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(54) **POWER STORAGE DEVICE**

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(30) **Foreign Application Priority Data**

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H01M 50/242 (2021.01)
H01M 50/209 (2021.01)

(52) **U.S. Cl.**
CPC ***H01M 50/242*** (2021.01); ***H01M 50/209*** (2021.01)

(58) **Field of Classification Search**
CPC H01M 50/242; H01M 50/209; H01M 50/293; Y02E 60/10
See application file for complete search history.

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(57) **ABSTRACT**

The power storage device includes a plurality of power storage stacks, a case, and a protective structure that protects a plurality of power storage cells from a load applied to the case in the vertical direction. The case has a bottom wall, a top wall, and a circumferential wall. The protective structure has a cross member, and a load transfer member located on the cross member. The load transfer member has at least one contact portion that is compressible and deformable in an orthogonal direction, and contacts a pair of power storage stacks adjacent to each other in the orthogonal direction when being in a compressed state.

8 Claims, 5 Drawing Sheets

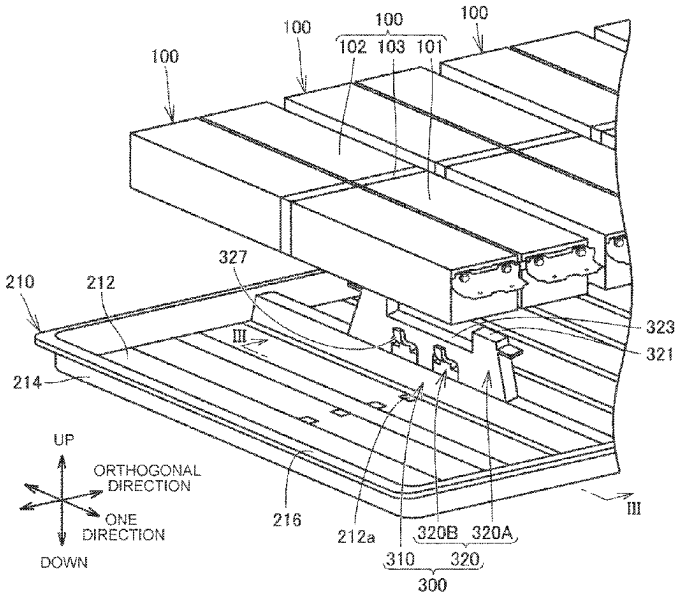
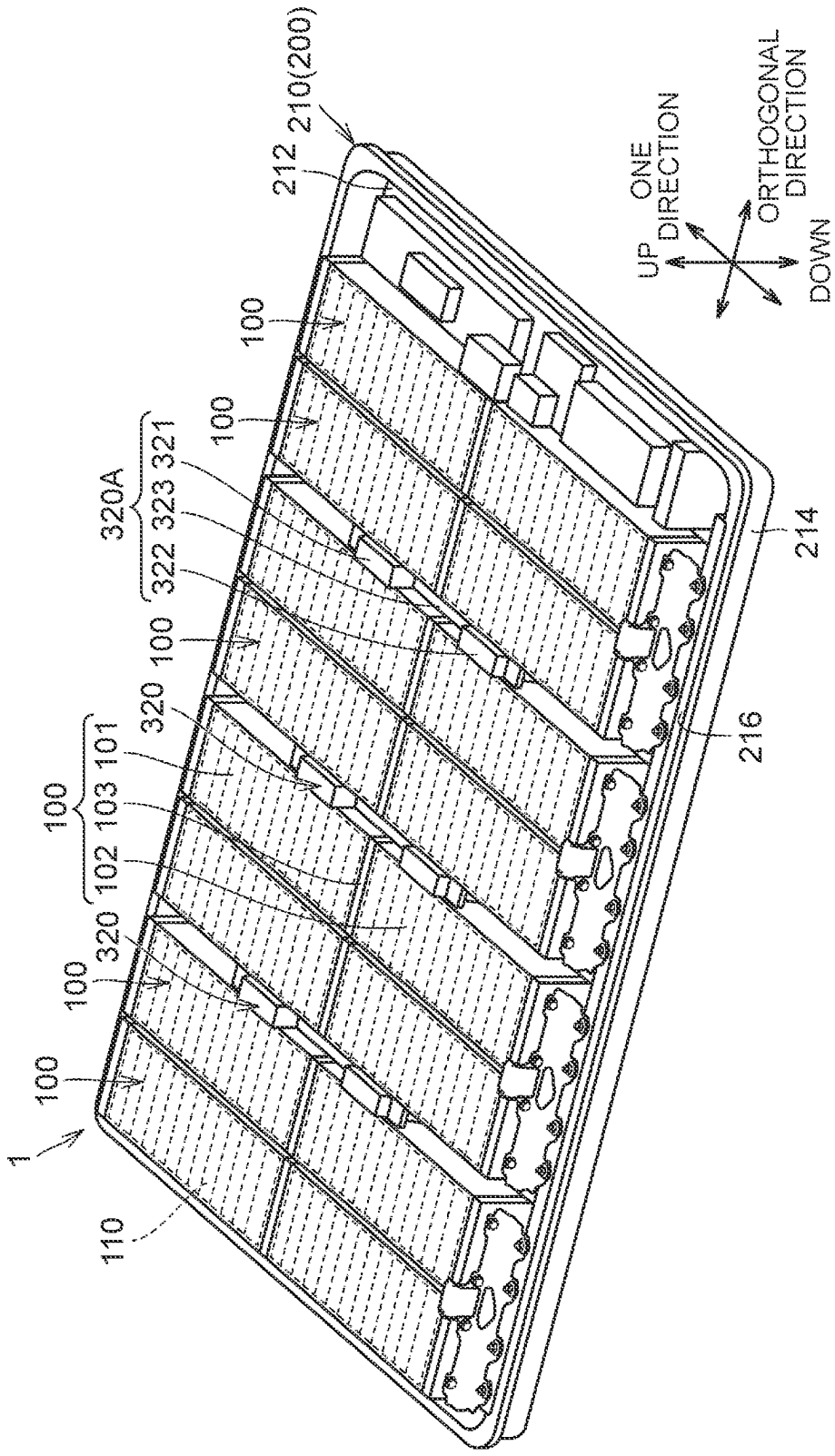


