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POWER STORAGE DEVICE

Abstract

A power storage device includes a plurality of power storage modules, a case that accommodates the plurality of power storage modules, and a coupling bracket disposed between two of the plurality of power storage modules, which are arranged in an X direction. The case includes an upper cover that covers the plurality of power storage modules from above. The coupling bracket includes an upper surface. The upper surface of the coupling bracket is in surface contact with the upper cover.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This nonprovisional application is based on Japanese Patent Application No. 2024-018054 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] Japanese Patent Laying-Open No. 2023-046977 discloses a battery pack structure including an upper case, a lower case, and a power storage module. The power storage module includes a plurality of secondary battery cells having smoke outlets and is accommodated inside a case (the upper case and the lower case).

SUMMARY

[0004] A bracket may be disposed between power storage modules adjacent to each other, which is not described in Japanese Patent Laying-Open No. 2023-046977 mentioned above. In this case, it is assumable that debris caused by generation of smoke from a power storage module can be accumulated on the upper surface of the bracket and diffused to an adjacent power storage module. Accordingly, heat is conducted to the adjacent power storage module via the accumulated debris. This leads to generation of smoke in the adjacent power storage module as well and generation of smoke may occur in series in the power storage modules. In this case, the power storage modules adjacent to each other are brought into conduction via the smoke generated and a large-scale short circuit is caused in the power storage device.

[0005] The present disclosure has been made to solve the above-described problem and is aimed at providing a power storage device that, with a bracket disposed between power storage modules adjacent to each other, enables it to hinder conduction of heat between the power storage modules adjacent to each other.

[0006] A power storage device according to an aspect of the present disclosure includes a plurality of power storage modules, a case that accommodates the plurality of power storage modules, and a bracket disposed between two power storage modules of the plurality of power storage modules, the two power storage modules being arranged in a predetermined direction orthogonal to an up-and-down direction. The case includes an upper cover that covers the plurality of power storage modules from above. The bracket includes an upper surface. The upper surface of the bracket is in surface contact with the upper cover.

[0007] In the power storage device according to the aspect of the present disclosure, as described above, the upper surface of the bracket is in surface contact with the upper cover. Thus, it is enabled to hinder smoke generated from a power storage module from passing between the bracket and the upper cover. As a result, it is enabled to hinder accumulation of debris on the upper surface of the bracket and diffusion of the debris. Accordingly, conduction of heat between two power storage modules via debris can be hindered.

[0008] In the power storage device according to the aspect, preferably, the bracket includes a lower surface opposite to the upper surface. The lower surface of the bracket is positioned below an upper end surface of each of the two power storage modules. The foregoing configuration enables it to hinder passage of smoke under the lower surface of the bracket. As a result, conduction of heat between the two power storage modules due to smoke flowing between the two power storage modules can be hindered. Accordingly, generation of smoke can be hindered from occurring in series in the two adjacent power storage modules.

[0009] In the power storage device according to the aspect, preferably, the bracket includes a heat insulation material forming the upper surface. This configuration enables it to further hinder conduction of heat between two power storage modules, because of the heat insulation material, even when debris is slightly accumulated between the bracket and the upper cover.
[0010] In the power storage device according to the aspect, preferably, the upper cover includes a cover upper surface portion positioned so as to face the plurality of power storage modules in the up-and-down direction. The cover upper surface portion is provided with a bead portion extending along the upper surface of the bracket and formed so as to rise upward. The bead portion is in surface contact with the upper surface of the bracket. An object with a bead is higher in rigidity (flexural rigidity) than an object without any bead. Thus, the foregoing configuration enables it to hinder conduction of heat between the two power storage modules while the rigidity of the upper cover is enhanced. Further, by disposing the bracket so that the upper surface of the bracket is in surface contact of the bead portion rising upward, space for disposing the bracket under the upper cover can be easily reserved.
[0011] In this case, preferably, the case includes a lower case supporting the plurality of power storage modules from below and connected to the upper cover so that an accommodation space of the plurality of power storage modules is formed. The upper cover includes a connection portion connected to the lower case, and a coupling portion coupling the cover upper surface portion and the connection portion. At least one of the connection portion and the coupling portion is lower in rigidity than the cover upper surface portion. This configuration enables it to connect the upper cover and the lower case while the at least one of the connection portion and the coupling portion is deformed. As a result, the upper cover and the lower case can be connected easily.
[0012] In the power storage device according to the aspect, preferably, a laid material accommodated in the case is included. The case includes an inner side surface provided so as to surround the plurality of power storage modules when viewed from above. The laid material is disposed in a space between at least one of the plurality of power storage modules and the inner side surface. This configuration enables it to hinder smoke generated from a power storage module from flowing along the inner side surface of the case because of the laid material.
[0013] In the power storage device according to the aspect, preferably, each of the two power storage modules includes a side surface provided so as to face the bracket in the predetermined direction. In the predetermined direction, the bracket has a width substantially equal to a distance between the side surfaces of the two power storage modules. The foregoing configuration enables it to effectively hinder (block) passage of smoke over the bracket. The width of the bracket being substantially equal to the distance indicates that the bracket occupies most of the gap (space) between the side surfaces.
[0014] The foregoing and other objects, features, aspects, and advantages of the present disclosure will become apparent from the following detailed description of the present disclosure, which will be understood in conjunction with the accompanying drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0015] FIG. **1** is a plan view illustrating a configuration of a power storage device (a lower case and power storage modules) according to an embodiment.
[0016] FIG. **2** is a plan view illustrating a configuration of the power storage device (an upper cover) according to the embodiment.
[0017] FIG. **3** is a partial perspective view of FIG. **1** on an enlarged scale.
[0018] FIG. **4** is an exploded perspective view of the power storage module according to the embodiment.

