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POWER STORAGE DEVICE

Abstract

A power storage device includes: a first power storage cell and a second power storage cell disposed side by side in a first direction; and a cross member extending along a second direction perpendicular to the first direction and disposed in a gap between the first power storage cell and the second power storage cell. The first power storage cell includes a first side wall portion facing the cross member. The first side wall portion is provided with a first exhaust valve. The cross member is provided with a hollow portion, and is provided with a first opening such that the first opening faces the first side wall portion. The cross member is provided with a communicating portion that allows the hollow portion and a space around the cross member to communicate with each other. The communicating portion is provided at a position not facing the first exhaust valve.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This nonprovisional application is based on Japanese Patent Application No. 2024-024265 filed on Feb. 21, 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] As a conventional power storage device, Japanese Patent Laying-Open No. 2023-165300 discloses a power storage device including a cross member that partitions a space in a battery case into a plurality of regions, wherein a power storage module is disposed in each of the plurality of regions.

SUMMARY

[0004] Generally, a power storage module includes a plurality of power storage cells each having an exhaust valve, and when one power storage cell generates heat, an emission is discharged from an exhaust valve of the power storage cell having generated the heat. The emission includes a gas, an electrolyte and the like, and if no measures are taken, the emission is accumulated in a region where the power storage module having generated the heat is disposed. As a result, the emission may adhere to the power storage module, which may cause a short circuit of the power storage module.

[0005] The present disclosure has been made in view of the above-described problem, and an object of the present disclosure is to provide a power storage device capable of suppressing scattering of an emission discharged from a power storage cell having generated heat.

[0006] A power storage device according to the present disclosure includes: a first power storage cell and a second power storage cell spaced apart from each other and disposed side by side in a first direction; and a cross member extending along a second direction perpendicular to the first direction and disposed in a gap between the first power storage cell and the second power storage cell. The first power storage cell includes a first side wall portion facing the cross member. The first side wall portion is provided with a first exhaust valve. The cross member is provided with a hollow portion in a cross section perpendicular to the second direction, and is provided with a first opening such that the first opening faces the first side wall portion. The cross member is provided with a communicating portion that allows the hollow portion and a space around the cross member to communicate with each other. The communicating portion is provided at a position where the communicating portion does not face the first exhaust valve.

[0007] According to the above-described configuration, when the first power storage cell generates heat and an emission is discharged from the first exhaust valve, the emission can be introduced into the hollow portion of the cross member through the first opening provided in the cross member to face the first power storage cell. Thus, the emission can be collected inside the cross member (hollow portion). As a result, scattering of the emission discharged from the power storage cell having generated the heat can be suppressed.

[0008] In addition, the emission includes a gas, and the gas introduced into the cross member through the first opening is discharged from the communicating portion provided at the position where the communicating portion does not face the first exhaust valve, whereby an excessive increase in internal pressure of the cross member caused by the gas introduced into the cross member through the first opening can be suppressed. Generally, when the internal pressure of the cross member increases excessively, there is a concern that a part of the cross member may be deformed or broken and the gas may be jetted from an unintended location and the emission collected inside the cross member may be blown out. However, since the communicating portion is provided as described above, the excessive increase in internal pressure of the cross member can be suppressed and the above-described blowout of the emission from the unintended location can be suppressed. This also makes it possible to suppress scattering of the emission discharged from the power storage cell having generated the heat.
[0009] In the power storage device according to the present disclosure, the first opening may be disposed to face the first exhaust valve.
[0010] According to the above-described configuration, the emission is discharged directly to the first opening from the first exhaust valve. Therefore, diffusion of the emission to the surroundings of a power storage module can be suppressed and the emission can be directly introduced into the cross member. Thus, scattering of the emission can be further suppressed.
[0011] In the power storage device according to the present disclosure, the second power storage cell may include a second side wall portion facing the cross member. The second side wall portion may be provided with a second exhaust valve. In this case, the cross member may be provided with a second opening such that the second opening faces the second side wall portion.
[0012] According to the above-described configuration, when the second power storage cell generates heat and an emission is discharged from the second exhaust valve, the emission can be introduced into the hollow portion of the cross member through the second opening provided in the cross member to face the second power storage cell. Thus, the emission can be collected inside the cross member (hollow portion). As a result, scattering of the emission included in the gas discharged from the power storage cell having generated the heat can be suppressed.
[0013] In the power storage device according to the present disclosure, the first opening and the second opening may be covered with a heat insulating member provided to be breakable.
[0014] According to the above-described configuration, when the emission is discharged from the first exhaust valve of the first power storage cell, the heat insulating member is broken by the momentum of the discharged emission. Thus, the emission can be introduced into the cross member through the first opening and the emission can be collected inside the cross member. In addition, since the second opening is provided with the heat insulating member, transmission of the heat from the emission introduced through the first opening to the second power storage cell through the second opening can be suppressed. Thus, an increase in temperature of the second power storage cell can be suppressed.
[0015] On the other hand, when the emission is discharged from the second exhaust valve of the second power storage cell, the heat insulating member is broken by the momentum of the discharged emission. Thus, the emission can be introduced into the cross member through the second opening and the emission can be collected inside the cross member. In addition, since the first opening is provided with the heat insulating member, transmission of the heat from the emission introduced through the second opening to the first power storage cell through the first opening can be suppressed. Thus, an increase in temperature of the first power storage cell can be suppressed.
[0016] In the power storage device according to the present disclosure, the heat insulating member may be provided with an easily breakable portion.
[0017] According to the above-described configuration, when the emission is discharged from one power storage cell of the first power storage cell and the second power storage cell, the heat

