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POWER STORAGE DEVICE AND VEHICLE

Abstract

A power storage device includes: a power storage module; a housing case in which an accommodating space is formed; and a restraint. The power storage module is accommodated in the accommodating space, and the housing case includes a base member, a front wall connected to the base member, and a rear wall connected to the base member and disposed spaced apart from the front wall. The front wall includes a first connecting portion connected to the base member, and a first restraining portion located spaced apart from the first connecting portion in an up-down direction. The rear wall includes a second connecting portion connected to the base member, and a second restraining portion located spaced apart from the second connecting portion in the up-down direction. The restraint is formed to restrain the first restraining portion and the second restraining portion.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This nonprovisional application is based on Japanese Patent Application No. 2024-021248 filed on Feb. 15, 2024 with the Japan Patent Office, the entire content of which is hereby incorporated by reference.

BACKGROUND

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

DESCRIPTION OF THE BACKGROUND ART

[0003] For example, Japanese Patent Laying-Open No. 2022-55798 discloses the power storage module including stacked power storage cells, and a fastener member. The fastener member includes a pair of end plates and a restraint member. The pair of end plates are disposed on opposing ends of the stacked cells in the stacking direction. The restraint member restrains the pair of end plates in the stacking direction.

[0004] A power storage device mounted on a vehicle includes a power storage module and a case. The power storage module is accommodated in the case. The power storage module includes multiple power storage cells. The power storage cells each expand by repeatedly charging and discharging power. An external force due to the expansion of the power storage cells is loaded to the case.

[0005] For example, in order to inhibit the case from being deformed by the external force applied from the power storage cells, the power storage module may be provided with the fastener member described above. However, this increases the part count of the power storage device, thereby increasing the power storage device assembly workload and the weight of the power storage device.

SUMMARY

[0006] The present disclosure is made to solve the above problem, and an object of the present disclosure is to provide a power storage device which can restrain the stacked power storage cells in the stacking direction, while reducing the part count, and a vehicle having the power storage device mounted thereon.

[0007] A power storage device according to the present disclosure includes: a power storage module, a housing case in which an accommodating space is formed; and a restraint. The power storage module is accommodated in the accommodating space. The housing case includes: a base member; a first side wall connected to the base member; and a second side wall connected to the base member and disposed spaced apart from the first side wall. The first side wall includes: a first connecting portion connected to the base member; and a first restraining portion located spaced apart from the first connecting portion in an up-down direction. The second side wall includes: a second connecting portion connected to the base member; and a second restraining portion located spaced apart from the second connecting portion in the up-down direction. The restraint is formed to restrain the first restraining portion and the second restraining portion.

[0008] The power storage module may include a plurality of power storage cells arranged in a first

direction. The plurality of power storage cells may be each formed to extend in a second direction intersecting with the first direction, and the restraint may be arranged to run through a center of the power storage cell in the second direction.

[0009] An opening open to the accommodating space may be formed in the first side wall, and a route may be formed in the first side wall and in communication with the opening. The housing case may further include a dividing wall. The accommodating space may have a first accommodating space and a second accommodating space. The dividing wall may be formed to extend in the first direction and disposed between a center of the first side wall in the second direction and a center of the second side wall in the second direction to define the first accommodating space and the second accommodating space.

[0010] The housing case may further include: a third side wall connected to the base member; a fourth side wall connected to the base member and disposed spaced apart from the third side wall in the second direction; and a dividing wall. The accommodating space may have a first accommodating space and a second accommodating space. The dividing wall may be formed to extend in the second direction and disposed between a center of the third side wall in the first direction and a center of the fourth side wall in the first direction to define the first accommodating space and the second accommodating space. The power storage module may include a plurality of power storage cells arranged in a first direction, and the plurality of power storage cells may each be formed to extend in a second direction intersecting with the first direction. The first side wall and the second side wall may be disposed spaced apart from each other in the first direction. The housing case may further include: a third side wall connected to the base member; and a fourth side wall connected to the base member and disposed spaced apart from the third side wall in the second direction. The plurality of power storage cells may each be disposed across the third side wall and the fourth side wall.

[0011] A vehicle according to the present disclosure includes: a vehicle body; and the power storage device mounted on the vehicle body. The first direction is a front-rear direction of the vehicle.

[0012] A vehicle according to the present disclosure includes: a vehicle body; and the power storage device mounted on the vehicle body. The first direction is a width direction of the vehicle.

[0013] 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.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. 1 is a side view schematically showing a vehicle and a power storage device according to an embodiment of the present disclosure.

[0015] FIG. 2 is a perspective view schematically showing a vehicle frame of the vehicle.

