United States Patent Application Publication	20250260088
Kind Code	A1
Publication Date	August 14, 2025
Inventor(s)	OGUSHI; Masataka et al.

ELECTRIC STORAGE APPARATUS

Abstract

An electric storage apparatus according to the present disclosure includes: a plurality of stacked battery cells; a plurality of heat insulating plates provided between the plurality of battery cells; and a case for accommodating a cell stack including the plurality of battery cells and the plurality of heat insulating plates, in which each of the heat insulating plates is formed so as to cover an entire stack surface of the battery cell adjacent to the heat insulating plate and includes a tapered edge part so that it does not come into contact with an edge of the battery cell adjacent to the heat insulating plate.

Inventors: **OGUSHI; Masataka (Nisshin-shi, JP), MATSUSHITA; Taro (Toyokawa-shi, JP), TANABE; Yukinari (Okazaki-shi, JP)**

Applicant: **TOYOTA JIDOSHA KABUSHIKI KAISHA** (Aichi-ken, JP)

Family ID: **1000008475259**

Assignee: **TOYOTA JIDOSHA KABUSHIKI KAISHA (Aichi-ken, JP)**

Appl. No.: **19/044628**

Filed: **February 04, 2025**

Foreign Application Priority Data

JP	2024-018930	Feb. 09, 2024

Publication Classification

Int. Cl.: **H01M10/6555** (20140101); **H01M10/658** (20140101); **H01M50/209** (20210101); **H01M50/249** (20210101); **H01M50/296** (20210101)

U.S. Cl.:

CPC **H01M10/6555** (20150401); **H01M10/658** (20150401); **H01M50/209** (20210101); **H01M50/249** (20210101); **H01M50/296** (20210101);

Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is based upon and claims the benefit of priority from Japanese patent application No. 2024-018930, filed on Feb. 9, 2024, the disclosure of which is incorporated herein in its entirety by reference.

BACKGROUND

[0002] The present disclosure relates to an electric storage apparatus.

[0003] Patent Literature 1 discloses a battery module including a plurality of battery cells arranged in a stacked manner and a plurality of buffer sheets arranged alternately with the plurality of battery cells. [0004] Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2023-046073

SUMMARY

[0005] In the battery module disclosed in Patent Literature 1, when each of the buffer sheets is arranged so as to cover the entire stack surface of the battery cell adjacent to the buffer sheet in order to make it difficult for the plurality of battery cells to transmit heat to each other, there is a possibility that a load is applied from the buffer sheet to a peripheral part of the battery cell adjacent thereto, and as a result, the peripheral part of the battery cell is deteriorated. On the other hand, when each of the buffer sheets is arranged so as to cover a stack surface of the battery cell adjacent to the buffer sheet other than peripheral parts of the plurality of battery cells in order to suppress the deterioration of the peripheral parts, there is a possibility that heat of the plurality of battery cells is easily conducted to each other through the peripheral parts, and as a result, each battery cell deteriorates due to the heat. That is, the battery module disclosed in Patent Literature 1 has a problem that the deterioration of the peripheral parts of the plurality of battery cells due to heat cannot be suppressed while suppressing the deterioration of the plurality of battery cells due to a load.

[0006] The present disclosure is made in view of the above background, and it is an object of the present disclosure to provide an electric storage apparatus capable of suppressing the deterioration of a plurality of battery cells due to heat while suppressing the deterioration of peripheral parts of the plurality of battery cells due to a load.

[0007] An electric storage apparatus according to the present disclosure includes: a plurality of stacked battery cells; a plurality of heat insulating plates provided between the plurality of battery cells; and a case for accommodating a cell stack including the plurality of battery cells and the plurality of heat insulating plates, in which each of the heat insulating plates is formed so as to cover an entire stack surface of the battery cell adjacent to the heat insulating plate and includes a tapered edge part so that it does not come into contact with an edge of the battery cell adjacent to the heat insulating plate. In the electric storage apparatus, each of the heat insulating plates is formed so as to cover an entire stack surface of the battery cell adjacent to the heat insulating plate. This makes it difficult for the plurality of battery cells to conduct heat to each other, so that deterioration of each battery cell due to heat is suppressed. Further, in the electric storage apparatus, each of the heat insulating plates includes a tapered edge part so that it does not come into contact with a peripheral part of the battery cell adjacent to the heat insulating plate. Thus, a load applied from each heat insulating plate to the peripheral part of the battery cell adjacent thereto is reduced, so that the deterioration of the peripheral part of each battery cell due to a load is suppressed. That is, the electric storage apparatus can suppress the deterioration of the plurality of