insulating member located on the one power storage cell side can be broken more reliably.
[0018] In the power storage device according to the present disclosure, the first opening and the second opening may be disposed to be displaced in a vertical direction perpendicular to the first direction and the second direction, when viewed in the first direction.
[0019] According to the above-described configuration, even when the emission is introduced through one opening of the first opening and the second opening, a flow of the emission directly to the other opening can be suppressed.
[0020] In the power storage device according to the present disclosure, the communicating portion may be provided above the first exhaust valve in a vertical direction perpendicular to the first direction and the second direction.
[0021] According to the above-described configuration, when the gas included in the emission introduced into the cross member through the first opening is discharged from the communicating portion, the gas can be discharged above the first exhaust valve. Thus, blowing of the gas discharged from the communicating portion against the first exhaust valve can be suppressed.
[0022] In the power storage device according to the present disclosure, a height of the cross member in the vertical direction may be higher than a height of the first power storage cell and the second power storage cell in the vertical direction. In this case, the communicating portion may be provided above the first power storage cell and the second power storage cell.
[0023] According to the above-described configuration, when the gas included in the emission introduced into the cross member through the first opening is discharged from the communicating portion, the gas can be discharged above the first power storage cell and the second power storage cell. Thus, blowing of the gas discharged from the communicating portion against the first power storage cell and the second power storage cell can be suppressed and an increase in temperature of the first power storage cell and the second power storage cell can be suppressed.
[0024] In the power storage device according to the present disclosure, the cross member may include an upper wall portion on an upper side in the vertical direction, and the communicating portion may be provided in the upper wall portion.
[0025] According to the above-described configuration, when the gas included in the emission introduced into the cross member through the first opening is discharged from the communicating portion, the gas is discharged upward from the upper wall portion. Thus, blowing of the gas discharged from the communicating portion against the first power storage cell and the second power storage cell can be suppressed and an increase in temperature of the first power storage cell and the second power storage cell can be suppressed.
[0026] The power storage device according to the present disclosure may include: a first power storage module in which a plurality of the first power storage cells are arranged in the second direction; and a second power storage module in which a plurality of the second power storage cells are arranged in the second direction. The cross member may be disposed between the first power storage module and the second power storage module. A length of the communicating portion in the second direction may be equal to or longer than a length in the second direction from a first exhaust valve located on one side in the second direction, of the first exhaust valves of the plurality of the first power storage cells, to a first exhaust valve located on the other side in the second direction, of the first exhaust valves of the plurality of the first power storage cells.
[0027] According to the above-described configuration, the communicating portion is provided over a wide range. Therefore, even when the emission is discharged from the first exhaust valve of the arbitrary first power storage cell included in the first power storage module, the gas included in the emission introduced into the cross member through the first opening can be stably discharged from the communicating portion. Thus, an excessive increase in internal pressure of the cross member can be suppressed.
[0028] The power storage device according to the present disclosure may further include: a third power storage cell disposed on a side opposite to a side where the second power storage cell is

located, with respect to the first power storage cell in the first direction; and a cooler disposed in a gap between the first power storage cell and the third power storage cell to cool the first power storage cell and the third power storage cell.
[0029] According to the above-described configuration, even when the heat is transmitted from the second power storage cell to the first power storage cell, the first power storage cell can be cooled by the cooler and transmission of the heat to the third power storage cell can be suppressed by the cooler disposed between the first power storage cell and the third power storage cell.
[0030] 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
[0031] FIG. **1** is a schematic view of a vehicle including a power storage device according to a first embodiment.
[0032] FIG. **2** shows a state in which the power storage device according to the first embodiment is fixed to the vehicle.
[0033] FIG. **3** is a plan view showing an inside of the power storage device according to the first embodiment.
[0034] FIG. **4** is a cross-sectional view taken along line IV-IV shown in FIG. **3**.
[0035] FIG. **5** is a plan view of a heat insulating member that covers an opening of a cross member in the power storage device according to the first embodiment.
[0036] FIG. **6** is a schematic cross-sectional view showing movement of an emission discharged from a second power storage cell in the power storage device according to the first embodiment.
[0037] FIG. **7** is a cross-sectional view showing a cross member and a surrounding structure thereof according to a first modification.
[0038] FIG. **8** is a cross-sectional view showing a cross member and a surrounding structure thereof according to a second modification.
[0039] FIG. **9** is an exploded perspective view of a power storage device according to a second embodiment.
[0040] FIG. **10** is a plan view showing an inside of the power storage device according to the second embodiment.
DESCRIPTION OF THE PREFERRED EMBODIMENTS
[0041] Hereinafter, embodiments of the present disclosure will be described in detail with reference to the drawings. In the embodiments described below, the same or corresponding portions are denoted by the same reference characters in the drawings, and description thereof will not be repeated.
[0042] When the number, an amount, or the like is mentioned in an embodiment and modification described below, the scope of the present disclosure is not necessarily limited to the number, the amount, or the like unless otherwise specified. Each constituent element in the embodiment and modification below is not necessarily essential to the present disclosure unless otherwise specified. When there are a plurality of embodiments and modifications below, combination of features in the embodiments and modifications as appropriate is originally intended unless otherwise specified.
First Embodiment
[0043] FIG. **1** is a schematic view of a vehicle including a power storage device according to a first embodiment. FIG. **2** shows a state in which the power storage device according to the first embodiment is fixed to the vehicle. A vehicle **1** according to the first embodiment will be described with reference to FIGS. **1** and **2**.