[0016] FIG. 3 is a cross-sectional view of the vehicle frame taken along a III-III cross section of FIG. 2.

[0017] FIG. 4 is a perspective view schematically showing a power storage device.

[0018] FIG. 5 is an exploded perspective view of the power storage device of FIG. 4.

[0019] FIG. 6 is a cross-sectional view of the power storage device taken along a VI-VI cross section of FIG. 4.

[0020] FIG. 7 is a cross-sectional view of the power storage device taken along a VII-VII cross section of FIG. 4.

[0021] FIG. 8 is a cross-sectional view of the power storage device taken along a VIII-VIII cross section of FIG. 4.

[0022] FIG. **9** is a perspective view schematically showing the power storage device of FIG. **4** additionally including a dividing wall.

[0023] FIG. **10** is a schematic view of a power storage device according to Variation 1 of the embodiment.

[0024] FIG. **11** is an exploded perspective view of the power storage device according to Variation 1 of the embodiment.

[0025] FIG. **12** is a cross-sectional view of the power storage device taken along an XI-XI cross section of FIG. **10**.

[0026] FIG. **13** is a schematic view of a power storage device according to Variation 2 of the embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0027] Embodiments according to the present disclosure will be described, with reference to the accompanying drawings. Referring now to the drawings wherein like numerals are used to refer to like or corresponding members.

[0028] FIG. **1** is a side view schematically showing a vehicle and a power storage device according to the present embodiment. A width direction W shown in FIG. **1** indicates the width direction of the vehicle. A stacking direction L indicates the direction in which power storage cells (described below) are stacked. An up-down direction H indicates the up-down direction of the vehicle. Note that, in the present embodiment, the stacking direction L coincides with the front-rear direction of the vehicle and is one example of a “first direction” according to the present disclosure. The width direction W is one example of a “second direction” according to the present disclosure.

[0029] A vehicle **1** includes a vehicle frame **2** and a power storage device **10**. The vehicle **1** is, for example, a battery electric vehicle that can be driven by a motor, or an electric-powered vehicle such as a hybrid vehicle. The vehicle **1** includes the power storage device **10** mounted underneath the vehicle **1**.

[0030] FIG. **2** is a perspective view schematically showing a vehicle frame of the vehicle **1**. The vehicle frame **2** includes a side sill **3**, a cross member **4**, and a side member **5**.

[0031] The side sill **3** extends in the stacking direction L. The side sill **3** includes a left side sill **3a** and a right side sill **3b**. The left side sill **3a** and the right side sill **3b** are disposed spaced apart from each other in the width direction W.

[0032] The cross member **4** extends in the width direction W. The cross member **4** couples the left side sill **3a** and the right side sill **3b**. The cross member **4** includes a front cross member **4a** and a rear side member **4b**. The front cross member **4a** and the rear side member **4b** are disposed spaced apart from each other in the stacking direction L.

[0033] The side member **5** extends in the stacking direction L. The side member **5** includes a left-side member **5a** and a right-side member **5b**.

[0034] FIG. **3** shows a cross-sectional view of the vehicle **1** taken along a III-III cross section of FIG. **2**. The left-side member **5a** is disposed further inside the vehicle **1** than the left side sill **3a** in the width direction W. The right-side member **5b** is disposed further inside the vehicle **1** than the right side sill **3b** in the width direction W.

[0035] The left-side member **5a** and the right-side member **5b** are supported by the cross member **4**. More specifically, the upper surface of the left-side member **5a** and the upper surface of the right-side member **5b** are joined to the lower surface of the cross member **4**. Screws for coupling the left-side member **5a** and the right-side member **5b** to the power storage device **10** pass through through-holes **5c** formed in the lower surface of the left-side member **5a** and the lower surface of the right-side member **5b**.

[0036] FIG. **4** is a perspective view schematically showing the power storage device **10**. FIG. **5** is an exploded perspective view of the power storage device **10** of FIG. **4**.

[0037] In FIG. **5**, the power storage device **10** includes a housing case **100**, a power storage module **200**, a restraint **300**, and a cooling device **500**.

[0038] An accommodating space R1 for accommodating the power storage module 200 is formed in the housing case 100. The housing case 100 includes an upper cover 400, a base member 110, a surrounding wall 120, and a bottom plate 130.

[0039] The bottom plate 130 covers an opening in the base member 110.

[0040] The power storage module 200 is accommodated in the accommodating space R1 formed in the housing case 100. The power storage module 200 is formed of multiple power storage cells 210.