battery cells due to heat while suppressing the deterioration of the peripheral parts of the plurality of battery cells due to a load.
[0008] According to the present disclosure, it is possible to provide an electric storage apparatus capable of suppressing the deterioration of a plurality of battery cells due to heat while suppressing the deterioration of peripheral parts of the plurality of battery cells due to a load.
[0009] The above and other objects, features and advantages of the present disclosure will become more fully understood from the detailed description given hereinbelow and the accompanying drawings.

Description

BRIEF DESCRIPTION OF DRAWINGS
[0010] FIG. **1** is a schematic perspective view showing an external view of a replaceable battery according to a first embodiment;
[0011] FIG. **2** is an enlarged schematic perspective view of the periphery of a front case provided at the front end of the replaceable battery according to the first embodiment;
[0012] FIG. **3** is an enlarged schematic perspective view of the periphery of a rear case provided at the rear end of the replaceable battery according to the first embodiment;
[0013] FIG. **4** is a flowchart showing the flow of assembly of the replaceable battery according to the first embodiment;
[0014] FIG. **5** is a schematic perspective view for explaining the flow of assembly of the replaceable battery according to the first embodiment;
[0015] FIG. **6** is a schematic perspective view for explaining the flow of assembly of the replaceable battery according to the first embodiment;
[0016] FIG. **7** is a schematic cross-sectional view of the ZX plane of the replaceable battery according to the first embodiment; and
[0017] FIG. **8** is a schematic exploded view of a cell stack installed in the replaceable battery according to the first embodiment.
DESCRIPTION OF EMBODIMENTS
[0018] Hereinafter, the present disclosure will be described through embodiments of the present disclosure. However, the embodiments are not intended to limit the scope of the present disclosure according to the claims. Further, not all of the components/structures described in the embodiments are necessarily indispensable as means for solving the problem. Further, not all of the components/structures described in the embodiments are necessarily indispensable as means for solving the problem. In the figures, the identical reference symbols denote identical structural elements and redundant explanation thereof is omitted.
First Embodiment
[0019] FIG. **1** is a schematic perspective view showing an external view of a replaceable battery **1** according to a first embodiment. The replaceable battery **1** is also referred to as a battery pack, a battery module, or the like, and is detachably attached to a vehicle such as an electric vehicle driven by a motor using electricity as a power source. The replaceable battery **1** is reduced in size and weight so that, for example, an operator can easily insert and remove the battery into and from the electric vehicle. Examples of an operator include a working robot.
[0020] As shown in FIG. **1**, in the replaceable battery **1**, the outside shape of a rectangular parallelepiped is defined by a case **100** for accommodating a cell stack or the like. The case **100** includes a case main body **101** having a rectangular tube shape, a front case **102** serving as a lid part for closing an opening part (namely, one opening end) at the front end of the case main body **101**, and a rear case **103** serving as a lid part for closing an opening part (namely, the other opening end) at the rear end of the case main body **101**. The rear case **103** provided at the rear end of the

replaceable battery **1** includes a connector **104** protruding outward and formed to be connectable to a connector on the vehicle side. For example, when an operator accommodates the replaceable battery **1** in in housing space of the vehicle while sliding the replaceable battery **1** in the longitudinal direction (X-axis direction), the connector **104** of the replaceable battery **1** and the connector on the vehicle side are connected.

[0021] FIG. **2** is an enlarged schematic perspective view of the periphery of the front case **102** provided at the front end of the replaceable battery **1**. As shown in FIG. **2**, the front case **102** is provided with a pull-handle **141** for sliding the replaceable battery **1**. An operator can slide the replaceable battery **1** by holding the pull-handle **141** and pushing or pulling the replaceable battery **1**.

