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(54) **ENERGY STORAGE APPARATUS**

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(57) **ABSTRACT**

An energy storage apparatus includes an energy storage assembly including a spacer including a spacer main body, and a first energy storage device on one side in a first direction of the spacer main body, where the spacer main body includes a first surface opposed to the first energy storage device, and a second surface at a position in a second direction of the first surface intersecting the first direction, the position being recessed relative to the first surface, the energy storage assembly includes a first opening connecting a first space between the second surface and the first energy storage device to an external space, and being positioned in the second direction of the energy storage assembly, and the spacer protrudes on the one side in the first direction from the spacer main body, and includes a first wall opposed to the first energy storage device in the second direction.

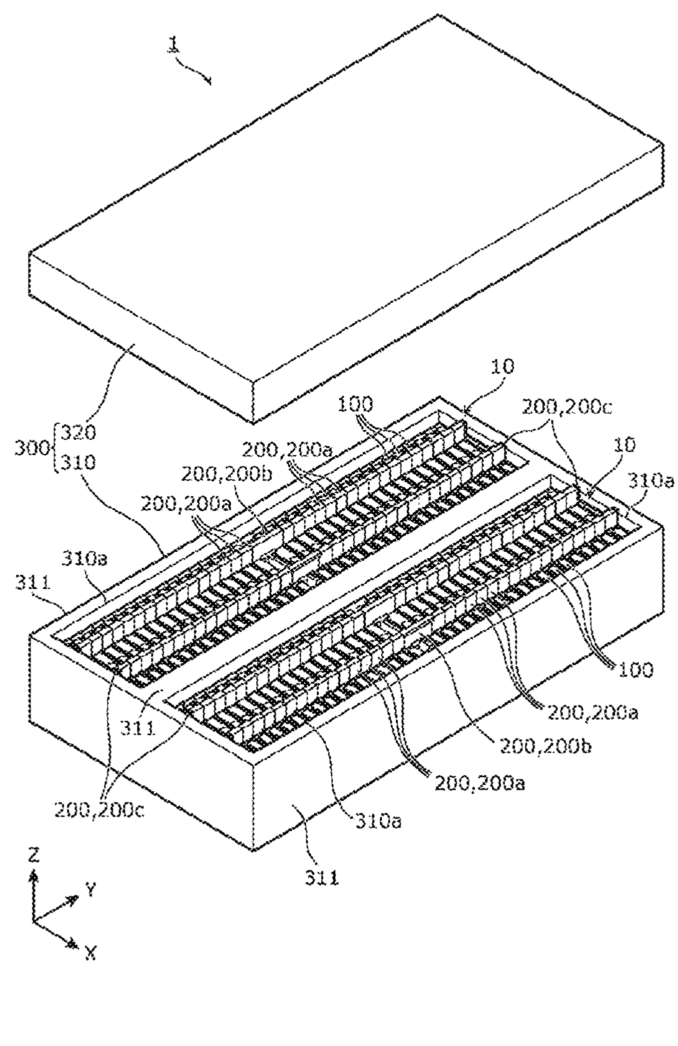

FIG. 1

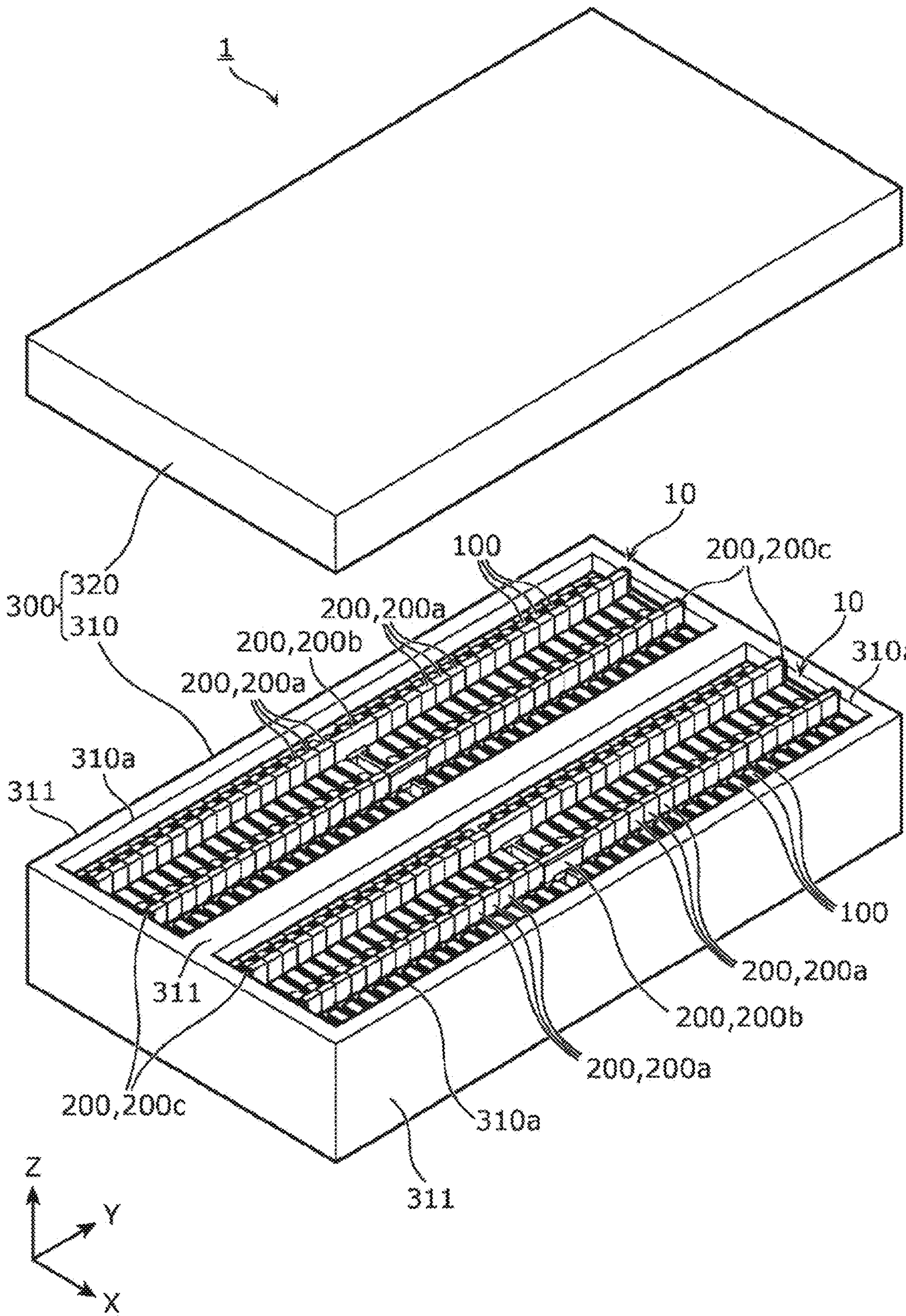
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FIG. 2