[0044] Vehicle **1** is a hybrid vehicle that can travel using motive power of at least one of a motor and an engine, or an electrically powered vehicle that travels using driving force obtained by electrical energy.
[0045] Vehicle **1** includes a vehicle main body **2**, a front wheel **3**, a rear wheel **4**, and a power storage device **10**. Vehicle main body **2** includes a frame member **5**. Power storage device **10** is disposed below vehicle main body **2**. Power storage device **10** is disposed between front wheel **3** and rear wheel **4**, for example. A part of power storage device **10** may be disposed to overlap with at least one of front wheel **3** and rear wheel **4** when viewed in a width direction of vehicle **1**. Power storage device **10** has an upper surface **10***a*. Upper surface **10***a* may function as a floor member that defines a vehicle interior.
[0046] Frame member **5** includes a pair of side members **6** and a pair of side sills **7**.
[0047] The pair of side sills **7** are disposed at both ends in the width direction of vehicle **1**. The pair of side members **6** are disposed inside the pair of side sills **7** with a distance therebetween. The pair of side members **6** and the pair of side sills **7** extend along a front-rear direction of vehicle **1**.
[0048] The pair of side members **6** are spaced apart from each other in the width direction of vehicle **1**. A main body portion **35** of power storage device **10** is disposed in a gap between the pair of side members **6**. A void space is provided between main body portion **35** and the pair of side members **6**. As a result, even when vehicle **1** experiences side collision, input of the impact to power storage device **10** can be suppressed.
[0049] Fixed portions **36** are provided on both side surfaces of main body portion **35** in the width direction of vehicle **1**. Fixed portions **36** are fixed to the pair of side members **6** by fastening members **8**, respectively.
[0050] Frame member **5** also includes a cross frame member **9**. Cross frame member **9** is provided above power storage device **10** to extend from one side sill **7** to the other side sill **7**. Upper surface **10***a* of power storage device **10** is fixed to cross frame member **9**.
[0051] Although the example in which frame member **5** includes the pair of side members **6** and the pair of side sills **7** has been illustrated and described above, the present disclosure is not limited thereto. The pair of side sills **7** may have the function of the pair of side members **6**. In this case, the pair of side members **6** can be omitted and fixed portions **36** described above may be fixed to the pair of side sills **7**.
[0052] FIG. **3** is a plan view showing an inside of the power storage device according to the first embodiment. Details of power storage device **10** will be described with reference to FIG. **3**.
[0053] As shown in FIG. **3**, power storage device **10** includes a plurality of power storage modules **20**, an accommodation case **30**, a plurality of cross members **40**, and an electronic device **95**.
[0054] The plurality of power storage modules **20** include a first power storage module **21** and a second power storage module **22**. First power storage module **21** and second power storage module **22** are spaced apart from each other in a first direction (DR**1** direction). In the present embodiment, the first direction is, for example, parallel to the front-rear direction of vehicle **1** in a mounted state in which power storage device **10** is mounted on vehicle main body **2**.
[0055] First power storage module **21** includes a plurality of first power storage cells **211**. The plurality of first power storage cells **211** are arranged in a second direction (DR**2** direction) perpendicular to the first direction. In the present embodiment, the second direction is, for example, parallel to the width direction of vehicle **1** in the above-described mounted state. Second power storage module **22** includes a plurality of second power storage cells **221**. The plurality of second power storage cells **221** are disposed side by side in the second direction.
[0056] Each of first power storage cells **211** and second power storage cells **221** has an elongated shape whose longitudinal direction is the first direction. Each of first power storage cells **211** and second power storage cells **221** has a flat rectangular parallelepiped shape having a thickness in the second direction.
[0057] First power storage cells **211** and second power storage cells **221** may be configured by the

same power storage cell. In this case, the number of components can be reduced, and the manufacturing cost can be reduced. It should be noted that “same” encompasses the inclusion of manufacturing errors such as tolerance. Alternatively, first power storage cells **211** and second power storage cells **221** may be configured by different power storage cells.

[0058] Each of first power storage cells **211** includes a housing **212** (see FIG. **4**), and each of second power storage cells **221** includes a housing **222** (see FIG. **4**). A single or a plurality of electrode assemblies **25** (see FIG. **4**) are accommodated in each of housings **212** and **222**.

[0059] When single electrode assembly **25** is accommodated in each of housings **212** and **222**, the electrode assembly has a shape extending in the above-described longitudinal direction. Electrode assembly **25** may be a stacked electrode assembly in which a negative electrode sheet, a separator and a positive electrode sheet are stacked, or may be a wound electrode assembly in which a negative electrode sheet, a separator and a positive electrode sheet are wound.

[0060] When the plurality of electrode assemblies are accommodated in each of housings **212** and **222**, the plurality of electrode assemblies are disposed side by side in the longitudinal direction and are connected in series. In this case as well, each of the electrode assemblies may be a stacked electrode assembly, or may be a wound electrode assembly.

[0061] Each of first power storage cells **211** and second power storage cells **221** is a secondary battery such as a nickel-metal hydride battery or a lithium ion battery. Each of first power storage cells **211** and second power storage cells **221** may be a power storage cell including a liquid electrolyte, or may be a power storage cell including a solid electrolyte. Each of first power storage cells **211** and second power storage cells **221** may be a chargeable and dischargeable capacitor.

[0062] Accommodation case **30** includes an upper member **31** (see FIG. **4**) and a lower member **32** serving as a lower case. Lower member **32** has a substantially box shape that is opened upward. Lower member **32** includes main body portion **35** and fixed portions **36**. Main body portion **35** has a bottom wall portion **321**, a front wall portion **322**, a rear wall portion **323**, and side wall portions **324** and **325**. Front wall portion **322**, rear wall portion **323**, and side wall portions **324** and **325** are provided to rise from a perimeter edge of bottom wall portion **321**.

[0063] Front wall portion **322** and rear wall portion **323** face each other in the first direction. Side wall portions **324** and **325** face each other in the second direction. Fixed portions **36** are provided on outer surfaces of side wall portions **324** and **325**.

[0064] The plurality of cross members **40** are fixed to above-described lower member **32**. The plurality of cross members **40** are provided to partition an accommodation space in accommodation case **30**. Specifically, cross members **40** are provided to extend in the second direction. In the present embodiment, the accommodation space in accommodation case **30** is divided into three regions in the first direction by two cross members **40**.