[0041] The power storage cells 210 are stacked in the stacking direction L. The power storage cell 210 is formed in a cuboid shape extending in the width direction W. One of the end surfaces of the power storage cell 210 in the width direction W reaches the inner wall of a side wall 123, and the other of the end surfaces reaches the inner wall of a side wall 124.

[0042] An electrode assembly and an electrolyte solution are accommodated in the power storage cell 210. As the power storage cell 210 charge or discharge power, the electrode assembly may expand and contract. As the electrode assembly expands, the power storage cell 210 expands in the stacking direction L. As a result, the power storage module 200 expands in the stacking direction L due to the cumulative effect of expansion of the power storage cells 210. Note that as the power storage cell 210 is internally shorted, hot gas may be produced within and exhausted out of the power storage cell 210.

[0043] The cooling device 500 covers the lower surface of the power storage module 200. The cooling device 500 and the power storage module 200 are accommodated in the housing case 100.

[0044] The upper cover 400 covers the entirety of the upper surface of the housing case 100.

[0045] The base member 110 is formed in a frame shape. A connecting zone 110a is formed on the base member 110 and faces the lower surface of the upper surface of the surrounding wall 120.

[0046] The base member 110 includes a side frame 111, a side frame 112, a front frame 113, and a rear frame 114.

[0047] The side frame 111 and the side frame 112 extend in the stacking direction L. The side frame 111 and the side frame 112 are disposed spaced apart from each other in the width direction W.

[0048] The front frame 113 and the rear frame 114 extend in the width direction. The front frame 113 and the rear frame 114 are provided spaced apart from each other in the stacking direction L.

[0049] The front frame 113 connects the front end portion of the side frame 111 and the front end portion of the side frame 112. The rear frame 114 connects the rear end portion of the side frame 111 and the rear end portion of the side frame 112.

[0050] FIG. 6 is a cross-sectional view of the power storage device 10 taken along an IV-IV cross section of FIG. 4. In FIG. 6, the upper cover and the power storage module are not shown.

[0051] A first connecting region 111a and a second connecting region 111b are formed on the upper surface of the side frame 111. The first connecting region 111a faces a portion of a connecting section 120a which is the lower surface of the surrounding wall 120. The second connecting region 111b faces the lower surface of the left-side member 5a. Through-holes 110c are formed in the second connecting region 111b, passing therethrough in the up-down direction H. The first connecting region 111a and the second connecting region 111b are aligned in the width direction W.

[0052] A first connecting region 112a and a second connecting region 112b are formed on the upper surface of the side frame 112. The first connecting region 112a faces a portion of the connecting section 120a which is the lower surface of the surrounding wall 120. The second connecting region 112b faces the lower surface of the right-side member 5b. Through-holes 110c are formed in the second connecting region 112b, passing therethrough in the up-down direction H. The first connecting region 112a and the second connecting region 112b are aligned in the width direction W.

[0053] The first connecting region 111a and the first connecting region 112a are part of the

components constituting the connecting zone **110a**.

[0054] The power storage device **10** is fastened to the side member **5** with bolts **11** passing through the through-holes **110c** of the power storage device **10** and the through-holes **5c** of the side member **5**, and nuts **12**.

[0055] The cooling device **500** is disposed on the upper surface of the bottom plate **130** and the lower surface of the power storage module **200** not shown. A coolant route **500a** is formed inside the cooling device **500**. A coolant **501** flows through the coolant route **500a**. This allows the cooling device **500** to cool the power storage module **200** from below.

[0056] Note that the lower surface of the bottom plate **130**, on which the cooling device **500** is disposed, is flush with the lower surface of the base member **110**.

[0057] Referring, again, to FIG. 5, the surrounding wall **120** is formed in a frame shape extending upward from the connecting zone **110a** of the base member **110**. The surrounding wall **120** has the connecting section **120a**. The connecting section **120a** is the lower surface of the surrounding wall **120**. The connecting section **120a** faces the connecting zone **110a** of the base member **110**.

[0058] The surrounding wall **120** is joined to the base member **110** at the connecting zone **110a** of the base member **110** and the connecting section **120a** of the surrounding wall **120**.

[0059] The surrounding wall **120** includes a front wall **121**, a rear wall **122**, the side wall **123**, and the side wall **124**. Note that the front wall **121** is one example of a “first side wall” according to the present disclosure, the rear wall **122** is one example of a “second side wall” according to the present disclosure, the side wall **123** is one example of a “third side wall” according to the present disclosure, and the side wall **124** is one example of a “fourth side” wall according to the present disclosure.

