of the second upper cover **110***a***2** is disposed only in the area corresponding to some of the first fastening holes AH**1** of the first upper cover **110***a***1**. However, the present disclosure is not limited thereto. The second upper cover **110***a***2** may include the first fastening holes AH**1** disposed at the positions corresponding to the plurality of fastening members, and the first upper cover **110***a***1** may include the first fastening holes AH**1** corresponding to some of the plurality of fastening members. In this case, the first fastening hole AH**1** of the first upper cover **110***a***1** may have a shape having a width in the upward/downward direction larger than a width in the leftward/rightward direction.

Next, the second upper cover **110***a***2** includes the second fastening holes AH**2** disposed in the area corresponding to the second area A**2** of the upper cover **110***a*. In FIG. **6**B, the second fastening holes AH**2** of the second upper cover **110***a***2** may be holes for fixing the lower cover **110***b* and the upper cover **110***a*.

In the area corresponding to the third area A**3** of the upper cover **110***a*, the second upper cover **110***a***2** includes a plurality of second flexible areas MA**2**, and a plurality of support areas PA disposed between the plurality of second flexible areas MA**2**. That is, in the area corresponding to the third area A**3** of the upper cover **110***a*, the plurality of second flexible areas MA**2** and the plurality of support areas PA of the second upper cover **110***a***2** may be alternately disposed.

First, the second flexible area MA**2** of the second upper cover **110***a***2** may include a plurality of second opening portions **111***b*. A shape of each of the plurality of second opening portions **111***b* may be identical to a shape of the first opening portion **111***a* of the first upper cover **110***a***1**, or may be different. That is, a size of each of the plurality of second opening portions **111***b* may be equal to a size of each of the plurality of first opening portions **111***a*. In this case, the configuration in which the second opening portion **111***b* and the first opening portion **111***a* have the equal size may mean that an area occupied by the second opening portion **111***b* and an area occupied by the single first opening portion **111***a* are equal to each other in a plan or elevational view. However, the present disclosure is not limited thereto.

In addition, a center of each of the plurality of first opening portions **111***a* and a center of each of the plurality of second opening portions **111***b* may be coincident with each other. Therefore, the first opening portion **111***a* and the second opening portion **111***b* may completely overlap each other. In the area in which the first opening portion **111***a* and the second opening portion **111***b* overlap each other, an object disposed rearward of the second upper cover **110***a***2** may be visually recognized from a front surface of the first upper cover **110***a***1** through the first opening portion **111***a* and the second opening portion **111***b*. Therefore, the plurality of first opening portions **111***a* and the plurality of second opening portions **111***b* may define the opening portions **111**.

The plurality of support areas PA of the second upper cover **110***a***2** is disposed between the plurality of second flexible areas MA**2**. The plurality of support areas PA of the second upper cover **110***a***2** disposed on the rear surface of the first upper cover **110***a***1**, may support the first upper cover **110***a***1**.

The plurality of opening portions, which is disposed in the plurality of second flexible areas MA**2** of the second upper cover **110***a***2**, is not disposed in the plurality of support areas PA. Therefore, the plurality of second opening portions **111***b* may overlap some, but not all, of the plurality of first opening portions **111***a* in the first upper cover **110***a***1** in some embodiments.

The plurality of support areas PA of the second upper cover **110***a***2** may overlap the first opening portion **111***a* of the first upper cover **110***a***1**. In the areas that overlap the plurality of support areas PA of the second upper cover **110***a***2**, a support area PA or a portion of the support area PA of the second upper cover **110***a***2** may be exposed in a shape corresponding to the first opening portion **111***a* of the first upper cover **110***a***1**.

Like the first upper cover **110***a***1**, the second upper cover **110***a***2** may be made of a material having rigidity but have flexibility so as to be wound or unwound together with the display panel **120**. For example, the second upper cover **110***a***2** may be made of a metallic material such as stainless steel (steel use stainless (SUS)) or Invar or a plastic material. However, the present disclosure is not limited thereto.

With reference to FIG. **6**C, the first upper cover **110***a***1** includes a plurality of convex portions **110***a***11** and a plurality of concave portions **110***a***12**. The plurality of convex portions **110***a***11** and the plurality of concave portions **110***a***12** may each be disposed in the row direction. The convex portion **110***a***11** of the first upper cover **110***a***1** is disposed between the plurality of concave portions **110***a***12** and protrudes in a direction in which the second upper cover **110***a***2** is disposed.

With reference to FIG. **6**C, the second upper cover **110***a***2** includes a plurality of convex portions **110***a***21** and a plurality of concave portions **110***a***22**. The plurality of convex portions **110***a***21** and the plurality of concave portions **110***a***22** of the second upper cover **110***a***2** may each be disposed in the row direction. The plurality of convex portions **110***a***21** of the second upper cover **110***a***2** is disposed between the plurality of concave portions **110***a***22** and protrudes in a direction in which the first upper cover **110***a***1** is disposed. In one or more embodiments, the convex portions **110***a***11** of the first upper cover **110***a***1** are implemented as protrusions or ridges that extend from the first upper cover **110***a***1** toward the second upper cover **110***a***2**. The concave portions **110***a***12** of the first upper cover **110***a***1** are implemented as channels or cavities that extend into the first upper cover **110***a*, i.e., away from the second upper cover **110***a***2**, and are positioned between the convex portions **110***a***11** to define a space or gap between the convex portions **110***a***11**. The second upper cover **110***a***2** has an opposite arrangement configured to mate and interface with the first upper cover **110***a***1**, namely convex portions **110***a***21** that extend toward the first cover **110***a***1** and are received in the channels or cavities defined by the concave portions **110***a***12** of the first upper cover **110***a***1**. The second upper cover **110***a***2** further includes concave portions **110***a***22** implemented as channels or cavities that receive the convex portions **110***a***11** of the first upper cover **110***a***1**. Except as otherwise noted, the convex portions **110***a***11**, **110***a***21** of both of the first and second upper covers **110***a***1**, **110***a***2** have a thickness or width relative to the respective upper cover **110***a***1**, **110***a***2** that is greater than a thickness of the concave portions **110***a***12**, **110***a***22** of the first and second upper covers **110***a***1**, **110***a***2**.

In this case, the plurality of concave portions **110***a***22** and the plurality of convex portions **110***a***21** of the second upper cover **110***a***2** and the plurality of concave portions **110***a***12** and the plurality of convex portions **110***a***11** of the first upper cover **110***a***1** may be disposed in a staggered manner. In addition, a width or height of each of the plurality of concave portions **110***a***22** of the second upper cover **110***a***2** may be larger than a width or height of each of the plurality of convex portions **110***a***11** of the first upper cover **110***a***1**. A width or height of each of the plurality of concave portions **110***a***12** of the first upper cover **110***a***1** may be larger than a width or height of each of the plurality of convex portions **110***a***21** of the second upper cover **110***a***2**. Therefore, the plurality of concave portions **110***a***12** and the plurality of convex portions **110***a***11** of the first upper cover **110***a***1** are disposed to engage with the plurality of concave portions **110***a***22** and the plurality of convex portions **110***a***21** of the second upper cover **110***a***2**.

A difference in width or height between the plurality of concave portions **110***a***12** of the first upper cover **110***a***1** and the plurality of convex portions **110***a***21** of the second upper cover **110***a***2**, which correspond to one another, and a difference in width or height between the plurality of concave portions **110***a***22** of the second upper cover **110***a***2** and the plurality of convex portions **110***a***11** and the first upper cover **110***a***1**, which correspond to one another may increase in a direction from a lower side of the upper cover **110***a* adjacent to the roller **161** to an upper side of the upper cover **110***a*, as generally indicated by dimensions d**1**, d**2**, d**3**, dn−1, and dn. The increase in the gap or space between the convex portions **110***a***11** of the first upper cover **110***a***1** and the convex portions **110***a***21** of the second upper cover **110***a***2** over the height of the upper cover **110***a* assists with accounting for, and reducing, a slip phenomenon that may occur as the display device **100** is roller and unrolled. In general, as the display device **100** is wound about the roller **161**, the layers of the display device **100** closest to the roller **161** are wound by a distance (i.e., have a circumference) that is less than a winding distance (i.e., a circumference) of the layers furthest from the roller **161** because of the thickness of the layers of the display device **100**. Thus, the layers can tend to slip relative to one another to offset the difference in winding amount and cause damage to the display device **100**. This issue is more pronounced at the top of the display device **100** because as the roller **161** winds the display device **100**, the overall circumference of the roll increases with each revolution about the roller **161**.

In one or more embodiments of the disclosure, the spaces or gaps between convex portions **110***a***11**, **110***a***21** of the first and second upper covers **110***a***1**, **110***a***2** increases (as shown by dimensions d**1** . . . dn) to account for, and reduce this slip phenomenon. The gaps or spaces enable deformation and/or movement of the first cover **110***a***1** relative to the second cover **110***a***2** that relieves stress produced by the slip phenomenon and reduces the likelihood of damage to the display device **100**.

Hereinafter, fastening structures between the concave portion **110***a***12** and the convex portion **110***a***11** of the first upper cover **110***a***1**, the concave portion **110***a***22** and the convex portion **110***a***21** of the second upper cover **110***a***2**, and the head bar **172** will be described in more detail with reference to FIG. **7**.

FIG. **7** is a schematic cross-sectional view for explaining the head bar **172** and the display panel **120** of the display device **100** according to one or more embodiments of the present disclosure. FIG. **7** illustrates only the head bar **172**, the display panel **120**, the upper cover **110***a*, the lower cover **110***b*, a top cover **151**, the flexible film **130**, and the printed circuit board **140**. In addition, for convenience of illustration, FIG. **7** does not illustrate the concave portion **110***a***12** and the convex portion **110***a***11** of the first upper cover **110***a***1** and the concave portion **110***a***22** and the convex portion **110***a***21** of the second upper cover **110***a***2**.

