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(54) **REPLACEABLE BATTERY**

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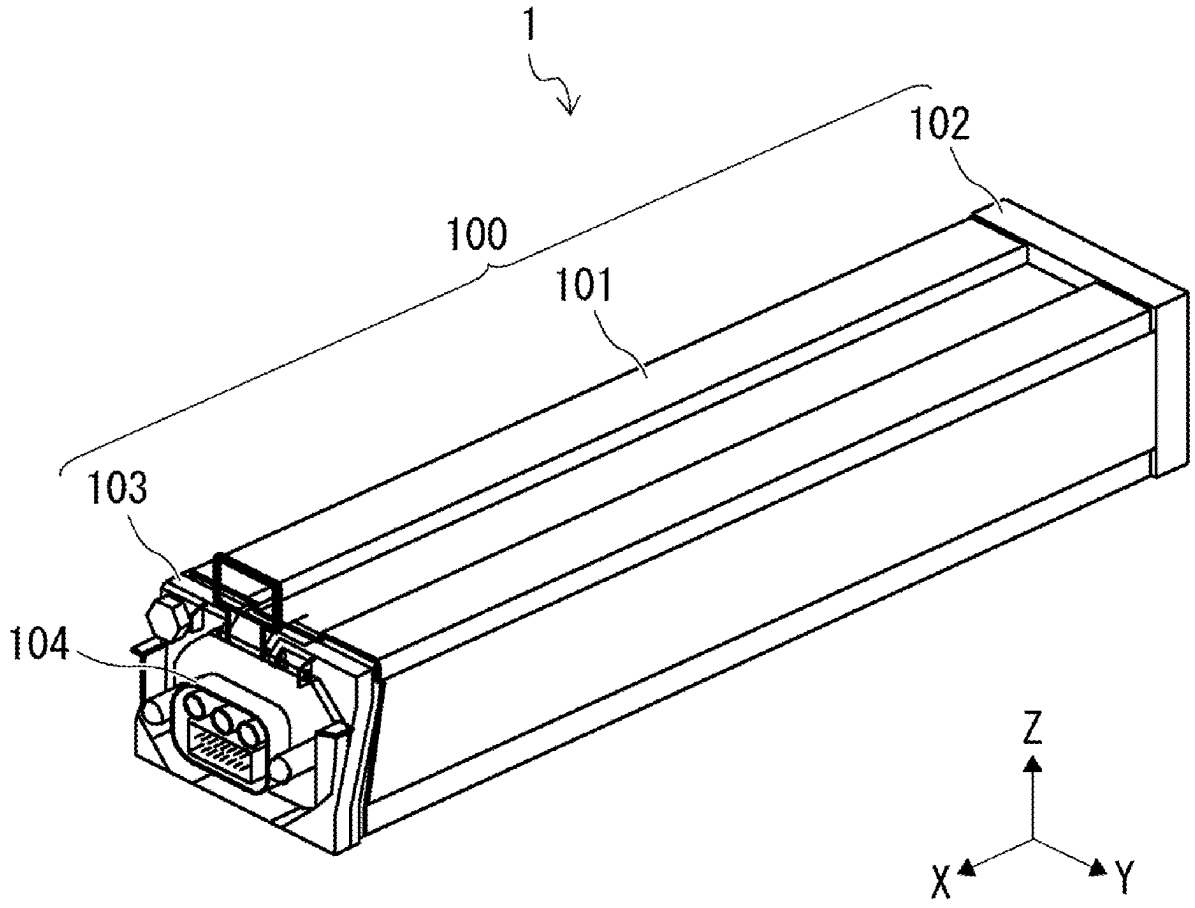
(57) **ABSTRACT**

A replaceable battery includes: a cell stack having a rectangular parallelepiped shape, in which a plurality of battery cells are stacked; a binding member for binding the cell stack; and a case for accommodating the cell stack, in which the case includes: a main body part having a rectangular tube shape and covering a side surface of the cell stack; a first lid part connected to a front end of the cell stack and configured to close an opening end at a front of the main body part having the rectangular tube shape; and a second lid part having a connector formed so as to project outwardly and be connectable to the vehicle, and connected to a rear end of the cell stack via a support rod and configured to close an opening end at a rear of the main body part having the rectangular tube shape.