[0060] The front wall **121** and the rear wall **122** extend in the width direction **W**. The front wall **121** and the rear wall **122** are disposed spaced apart from each other in the stacking direction **L**.

[0061] The front wall **121** connects the front end portion of the side wall **123** and the front end portion of the side wall **124**. The rear wall **122** connects the rear end portion of the side wall **123** and the rear end portion of the side wall **124**.

[0062] The side wall **123** and the side wall **124** extend in the stacking direction **L**. The side wall **123** and the side wall **124** are disposed spaced apart from each other in the width direction **W**.

[0063] FIG. 7 is a cross-sectional view of the power storage device **10** taken along a VII-VII line of FIG. 4.

[0064] The front wall **121** has a first connecting portion **121a**. The first connecting portion **121a** is the lower surface of the front wall **121**. The first connecting portion **121a** forms a portion of the connecting section **120a**.

[0065] The front wall **121** has a first restraining portion **121b**. The first restraining portion **121b** is a center portion of the outer wall of the front wall **121** in the width direction **W**. The first restraining portion **121b** is an upper end portion of the front wall **121** or a portion located around it. The first restraining portion **121b** is located spaced apart from the first connecting portion **121a** in the up-down direction **H**. A through-hole **121c** is formed in the first restraining portion **121b**.

[0066] The rear wall **122** has a second connecting portion **122a**. The second connecting portion **122a** is the lower surface of the rear wall **122**. The second connecting portion **122a** forms a portion of the connecting section **120a**.

[0067] The rear wall **122** further has a second restraining portion **122b**. The second restraining portion **122b** is disposed at the outer wall of the rear wall **122**. The second restraining portion **122b** is also a center portion of the outer wall of the rear wall **122** in the width direction **W**. The second restraining portion **122b** is an upper end portion of the rear wall **122** or a portion located around it. The second restraining portion **122b** is located spaced apart from the second connecting portion **122a** in the up-down direction **H**. A through-hole **122c** is formed in the second restraining portion **122b**.

[0068] The restraint **300** includes a first restraint member **311**, a second restraint member **312**, and

a coupling member **320**.

[0069] The first restraint member **311** and the second restraint member **312** are arranged in the stacking direction L.

[0070] The first restraint member **311** passes through the top of the front wall **121**, covering a side surface of the front wall **121**. The first restraint member **311** covers the first restraining portion **121b**.

[0071] A through-hole **311a** is formed in the first restraint member **311**, passing therethrough in the stacking direction L. The first restraint member **311** is restrained to the front wall **121** with a bolt **331** passing through the through-hole **311a** and the through-hole **121c** and a nut **332**.

[0072] The second restraint member **312** passes through the top of the rear wall **122**, covering a side surface of the rear wall **122**. The second restraint member **312** covers the second restraining portion **122b**.

[0073] A through-hole **312a** is formed in the second restraint member **312**. The second restraint member **312** is restrained to the rear wall **122** with a bolt **331** passing through the through-hole **312a** and the through-hole **122c** and a nut **332**.

[0074] The coupling member **320** extends in the stacking direction L. The coupling member **320** couples the first restraint member **311** and the second restraint member **312**.

[0075] FIG. **8** is a cross-sectional view of the power storage device **10** taken along a VIII-VIII cross section of FIG. **4**. In FIG. **8**, the upper cover **400** and the power storage module **200** are not shown. A route R2 is formed inside the front wall **121**. An opening **121d**, open to the accommodating space R1, is formed in the inner wall surface of the front wall **121**. An opening **121e**, open externally, is formed in the outer wall surface of the front wall **121**. The openings **121d** and **121e** are in communication with the route R2.

[0076] In the above embodiment, in the power storage device **10**, the power storage module **200** expands in the stacking direction L by repeatedly charging and discharging power, which applies a load to the housing case **100**. In FIG. **5**, the restraint **300** restrains the first restraining portion **121b** of the front wall **121** and the second restraining portion **122b** of the rear wall **122**. The front wall **121** and the rear wall **122** are disposed spaced apart from each other in the stacking direction L. The front wall **121** is joined to the front frame **113** at the first connecting portion **121a**. The rear wall **122** is joined to the rear frame **114** at the second connecting portion **122a**.

[0077] With this configuration, the power storage device **10** is provided, in which the surrounding wall **120** can be inhibited by not only the base member **110**, but also the restraint **300**, from being deformed in the stacking direction L due to the expansion of the power storage module **200**.

[0078] Plus, in the power storage device **10** according to the present embodiment, the front wall **121** and the rear wall **122** function as the end plates of a conventional power storage device, and the conventional end plates are not used. In addition, the restraint **300** inhibits the front wall **121** and the rear wall **122** from being deformed. As such, the power storage device **10** can be provided, which inhibits the housing case **100** from being deformed in the stacking direction L, while reducing the part count.