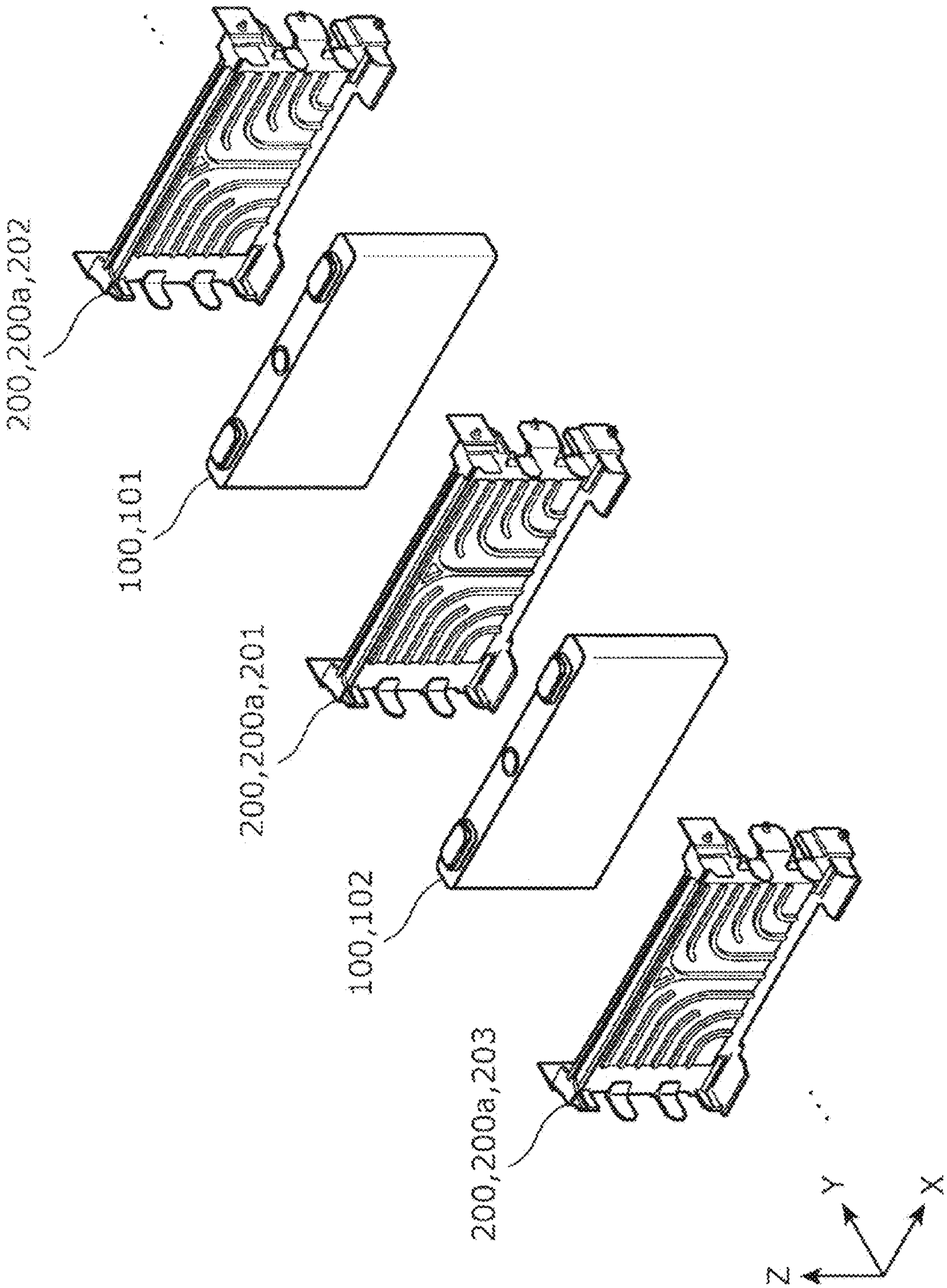
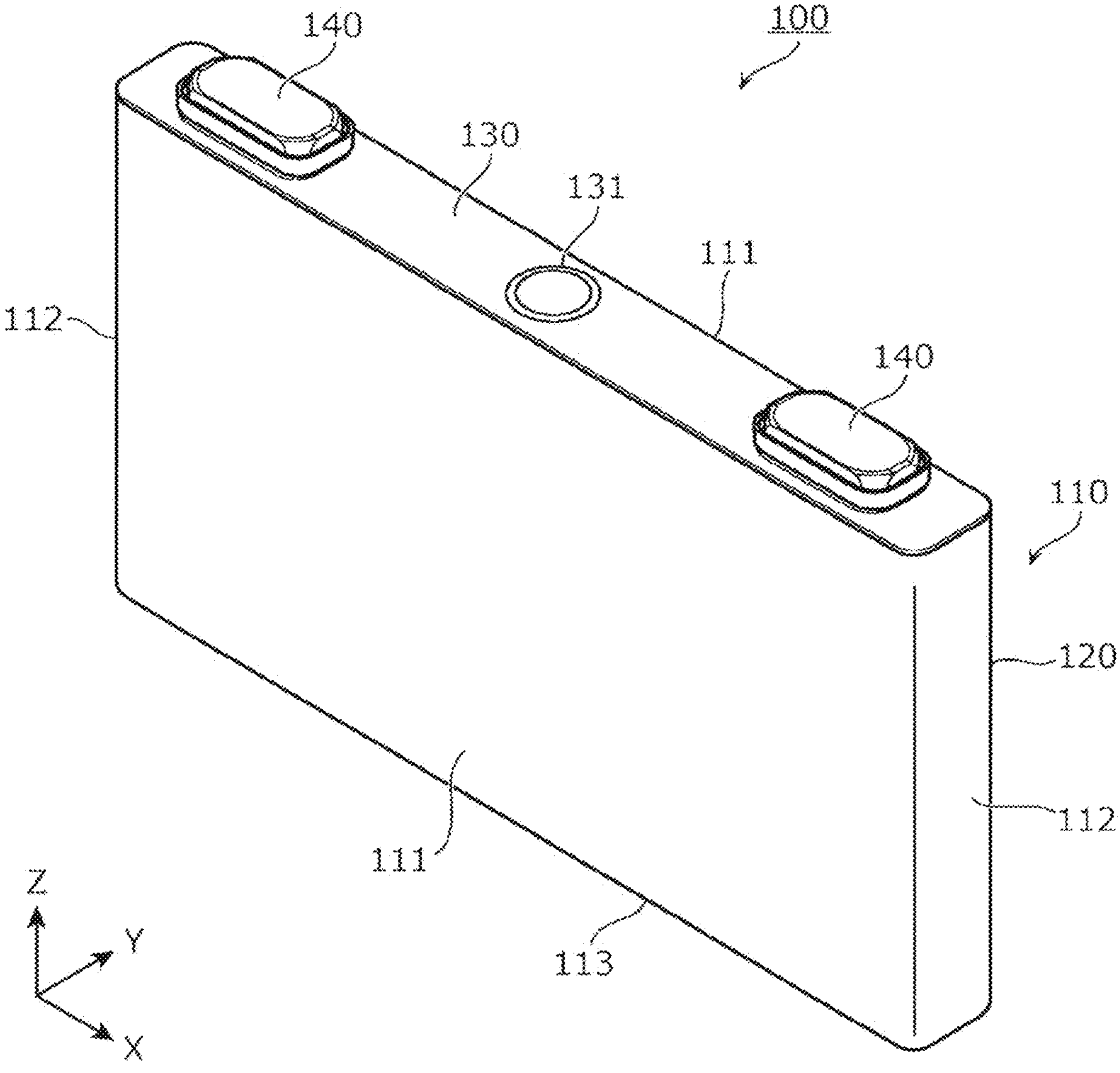
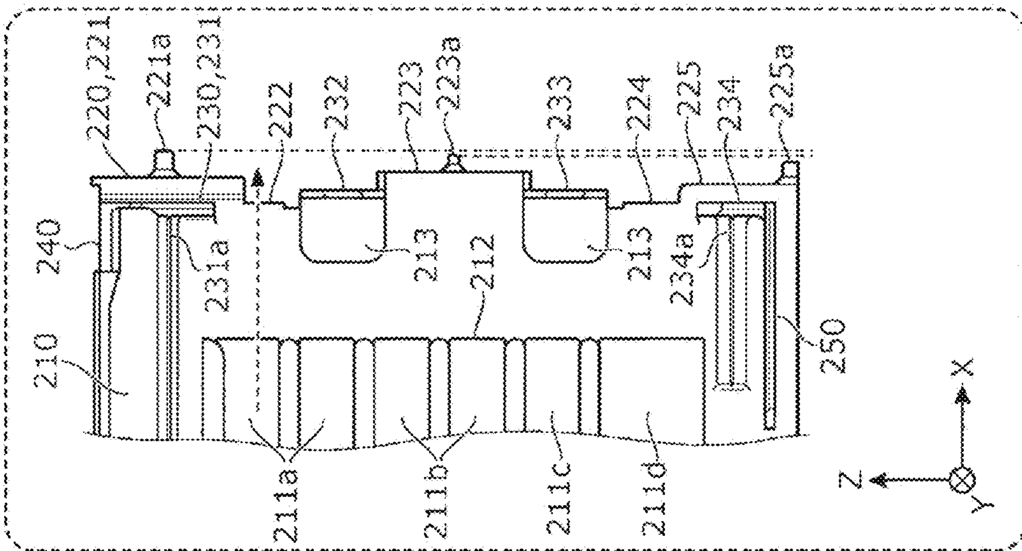


FIG. 3





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211d
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FIG. 4B

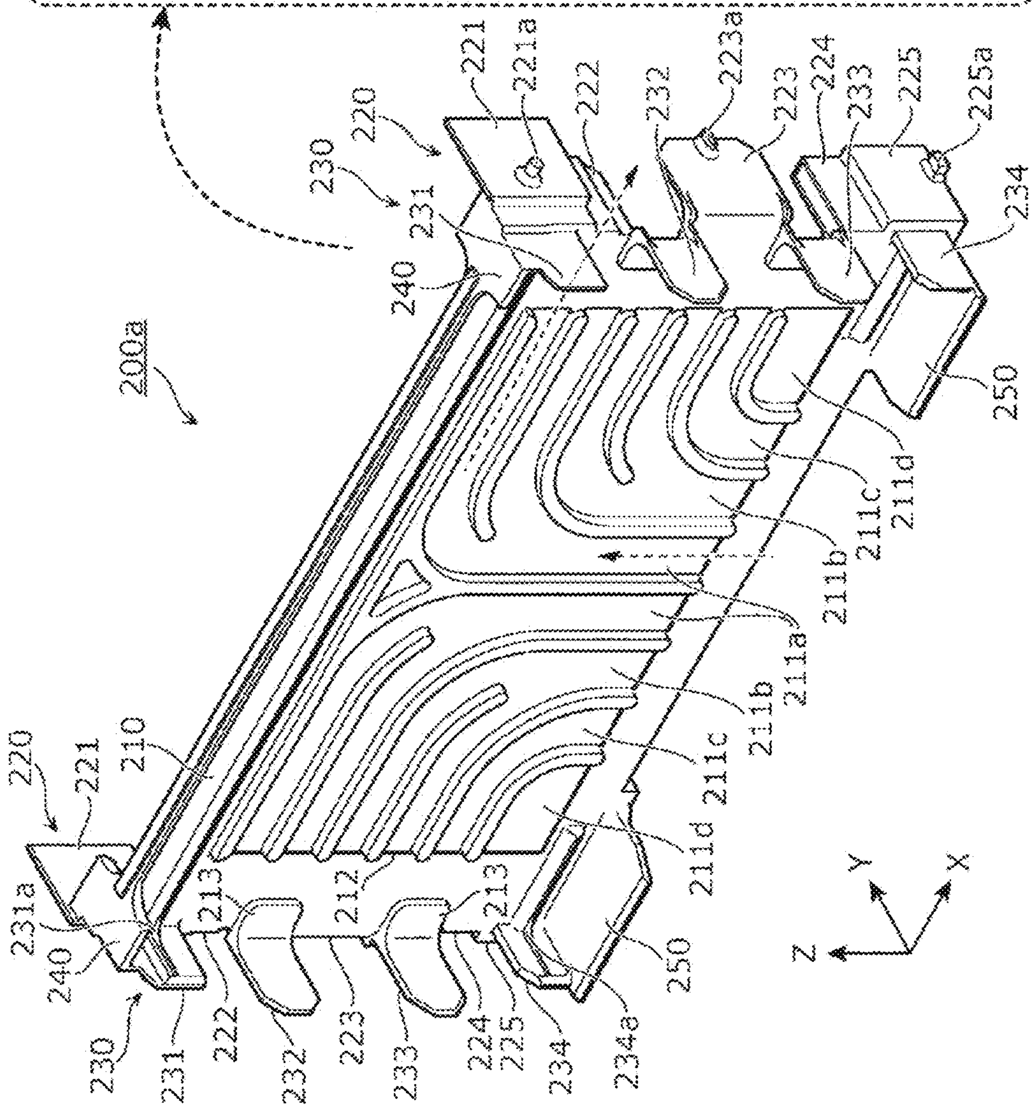

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FIG. 4A

FIG. 5B

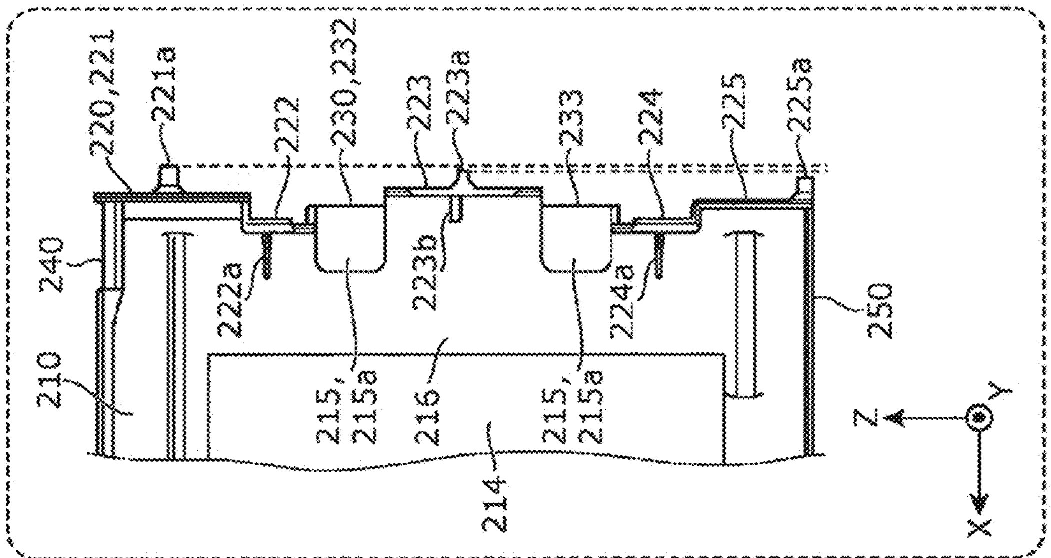
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FIG. 5A

