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(54) **POWER STORAGE DEVICE**

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

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(57) **ABSTRACT**

A power storage device includes a plurality of power storage stacks, a case, a pressure relief valve, and a breathable membrane. The case includes a bottom wall, a peripheral wall, and a top wall. The pressure relief valve is provided on the top wall. The breathable membrane is provided at a part of the bottom wall and the peripheral wall located below the pressure relief valve.

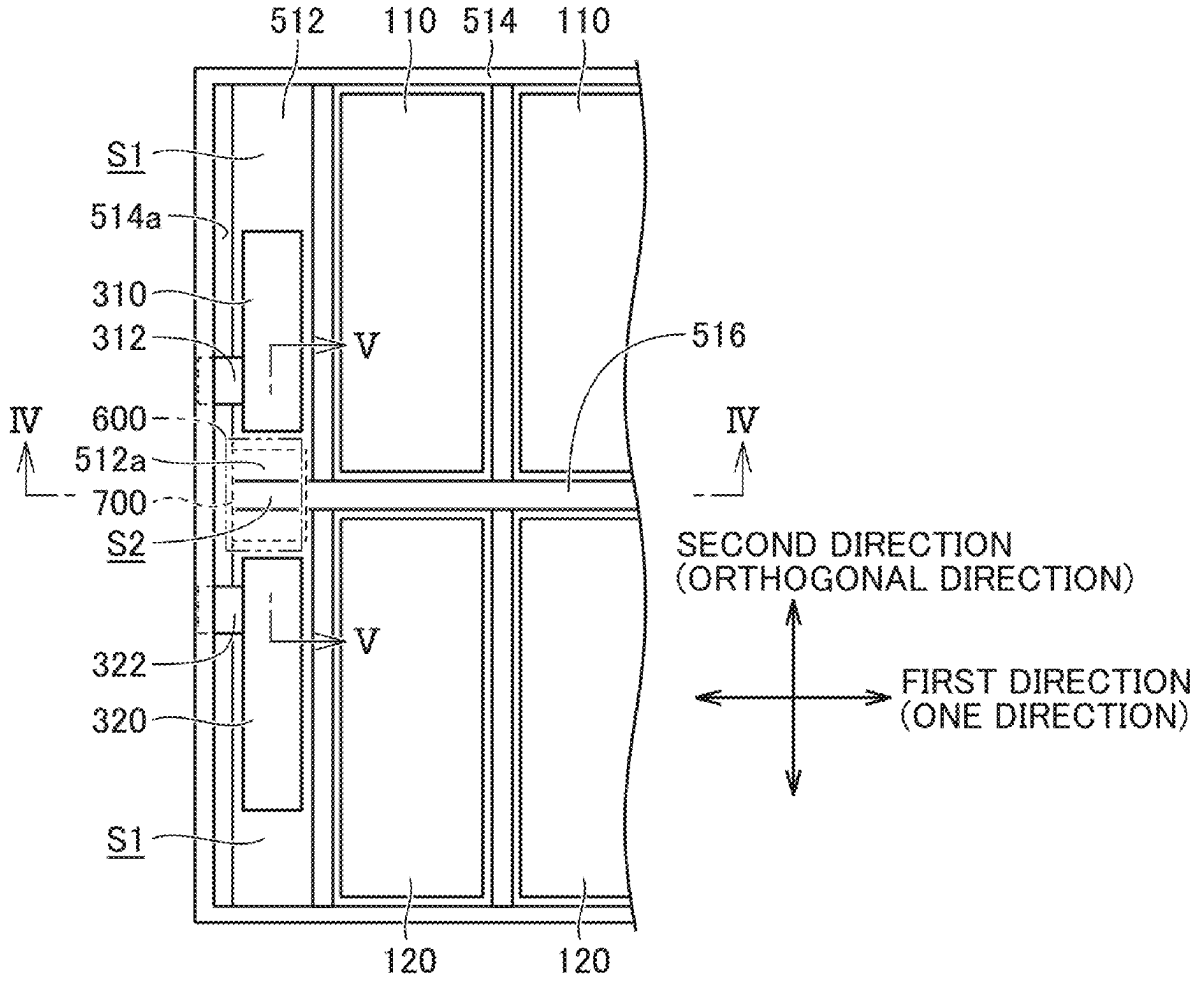


FIG.1

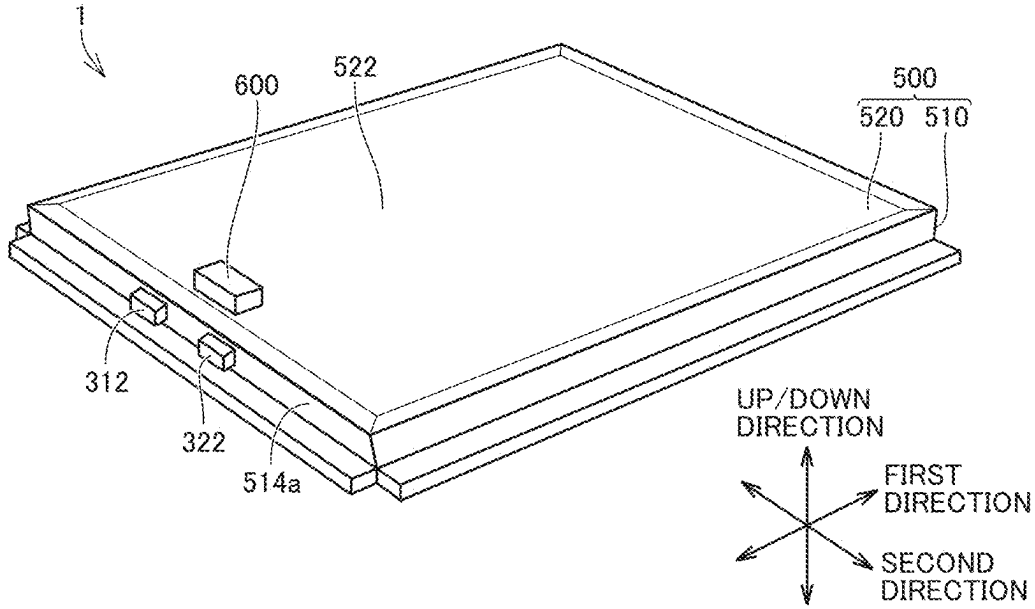

1
600
522
500
520
510
312
322
514a
UP/DOWN DIRECTION
FIRST DIRECTION
SECOND DIRECTION

FIG.2

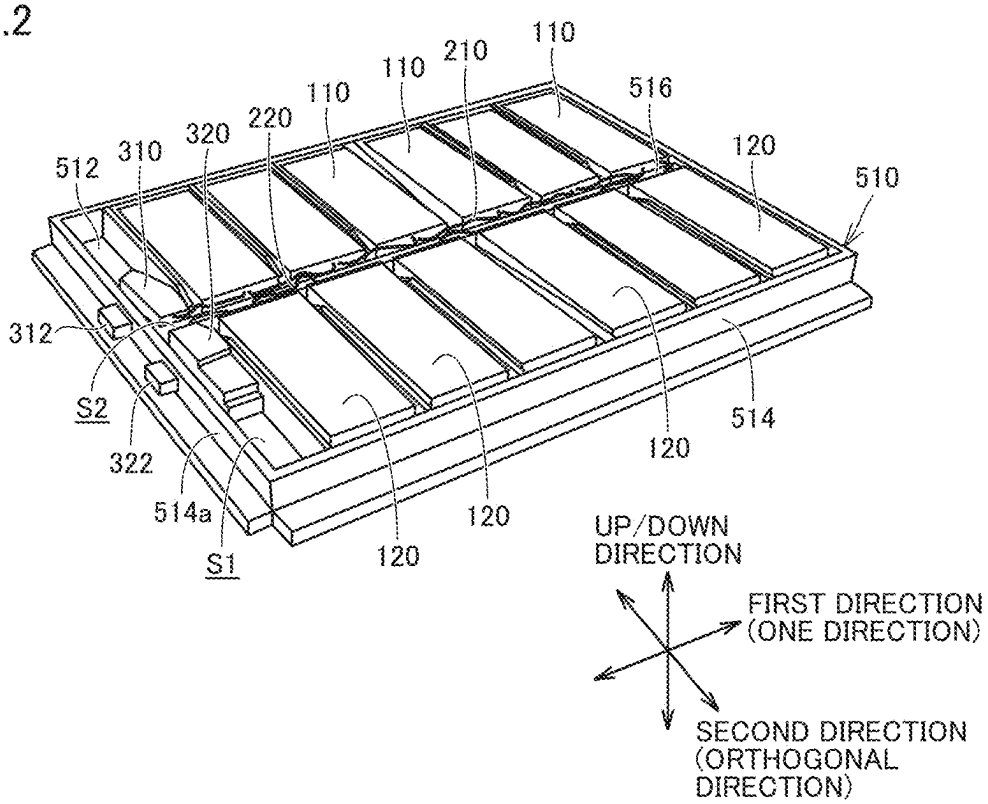

110
210
110
110
516
220
320
310
512
120
510
312
S2
322
514a
S1
120
120
120
514
UP/DOWN DIRECTION
FIRST DIRECTION (ONE DIRECTION)
SECOND DIRECTION (ORTHOGONAL DIRECTION)