FIG. 1


1
110
100
100
100
100
100
100
100
320
320
320A
321
323
322
101
103
102
212
210(200)
214
216
ONE DIRECTION
UP
DOWN
ORTHOGONAL DIRECTION

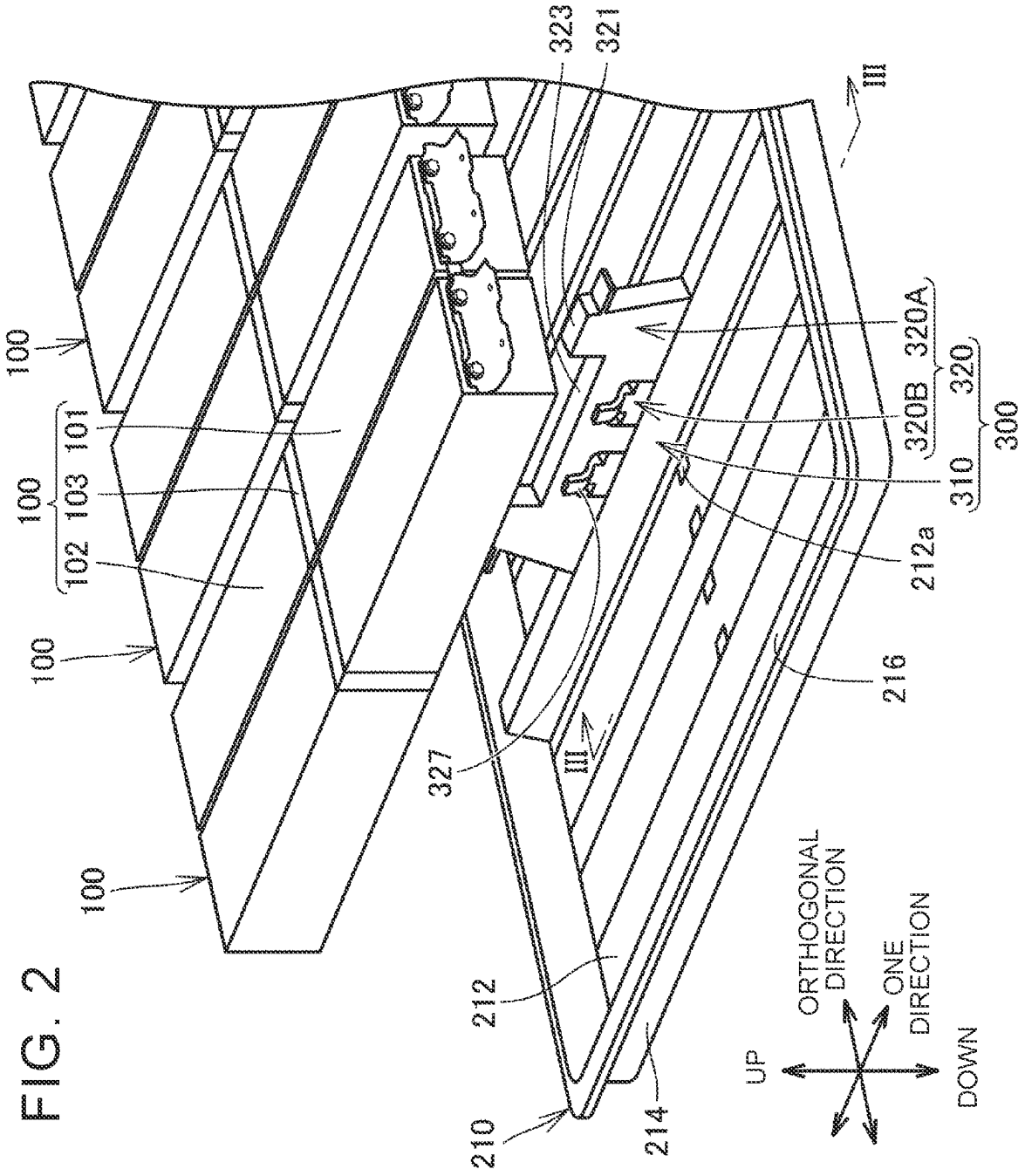
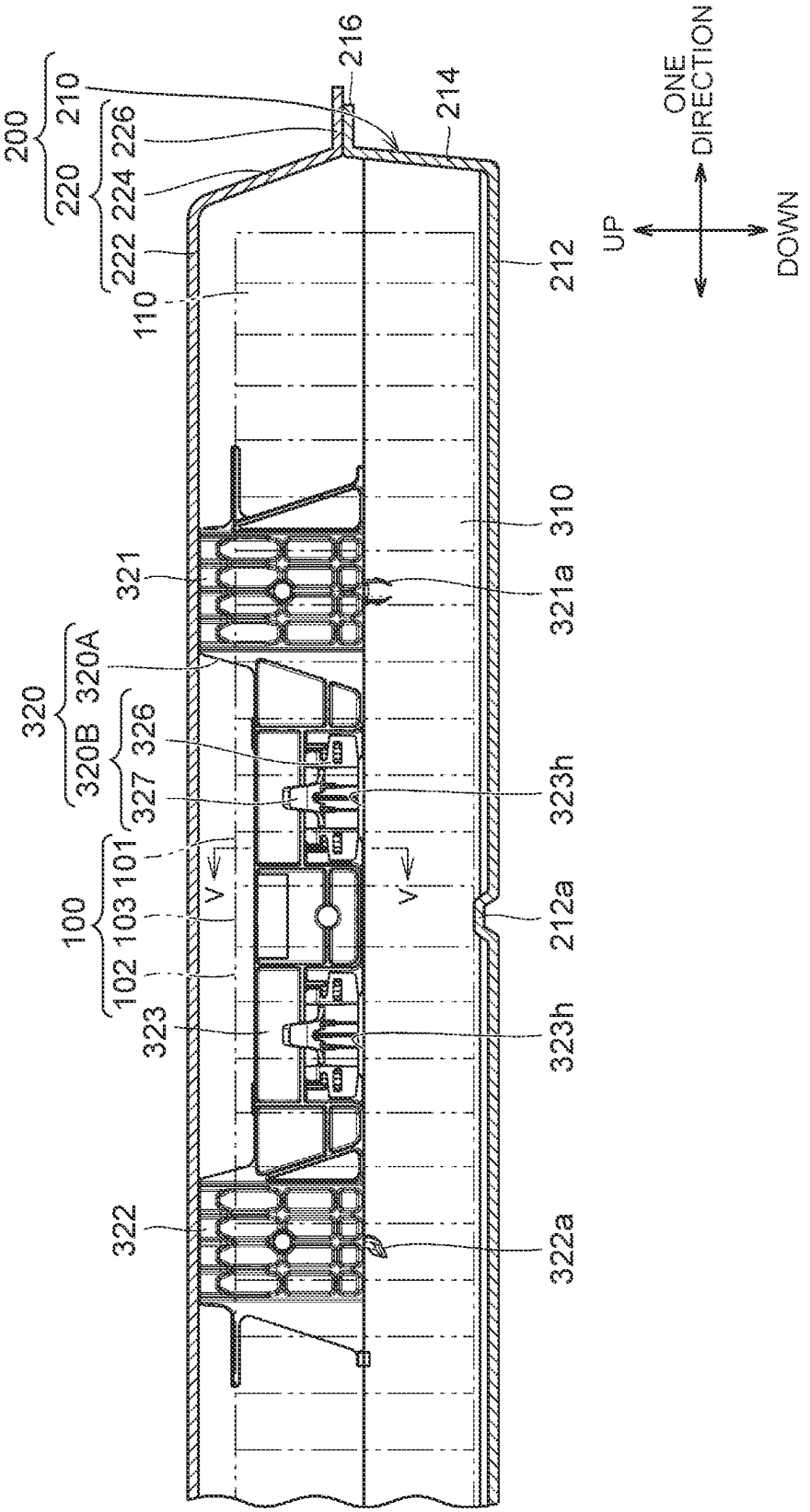