[0019] FIG. **5** is a side view illustrating a configuration of a power storage cell according to the embodiment.
[0020] FIG. **6** is a partial perspective view on an enlarged scale, which illustrates a configuration of a coupling bracket and its vicinity according to the embodiment.
[0021] FIG. **7** is a cross sectional view along line VII-VII in FIG. **6**.
[0022] FIG. **8** is a cross sectional view along line VIII-VIII in FIG. **6**.
[0023] FIG. **9** is a cross sectional view along line IX-IX in FIG. **1**.
[0024] FIG. **10** is a cross sectional view of a coupling bracket according to a variation of the embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0025] Embodiments of the present disclosure are described in detail below with reference to the drawings. In the drawings, the same or corresponding portions are denoted by the same reference characters, which will not be described repeatedly.
[0026] FIG. **1** is a plan view illustrating a power storage device **100** according to the present embodiment. Power storage device **100** stores power for driving an electrically powered vehicle (not illustrated), for example. Power storage device **100** includes a plurality of (in the present embodiment, thirteen) power storage modules **10**, a case **20**, and a plurality of (in the present embodiment, six) coupling brackets **30**. The number of power storage modules **10** is not limited to this example. Coupling bracket **30** is an example of the "bracket" according to the present disclosure.
[0027] In power storage device **100**, two power storage modules **10** are arranged in an X direction. Six sets of two power storage modules **10** arranged in the X direction are arranged in a Y direction. One of thirteen power storage modules **10** is arranged on the Y2 side of the endmost set in the Y2 direction among the six sets. The X direction is a direction orthogonal to an up-and-down direction (a Z direction) (i.e., the X direction is a direction along a horizontal surface). The Y direction is a direction orthogonal to each of the X direction and the Z direction. The Y direction is a forward and rearward direction of the electrically powered vehicle. For example, the Y1 side and the Y2 side correspond to the front side and the rear side, respectively. The X direction and the Z direction are respective examples of the "predetermined direction" and the "up-and-down direction" according to the present disclosure.
[0028] In FIG. **1**, counterclockwise from the endmost power storage module **10** in the Y1 direction and also in the X2 direction, thirteen power storage modules **10** are respectively denoted as power storage modules **10**A, **10**B, **10**C, **10**D, **10**E, **10**F, **10**G, **10**H, **10**I, **10**J, **10**K, **10**L, and **10**M. Thus, power storage modules **10**A and **10**M are adjacent to each other in the X direction. Power storage modules **10**B and **10**L are adjacent to each other in the X direction. Power storage modules **10**C and **10**K are adjacent to each other in the X direction. Power storage modules **10**D and **10**J are adjacent to each other in the X direction. Power storage modules **10**E and **10**I are adjacent to each other in the X direction. Power storage modules **10**F and **10**H are adjacent to each other in the X direction. Power storage module **10**G is adjacent to each of power storage modules **10**F and **10**H in the Y direction while not adjacent to any other power storage module **10** in the X direction.
[0029] Case **20** accommodates the plurality of power storage modules **10**. Case **20** includes a lower case **21** and an upper cover **22** (see FIG. **2**). In FIG. **1**, upper cover **22** is not illustrated for simplification.
[0030] Lower case **21** supports the plurality of power storage modules **10** from the Z2 side (from below). Upper cover **22** (see FIG. **2**) covers the plurality of power storage modules **10** from the Z1 side (from above). Lower case **21** is connected to upper cover **22** so that an accommodation space of the plurality of power storage modules **10** is formed. Specifically, lower case **21** has a depressed shape depressed downward. Thus, lower case **21** and upper cover **22** are connected to each other and the above-mentioned accommodation space is formed accordingly.
[0031] Lower case **21** includes an edge portion **21***a* provided so as to surround the plurality of

power storage modules **10** when viewed from the Z1 side. Edge portion **21***a* is connected to an edge portion **22***b* of upper cover **22**, which is described later.