FIG.3

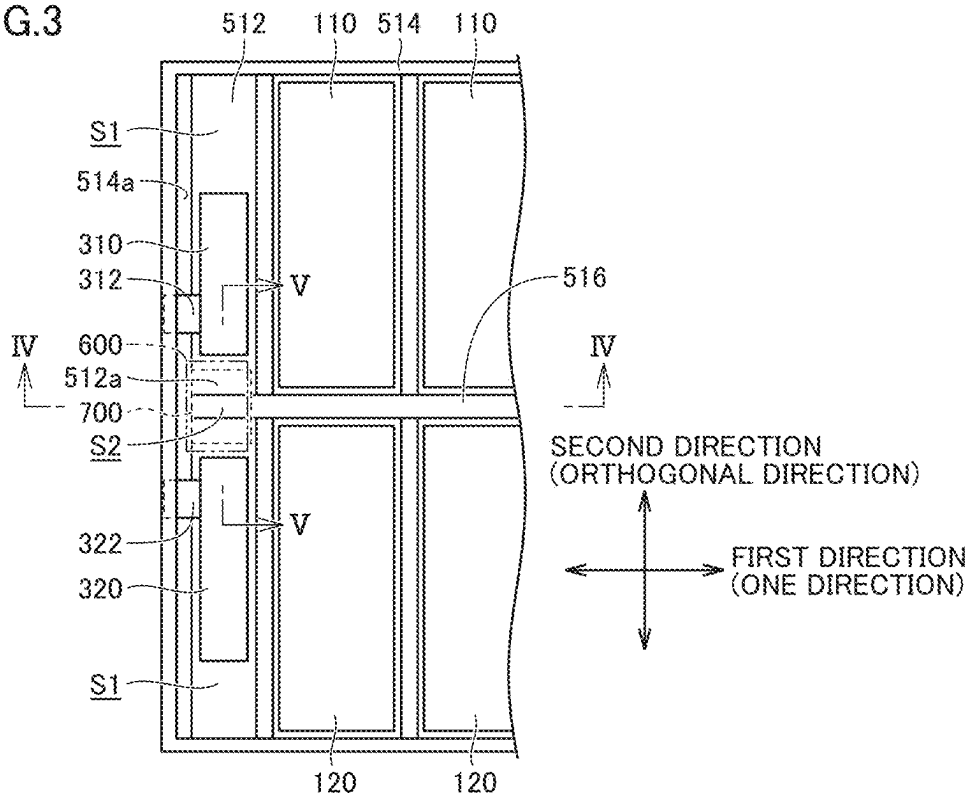

512
110
514
110
S1
514a
310
312
V
516
IV
600
512a
700
S2
IV
SECOND DIRECTION
(ORTHOGONAL DIRECTION)
V
322
320
FIRST DIRECTION
(ONE DIRECTION)
S1
120
120