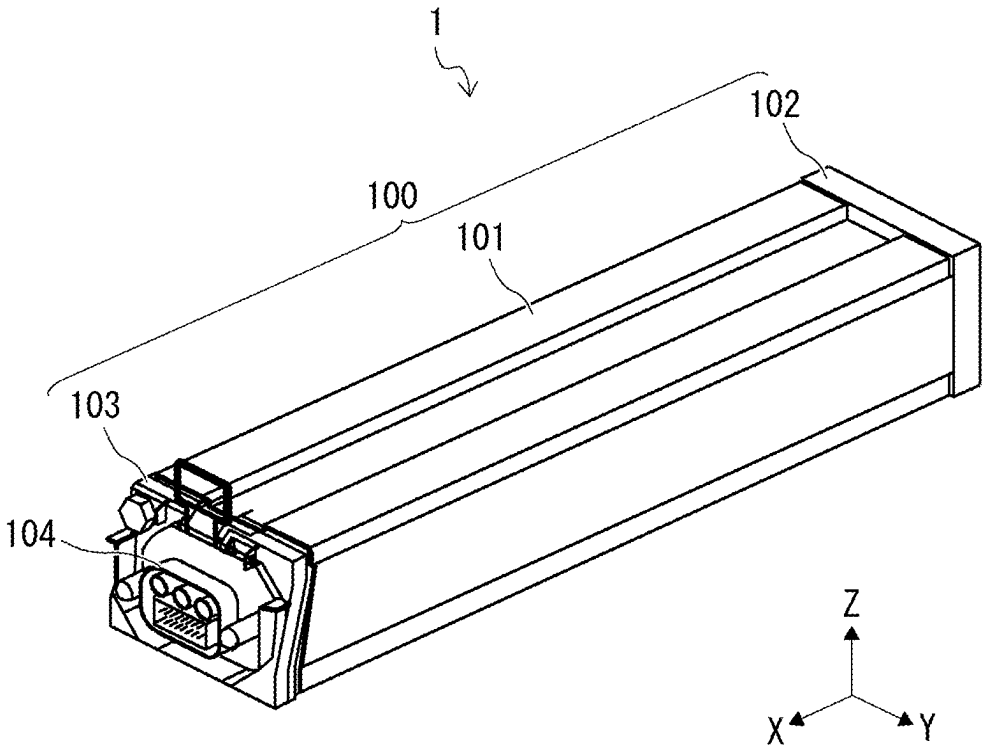


Fig. 1

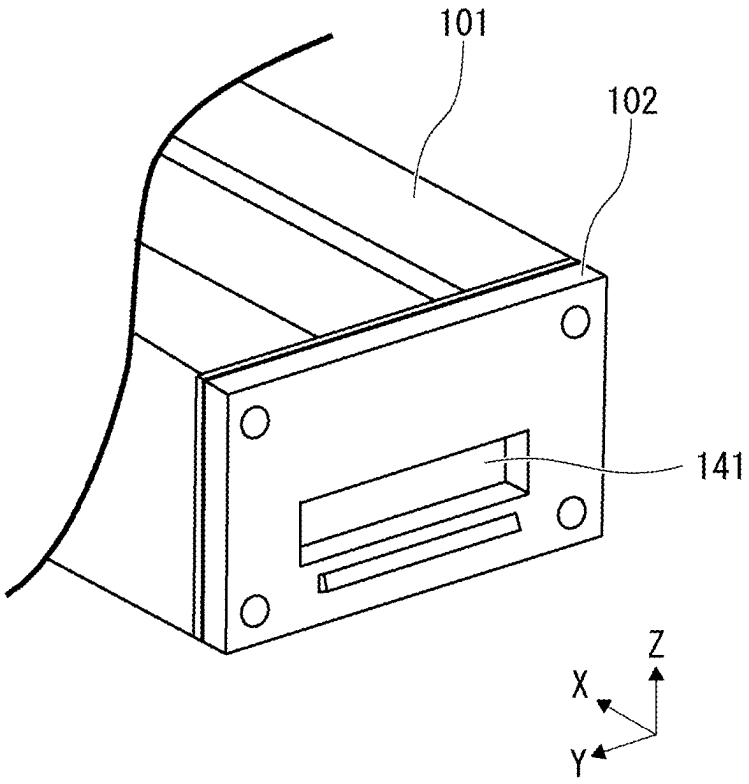


Fig. 2

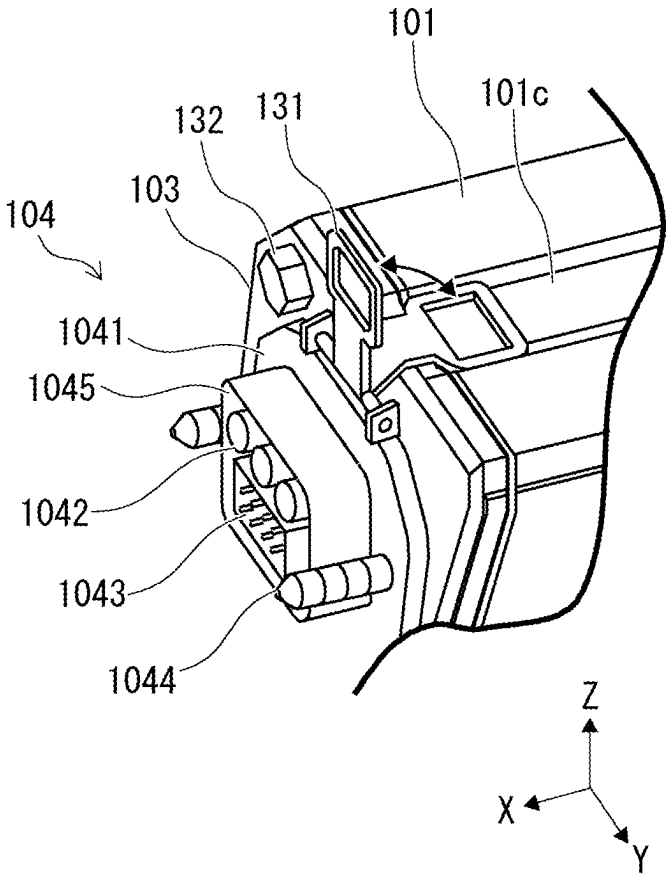


Fig. 3

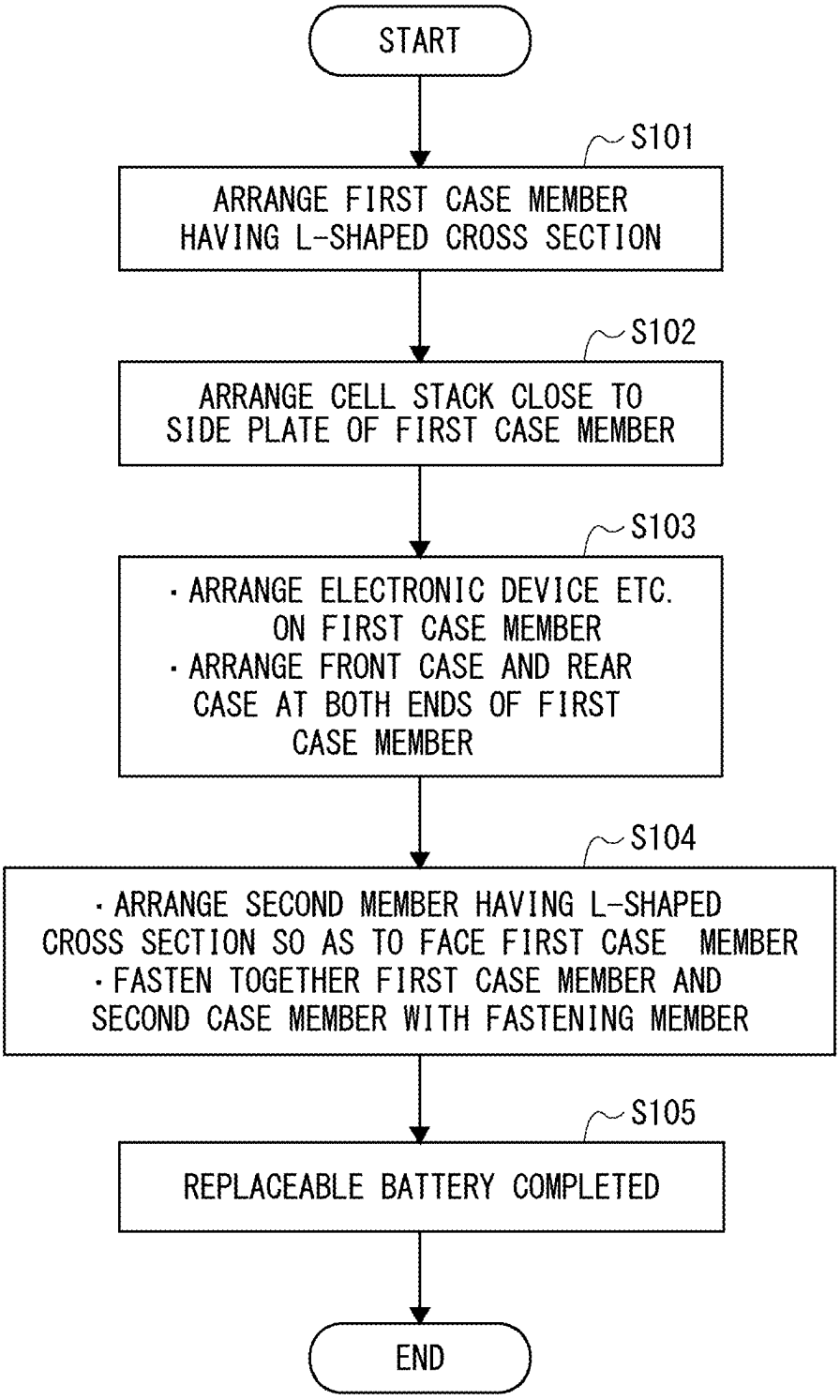

START
S101
ARRANGE FIRST CASE MEMBER HAVING L-SHAPED CROSS SECTION
S102
ARRANGE CELL STACK CLOSE TO SIDE PLATE OF FIRST CASE MEMBER
S103
・ARRANGE ELECTRONIC DEVICE ETC. ON FIRST CASE MEMBER
・ARRANGE FRONT CASE AND REAR CASE AT BOTH ENDS OF FIRST CASE MEMBER
S104
・ARRANGE SECOND MEMBER HAVING L-SHAPED CROSS SECTION SO AS TO FACE FIRST CASE MEMBER
・FASTEN TOGETHER FIRST CASE MEMBER AND SECOND CASE MEMBER WITH FASTENING MEMBER
S105
REPLACEABLE BATTERY COMPLETED
END