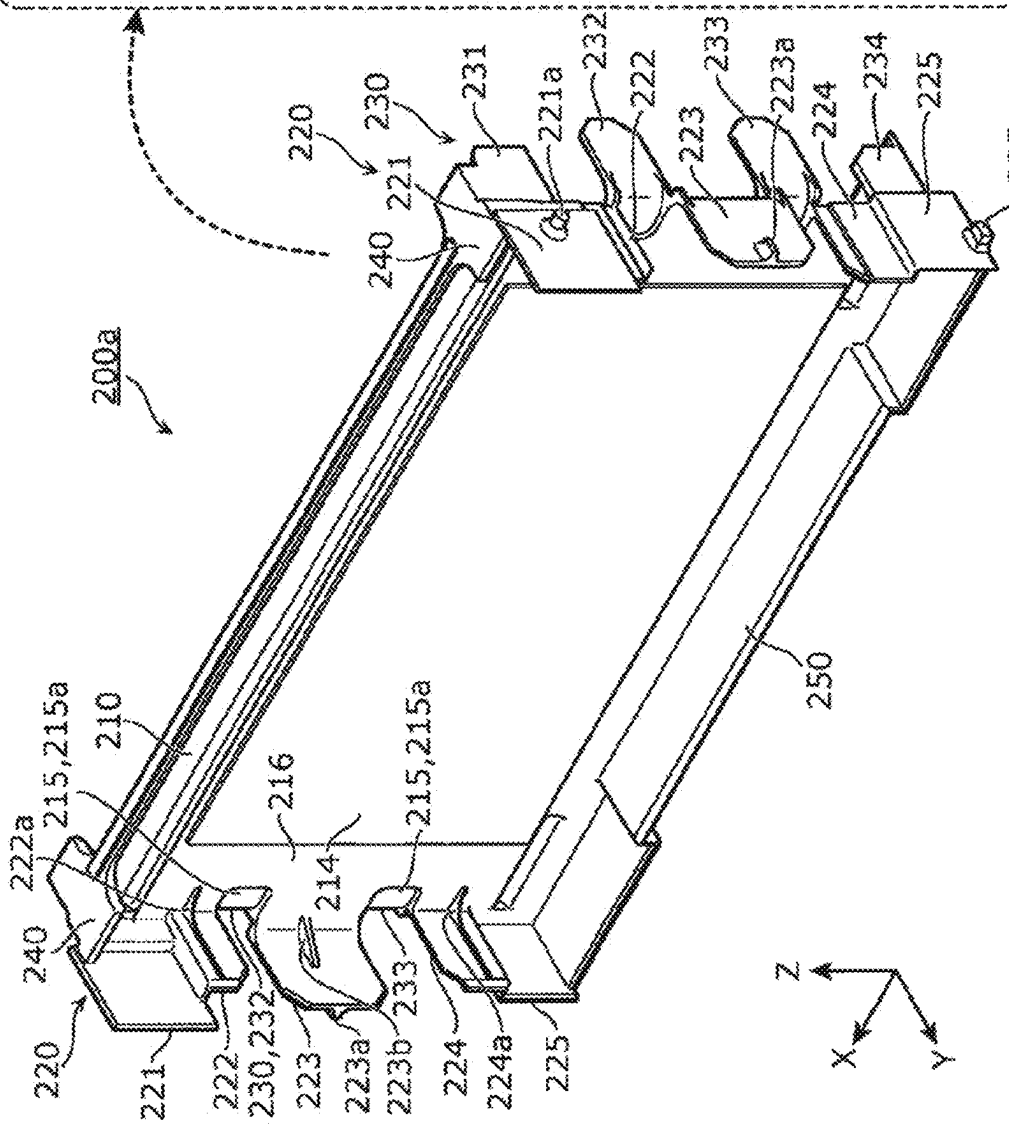
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FIG. 6

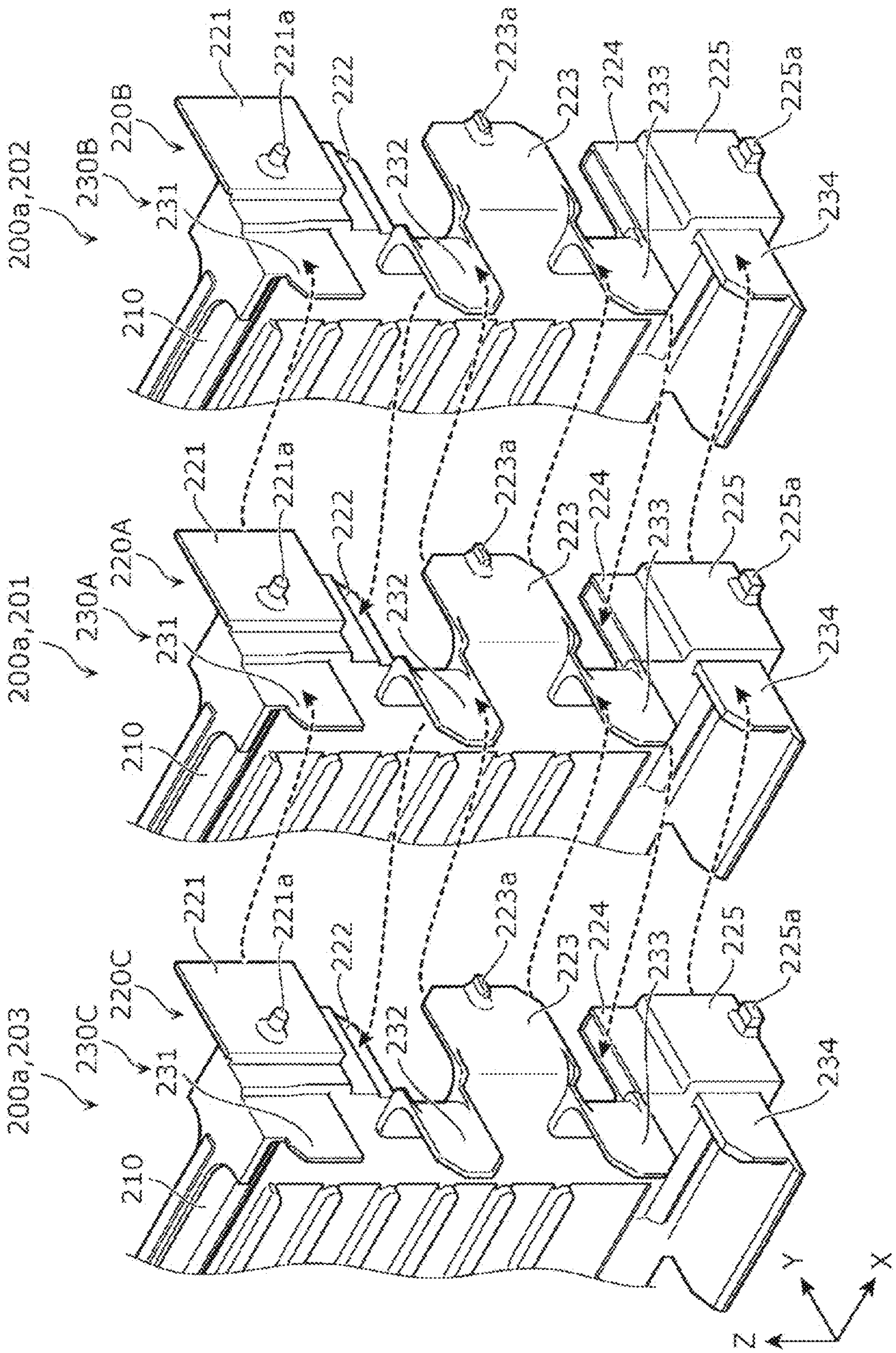
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FIG. 7