FIG.4

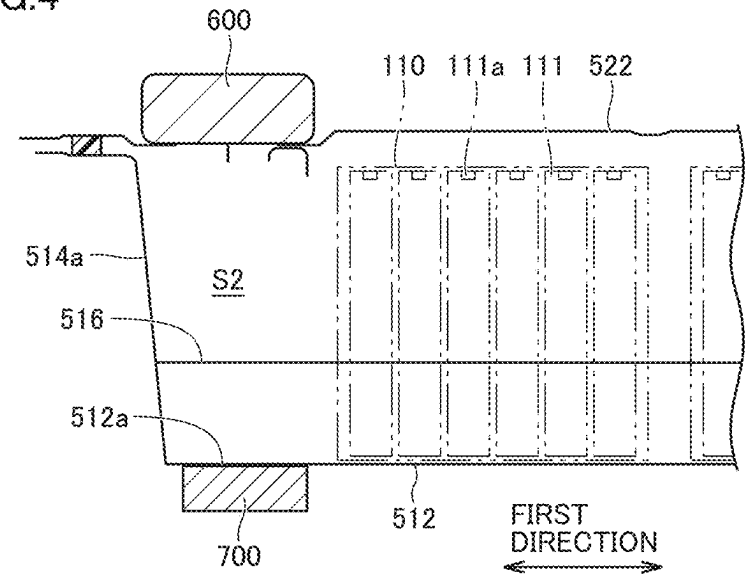

600
110
111a
111
522
514a
S2
516
512a
512
FIRST
DIRECTION
700

FIG.5

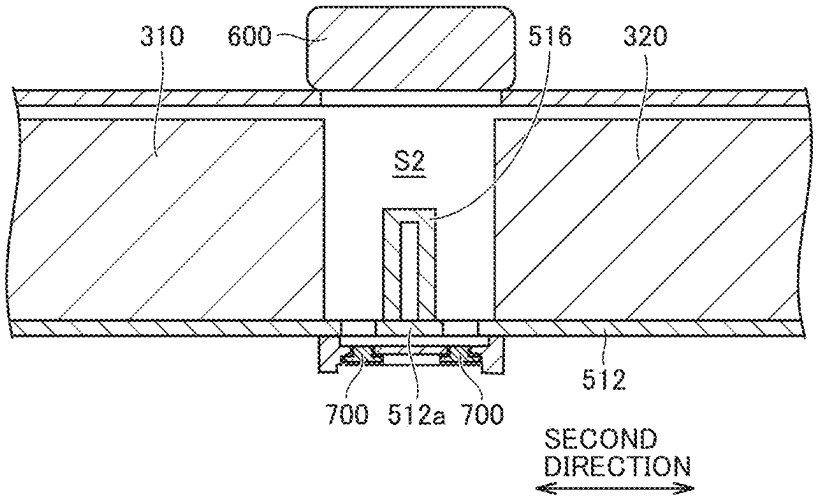

310
600
516
320
S2
512
700
512a
700
SECOND
DIRECTION

FIG.6

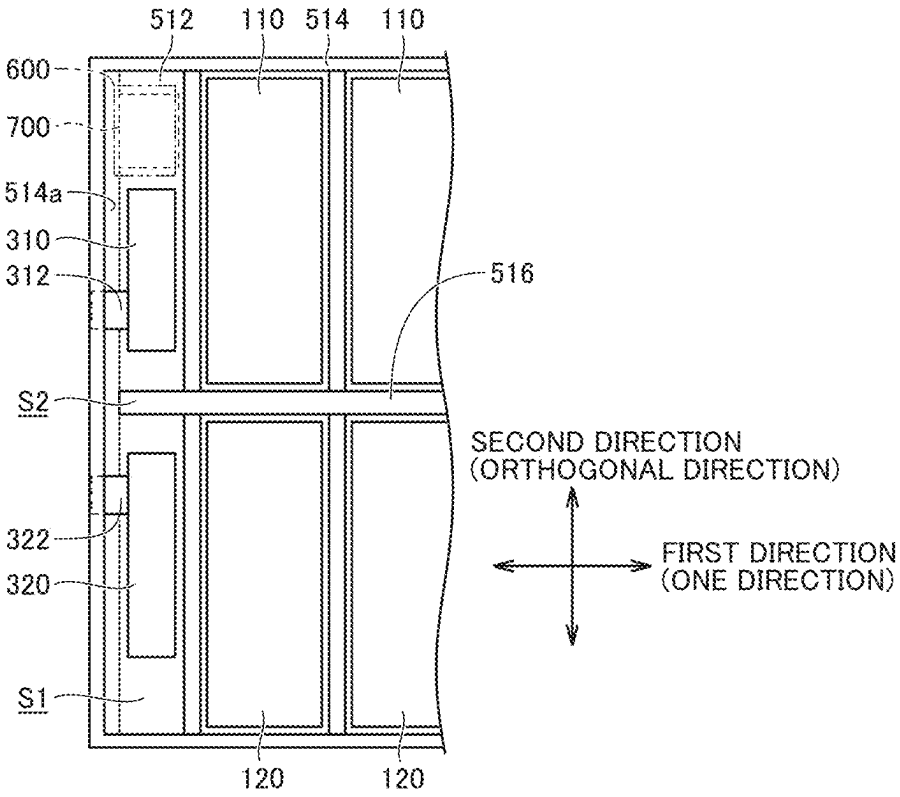

512
110
514
110
600
700
514a