Fig. 4

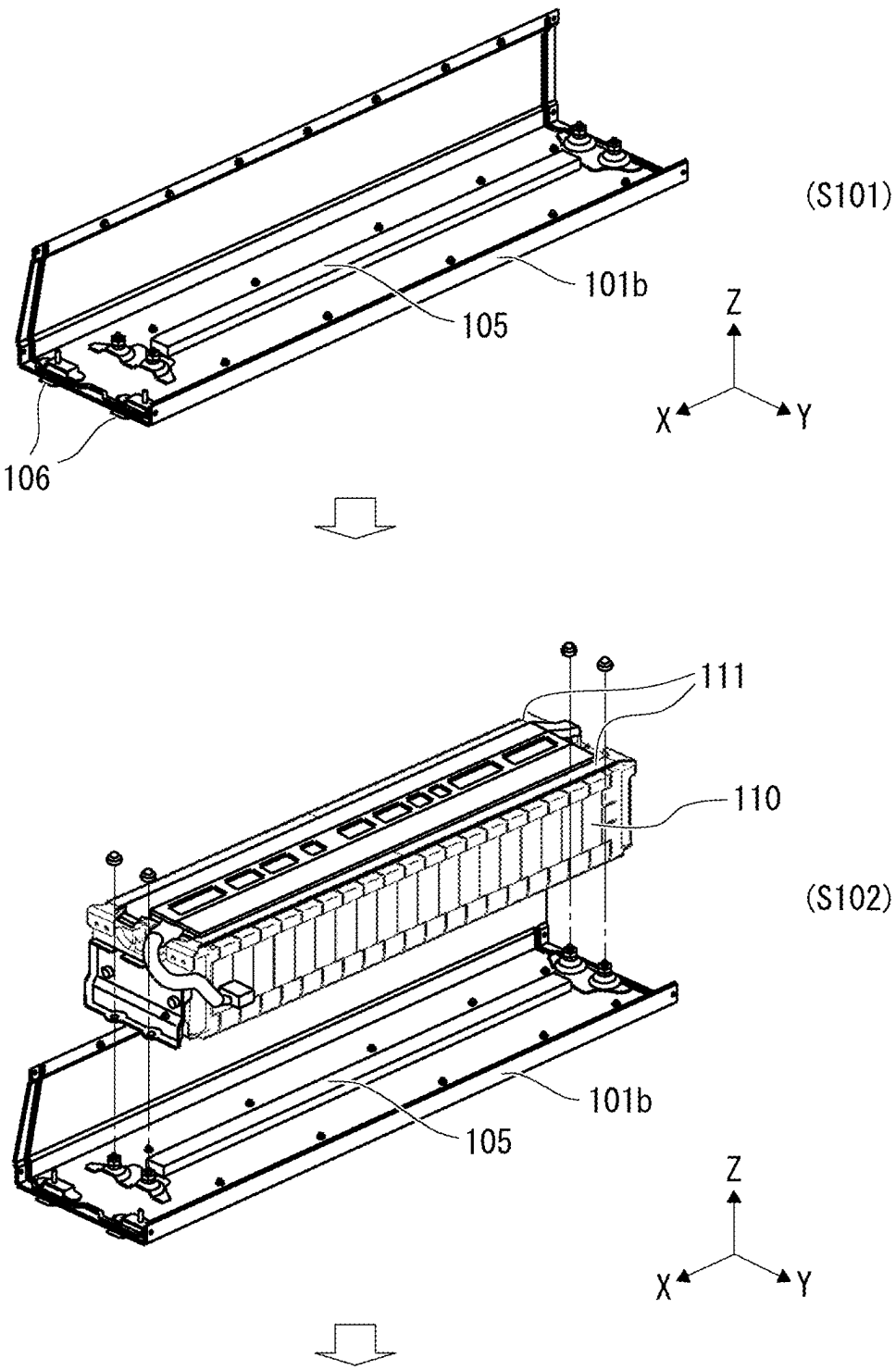
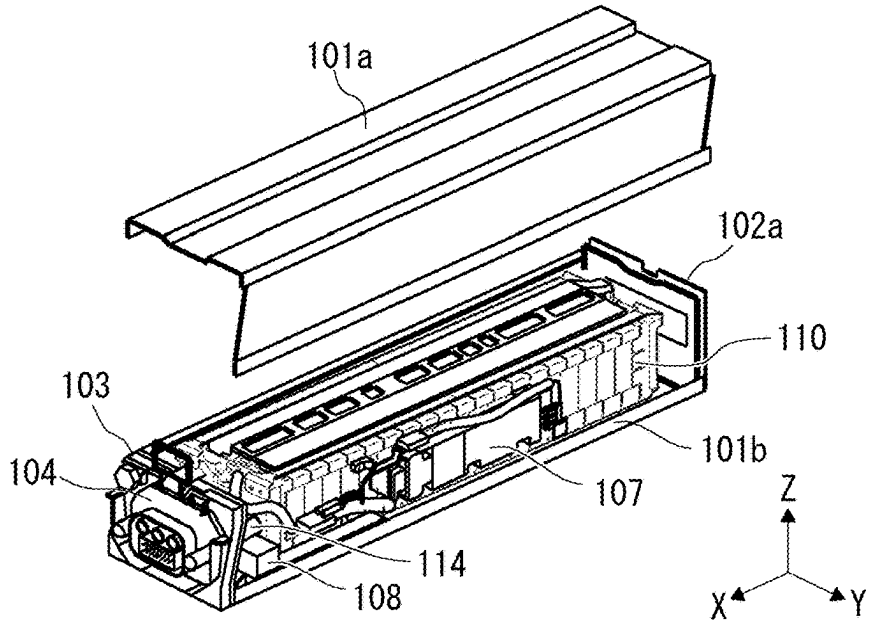
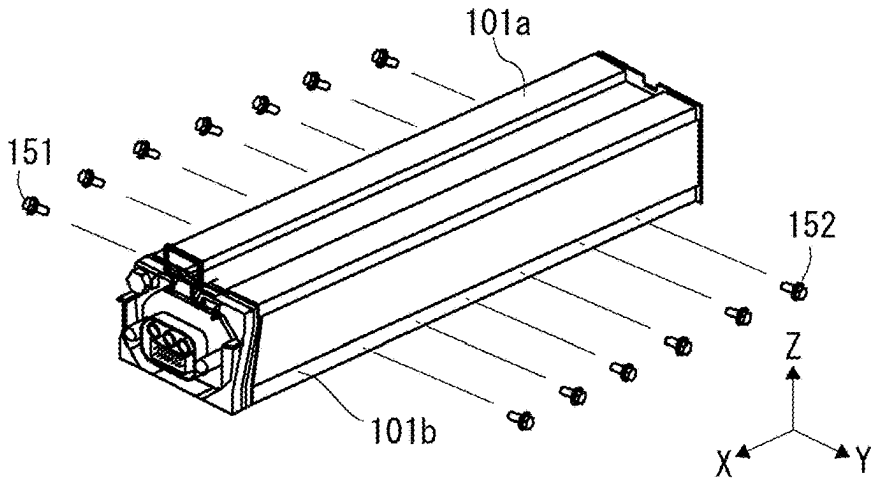


Fig. 5



(S103)