[0065] In the three divided regions, electronic device **95**, first power storage module **21** and second power storage module **22** are disposed in this order from one side in the first direction. Cross member **40** is disposed in a gap between electronic device **95** and first power storage module **21**, and cross member **40** is disposed in a gap between first power storage module **21** and second power storage module **22**.

[0066] The number of cross members **40** is not limited to two, and may be one or three or more as long as cross member **40** is disposed in a gap between first power storage module **21** and second power storage module **22** adjacent to each other. Cross member **40** is made of, for example, a metal member such as SUS.

[0067] At least the cross member disposed in the gap between first power storage module **21** and second power storage module **22**, of the plurality of cross members **40**, is provided with a hollow portion H (see FIG. **4**). All of the plurality of cross members **40** may be provided with hollow portions H. Hollow portion H may constitute a part of a smoke discharge path of a gas discharged when any one of the power storage cells included in first power storage module **21** and second power storage module **22** generates heat.

[0068] Upper member **31** covers the plurality of power storage modules **20** and closes an open space of lower member **32**. A sealing member may be filled into a gap between upper member **31** and power storage modules **20**. The sealing member may have insulating properties. Upper member **31** has a substantially flat plate shape, for example. The shape of upper member **31** is not limited to the flat plate shape, and may be a substantially box shape that is opened downward. Upper member **31** may also be provided with a discharge portion **80** (see FIG. **9**) for discharging the gas inside accommodation case **30** when an internal pressure in accommodation case **30** becomes higher than a predetermined pressure. When discharge portion **80** is provided, vehicle **1** has a structure that prevents the gas discharged from discharge portion **80** from being introduced into the interior of vehicle **1**.
[0069] Electronic device **95** controls the plurality of power storage modules **20**. Electronic device **95** is a battery ECU, for example.
[0070] FIG. **4** is a cross-sectional view taken along line IV-IV shown in FIG. **3**, and more particularly, is a cross-sectional view showing the cross member and a surrounding structure thereof. For the sake of convenience, FIG. **4** also shows the upper member of accommodation case **30**. Details of cross member **40** and the surrounding structure thereof will be described with reference to FIG. **4**.
[0071] As described above, cross member **40** is provided with hollow portion H in a cross section perpendicular to the second direction. Hollow portion H is provided to continuously extend in the second direction. Cross member **40** is also provided with a first opening **47**, a second opening **48** and a communicating portion **49**. Cross member **40** includes a first wall portion **41**, a second wall portion **42**, an upper wall portion **43**, and a bottom wall portion **44**.
[0072] First wall portion **41** is located on one side in the first direction. First wall portion **41** faces first power storage cell **211** in the first direction. First wall portion **41** is provided with first opening **47**. First opening **47** is provided to face first power storage cell **211**. More particularly, first opening **47** is disposed to face a first exhaust valve **216** described below. A plurality of first openings **47** are provided side by side in the second direction and the plurality of first openings **47** face power storage cells **211**, respectively.
[0073] Second wall portion **42** is located on the other side in the first direction. Second wall portion **42** faces second power storage cell **221** in the first direction. Second wall portion **42** is provided with second opening **48**. Second opening **48** is provided to face second power storage cell **221**. More particularly, second opening **48** is disposed to face a second exhaust valve **226** described below. A plurality of second openings **48** are provided side by side in the second direction and the plurality of second openings **48** face power storage cells **221**, respectively.
[0074] Above-described first opening **47** and second opening **48** are disposed to be displaced in a vertical direction (up-down direction) perpendicular to the first direction and the second direction, when viewed in the first direction. Specifically, for example, first opening **47** is located above second opening **48** when viewed in the first direction. First opening **47** may be located below second opening **48** when viewed in the first direction.
[0075] First opening **47** is covered with a heat insulating member **60** described below. Second opening **48** is covered with heat insulating member **60**.
[0076] A height of first wall portion **41** and second wall portion **42** in the vertical direction is higher than a height of first power storage cell **211** and second power storage cell **221**. The above-described height of first wall portion **41** and second wall portion **42** may be the same as the height of first power storage cell **211** and second power storage cell **221**.
[0077] Upper wall portion **43** and bottom wall portion **44** face each other in the vertical direction. Upper wall portion **43** connects upper ends of first wall portion **41** and second wall portion **42** to each other. Bottom wall portion **44** connects lower ends of first wall portion **41** and second wall portion **42** to each other. Bottom wall portion **44** functions as a bottom surface defining portion that defines a bottom surface of hollow portion H. Bottom wall portion **44** is fixed to bottom wall