310
312
516
S2
322
320
S1
120
120
SECOND DIRECTION
(ORTHOGONAL DIRECTION)
FIRST DIRECTION
(ONE DIRECTION)

FIG.7

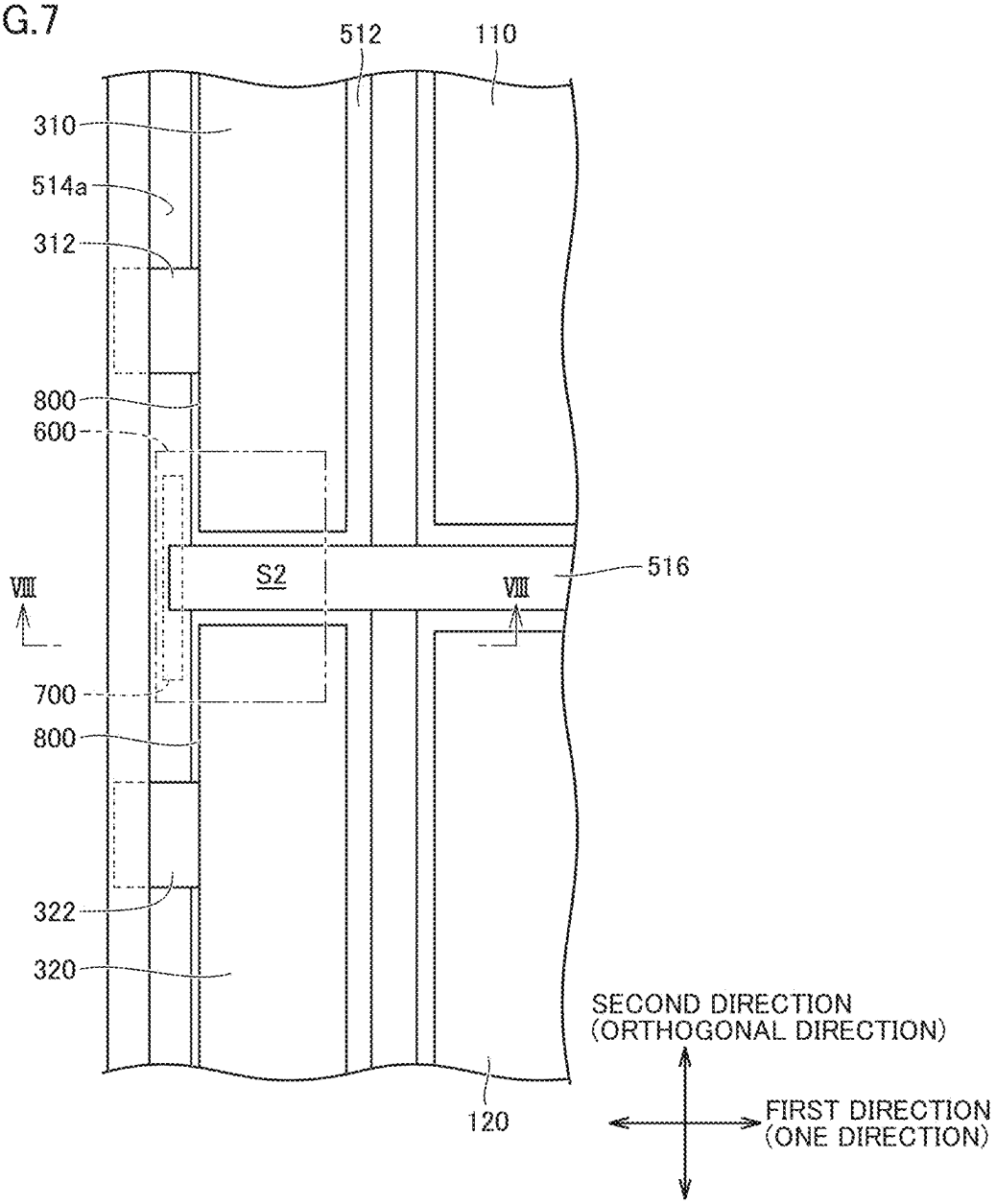

512
110
310
514a
312
800
600
S2
516
VIII
VIII
700
800
322
320
120
SECOND DIRECTION
(ORTHOGONAL DIRECTION)
FIRST DIRECTION
(ONE DIRECTION)