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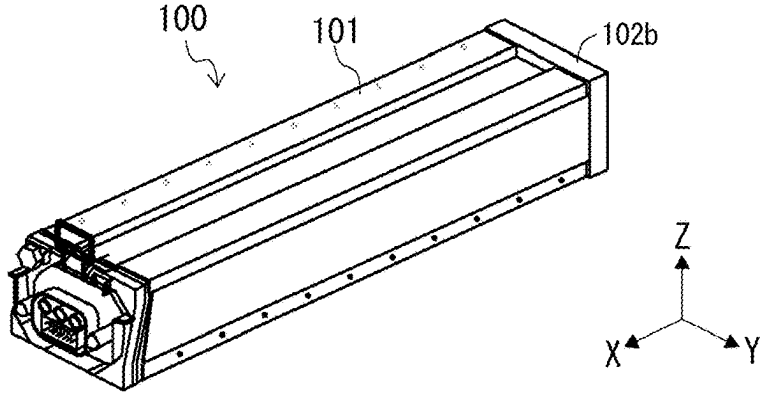

(S105)

Fig. 6

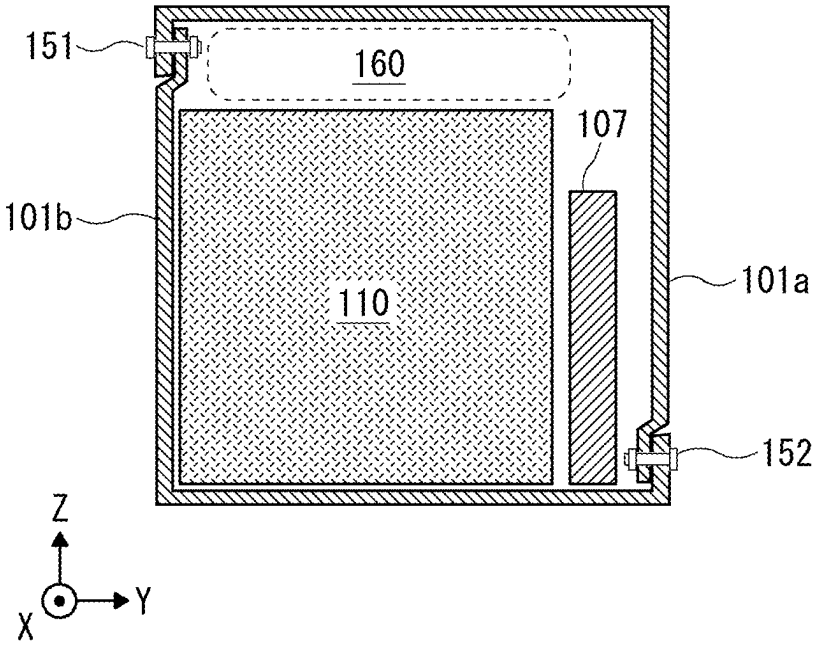

Fig. 7

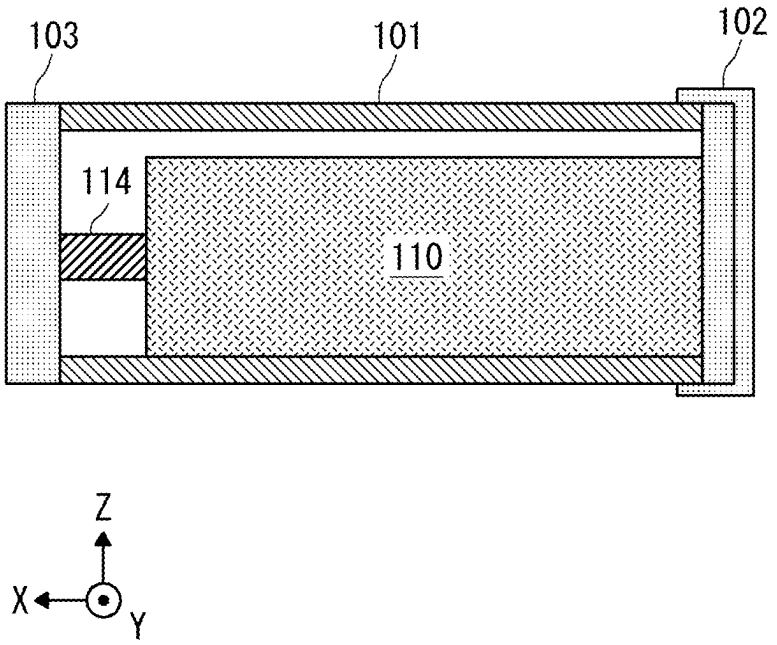

Fig. 8

REPLACEABLE BATTERY

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is based upon and claims the benefit of priority from Japanese patent application No. 2024-018931, filed on Feb. 9, 2024, the disclosure of which is incorporated herein in its entirety by reference.

BACKGROUND

[0002] The present disclosure relates to a replaceable battery.

[0003] Patent Literature 1 discloses a replaceable battery removably mounted on a vehicle.

[0004] Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2019-169337

SUMMARY

[0005] A replaceable battery is required to be lightweight while maintaining its high rigidity.

[0006] The present disclosure has been made in view of the above background, and it is an object of the present disclosure to provide a replaceable battery capable of realizing weight reduction while preventing deterioration in rigidity.