portion **321** of accommodation case **30**.
[0078] Communicating portion **49** is provided at a position where communicating portion **49** does not face first exhaust valve **216** in cross member **40**. In the present embodiment, communicating portion **49** is provided in upper wall portion **43**.
[0079] Communicating portion **49** allows hollow portion H and a space around cross member **40** to communicate with each other. More particularly, communicating portion **49** allows hollow portion H and a space in accommodation case **30** to communicate with each other. Communicating portion **49** extends along the second direction.
[0080] Cross member **40** has a first end portion and a second end portion at both ends in the second direction. Communicating portion **49** continuously extends from the first end portion side to the second end portion side. A length of communicating portion **49** in the second direction is, for example, equal to or longer than a length in the second direction from a first exhaust valve located on one side in the second direction, of first exhaust valves **216** of the plurality of first power storage cells **211** in first power storage module **21**, to first exhaust valve **216** located on the other side in the second direction, of above-described first exhaust valves **216**.
[0081] Communicating portion **49** may have a shape extending in the second direction intermittently to correspond to power storage modules **20** disposed side by side in the second direction.
[0082] Above-described housing **212** of first power storage cell **211** has a first side wall portion **213** facing first wall portion **41** in the first direction. First side wall portion **213** is provided with an external terminal **213**A and first exhaust valve **216**.
[0083] First exhaust valve **216** is a valve for discharging an emission from inside first power storage cell **211**. The emission includes a gas. The emission may include a foreign substance such as an electrolyte or a metal foreign substance. First exhaust valve **216** functions as a pressure relief valve. First exhaust valve **216** is provided to be broken when an internal pressure of housing **212** becomes equal to or higher than a predetermined pressure. First exhaust valve **216** faces cross member **40** (more particularly, first wall portion **41**) in the first direction.
[0084] External terminal **213**A is, for example, disposed above first exhaust valve **216**. External terminal **213**A faces first wall portion **41** in the first direction.
[0085] Above-described housing **222** of second power storage cell **221** has a second side wall portion **223** facing second wall portion **42** in the first direction. Second side wall portion **223** is provided with an external terminal **223**A and second exhaust valve **226**.
[0086] Second exhaust valve **226** is a valve for discharging the above-described emission from inside second power storage cell **221**. Second exhaust valve **226** functions as a pressure relief valve. Second exhaust valve **226** is provided to be broken when an internal pressure of housing **222** becomes equal to or higher than a predetermined pressure. Second exhaust valve **226** faces cross member **40** (more particularly, second wall portion **42**) in the first direction.
[0087] External terminal **223**A is, for example, disposed above second exhaust valve **226**. External terminal **223**A faces second wall portion **42** in the first direction.
[0088] Above-described first exhaust valve **216** and second exhaust valve **226** are disposed to be displaced in the vertical direction when viewed in the first direction. Specifically, first exhaust valve **216** is, for example, provided above a central portion of first side wall portion **213** in the vertical direction. Second exhaust valve **226** is, for example, provided below a central portion of second side wall portion **223** in the vertical direction.
[0089] FIG. **5** is a plan view of the heat insulating member that covers the opening of the cross member in the power storage device according to the first embodiment.
[0090] As shown in FIG. **5**, heat insulating member **60** is provided to have a sheet shape. Heat insulating member **60** is made of a mica sheet, for example. Heat insulating member **60** is provided to be breakable. More particularly, heat insulating member **60** is provided with an easily breakable portion **61**.

[0091] Easily breakable portion **61** is configured by a breaking line, for example. The breaking line is formed by through holes arranged in a ring shape or in a frame shape. First exhaust valve **216** or second exhaust valve **226** faces, in the first direction, the region of heat insulating member **60** surrounded by the breaking line.
[0092] Heat insulating member **60** is not limited to the mica sheet, and may be made of a heat insulating resin sheet that is lower in strength than the mica sheet. In this case, easily breakable portion **61** may be omitted.
[0093] Heat insulating member **60** facing first exhaust valve **216** is configured to be breakable by the emission discharged from first exhaust valve **216**. When the emission is not discharged from first exhaust valve **216** and the emission is discharged from second exhaust valve **226**, it is preferable that heat insulating member **60** facing first exhaust valve **216** should not be broken by the emission discharged from second exhaust valve **226**.
[0094] Similarly, heat insulating member **60** facing second exhaust valve **226** is configured to be breakable by the emission discharged from second exhaust valve **226**. When the emission is not discharged from second exhaust valve **226** and the emission is discharged from first exhaust valve **216**, it is preferable that heat insulating member **60** facing second exhaust valve **226** should not be broken by the gas discharged from first exhaust valve **216**.
[0095] FIG. **6** is a schematic cross-sectional view showing movement of the emission discharged from the second power storage cell in the power storage device according to the first embodiment.
[0096] As shown in FIG. **6**, when the emission is discharged from first exhaust valve **216** of first power storage cell **211**, heat insulating member **60** facing this first exhaust valve **216** is broken, whereby the emission is introduced into cross member **40** through first opening **47**. Since heat insulating member **60** is provided with easily breakable portion **61**, heat insulating member **60** is easily broken by the momentum of the emission. In addition, since first exhaust valve **216** faces the region surrounded by the breaking line that constitutes easily breakable portion **61**, heat insulating member **60** can be broken more reliably.
[0097] Since the emission is introduced into cross member **40**, the emission can be collected inside the cross member (hollow portion H). Particularly, a substance heavier than air, which is included in the emission, is accumulated on bottom wall portion **44**. Thus, it is possible to suppress scattering of the emission discharged from first power storage cell **211** having generated heat to a space around first power storage cell **211** and thus a region where first power storage module **21** is accommodated.
[0098] Furthermore, since first opening **47** and first exhaust valve **216** face each other in the first direction, the emission is discharged directly to first opening **47** from first exhaust valve **216**. Therefore, diffusion of the emission to the surroundings of first power storage module **21** can be suppressed and the emission can be directly introduced into cross member **40**. Thus, scattering of the emission can be further suppressed.
[0099] In addition, the gas included in the emission introduced into cross member **40** through first opening **47** is discharged to a space (in accommodation case **30**) around cross member **40** from communicating portion **49** provided at the position where communicating portion **49** does not face first exhaust valve **216**. Thus, an excessive increase in internal pressure of cross member **40** caused by the gas introduced into cross member **40** through first opening **47** can be suppressed.
[0100] Generally, when the internal pressure of cross member **40** increases excessively, there is a concern that a part of cross member **40** may be deformed or broken and the gas may be jetted from an unintended location and the emission collected inside the cross member may be blown out.
[0101] In the present embodiment, communicating portion **49** is provided as described above. Therefore, the excessive increase in internal pressure of cross member **40** can be suppressed and the above-described blowout of the emission from the unintended location can be suppressed. This also makes it possible to suppress scattering of the emission discharged from first power storage cell **211** having generated the heat.