The top cover **151** is disposed on one surface of the upper cover **110***a*, such as a rear surface of the upper cover **110***a* relative to the viewing direction shown in FIG. **7**. The top cover **151** may be disposed to cover the pad area of the display panel **120**, the plurality of flexible films **130**, and the printed circuit board **140** and protect the pad area of the display panel **120**, the plurality of flexible films **130**, and the printed circuit board **140**.

The top cover **151** may be made of a material having rigidity, such that the top cover **151** may not be deformed when the display part DP is wound. The top cover **151** may protect the pad area and the plurality of flexible films **130** at one end of the display panel **120**.

An outer surface of the top cover **151** may have a convex shape and be connected to a curved surface portion **161**R of the roller **161**, thereby defining a rounded shape or defining a circular shape connected to the curved surface portion **161**R of the roller. That is, one surface of the top cover **151** may be formed as a curved surface. Further, when the display panel **120** is wound, the top cover **151** may define a

rounded shape connected to the curved surface portion **161**R of the roller **161** or define a circular shape connected to the curved surface portion **161**R of the roller.

With reference to FIG. **7**, the head bar **172** includes a first head bar **172***a* and a second head bar **172***b*. The second head bar **172***b* covers the front surface of the display panel **120**. The second head bar **172***b* may cover only a part of the front surface of the display panel **120** adjacent to the edge of the uppermost end of the display panel **120** so as not to cover an image displayed on the front surface of the display panel **120**.

With reference to FIG. **7**, a bottom cover **152** may be disposed on the display panel **120**. The bottom cover **152**, together with the top cover **151**, may protect the pad area of the display panel **120**, the plurality of flexible films **130**, and the printed circuit board **140**.

With reference to FIG. **7**, the display device **100** is wound in an inward manner in which a display surface of the display panel **120** is directed toward the roller **161**. That is, in case that the display panel **120** is wound around the roller **161**, the display panel **120** may be disposed to be closer to the roller **161** than the upper cover **110***a* to the roller **161**. As illustrated in FIG. **7**, a viewing direction may be a direction directed toward the display panel **120** from the bottom cover **152** instead of the top cover **151**.

With reference back to FIG. **6**C, the plurality of convex portions **110***a***21** of the second upper cover **110***a***2** is disposed closer to the convex portions **110***a***11** of the first upper cover **110***a***1**, which are disposed at the upper side among the plurality of concave portions **110***a***12** of the first upper cover **110***a***1**, than the convex portions **110***a***11** of the first upper cover **110***a***1** that are disposed at the lower side among the plurality of concave portions **110***a***12** of the first upper cover **110***a***1**.

As described above, in case that the display device **100** is wound in an inward manner, the display device **100** is wound so that the first upper cover **110***a***1** is closer to the roller **161** than the second upper cover **110***a***2** to the roller **161**. Therefore, the display device **100** is wound with the display panel **120** having a smaller radius of curvature than the upper cover **110***a* generally, and with the first upper cover **110***a* having a smaller radius of curvature than the second upper cover **110***a***2**. Therefore, a relatively small slip occurs on the first upper cover **110***a***1** in comparison with the second upper cover **110***a***2**. Further, the position of the first upper cover **110***a***1** is less changed than the position of the second upper cover **110***a***2**. That is, during the winding process, an upper end of the second upper cover **110***a***2** may be further moved downward than an upper end of the first upper cover **110***a***1**. Therefore, the plurality of convex portions **110***a***21** of the second upper cover **110***a***2** may be further moved downward than the plurality of concave portions **110***a***12** of the first upper cover **110***a***1**. Therefore, spacing distances (d**1**, d**2**, . . . , dn−1, and dn) may be ensured and increasing over a height of the upper cover **110***a* between the convex portion **110***a***21** of the second upper cover **110***a***2** and the convex portion **110***a***11** of the first upper cover **110***a***1**, thereby accommodating a slip of the convex portion **110***a***21** of the second upper cover **110***a***2**.

With reference back to FIG. **6**C, the spacing distances (d**1**, d**2**, . . . , dn−1, and dn) between the convex portion **110***a***21** of the second upper cover **110***a***2** and the convex portion **110***a***11** of the first upper cover **110***a***1** may increase as the distance from the roller **161** increases. With reference to FIG. **6**C, at the lower side of the upper cover **110***a* adjacent to the roller **161**, the convex portion **110***a***11** of the first upper cover **110***a***1** is spaced apart from the convex portion **110***a***21** of the second upper cover **110***a***2** at a predetermined interval. For example, a spacing distance d**1** between the convex portion **110***a***21** of the second upper cover **110***a***2** and the convex portion **110***a***11** of the first upper cover **110***a***1** may correspond to an assembling tolerance. Therefore, even though a process error occurs, the second upper cover **110***a***2** may engage with the first upper cover **110***a***1** without separating from the first upper cover **110***a***1**. Meanwhile, a spacing distance (dn) between the convex portion **110***a***21** of the second upper cover **110***a***2** and the convex portion **110***a***11** of the first upper cover **110***a***1** at the upper side of the upper cover **110***a*, which is disposed to be distant from the roller **161**, may be longer than a distance (dn, dn**2**, . . . , dn−1) between the convex portion **110***a***21** of the second upper cover **110***a***2** and the convex portion **110***a***11** of the first upper cover **110***a***1** at the lower side of the upper cover **110***a*. That is, the spacing distances (dn, dn**2**, . . . , dn−1) between the convex portion **110***a***21** of the second upper cover **110***a***2** and the convex portion **110***a***11** of the first upper cover **110***a***1** may increase in a direction from the roller **161** to the head bar **172**. Therefore, a slip of the second upper cover **110***a***2** may be accommodated by increasing the spacing distances (dn, dn**2**, . . . , dn−1) between the convex portion **110***a***21** of the second upper cover **110***a***2** and the convex portion **110***a***11** of the first upper cover **110***a***1** over a height of the upper cover **110***a*, and most pronounced at the upper side of the upper cover **110***a* at which a radius between the roller **161** and the display panel **120** increases.

Meanwhile, the first opening portions **111***a* may be disposed in all the plurality of convex portions **110***a***11** and the plurality of concave portions **110***a***12** of the first upper cover **110***a***1** (see FIG. **6**A). Therefore, all the plurality of convex portions **110***a***11** and the plurality of concave portions **110***a***12** of the first upper cover **110***a***1** may be the first flexible area MA**1**.

In contrast, the second opening portions **111***b* of the second upper cover **110***a***2** (see FIG. **6**B) may be disposed in one area of the plurality of concave portions **110***a***22**, or the plurality of convex portions **110***a***21** of the second upper cover **110***a***2**, or disposed in a partial area of the plurality of concave portions **110***a***22** and a partial area of the plurality of convex portions **110***a***21**. Therefore, the plurality of concave portions **110***a***22** and the plurality of convex portions **110***a***21** of the second upper cover **110***a***2** may each correspond to the second flexible area MA**2** and the support area PA of the second upper cover **110***a***2**. However, the present disclosure is not limited thereto. The plurality of concave portions **110***a***22** and the plurality of convex portions **110***a***21** of the second upper cover **110***a***2** may correspond to a partial area of the support area PA or a partial area of the second flexible area MA**2**. That is, the arrangement position of the second opening portion **111***b* of the second upper cover **110***a***2** may be designed independently regardless of the arrangement of the plurality of concave portions **110***a***22** and the plurality of convex portions **110***a***21** of the second upper cover **110***a***2**.

With reference to FIGS. **6**A and **7**, the head bar **172** is disposed at the uppermost end of the display panel **120** and surrounds the front and rear surfaces of the display panel **120**.

Fastening members SC are disposed to penetrate the first fastening holes AH**1**, the head bar **172**, and the first fastening holes AH**1** to fasten the head bar **172** to the uppermost end area of the upper cover **110***a*. Therefore, when the link part **171** fastened to the head bar **172** moves upward or down-

ward, the upper cover **110***a* and the display panel **120** attached to the upper cover **110***a* may move upward or downward.

First, with reference to FIGS. **6**A and **7**, the first fastening holes AH**1** of the first upper cover **110***a***1** include the first upper fastening holes AH**1***a* disposed in the first row, and the first lower fastening holes AH**1***b* disposed in the second row.

The first fastening hole AH**1** of the first upper cover **110***a***1** may be disposed at a position corresponding to the fastening member SC and have a size corresponding to a size of each of the plurality of fastening members SC. Therefore, the first upper cover **110***a***1** is fixed to the head bar **172** by the fastening member SC, such that the end of the first upper cover **110***a***1** moves upward or downward together with the head bar **172** when the link part **171** moves upward or downward.

Next, with reference to FIGS. **6**B and **7**, the first fastening holes AH**1** of the second upper cover **110***a***2** may be disposed at the positions corresponding to some of the plurality of fastening members SC and each have a width in the upward and downward direction larger than a width in the leftward/rightward direction. In this case, as illustrated in FIG. **7**, when the display panel **120** is fully unwound, the plurality of fastening members SC is disposed adjacent to lower sides of the first fastening holes AH**1** of the second upper cover **110***a***2**.

Meanwhile, because the first upper cover **110***a***1** is wound to be closer to the roller **161** than the second upper cover **110***a***2** to the roller **161**, a relatively small slip occurs on the first upper cover **110***a***1** in comparison with the second upper cover **110***a***2**. Therefore, during the winding process, the upper end of the second upper cover **110***a***2** may be further moved downward than the upper end of the first upper cover **110***a***1**. Therefore, the first fastening hole AH**1** of the second upper cover **110***a***2** is formed to be long in the upward and downward direction, and the fastening member SC may move to the upper side of the first fastening hole AH**1** of the second upper cover **110***a***2** during the process of winding the display panel **120**, thereby accommodating the movements of the plurality of fastening members SC during the winding process. In other words, the comparatively longer or taller shape of the first fastening hole AH**1** of the second upper cover **110***a***2** enables movement of the fastening members SC during winding or unwinding to account for additional slip of the second upper cover **110***a***2** that can result from the second upper cover **110***a***2** being positioned further from the roller **161** and therefore having a greater radius of curvature than the first upper cover **110***a***1**.