[0022] In addition, the replaceable battery **1** can be placed on, for example, a carriage and transported. When unloading the replaceable battery **1** from the carriage and housing it in the housing space, the height of the carriage is made to match with that of the housing space, and the replaceable battery **1** is housed in the housing space by pushing the pull-handle **141**. On the other hand, when taking the replaceable battery **1** out of the housing space and loading it on the carriage, the height of the carriage is made to match that of the housing space, and the replaceable battery **1** is taken out of the housing space by pulling the pull-handle **141**.

[0023] FIG. **3** is an enlarged schematic perspective view of the periphery of the rear case **103** provided at the rear end of the replaceable battery **1**. As shown in FIG. **3**, in addition to the connector **104**, the rear case **103** is provided with a grip-handle **131** and a relief valve **132**.

[0024] The connector **104** includes a base part **1041**, a high-voltage terminal **1042**, a low-voltage terminal **1043**, an alignment pin **1044**, and a metal cover **1045**. The base part **1041** is disposed on the main surface of the rear case **103**. The high-voltage terminal **1042**, the low-voltage terminal **1043**, and the alignment pin **1044** are each formed so at to project outwardly from the main surface of the base part **1041**. The cover **1045** is formed to surround the side surfaces of the high-voltage terminal **1042** and the low-voltage terminal **1043**. The high-voltage terminal **1042** is a terminal for transmitting electricity output from the cell stack housed in the case **100** of the replaceable battery **1** to a vehicle in which the replaceable battery **1** is mounted. The low-voltage terminal **1043** is a terminal for transmitting a control signal directed from the vehicle to the replaceable battery **1**, and for transmitting a signal representing a monitoring result (a voltage measurement result, etc.) of the cell stack from the replaceable battery **1** to the vehicle.

[0025] The relief valve **132** discharges gas generated in the cell stack housed in the case **100** of the replaceable battery **1**. Here, even when gas is discharged from the relief valve **132**, the high-voltage terminal **1042** and the low-voltage terminal **1043** are protected by the metal cover **1045**.

[0026] The grip-handle **131** is rotatably provided around an axis extending along the upper edge of the rear case **103**, and is mounted on the upper surface of the case main body **101** when not in use. Therefore, the rear end of the replaceable battery **1** can be suspended by the grip-handle **131** without obstructing the connection of the connector **104**.

[0027] More specifically, when an operator carries the replaceable battery **1**, the operator holds the rotatable grip-handle **131** with one hand and lifts the replaceable battery **1** and at the same time holds the pull-handle **141** and supports the replaceable battery **1** with the other hand. By doing so, the operator can carry the replaceable battery **1** while stabilizing the center of gravity (i.e., maintaining balance).

[0028] Here, a rib groove **101***c* is formed on the upper surface of the case main body **101** along the longitudinal direction (X-axis direction) of the case main body **101**. Therefore, the grip-handle **131** is accommodated in the rib groove **101***c* when not in use. This makes it easier for an operator to house the replaceable battery **1** in a housing space of the vehicle. Further, by forming the rib groove **101***c*, the strength of the upper surface of the case main body **101** is also improved.

[0029] The thickness of the case main body **101** is preferably made small, and the thickness of the rear case **103** is preferably larger than the thickness of the case main body **101**. The case **100** is

reduced in weight by reducing the thickness of the case main body **101**, and the deformation of the case **100** is suppressed by providing the grip-handle **131** on the rear case **103** which is thicker. For example, a die-cast member is used as the rear case **103**. With this configuration, the rigidity of the rear case **103** on which the grip-handle **131** is provided is improved, and the workability when the grip-handle **131** is used is also improved. Moreover, by reducing the thickness of the case main body **101**, even when gas is generated in a cell stack **110**, the case main body **101** is elastically deformed and inflates outward, so that a rapid increase in the internal pressure of the case is suppressed.

[0030] Next, the flow of assembly of the replaceable battery **1** will be described with reference to FIGS. **4** to **6**, while the contents contained in the case **100** of the replaceable battery **1** are described. FIG. **4** is a flowchart showing the flow of assembly of the replaceable battery **1**. FIGS. **5** and **6** are schematic perspective views for explaining the flow of assembly of the replaceable battery **1**. The display contents of Steps S**101** to S**105** in FIGS. **5** and **6** correspond to the processing results of Steps S**101** to S**105** in FIG. **4**.