[0102] Since communicating portion **49** is provided in upper wall portion **43** of cross member **40**, the gas in cross member **40** can be discharged upward. Thus, blowing of the gas discharged from communicating portion **49** directly against power storage module **20** (first power storage cell **211** and second power storage cell **221**) can be suppressed. As a result, an increase in temperature of power storage module **20** caused by the gas discharged from communicating portion **49** can be suppressed. A gap is provided between upper wall portion **43** and upper member **31**, and the gas is discharged toward the gap.
[0103] In addition, the length of communicating portion **49** is equal to or longer than the length in the second direction from first exhaust valve **216** located on one side in the second direction, of first exhaust valves **216** of the plurality of first power storage cells **211**, to first exhaust valve **216** located on the other side in the second direction, of above-described first exhaust valves **216**. Thus, even when the emission is discharged from first exhaust valve **216** of arbitrary first power storage cell **211** included in first power storage module **21**, the gas included in the emission introduced into cross member **40** through first opening **47** can be stably discharged from communicating portion **49**. As a result, the excessive increase in internal pressure of the cross member can be further suppressed.
[0104] In addition, as described above, second opening **48** located opposite to first opening **47** is covered with heat insulating member **60**. Therefore, transmission of the heat from second opening **48** to second power storage cell **221** can be suppressed by heat insulating member **60**. Thus, an increase in temperature of second power storage cell **221** and thus second power storage module **22** can be suppressed.
[0105] Furthermore, since first opening **47** and second opening **48** are disposed to be displaced in the vertical direction when viewed in the first direction, a flow of the emission introduced through first opening **47** directly to second opening **48** can be suppressed. Thus, an increase in temperature of second power storage cell **221** and thus second power storage module **22** can be suppressed.
[0106] Although the example in which the emission is discharged from first power storage cell **211** has been described above, an effect that is substantially the same as the above can also be obtained when the emission is discharged from second power storage cell **221**. For example, when the gas is discharged from second power storage cell **221**, heat insulating member **60** that covers second opening **48** is broken and the emission can be introduced into cross member **40** through second opening **48**. Thus, the emission can be retained in cross member **40** and scattering of the emission within accommodation case **30** can be prevented.
[0107] In addition, since first opening **47** located opposite to second opening **48** is covered with heat insulating member **60**, transmission of the heat from first opening **47** to first power storage cell **211** can be suppressed. Furthermore, since second opening **48** is displaced from first opening **47** in the vertical direction when viewed in the first direction, a flow of the emission introduced into cross member **40** through second opening **48** directly to first opening **47** can be suppressed. An effect produced by discharge of the gas from communicating portion **49** is the same as the above.
First Modification
[0108] FIG. **7** is a cross-sectional view showing a cross member and a surrounding structure thereof according to a first modification. A power storage device **10**A according to the first modification will be described with reference to FIG. **7**.
[0109] As shown in FIG. **7**, power storage device **10**A according to the first modification is different from power storage device **10** according to the first embodiment in terms of the position of communicating portions **49** provided in cross member **40**. Power storage device **10**A according to the first modification is otherwise substantially the same as power storage device **10** according to the first embodiment.
[0110] In the first modification, a height of cross member **40** in the vertical direction is higher than a height of first power storage cell **211** and second power storage cell **221** in the vertical direction, and communicating portions **49** are provided above first power storage cell **211** and second power

storage cell **221**.
[0111] Specifically, communicating portions **49** are provided in portions of first wall portion **41** and second wall portion **42** located above first power storage cell **211** and second power storage cell **221**. Communicating portion **49** may be provided in any one of first wall portion **41** and second wall portion **42**.
[0112] With the above-described configuration as well, power storage device **10**A according to the first modification can obtain substantially the same effect as that of power storage device **10** according to the first embodiment. In addition, in the case where cross member **40** in the first modification is adopted, the gas can be effectively discharged toward a space located above first power storage cell **211** and second power storage cell **221** when there is no sufficient gap between upper wall portion **43** of cross member **40** and upper member **31**.
Second Modification
[0113] FIG. **8** is a cross-sectional view showing a cross member and a surrounding structure thereof according to a second modification. A power storage device **10**B according to the second modification will be described with reference to FIG. **8**.
[0114] As shown in FIG. **8**, power storage device **10**B according to the second modification is different from power storage device **10** according to the first embodiment in terms of the position of first opening **47** and second opening **48** provided in cross member **40** and the position of first exhaust valve **216** and second exhaust valve **226**. Power storage device **10**B according to the second modification is otherwise substantially the same as power storage device **10** according to the first embodiment.
[0115] In the second modification, first opening **47** and second opening **48** are disposed to overlap with each other when viewed in the first direction. In addition, first exhaust valve **216** and second exhaust valve **226** are also disposed to overlap with each other when viewed in the first direction. First exhaust valve **216** is, for example, provided in the central portion of first side wall portion **213** in the vertical direction. Second exhaust valve **226** is, for example, provided in the central portion of second side wall portion **223** in the vertical direction.
[0116] With the above-described configuration as well, power storage device **10**B according to the second modification can obtain substantially the same effect as that of power storage device **10** according to the first embodiment. In the second modification, when the emission is introduced into cross member **40** through one opening of first opening **47** and second opening **48**, the emission flows directly to the other opening of first opening **47** and second opening **48**. However, the momentum of the emission is suppressed by heat insulating member **60** provided at one opening and heat insulating member **60** provided at the other opening. Thus, an influence of the heat on the power storage cell located on the other opening side can be suppressed.
Second Embodiment
[0117] FIG. **9** is an exploded perspective view of a power storage device according to a second embodiment. A power storage device **10**C according to the second embodiment will be described with reference to FIG. **9**.
[0118] Power storage device **10**C according to the second embodiment is different from power storage device **10** according to the first embodiment mainly in terms of the arrangement and structure of the plurality of power storage modules **20** and cross members **40**, and the presence of partition walls **50**. Power storage device **10**C according to the second embodiment is otherwise substantially the same as power storage device **10** according to the first embodiment.
[0119] In the second embodiment, the first direction is parallel to the width direction of vehicle **1** and the second direction is parallel to the front-rear direction of vehicle **1** in the mounted state in which power storage device **10**C is mounted on vehicle main body **2**.
[0120] The plurality of power storage modules **20** are disposed in a matrix shape in the first direction and the second direction. In accommodation case **30**, a region where power storage modules **20** are disposed is partitioned by the plurality of cross members **40** and the plurality of