In addition, with reference to FIG. **7**, the upper end and the side surface of the second upper cover **110***a***2** is disposed to be spaced apart from the head bar **172**. As described above, because a slip may occur on the second upper cover **110***a***2** during the process of winding and unwinding the display panel **120**, the upper end of the second upper cover **110***a***2** may be spaced apart from the head bar **172**, thereby suppressing friction generated in the event of a slip.

The plurality of opening portions **111** is disposed on the upper cover **110***a* for supporting the display panel **120** to minimize a slip of the display panel and reduce stress applied to the display panel when the display panel is wound or unwound. However, the time and costs required for the process of forming the opening portions in the upper cover may increase in accordance with a thickness of the upper cover. For example, in case that the opening portion of the upper cover is formed by an etching process, the etching process time and process costs may increase as the thickness of the upper cover increases. In addition, in case that the opening portion is formed by the etching process, the area of the opening portion to be etched may increase as the thickness of the upper cover increases. Therefore, the area of the opening portion of the upper cover increases, which may cause a problem, in which the opening portion of the upper cover is visually recognized by the user, and cause a process deviation in the etching direction.

A general polarizing plate includes a polarizing layer configured as a polyvinyl alcohol (PVA) based polymer film to polarize the entering light. However, because the polyvinyl alcohol (PVA) based polymer material is a material having excellent hygroscopicity, a volume varies depending on humidity. That is, the polarizing layer expands by absorbing moisture in an environment with high humidity, and the polarizing layer contracts by discharging moisture in an environment with low humidity, such that bending occurs in an expansion/contraction direction. Therefore, the polarizing plate and the display panel, to which the polarizing plate is attached, are bent.

In the display device **100** according to one or more embodiments of the present disclosure, the upper cover **110***a* includes the first and second upper covers **110***a***1** and **110***a***2** having a small thickness. In other words, each of the first and second upper covers **110***a***1**, **110***a***2** may have a thickness that is less than a thickness of an upper cover that is a single, unitary, integral sheet. Further, in some embodiments, the sum of the thickness of the first and second upper covers **110***a*, **110***a***2** may be less than a thickness of an upper cover that is a single sheet. Therefore, the first opening portion **111***a* of the first upper cover **110***a***1** and the second opening portion **111***b* of the second upper cover **110***a***2** may be formed by independent processes. Despite the opening portions **111***a*, **11***b* being formed independently, the time for which the etching process is performed to form the first opening portion **111***a* in the first upper cover **110***a***1** and the time for which the etching process is performed to form the second opening portion **111***b* in the second upper cover **110***a***2** may be shorter than the time for which the etching process is performed to form the opening portion in an upper cover that is a single sheet having a thickness that is a sum of the thickness of the first upper cover **110***a***1** and the thickness of the second upper cover **110***a***2**. In addition, the opening portion **111** having a smaller size may be formed in the case in which the opening portions are respectively formed in the first upper cover **110***a***1** and the second upper cover **110***a***2** in comparison with the case in which the opening portions are formed in the entire single upper cover having the thickness that is the sum of the thickness of the first upper cover **110***a***1** and the thickness of the second upper cover **110***a***2**. Therefore, in the display device **100** according to one or more embodiments of the present disclosure, the first opening portion **111***a* of the first upper cover **110***a***1** and the second opening portion **111***b* of the second upper cover **110***a***2** are formed by the independent processes. Therefore, it is possible to minimize the area of the opening portion **111** without reducing a final thickness of the upper cover **110***a*. Therefore, it is possible to maintain rigidity of the display device **100** and solve the problem in which the opening portion **111** is visually recognized by the user even in embodiments that do not include a polarizing layer.

In addition, in the display device **100** according to one or more embodiments of the present disclosure, the second upper cover **110***a***2** includes the plurality of support areas PA disposed between the plurality of second flexible areas MA**2**. Therefore, the upper cover may have rigidity in comparison with a case in which the entire surface of the upper cover is configured as the flexible area including the

opening portions. In addition, in case that the upper cover **110***a* includes the plurality of covers that engages with each other, the upper cover **110***a* may have high rigidity with respect to the thickness in comparison with the case in which the upper cover **110***a* is configured as a single cover. Therefore, in the display device **100** according to one or more embodiments of the present disclosure, it is possible to improve bending of the display device **100**, which may be caused by expansion of the polarizing plate, and inhibit the opening portion **111** from being visually recognized.

In addition, the display device **100** according to one or more embodiments of the present disclosure is disposed so that a difference in width or height between the plurality of concave portions **110***a***12** of the first upper cover **110***a***1** and the plurality of convex portions **110***a***21** of the second upper cover **110***a***2**, which correspond to one another, and a difference in width or height between the plurality of concave portions **110***a***22** of the second upper cover **110***a***2** and the plurality of convex portions **110***a***11** and the first upper cover **110***a***1**, which correspond to one another may increase in a direction from a lower side of the upper cover **110***a* adjacent to the roller **161** to an upper side of the upper cover **110***a*, i.e., over a height or length of the upper cover **110***a*. In addition, in the display device **100** according to one or more embodiments of the present disclosure, in case that the display panel **120** is wound around the roller **161**, the plurality of convex portions **110***a***21** of the second upper cover **110***a***2** is disposed closer to the convex portions **110***a***11** of the first upper cover **110***a***1**, which are disposed at the upper side among the plurality of concave portions **110***a***12** of the first upper cover **110***a***1**, than the convex portions **110***a***11** of the first upper cover **110***a***1** that are disposed at the lower side among the plurality of concave portions **110***a***12** of the first upper cover **110***a***1**. Therefore, it is possible to accommodate the movements of the plurality of convex portions **110***a***21** of the second upper cover **110***a***2** that may be caused by a slip of the second upper cover **110***a***2**. Therefore, in the display device **100**, it is possible to reduce a problem in which the display panel **120** is lifted up or the display panel **120** is creased.

FIG. **8** is a schematic cross-sectional view of an upper cover **810***a* of a display device **800** according to one or more embodiments of the present disclosure. The upper cover **810***a* of the display device **800** in FIG. **8** is substantially identical in configuration to the upper cover **110***a* of the display device **100** in FIGS. **1** to **7**, except for only a plurality of convex portions **810***a***21** and a plurality of concave portions **810***a***22** of a second upper cover **810***a***2**. Therefore, repeated descriptions of the identical components will be omitted. For convenience of illustration, FIG. **8** illustrates only the upper cover **810***a* among various constituent elements of the display device **800**.

With reference to FIG. **8**, the second upper cover **810***a***2** includes the plurality of convex portions **810***a***21** and the plurality of concave portions **810***a***22**. The plurality of convex portions **810***a***21** and the plurality of concave portions **810***a***22** may be respectively disposed to engage with the plurality of concave portions **110***a***12** and the plurality of convex portions **110***a***11** of the first upper cover **110***a***1**.

Meanwhile, the display device **800** according to one or more embodiments of the present disclosure is wound in an outward manner in which the display surface of the display panel **120** is directed away from the roller **161**. That is, an upper cover **810***a* may be disposed to be closer to the roller **161** than the display panel **120** is to the roller **161**, which is the opposite arrangement in comparison with the embodiments above in which the display panel **120** is wound facing the roller **161**.

With reference back to FIG. **8**, the plurality of convex portions **810***a***21** of the second upper cover **810***a***2** is disposed closer to the convex portions **110***a***11** of the first upper cover **110***a***1**, which are disposed at the lower side among the plurality of concave portions **110***a***12** of the first upper cover **110***a***1**, than the convex portions **110***a***11** of the first upper cover **110***a***1** that are disposed at the upper side among the plurality of concave portions **110***a***12** of the first upper cover **110***a***1**. As described above, in case that the display device **800** is wound in an outward manner, the first upper cover **110***a***1** is wound with a larger radius of curvature than the second upper cover **810***a***2** wound to be adjacent to the roller **161**. Therefore, during the winding process, the upper end of the first upper cover **110***a***1** may be further moved downward than the upper end of the second upper cover **810***a***2**, and the plurality of convex portions **110***a***11** of the first upper cover **110***a***1** may be further moved downward than the plurality of concave portions **810***a***22** of the second upper cover **810***a***2**. Therefore, the spacing distances (d**1**, d**2**, . . . , dn−1, and dn) may be ensured between the convex portion **810***a***21** of the second upper cover **810***a***2** and the convex portion **110***a***11** of the first upper cover **110***a***1**, thereby accommodating a slip of the convex portion **110***a***11** of the first upper cover **110***a***1**.

With reference to FIG. **8**, the spacing distances (d**1**, d**2**, . . . , dn−1, and dn) between the convex portion **810***a***21** of the second upper cover **810***a***2** and the convex portion **110***a***11** of the first upper cover **110***a***1** may increase as the distance from the roller **161** increases. That is, a difference in width between the plurality of concave portions **110***a***12** of the first upper cover **110***a***1** and the plurality of convex portions **810***a***21** of the second upper cover **810***a***2**, which correspond to one another, and a difference in width between the plurality of concave portions **810***a***22** of the second upper cover **810***a***2** and the plurality of convex portions **110***a***11** and the first upper cover **110***a***1**, which correspond to one another may increase in a direction from a lower side of the upper cover **810***a* adjacent to the roller **161** to an upper side of the upper cover **810***a*. Therefore, it is possible to accommodate a slip of the first upper cover **110***a***1** that increases at the upper side of the upper cover **810***a* as a radius between the roller **161** and the display panel **120** increases.