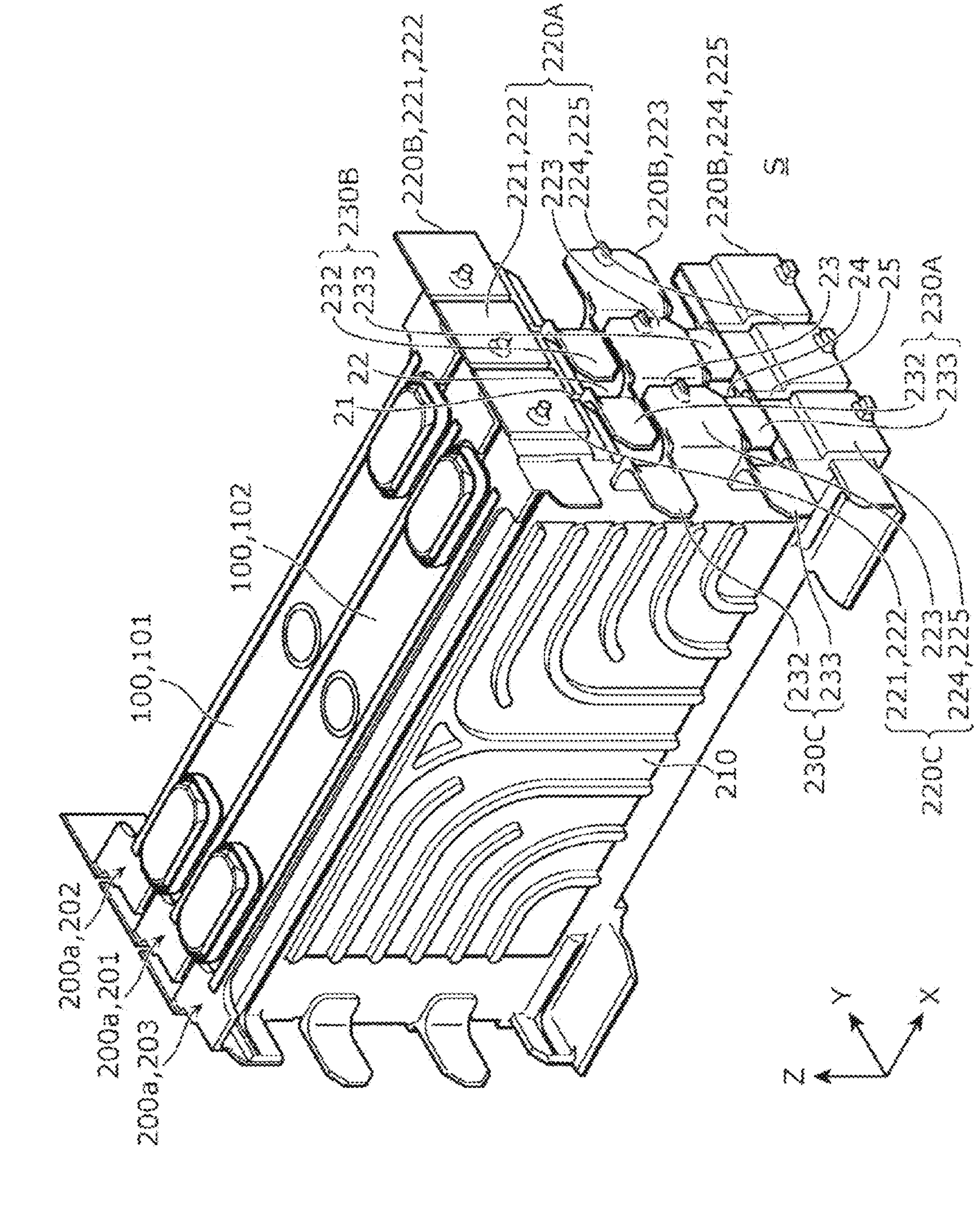
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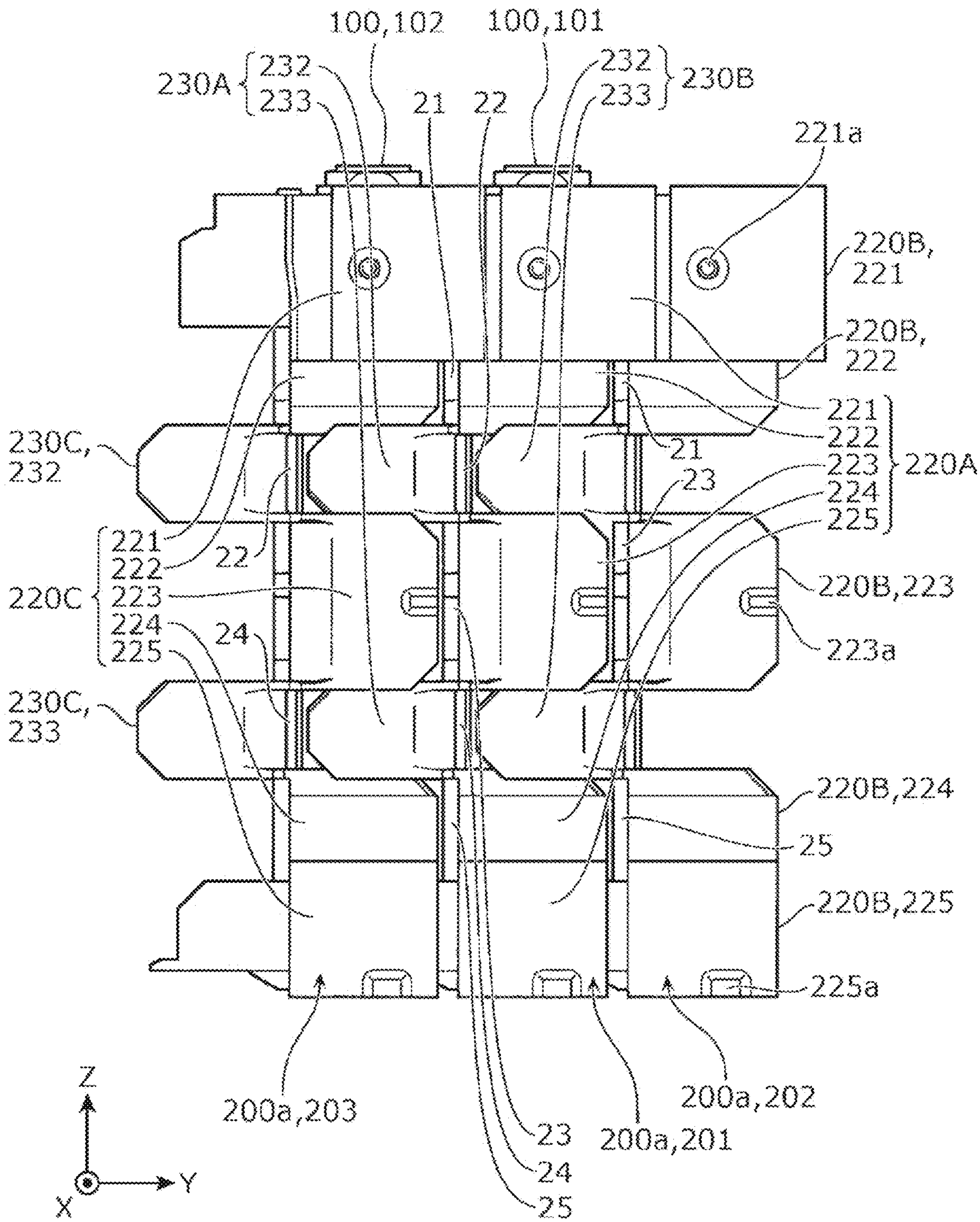
FIG. 8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200a,202
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200a,201
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ENERGY STORAGE APPARATUS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority to Japanese Patent Application No. 2022-178939 filed on Nov. 8, 2022 and is a Continuation Application of PCT Application No. PCT/JP2023/039067 filed on Oct. 30, 2023. The entire contents of each application are hereby incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention relates to energy storage apparatuses that each include an energy storage device and a spacer.

2. Description of the Related Art

[0003] Conventionally, an energy storage apparatus that includes an energy storage device and a spacer is widely known. For example, JP 2008-277085 A discloses a battery pack (energy storage apparatus) that includes a battery block in which battery cells (energy storage devices) are stacked via spacers, in which, in the battery block, a ventilation duct is provided between the stacked battery cells by a spacer.

[0004] In an energy storage apparatus, during manufacturing, assembly work is occasionally performed by holding short side surfaces of the energy storage devices by a jig. In such a case, no other structure can be positioned on the short side surfaces of the energy storage devices, and there is a concern that the short side surfaces of the energy storage devices cannot be insulated. In this regard, such an approach can be considered in which a jig is inserted between the energy storage devices and the spacers to hold the energy storage devices during assembly work. For example, in the energy storage apparatus disclosed in JP 2008-277085 A, a jig can be inserted into the ventilation duct between the energy storage devices and the spacers. However, in this energy storage apparatus, a plurality of convex stripes are provided in a spacer to form a ventilation duct, and there is a need to restrain swelling of the energy storage devices by these convex stripes, and thus there is a possibility that the swelling of the energy storage devices cannot be effectively restrained. In the energy storage apparatus, the short side surfaces of the energy storage devices are exposed from the ventilation hole of the cable tie, and therefore there is a concern that the energy storage devices are not sufficiently insulated. In this way, in the conventional energy storage apparatus, it is difficult to balance both an improvement in workability during manufacturing and maintenance of performance.

SUMMARY OF THE INVENTION

[0005] Example embodiments of the present invention provide energy storage apparatuses in each of which workability during manufacturing is improved while performance is maintained.

[0006] An energy storage apparatus according to an example embodiment of the present invention includes an energy storage assembly including a spacer including a spacer main body, and a first energy storage device positioned on one side in a first direction of the spacer main body, where the spacer main body includes a first surface opposed to the first energy storage device, and a second surface at a position in a second direction of the first surface, the second direction intersecting the first direction, the position being recessed relative to the first surface, the energy storage assembly includes a first opening which connects a first space between the second surface and the first energy storage device to an external space outside the energy storage assembly, being positioned in the second direction of the energy storage assembly, and the spacer protrudes on the one side in the first direction from the spacer main body, and includes a first wall opposed to the first energy storage device in the second direction.

[0007] According to energy storage apparatuses of example embodiments of the present invention, workability during manufacturing is improved while performance is maintained.

[0008] The above and other elements, features, steps, characteristics and advantages of the present invention will become more apparent from the following detailed description of the example embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1** is a perspective view illustrating a configuration of an energy storage apparatus according to an example embodiment of the present invention.

[0010] FIG. **2** is an exploded perspective view of an energy storage device and a spacer included in an energy storage assembly included in the energy storage apparatus according to an example embodiment of the present invention.

[0011] FIG. **3** is a perspective view illustrating a configuration of the energy storage device according to an example embodiment of the present invention.

[0012] FIGS. **4**A and **4**B are a perspective view and a front view illustrating a configuration of a spacer according to an example embodiment of the present invention.

[0013] FIGS. **5**A and **5**B are a perspective view and a rear view illustrating a configuration of a spacer according to an example embodiment of the present invention.

[0014] FIG. **6** is a perspective view illustrating a configuration of a spacer wall of a first spacer, a second spacer, and a third spacer, according to an example embodiment of the present invention.

[0015] FIG. **7** is a perspective view illustrating a configuration of a first spacer, a second spacer, and a third spacer in a state in which they are positioned with respect to the energy storage device, according to an example embodiment of the present invention.

[0016] FIG. **8** is a side view illustrating a configuration of a first spacer, a second spacer, and a third spacer in a state in which they are positioned with respect to the energy storage device, according to an example embodiment of the present invention.

DETAILED DESCRIPTION OF THE EXAMPLE EMBODIMENTS

[0017] (1) An energy storage apparatus according to an example embodiment of the present invention includes an energy storage assembly including a spacer including a spacer main body, and a first energy storage device positioned on one side in a first direction of the spacer main body

body, where the spacer main body includes a first surface opposed to the first energy storage device, and a second surface at a position in a second direction of the first surface, the second direction intersecting the first direction, the position being recessed relative to the first surface, the energy storage assembly includes a first opening which connects a first space between the second surface and the first energy storage device to an external space outside the energy storage assembly, being positioned in the second direction of the energy storage assembly, and the spacer protrudes on the one side in the first direction from the spacer main body, and includes a first wall opposed to the first energy storage device in the second direction.

[0018] According to this, in the energy storage apparatus, the spacer main body of the spacer includes a second surface at a position recessed relative to a first surface opposed to the first energy storage device, and in a second direction of the first surface, and the energy storage assembly includes a first opening which connects a first space between the second surface and the first energy storage device to an external space outside the energy storage assembly. In this way, in addition to including a first surface opposed to the first energy storage device, the spacer main body includes a second surface at a position in a second direction of the first surface, the position being recessed relative to the first surface, thus restraining the swelling of the first energy storage device by the first surface and providing a first space by the second surface. Since the energy storage assembly includes a first opening which connects the first space (internal space of the energy storage assembly) to an external space outside the energy storage assembly, the first energy storage device can be held by inserting a jig into the first space from the first opening, and therefore, workability during manufacturing can be improved. Furthermore, since the spacer includes a first wall opposed to the first energy storage device in the second direction, insulation of the first energy storage device in the second direction is ensured using the first wall. Due to these reasons, workability during manufacturing is improved while performance is maintained in the energy storage apparatus.

[0019] (2) In the energy storage apparatus according to the above item (1), an area of the first surface may be larger than an area of the second surface.

[0020] According to this, because an area of the first surface is larger than an area of the second surface in the spacer, even when the spacer main body is recessed to provide a second surface which defines a first space, the swelling of the first energy storage device can be effectively restrained by the first surface.

[0021] (3) In the energy storage apparatus according to the above (1) or (2), the spacer main body may further include a third surface recessed relative to the first surface, and the second surface may be recessed relative to the third surface.

[0022] According to this, in the spacer, the spacer main body includes a third surface recessed relative to the first surface, and a second surface recessed relative to the third surface. As a result, the first surface protrudes beyond the third surface, and the second surface is recessed relative to the third surface. Therefore, since the first surface which reduces or prevents swelling of the first energy storage device protrudes from the third surface, and the second surface which defines the first space is recessed from the third surface, the first surface and the second surface can be structured in desired shapes at desired positions.