[0079] In the above embodiment, the first restraining portion **121b** is a center portion of the front wall **121** in the width direction W. The second restraining portion **122b** is a center portion of the rear wall **122** in the width direction W. This allows the restraint **300** to be arranged to run through the center of the power storage cells **210** in the width direction W.

[0080] With this configuration, the restraint **300** can restrain the portion of the power storage module **200** that has the greatest amount of change upon the expansion. This can reduce the number of restraints **300**, and the part count of the power storage device **10**.

[0081] In the above embodiment, in the front wall **121**, the route R2 is formed inside the front wall **121**, the opening **121d** that is open to the accommodating space R1 accommodating the power storage module **200** and in communication with the route R2 is formed, and the opening **121e** that is open externally and in communication with the route R2 is formed.

[0082] With this configuration, the power storage device **10** can exhaust the gas, out of the power storage module **200**, to the outside of the power storage device **10** via the route **R2**.

[0083] For example, the restraint **300** includes the restraining band connecting the front wall **121** and the dividing wall, and the restraining band connecting the dividing wall and the rear wall **122**. As such, the restraint **300** may be formed of multiple restraining bands.

[0084] Note that, in such a power storage device, the restraint **300** can inhibit the power storage module **200** from being expanded and deformed in the stacking direction **L**.

[0085] In the above embodiment, the restraint **300** runs through the center of the cells. However, the present disclosure is not limited thereto. For example, a number of restraints **300** may be provided, besides the restraint **300** running through the center of the cells. A number of restraints **300** may be disposed equidistantly in the width direction.

[0086] In the above embodiment, the power storage device **10** is fastened to the side member **5**. However, the present disclosure is not limited thereto. For example, the power storage device **10** may be mounted on the vehicle by being fastened to the cross member **4**.

[0087] In the above embodiment, the vehicle **1** includes the power storage device **10** that is inhibited by the restraint **300** from being deformed, thereby reducing the load applied from the power storage device **10** to the side member **5**. As a result, the vehicle frame **2** can be inhibited from being deformed.

[0088] In the above embodiment, the accommodating space **R1** is formed in the housing case **100**. However, the present disclosure is not limited thereto. For example, the housing case **100** may further include a dividing wall **170** dividing the accommodating space **R1** into a first accommodating space **R3** and a second accommodating space **R4** arranged in the stacking direction **L**.

[0089] FIG. **9** shows an example in which the housing case **100** of the power storage device **10** according to the above embodiment further includes a dividing wall **170**. The dividing wall **170** extends in the width direction **W**. One of the end surfaces of the dividing wall **170** in the width direction **W** reaches the inner wall of the side wall **123**, and the other of the end surfaces reaches the inner wall of the side wall **124**. The dividing wall **170** is arranged to run through the center of the surrounding wall **120** in the stacking direction **L**. In other words, the dividing wall **170** is arranged to run through the center of the side wall **123** and the center of the side wall **124**. The dividing wall **170** divides the accommodating space **R1** formed in the housing case **100** into the first accommodating space **R3** and the second accommodating space **R4**.

Variation 1

[0090] In the above embodiment, the connecting zone **110a** is located on the upper surface of the base member **110**, and the connecting section **120a** is located on the lower surface of the surrounding wall **120**. However, the present disclosure is not limited thereto. For example, the connecting zone **110a** may be located on the inner surrounding wall of the base member **110**, and the connecting section **120a** may be located on the outer surrounding wall of the surrounding wall **120**. Details are now described below.

[0091] FIG. **10** is a schematic view of the power storage device according to Variation 1 of the present embodiment. FIG. **11** is an exploded perspective view of the power storage device according to Variation 1 of the present embodiment.

[0092] FIG. **11** shows a housing case **101** and the restraint **300**, without showing the other components. Unless otherwise specified below, a power storage device **10a** is the same as the power storage device **10** according to the embodiment of the present disclosure.

[0093] The housing case **101** includes a base member **140** and a surrounding wall **150**.

[0094] The base member **140** is formed in a frame shape. The base member **140** includes a side frame **141**, a side frame **142**, a front frame **143**, and a rear frame **144**.

[0095] The side frame **141** and the side frame **142** extend in the stacking direction **L**. The side frame **141** and the side frame **142** are located spaced apart from each other in the width direction

W.

[0096] The front frame **143** and the rear frame **144** extend in the width direction W. The front frame **143** and the rear frame **144** are located spaced apart from each other in the stacking direction L.