Meanwhile, the first fastening hole AH**1** of the second upper cover **810***a***2** may have a shape having a width in the upward/downward direction larger than a width in the leftward/rightward direction. In this case, when the display panel **120** is fully unwound, the plurality of fastening members SC is disposed adjacent to upper sides of the first fastening holes AH**1** of the second upper cover **810***a***2**. Therefore, it is possible to accommodate the movement of the fastening member SC when the first fastening hole AH**1** of the second upper cover **810***a***2** moves upward during the process of winding the display panel **120** in an outward manner.

Meanwhile, the second upper cover **810***a***2** includes the plurality of second opening portions **111***b* each equal in shape to the first opening portion **111***a* of the first upper cover **110***a***1**. The arrangement position of the second opening portion **111***a* of the second upper cover **810***a***2** may be designed independently regardless of the arrangement of the plurality of concave portions **810***a***22** and the plurality of convex portions **810***a***21** of the second upper cover **810***a***2**.

In the display device **800** according to one or more embodiments of the present disclosure, the upper cover **810***a* includes the first and second upper covers **110***a***1** and **810***a***2**

having a small thickness. The first upper cover **110***a***1** and the second upper cover **810***a***2** are configured to engage with each other. Therefore, the upper cover **810***a* may have high rigidity with respect to the thickness, thereby improving the bending of the display device **800** that may be caused by the expansion of the polarizing plate, in comparison with the case in which the upper cover is configured as a single cover.

In addition, in the display device **800** according to one or more embodiments of the present disclosure, the first opening portion **111***a* of the first upper cover **110***a***1** and the second opening portion **111***b* of the second upper cover **810***a***2** are formed by the independent processes. Therefore, it is possible to minimize the area of the first opening portion **111***a*, the area of the second opening portion **111***b*, and the area of the opening portion **111**. Therefore, it is possible to maintain rigidity of the display device **800** and solve the problem in which the opening portion **111** is visually recognized by the user.

In addition, the display device **800** according to one or more embodiments of the present disclosure is disposed so that a difference in width between the plurality of concave portions **110***a***12** of the first upper cover **110***a***1** and the plurality of convex portions **110***a***21** of the second upper cover **810***a***2**, which correspond to one another, and a difference in width between the plurality of concave portions **810***a***22** of the second upper cover **810***a***2** and the plurality of convex portions **110***a***11** and the first upper cover **110***a***1**, which correspond to one another may increase in a direction from a lower side of the upper cover **810***a* adjacent to the roller **161** to an upper side of the upper cover **810***a*. Therefore, in case that the display device **800** is wound in an outward manner, it is possible to accommodate the movements of the plurality of convex portions **110***a***11** of the first upper cover **110***a***1** that increases at the upper side of the upper cover **810***a*. Therefore, it is possible to reduce a problem in which the display panel **120** is lifted up or the display panel **120** is creased. In sum, FIG. **8** is provided as a non-limiting example of techniques to account for the slip phenomenon, among other benefits discussed herein, for an outward-type roller **161**, whereas FIGS. **1-7** are designed for an inward-type roller **161**. The direction of rotation of the roller **161** changes which layer of the upper cover **110***a*, **810***a* is closest to the roller **161** and thus, where slip is likely to occur. In FIGS. **1-7**, the gaps d**1** . . . dn are provided between a top surface of the convex portions **110***a***11** of the first upper cover **110***a***1** and a bottom surface of the convex portions **110***a***21** of the second upper cover **110***a***2**, while in FIG. **8**, the gaps d**1** . . . dn are provided between a top surface of the convex portions **810***a***21** of the second upper cover **810***a***2** and a bottom surface of the convex portions **110***a***11** of the first upper cover **110***a***1**.

FIG. **9** is a schematic cross-sectional view of an upper cover **910***a* of a display device **900** according to one or more embodiments of the present disclosure. The upper cover **910***a* of the display device **900** in FIG. **9** is substantially identical in configuration to the upper cover **110***a* of the display device **100** in FIGS. **1** to **7**, except for only a plurality of convex portions **910***a***21** and a plurality of concave portions **910***a***22** of a second upper cover **910***a***2**. Therefore, repeated descriptions of the identical components will be omitted. For convenience of illustration, FIG. **9** illustrates only the upper cover **910***a* among various constituent elements of the display device **900**.

With reference to FIG. **9**, the second upper cover **910***a***2** includes the plurality of convex portions **910***a***21** and the plurality of concave portions **910***a***22**. The plurality of convex portions **910***a***21** and the plurality of concave portions **910***a***22** of the second upper cover **910***a***2** are respectively disposed to engage with the plurality of concave portions **110***a***12** and the plurality of convex portions **110***a***11** of the first upper cover **110***a***1**.

Meanwhile, the display device **900** according to one or more embodiments of the present disclosure may be wound in an outward manner in which the display surface of the display panel **120** is directed toward the roller **161**. Further, the display device **900** may be wound in an inward manner. Therefore, in case that the display panel **120** is wound around the roller **161**, the upper cover **910***a* may be disposed to be closer to the roller **161** than the display panel **120** to the roller **161**, or the display panel **120** may be disposed to be closer to the roller **161**.

With reference to FIG. **9**, spacing distances (d**1'**, d**2'**, . . . , dn−1', dn') between the plurality of convex portions **910***a***21** of the second upper cover **910***a***2** and the convex portion **110***a***11** of the first upper cover **110***a***1** at the lower side of the plurality of concave portions **110***a***12** of the first upper cover **110***a***1** are equal to the spacing distances (d**1**, d**2**, . . . , dn−1, and dn) between the plurality of convex portions **910***a***21** of the second upper cover **910***a***2** and the convex portion **110***a***11** of the first upper cover **110***a***1** at the upper side of the plurality of concave portions **110***a***12** of the first upper cover **110***a***1**.

Therefore, in case that the display device **900** is wound in an outward manner, the first upper cover **110***a***1** is wound with a larger radius of curvature than the second upper cover **910***a***2** wound to be adjacent to the roller **161**. Therefore, the plurality of convex portions **110***a***11** of the first upper cover **110***a***1** may be further moved downward than the plurality of concave portions **910***a***22** of the second upper cover **910***a***2**. In addition, in case that the display device **900** is wound in an inward manner, the second upper cover **910***a***2** is wound with a larger radius of curvature than the first upper cover **110***a***1** wound to be adjacent to the roller **161**. Therefore, the plurality of convex portions **910***a***21** of the second upper cover **910***a***2** may be further moved downward than the plurality of concave portions **110***a***12** of the first upper cover **110***a***1**. Therefore, the spacing distances (d**1'**, d**2'**, . . . , dn−1', dn') between the convex portion **910***a***21** of the second upper cover **910***a***2** and the convex portion **110***a***11** of the first upper cover **110***a***1** are disposed and ensured not only at the upper side of the convex portion **910***a***21** of the second upper cover **910***a***2** by way of at the lower side of the convex portion **910***a***21** of the second upper cover **910***a***2**. Therefore, it is possible to accommodate a slip of the convex portion **110***a***11** of the first upper cover **110***a***1** or a slip of the convex portion **910***a***21** of the second upper cover **910***a***2**.

With reference to FIG. **9**, the spacing distances (d**1**, d**1'**, d**2**, d**2'**, . . . , dn−1, dn−1'dn, dn') between the convex portion **910***a***21** of the second upper cover **910***a***2** and the convex portion **110***a***11** of the first upper cover **110***a***1** may increase as the distance from the roller **161** increases. Therefore, it is possible to accommodate a slip of the first upper cover **110***a***1** or a slip of the second upper cover **910***a***2** that increases as a radius between the roller **161** and the display panel **120** increases.

In the display device **900** according to one or more embodiments of the present disclosure, the upper cover **910***a* includes the first and second upper covers **110***a***1** and **910***a***2** having a small thickness. The first upper cover **110***a***1** and the second upper cover **910***a***2** are configured to engage with each other. Therefore, the upper cover may have high rigidity with respect to the thickness, thereby improving the bending of the display device **900** that may be caused by the

expansion of the polarizing plate, in comparison with the case in which the upper cover is configured as a single cover.

In addition, in the display device **900** according to one or more embodiments of the present disclosure, the first opening portion **111***a* of the first upper cover **110***a***1** and the second opening portion **111***b* of the second upper cover **910***a***2** are formed by the independent processes. Therefore, it is possible to minimize the area of the first opening portion **111***a*, the area of the second opening portion **111***b*, and the area of the opening portion **111**. Therefore, it is possible to maintain rigidity of the display device **900** and solve the problem in which the opening portion **111** is visually recognized by the user.

In addition, the display device **900** according to one or more embodiments of the present disclosure is disposed so that a difference in width between the plurality of concave portions **110***a***12** of the first upper cover **110***a***1** and the plurality of convex portions **910***a***21** of the second upper cover **910***a***2**, which correspond to one another, and a difference in width between the plurality of concave portions **910***a***22** of the second upper cover **910***a***2** and the plurality of convex portions **110***a***11** and the first upper cover **110***a***1**, which correspond to one another may increase in a direction from a lower side of the upper cover **910***a* adjacent to the roller **161** to an upper side of the upper cover **910***a*. In addition, the spacing distances (d**1**', d**2**', . . . , dn−1', dn') between the plurality of convex portions **910***a***21** of the second upper cover **910***a***2** and the convex portion **110***a***11** of the first upper cover **110***a***1** at the lower side of the plurality of concave portions **110***a***12** of the first upper cover **110***a***1** are equal to the spacing distances (d**1**, d**2**, . . . , dn−1, and dn) between the plurality of convex portions **910***a***21** of the second upper cover **910***a***2** and the convex portion **110***a***11** of the first upper cover **110***a***1** at the upper side of the plurality of concave portions **110***a***12** of the first upper cover **110***a***1**. Therefore, in case that the display device **900** is wound in an inward manner, it is possible to accommodate the movements of the plurality of convex portions **910***a***21** of the second upper cover **910***a***2** that increases at the upper side of the upper cover **910***a*. In case that the display device **900** is wound in an outward manner, it is possible to accommodate the movements of the plurality of convex portions **110***a***11** of the first upper cover **110***a***1** and reduce a problem in which the display panel **120** is lifted up or the display panel **120** is creased.