[0032] Each of the plurality of coupling brackets **30** is disposed between two power storage modules **10** arranged (adjacent to each other) in the X direction. Specifically, each of the plurality of coupling brackets **30** couples two power storage modules **10** arranged in the X direction. Thus, the distance between the two power storage modules can be made relatively small and power storage device **100** can be decreased in size. As a result, a crash stroke of power storage device **100** for a case of a collision of the electrically powered vehicle can be spared easily.

[0033] Power storage device **100** includes a busbar **40** that electrically connects power storage modules **10** arranged in the Y direction. Busbar **40** electrically connects power storage modules **10**A and **10**B. Busbar **40** electrically connects power storage modules **10**B and **10**C. Busbar **40** electrically connects power storage modules **10**C and **10**D. Busbar **40** electrically connects power storage modules **10**D and **10**E. Busbar **40** electrically connects power storage modules **10**E and **10**F. Busbar **40** electrically connects power storage modules **10**F and **10**G.

[0034] Busbar **40** electrically connects power storage modules **10**G and **10**H. Busbar **40** electrically connects power storage modules **10**H and **10**I. Busbar **40** electrically connects power storage modules **10**I and **10**J. Busbar **40** electrically connects power storage modules **10**J and **10**K. Busbar **40** electrically connects power storage modules **10**K and **10**L. Busbar **40** electrically connects power storage modules **10**L and **10**M.

[0035] Power storage device **100** includes a junction box **50** where wiring units in power storage device **100** are housed collectively. Further, power storage device **100** includes a busbar **41** that electrically connects junction box **50** and power storage module **10**A. Further, power storage device **100** includes a busbar **42** that electrically connects junction box **50** and power storage module **10**M.

[0036] Twelve busbars **40**, busbar **41**, and busbar **42** form a circuit with a path from junction box **50** via power storage modules **10**A to **10**M to junction box **50**. That is, a high-voltage circuit is made by busbars **40** to **42** and junction box **50**, running inside case **20**.

[0037] Junction box **50** is provided with a fuse **51**. Fuse **51** is blown as a result of large current flowing in the circuit. In this case, current stops flowing in the circuit. For example, when power storage module **10**A and power storage module **10**M with respective voltages that are largely different are brought into conduction by generation of smoke or the like, large current flows.

[0038] Power storage device **100** includes two protection covers **60**. Protection cover **60** is provided so as to prevent a conductive foreign substance from adhering to busbar **40** (**41**, **42**) when smoke is generated in power storage module **10**. One of two protection covers **60** is provided on the X1 side so as to cover busbars **40** (**41**) arranged in the Y direction from the Z1 side. The other of two protection covers **60** is provided on the X2 side so as to cover busbars **40** (**42**) arranged in the Y direction from the Z1 side.

[0039] FIG. **2** is a plan view of upper cover **22** viewed from the Z1 side. Upper cover **22** includes a cover upper surface portion **22***a*, edge portion **22***b*, and a coupling portion **22***c*. Cover upper surface portion **22***a* is positioned so as to face the plurality of power storage modules **10** in the Z direction. In other words, cover upper surface portion **22***a* is provided so as to cover the region where the plurality of power storage modules **10** are arranged from the Z1 side. Edge portion **22***b* forms an outer edge of upper cover **22**. By edge portion **22***b* being connected to edge portion **21***a* (see FIG. **1**) of lower case **21**, upper cover **22** is attached to lower case **21**. Coupling portion **22***c* couples cover upper surface portion **22***a* and edge portion **22***b*. When viewed from the Z1 side, coupling portion **22***c* is provided so as to surround cover upper surface portion **22***a*. That is, coupling portion **22***c* is formed so as to have a ring-like shape. Edge portion **22***b* is an example of the “connection portion” according to the present disclosure.