323
321
III
100
101
103
102
320A
320B
320
310
300
212a
216
327
III
212
210
214
UP
DOWN
ORTHOGONAL DIRECTION
ONE DIRECTION

FIG. 2

FIG. 3


200
210
220
226
224
222
216
214
110
212
ONE DIRECTION
UP
DOWN
310
321
321a
320
320A
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327
323h
100
101
103
102
V
V
212a
323
323h
322
322a

FIG. 4

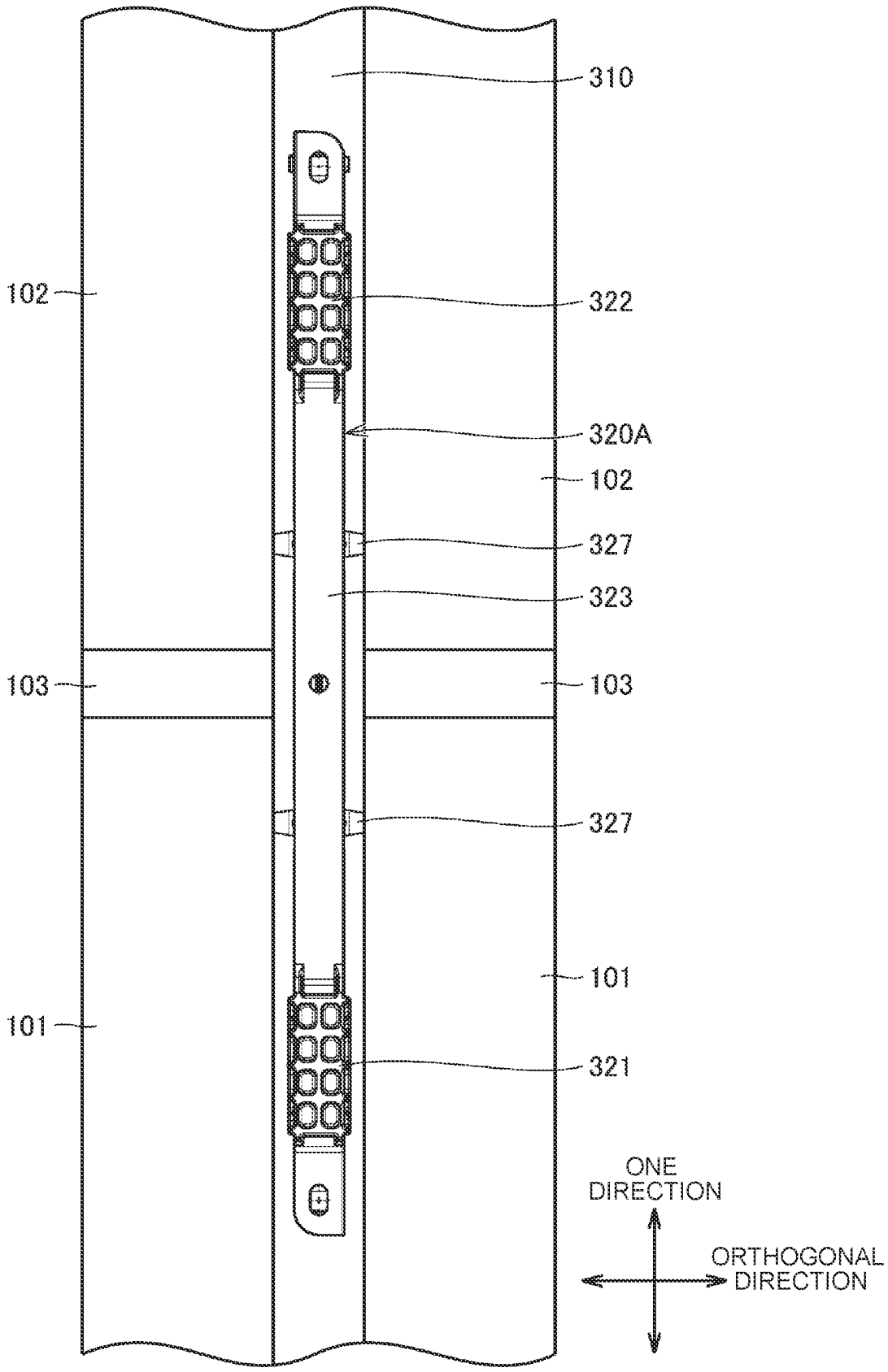
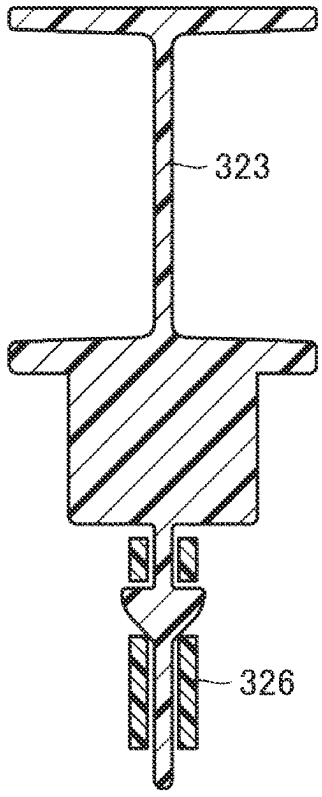