[0097] The front frame **143** connects the front end portion of the side frame **141** and the front end portion of the side frame **142**. The rear frame **144** connects the rear end portion of the side frame **141** and the rear end portion of the side frame **142**.

[0098] The base member **140** includes a first connecting region **140a** and a second connecting region **140b**.

[0099] The first connecting region **140a** is the entire surface of the inner surrounding wall of the base member **140**. The first connecting region **140a** includes a first connecting region **143a** and a first connecting region **144a**.

[0100] The first connecting region **143a** is formed on the entire surface of the inner wall of the front frame **143**. The first connecting region **144a** is formed on the entire surface of the inner wall of the rear frame **144**.

[0101] The second connecting regions **140b** are the upper surface of the side frame **141** and the upper surface of the side frame **142** and formed in a region of the side frame **141** and a region of the side frame **142** and face the lower surface of the side member **5**.

[0102] FIG. **12** is a cross-sectional view of the power storage device **10b** taken along an XI-XI cross section of FIG. **10**. In FIG. **12**, the power storage module **200** and the upper cover **400** are not shown.

[0103] The surrounding wall **150** is formed in a frame shape. The surrounding wall **150** includes a front wall **151** and a rear wall **152**. The front wall **151** and the rear wall **152** extend in the width direction W. The front wall **151** and the rear wall **152** are located spaced apart from each other in the stacking direction L.

[0104] The surrounding wall **150** further has a connecting section **150a**. The connecting section **150a** is the outer wall of the surrounding wall **150**. The connecting section **150a** has a first connecting portion **151a** and a second connecting portion **152a**.

[0105] The front wall **151** has a first connecting portion **151a** and a first restraining portion **151b**.

[0106] The first connecting portion **151a** is a region of the outer wall of the front wall **151**, facing the first connecting region **143a**.

[0107] The first restraining portion **151b** is a center portion of the outer wall of the front wall **151** in the width direction W. The first restraining portion **151b** is an upper end portion of the front wall **151** and a portion located around it. The first restraining portion **151b** is located spaced apart from the first connecting portion **151a** in the up-down direction H. A through-hole **151c** is formed in the first restraining portion **151b**.

[0108] The rear wall **152** has a second connecting portion **152a** and a second restraining portion **152b**.

[0109] The second connecting portion **152a** is a region of the outer wall of the rear wall **152**, facing the first connecting region **144a**.

[0110] The second restraining portion **152b** is a center portion of the outer wall of the rear wall **152** in the width direction W. The second restraining portion **152b** is an upper end portion of the front wall **151** and a portion located around it. The second restraining portion **152b** is located spaced apart from the second connecting portion **152a** in the up-down direction H. The through-hole **152c** is formed in the second restraining portion **152b**.

[0111] Note that the first connecting portion **151a** and the second connecting portion **152a** form a part of the connecting section **150a**.

[0112] As noted above, in Variation 1 according to the embodiment, the surrounding wall **150** is joined to the base member **140** so that the first connecting region **140a** and the connecting section **150a** are in contact.

Variation 2

[0113] In the above embodiment, the stacking direction L coincides with the front-rear direction of the vehicle. However, the present disclosure is not limited thereto. For example, the stacking direction L may coincide with the width direction. Details are now described below.

[0114] FIG. **13** is a schematic view of a power storage device according to Variation 2 of the present embodiment. In FIG. **13**, the upper cover **400** is not shown. Unless otherwise specified below, a power storage device **10b** is the same as the power storage device **10** according to the present disclosure.

[0115] Here, in FIG. **13**, a front-rear direction F indicates the front-rear direction of the vehicle, and the stacking direction L indicates the direction in which the power storage cells are stacked. Note that, in Variation 2, the stacking direction L coincides with the width direction of the vehicle and is one example of the “first direction” according to the present disclosure. The front-rear direction F is one example of the “second direction” according to the present disclosure.

[0116] The power storage device **10b** includes a housing case **102**, power storage modules **201** and **202**, and restraints **301** and **302**.

[0117] The housing case **102** accommodates the power storage module **201** and the power storage module **202** in the first accommodating space R3 and the second accommodating space R4. The housing case includes a base member **110**, a surrounding wall **160**, and a dividing wall **170**.

[0118] The surrounding wall **160** is formed in a frame shape extending upward from the connecting zone **110a** of the base member **110**. The surrounding wall **160** has a connecting section **160a**. The connecting section **160a** is the lower surface of the surrounding wall **160**, facing the connecting zone **110a**. The surrounding wall **160** is joined to the base member **110** at the connecting zone **110a** of the base member **110** and the connecting section **160a** of the surrounding wall **160**.