[0040] On cover upper surface portion **22***a*, a plurality of (in the present embodiment, five) bead portions **22***d* are formed. Each of the plurality of bead portions **22***d* is formed so as to rise toward the Z1 side. Each of the plurality of bead portions **22***d* extends along the Y direction. The plurality

of bead portions **22***d* are arranged in the X direction. One of the plurality of bead portions **22***d* (in FIG. **2**, bead portion **22***d* in the center) extends along an upper surface **33***a* of coupling bracket **30**, which is described later. Bead portion **22***d* in the center is arranged so as to cover six coupling brackets **30** arranged in the Y direction from the Z1 side. Among five bead portions **22***d*, bead portions **22***d* other than bead portion **22***d* in the center are not necessarily required to be provided on upper cover **22** (cover upper surface portion **22***a*). In addition, the number of bead portions **22***d* is not limited to the above-described example.

[0041] Upper cover **22** is provided with a pressure release valve **22***e*. When pressure in case **20** becomes higher than or equal to a threshold value owing to gas (including smoke) generated from the plurality of power storage modules **10**, pressure release valve **22***e* discharges the gas to the outside of case **20**. Pressure release valve **22***e* is provided on the Y1 side of the endmost coupling bracket **30** in the Y1 direction among six coupling brackets **30** arranged in the Y direction. The position of pressure release valve **22***e* is not limited to the above-described example.

[0042] FIG. **3** is a partial perspective view on an enlarged scale, which illustrates part of the plurality of power storage modules **10**. In FIG. **3**, junction box **50**, busbar **41**, busbar **42**, protection cover **60**, and the like are not illustrated for simplification.

[0043] Lower case **21** includes an inner side surface **21***b* provided so as to surround the plurality of power storage modules **10** when viewed from the Z1 side. Inner side surface **21***b* is positioned so as to face the plurality of power storage modules **10**. Inner side surface **21***b* is an example of the "inner side surface" according to the present disclosure.

[0044] FIG. **4** is an exploded perspective view of power storage module **10**. Power storage module **10** includes a plurality of power storage cells **1**, an upper plate **2**, a lower frame **3**, a pair of busbar frame units **4**, a pair of electrical insulation covers **5**, a pair of end plates **6**, and a pair of compression pads **7**.

[0045] Each of the plurality of power storage cells **1** is formed so as to extend in the X direction. Each of the plurality of power storage cells **1** has a shape of a prism (a shape of a rectangular prism). The plurality of power storage cells **1** are arranged in the Y direction. An end portion of each of the plurality of power storage cells **1** on the X1 side is provided with an electrode terminal **1***a* (for example, a positive electrode terminal). An end portion of each of the plurality of power storage cells **1** on the X2 side is provided with an electrode terminal **1***b* (see FIG. **5**) (for example, a negative electrode terminal).

[0046] Upper plate **2** is disposed so as to cover (close) the plurality of power storage cells **1** from the Z1 side. Upper plate **2** is provided with a gas discharge hole **2***a*. Gas generated from power storage cell **1** is discharged through gas discharge hole **2***a*.

[0047] Lower frame **3** includes a bottom plate **3***a* and a pair of side plates **3***b*. The pair of side plates **3***b* are provided so as to extend from respective end portions of bottom plate **3***a* on the Y1 side and the Y2 side to the Z1 side. Bottom plate **3***a* supports the plurality of power storage cells **1** from the Z2 side. The pair of side plates **3***b* are provided so that the plurality of power storage cells **1** are sandwiched therebetween in the Y direction.

[0048] Each of the pair of busbar frame units **4** is disposed along the plurality of power storage cells **1** so as to fix (hold) busbar **40** (**41**, **42**) attached to power storage module **10**. The pair of busbar frame units **4** are respectively disposed on the X1 side and the X2 side of the plurality of power storage cells **1**.

[0049] One of the pair of electrical insulation covers **5** is provided so as to cover busbar frame unit **4** on the X1 side from the X1 side. The other of the pair of electrical insulation covers **5** is provided so as to cover busbar frame unit **4** on the X2 side from the X2 side.

[0050] One of the pair of end plates **6** is provided so as to cover electrical insulation cover **5** on the X1 side from the X1 side. The other of the pair of end plates **6** is provided so as to cover electrical insulation cover **5** on the X2 side from the X2 side.

[0051] One of the pair of compression pads **7** is disposed so as to be sandwiched between power

storage cell **1** and side plate **3***b* on the Y1 side. The other of the pair of compression pads **7** is disposed so as to be sandwiched between power storage cell **1** and side plate **3***b* on the Y2 side. The pair of compression pads **7** compress the plurality of power storage cells **1** in the Y direction.