[0007] According to the present disclosure, a replaceable battery configured to be removably mounted on a vehicle includes at least:

[0008] a cell stack having a rectangular parallelepiped shape, in which a plurality of battery cells are stacked;

[0009] a binding member for binding the cell stack; and

[0010] a case for accommodating the cell stack bound by the binding member,

[0011] in which the case includes:

[0012] a main body part having a rectangular tube shape and covering a side surface of the cell stack;

[0013] a first lid part connected to a front end of the cell stack and configured to close an opening end at a front of the main body part having the rectangular tube shape; and

[0014] a second lid part having a connector formed so as to project outwardly and be connectable to the vehicle, and connected to a rear end of the cell stack via a support rod and configured to close an opening end at a rear of the main body part having the rectangular tube shape.

[0015] In the replaceable battery, the front end of the cell stack is connected to the first lid part, and rear end of cell stack is connected to the second lid part via the support rod. Thus, when a worker lifts replaceable battery, the load on the main body part of the case is reduced. Therefore, replaceable battery can reduce the thickness of the main body part of the case in which the load is reduced to reduce the weight. That is, replaceable battery can reduce the weight while preventing the deterioration of rigidity.

[0016] According to the present disclosure, it is possible to provide a replaceable battery capable of realizing weight reduction while preventing deterioration in rigidity of the replaceable battery.

[0017] 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.

BRIEF DESCRIPTION OF DRAWINGS

[0018] FIG. **1** is a schematic perspective view showing an external view of a replaceable battery according to a first embodiment;

[0019] 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;

[0020] 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;

[0021] FIG. **4** is a flowchart showing a flow of assembly of the replaceable battery according to the first embodiment;

[0022] FIG. **5** is a schematic perspective view for explaining the flow of assembly of the replaceable battery according to the first embodiment;

[0023] FIG. **6** is a schematic perspective view for explaining the flow of assembly of the replaceable battery according to the first embodiment;

[0024] FIG. **7** is a schematic cross-sectional diagram of a YZ plane of the replaceable battery according to the first embodiment; and

[0025] FIG. **8** is a schematic cross-sectional view of a ZX plane of the replaceable battery according to the first embodiment.

DESCRIPTION OF EMBODIMENTS

[0026] The present disclosure will be described hereinafter through embodiments of the present disclosure. However, the disclosure according to the claims is not limited to the following embodiments. Further, not all of the components/structures described in the embodiments are necessarily essential as means for solving the problem. For the clarification of the description, the following descriptions and the drawings are partially omitted and simplified as appropriate. The same elements are denoted by the same reference numerals or symbols throughout the drawings, and redundant descriptions are omitted, as necessary.

First Embodiment

[0027] 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 removably mounted on a vehicle such as a battery electric vehicle (BEV) driven by a motor using electricity as a power source. The replaceable battery **1** is reduced in size and weight so that, for example, a worker (including a work robot and the like) can easily insert and remove the replaceable battery **1** into and from a battery electric vehicle (BEV). The worker includes a work robot.

[0028] As shown in FIG. **1**, in the replaceable battery **1**, the outer shape of a rectangular parallelepiped shape is defined by a case **100** for accommodating a cell stack and the like. The case **100** includes a case main body (a main body part) **101** having a rectangular tube shape, a front case **102** serving as a lid part for closing one opening end of the case main body **101** (an opening part of the case main body **101** at the front end thereof), and a rear case **103** serving as a lid part for closing the other opening end of the case main body **101** (an opening part of the case main body **101** at the rear end thereof). Further, a connector **104** formed so that it protrudes outward so as to be connectable to a connector on the vehicle side is provided in the rear case **103** that is

provided at the rear end of the replaceable battery **1**. For example, a worker accommodates the replaceable battery **1** in the storage space of the vehicle while sliding the replaceable battery **1** in the longitudinal direction (the X-axis direction), whereby the connector **104** of the replaceable battery **1** is connected to the connector on the vehicle side.

[0029] 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**, a pull-handle **141** for sliding the replaceable battery **1** is provided at the front case **102**. The worker can slide the replaceable battery **1** by holding the pull-handle **141** and then pushing or pulling the replaceable battery **1**.

[0030] Further, the replaceable battery **1** can be placed on, for example, a carriage and then conveyed. When the replaceable battery **1** is taken out of the carriage so as to be accommodated in the storage space, the height of the carriage is adjusted to that of the storage space and the pull-handle **141**, so that the replaceable battery **1** is accommodated in (i.e., slid into) the storage space. On the other hand, when taking the replaceable battery **1** out of the storage space and placing it on the carriage, the height of the carriage is adjusted to that of the storage space and the replaceable battery **1** is taken out of the storage space by pulling the pull-handle **141**.

[0031] 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**, a grip-handle **131** and a relief valve **132** are provided in the rear case **103**.

[0032] The connector **104** includes a base **1041**, a high-voltage terminal **1042**, a low-voltage terminal **1043**, a pin **1044** for alignment, and a cover **1045** made of metal. The base **1041** is disposed on the main surface of the rear case **103**. All of the high-voltage terminal **1042**, the low-voltage terminal **1043**, and the pin **1044** for alignment are formed so that they protrude outward from main surface of the base **1041**. The cover **1045** is formed so that it surrounds 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 a cell stack accommodated in the case **100** of the replaceable battery **1** to a vehicle on which the replaceable battery **1** is mounted. The low-voltage terminal **1043** is a terminal for transmitting a control signal from a vehicle to the replaceable battery **1**, and for transmitting a signal indicative of a result of monitoring of a cell stack (a result of a voltage measurement etc.) from the replaceable battery **1** to a vehicle.

[0033] The relief valve **132** discharges gas generated in the cell stack accommodated 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** can be protected by the cover **1045** made of metal.