FIG.8

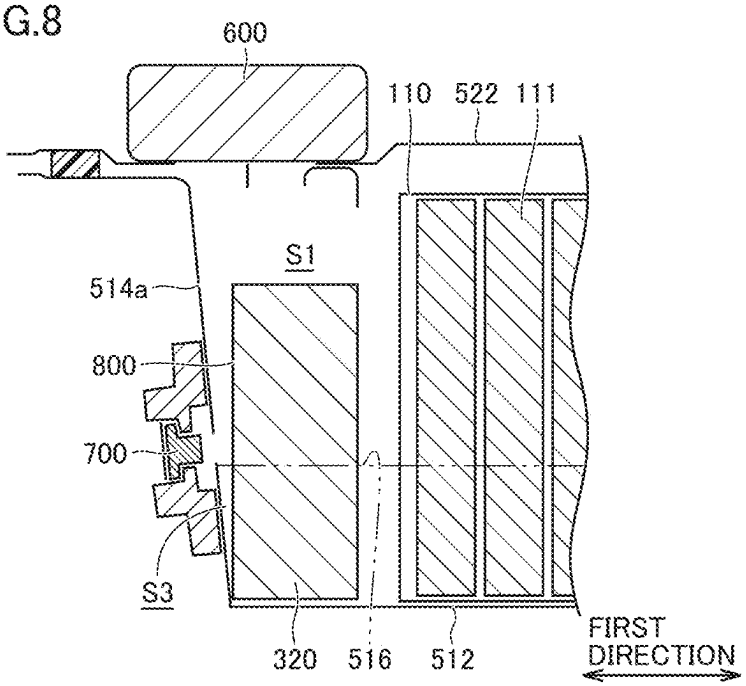
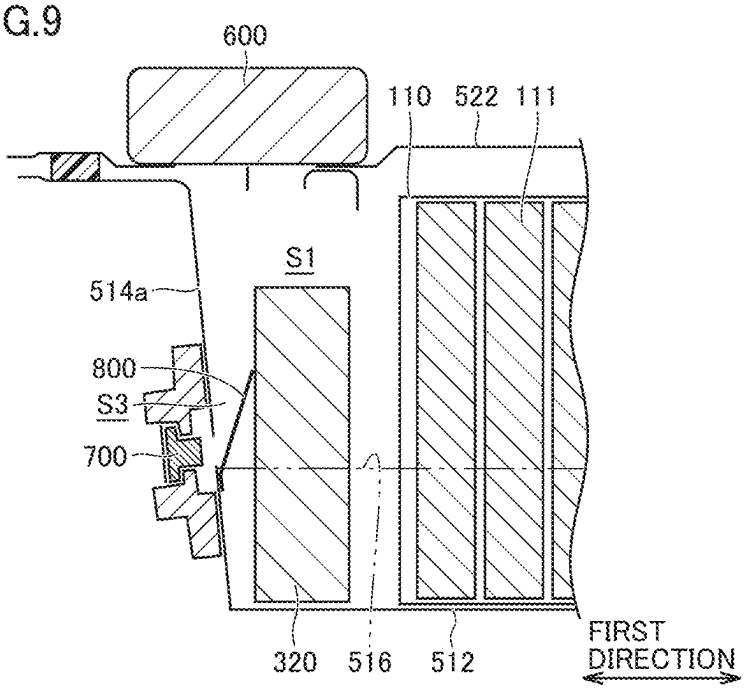

600
110
522
111
S1
514a
800
700
S3
320
516
512
FIRST
DIRECTION

FIG.9


600
110
522
111
S1
514a
800
S3
700
320
516
512
FIRST
DIRECTION

POWER STORAGE DEVICE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This nonprovisional application is based on Japanese Patent Application No. 2024-018030 filed on Feb. 8, 2024 with the Japan Patent Office, the entire contents of which are hereby incorporated by reference.

BACKGROUND

Field

[0002] The present disclosure relates to a power storage device.

Description of the Background Art

[0003] For example, Japanese Patent Laying-Open No. 2023-47012 discloses a battery pack including a plurality of battery cells, a case that accommodates the plurality of battery cells, a pressure relief valve provided to the case, and a breathable membrane provided to the case. The case has a lower case and an upper cover. The pressure relief valve is provided to the upper cover, and the breathable membrane is provided to a side wall portion of the lower case.

SUMMARY

[0004] In the battery pack described in Japanese Patent Laying-Open No. 2023-47012, when gas is generated from any of the battery cells and pressure in the case reaches a reference value, the gas is discharged through the pressure relief valve. Thereafter, air flows into the case through the breathable membrane to adjust the internal pressure in the case.

[0005] On this occasion, when a battery cell different from the battery cell that has previously generated the gas generates heat, the air flowing into the case through the breathable membrane may come into contact with that battery cell and thereby heat generation may be promoted in the case.

[0006] An object of the present disclosure is to provide a power storage device that can suppress promotion of heat generation in a case.

[0007] An object of the present disclosure is to provide a power storage device that can suppress promotion of heat generation in a case after gas is discharged through a pressure relief valve.

[0008] A power storage device according to one aspect of the present disclosure includes: a plurality of power storage stacks disposed to be arranged along one direction; a case that accommodates the plurality of power storage stacks; a pressure relief valve provided to the case; and a breathable membrane provided to the case, wherein each of the plurality of power storage stacks includes a plurality of power storage cells, the case includes a bottom wall supporting the plurality of power storage stacks, a peripheral wall surrounding the plurality of power storage stacks, and a top wall covering the plurality of power storage stacks, the pressure relief valve is provided on the top wall, and the breathable membrane is provided at a part of the bottom wall and the peripheral wall located below the pressure relief valve.

[0009] The foregoing and other objects, features, aspects and advantages of the present disclosure will become more apparent from the following detailed description of the present disclosure when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. **1** is a perspective view schematically showing a power storage device in one embodiment of the present disclosure.

[0011] FIG. **2** is a perspective view schematically showing a state in which an upper cover is removed from the power storage device shown in FIG. **1**.