[0052] FIG. **5** is a side view of power storage cell **1** viewed from a side. Power storage cell **1** includes a cell body portion **1***c* and a laminate film **1***d*. Cell body portion **1***c* is wrapped in laminate film **1***d*. Laminate film **1***d* includes a welded portion **1***e* (the shaded portion in FIG. **5**) formed by welding edge portions of laminate film **1***d* together. Welded portion **1***e* is formed in respective end portions of laminate film **1***d* on the X1 side, the X2 side, and the Z1 side.

[0053] Welded portion **1***e* on the X1 side is formed so as to extend along the Z direction and has a length L**1** in the Z direction. Welded portion **1***e* on the X2 side is formed so as to extend along the Z direction and has a length L**2** in the Z direction. Welded portion **1***e* on the Z1 side is formed so as to extend along the X direction and has a length L**3** in the X direction. Length L**3** is larger than (for example, five or more times as large as) each of length L**1** and length L**2**.

[0054] FIG. **6** is a partial perspective view of coupling bracket **30** and its vicinity on an enlarged scale. Power storage device **100** includes a plurality of bolts **30***a* and a plurality of fixing jigs **70**. Coupling bracket **30** includes a pair of end portions **31**, a pair of sloping portions **32**, and a flat portion **33**. The pair of end portions **31** are provided on respective end portions of coupling bracket **30** on the Y1 side and the Y2 side. Fixing jig **70** is disposed on the Z2 side of (under) each of the pair of end portions **31** of coupling bracket **30**.

[0055] Power storage module **10** is provided with a pair of cut portions **11**. In power storage module **10**, each of the pair of cut portions **11** is provided in a corner portion that is on the Z1 side and on the coupling bracket **30** side. Power storage module **10** includes a pair of portions **12**. One and the other of the pair of portions **12** are disposed on the respective Z2 sides of one and the other of the pair of cut portions **11**. End portion **31** of coupling bracket **30** is supported from the Z2 side by respective portions **12** of two power storage modules **10** arranged in the X direction.

[0056] Two bolts **30***a* are used for each of end portions **31** of coupling bracket **30**. Each of these two bolts **30***a* is inserted in fixing jig **70** through end portion **31** of coupling bracket **30** and portion **12** of power storage module **10**. Thus, coupling bracket **30** and power storage module **10** are fastened together.

[0057] Two bolts **30***a* corresponding to each end portion **31** are arranged in the X direction. Bolt **30***a* of two bolts **30***a* arranged in the X direction that is on the X1 side couples (fastens) power storage module **10** of two power storage modules **10** arranged in the X direction that is on the X1 side and coupling bracket **30** together. Bolt **30***a* of two bolts **30***a* arranged in the X direction that is on the X2 side couples (fastens) power storage module **10** of two power storage modules **10** arranged in the X direction that is on the X2 side and coupling bracket **30** together.

[0058] One of the pair of sloping portions **32** is connected to end portion **31** on the Y1 side. The other of the pair of sloping portions **32** is connected to end portion **31** on the Y2 side. Each of the pair of sloping portions **32** is provided so as to extend from end portion **31** toward the Z1 side. Each of the pair of sloping portions **32** slopes so as to intersect each of the Z direction and the Y direction.

[0059] Flat portion **33** is situated between the pair of sloping portions **32**. Flat portion **33** connects the pair of sloping portions **32**. Flat portion **33** is provided on the Z1 side in relation to each of the pair of end portions **31**. Flat portion **33** is formed like a flat surface extending so as to be orthogonal to the Z direction. When viewed from the Z1 side, flat portion **33** has a shape of a rectangle with a shorter side extending in the X direction and a longer side extending in the Y direction.

[0060] Flat portion **33** includes an upper surface **33***a* on the Z1 side and a lower surface **33***b* on the Z2 side (see FIG. **7**). That is, lower surface **33***b* is provided so as to be opposite to upper surface **33***a*.

[0061] In the case of a conventional power storage device, it is assumable that debris caused by

generation of smoke from a power storage module can be accumulated on an upper surface of a coupling bracket and diffused to an adjacent power storage module. Accordingly, heat is conducted to the adjacent power storage module via the accumulated debris. This leads to generation of smoke in the adjacent power storage module as well and generation of smoke may occur in series in the power storage modules. In this case, the power storage modules adjacent to each other are brought into conduction via the smoke generated and a large-scale short circuit is caused in the power storage device.