[0034] Although not shown, in a wall surface that faces the rear case **103** in the storage space of the vehicle in which the replaceable battery **1** is accommodated, an exhaust port through which gas discharged through the relief valve **132** is discharged to the outside via the vehicle is provided. The gas discharged from the relief valve **132** of the replaceable battery **1** is discharged, for example, from the lower side of the vehicle to the outside of the vehicle through a duct connected to the exhaust port. Therefore, even if gas is discharged from the relief valve **132** in a state in which the replaceable battery **1** is accommodated in the storage space of the vehicle, the gas does not flow to an area where a worker is present, and thus the safety of the worker can be ensured.

[0035] The grip-handle **131** is provided so at to be rotatable around a shaft extended along an upper edge of the rear case **103** and is placed on an upper surface of the case main body **101** when not in use. Therefore, by holding the grip-handle **131**, the replaceable battery **1** can be carried in such a way that the rear end thereof is suspended without interfering with the connection of the connector **104**.

[0036] More specifically, when carrying the replaceable battery **1**, the worker holds the rotatable grip-handle **131** with one hand to lift the replaceable battery **1** and holds the pull-handle **141** with the other hand to support the replaceable battery **1**. Thus, the worker can carry the replaceable battery **1** while stabilizing the center of gravity (keeping balance).

[0037] Here, on the upper surface of the case main body **101**, a rib groove **101***c* is formed along 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. Thus, a worker can easily accommodate the replaceable battery **1** in the storage space of a vehicle. Further, the strength of the upper surface of the case main body **101** is improved as well by forming the rib groove **101***c* on the upper surface thereof.

[0038] Note that it is preferable to reduce the thickness of the case main body **101**, and to make the thickness of the rear case **103** larger than the thickness of the case main body **101**. By reducing the thickness of the case main body **101**, the case **100** is reduced in weight, and by providing the grip-handle **131** on the thicker the rear case **103**, the deformation of the case **100** is suppressed. For example, a die-cast member is used as the rear case **103**. By this configuration, the rigidity of the rear case **103** on which the grip-handle **131** is provided is improved, and workability when the grip-handle **131** is used is also improved. In addition, by reducing the thickness of the case main body **101**, even when gas is generated in the cell stack **110**, the case main body **101** is elastically deformed and swells outward, thereby suppressing a rapid increase in the internal pressure of the case.

[0039] Next, with reference to FIGS. **4** to **6**, an object to be accommodated in the case **100** of the replaceable battery **1** will be described, and the flow of assembling the replaceable battery **1** will be described. FIG. **4** is a flowchart showing the flow of assembling 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** shown in FIGS. **5** and **6** correspond to the results of the processes of Steps S**101** to S**105** in FIG. **4**, respectively.

[0040] First, a lower case **101***b* forming the bottom plate and one side plate of the case main body **101** are disposed (Step S**101**). The lower case **101***b* is formed so that the YZ cross section thereof has an L-shape and so that it extends along the X-axis direction. A pair of rails **106** extending along the longitudinal direction (the X-axis direction) of the lower case **101***b* are disposed to the lower side of the bottom plate of the lower case **101***b*. This facilitates sliding of the replaceable battery **1** along the guide. On an upper side of the bottom plate, a metal member **105** is provided along the longitudinal direction of the lower case **101***b*. The metal

member **105** is made of, for example, aluminum or an alloy containing aluminum (i.e., an aluminum-based metal).

[0041] Thereafter, the cell stack **110** having a rectangular parallelepiped shape is arranged at the upper side of the bottom plate of the lower case **101***b* close to the side plate of the lower case **101***b* (Step S**102**). The cell stack **110** is formed by stacking a plurality of battery cells into a rectangular parallelepiped shape, the plurality of battery cells being bound together with a binding member **111** such as binding band. Here, the metal member **105** provided at an upper side of the bottom plate formed by the lower case **101***b* and at the lower side of the cell stack **110** serves to release heat of the cell stack **110** to the outside of the case **100**.

[0042] Thereafter, electronic devices such as a junction box **108** including a relay and the like and a battery monitoring apparatus **107** are further arranged on the upper side of the bottom plate of the lower case **101***b* (Step S**103**). The battery monitoring apparatus **107** includes a voltage measurement apparatus 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 area to be described later formed between the cell stack **110** and the other side plate of the case main body **101** of an area at the upper side of the bottom plate defined by the lower case **101***b*. This spatial area 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 the spatial area between the rear end of the cell stack **110** and the rear case **103** to be described later.

[0043] An inner-side case **102***a* of the front case **102** is disposed 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 disposed 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 rod **114**. Thus, the junction box **108** is arranged in the spatial area between the rear end of the cell stack **110** and the rear case **103**. Further, since the front end of the cell stack **110** is connected to the front case **102** having the pull-handle **141**, and the rear end of the cell stack **110** is connected to the rear case **103** having the grip-handle **131** via a support rod **114**, a load on the case main body **101** is reduced when an worker holds the pull-handle **141** or the grip-handle **131** and lifts the replaceable battery **1**.

[0044] The support rod **114** is formed of a high-rigidity member such as steel, for example. The support rod **114** may be formed integrally with the rear case **103** by die casting or the like. This increases the strength of the connecting part between the support rod **114** and the rear case **103**.

[0045] In the present embodiment, the description is given by way of example, of a case where the support rod **114** for connecting the rear end of the cell stack **110** and the rear case **103** is provided therebetween, but it is not limited thereto and another support rod for connecting the front end of the cell stack **110** and the front case **102** may be further provided. In this case, it is preferable that the two support rods overlap when viewed in a stacking direction (x-axis direction) of the plurality of battery cells. As a result, the stability when the replaceable battery **1** is lifted is improved.