[0012] FIG. **3** is a plan view schematically showing the state in which the upper cover is removed from the power storage device.

[0013] FIG. **4** is a cross sectional view taken along a line IV-IV in FIG. **3**.

[0014] FIG. **5** is a cross sectional view taken along a line V-V in FIG. **3**.

[0015] FIG. **6** is a plan view schematically showing a modification of disposition of a pressure relief valve and a breathable membrane.

[0016] FIG. **7** is a plan view schematically showing a modification of the disposition of the pressure relief valve and the breathable membrane.

[0017] FIG. **8** is a cross sectional view taken along a line VIII-VIII in FIG. **7**.

[0018] FIG. **9** is a cross sectional view schematically showing a modification of an facing plate portion.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0019] An embodiment of the present disclosure will be described with reference to the drawings. It should be noted that, in the drawings referred to below, the same or corresponding members will be designated by the same reference numerals.

[0020] FIG. **1** is a perspective view schematically showing a power storage device in one embodiment of the present disclosure. FIG. **2** is a perspective view schematically showing a state in which an upper cover is removed from the power storage device shown in FIG. **1**. FIG. **3** is a plan view schematically showing the state in which the upper cover is removed from the power storage device. FIG. **4** is a cross sectional view taken along a line IV-IV in FIG. **3**. FIG. **5** is a cross sectional view taken along a line V-V in FIG. **3**. A power storage device **1** is mounted on a bottom portion of a vehicle, for example.

[0021] As shown in FIGS. **1** to **5**, power storage device **1** includes a plurality of first power storage stacks **110**, a plurality of second power storage stacks **120**, a first bus bar **210**, a second bus bar **220**, a first junction box **310**, a second junction box **320**, a case **500**, a pressure relief valve **600**, and a breathable membrane **700**.

[0022] The plurality of first power storage stacks **110** are disposed to be arranged in a first direction. In the present embodiment, the plurality of first power storage stacks **110** include six first power storage stacks **110**. However, the number of first power storage stacks **110** is not limited to six. Each first power storage stack **110** is formed in a rectangular solid shape elongated in a second direction orthogonal to both the first direction and an up/down direction. First power storage stack **110** is an example of the "power storage stack" in the present disclosure. Further, the first direction is an

example of the "one direction" in the present disclosure, and the second direction is an example of the "orthogonal direction" in the present disclosure.

[0023] Each first power storage stack **110** includes a plurality of power storage cells **111** (see FIG. **4**). The plurality of power storage cells **111** are disposed to be arranged in the first direction, for example. It should be noted that the plurality of power storage cells **111** may be disposed to be arranged in the second direction. Each power storage cell **111** is formed in a flat rectangular solid shape. As each power storage cell **111**, a lithium ion battery may be used, for example. Each power storage cell **111** may be constituted by an all-solid-state battery using a solid electrolyte. As shown in FIG. **4**, each power storage cell **111** includes a safety valve **111***a* provided on an upper surface of a casing of power storage cell **111**.

[0024] The plurality of second power storage stacks **120** are disposed to face the plurality of first power storage stacks **110** in the second direction, and to be arranged in the first direction. In the present embodiment, the plurality of second power storage stacks **120** include six second power storage stacks **120**. However, the number of second power storage stacks **120** is not limited to six. The configuration of each second power storage stack **120** is the same as the configuration of first power storage stack **110**. Second power storage stack **120** is an example of the "other power storage stack" in the present disclosure.

[0025] First bus bar **210** connects a pair of first power storage stacks **110** adjacent to each other in the first direction. Second bus bar **220** connects a pair of second power storage stacks **120** adjacent to each other in the first direction. First bus bar **210** and second bus bar **220** are routed in a space between the plurality of first power storage stacks **110** and the plurality of second power storage stacks **120**. It should be noted that, in FIG. **3**, illustration of first bus bar **210** and second bus bar **220** is omitted.

[0026] First junction box **310** is disposed at a position facing the plurality of first power storage stacks **110** in the first direction. More specifically, first junction box **310** is disposed at a position facing first power storage stack **110** disposed on the outermost side in the first direction, of the plurality of first power storage stacks **110**, in the first direction. First junction box **310** accommodates a relay, a fuse, and the like. First junction box **310** has a first connector **312**. First connector **312** protrudes outward in the first direction.

[0027] Second junction box **320** is disposed at a position facing the plurality of second power storage stacks **120** in the first direction, and facing first junction box **310** in the second direction with a spacing therebetween. Second junction box **320** accommodates a relay, a fuse, and the like. Second junction box **320** has a second connector **322**. Second connector **322** protrudes outward in the first direction.

[0028] Case **500** accommodates the plurality of first power storage stacks **110**, the plurality of second power storage stacks **120**, first bus bar **210**, second bus bar **220**, first junction box **310**, and second junction box **320**. Case **500** includes a one-side space S**1** formed on one side of the plurality of first power storage stacks **110** and the plurality of second power storage stacks **120** in the first direction. Junction boxes **310** and **320** are disposed in one-side space S**1**. Case **500** has a lower case **510** and an upper cover **520**.

[0029] Lower case **510** is opened upward. Lower case **510** has a bottom wall **512**, a peripheral wall **514**, and a partition portion **516**.

[0030] Bottom wall **512** supports power storage stacks **110** and **120**. As shown in FIGS. **3** to **5**, bottom wall **512** includes an intermediate portion **512***a* located below an inter-box space S**2** between first junction box **310** and second junction box **320**. Inter-box space S**2** is a portion of one-side space S**1**.