[0062] In the present embodiment, as illustrated in FIG. **7**, upper surface **33***a* of coupling bracket **30** (flat portion **33**) is in surface contact with upper cover **22**. Specifically, upper surface **33***a* is entirely in (intimate) contact with upper cover **22**. That is, coupling bracket **30** is disposed so that no gap is formed between upper surface **33***a* and upper cover **22**.

[0063] In addition, in the present embodiment, lower surface **33***b* of coupling bracket **30** (flat portion **33**) is positioned on the Z2 side (below) in relation to an upper end surface **13** of each of two power storage modules **10**.

[0064] The foregoing configuration enables it to hinder (block) smoke discharged from gas discharge hole **2***a* (see FIG. **3**) provided in upper end surface **13** of power storage module **10** from passing over coupling bracket **30** (flat portion **33**). Thus, accumulation of debris on upper surface **33***a* of flat portion **33** can be hindered. In addition, passage of smoke under lower surface **33***b* of flat portion **33** can be hindered.

[0065] More specifically, upper surface **33***a* of coupling bracket **30** (flat portion **33**) is in surface contact with bead portion **22***d* of upper cover **22**. The end portion of bead portion **22***d* on the Z1 side is provided with a flat portion **22***f*. Flat portion **22***f* extends so as to be orthogonal to the Z direction. Upper surface **33***a* of coupling bracket **30** is in surface contact with flat portion **22***f* of bead portion **22***d*.

[0066] Further, coupling bracket **30** includes a heat insulation material **33***c* forming upper surface **33***a*. Specifically, flat portion **33** is constituted of heat insulation material **33***c* and a resin portion **33***d*. Heat insulation material **33***c* is formed like a sheet. Heat insulation material **33***c* is fixed (bonded) to a surface of resin portion **33***d* on the Z1 side. Heat insulation material **33***c* like a sheet is in surface contact with upper cover **22**.

[0067] The pair of end portions **31** and the pair of sloping portions **32** of coupling bracket **30** are each formed of resin similarly to resin portion **33***d*. Resin portion **33***d* may be formed integrally with the pair of sloping portions **32** and the pair of end portions **31**.

[0068] FIG. **8** is a cross sectional view along line VIII-VIII in FIG. **6**. As illustrated in FIG. **8**, upper end surface **31***a* of end portion **31** of coupling bracket **30** is positioned on the Z1 side in relation to upper end surface **13** of power storage module **10**.

[0069] Two through holes **31***b* in which bolts **30***a* are inserted are provided in end portion **31** of coupling bracket **30**. A through hole **12***a* in which bolt **30***a* is inserted is provided in portion **12** of power storage module **10**. Two insertion holes **71** in which bolts **30***a* are inserted are provided in fixing jig **70**. Bolt **30***a* is inserted in insertion hole **71** through through hole **31***b* and through hole **12***a*. Insertion hole **71** may be a through hole.

[0070] A width W**1** of coupling bracket **30** (flat portion **33**) in the X direction is smaller than a width W**2** (see FIG. **2**) of bead portion **22***d* in the X direction. More specifically, width W**1** of coupling bracket **30** is smaller than a width (not given a reference character) of flat portion **22***f* of bead portion **22***d* in the X direction.

[0071] Each of the plurality of power storage modules **10** includes a side surface **14** provided so as to face coupling bracket **30** in the X direction. Respective side surfaces **14** of two power storage modules **10** arranged in the X direction are situated away from each other by a distance D. Width W**1** of coupling bracket **30** in the X direction is substantially equal to distance D between side surfaces **14**. Coupling bracket **30** occupies most of the space between side surfaces **14**. For example, width W**1** equals 95% or more of distance D. Width W**1** may be completely equal to

distance D. In this case, respective side surfaces **14** of two power storage modules **10** are in contact with coupling bracket **30**.

[0072] FIG. **9** is a cross sectional view along line IX-IX in FIG. **1**. Power storage device **100** includes a laid material **90** accommodated in case **20**. In case **20**, two laid materials **90** (see FIG. **1**) are accommodated. Laid material **90** is formed of a foamed material for example.

[0073] Each of two laid materials **90** is disposed in a space between power storage module **10** and the inner side surface of case **20**. The inner side surface of case **20** is constituted of inner side surface **21***b* of lower case **21** and an inner side surface **22***g* of upper cover **22**. One of two laid materials **90** is disposed in the space between the inner side surface (**21***b*, **22***g*) of case **20** and each of power storage modules **10**F and **10**G (see FIG. **1**). The other of two laid materials **90** is disposed in the space between the inner side surface (**21***b*, **22***g*) of case **20** and each of power storage modules **10**G and **10**H (see FIG. **1**). Each of two laid materials **90** is in contact with both inner side surface **21***b* of lower case **21** and inner side surface **22***g* of upper cover **22**. Inner side surface **22***g* is an example of the "inner side surface" according to the present disclosure.