310
102
322
320A
102
327
323
103
103
327
101
101
321
ONE DIRECTION
ORTHOGONAL DIRECTION

FIG. 5



POWER STORAGE DEVICE

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to Japanese Patent Application No. 2021-155625 filed on Sep. 24, 2021, incorporated herein by reference in its entirety.

BACKGROUND

1. Technical Field

The disclosure relates to a power storage device.

2. Description of Related Art

For example, a battery unit disclosed in Japanese Unexamined Patent Application Publication No. 2014-24488 (JP 2014-24488 A) includes a battery case having a battery tray and a battery cover, a plurality of batteries located in the battery case, and battery brackets in the form of single plates fixed to the battery tray. The battery tray has a bottom wall, a plurality of ribs erected on the bottom wall, and a plurality of partition walls erected on the bottom wall.

SUMMARY

In the battery unit described in JP 2014-24488 A, there is a concern that if a load is applied to the case in the vertical direction, the load will be transferred to power storage cells.

The disclosure provides a power storage device that can protect power storage cells from a load applied to a case in the vertical direction.

A power storage device according to one aspect of the disclosure includes a plurality of power storage stacks each of which includes a plurality of power storage cells arranged in line in one direction, and which are arranged in line in an orthogonal direction orthogonal to both the one direction and a vertical direction, a case that houses the power storage stacks, a protective structure provided in the case and configured to protect the power storage cells from a load applied to the case in the vertical direction. The case has a bottom wall located below the power storage stacks, a top wall located above the power storage stacks, and a circumferential wall that is connected to the periphery of the bottom wall and the periphery of the top wall and surrounds the power storage stacks. The protective structure has a cross member and a load transfer member located on the cross member. The cross member is located on the bottom wall and between a pair of power storage stacks adjacent to each other in the orthogonal direction, and the cross member is shaped to extend in the one direction and connected to the circumferential wall. The load transfer member has at least one contact portion that is compressible and deformable in the orthogonal direction and is configured to contact the pair of power storage stacks adjacent to each other in the orthogonal direction when being in a compressed state.

According to the disclosure, the power storage device that can protect the power storage cells from the load applied to the case in the vertical direction can be provided.

BRIEF DESCRIPTION OF THE DRAWINGS

Features, advantages, and technical and industrial significance of exemplary embodiments of the disclosure will be described below with reference to the accompanying drawings, in which like signs denote like elements, and wherein:

FIG. **1** is a perspective view schematically showing the configuration of a power storage device according to one embodiment of the disclosure;

FIG. **2** is a perspective view schematically showing a condition before power storage stacks are placed in a lower case;

FIG. **3** is a cross-sectional view taken along line in FIG. **2**;

FIG. **4** is a plan view schematically showing the positional relationship between a load transfer member and middle plates; and

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

DETAILED DESCRIPTION OF EMBODIMENTS

One embodiment of the disclosure will be described with reference to the drawings. In the drawings referred to below, the same reference signs are assigned to the same or corresponding components or portions.

FIG. **1** is a perspective view schematically showing the configuration of a power storage device as one embodiment of the disclosure. The power storage device **1** is installed in a vehicle, for example.

As shown in FIG. **1** to FIG. **3**, the power storage device **1** includes a plurality of power storage stacks **100**, a case **200**, and protective structures **300**.

As shown in FIG. **1**, each of the power storage stacks **100** has a plurality of power storage cells **110** arranged in line in one direction. The power storage cells **110** are, for example, lithium-ion cells. Each power storage cell **110** is in the form of a rectangular parallelepiped. As shown in FIG. **1**, the power storage stacks **100** are arranged in line in an orthogonal direction orthogonal to both the above-indicated one direction and the vertical direction.