[0119] The surrounding wall **160** includes a side wall **161**, a side wall **162**, a front wall **163**, and a rear wall **164**. Note that, in Variation 2, the side wall **161** is one example of the “first side wall” according to the present disclosure, the side wall **162** is one example of the “second side wall” according to the present disclosure, the front wall **163** is one example of the “third side wall” according to the present disclosure, and the rear wall **164** is one example of a “fourth side wall” according to the present disclosure.

[0120] The side wall **161** and the side wall **162** extend in the front-rear direction F. The side wall **161** and the side wall **162** are located spaced apart from each other in the stacking direction L.

[0121] The front wall **163** and the rear wall **164** extend in the stacking direction L. The front wall **163** and the rear wall **164** are located spaced apart from each other in the stacking direction L.

[0122] The front wall **163** connects the front end portion of the side wall **161** and the front end portion of the side wall **162**. The rear wall **164** connects the rear end portion of the side wall **161** and the rear end portion of the side wall **162**.

[0123] The dividing wall **170** extends in the stacking direction L. One of the end surfaces of the dividing wall **170** in the stacking direction L reaches the inner wall of the side wall **161**, and the other of the end surfaces reaches the inner wall of the side wall **162**. The dividing wall **170** is arranged to run through the center of the surrounding wall **160** in the front-rear direction F. In other words, the dividing wall **170** is arranged to run through the center of the side wall **161** and the center of the side wall **162**. The dividing wall **170** divides the accommodating space R1 formed in the housing case **100** into a first accommodating space and a second accommodating space. The dividing wall **170** divides the housing case **102** into the first accommodating space R3 and the second accommodating space R4.

[0124] The side wall **161** has a first connecting portion **161a** and first restraining portions **161b** and **161c**.

[0125] The first connecting portion **161a** is the lower surface of the side wall **161**. The first connecting portion **161a** forms a portion of the connecting section **160a**.

[0126] The first restraining portion **161b** is a center portion of the outer wall of the side wall **161** in the front-rear direction F between the front wall **163** and the dividing wall **170**. The first restraining

portion **161c** is a center portion of the outer wall of the side wall **161** in the front-rear direction F between the dividing wall **170** and the rear wall **164**. The first restraining portions **161b** and **161c** are located spaced apart from the first connecting portion **161a** in the up-down direction H.

Through-holes **161d** are formed in the first restraining portions **161b** and **161c**.

[0127] The side wall **162** has a first connecting portion **162a** and first restraining portions **162b** and **162c**.

[0128] The first connecting portion **162a** is the lower surface of the side wall **162**. The first connecting portion **162a** forms a portion of the connecting section **160a**.

[0129] The first restraining portion **162b** is a center portion of the outer wall of the side wall **162** between the front wall **163** and the dividing wall **170** in the front-rear direction F. The first restraining portion **162c** is a center portion of the outer wall of the side wall **161** between the dividing wall **170** and the rear wall **164** in the front-rear direction F. The first restraining portions **162b** and **162c** are located spaced apart from the first connecting portion **162a** in the up-down direction H. Through-holes **162d** are formed in the first restraining portions **162b** and **162c**.

[0130] The power storage modules **201** and **202** are accommodated in the first accommodating space R3 and the second accommodating space R4 formed in the housing case **102**. The power storage modules **201** and **202** are formed of multiple power storage cells **210**.

[0131] The plurality of power storage cells **210** are stacked in the stacking direction L. The power storage cell **210** is formed in a cuboid shape extending in the front-rear direction F.

[0132] The restraints **301** and **302** extend in the stacking direction L. The restraint **301** extends from the first restraining portion **161b** of the side wall **161** to the first restraining portion **162b** of the side wall **162**. The restraint **302** bridges the first restraining portion **161c** of the side wall **161** and the first restraining portion **162c** of the side wall **162**.

[0133] In Variation 2 above, the restraint **301** connects the first restraining portion **161b** and the first restraining portion **162b**. With this configuration, the restraint **301** is arranged to run through the center, in the front-rear direction F, of power storage cells **210**, forming the power storage module **201**. Similarly, the restraint **302** is arranged to run through the center, in the front-rear direction F, of power storage cells **210**, forming the power storage module **202**.

[0134] With this configuration, the restraints **301** and **302** can restrain the portions of the power storage modules **201** and **202** that have greatest amounts of change upon the expansion. This can reduce the number of restraints **301** and **302**, and the part count of the power storage device **10**.