[0074] Each of two laid materials **90** is provided so as to be sandwiched between (compressed by) upper cover **22** (cover upper surface portion **22***a*) and a bottom surface portion **21***c* of lower case **21** in the Z direction.

[0075] In the present embodiment, edge portion **22***b* of upper cover **22**, which is connected to lower case **21**, is lower in rigidity than cover upper surface portion **22***a*. In other words, edge portion **22***b* becomes deformed more easily than cover upper surface portion **22***a*. Specifically, a thickness t**1** (a thickness in the Z direction) of edge portion **22***b* is smaller than a thickness t**2** (a thickness in the Z direction) of cover upper surface portion **22***a*.

[0076] Further, as illustrated in FIG. **9**, coupling portion **22***c* includes a first portion **22***h* extending along the Z direction, a second portion **22***i* extending along a horizontal direction, and a connection portion **22***j*. Connection portion **22***j* connects first portion **22***h* and second portion **22***i*. Connection portion **22***j* is bent.

[0077] In the present embodiment, coupling portion **22***c* is lower in rigidity than cover upper surface portion **22***a*. In other words, coupling portion **22***c* becomes deformed more easily than cover upper surface portion **22***a*. Specifically, a thickness t**3** of coupling portion **22***c* is smaller than thickness t**2** of cover upper surface portion **22***a*. In FIG. **9**, the thickness of second portion **22***i* of coupling portion **22***c* is illustrated as thickness t**2** of coupling portion **22***c*. The thickness of each of first portion **22***h* and connection portion **22***j* is equal to the thickness of second portion **22***i*. Only one or two of first portion **22***h*, second portion **22***i*, and connection portion **22***j* may have thickness t**3** smaller than thickness t**2** of cover upper surface portion **22***a*.

[0078] Power storage device **100** includes a seal member **80**. A connection portion between edge portion **21***a* of lower case **21** and edge portion **22***b* of upper cover **22** is sealed with seal member **80**. Seal member **80** has a shape of a flange (a shape of a ring). Seal member **80** is formed of resin, such as rubber.

[0079] As described above, in the present embodiment, upper surface **33***a* of coupling bracket **30** is in surface contact with upper cover **22**. Thus, it is enabled to hinder smoke discharged from power storage module **10** from passing over coupling bracket **30**. Accordingly, diffusion of debris between power storage modules **10** arranged in the X direction can be hindered. As a result, conduction of heat between power storage modules **10** can be hindered and generation of smoke can be hindered from occurring in series among power storage modules **10**.

[0080] In addition, in the present embodiment, lower surface **33***b* of coupling bracket **30** is positioned below upper end surface **13** of power storage module **10**. Thus, it is enabled to hinder smoke discharged from gas discharge hole **2***a* provided in upper end surface **13** of power storage module **10** from passing under coupling bracket **30**. Accordingly, conduction of heat between two power storage modules **10** caused by passage of smoke between two power storage modules **10** can be hindered. Moreover, since accumulation (adhesion) of debris under coupling bracket **30** can be