In sum, the upper cover **910***a* is similar to the upper covers **110***a*, **810***a*, described herein, except that the convex portions **910***a***21** of the second upper cover **910***a***2** are centered with respect to the concave portions **110***a***12** of the first upper cover **110***a***1** and may be spaced equidistant (or in some other arrangement) from the convex portions **110***a***11** of the first upper cover **110***a***1**. Thus, the upper cover **910***a* may be particularly beneficial for use with an inward type roller **161** or an outward type roller **161** (i.e., winding or unwinding in either a clockwise or counterclockwise direction, or both) in order to account for, and reduce, slip regardless of the direction of rotation of the roller during winding.

FIG. **10**A is an elevational view of a first upper cover **1010***a***1** of a display device **1000** according to one or more embodiments of the present disclosure. FIG. **10**B is an elevational view of a second upper cover **1010***a***2** of the display device **1000**. FIG. **10**C is a schematic elevational view of an upper cover **1010***a* of the display device **1000**. FIG. **10**D is a schematic cross-sectional view of the upper cover **1010***a* of the display device **1000**. The upper cover **1010***a* of the display device **1000** according to one or more embodiments of the present disclosure is substantially identical in configuration to the upper cover **110***a* of the display device **100** in FIGS. **1** to **7**, except for a third area A**3** of a first upper cover **1010***a***1** and a third area A**3** of a second upper cover **1010***a***2**. Therefore, repeated descriptions of the identical components will be omitted. For convenience of illustration, FIGS. **10**A to **10**D illustrate only the upper cover **1010***a* among various constituent elements of the display device **1000**.

With reference to FIG. **10**A, the first upper cover **1010***a***1** includes the first area A**1**, the second area A**2**, and the third area A**3**.

The third area A**3** of the first upper cover **1010***a***1** includes the first flexible area MA**1**. The first flexible area MA**1** of the first upper cover **1010***a***1** includes a plurality of first opening portions **1011***a*.

With reference to FIG. **10**B, the second upper cover **1010***a***2** includes the first area A**1**, the second area A**2**, and the third area A**3**.

In the third area A**3**, the second upper cover **1010***a***2** includes a plurality of second flexible areas MA**2**, and a plurality of support areas PA disposed between the plurality of second flexible areas MA**2**.

The second flexible area MA**2** of the second upper cover **1010***a***2** includes a plurality of second opening portions **1011***b*. The second flexible area MA**2** of the second upper cover **1010***a***2** is disposed to correspond to another partial area of the first flexible area MA**1** of the first upper cover **1010***a***1**, which does not overlap the plurality of support areas PA of the second upper cover **1010***a***2**, among the portions of the first upper cover **1010***a***1**. In this case, the first opening portion **1011***a* and the second opening portion **1011***b* may completely overlap each other. In the second flexible area MA**2** of the second upper cover **1010***a***2**, an object disposed rearward of the second upper cover **1010***a***2** may be visually recognized from the front surface of the first upper cover **1010***a***1** through the first opening portion **1011***a* and the second opening portion **1011***b*.

The plurality of support areas PA of the second upper cover **1010***a***2** is disposed to correspond to some of the plurality of first flexible areas MA**1** of the first upper cover **1010***a***1**.

With reference to FIGS. **10**C and **10**D, a plurality of protruding patterns **1013** may be disposed in the plurality of support areas PA of the second upper cover **1010***a***2**. The plurality of protruding patterns **1013** protrudes in the direction in which the first upper cover **1010***a***1** is disposed. The plurality of protruding patterns **1013** may be identical in shape to the first opening portion **1011***a* of the first upper cover **1010***a***1**. Meanwhile, a size of each of the plurality of protruding patterns **1013** may be smaller than a size of the plurality of first opening portions **1011***a* in the first upper cover **1010***a***1**.

With reference to FIGS. **10**C and **10**D, the plurality of protruding patterns **1013** is disposed at positions corresponding to the plurality of first opening portions **1011***a* of the first upper cover **1010***a***1**. Therefore, the plurality of protruding patterns **1013** of the second upper cover **1010***a***2** may be inserted into, and received in, the plurality of first opening portions **1011***a* of the first upper cover **1010***a***1**. Therefore, as illustrated in FIG. **10**C, in the first flexible area MA**1** of the first upper cover **1010***a***1**, top surfaces of the plurality of protruding patterns **1013** of the second upper cover **1010***a***2** may be visually recognized through the plurality of first opening portions **1011***a*.

Meanwhile, the first upper cover **1010***a***1** and the second upper cover **1010***a***2** may respectively include a plurality of concave portions **1010***a***12** and **1010***a***22** and a plurality of

convex portions **1010***a***11** and **1010***a***21**. The plurality of concave portions **1010***a***12** and the plurality of convex portions **1010***a***11** of the first upper cover **1010***a***1** may be disposed to engage with the plurality of concave portions **1010***a***22** and the plurality of convex portions **1010***a***21** of the second upper cover **1010***a***2**.

In the display device **1000** according to one or more embodiments of the present disclosure, the upper cover **1010***a* includes the first and second upper covers **1010***a***1** and **1010***a***2** having a small thickness. The first upper cover **1010***a***1** and the second upper cover **1010***a***2** are configured to engage with each other. Therefore, the upper cover may have high rigidity with respect to the thickness, thereby improving the bending of the display device **1000** that may be caused by the expansion of the polarizing plate, in comparison with the case in which the upper cover is configured as a single cover.

In addition, in the display device **1000** according to one or more embodiments of the present disclosure, the first opening portion **1011***a* of the first upper cover **1010***a***1** and the second opening portion **1011***b* of the second upper cover **1010***a***2** are formed by the independent processes. Therefore, it is possible to minimize the area of the first opening portion **1011***a* and the area of the second opening portion **1011***b*. Therefore, it is possible to maintain rigidity of the display device **1000** and solve the problem in which the first opening portion **1011***a* and the second opening portion **1011***b* are visually recognized by the user.

In addition, in the display device **1000** according to one or more embodiments of the present disclosure, the plurality of protruding patterns **1013** is disposed in the support area PA of the second upper cover **1010***a***2**. Therefore, the plurality of protruding patterns **1013** of the second upper cover **1010***a***2** is inserted into the plurality of first opening portions **1011***a* of the first upper cover **1010***a***1**, such that a coupling force between the first upper cover **1010***a***1** and the second upper cover **1010***a***2** is reinforced or increased, thereby improving overall rigidity of the upper cover **1010***a*. In other words, the plurality of protruding patterns **1013** are received in and at least partially or substantially completely fill the plurality of first opening portions **1011***a* of the first upper cover **1010***a***1** to increase rigidity, while still allowing deformation of the first opening portions **1011***a* to reduce stress. In addition, the plurality of protruding patterns **1013** protrudes in a direction in which the plurality of first opening portions **1011***a* is disposed, such that the plurality of protruding patterns **1013** is disposed while filling the plurality of first opening portions **1011***a*. In this case, a size of each of the plurality of protruding patterns **1013** may be smaller than a size of the plurality of first opening portions **1011***a*. Therefore, it is possible to inhibit the plurality of first opening portions **1011***a* from being visually recognized in the front surface of the upper cover **1010***a* and the display panel **120** and improve the flatness of the upper cover **1010***a*.

FIG. **11**A is an elevational view of a first upper cover **1110***a***1** of a display device **1100** according to one or more embodiments of the present disclosure. FIG. **11**B is an elevational view of a second upper cover **1110***a***2** of the display device **1100** according to one or more embodiments. FIG. **11**C is a schematic elevational view of an upper cover **1110***a* of the display device **1000**. FIG. **11**D is a schematic cross-sectional view of the upper cover **1110***a* of the display device **1100**. The upper cover **1110***a* of the display device **1100** according to one or more embodiments of the present disclosure is substantially identical in configuration to the upper cover **110***a* of the display device **100** in FIGS. **1** to **7**, except for a third area A**3** of a first upper cover **1110***a***1** and a third area A**3** of a second upper cover **1110***a***2**. Therefore, repeated descriptions of the identical components will be omitted. For convenience of illustration, FIGS. **11**A to **11**D illustrate only the upper cover **1110***a* among various constituent elements of the display device **1100**.

The first upper cover **1110***a***1** includes the plurality of first flexible areas MA**1** disposed in the third area A**3**, and the plurality of support areas PA disposed between the plurality of first flexible areas MA**1**.

The first flexible area MA**1** of the first upper cover **1110***a***1** includes a plurality of first opening portions **1111***a*.

The plurality of support areas PA of the first upper cover **1110***a***1** may be disposed between the plurality of second flexible areas MA**2**. The plurality of opening portions **1111***a*, which is disposed in the plurality of first flexible areas MA**1**, is not disposed in the plurality of support areas PA. Thus, the first upper cover **1110***a***1** may optionally include flexible areas MA**1** separated by support areas PA with the flexible areas MA**1** including openings **1111***a*, similar to the second upper cover **110***a***2** described above. In some embodiments, any of the features of the first cover **110***a***1** can be incorporated into the second cover **110***a***2**, and vice versa, depending on design factors.