[0046] Thereafter, the upper case **101***a* forming the 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 the YZ cross section thereof is L-shaped and extends along the X-axis direction. The upper case **101***a* and the lower case **101***b* form the case main body **101** having a rectangular tube. A spatial area **160** is provided above the cell stack **110** in an internal area of the case main body **101**. The spatial area **160** is also used as a smoke exhaust area for releasing gas generated in the cell stack **110**. For example, gas generated in the cell stack **110** is discharged from the spatial area **160** to the outside of the case **100** via the relief valve **132**.

[0047] The upper case **101***a* and the lower case **101***b* are fastened by fastening members **151**,**152** (Step S**104**). FIG. **7** is a schematic cross-sectional view of the YZ plane of the replaceable battery **1**. As shown in FIG. **7**, an end of one side plate formed by the lower case **101***b* that protrudes from the spatial area **160** is fastened to an end of the top plate formed by the upper case **101***a* by the fastening member **151**. Further, an end of the other side plate formed by the upper case **101***a* is fastened to an end of the bottom plate formed by the lower case **101***b* by the fastening member **152**. By the above configuration, the cell stack **110** can be arranged close to one side plate formed by the lower case **101***b* without being subject to interference of the fastening member **151**. As a result, for example, a spatial area sufficiently large enough for the battery monitoring apparatus **107** to be disposed therein can be secured between the cell stack **110** and the other side plate formed by the upper case **101***a*.

[0048] Then, an outer-side case **102***b* of the front case **102** is disposed at the front end of the case main body **101**. In this way, the replaceable battery **1** is completed (Step S**105**). The outer-side case **102***b* has a cap-like shape, and is attached to the front end of the case main body **101** so that it covers the opening part (the opening end) of the case main body **101** at the front end thereof together with the side surfaces of the case main body **101**. By this configuration, it is possible to, before gas is discharged through the relief valve **132**, reduce the number of occurrences of leakage of the gas from the side of the front case **102** where a worker is working.

[0049] FIG. **8** is a schematic cross-sectional view of the ZX surface of the replaceable battery **1**. As shown in FIG. **8**, in the replaceable battery **1**, the front end of the cell stack **110** is connected to the front case **102** having the pull-handle **141**, and the rear end of the cell stack **110** is connected to the rear case **103** having the grip-handle **131** through the support rod **114**. This reduces the load on the case main body **101** when the worker holds the pull-handle **141** and the grip-handle **131** and lifts the replaceable battery **1**.

[0050] Thus, in the replaceable battery **1** according to the present disclosure, the front end of the cell stack **110** and the front case **102** having the pull-handle **141** are connected, and the rear end of the cell stack **110** and the rear case **103** having the grip-handle **131** are connected through the support rod **114**. Thus, when a worker holds the pull-handle **141** and the grip-handle **131** and lifts the replaceable battery **1**, the load on the case main body **101** is reduced. Therefore, the replaceable battery **1** can reduce the thickness of the case main body **101** with the reduced load, thereby reducing the weight. That is, the replaceable battery **1** can realize weight reduction while preventing deterioration in rigidity of the replaceable battery.

[0051] In the replaceable battery **1** according to the present disclosure, a heavy cell stack is arranged to one side in the case. Therefore, the worker is apt to lose balance when carrying the replaceable battery **1** due to the deviation of the center of gravity of the replaceable battery **1**. On the other

hand, in the replaceable battery **1** according to the present disclosure, as described above, the replaceable battery **1** can be lifted by holding the rotatable the grip-handle **131** and carrying the replaceable battery in such a way that the rear end thereof is suspended. More specifically, when carrying the replaceable battery **1**, the worker holds the rotatable the grip-handle **131** with one hand to lift the replaceable battery **1** and holds the pull-handle **141** with the other hand to support the replaceable battery **1**. Thus, the worker can carry the replaceable battery **1** while stabilizing the center of gravity (keeping balance).

[0052] In the replaceable battery according to the present disclosure, since the case main body is composed of a pair of members having an L-shaped cross section, it is easy to accommodate an object to be accommodated such as a cell stack in a case upon assembly of the cell stack. That is, the replaceable battery according to the present disclosure improves workability during assembly.

[0053] 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.

What is claimed is:

1. A replaceable battery configured to be removably mounted on a vehicle, comprising at least:

a cell stack having a rectangular parallelepiped shape, in which a plurality of battery cells are stacked;

a binding member for binding the cell stack; and

a case for accommodating the cell stack bound by the binding member,

wherein the case comprises:

a main body part having a rectangular tube shape and covering a side surface of the cell stack;

a first lid part connected to a front end of the cell stack and configured to close an opening end at a front of the main body part having the rectangular tube shape; and

a second lid part having a connector formed so as to project outwardly and be connectable to the vehicle, and connected to a rear end of the cell stack via a support rod and configured to close an opening end at a rear of the main body part having the rectangular tube shape.

2. The replaceable battery according to claim **1**, wherein the binding member comprises:

a strip-shaped member extending along a stacking direction of the plurality of the battery cells;

a grip part provided at both end parts of the strip-shaped member for gripping the cell stack at both ends thereof.

3. The replaceable battery according to claim **1**, further comprising a relay provided between the connector and the cell stack,

wherein the relay is disposed in a spatial area between the second lid part and the rear end of the cell stack.

4. The replaceable battery according to claim **1**, wherein

the battery is mounted on and removed from the vehicle by being slid in a longitudinal direction,

the first lid part includes a pull-handle, and

the second lid part includes a grip-handle.

5. The replaceable battery according to claim **4**, wherein

a rib groove is extended on an upper surface of the main body part in a longitudinal direction of the main body part, and

the grip-handle is accommodated in the rib groove when not in use.

* * * * *