hindered, conduction of heat between two power storage modules **10** can be further hindered.
[0081] Moreover, in the present embodiment, coupling bracket **30** includes heat insulation material **33***c* forming upper surface **33***a*. Thus, conduction of heat between two power storage modules **10** via coupling bracket **30** can be hindered by heat insulation material **33***c*.
[0082] Although the present embodiment shows an example in which lower surface **33***b* of coupling bracket **30** is positioned below upper end surface **13** of power storage module **10**, the present disclosure is not limited to this example. The lower surface of the coupling bracket may be positioned above upper end surface **13** of power storage module **10**. For example, as illustrated in FIG. **10**, a lower surface **133***b* of a coupling bracket **130** (a resin portion **133***d* of a flat portion **133**) is positioned on the Z1 side (above) in relation to upper end surface **13**. Coupling bracket **130** is an example of the "bracket" according to the present disclosure.
[0083] Although the present embodiment shows an example in which coupling bracket **30** couples two power storage modules **10**, the present disclosure is not limited to this example. A bracket not coupled to each power storage module **10** may just be disposed between two power storage modules **10**.
[0084] Although the present embodiment shows an example in which two power storage modules **10** are arranged in the X direction, the present disclosure is not limited to this example. Three or more power storage modules **10** may be arranged in the X direction.
[0085] Although the present embodiment shows an example in which upper surface **33***a* of coupling bracket **30** is formed by heat insulation material **33***c*, the present disclosure is not limited to this example. For example, coupling bracket **30** is not necessarily required to be provided with heat insulation material **33***c*. Instead of heat insulation material **33***c*, an adhesive material may be provided.
[0086] Although the present embodiment shows an example in which bead portion **22***d* of upper cover **22** is in surface contact with upper surface **33***a* of coupling bracket **30**, the present disclosure is not limited to this example. Upper surface **33***a* of coupling bracket **30** may be in surface contact with a portion of cover upper surface portion **22***a*, where bead portion **22***d* is not formed.
[0087] Although the present embodiment shows an example in which thickness t**1** of edge portion **22***b* of upper cover **22** is smaller than thickness t**2** of cover upper surface portion **22***a* and accordingly, edge portion **22***b* is lower in rigidity than cover upper surface portion **22***a*, the present disclosure is not limited to this example. The material of which edge portion **22***b* of upper cover **22** is formed may be lower in rigidity than the material of which cover upper surface portion **22***a* is formed. Similarly, the material of which coupling portion **22***c* of upper cover **22** is formed may be lower in rigidity than the material of which cover upper surface portion **22***a* is formed. The rigidity of upper cover **22** may be uniform regardless of the position. Further, only one of edge portion **22***b* and coupling portion **22***c* may be lower in rigidity than cover upper surface portion **22***a*.
[0088] Although the present embodiment shows an example in which gas discharge hole **2***a* is provided in upper end surface **13** of power storage module **10**, the present disclosure is not limited to this example. For example, a gas discharge hole may be provided in a side surface or a bottom surface of power storage module **10**.
[0089] Although the present embodiment shows an example in which laid material **90** is accommodated in case **20**, the present disclosure is not limited to this example. Laid material **90** is not necessarily required to be accommodated in case **20**. Instead of laid material **90**, another member (for example, a smoke absorption material or the like) may be provided.
[0090] Although the present embodiment shows an example in which width W**1** of coupling bracket **30** in the X direction is substantially equal to distance D between respective side surfaces **14** of power storage modules **10**, the present disclosure is not limited to this example. Width W**1** may be smaller than (for example, 80% or less of) distance D.
[0091] Although embodiments of the present disclosure have been described, it should be understood that the herein-disclosed embodiments are presented by way of illustration and example

in all respects and are not to be taken by way of limitation. The scope of the present disclosure is defined by the claims and intended to include any modifications within the purport and scope equivalent to the claims.

Claims

1. A power storage device comprising: a plurality of power storage modules; a case that accommodates the plurality of power storage modules; and a bracket disposed between two power storage modules of the plurality of power storage modules, the two power storage modules being arranged in a predetermined direction orthogonal to an up-and-down direction, wherein the case includes an upper cover that covers the plurality of power storage modules from above, the bracket includes an upper surface, and the upper surface of the bracket is in surface contact with the upper cover.

2. The power storage device according to claim 1, wherein the bracket includes a lower surface opposite to the upper surface, and the lower surface of the bracket is positioned below an upper end surface of each of the two power storage modules.

3. The power storage device according to claim 1, wherein the bracket includes a heat insulation material forming the upper surface.

4. The power storage device according to claim 1, wherein the upper cover includes a cover upper surface portion positioned so as to face the plurality of power storage modules in the up-and-down direction, the cover upper surface portion is provided with a bead portion extending along the upper surface of the bracket and formed so as to rise upward, and the bead portion is in surface contact with the upper surface of the bracket.

5. The power storage device according to claim 4, wherein the case includes a lower case supporting the plurality of power storage modules from below and connected to the upper cover so that an accommodation space of the plurality of power storage modules is formed, the upper cover includes a connection portion connected to the lower case, and a coupling portion coupling the cover upper surface portion and the connection portion, and at least one of the connection portion and the coupling portion is lower in rigidity than the cover upper surface portion.

6. The power storage device according to claim 1, further comprising a laid material accommodated in the case, wherein the case includes an inner side surface provided so as to surround the plurality of power storage modules when viewed from above, and the laid material is disposed in a space between at least one of the plurality of power storage modules and the inner side surface.

7. The power storage device according to claim 1, wherein each of the two power storage modules includes a side surface provided so as to face the bracket in the predetermined direction, and in the predetermined direction, the bracket has a width substantially equal to a distance between the side surfaces of the two power storage modules.