[0031] First, a lower case **101***b* forming the bottom plate and one side plate of the case main body **101** is arranged (Step S**101**). The lower case **101***b* is formed so that its YZ section is L-shaped and extends along the X-axis direction. A pair of rails **106** are provided along the longitudinal direction (X-axis direction) of the lower case **101***b* on the lower side of the bottom plate formed by the lower case **101***b*. Thus, the replaceable battery **1** can easily slide along the guide. Further, a metal member **105** is provided along the longitudinal direction of the lower case **101***b* on the upper side of the bottom plate. The metal member **105** is formed of, for example, aluminum or an alloy containing aluminum (i.e., a metal mainly composed of aluminum).

[0032] Then, the cell stack **110** having a rectangular parallelepiped shape is arranged on the upper side of the bottom plate formed by the lower case **101***b* so as to be close to one side plate formed by the lower case **101***b* (Step S**102**). The cell stack **110** includes a plurality of stacked battery cells and a heat insulating plate provided between the plurality of battery cells. The cell stack **110** is bundled into a rectangular parallelepiped shape by a binding member **111** such as a binding band. Here, the metal member **105** provided on the upper side of the bottom plate formed by the lower case **101***b* and the lower side of the cell stack **110** serves to release heat of the cell stack **110** to the outside of the case **100**.

[0033] Then, electronic devices such as a junction box **108** including a relay and a battery monitoring apparatus **107** are further arranged on the upper side of the bottom plate formed by the lower case **101***b* (Step S**103**). The battery monitoring apparatus **107** includes a voltage measuring device for measuring the voltage of the cell stack **110** and the voltage of each battery cell configuring the cell stack. The battery monitoring apparatus **107** is arranged in a spatial region between the cell stack **110** and the other side plate of the case main body **101** to be described later in the upper region of the bottom plate formed by the lower case **101***b*. This spatial region is formed by arranging the cell stack **110** close to one side plate of the case main body **101**. The junction box **108** is arranged in a spatial region between the rear end of the cell stack **110** and the rear case **103** to be described later.

[0034] An inner-side case **102***a* of the front case **102** is arranged at the front end of the lower case **101***b* (the case main body **101**) (Step S**103**). The rear case **103** including the connector **104** is arranged at the rear end of the lower case **101***b* (the case main body **101**) (Step S**103**). The rear end of the cell stack **110** and the rear case **103** are connected via a support bar **114**. As a result, a spatial area sufficient for arranging the junction box **108** is secured between the rear end of the cell stack **110** and the rear case **103**. Further, the front end of the cell stack **110** and the front case **102** including the pull-handle **141** are connected, and the rear end of the cell stack **110** and the rear case **103** including the grip-handle **131** are connected via the support bar **114**. As a result, when an operator holds the pull-handle **141** and the grip-handle **131** and lifts the replaceable battery **1**, a load on the case main body **101** is reduced.