The second upper cover **1110***a***2** includes the plurality of second flexible areas MA**2** disposed in the third area A**3**, and the plurality of support areas PA disposed between the plurality of second flexible areas MA**2**.

The second flexible area MA**2** of the second upper cover **1110***a***2** is disposed to correspond to the plurality of support areas PA of the first upper cover **1110***a***1**.

A plurality of second opening portions **1111***b* is disposed in the plurality of second flexible areas MA**2** of the second upper cover **1110***a***2**. The plurality of second opening portions **1111***b* may be identical in shape to the first opening portion **1111***a* of the first upper cover **1110***a***1**. However, the present disclosure is not limited thereto.

The plurality of support areas PA of the second upper cover **1110***a***2** is disposed to correspond to the plurality of first flexible areas MA**1** of the first upper cover **1110***a***1**.

The plurality of second opening portions **1111***b*, which is disposed in the second flexible area MA**2**, is not disposed in the support area PA of the second upper cover **1110***a***2**. Therefore, the second upper cover **1110***a***2** may support the first upper cover **1110***a***1** disposed on the front surface of the second upper cover **1110***a***2** in the support area PA.

Meanwhile, with reference to FIGS. **11**B to **11**D, a plurality of protruding patterns **1113** is disposed in the plurality of support areas PA of the second upper cover **1110***a***2**. The protruding pattern **1113** of the second upper cover **1110***a***2** may be disposed to protrude by a thickness of the first upper cover **1110***a***1**.

The protruding pattern **1113** of the second upper cover **1110***a***2** may be identical in shape to the first opening portion **1111***a*. In addition, the protruding pattern **1113** of the second upper cover **1110***a***2** may be identical in size to the first opening portion **1111***a* of the first upper cover **1110***a***1**.

Therefore, with reference to FIG. **11**D, the plurality of protruding patterns **1113** may be inserted into the plurality of first opening portions **1111***a* of the first upper cover **1110***a***1**. Therefore, as illustrated in FIG. **11**C, in the area that overlaps the plurality of support areas PA of the second upper cover **1110***a***2**, the protruding pattern **1113** of the second upper cover **1110***a***2** may be exposed through the first opening portion **1111***a* of the first upper cover **1110***a***1**. In this case, the plurality of protruding patterns **1113** may fill the plurality of first opening portions **1111***a* of the first upper cover **1110***a***1** without a separation space.

Meanwhile, with reference to FIGS. **11**C and **11**D, the second opening portion **1111***b* of the second upper cover **1110***a***2** may be supported by the plurality of support areas PA of the first upper cover **1110***a***1**. Therefore, the second opening portion **1111***b* may not be visually recognized from the front surface of the upper cover **1110***a*.

In the display device **1100** according to one or more embodiments of the present disclosure, the upper cover **1110***a* includes the first and second upper covers **1110***a***1** and **1110***a***2** having a small thickness. The first upper cover **1110***a***1** and the second upper cover **1110***a***2** are configured to engage with each other. Therefore, the upper cover may have high rigidity with respect to the thickness, thereby improving the bending of the display device **1100** that may be caused by the expansion of the polarizing plate, in comparison with the case in which the upper cover is configured as a single cover.

In addition, in the display device **1100** according to one or more embodiments of the present disclosure, the first opening portion **1111***a* of the first upper cover **1110***a***1** and the second opening portion **1111***b* of the second upper cover **1110***a***2** are formed by the independent processes. Therefore, it is possible to minimize the area of the first opening portion **1111***a* and the area of the second opening portion **1111***b*. Therefore, it is possible to maintain rigidity of the display device **1100** and solve the problem in which the first opening portion **1111***a* and the second opening portion **1111***b* are visually recognized by the user.

In addition, in the display device **1110** according to one or more embodiments of the present disclosure, the protruding pattern **1113** is disposed in the support area PA of the second upper cover **1110***a***2**. Therefore, the protruding pattern **1113** of the second upper cover **1110***a***2** is inserted into the first opening portion **1111***a* of the first upper cover **1110***a***1**, such that a coupling force between the first upper cover **1110***a***1** and the second upper cover **1110***a***2** is reinforced, thereby improving overall rigidity of the upper cover **1110***a*.

In addition, in the display device **1110** according to one or more embodiments of the present disclosure, the plurality of protruding patterns **1113** of the second upper cover **1110***a***2** may be identical in size to the plurality of first opening portions **1111***a*. Therefore, the plurality of protruding patterns **1113** fills the plurality of first opening portions **1111***a*, such that the front surface of the upper cover **1110***a* may be recognized as a flat shape without an opening area. Therefore, it is possible to improve the flatness of the upper cover **1110***a* and inhibit the plurality of first opening portions **1111***a* from being visually recognized in the front surface of the upper cover **1110***a* and the display panel **120**. Meanwhile, a top surface of the protruding pattern **1113** may adjoin the display panel **120** through the first opening portion **1111***a*. Therefore, the front surface of the upper cover **1110***a* may adjoin the display panel **120**. Therefore, a bonding area between the display panel **120** and the upper cover **1110***a* increases, which increases overall bond strength between the display panel **120** and the upper cover **1110***a* and may suppress the separation of the display panel **120** and the upper cover **1110***a*.

FIG. **12** is a schematic cross-sectional view of a second upper cover of a display device **1200** according to one or more embodiments of the present disclosure. An upper cover of a display device **1200** according to of the present disclosure is substantially identical in configuration to the upper cover **110***a* of the display device **100** in FIGS. **1** to **7**, except that a friction reduction layer **1280** is added to the second upper cover **110***a***2**. Therefore, repeated descriptions of the identical components will be omitted. For convenience of illustration, FIG. **12** illustrates only the second upper cover **110***a***2** and the friction reduction layer **1280** among various constituent elements of the display device **1200**.

The friction reduction layer **1280** may be disposed on at least one of a surface of the first upper cover **110***a***1** and a surface of the second upper cover **110***a***2** that face each other. For example, as illustrated in FIG. **12**, the friction reduction layer **1280** may be disposed on one surface of the second upper cover **110***a***2** that faces the first upper cover **110***a***1**, or the friction reduction layer **1280** may be disposed on one surface of the first upper cover **110***a***1** that faces the second upper cover **110***a***2**, or both.

The friction reduction layer **1280** may be made of a material having a low frictional coefficient. For example, the friction reduction layer **1280** may be made of a material such as Teflon. However, the present disclosure is not limited thereto. Therefore, the friction reduction layer **1280** may be disposed between the first upper cover **110***a***1** and the second upper cover **110***a***2** and reduce a frictional force in a horizontal direction between the first and second upper covers **110***a***1**, **110***a***2**.

Meanwhile, although not illustrated in FIG. **12**, the display device may further include a magnet disposed on at least one of the surface of the first upper cover **110***a***1** and the surface of the second upper cover **110***a***2** that face each other, or the magnet may be disposed on the friction reduction layer **1280** along the shape of the friction reduction layer **1280**. The magnet may attach the first upper cover **110***a***1** and the second upper cover **110***a***2** and increase a coupling force between the first upper cover **110***a***1** and the second upper cover **110***a***2** to further improve the connection between the first and second upper covers **110***a***1**, **110***a***2** and reduce separation of the first and second upper covers **110***a***1**, **110***a***2**.

In the display device **1200** according to one or more embodiments of the present disclosure, the upper cover **110***a* includes the first and second upper covers **110***a***1** and **110***a***2** having a small thickness. The first upper cover **110***a***1** and the second upper cover **110***a***2** are configured to engage with each other. Therefore, the upper cover may have high rigidity with respect to the thickness, thereby improving the bending of the display device **1200** that may be caused by the expansion of the polarizing plate, in comparison with the case in which the upper cover is configured as a single cover.

In addition, in the display device **1200** according to one or more embodiments of the present disclosure, the first opening portion **111***a* of the first upper cover **110***a***1** and the second opening portion **111***b* of the second upper cover **110***a***2** are formed by the independent processes. Therefore, it is possible to minimize the area of the opening portion **111**. Therefore, it is possible to maintain rigidity of the display device **1200** and solve the problem in which the opening portion **111** is visually recognized by the user.

In addition, in the display device **1200** according to one or more embodiments of the present disclosure, the friction reduction layer **1280** and/or the magnet are disposed between the first upper cover **110***a***1** and the second upper cover **110***a***2**. In case that the first upper cover **110***a***1** and the second upper cover **110***a***2** directly adjoin each other, friction may be generated between the first upper cover **110***a***1** and the second upper cover **110***a***2** during the winding process. For this reason, the display panel **120** may not be smoothly wound. Therefore, in the display device **1200** according to one or more embodiments of the present disclosure, the friction reduction layer **1280** and/or the magnet are disposed between the first upper cover **110***a***1** and the second upper cover **110***a***2**. Therefore, the coupling force may be main-

tained so that the first upper cover **110***a***1** and the second upper cover **110***a***2** are not separated. Further, the first upper cover **110***a***1** and the second upper cover **110***a***2** may slip without physical impact during the winding process. Therefore, in the display device **1200** according to a further embodiment of the present disclosure, it is possible to suppress a defect such as separation or cracks that may occur between the first upper cover **110***a***1** and the second upper cover **110***a***2**.

FIG. **13** is a schematic elevational view of a plate **1310***a* of a display device **1300** according to one or more embodiments of the present disclosure. FIGS. **14**A-**14**C are enlarged views of FIG. **13**. FIG. **14**A is an enlarged view of area A in FIG. **13**. FIG. **14**B is an enlarged view of area B in FIG. **13**. FIG. **14**C is an enlarged view of area C in FIG. **13**. Although not specifically illustrated, the plate **1310***a* may include a first plate **1310***a***1** and a second plate **1310***a***2** similar to the first and second upper covers **110***a***1**, **110***a***2** and other first and second covers described herein, except as otherwise noted below.