Each power storage stack **100** has a first unit stack **101**, a second unit stack **102**, and a middle plate **103**.

The first unit stack **101** is located on one side in the one direction. The first unit stack **101** includes power storage cells as a part of the power storage cells **110**. The first unit stack **101** may include an end plate. The end plate is located outside the outermost power storage cell **110** in the one direction.

The second unit stack **102** is located on the other side in the one direction. The second unit stack **102** includes power storage cells **110** other than the power storage cells **110** included in the first unit stack **101**, out of the plurality of power storage cells **110**. In this embodiment, the number of the power storage cells **110** included in the second unit stack **102** is the same as the number of the power storage cells **110** included in the first unit stack **101**. The second unit stack **102** may include an end plate located outside the power storage cells **110** in the one direction.

The middle plate **103** is located between the first unit stack **101** and the second unit stack **102**. The middle plate **103** is located in the middle of the power storage stack **100** in the one direction. The middle plate **103** is formed of synthetic resin, for example.

The case **200** houses the power storage stacks **100**. The case **200** has a lower case **210** and an upper case **220** (see FIG. **3**). In FIG. **1** and FIG. **2**, the upper case **220** is not illustrated.

The lower case **210** is shaped to open upward. The lower case **210** is formed of metal or synthetic resin, for example.

The lower case **210** has a bottom wall **212**, a lower surrounding wall **214**, and a lower flange **216**.

The bottom wall **212** is located below the power storage stacks **100**. As shown in FIG. **2** and FIG. **3**, raised portions **212***a* that rise upward are formed in a middle portion of the bottom wall **212** in the one direction. The top of the raised portion **212***a* is formed flat. As shown in FIG. **3**, the middle plate **103** is placed on the raised portions **212***a*.

The lower surrounding wall **214** rises from the periphery of the bottom wall **212**, and surrounds lower portions of the power storage stacks **100**.

The lower flange **216** is shaped to extend outward from the upper end portion of the lower surrounding wall **214**.

The upper case **220** is shaped to open downward. The upper case **220** cooperates with the lower case **210** to house the power storage stacks **100**. The upper case **220** is formed of metal or synthetic resin, for example. The upper case **220** has a top wall **222**, an upper surrounding wall **224**, and an upper flange **226**.

The top wall **222** is located above the power storage stacks **100**. The top wall **222** may be formed like a flat plate. A clearance is formed between the top wall **222** and each power storage stack **100**.

The upper surrounding wall **224** extends downward from the periphery of the top wall **222**, and surrounds upper portions of the power storage stacks **100**. The upper surrounding wall **224** and the lower surrounding wall **214** constitute a circumferential wall. The circumferential wall **214**, **224** connects the periphery of the bottom wall **212** with the periphery of the top wall **222**, and surrounds the power storage stacks **100**.

The upper flange **226** is shaped to extend outward from the lower end portion of the upper surrounding wall **224**. The upper flange **226** is fixed to the lower flange **216** with bolts, or the like.

The protective structures **300** are provided in the case **200** for protecting the power storage cells **110** from a load applied to the case **200** in the vertical direction. As shown in FIG. **3**, the length of the protective structure **300** measured in the vertical direction is larger than the length of the power storage cells **110** measured in the vertical direction. As shown in FIG. **4**, the protective structure **300** is located between a pair of middle plates **103** adjacent to each other in the orthogonal direction. In this embodiment, the protective structure **300** has a cross member **310** and a load transfer member **320**. The first unit stack **101**, second unit stack **102**, and middle plate **103** are indicated by two-dot chain lines in FIG. **3**, and the first unit stacks **101** and second unit stacks **102** are simply depicted in FIG. **4**. In fact, after the power storage stacks **100** are mounted to the lower case **210**, the load transfer members **320** are placed on the cross members **310**. However, FIG. **2** shows a condition before the power storage stacks **100** are housed in the lower case **210**, for convenience.

The cross member **310** is located on the bottom wall **212**. The cross member **310** extends in the one direction, and is connected to the lower surrounding wall **214**. Namely, the cross member **310** has the function of reinforcing the lower surrounding wall **214**. The cross section of the cross member **310** in the plane orthogonal to the one direction is shaped to be convex upward. In some embodiments, the upper face of the cross member **310** is formed flat. The cross member **310** is located between a pair of power storage stacks **100** adjacent to each other in the orthogonal direction. Namely, the cross member **310** provides a partition between a pair of power storage stacks **100** adjacent to each other in the orthogonal direction.