[0135] In Variation 2 above, the dividing wall **170** divides the housing case **102** into the first accommodating space R3 and the second accommodating space R4. However, the present disclosure is not limited thereto. For example, the housing case **102** may not have the dividing wall **170**. In this case, the accommodating space R1 is formed in the housing case **102**. The power storage module **200** accommodated in the accommodating space R1 includes the power storage cells **210** that are arranged in the stacking direction L and extend in the front-rear direction F. One of the end surfaces of the power storage cell **210** reaches the inner wall of the front wall **163**, and the other of the end surfaces reaches the inner wall of the rear wall **164**.

[0136] While the embodiments according to the present disclosure has been described above, the presently disclosed embodiments should be considered in all aspects illustrative and not restrictive. The scope of the present disclosure is defined by the appended claims. All changes which come within the meaning and range of equivalency of the appended claims are to be embraced within their scope.

Claims

1. A power storage device, comprising: a power storage module; a housing case in which an accommodating space is formed; and a restraint, wherein the power storage module is accommodated in the accommodating space, the housing case includes: a base member; a first side

wall connected to the base member; and a second side wall connected to the base member and disposed spaced apart from the first side wall in a first direction, the first side wall includes: a first connecting portion connected to the base member; and a first restraining portion located spaced apart from the first connecting portion in an up-down direction, the second side wall includes: a second connecting portion connected to the base member; and a second restraining portion located spaced apart from the second connecting portion in the up-down direction, and the restraint is formed to restrain the first restraining portion and the second restraining portion.

2. The power storage device according to claim 1, wherein the power storage module includes a plurality of power storage cells arranged in the first direction, the plurality of power storage cells are each formed to extend in a second direction intersecting with the first direction, and the restraint is arranged to run through a center of the plurality of power storage cells in the second direction.

3. The power storage device according to claim 2, wherein an opening open to the accommodating space is formed in the first side wall, and a route is formed in the first side wall and in communication with the opening.

4. The power storage device according to claim 3, wherein the housing case further includes a dividing wall, the accommodating space has a first accommodating space and a second accommodating space, and the dividing wall is formed to extend in the first direction and disposed between a center of the first side wall in the second direction and a center of the second side wall in the second direction to define the first accommodating space and the second accommodating space.

5. The power storage device according to claim 3, wherein the housing case further includes: a third side wall connected to the base member; a fourth side wall connected to the base member and disposed spaced apart from the third side wall in the second direction; and a dividing wall, the accommodating space has a first accommodating space and a second accommodating space, and the dividing wall is formed to extend in the second direction and disposed between a center of the third side wall in the first direction and a center of the fourth side wall in the first direction to define the first accommodating space and the second accommodating space.

6. The power storage device according to claim 1, wherein the power storage module includes a plurality of power storage cells arranged in the first direction, the plurality of power storage cells are each formed to extend in a second direction intersecting with the first direction, the first side wall and the second side wall are disposed spaced apart from each other in the first direction, the housing case further includes: a third side wall connected to the base member; and a fourth side wall connected to the base member and disposed spaced apart from the third side wall in the second direction, and the plurality of power storage cells are each disposed from the third side wall to the fourth side wall.

7. A vehicle, comprising: a vehicle body; and a power storage device according to claim 2, the power storage device being mounted on the vehicle body, wherein the first direction is a front-rear direction of the vehicle.

8. A vehicle, comprising: a vehicle body; and the power storage device according to claim 3, the power storage device being mounted on the vehicle body, wherein the first direction is a front-rear direction of the vehicle.

9. A vehicle, comprising: a vehicle body; and the power storage device according to claim 5, the power storage device being mounted on the vehicle body, wherein the first direction is a front-rear direction of the vehicle.

10. A vehicle, comprising: a vehicle body; and the power storage device according to claim 6, the power storage device being mounted on the vehicle body, wherein the first direction is a front-rear direction of the vehicle.

11. A vehicle, comprising: a vehicle body; and the power storage device according to claim 2, the power storage device being mounted on the vehicle body, wherein the first direction is a width direction of the vehicle.

- 12.** A vehicle, comprising: a vehicle body; and the power storage device according to claim 3, the power storage device being mounted on the vehicle body, wherein the first direction is a width direction of the vehicle.
- 13.** A vehicle, comprising: a vehicle body; and the power storage device according to claim 4, the power storage device being mounted on the vehicle body, wherein the first direction is a width direction of the vehicle.
- 14.** A vehicle, comprising: a vehicle body; and the power storage device according to claim 6, the power storage device being mounted on the vehicle body, wherein the first direction is a width direction of the vehicle.
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