[0031] Peripheral wall **514** rises from a peripheral edge portion of bottom wall **512**. Peripheral wall **514** surrounds the plurality of first power storage stacks **110** and the plurality of second power storage stacks **120**. Peripheral wall **514** is formed in a substantially rectangular tube shape.

[0032] Peripheral wall **514** includes a side wall **514***a* facing power storage stacks **110** and **120** in the first direction. Side wall **514***a* faces power storage stacks **110** and **120** in the first direction with one-side space S**1** being sandwiched therebetween. Side wall **514***a* extends along the second direction. Side wall **514***a* is inclined to be gradually spaced apart from power storage stacks **110** and **120** toward an upper side. However, side wall **514***a* may be orthogonal to bottom wall **512**.

[0033] Partition portion **516** provides a partition between the plurality of first power storage stacks **110** and the plurality of second power storage stacks **120**. Partition portion **516** has a shape extending along the first direction. The height of partition portion **516** is lower than the height of peripheral wall **514**. As shown in FIG. **2**, bus bars **210** and **220** are routed on partition portion **516**.

[0034] Upper cover **520** and lower case **510** accommodate the plurality of first power storage stacks **110**, the plurality of second power storage stacks **120**, first bus bar **210**, second bus bar **220**, first junction box **310**, and second junction box **320**. A peripheral edge portion of upper cover **520** is fixed to an upper end portion of peripheral wall **514** by bolts or the like.

[0035] Upper cover **520** has a top wall **522**. Top wall **522** faces bottom wall **512**. Top wall **522** covers the plurality of first power storage stacks **110**, the plurality of second power storage stacks **120**, first bus bar **210**, second bus bar **220**, first junction box **310**, and second junction box **320**.

[0036] Pressure relief valve **600** is provided to case **500**. Pressure relief valve **600** releases pressure in case **500**. Pressure relief valve **600** opens when the pressure in case **500** becomes equal to or higher than a reference value. Pressure relief valve **600** is constituted by a check valve. Pressure relief valve **600** is provided on top wall **522** of upper cover **520**. Pressure relief valve **600** is preferably provided at a part of top wall **522** above one-side space S**1**. In the present embodiment, pressure relief valve **600** is provided at a part of top wall **522** above inter-box space S**2**.

[0037] Breathable membrane **700** is provided to case **500**. Breathable membrane **700** regulates the pressure in case **500** by allowing passage of a gaseous body between the inside of case **500** and the outside of case **500**. Breathable membrane **700** is provided at a part of bottom wall **512** and peripheral wall **514** located below pressure relief valve **600**. In the present embodiment, breathable membrane **700** is provided on bottom wall **512**. The breathable membrane is preferably provided at a part of bottom wall **512** located below one-side space S**1**. Specifically, breathable membrane **700** is provided at intermediate portion **512***a* of bottom wall **512**. Intermediate portion **512***a* is provided with a through hole, and

breathable membrane **700** is attached to an outer surface of intermediate portion **512***a* to cover the through hole. As shown in FIGS. **3** to **5**, at least a portion of breathable membrane **700** may underlie a projection plane of pressure relief valve **600**. Entire breathable membrane **700** may underlie the projection plane of pressure relief valve **600**.

[0038] In power storage device **1** described above, for example, when gas is generated from one power storage cell **111** and the internal pressure in case **500** becomes equal to or higher than a reference value, the gas is discharged from pressure relief valve **600** to the outside of case **500**. On this occasion, a contained substance (so-called debris) in power storage cell **111** contained in the gas discharged from pressure relief valve **600** is deposited on breathable membrane **700** provided below pressure relief valve **600**, and thus breathable membrane **700** is blocked. Accordingly, inflow of air into case **500** through breathable membrane **700** after the gas is discharged through pressure relief valve **600** is suppressed. Therefore, also when power storage cell **111** different from one power storage cell **111** (for example, power storage cell **111** adjacent to one power storage cell **111**) generates heat, promotion of heat generation in case **500** caused by the inflow of the air into case **500** is suppressed.

[0039] In the following, modifications of the embodiment described above will be described.

<First Modification>

[0040] As shown in FIG. **6**, pressure relief valve **600** may be provided at a part of top wall **522** located above a space of one-side space S**1** outside junction boxes **310** and **320** in the second direction. In this case, breathable membrane **700** is preferably provided at a position where at least a portion of breathable membrane **700** underlies the projection plane of pressure relief valve **600**.

<Second Modification>

[0041] As shown in FIGS. **7** and **8**, breathable membrane **700** may be provided on side wall **514***a*. In this case, preferably, power storage device **1** further includes a facing plate portion **800**. Facing plate portion **800** is provided in case **500** and faces power storage stacks **110** and **120** in the first direction. Facing plate portion **800** forms a deposition space S**3** (see FIG. **8**) between facing plate portion **800** and side wall **514***a*. In this example, a part of each junction box **310**, **320** facing side wall **514***a* constitutes facing plate portion **800**.

[0042] In this aspect, breathable membrane **700** is blocked by deposition of the debris in deposition space S**3**.

<Third Modification>

[0043] As shown in FIG. **9**, facing plate portion **800** may be constituted by a member different from each junction box **310**, **320**. In this example, facing plate portion **800** is connected to a part of side wall **514***a* below a through hole formed at a position facing breathable membrane **700**, by welding or the like.

[0044] It will be understood by a person skilled in the art that the exemplary embodiment described above is a specific example of the following aspects.