[0023] (4) In the energy storage apparatus according to any one of the above (1) to (3), the spacer may further include a second wall which protrudes on an other side in the first direction from a position of the first opening in the spacer main body.

[0024] According to this, the spacer includes a second wall. As a result, insulation of an other energy storage device positioned on an other side in the first direction of the spacer main body in the second direction is ensured using the second wall.

[0025] (5) In the energy storage apparatus according to any one of the above (1) to (4), the first wall may be positioned such that an edge thereof on the one end in the first direction overlaps the first energy storage device, when viewed from the second direction.

[0026] According to this, an edge (tip end) on one side in the first direction of the first wall of the spacer overlaps the first energy storage device when viewed from the second direction. Accordingly, the first wall does not protrude from the first energy storage device. Therefore, it is possible to restrain the first wall from becoming an obstacle when a jig is inserted toward the one direction in the first direction of the first energy storage device.

[0027] (6) In the energy storage apparatus according to any one of the above (1) to (5), the energy storage assembly may further include a second energy storage device positioned on an other side in the first direction of the spacer main body, and a second opening positioned on the other side in the first direction of the first wall and in a position different from the first opening, the second opening connecting a second space between the spacer main body and the second energy storage device to the external space, and the second space is a flow path for a fluid that flows between the spacer main body and the second energy storage device.

[0028] According to this, the energy storage assembly includes a second opening which connects a second space (an internal space of the energy storage assembly) between the spacer main body of the spacer and the second energy storage device to an external space of the energy storage assembly. The second space is a flow path for a fluid that flows between the spacer main body and the second energy storage device. Accordingly, by using, as the second space, a flow path for a fluid that flows between the spacer main body and the second energy storage device, a jig can be inserted into the flow path (the second space) from the second opening, and therefore the second energy storage device can be held with a simple configuration.

[0029] The following describes energy storage apparatuses according to example embodiments and modifications thereof, with reference to the drawings. Each of the example embodiments described below is either a comprehensive or a specific example. A numerical value, a shape, a material, an included structure, a position and coupling configuration of the included structures, manufacturing processes, an order of manufacturing processes, and the like, which are described in the following example embodiments, are merely examples, and are not intended to limit the present invention. In the drawings, dimensions, and the like, are not strictly illustrated. In the drawings, same or similar included structures are assigned a same or similar reference numeral.

[0030] In the following description and in the drawings, a positioning direction in which a pair of terminals included in an energy storage device position, or a facing direction in which a pair of short side surfaces of a container of an energy storage device faces each other, or a positioning direction of the energy storage assemblies, is defined to be an X-axis direction. A facing direction in which a pair of long side surfaces of a container of an energy storage device faces each other, a thickness direction (flat direction) of a container of an energy storage device, a positioning direction in which a plurality of energy storage devices included in an energy storage assembly or a plurality of spacers are positioned, or a positioning direction in which spacers and energy storage devices included in an energy storage assembly are positioned, is defined to be a Y-axis direction. A protruding direction in which a terminal of an energy storage device protrudes, a positioning direction in which a container main body and a container lid portion of an energy storage device position, a positioning direction in which a case main body and a lid of a case are positioned, a facing direction in which an opening and a bottom wall of a case main body face each other, or an up-down direction is defined as a Z-axis direction. The X-axis direction, the Y-axis direction, and the Z-axis direction are directions intersecting each other (orthogonal to each other in the present example embodiment). Although there may be case where the Z-axis direction does not conform to the up-down direction depending on a use mode, the Z-axis direction is described as the up-down direction in the following for convenience of description.

[0031] In the following description, an X-axis positive direction indicates a direction of an arrow in the X-axis, and an X-axis negative direction indicates a direction opposite to the X-axis positive direction. When simply referred to as the X-axis direction, it indicates both or one of the X-axis positive direction and the X-axis negative direction. When referred to as one side and an other side in the X-axis direction, it indicates one and the other of the X-axis positive direction and the X-axis negative direction. The same applies to the Y-axis direction and the Z-axis direction. Hereinafter, the Y-axis direction is also referred to as a first direction, the X-axis direction is also referred to as a second direction, and the Z-axis direction is also referred to as a third direction. That is, the first direction, the second direction, and the third direction are directions intersecting each other (orthogonal to each other in the present example embodiment). Expressions indicating relative directions or postures, such as parallel and orthogonal, include cases where the directions or postures are not parallel or orthogonal in a strict sense. For example, two directions being parallel to each other means not only that the two directions are completely parallel to each other, but also that the two directions are substantially parallel to each other, in other words, a difference by several percent or so, for example, is included in the scope. In the following description, when the expression "insulative properties" is used, "insulative properties" is intended as "electrical insulative properties".

[0032] First, a schematic configuration of an energy storage apparatus **1** according to the present example embodiment is described. FIG. **1** is a perspective view illustrating a configuration of an energy storage apparatus **1** according to the present example embodiment. FIG. **1** illustrates a state in which the lid **320** is removed from the case main body **310** of the case **300** in the energy storage apparatus **1**. Accordingly, two energy storage assemblies **10**, positioned inside the case **300**, are illustrated in FIG. **1**. FIG. **2** is an exploded perspective view of an energy storage device **100** and a spacer **200** included in an energy storage assembly **10** included in the energy storage apparatus **1** according to the present example embodiment. In FIG. **2**, the constituting elements included in the energy storage assembly **10** are disassembled and, of them, two energy storage devices **100** and three spacers **200** (spacer **200***a*) are illustrated. In FIG. **1**, the spacer **200***a* includes a portion protruding upward, whereas FIG. **2** omits illustration of that portion protruding upward from **1** the spacer **200***a*, for the convenience of explanation. This applies to FIGS. **4**A and **4**B and subsequent drawings.

[0033] The energy storage apparatus **1** is an apparatus which can be charged with electricity from outside and can discharge electricity to outside. The energy storage apparatus **1** is used for an electric energy storage purpose, a power supply purpose, and the like. The energy storage apparatus **1** is used as a battery for driving or starting an engine of movable bodies such as automobiles, motorcycles, watercrafts, ships, snowmobiles, agricultural machines, construction machines, or railway vehicles for electric railway. As the above-mentioned automobile, electric vehicles (EVs), hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), and fossil fuel (gasoline, light oil, liquefied natural gas, or the like) automobiles are exemplified. As the above-mentioned railway vehicles for electric railway, trains, monorails, linear induction motor trains, and hybrid trains provided with both a diesel engine and an electric motor are exemplified. The energy storage apparatus **1** can also be used as a stationary battery, or the like, for home or business, etc.

[0034] As illustrated in FIG. **1**, the energy storage apparatus **1** includes an energy storage assembly **10**, and a case **300** accommodating therein the energy storage assembly **10**. The energy storage apparatus **1** also includes an external terminal (positive electrode external terminal and negative electrode external terminal), or the like, to electrically couple with an external apparatus, whose illustration and explanation are omitted. The energy storage apparatus **1** may include, aside from the above-described structural elements, a circuit board to monitor or control a charge state, a discharge state, or the like, of the energy storage assembly **10**, an electric appliance such as a relay, etc.

[0035] The energy storage assembly **10** is a battery module (battery pack) including a plurality of energy storage devices **100**. The energy storage assembly **10** includes a plurality of energy storage devices **100** positioned alternately with the spacers **200** in the Y-axis direction (first direction), to have a substantially rectangular parallelepiped shape which is long in the Y-axis direction. In the present example embodiment, two energy storage assemblies **10** positioned in the X-axis direction are accommodated inside the case **300**. The energy storage assembly **10** includes a plurality of energy storage devices **100** and a plurality of spacers **200** (**200***a*, **200***b*, and **200***c*). The energy storage assembly **10** also includes a bus bar to couple the energy storage devices **100** either in series or in parallel, a bus bar frame to hold the bus bar, a bus bar to couple the energy storage devices **100** with an external terminal, or the like, whose illustration is omitted. The bus bar may couple all the energy storage devices **100** in series, may couple some of the energy storage devices **100** in parallel and then couple the energy storage devices **100** in series, or may couple all the energy storage devices **100** in parallel. The energy storage assembly **10** is a non-restraint type module which does not include a restraint member (such as an end plate and a side plate) to restrain the plurality of energy storage devices **100** and the spacers **200** in the Y-axis direction.

[0036] The energy storage device **100** is a secondary battery (a single battery) capable of charging electricity and discharging electricity, and more specifically, is a non-aqueous electrolyte secondary battery such as a lithium-ion secondary battery. The energy storage device **100** has a rectangular parallelepiped shape (square shape or square type) which is flat in the Y-axis direction. In the present example embodiment, the plurality of energy storage devices **100** are positioned in the Y-axis direction. However, the number of energy storage devices **100** provided is not particularly limited, and may be one, several tens, or even more. Additionally, the size and shape of the energy storage device **100** is not particularly limited, and may have a long cylindrical shape, an elliptical cylindrical shape, a cylindrical shape, or a polyhedral prism shape other than a rectangular parallelepiped shape. The energy storage device **100** is not limited to the non-aqueous electrolyte secondary battery, and may be a secondary battery other than the non-aqueous electrolyte secondary battery, or may be a capacitor. The energy storage device **100** does not have to be a secondary, and may be a primary battery from which electricity that is stored not by being charged by the user can be used. The energy storage device **100** may be a battery using a solid electrolyte. The energy storage device **100** may be a pouch-type energy storage device.

[0037] The spacer **200** is flat in the Y-axis direction, which is positioned with the energy storage device **100** in the Y-axis direction and insulates and/or thermally insulates the energy storage device **100** from other structures. The spacer **200** is an insulating plate or a thermally insulating plate which is positioned in the Y-axis positive direction or the Y-axis negative direction of the energy storage device **100**, and insulates and/or thermally insulates the energy storage devices **100** from each other or the energy storage device **100** from the case **300**. The spacer **200** includes walls on both sides of the energy storage device **100** in the X-axis direction and both sides of the energy storage device **100** in the Z-axis direction, thus also having a function of a holder to hold the energy storage device **100** and to position the energy storage device **100**. The spacer **200** is provided with a flow path through which a refrigerant (fluid such as air) flows, and also has a function of cooling the energy storage device **100**.

[0038] The spacer **200** may include polycarbonate (PC), polypropylene (PP), polyethylene (PE), polystyrene (PS), polyphenylene sulfide resin (PPS), polyphenylene ether (PPE (including modified PPE)), polyethylene terephthalate (PET), polybutylene terephthalate (PBT), polyether ether ketone (PEEK), tetrafluoroethylene-perfluoroalkyl vinyl ether (PFA), polytetrafluoroethylene (PTFE), polyether sulfone (PES), polyamide (PA), or ABS resin, or alternatively, an insulating material such as a composite material thereof, or a material having heat insulative properties, such as mica, or the like.