partition walls **50**.
[0121] Cross members **40** are spaced apart from each other and disposed side by side in the first direction. Each of cross members **40** is disposed in a gap between power storage modules **20** adjacent to each other in the first direction. Each of cross members **40** extends in the second direction. Each of cross members **40** extends from front wall portion **322** to rear wall portion **323** of lower member **32** of accommodation case **30**.
[0122] Partition walls **50** partition the space in accommodation case **30** divided by cross members **40**, to correspond to the number of the plurality of power storage modules **20**. Each of partition walls **50** extends in the first direction. Each of partition walls **50** may have a hollow structure.
[0123] Discharge portion **80** is provided in upper member **31** of accommodation case **30**. Discharge portion **80** discharges the gas inside accommodation case **30** when the internal pressure in accommodation case **30** becomes higher than a predetermined pressure. Specifically, the gas included in the emission is discharged into accommodation case **30** from the power storage cells included in the plurality of power storage modules **20**, and the gas is discharged outside accommodation case **30** when the internal pressure in accommodation case **30** becomes higher than the predetermined pressure.
[0124] FIG. **10** is a plan view showing an inside of the power storage device according to the second embodiment. As shown in FIG. **10**, power storage module **20** located on one side in the first direction, of power storage modules **20** adjacent to each other in the first direction, includes first power storage module **21** and a third power storage module **23**. Power storage module **20** located on the other side in the first direction, of power storage modules **20** adjacent to each other in the first direction, includes second power storage module **22** and a fourth power storage module **24**.
[0125] In above-described power storage module **20** located on one side in the first direction, first power storage module **21** and third power storage module **23** are disposed to face each other in the first direction.
[0126] First power storage module **21** has a plurality of first power storage cells **211**. The plurality of first power storage cells **211** are arranged in the second direction. Each of first power storage cells **211** has a pair of side wall portions in the first direction, and first side wall portion **213** located on the closest cross member **40** side is provided with a pair of external terminals having different polarities. The side wall portion located opposite to above-described first side wall portion **213**, of the above-described pair of side wall portions, is in thermal contact with a cooler **70** described below.
[0127] Third power storage module **23** is disposed on a side opposite to a side where above-described second power storage module **22** is located, with respect to first power storage module **21**. Third power storage module **23** has a plurality of third power storage cells **231**. The plurality of third power storage cells **231** are arranged in the second direction. Each of third power storage cells **231** is disposed on a side opposite to a side where second power storage cell **221** included in above-described second power storage module **22** is located, with respect to first power storage cell **211**. Each of third power storage cells **231** includes a side wall portion on a side opposite to a side where first power storage cell **211** is located, and the side wall portion is provided with a pair of external terminals having different polarities.
[0128] In above-described power storage module **20** located on the other side in the first direction, second power storage module **22** and fourth power storage module **24** are disposed to face each other in the first direction.
[0129] Second power storage module **22** has a plurality of second power storage cells **221**. The plurality of second power storage cells **221** are arranged in the second direction. Each of second power storage cells **221** has a pair of side wall portions in the first direction, and second side wall portion **223** located on the closest cross member **40** side is provided with a pair of external terminals having different polarities. The side wall portion located opposite to above-described second side wall portion **223**, of the above-described pair of side wall portions, is in thermal

contact with cooler **70** described below.
[0130] Fourth power storage module **24** is disposed on a side opposite to a side where above-described first power storage module **21** is located, with respect to second power storage module **22**. Fourth power storage module **24** has a plurality of fourth power storage cells **241**. The plurality of fourth power storage cells **241** are arranged in the second direction. Each of fourth power storage cells **241** is disposed on a side opposite to a side where first power storage cell **211** included in above-described first power storage module **21** is located, with respect to second power storage cell **221**. Each of fourth power storage cells **241** includes a side wall portion on a side opposite to a side where second power storage cell **221** is located, and the side wall portion is provided with a pair of external terminals having different polarities.
[0131] First power storage cells **211**, second power storage cells **221**, third power storage cells **231**, and fourth power storage cells **241** have substantially the same configuration. Each of first power storage cells **211**, second power storage cells **221**, third power storage cells **231**, and fourth power storage cells **241** has a flat rectangular tube shape in the second direction.
[0132] Power storage device **10**C includes cooler **70**. Cooler **70** is provided in each of power storage modules **20**. Cooler **70** is disposed between the power storage modules adjacent to each other in the second direction so as to cool both of the power storage modules adjacent to each other in the second direction in power storage modules **20**. For example, in above-described power storage module **20** located on one side in the first direction, cooler **70** is sandwiched between first power storage module **21** and third power storage module **23** as described above. Similarly, in above-described power storage module **20** located on the other side in the first direction, cooler **70** is sandwiched between second power storage module **22** and fourth power storage module **24** as described above. Cooler **70** has therein a refrigerant flow path through which a cooling medium flows.
[0133] Cross member **40** has a first end portion and a second end portion at both ends in the second direction. Communicating portion **49** continuously extends from the first end portion side to the second end portion side.
[0134] Communicating portion **49** may have a shape extending in the second direction intermittently to correspond to power storage modules **20** disposed side by side in the second direction. In this case, at a location corresponding to each power storage module **20** (specifically, a portion of cross member **40** facing each power storage module **20**), a length of communicating portion **49** in the second direction may be, for example, equal to or longer than a length in the second direction from first exhaust valve **216** located on one side in the second direction, of first exhaust valves **216** of the plurality of first power storage cells **211**, to first exhaust valve **216** located on the other side in the second direction, of above-described first exhaust valves **216**.
[0135] Cross member **40** in any one of the first embodiment, the first modification and the second modification can be adopted as cross member **40** in the second embodiment. Thus, power storage device **10**C according to the second embodiment can also obtain substantially the same effect as that of the power storage device according to the first embodiment, the first modification or the second modification.
[0136] In addition, cooler **70** is provided between first power storage cell **211** and third power storage cell **231** as described above. Thus, even when the heat is transmitted from the second power storage cell **221** side to first power storage cell **211**, first power storage cell **211** can be cooled by cooler **70** and transmission of the heat to third power storage cell **231** can be suppressed.
[0137] Similarly, cooler **70** is provided between second power storage cell **221** and fourth power storage cell **241**. Thus, even when the heat is transmitted from the first power storage cell **211** side to second power storage cell **221**, second power storage cell **221** can be cooled by cooler **70** and transmission of the heat to fourth power storage cell **241** can be suppressed.
Other Modifications
[0138] Although the example in which first exhaust valve **216** faces first opening **47** and second