[Aspect 1]

[0045] A power storage device comprising:

[0046] a plurality of power storage stacks disposed to be arranged along one direction;

[0047] a case that accommodates the plurality of power storage stacks;

[0048] a pressure relief valve provided to the case to release pressure in the case; and

[0049] a breathable membrane provided to the case to regulate the pressure in the case by allowing passage of a gaseous body between the inside of the case and the outside of the case, wherein

[0050] each of the plurality of power storage stacks includes a plurality of power storage cells,

[0051] the case includes

[0052] a bottom wall supporting the plurality of power storage stacks,

[0053] a peripheral wall surrounding the plurality of power storage stacks, and

[0054] a top wall covering the plurality of power storage stacks,

[0055] the pressure relief valve is provided on the top wall, and

[0056] the breathable membrane is provided at a part of the bottom wall and the peripheral wall located below the pressure relief valve.

[0057] In this power storage device, a contained substance (so-called debris) in one power storage cell contained in gas generated from the power storage cell and discharged from the pressure relief valve is deposited on the breathable membrane provided below the pressure relief valve, and thus the breathable membrane is blocked. Accordingly, inflow of air into the case through the breathable membrane after the gas is discharged through the pressure relief valve and promotion of heat generation in the case caused thereby are suppressed.

[Aspect 2]

[0058] The power storage device according to aspect 1, wherein the breathable membrane is provided on the bottom wall.

[0059] In this aspect, the debris is more effectively deposited on the breathable membrane.

[Aspect 3]

[0060] The power storage device according to aspect 2, further comprising:

[0061] a plurality of other power storage stacks disposed to face the plurality of power storage stacks in an orthogonal direction orthogonal to both the one direction and an up/down direction, and to be arranged along the one direction;

[0062] a first junction box disposed at a position facing the plurality of power storage stacks in the one direction; and

[0063] a second junction box disposed at a position facing the plurality of other power storage stacks in the one direction, and facing the first junction box in the orthogonal direction with a spacing therebetween, wherein

[0064] the bottom wall includes an intermediate portion located below a space between the first junction box and the second junction box, and

[0065] the breathable membrane is provided at the intermediate portion.

[0066] In this aspect, since the debris is deposited between the first junction box and the second junction box, that is, on the intermediate portion, blockage of the breathable membrane is further promoted.

[Aspect 4]

[0067] The power storage device according to aspect 1, further comprising a facing plate portion provided in the case and facing the plurality of power storage stacks in the one direction, wherein

[0068] the peripheral wall includes a side wall facing the plurality of power storage stacks in the one direction and inclined to be gradually spaced apart from the plurality of power storage stacks toward an upper side,

[0069] the breathable membrane is provided on the side wall, and

[0070] the facing plate portion forms a deposition space between the facing plate portion and the side wall.

[0071] In this aspect, the breathable membrane is blocked by deposition of the debris in the deposition space.

[Aspect 5]

[0072] The power storage device according to aspect 4, further comprising a junction box disposed between the plurality of power storage stacks and the side wall, wherein

[0073] the junction box includes the facing plate portion.

[0074] In this aspect, since a portion of the junction box also serves as the facing plate portion, the number of components is reduced when compared with a case where a dedicated facing plate portion is provided.

[Aspect 6]

[0075] The power storage device according to any one of aspects 1 to 5, wherein at least a portion of the breathable membrane underlies a projection plane of the pressure relief valve.

[0076] In this aspect, when the gas is discharged from the pressure relief valve, the debris dropped by impinging on the pressure relief valve is efficiently deposited on the breathable membrane.

[0077] Although the embodiment of the present disclosure has been described, it should be understood that the embodiment disclosed herein is illustrative and non-restrictive in every respect. The scope of the present disclosure is defined by the scope of the claims, and is intended to include any modifications within the scope and meaning equivalent to the scope of the claims.

What is claimed is:

1. A power storage device comprising:

a plurality of power storage stacks disposed to be arranged along one direction;

a case that accommodates the plurality of power storage stacks;

a pressure relief valve provided to the case; and

a breathable membrane provided to the case, wherein

each of the plurality of power storage stacks includes a plurality of power storage cells,

the case includes

a bottom wall supporting the plurality of power storage stacks,

a peripheral wall surrounding the plurality of power storage stacks, and

a top wall covering the plurality of power storage stacks,

the pressure relief valve is provided on the top wall, and

the breathable membrane is provided at a part of the bottom wall and the peripheral wall located below the pressure relief valve.

2. The power storage device according to claim **1**, wherein the breathable membrane is provided on the bottom wall.

3. The power storage device according to claim **2**, further comprising:

a plurality of other power storage stacks disposed to face the plurality of power storage stacks in an orthogonal direction orthogonal to both the one direction and an up/down direction, and to be arranged along the one direction;

a first junction box disposed at a position facing the plurality of power storage stacks in the one direction; and

a second junction box disposed at a position facing the plurality of other power storage stacks in the one direction, and facing the first junction box in the orthogonal direction with a spacing therebetween, wherein

the bottom wall includes an intermediate portion located below a space between the first junction box and the second junction box, and

the breathable membrane is provided at the intermediate portion.

4. The power storage device according to claim **1**, further comprising a facing plate portion provided in the case and facing the plurality of power storage stacks in the one direction, wherein

the peripheral wall includes a side wall facing the plurality of power storage stacks in the one direction and inclined to be gradually spaced apart from the plurality of power storage stacks toward an upper side,

the breathable membrane is provided on the side wall, and

the facing plate portion forms a deposition space between the facing plate portion and the side wall.

5. The power storage device according to claim **4**, further comprising a junction box disposed between the plurality of power storage stacks and the side wall, wherein

the junction box includes the facing plate portion.

6. The power storage device according to claim **1**, wherein at least a portion of the breathable membrane underlies a projection plane of the pressure relief valve.

* * * * *