[0035] Thereafter, an upper case **101***a* forming a top plate and the other side plate of the case main body **101** are arranged so as to face the lower case **101***b* (Step S**104**). The upper case **101***a* is formed so that its YZ section is L-shaped and extends along the X-axis direction. The case main body **101** having a rectangular tube shape is formed of the upper case **101***a* and the lower case **101***b*. A spatial region **160** is provided above the cell stack **110** in the internal region of the case main body **101**. The spatial region **160** is also used as a smoke exhaust region for releasing gas generated in the cell stack **110**. For example, gas generated in the cell stack **110** is discharged from the spatial region **160** to the outside of the case **100** via the relief valve **132**.
[0036] The upper case **101***a* and the lower case **101***b* are fastened together with fastening members **151** and **152** (Step S**104**).
[0037] Thereafter, an outer-side case **102***b* of the front case **102** is arranged at the front end of the case main body **101**. Thus, the replaceable battery **1** is completed (Step S**105**). The case **102***b* has a cap shape and is attached so as to wrap the opening part (an opening end) at the front end of the case main body **101** from the side surface. Thus, before the gas is discharged from the relief valve **132**, it is possible to suppress the gas from leaking out from the side of the front case **102** where an operator is working.
[0038] FIG. **7** is a schematic cross-sectional view of the ZX plane of the replaceable battery **1**. As shown in FIG. **7**, in the replaceable battery **1**, the front end of the cell stack **110** and the front case **102** including the pull-handle **141** are connected, and the rear end of the cell stack **110** and the rear case **103** including the grip-handle **131** are connected via the support bar **114**. Thus, when an operator holds the pull-handle **141** and the grip-handle **131** and lifts the replaceable battery **1**, a load on the case main body **101** is reduced. As a result, the thickness of the case main body **101** of the replaceable battery **1** can be reduced, whereby it is possible to reduce the weight thereof.
[0039] Further, as shown in FIG. **7**, in the cell stack **110**, a plurality of heat insulating plates **110***b* are provided between a plurality of stacked battery cells **110***a*. FIG. **8** is a schematic exploded view of the cell stack **110**. Each battery cell **110***a* includes a rectangular stack surface, and each heat insulating plate **110***b* includes a rectangular stack surface. Each heat insulating plate **110***b* is composed of, for example, a heat insulating material formed by solidifying a heat insulating powder such as silica, and a film that wraps the heat insulating material. Here, each heat insulating plate **110***b* is formed so as to cover the entire stack surface of the battery cell **110***a* adjacent to the heat insulating plate. This makes it difficult for the plurality of battery cells **110***a* to conduct heat to each other, so that deterioration of each battery cell **110***a* due to heat is suppressed. Further, each heat insulating plate **110***b* includes a tapered edge part **110***c* so that it does not come into contact with a peripheral part (an edge) of the battery cell **110***a* adjacent to the heat insulating plate. Thus, a load applied from each heat insulating plate **110***b* to the peripheral part of the battery cell **110***a* adjacent thereto is reduced, so that the deterioration of the peripheral part of each battery cell **110***a* due to a load is suppressed.
[0040] Thus, in the replaceable battery **1** according to the present disclosure, each heat insulating plate **110***b* is formed so as to cover the entire stack surface of the battery cell **110***a* adjacent to the heat insulating plate. This makes it difficult for the plurality of battery cells **110***a* to conduct heat to each other, so that deterioration of each battery cell **110***a* due to heat is suppressed. Further, each heat insulating plate **110***b* includes the tapered edge part **110***c* so that it does not come into contact with a peripheral part (an edge) of the battery cell **110***a* adjacent to the heat insulating plate. Thus, a load applied from each heat insulating plate **110***b* to the peripheral part of the battery cell **110***a* adjacent thereto is reduced, so that the deterioration of the peripheral part of each battery cell **110***a* due to a load is suppressed. That is, the replaceable battery **1** according to the present disclosure can suppress the deterioration of the plurality of battery cells **110***a* due to heat while suppressing the deterioration of the peripheral parts of the plurality of battery cells **110***a* due to a load.
[0041] The present disclosure is not limited to the above-described embodiments and may be changed as appropriate without departing from the scope and spirit of the present disclosure.

[0042] In the present disclosure, a description has been given of a case in which in the cell stack mounted on the replaceable battery **1**, each heat insulating plate is formed so as to cover the entire stack surface of the battery cell adjacent to the heat insulating plate and includes a tapered edge part so that it does not come into contact with the edge of the battery cell adjacent to the heat insulating plate. However, the present disclosure is not limited to this case. The cell stack according to the present disclosure may be applied to various electric storage apparatuses other than the replaceable battery.

[0043] From the disclosure thus described, it will be obvious that the embodiments of the disclosure may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the disclosure, and all such modifications as would be obvious to one skilled in the art are intended for inclusion within the scope of the following claims.

Claims

1. An electric storage apparatus comprising: a plurality of stacked battery cells; a plurality of heat insulating plates provided between the plurality of battery cells; and a case for accommodating a cell stack comprising the plurality of battery cells and the plurality of heat insulating plates, wherein each of the heat insulating plates is formed so as to cover an entire stack surface of the battery cell adjacent to the heat insulating plate and includes a tapered edge part so that it does not come into contact with an edge of the battery cell adjacent to the heat insulating plate.

2. The electric storage apparatus according to claim 1, wherein each of the heat insulating plates comprises: a heat insulating material formed by solidifying a heat insulating powder; and a film that wraps the heat insulating material.

3. The electric storage apparatus according to claim 1, wherein the heat insulating plate contains silica.

4. The electric storage apparatus according to claim 1, wherein the plurality of battery cells include rectangular stack surfaces, and the plurality of heat insulating plates include rectangular stack surfaces.