[0039] Hereinafter, the spacer **200** positioned at the central position of the energy storage assembly **10** in the Y-axis direction (between the two energy storage devices **100** at the central position) is also referred to as a spacer **200***b*. The spacers **200** positioned at both ends of the energy storage assembly **10** in the Y-axis direction (between the energy storage devices **100** at the ends and the case **300**) are also referred to as spacers **200***c*. The spacer **200** positioned between the spacer **200***b* and the spacer **200***c* (between two energy storage devices **100** other than those at the central position) is also referred to as a spacer **200***a*. The spacers **200** (spacer **200***a*, **200***b*, and **200***c*) are positioned alternately with the energy storage devices **100**. Although FIG. **2** illustrates a configuration in which the energy storage devices **100** and the spacers **200***a* are alternately positioned, the spacers **200***a*, and the spacers **200***b* and **200***c*, are alternately positioned with the energy storage devices **100**.

[0040] To be more specific, as illustrated in FIG. **2**, the spacer **200***a* is an intermediate spacer (intermediate holder) which includes walls on both sides in the X-axis direction and both sides in the Z-axis direction of two energy storage devices **100** positioned on both sides of the spacer **200***a* in the Y-axis direction, and holds the two energy storage devices **100**. Similarly, the spacer **200***b* is a center plate (center spacer or center holder) which includes walls on both sides in the X-axis direction and both sides in the Z-axis direction of two energy storage devices **100** positioned on both sides of the spacer **200***b* in the Y-axis direction, and holds the two energy storage devices **100**. The spacer **200***b* increases the rigidity of the energy storage assembly **10** which is long in the Y-axis direction. The spacer **200***c* is an end spacer (end holder) which includes walls on both sides in the X-axis direction and both sides in the Z-axis direction of one energy storage device **100** positioned on one side in the spacer **200***c* in the Y-axis direction, and holds the one energy storage device **100**.

[0041] That is, the energy storage device **100** positioned at the central portion of the energy storage assembly **10** in the Y-axis direction is held by a spacer **200***a* and a spacer **200***b*. The energy storage device **100** positioned at an end of the energy storage assembly **10** in the Y-axis direction is held by the spacer **200***a* and the spacer **200***c*. The other energy storage devices **100** are each held by two spacers **200***a*. All of the spacers **200** (spacers **200***a*, **200***b*, and **200***c*) may be made of a same material, or any of the spacers **200** may be made of a different material.

[0042] The case **300** is a container in a substantially rectangular parallelepiped shape (box shape), defining an outer body (outer shell) of the energy storage apparatus **1**. The case **300** is positioned outside the energy storage assembly **10**, fixes the energy storage assembly **10** in a predetermined position, and protects the energy storage assembly **10** from shocks, etc. The case **300** is a metal case made of metal, such as aluminum, an aluminum alloy, stainless steel, iron, or a plated steel plate. In the present example embodiment, the case **300** is formed by die casting aluminum (aluminum die casting).

[0043] As illustrated in FIG. **1**, the case **300** includes a case main body **310** defining a main body of the case **300**, and a lid **320** defining a lid of the case **300**. The case main body **310** is a housing (casing) in which an opening **310***a* is provided in the Z-axis positive direction (one side in the third direction), and accommodates therein the energy storage assembly **10** (the energy storage devices **100** and the spacers **200** (the spacers **200***a*, **200***b*, and **200***c*)). The lid **320** has a flat rectangular shape which closes an opening **310***a* of the case main body **310**. The case main body **310** includes two rectangular openings **310***a* positioned in the X-axis direction, and after the energy storage assembly **10** is inserted from each opening **310***a*, the case main body **310** and the lid **320** are joined together by fastening using bolts or the like, welding, adhesive bonding, or the like. Accordingly, the case **300** has a sealed (airtight) structure. As described above, the case **300** (the case main body **310**) includes the case walls **311** in the X-axis positive direction (one side in a second direction intersecting the first direction) and the X-axis negative direction (an other side in the second direction) of the energy storage assembly **10**. The case wall **311** is a plate-shaped wall which is opposed to the energy storage assembly **10** in the X-axis direction, is parallel to the YZ plane, and extends in the Y-axis direction. To the case main body **310** or the lid **320**, a terminal block for the external terminal (the positive electrode external terminal and the negative electrode external terminal) may be mounted, and the external terminal may be positioned on the terminal block.

[0044] Next, configurations of the energy storage device **100** and the spacer **200***a* are described in detail.

[0045] FIG. **3** is a perspective view illustrating a configuration of the energy storage device **100** according to the present example embodiment. FIG. **3** illustrates an enlarged view of the energy storage device **100** illustrated in FIG. **2**. Since the plurality of energy storage devices **100** included in the energy storage assembly **10** all have the same configuration, FIG. **3** illustrates one energy storage device **100**, and the configuration of one energy storage device **100** is described in detail below.

[0046] As illustrated in FIG. **3**, the energy storage device **100** includes a container **110**, and a pair of (positive and negative) terminals **140**. An electrode body, a pair of (positive electrode and negative electrode) current collectors, and an electrolyte solution (non-aqueous electrolyte) are accommodated inside the container **110**, and a gasket is positioned between the terminal **140** and the current collector, and the container **110**. However, these are not illustrated in the drawings. This electrolyte solution may be of any type as long as it does not impair the performance of the energy storage device **100**, and may be selected from various alternatives. The gasket may include any material as long as it has insulative properties. The energy storage device **100** may include, aside from the above-described structural elements, a spacer to be positioned on a side of the electrode body, an insulating film to wrap around the electrode body, or the like, and an insulating film (e.g. shrink tube), or the like, to cover an outer surface of the container **110**.

[0047] The container **110** is a case having a rectangular parallelepiped shape (a square shape or a box shape), the case including a container main body **120** including an opening and a container lid portion **130** that closes the opening of the container main body **120**. The container main body **120** has a rectangular cylindrical shape and includes a bottom, which defines a main body portion of the container **110**, and includes an opening on the Z-axis positive direction side. The container lid portion **130** is plate-shaped structure with a rectangular shape, which is long in the X-axis direction, defining a lid portion of the container **110**. The container lid portion **130** is positioned in the Z-axis positive direction of the container main body **120**. The container lid portion **130** includes a gas exhaust valve **131** to release pressure inside the container **110** in case the pressure is raised excessively, a liquid injection portion (not illustrated) inside the container **110** to inject the electrolyte solution, and the like. The material of the container **110** (the container main body **120** and the container lid portion **130**) is not particularly limited. For example, while a weldable (joinable) metal such as stainless steel, aluminum, an aluminum alloy, iron, or a plated steel plate can be used, a resin can also be used.

[0048] The container **110** is sealed and is airtight as a result of joining the container main body **120** and the container lid portion **130** by welding or the like, after an electrode body, or the like, is accommodated inside the container main body **120**. The container **110** includes a pair of long side surfaces **111** on side surfaces on both sides in the Y-axis direction, a pair of short side surfaces **112** on side surfaces on both sides in the X-axis direction, and a bottom surface **113** on the Z-axis negative direction side. The long side surface **111** is a rectangular planar portion that defines a long side surface of the container **110**, and is opposed to an adjacent spacer **200** in the Y-axis direction. The long side surfaces **111** are adjacent to the short side surfaces **112** and the bottom surface **113**, and are larger than the short side surfaces **112**. The short side surface **112** is a rectangular planar portion that defines a short side surface of the container **110**, and is opposed to a wall of the spacer **200** and the case **300** in the X-axis direction. The short side surfaces **112** are adjacent to the long side surfaces **111** and the bottom surface **113**, and are smaller than the long side surfaces **111**. The bottom surface **113** is a rectangular planar portion that defines a bottom surface of the container **110**, and is opposed to a wall of the spacer **200** and the bottom wall of the case **300** in the Z-axis direction. The bottom surface **113** is positioned adjacent to the long side surfaces **111** and the short side surfaces **112**.

[0049] The terminals **140** are electrode terminals (positive electrode terminal and negative electrode terminal) of the energy storage device **100**, and are positioned on the container lid portion **130**. Specifically, the terminals **140** protrude from an upper surface (terminal placement surface) of the container lid portion **130** towards the Z-axis positive direction. The terminals **140** are electrically coupled to a positive electrode plate and a negative electrode plate of the electrode body via the current collector. Namely, the terminal **140** is a metal structure to lead out electricity stored in the electrode body to an external space of the energy storage device **100** and to introduce electricity into the internal space of the energy storage device **100** in order to store the electricity in the electrode body. The terminal **140** is made of aluminum, an aluminum alloy, copper, a copper alloy, or the like.

[0050] The electrode body is an energy storage component (power generating component) constructed preferably by stacking a positive electrode plate, a negative electrode plate, and a separator. The positive electrode plate is constructed preferably by forming a positive electrode active material layer on a positive electrode base material layer being current collector foil made of metal such as aluminum or an aluminum alloy. The negative electrode plate is constructed preferably by forming a negative electrode active material layer on a negative electrode base material layer being current collector foil made of metal such as copper or a copper alloy. The active material used for the positive electrode active material layer and the negative electrode active material layer may be any known material as long as it can store and discharge lithium ions. As the separator, a microporous sheet, nonwoven fabric, or the like, made of resin may be used. In the present example embodiment, the electrode body is constructed preferably by stacking polar plates (a positive electrode plate and a negative electrode plate) in the Y-axis direction. The electrode body may be any type of electrode body such as a wound electrode body constructed preferably by winding a polar plate (a positive electrode plate and a negative electrode plate), a stacked-layer type (stack type) electrode body constructed preferably by stacking a plurality of plate-shaped electrode plates, or a bellows-type electrode body constructed preferably by folding an electrode plate in a bellows style.

[0051] The current collector is a conductive current collector (positive electrode current collector and negative electrode current collector), which is either electrically or mechanically coupled to the terminal **140** and the electrode body. The positive electrode current collector is made of aluminum or an aluminum alloy, etc. just as the positive electrode base material layer of the positive electrode plate of the electrode body. The negative electrode current collector is made of copper or a copper alloy, etc. just as the negative electrode base material layer of the negative electrode plate of the electrode body.

[0052] Next, a configuration of the spacer **200***a* is described in detail. FIGS. **4**A and **4**B are a perspective view and a front view illustrating a configuration of the spacer **200***a* according to the present example embodiment. Specifically, FIG. **4**A is an enlarged perspective view illustrating the spacer **200***a* illustrated in FIG. **2**. FIG. **4**B is a front view illustrating a configuration when an end of the spacer **200***a* illustrated in FIG. **4**A in the X-axis positive direction is viewed from the Y-axis negative direction. FIGS. **5**A and **5**B are a perspective view and a rear view illustrating a configuration of the spacer **200***a* according to the present example embodiment. Specifically, FIG. **5**A is a perspective view illustrating a configuration on an opposite side of the spacer **200***a* illustrated in FIG. **4**A (a configuration when viewed from the Y-axis positive direction). FIG. **5**B is a rear view illustrating a configuration when an end of the spacer **200***a* illustrated in FIG. **5**A in the X-axis negative direction is viewed from the Y-axis positive direction. Since all of the plurality of spacers **200***a* included in the energy storage assembly **10** have the same configuration, one spacer **200***a* is illustrated in FIGS. **4**A, **4**B, **5**A, and **5**B, and the configuration of one spacer **200***a* is described in detail below.