With reference to FIG. **13**, a first plate includes the plurality of support areas disposed between the plurality of first flexible areas and the plurality of first flexible areas.

The first flexible area of the first plate includes a plurality of first opening portions **1311***a*.

The plurality of support areas of the first plate is disposed between the plurality of first flexible areas. The plurality of first opening portions **1311***a*, which is disposed in the plurality of first flexible areas, is not disposed in the plurality of support areas.

A plurality of protruding patterns **1313** is disposed in the support area of a second plate. The plurality of protruding patterns **1313** is disposed to correspond to the plurality of first flexible areas of the first plate.

The plurality of protruding patterns **1313** may be disposed to protrude by a thickness of the first plate.

The plurality of protruding patterns **1313** may be inserted into the plurality of first opening portions **1311***a* of the first plate. That is, in an area that overlaps the plurality of support areas of the second plate, the protruding pattern **1313** of the second plate may be exposed through the first opening portion **1311***a* of the first plate.

When the plate **1310***a* is in a curved state, the plate **1310***a* may be curved with a radius of curvature that varies depending on positions or locations of the plate **1310***a*. For example, the radius of curvature of the plate **1310***a* may decrease in a direction from a central portion to an edge of the plate **1310***a*. However, the present disclosure is not limited thereto.

In this case, shapes, positions, intervals, sizes, and the like of the plurality of protruding patterns **1313** may be variously defined in accordance with a radius of curvature set when the curved display device **1300** is in a curved state. For example, in case that a central portion **1300**C of the display device **1300** is curved with a relatively large radius of curvature and an edge **1300**E of the display device **1300** is curved with a relatively small radius of curvature, a width of each of the plurality of protruding patterns **1313** may decrease in the direction from the central portion **1300**C to the edge **1300**E of the plate **1310***a*. Therefore, a spacing distance between the protruding pattern **1313** and a side surface of the first opening portion **1311***a* may increase in the direction from the central portion **1300**C to the edge **1300**E of the plate **1310***a*.

With reference to FIGS. **14**A and **14**B, a spacing distance d**1** between the protruding pattern **1313** and the side surface **1311**S of the first opening portion **1311***a* at the edge **1300**E of the plate **1310***a* is larger than the spacing distance d**2** between the protruding pattern **1313** and the side surface **1311**S of the first opening portion **1311***a* at the central portion **1300**C of the plate **1310***a*. In addition, with reference to FIGS. **14**B and **14**C, a spacing distance d**3** between the protruding pattern **1313** and the side surface **1311**S of the first opening portion **1311***a* at the edge **1300**E of the plate **1310***a* is larger than the spacing distance d**2** between the protruding pattern **1313** and the side surface **1311**S of the first opening portion **1311***a* at the central portion **1300**C of the plate **1310***a*.

Meanwhile, although not illustrated in FIGS. **13** to **14**C, the second plate may include a plurality of second opening portions, as described herein. The plurality of second opening portions may be identical in shape to the first opening portion **1311***a* of the first plate. However, the present disclosure is not limited thereto.

The plurality of second opening portions of the second plate may be disposed to correspond to the plurality of support areas of the first plate. Therefore, the second opening portion of the second plate disposed on the rear surfaces of the plurality of support areas of the first plate may not be visually recognized from the front surface of the plate.

In the plate **1310***a* of the display device **1300** according to one or more embodiments of the present disclosure, the plate **1310***a* includes the first and second plates and having a small thickness, and the first plate and the second plate engage with each other. Therefore, the plate **1310***a* may have high rigidity with respect to the thickness in comparison with the case in which the plate **1310***a* includes a single cover.

In addition, in the plate **1310***a* of the display device **1300** according to one or more embodiments of the present disclosure, the first opening portion **1311***a* of the first plate and the second opening portion of the second plate may be formed by independent processes, thereby minimizing the area of the first opening portion **1311***a* and the area of the second opening portion. Therefore, it is possible to maintain rigidity of the display device **1300** and solve the problem in which the first opening portion **1311***a* and the second opening portion are visually recognized by the user in the display panel disposed on the front surface of the plate **1310***a*.

In addition, in the plate **1310***a* of the display device **1300** according to one or more embodiments of the present disclosure, the protruding pattern **1313** is disposed on the second plate. Therefore, the protruding pattern **1313** of the second plate is inserted into the first opening portion **1311***a* of the first plate, such that a coupling force between the first plate and the second plate is reinforced, thereby improving overall rigidity of the plate **1310***a*.

In addition, in the plate **1310***a* of the display device **1300** according to one or more embodiments of the present disclosure, in the curved state, the spacing distance between the protruding pattern **1313** and the side surface **1311**S of the first opening portion **1311***a* varies depending on radii of curvature. For example, the plate **1310***a* is curved in a direction of a center **1300**C thereof. As a radius of curvature of the curved plate **1310***a* decreases toward the edge **1300**E of the plate **1310***a*, the first opening portion **1311***a* may contract more greatly or by a larger amount at the edge **1300**E of the plate **1310***a* relative to the center **1300**C of the plate **1310***a*. Therefore, in an area in which a radius of curvature decreases, the spacing distance between the protruding pattern **1313** and the side surface **1311**S of the first opening portion **1311***a* may increase, thereby accommodat-

ing a change of the first opening portion **1311***a* and implementing stable curved operations with different radii of curvature.

Hereinafter, non-limiting examples of the benefits and advantages of display devices **100** and **1100** according to one or more embodiments of the present disclosure will be described with reference to Table 1.

TABLE 1

	Displacement Amount (mm)
Comparative embodiment	1.2225
Embodiment 1	0.7233
Embodiment 2	0.55095

In Table 1, Comparative embodiment is an example in which a display device includes an upper cover for supporting a display panel of a display device that is a single cover, Embodiment 1 is a non-limiting example in which the display device includes the upper cover **110***a* of the display device **100** illustrated in FIGS. **1** to **7**, and Embodiment 2 is a non-limiting example in which the display device includes the upper cover **1110***a* of the display device **1100** illustrated in FIGS. **11**A to **11**D. The upper cover of the Comparative Embodiment as well as the upper covers **110***a* and **1110***a* of Examples 1 and 2 have the same overall thickness of 0.4 mm. That is, in the Comparative Embodiment, the upper cover is provided as a single layer cover having a thickness of 0.4 mm. In Embodiment 1, a thickness of the first upper cover **110***a***1** is 0.2 mm, and a thickness of the second upper cover **110***a***2** is 0.2 mm. Even in Embodiment 2, a thickness of the first upper cover **1110***a***1** is 0.2 mm, and a thickness of the second upper cover **1110***a***2** is 0.2 mm. The displacement amount in Table 1 indicates a degree or amount of displacement that occurs when a first side or end of the covers is fixed and the other, second side or end of each of the covers is moved downward under a force of 20 N applied at the other, second side of each of the covers.

With reference to Table 1, the comparison of displacement amount indicates that a bending level in Embodiment 1 was improved by 59% in comparison with the Comparative Embodiment. In addition, it can be seen that the comparison of deformation amount according to a load indicates that a bending level of Embodiment 2 was improved by 76% in comparison with Embodiment 1. Thus, the techniques described herein significantly improve bending of a flexible or rollable display while reducing slip, as shown at least by the results in Table 1.

The embodiments of the present disclosure can also be described as follows:

According to one or more embodiments of the present disclosure, a display device comprises a display panel, a cover configured to support a rear surface of the display panel, and a roller configured to wind or unwind the display panel and the cover, the cover comprises an upper cover bonded to the display panel, the upper cover comprises a first upper cover, and a second upper cover including a plurality of concave portions and a plurality of convex portions, the first upper cover is disposed between the display panel and the second upper cover, and the first upper cover is disposed to engage with the plurality of concave portions and the plurality of convex portions of the second upper cover.

The first upper cover comprises a plurality of first opening portions, and the second upper cover may comprise a plurality of second opening portions that overlaps some of the plurality of first opening portions.

The first upper cover comprises a flexible area configured to overlap the display panel and provided in which the plurality of first opening portions is disposed, and the second upper cover may comprise a plurality of flexible areas in which the plurality of second opening portions is disposed, and a plurality of support areas disposed between the plurality of flexible areas.

The second upper cover further comprises a plurality of protruding patterns disposed in the plurality of support areas, and the plurality of protruding patterns may be inserted into the plurality of first opening portions of the first upper cover.

A size of each of the plurality of protruding patterns may be smaller than a size of each of the plurality of first opening portions.

The first upper cover comprises a plurality of flexible areas in which a plurality of first opening portions is disposed; and a plurality of support areas disposed between the plurality of flexible areas, and the second upper cover may comprise a plurality of flexible areas corresponding to the plurality of support areas of the first upper cover and provided in which a plurality of second opening portions is disposed, and a plurality of support areas correspond to the plurality of flexible areas of the first upper cover.

The second upper cover further comprises a plurality of protruding patterns disposed in the plurality of support areas of the second upper cover, and the plurality of protruding patterns may be inserted into the plurality of first opening portions of the first upper cover.

A size of each of the plurality of protruding patterns may be equal to a size of each of the plurality of first opening portions.

The first upper cover comprises a plurality of concave portions and a plurality of convex portions disposed to engage with the plurality of concave portions and the plurality of convex portions of the second upper cover, a width of each of the plurality of concave portions of the first upper cover is larger than a width of each of the plurality of convex portions of the second upper cover, and a width of each of the plurality of concave portions of the second upper cover may be larger than a width of each of the plurality of convex portions of the first upper cover.

A difference between the width of each of the plurality of concave portions of the first upper cover and the width of each of the plurality of convex portions of the second upper cover, which correspond to each other, and a difference between the width of each of the plurality of concave portions of the second upper cover and the width of each of the plurality of convex portions of the first upper cover, which correspond to each other, may increase in a direction from a lower side of the upper cover adjacent to the roller to an upper side of the upper cover.