The load transfer member **320** is located on the cross member **310**. The load transfer member **320** transfers the load applied downward to the top wall **222**, to the cross member **310**. The load transfer member **320** transfers the load applied upward to the bottom wall **212**, to the top wall **222**. The load transfer member **320** is formed of synthetic resin, for example. As shown in FIG. **4**, the load transfer member **320** is located between a pair of middle plates **103** adjacent to each other in the orthogonal direction.

As shown in FIG. **2** and FIG. **3**, the load transfer member **320** has a transfer member body **320**A and a pair of positioning members **320**B. The transfer member body **320**A has a first pillar portion **321**, a second pillar portion **322**, and a connecting portion **323**.

The first pillar portion **321** is located on the cross member **310**. The upper end portion of the first pillar portion **321** may be in contact with the top wall **222**, or may be spaced apart from the top wall **222**. As shown in FIG. **3**, a first engaging portion **321***a* is provided at a lower end portion of the first pillar portion **321**, and the first engaging portion **321***a* is engaged with a first mounting hole (not shown) provided in the upper face of the cross member **310**. In FIG. **3**, the first engaging portion **321***a* is indicated by solid lines, though it should actually be indicated by broken lines.

The second pillar portion **322** is located on the cross member **310**. The second pillar portion **322** is positioned at a distance from the first pillar portion **321** in the one direction. The upper end portion of the second pillar portion **322** may be in contact with the top wall **222**, or may be spaced apart from the top wall **222**. As shown in FIG. **3**, a second engaging portion **322***a* is provided at a lower end portion of the second pillar portion **322**, and the second engaging portion **322***a* is engaged with a second mounting hole (not shown) provided in the upper face of the cross member **310**. In FIG. **3**, the second engaging portion **322***a* is indicated by solid lines, though it should actually be indicated by broken lines.

The connecting portion **323** connects the first pillar portion **321** with the second pillar portion **322**. As shown in FIG. **3** and FIG. **4**, the connecting portion **323** is located between a pair of middle plates **103** adjacent to each other in the orthogonal direction. The connecting portion **323** is provided with through-holes **323***h* that extend through the connecting portion **323** in the orthogonal direction.

Each of the positioning members **320**B is located in the corresponding through-hole **323***h* of the connecting portion **323**, and is fixed to the connecting portion **323**. Each positioning member **320**B sandwiches the transfer member body **320**A and contacts the pair of power storage stacks **100** adjacent to each other in the orthogonal direction, thereby to determine the position of the transfer member body **320**A between the power storage stacks **100**. As shown in FIG. **3**, each positioning member **320**B has a middle portion **326** and contact portions **327**.

As shown in FIG. **3** and FIG. **5**, the middle portion **326** sandwiches the connecting portion **323**.

The contact portions **327** are connected to the upper end portion of the middle portion **326**. The contact portions **327** are compressible and deformable in the orthogonal direction (the lateral direction in FIG. **4**). More specifically, the contact portion **327** is gradually directed upward in a direction away from the middle portion **326** in the orthogonal direction, and is curved to be convex downward. The contact portion **327** is cantilevered and supported by the middle portion **326**. The contact portions **327**, which are in a compressed state where they are compressed in the orthogonal direction, are in contact with the corresponding pair of

power storage stacks **100** adjacent to each other in the orthogonal direction. The contact portions **327** receive the load applied in the orthogonal direction to the circumferential wall **214**, **224**.

As described above, in the power storage device **1** of this embodiment, when a downward load is applied to the top wall **222**, the load is transferred to the bottom wall **212** via the protective structures **300**. When an upward load is applied to the bottom wall **212**, the load is transferred to the top wall **222** via the protective structures **300**. Thus, the load applied to the case **200** in the vertical direction is less likely or unlikely to be transferred to the power storage cells **110**.

Furthermore, the load transfer member **320** has the contact portions **327** that contact the corresponding pair of power storage stacks **100** when being in the compressed state; therefore, the load transfer member **320** is less likely or unlikely to be displaced relative to the power storage stacks **100** and the cross member **310** due to vibration, etc. Thus, generation of abnormal noise caused by collision of the load transfer member **320** with the power storage stacks **100** or the cross member **310** is curbed.

In addition, mounting of the load transfer member **320** to the cross member **310** is completed by inserting the first engaging portion **321***a* and second engaging portion **322***a* into the respective mounting holes of the cross member **310**. Thus, the load transfer member **320** can be easily mounted to the cross member **310**. Also, centering of the load transfer member **320** in the orthogonal direction during mounting thereof can be performed easily.

It is understood by those skilled in the art that the exemplary embodiment described above is a specific example of the following aspects.