[0053] As illustrated in FIGS. **4**A, **4**B, **5**A, and **5**B, both ends of the spacer **200***a* in the X-axis direction have similar shapes. That is, the spacer **200***a* has a shape symmetrical with respect to a plane passing through the center position and parallel to the YZ plane. The spacer **200***a* includes a spacer main body **210** and spacer walls **220** to **250**.

[0054] The spacer r main body **210** is a plate-shaped and rectangular portion defining a main body portion of the spacer **200***a*, and is parallel to an XZ plane. In the present example embodiment, the spacer main body **210** is opposed to the long side surface **111** in the Y-axis direction and is in contact with the long side surface **111**, so as to cover the entire surface of the long side surface **111** of the container **110** of the energy storage device **100**, in the Y-axis positive direction or the Y-axis negative direction of the energy storage device **100**.

[0055] As illustrated in FIGS. **4**A and **4**B, spaces **211***a* to **211***d* are each provided on a surface of the spacer main body **210** in the Y-axis negative direction. The spaces **211***a* to **211***d* are each a space positioned between the spacer main body **210** and the energy storage device **100** when the spacer **200***a* and the energy storage device **100** positioned in the Y-axis negative direction of the spacer **200***a* (the spacer main body **210**) are assembled. The spaces **211***a* to **211***d* are flow paths for a fluid that flows between the spacer main body **210** and the energy storage device **100**. The fluid that flows through the spaces **211***a* to **211***d* is a fluid (refrigerant) to cool the energy storage device **100**, such as a gas such as air, or a liquid. The spaces **211***a* to **211***d* are each also used as a space into which a jig is inserted when the energy storage device **100** is held during manufacturing (during assembly work).

[0056] In the present example embodiment, the spaces **211***a* to **211***d* are each a space in an L-shaped groove portion defined by a plurality of ribs provided on a surface of the spacer main body **210** in the Y-axis negative direction and curved in an L-shape, and is curved in an L-shape along the spacer main body **210**. Specifically, a concave portion **212** recessed in the Y-axis positive direction is provided on a surface of the spacer main body **210** in the Y-axis negative direction. The concave portion **212** is a large concave portion which occupies most of a region of a surface of the spacer main body **210** in the Y-axis negative direction and has a rectangular shape when viewed in the Y-axis direction. A plurality of ribs are provided in the concave portion **212**, thus providing a spaces **211***a* to **211***d*.

[0057] The space **211***a* is a space elongating in the Z-axis positive direction from a central portion in the X-axis direction at an end of the spacer main body **210** in the Z-axis negative direction, and is curved in the X-axis direction to elongate in the X-axis direction. To be specific, two spaces **211***a* positioned in the X-axis direction elongate in the Z-axis positive direction, and are curved toward both sides in the X-axis direction to elongate to both sides in the X-axis direction. In the present example embodiment, each space **211***a* is curved in the X-axis direction and then divided into two spaces, and the two spaces merge at an end of the spacer main body **210** in the X-axis direction.

[0058] The space **211***b* is a space elongated in the Z-axis positive direction from outside in the X-axis direction of a space **211***a* at an end of the spacer main body **210** in the Z-axis negative direction, and being curved in the X-axis direction to elongate in the X-axis direction. To be specific, two spaces **211***b* elongate in the Z-axis positive direction from positions sandwiching two spaces **211***a* at an end of the spacer main body **210** in the Z-axis negative direction, and are curved toward both sides in the X-axis direction to elongate to both sides in the X-axis direction. In the present example embodiment, each space **211***b* is curved in the X-axis direction and then divided into two spaces, and the two spaces merge at an end of the spacer main body **210** in the X-axis direction.

[0059] The space **211***c* is a space elongated in the Z-axis positive direction from outside in the X-axis direction of a space **211***b* portion at an end of the spacer main body **210** in the Z-axis negative direction, and is curved in the X-axis direction to elongate in the X-axis direction. To be specific, two spaces **211***c* elongate in the Z-axis positive direction from positions sandwiching two spaces **211***b* at an end of the spacer main body **210** in the Z-axis negative direction, and are curved toward both sides in the X-axis direction to elongate to both sides in the X-axis direction. The space **211***d* is a space elongated in the X-axis direction from outside in the X-axis direction of a space **211***c* at an end of the spacer main body **210** in the Z-axis negative direction. To be specific, two spaces **211***d* elongate to both sides in the

X-axis direction from positions sandwiching two space **211**_c_ at an end of the spacer main body **210** in the Z-axis negative direction.

[0060] As illustrated in FIGS. **5**A and **5**B, the spacer main body **210** includes a first surface **214**, a second surface **215**, and a third surface **216**, which are provided on a surface thereof in the Y-axis positive direction.

[0061] The first surface **214** is a large plane (flat surface) having a rectangular shape when viewed in the Y-axis direction, and occupies most of a region of a surface of the spacer main body **210** in the Y-axis positive direction. The first surface **214** is larger than the second surface **215** and is larger than the third surface **216**. The first surface **214** is opposed to the energy storage device **100** positioned in the Y-axis positive direction of the spacer **200**_a_ (the spacer main body **210**). The first surface **214** is opposed to the long side surface **111** in the Y-axis direction and is in contact with the long side surface **111**, so as to cover most of a region of the long side surface **111** of the container **110** of the energy storage device **100**. The first surface **214** protrudes from the third surface **216** in the Y-axis positive direction, such that the first surface **214** protrudes more in the Y-axis positive direction than the second surface **215** and the third surface **216**. The first surface **214** is positioned on the rear side of the above-described concave portion **212** in the spacer main body **210** (in a position overlapping the concave portion **212** when viewed in the Y-axis direction). That is, the surface of the spacer main body **210** in the Y-axis positive direction protrudes in the Y-axis positive direction so as to provide the first surface **214**, such that the surface of the spacer main body **210** in the Y-axis negative direction is recessed in the Y-axis positive direction to define the concave portion **212**.

[0062] The third surface **216** is recessed relative to the first surface **214** toward the Y-axis negative direction, on a surface of the spacer main body **210** in the Y-axis positive direction. The third surface **216** is a plane (flat surface) recessed from the first surface **214** in the Y-axis negative direction so as to surround the periphery of the first surface **214**. The third surface **216** is a rectangular annular surface positioned on the outer circumference of the spacer main body **210** when viewed in the Y-axis direction, so as to surround the entire circumference of the first surface **214** on both sides in the X-axis direction and on both sides in the Z-axis direction.

[0063] The second surface **215** is positioned in the X-axis direction (a second direction intersecting the first direction) of the first surface **214**, and is recessed relative to the first surface **214** toward the Y-axis negative direction. Specifically, the second surface **215** is recessed relative to the third surface **216** toward the Y-axis negative direction. The second surface **215** is recessed from the third surface **216** in the Y-axis negative direction, at an end of the third surface **216** in the X-axis direction. The size and shape of the second surface **215** are not particularly limited. However, in the present example embodiment, the second surface **215** is smaller than the third surface **216**. The second surface **215** includes a plane (flat surface) which is recessed from the third surface **216** in the Y-axis negative direction and is long in the Z-axis direction, and a curved surface which is curved toward the Y-axis negative direction as it extends outward in the X-axis direction (i.e., towards an edge of the spacer main body **210** in the X-axis direction). In the present example embodiment, two second surfaces **215** positioning in the Z-axis direction are provided on each of both sides of the spacer main body **210** in the X-axis direction.

[0064] The second surface **215** is positioned in a position corresponding to walls **232** and **233** to be described later. Specifically, the second surface **215** is defined by a surface in the Y-axis positive direction at a base of the walls **232** and **233** (a coupling portion to the spacer main body **210**) being recessed in the Y-axis negative direction. Accordingly, as illustrated in FIGS. **4**A and **4**B, a surface in the Y-axis negative direction at a base of the walls **232** and **233** protrudes in the Y-axis negative direction, thus defining protruding portions **213**. Four protruding portions **213** are provided at positions corresponding to bases of the walls **232** and **233** on the surface of a spacer main body **210** in the Y-axis negative direction. The protruding portion **213** has a shape in which a surface in the Y-axis negative direction is along the second surface **215** (a shape with a plane which is long in the Z-axis direction and a curved surface which is curved in the Y-axis negative direction as it extends toward outside in the X-axis direction).

[0065] Since the second surface **215** is recessed from the third surface **216** toward the Y-axis negative direction, a space **215**_a_ is provided at the position of the second surface **215**. The space **215**_a_ is a space between the second surface **215** and the energy storage device **100** when the spacer **200**_a_ and the energy storage device **100** positioned in the Y-axis positive direction of the spacer **200**_a_ (the spacer main body **210**) are assembled. The space **215**_a_ is a space into which a jig is inserted when the energy storage device **100** is held during manufacturing (during assembly work). Unlike the above-described spaces **211**_a_ to **211**_d_, the space **215**_a_ is not a flow path for a fluid that flows between the spacer main body **210** and the energy storage device **100**.

[0066] The spacer wall **220** is a portion protruding in the Y-axis positive direction from an end of the spacer main body **210** in the X-axis direction, and includes walls **221** to **225**. The walls **221** to **225** are a plurality of plate-shaped walls parallel to the YZ plane, which are positioned at respectively different positions in the Z-axis direction, and positioned in the Z-axis direction toward the Z-axis negative direction in this order. The spacer wall **220** (the walls **221** to **225**) is positioned along the short side surface **112** of the container **110** of the energy storage device **100** positioned in the Y-axis positive direction of the spacer main body **210**, to be opposed to the short side surface **112** in the X-axis direction. The spacer wall **220** (the walls **221** to **225**) is opposed to the case wall **311** (refer to FIG. **1**) of the case **300** (the case main body **310**). The spacer wall **220** (the walls **221** to **225**) is separated (with a gap) from the case wall **311**. In the present example embodiment, two spacer walls **220** (two sets of walls **221** to **225**) are positioned at both ends of the spacer main body **210** in the X-axis direction.

[0067] The spacer wall **230** is a portion protruding in the Y-axis negative direction from an end of the spacer main body **210** in the X-axis direction, and includes walls **231** to **234**. The walls **231** to **234** are a plurality of plate-shaped walls parallel to the YZ plane, which are positioned at respectively different positions in the Z-axis direction, and positioned in the Z-axis direction toward the Z-axis negative direction in this order. The spacer wall **230** (the walls **231** to **234**) is positioned along the short side surface **112** of the container **110** of the energy storage device **100** positioned in the Y-axis negative direction of the spacer main body **210**, to be opposed to the short side surface **112** in the X-axis direction. The spacer wall **230** (the walls **231** to **234**) is opposed to the case wall **311** (refer to FIG. **1**) of the case **300** (the case main body **310**). The spacer wall **230** (the walls **231** to **234**) is separated (with a gap) from the case wall **311**. In the present example embodiment, two spacer walls **230** (two sets of walls **231** to **234**) are positioned at both ends of the spacer main body **210** in the X-axis direction.