In case that the display panel is wound so that a display surface of the display panel does not face the roller, the plurality of convex portions of the second upper cover may be disposed to be closer to the convex portion of the first upper cover at a lower side of the plurality of concave portions of the first upper cover than the convex portion of the first upper cover at an upper side of the plurality of concave portions of the first upper cover.

In case that the display panel is wound so that a display surface of the display panel faces the roller, the plurality of convex portions of the second upper cover may be disposed to be closer to the convex portion of the first upper cover at an upper side of the plurality of concave portions of the first

upper cover than the convex portion of the first upper cover at a lower side of the plurality of concave portions of the first upper cover.

A spacing distance between the plurality of convex portions of the second upper cover and the convex portion of the first upper cover at a lower side of the plurality of concave portions of the first upper cover may be equal to a spacing distance between the plurality of convex portions of the second upper cover and the convex portion of the first upper cover at an upper side of the plurality of concave portions of the first upper cover.

The display device may further comprise a head bar disposed at an upper end of the upper cover and an upper end of the display panel; and a plurality of fastening members configured to fix the head bar, the upper cover, and the display panel, one of the first upper cover and the second upper cover includes fastening holes corresponding to the plurality of fastening members, and the other of the first upper cover and the second upper cover includes fastening holes corresponding to some of the plurality of fastening members.

An upper end of the second upper cover and a side surface of the second upper cover may be disposed to be spaced apart from the head bar.

The fastening hole of the other of the first upper cover and the second upper cover may have a width in an upward/downward direction larger than a width in a leftward/rightward direction.

When the display panel is in a fully unwound state, the plurality of fastening members may be disposed above or below the fastening holes of the other of the first upper cover and the second upper cover.

The display device may further comprise a friction reduction layer configured to reduce a frictional force in a horizontal direction and disposed on at least one of a surface of the first upper cover and a surface of the second upper cover that face each other.

The display device may further comprise a magnet disposed on at least one of a surface of the first upper cover and a surface of the second upper cover that face each other.

The cover may further comprise a lower cover configured to connect the upper cover and the roller.

According to an one or more embodiments of the present disclosure, a plate for a display device, the plate comprising a first plate comprising a plurality of first opening portions; and a second plate disposed on a rear surface of the first plate and including a plurality of protruding patterns, the plurality of protruding patterns of the second plate is inserted into the plurality of first opening portions of the first plate, and a spacing distance between each of the plurality of protruding patterns and a side surface of each of the plurality of first opening portions increases in a direction from a central portion to an edge of the plate.

A radius of curvature of the plate may decrease in the direction from the central portion to the edge of the plate.

Although the embodiments of the present disclosure have been described in detail with reference to the accompanying drawings, the present disclosure is not limited thereto and may be embodied in many different forms without departing from the technical concept of the present disclosure. Therefore, the embodiments of the present disclosure are provided for illustrative purposes only but not intended to limit the technical concept of the present disclosure. The scope of the technical concept of the present disclosure is not limited thereto. Therefore, it should be understood that the above-described embodiments are illustrative in all aspects and do not limit the present disclosure. The protective scope of the present disclosure should be construed based on the following claims, and all the technical concepts in the equivalent scope thereof should be construed as falling within the scope of the present disclosure.

The various embodiments described above can be combined to provide further embodiments. Aspects of the embodiments can be modified, if necessary to employ concepts of the various patents, applications and publications to provide yet further embodiments.

These and other changes can be made to the embodiments in light of the above-detailed description. In general, in the following claims, the terms used should not be construed to limit the claims to the specific embodiments disclosed in the specification and the claims, but should be construed to include all possible embodiments along with the full scope of equivalents to which such claims are entitled. Accordingly, the claims are not limited by the disclosure.

The invention claimed is:

1. A display device, comprising:
- a display panel;
- a cover disposed on the display panel; and
- a roller configured to wind or unwind the display panel and the cover,
- wherein the cover includes an upper cover coupled to the display panel,
- wherein the upper cover includes a first upper cover and a second upper cover, the second upper cover including a plurality of concave portions and a plurality of convex portions, wherein an interval between the plurality of convex portions of the second upper cover increases from a lower side of the second upper cover to an upper side of the second upper cover,
- wherein the first upper cover is disposed between the display panel and the second upper cover,
- wherein the first upper cover engages with the plurality of concave portions and the plurality of convex portions of the second upper cover, and
- wherein the increasing interval between the plurality of convex portions of the second upper cover varies a spacing between the first upper cover and the second upper cover to account for slippage while winding and unwinding the display panel and the cover about the roller,
- wherein the first upper cover includes a plurality of first opening portions disposed in a plurality of convex portions and a plurality of concave portions of the first upper cover, and the second upper cover includes a plurality of second opening portions disposed in the plurality of concave portions and the plurality of convex portions of the second upper cover.

2. The display device of claim **1**, wherein the first upper cover includes a flexible area that overlaps the display panel, and includes the plurality of first opening portions, and
- wherein the second upper cover includes a plurality of flexible areas including the plurality of second opening portions, the second upper cover further including a plurality of support areas disposed between the plurality of flexible areas.

3. The display device of claim **2**, wherein the second upper cover further includes a plurality of protruding patterns disposed in the plurality of support areas, and
- wherein the plurality of protruding patterns are received in the plurality of first opening portions of the first upper cover.

4. The display device of claim **3**, wherein a size of each of the plurality of protruding patterns of the second upper

cover is smaller than a size of each of the plurality of first opening portions of the first upper cover.

5. The display device of claim **1**, wherein the first upper cover further includes a plurality of flexible areas including the plurality of first opening portions and a plurality of support areas disposed between the plurality of flexible areas, and

wherein the second upper cover further includes a plurality of flexible areas corresponding to the plurality of support areas of the first upper cover, the plurality of flexible areas of the second upper cover including the plurality of second opening portions, the second upper cover further including a plurality of support areas corresponding to the plurality of flexible areas of the first upper cover.

6. The display device of claim **5**, wherein the second upper cover further includes a plurality of protruding patterns disposed in the plurality of support areas of the second upper cover, and

wherein the plurality of protruding patterns are received in the plurality of first opening portions of the first upper cover.

7. The display device of claim **6**, wherein a size of each of the plurality of protruding patterns is equal to a size of each of the plurality of first opening portions.

8. The display device of claim **1**, wherein the first upper cover includes a plurality of concave portions and a plurality of convex portions that interface with the plurality of concave portions and the plurality of convex portions of the second upper cover,

wherein a width of each of the plurality of concave portions of the first upper cover is larger than a width of each of the plurality of convex portions of the second upper cover, and

wherein a width of each of the plurality of concave portions of the second upper cover is larger than a width of each of the plurality of convex portions of the first upper cover.

9. The display device of claim **8**, wherein a difference between the width of each of the plurality of concave portions of the first upper cover and the width of each of the corresponding plurality of convex portions of the second upper cover and a difference between the width of each of the plurality of concave portions of the second upper cover and the width of each of the respective plurality of convex portions of the first upper cover both increase in a direction from the lower side of the upper cover adjacent to the roller to the upper side of the upper cover.

10. The display device of claim **9**, wherein the roller is configured to wind or unwind the display panel with a display surface of the display panel facing away from the roller, and the plurality of convex portions of the second upper cover is disposed to be closer to a first convex portion of the first upper cover at a lower side of the plurality of concave portions of the first upper cover than a second convex portion of the first upper cover at an upper side of the plurality of concave portions of the first upper cover.

11. The display device of claim **9**, wherein the roller is configured to wind or unwind the display panel with a display surface of the display panel facing the roller, and the plurality of convex portions of the second upper cover is disposed to be closer to a first convex portion of the first upper cover at an upper side of the plurality of concave portions of the first upper cover than a second convex portion of the first upper cover at a lower side of the plurality of concave portions of the first upper cover.

12. The display device of claim **9**, wherein a spacing distance between the plurality of convex portions of the second upper cover and the plurality of convex portions of the first upper cover at a lower side of the plurality of concave portions of the first upper cover is equal to a spacing distance between the plurality of convex portions of the second upper cover and the plurality of convex portions of the first upper cover at an upper side of the plurality of concave portions of the first upper cover.

13. The display device of claim **1**, further comprising:

a head bar disposed at an upper end of the upper cover and an upper end of the display panel; and

a plurality of fasteners configured to fix the head bar, the upper cover, and the display panel to each other,

wherein a first one of the first upper cover and the second upper cover includes fastening holes corresponding to the plurality of fasteners, and

wherein a second one of the first upper cover and the second upper cover includes fastening holes corresponding to some of the plurality of fasteners.

14. The display device of claim **13**, wherein an upper end of the second upper cover and a side surface of the second upper cover are spaced apart from the head bar.

15. The display device of claim **13**, wherein the fastening holes of the second one of the first upper cover and the second upper cover have a width in an upward and downward direction that is greater than a width in a leftward and rightward direction.

16. The display device of claim **15**, wherein in response to the display panel being in a fully unwound state, the plurality of fasteners is disposed above or below the fastening holes of the second one of the first upper cover and the second upper cover.

17. The display device of claim **1**, further comprising: a friction reduction layer disposed on at least one of a surface of the first upper cover that faces the second upper cover and a surface of the second upper cover that faces the first upper cover, the friction reduction layer configured to reduce a frictional force between the first upper cover and the second upper cover.

18. The display device of claim **1**, further comprising:

a magnet disposed on at least one of a surface of the first upper cover and a surface of the second upper cover that face each other.

19. The display device of claim **1**, wherein the cover further includes a lower cover coupled to the upper cover and to the roller.

* * * * *