exhaust valve **226** faces second opening **48** has been illustrated and described in the first and second embodiments, first modification and second modification above, the present disclosure is not limited thereto. First exhaust valve **216** does not necessarily need to face first opening **47** as long as first exhaust valve **216** faces first side wall portion **213**, and second exhaust valve **226** does not necessarily need to face second opening **48** as long as second exhaust valve **226** faces second side wall portion **223**.

[0139] In this case as well, when the emission is discharged from one exhaust valve of first exhaust valve **216** and second exhaust valve **226**, the emission can be introduced into cross member **40** through the opening closer to this one exhaust valve, of the first opening and the second opening. Thus, the emission can be collected inside cross member **40**.

[0140] Although the example in which first opening **47** and second opening **48** are provided with heat insulating members **60** has been illustrated and described in the first and second embodiments, first modification and second modification above, the present disclosure is not limited thereto. Heat insulating members **60** may be omitted.

[0141] Although the example in which cross member **40** has bottom wall portion **44** has been illustrated in the first and second embodiments, first modification and second modification above, the present disclosure is not limited thereto. Bottom wall portion **44** may be omitted. In this case, a flange portion may be provided to extend outward from a lower end of each of first wall portion **41** and second wall portion **42**, and the flange portion may be fixed to bottom wall portion **321** of accommodation case **30**. In this case, a portion of bottom wall portion **321** of accommodation case **30** facing upper wall portion **43** in the up-down direction functions as a bottom surface defining portion that defines the bottom surface of hollow portion H.

[0142] Although the example in which communicating portion **49** is provided above upper wall portion **43** or first power storage cell **211** and second power storage cell **222** has been illustrated in the first and second embodiments, first modification and second modification above, communicating portion **49** may be provided above first exhaust valve **216** and second exhaust valve **226**.

[0143] Although the embodiments of the present disclosure have been described, it should be understood that the embodiments disclosed herein are illustrative and non-restrictive in every respect. The scope of the present disclosure is defined by the terms of the claims, and is intended to include any modifications within the scope and meaning equivalent to the terms of the claims.

Claims

1. A power storage device comprising: a first power storage cell and a second power storage cell spaced apart from each other and disposed side by side in a first direction; and a cross member extending along a second direction perpendicular to the first direction and disposed in a gap between the first power storage cell and the second power storage cell, wherein the first power storage cell includes a first side wall portion facing the cross member, the first side wall portion is provided with a first exhaust valve, the cross member is provided with a hollow portion in a cross section perpendicular to the second direction, and is provided with a first opening such that the first opening faces the first side wall portion, the cross member is provided with a communicating portion that allows the hollow portion and a space around the cross member to communicate with each other, and the communicating portion is provided at a position where the communicating portion does not face the first exhaust valve.

2. The power storage device according to claim 1, wherein the first opening is disposed to face the first exhaust valve.

3. The power storage device according to claim 2, wherein the second power storage cell includes a second side wall portion facing the cross member, the second side wall portion is provided with a second exhaust valve, and the cross member is provided with a second opening such that the

second opening faces the second side wall portion.

4. The power storage device according to claim 3, wherein the first opening and the second opening are covered with a heat insulating member provided to be breakable.

5. The power storage device according to claim 4, wherein the heat insulating member is provided with an easily breakable portion.

6. The power storage device according to claim 3, wherein the first opening and the second opening are disposed to be displaced in a vertical direction perpendicular to the first direction and the second direction, when viewed in the first direction.

7. The power storage device according to claim 1, wherein the communicating portion is provided above the first exhaust valve in a vertical direction perpendicular to the first direction and the second direction.

8. The power storage device according to claim 7, wherein a height of the cross member in the vertical direction is higher than a height of the first power storage cell and the second power storage cell in the vertical direction, and the communicating portion is provided above the first power storage cell and the second power storage cell.

9. The power storage device according to claim 7, wherein the cross member includes an upper wall portion on an upper side in the vertical direction, and the communicating portion is provided in the upper wall portion.

10. The power storage device according to claim 1, comprising: a first power storage module in which a plurality of the first power storage cells are arranged in the second direction; and a second power storage module in which a plurality of the second power storage cells are arranged in the second direction, wherein the cross member is disposed between the first power storage module and the second power storage module, and a length of the communicating portion in the second direction is equal to or longer than a length in the second direction from a first exhaust valve located on one side in the second direction, of the first exhaust valves of the plurality of the first power storage cells, to a first exhaust valve located on the other side in the second direction, of the first exhaust valves of the plurality of the first power storage cells.

11. The power storage device according to claim 1, further comprising: a third power storage cell disposed on a side opposite to a side where the second power storage cell is located, with respect to the first power storage cell in the first direction; and a cooler disposed in a gap between the first power storage cell and the third power storage cell to cool the first power storage cell and the third power storage cell.