The power storage device in the above embodiment includes a plurality of power storage stacks each of which includes a plurality of power storage cells arranged in line in one direction and which are arranged in line in an orthogonal direction orthogonal to both the one direction and a vertical direction, a case that houses the power storage stacks, and a protective structure that is provided in the case and protects the power storage cells from a load applied to the case in the vertical direction. The case has a bottom wall located below the power storage stacks, a top wall located above the power storage stacks, and a circumferential wall that is connected to the periphery of the bottom wall and the periphery of the top wall and surrounds the power storage stacks. The protective structure has a cross member and a load transfer member located on the cross member. The cross member is located on the bottom wall and between a pair of the power storage stacks adjacent to each other in the orthogonal direction, and the cross member is shaped to extend in the one direction and connected to the circumferential wall. The load transfer member has at least one contact portion that is compressible and deformable in the orthogonal direction and contacts the pair of the power storage stacks adjacent to each other in the orthogonal direction when being in a compressed state.

In the power storage device, when a downward load is applied to the top wall, the load is transferred to the bottom wall via the protective structure. When an upward load is applied to the bottom wall, the load is transferred to the top wall via the protective structure. Thus, the load applied to the case in the vertical direction is less likely or unlikely to be transferred to the power storage cells.

Furthermore, the load transfer member has the contact portion that contacts a pair of power storage stacks when being in the compressed state; therefore, the load transfer member is less likely or unlikely to be displaced relative to the power storage stacks and the cross member due to vibrations, etc. Thus, generation of abnormal noise caused by collision of the load transfer member with the power storage stacks or the cross member is curbed.

In some embodiments, the length of the protective structure measured in the vertical direction is larger than the length of the power storage stacks measured in the vertical direction.

In some embodiments, the above-indicated at least one contact portion includes a pair of contact portions positioned to be spaced apart from each other in the one direction.

In some embodiments, the load transfer member further has a first pillar portion, a second pillar portion positioned to be spaced apart from the first pillar portion in the one direction, and a connecting portion that connects the first pillar portion and the second pillar portion.

With this arrangement, the vertical load can be transferred by the first pillar portion and the second pillar portion at positions spaced apart from each other in the one direction, and, furthermore, the first pillar portion and the second pillar portion are connected by the connecting portion. This makes it easier to handle the load transfer member as compared with the case where the first pillar portion and the second pillar portion are formed as separate members.

In some embodiments, the above-indicated at least one contact portion is connected to the connecting portion.

The embodiment disclosed herein should be considered as being exemplary in all respects and not restrictive. The scope of the disclosure is defined by the claims rather than the above description of the embodiment, and includes all changes within the meaning and scope equivalent to the claims.

What is claimed is:

1. A power storage device comprising:

a plurality of power storage stacks each including a plurality of power storage cells arranged in line in one direction, the power storage stacks being arranged in line in an orthogonal direction orthogonal to both the one direction and a vertical direction;

a case that houses the power storage stacks; and

a protective structure provided in the case and configured to protect the power storage cells from a load applied to the case in the vertical direction,

wherein the case has a bottom wall located below the power storage stacks, a top wall located above the power storage stacks, and a circumferential wall that is connected to a periphery of the bottom wall and a periphery of the top wall and surrounds the power storage stacks,

wherein the protective structure has a cross member and a load transfer member located on the cross member, the cross member being located on the bottom wall and between a pair of the power storage stacks adjacent to each other in the orthogonal direction, the cross member being shaped to extend in the one direction and connected to the circumferential wall,

wherein the load transfer member has at least one contact portion that is compressible and deformable in the orthogonal direction and is configured to contact the pair of the power storage stacks adjacent to each other in the orthogonal direction when being in a compressed state, and

wherein the load transfer member further has a first pillar, a second pillar positioned to be spaced apart from the first pillar in the one direction, and a connecting portion that connects the first pillar and the second pillar.

2. The power storage device according to claim 1, wherein a length of the protective structure measured in the vertical direction is larger than a length of the power storage stacks measured in the vertical direction.

3. The power storage device according to claim 1, wherein the at least one contact portion includes a pair of contact portions positioned to be spaced apart from each other in the one direction.

4. The power storage device according to claim 1, wherein the at least one contact portion is connected to the connecting portion.

5. The power storage device according to claim 1, wherein the first pillar and the second pillar extend above the connecting portion.

6. The power storage device according to claim 1, wherein the contact portion is between the first pillar and the second pillar.

7. The power storage device according to claim 1, further comprising a positioning member supported on the cross member.

8. The power storage device according to claim 7, wherein the connecting portion has a through hole, and the positioning member is located in the through hole.

* * * * *