[0068] The spacer wall **240** is a plate-shaped portion protruding from an end of the spacer main body **210** in the Z-axis positive direction to both sides in the Y-axis direction, and is positioned parallel to the XY plane. The spacer walls **240** are opposed to the container lid portions **130** in the Z-axis direction, along the container lid portions **130** of the containers **110** of the energy storage devices **100** positioned on both sides of the spacer main body **210** in the Y-axis direction. The spacer wall **250** is a plate-shaped portion protruding from an end of the spacer main body **210** in the Z-axis negative direction to both sides in the Y-axis direction, and is positioned parallel to the XY plane. The spacer walls **250** are positioned along the bottom surfaces **113** of the containers **110** of the energy storage devices **100** positioned on both sides of the spacer main body **210** in the Y-axis direction, to be opposed to the bottom surfaces **113** in the Z-axis direction.

[0069] As described above, the spacer walls **220** to **250** cover both sides of the energy storage device **100** in the X-axis direction and both sides thereof in the Z-axis direction. Accordingly, the spacer **200*a*** holds the energy storage device **100**.

[0070] Hereinafter, a configuration of the spacer wall **220** (the walls **221** to **225**) and the spacer wall **230** (the walls **231** to **234**) is described in more detail with reference to FIG. **6** to FIG. **8**. In this description, hereinafter, as illustrated in FIG. **2**, among the three spacers **200*a*** positioned in the Y-axis direction, the spacer **200*a*** positioned at the center is also referred to as a first spacer **201**. The spacer **200*a*** positioned in the Y-axis positive direction of the first spacer **201** is also referred to as a second spacer **202**. The spacer **200*a*** positioned in the Y-axis negative direction of the first spacer **201** is also referred to as a third spacer **203**. The first spacer **201**, the second spacer **202**, and the third spacer **203** have the same configuration.

[0071] The energy storage device **100** positioned between the first spacer **201** and the second spacer **202** is also referred to as a first energy storage device **101**. The energy storage device **100** positioned between the first spacer **201** and the third spacer **203** is also referred to as a second energy storage device **102**. That is, the energy storage device **100** positioned in the Y-axis positive direction (one side in the first direction) of the spacer main body **210** of the first spacer **201** is also referred to as a first energy storage device **101**. The energy storage device **100** positioned in the Y-axis negative direction (an other side in the first direction) of the spacer main body **210** of the first spacer **201** is also referred to as a second energy storage device **102**. The first energy storage device **101** and the second energy storage device **102** have the same configuration. As described above, the second spacer **202**, the first energy storage device **101**, the first spacer **201**, the second energy storage device **102**, and the third spacer **203** are positioned in this order from the Y-axis positive direction.

[0072] FIG. **6** is a perspective view illustrating a configuration of the spacer walls **220** and **230** of the first spacer **201**, the second spacer **202**, and the third spacer **203** according to the present example embodiment. FIG. **6** illustrates a configuration of an end in the X-axis positive direction of the first spacer **201**, the second spacer **202**, and the third spacer **203** positioned in the Y-axis direction. FIG. **7** is a perspective view illustrating a configuration in a state in which the first spacer **201**, the second spacer **202**, and the third spacer **203** according to the present example embodiment are positioned with respect to the energy storage device **100**. FIG. **7** illustrates a state in which the first energy storage device **101** and the second energy storage device **102** are positioned between the first spacer **201**, the second spacer **202**, and the third spacer **203**, respectively. FIG. **8** is a side view illustrating a configuration in a state in which the first spacer **201**, the second spacer **202**, and the third spacer **203** according to the present example embodiment are positioned with respect to the energy storage device **100**. FIG. **8** illustrates the configuration in FIG. **7** viewed from the X-axis positive direction.

[0073] An end of the first spacer **201**, the second spacer **202**, and the third spacer **203** in the X-axis positive direction and an end thereof in the X-axis negative direction have the same configuration. Therefore, hereinafter, configurations of ends of the first spacer **201**, the second spacer **202**, and the third spacer **203** in the X-axis positive direction are described in detail, whereas descriptions of configurations of ends thereof in the X-axis negative direction are omitted. That is, the configurations of the ends of the first spacer **201**, the second spacer **202**, and the third spacer **203** in the X-axis negative direction are obtained by replacing "X-axis negative direction" in the description of the configuration of the end in the X-axis positive direction, which are described later, with "X-axis positive direction", and replacing "X-axis positive direction" with "X-axis negative direction".

[0074] As illustrated in FIG. **6** to FIG. **8**, the first spacer **201**, the second spacer **202**, and the third spacer **203** respectively include spacer walls **220** and **230**. The spacer walls **220** and **230** included in the first spacer **201** are referred to as first spacer walls **220**A and **230**A. The spacer walls **220** and **230** included in the second spacer **202** are referred to as second spacer walls **220**B and **230**B. The spacer walls **220** and **230** included in the third spacer **203** are referred to as third spacer walls **220**C and **230**C. The first spacer wall **220**A protrudes in the Y-axis positive direction toward the second spacer **202**, and the first spacer wall **230**A protrudes in the Y-axis negative direction toward the third spacer **203**. The second spacer wall **230**B protrudes in the Y-axis negative direction toward the first spacer **201**. The third spacer wall **220**C protrudes toward the first spacer **201** in the Y-axis positive direction. The first spacer wall **220**A, the second spacer wall **220**B, and the third spacer wall **220**C respectively include walls **221** to **225**. The first spacer wall **230**A, the second spacer wall **230**B, and the third spacer wall **230**C respectively include walls **231** to **234**.

[0075] The wall **221** is a plate-shaped wall parallel to the YZ plane, protruding in the Y-axis positive direction from an end in the Z-axis positive direction at an end of the spacer main body **210** in the X-axis positive direction. The wall **231** is a plate-shaped wall parallel to the YZ plane, protruding in the Y-axis negative direction from an end in the Z-axis positive direction at an end of the spacer main body **210** in the X-axis positive direction. The wall **221** is opposed to the energy storage device **100** positioned in the Y-axis positive direction of the spacer main body **210** and the case wall **311** (refer to FIG. **1**) of the case **300** (the case main body **310**), in the X-axis direction. The wall **231** is opposed to the energy storage device **100** positioned in the Y-axis negative direction of the spacer main body **210** and the case wall **311**, in the X-axis direction. In the first spacer **201**, the wall **221** of the first spacer wall **220**A is opposed to the first energy storage device **101** in the X-axis direction, and the wall **231** of the first spacer wall **230**A is opposed to the second energy storage device **102** in the X-axis direction. The same applies to the second spacer **202** and the third spacer **203**.

[0076] The wall **221** and the wall **231** are positioned at different positions in the X-axis direction, and at least a portion thereof is positioned at the same position in the Z-axis direction. Specifically, the wall **221** is positioned in the X-axis positive direction relative to the wall **231**, and is positioned at substantially the same position as the wall **231** in the Z-axis direction. Accordingly, the wall **221** of the first spacer wall **220**A is positioned in the X-axis positive direction of the wall **231** of the second spacer wall **230**B, and overlaps with the wall **231** in the X-axis direction. The same applies to the wall **221** of the third spacer wall **220**C and the wall **231** of the first spacer wall **230**A.

[0077] The wall **225** is a plate-shaped wall parallel to the YZ plane, protruding in the Y-axis positive direction from an end of the spacer main body **210** in the Z-axis negative direction, at an end of the spacer main body **210** in the X-axis positive direction. The wall **234** is a plate-shaped wall parallel to the YZ plane, protruding in the Y-axis negative direction from an end of the spacer main body **210** in the Z-axis negative direction, at an end of the spacer main body **210** in the X-axis positive direction. The wall **225** is opposed to the energy storage device **100** positioned in the Y-axis positive direction of the spacer main body **210** and the case wall **311**, in the X-axis direction. The wall **234** is opposed to the energy storage device **100** positioned in the Y-axis negative direction of the spacer main body **210** and the case wall **311**, in the X-axis direction. In the first spacer **201**, the wall **225** of the first spacer wall **220**A is opposed to the first energy storage device **101** in the X-axis direction, and the wall **234** of the first spacer wall **230**A is opposed to the second energy storage device **102** in the X-axis direction. The same applies to the second spacer **202** and the third spacer **203**.

[0078] The wall **225** and the wall **234** are positioned at different positions in the X-axis direction, and at least a portion thereof is positioned at the same position in the Z-axis direction. Specifically, the wall **225** is positioned in the X-axis positive direction relative to the wall **234**, and is positioned at substantially the same position as the wall **234** in the Z-axis direction. Accordingly, the wall **225** of the first spacer wall **220**A is positioned in the X-axis positive direction of the wall **234** of the second spacer wall **230**B, and overlaps with the wall **234** in the X-axis direction. The same applies to the wall **225** of the third spacer wall **220**C and the wall **234** of the first spacer wall **230**A.

[0079] The wall **222** is a plate-shaped wall parallel to the YZ plane, protruding in the Y-axis positive direction from a position in the Z-axis negative direction relative to the wall **221** at an end of the spacer main body **210** in the X-axis positive direction. In the present example embodiment, the wall **222** is coupled (continuously connected) to the wall **221**. However, the wall **222** may be spaced apart from the wall **221**. The wall **222** is opposed to the energy storage device **100** positioned in the Y-axis positive direction of the spacer main body **210** and the case wall **311**, in the X-axis direction. In the first spacer **201**, the wall **222** of the first spacer wall **220**A is opposed to the first energy storage device **101** in the X-axis direction, and in the third spacer **203**, the wall **222** of the third spacer wall **220**C is opposed to the second energy storage device **102** in the X-axis direction. The same applies to the second spacer **202**.

[0080] The wall **224** is a plate-shaped wall parallel to the YZ plane, protruding in the Y-axis positive direction from a position in the Z-axis positive direction relative to the wall **225** at an end of the spacer main body **210** in the X-axis positive direction. In the present example embodiment, the wall **224** is coupled (continuously connected) to the wall **225**. However, the wall **224** may be spaced apart from the wall **225**. The wall **224** is opposed to the energy storage device **100** positioned in the Y-axis positive direction of the spacer main body **210** and the case wall **311**, in the X-axis direction. In the first spacer **201**, the wall **224** of the first spacer wall **220**A is opposed to the first energy storage device **101** in the X-axis direction, and in the third spacer **203**, the wall **224** of the third spacer wall **220**C is opposed to the second energy storage device **102** in the X-axis direction. The same applies to the second spacer **202**.

[0081] The wall **223** is a plate-shaped wall parallel to the YZ plane, protruding in the Y-axis positive direction from a central portion in the Z-axis direction at an end of the spacer main body **210** in the X-axis positive direction. The wall **223** is opposed to the energy storage device **100** positioned in the Y-axis positive direction of the spacer main body **210** and the case wall **311**, in the X-axis direction. In the first spacer **201**, the wall **223** of the first spacer wall **220**A is opposed to the first energy storage device **101** in the X-axis direction, and in the third spacer **203**, the wall **223** of the third spacer wall **220**C is opposed to the second energy storage device **102** in the X-axis direction. The same applies to the second spacer **202**.

[0082] The wall **232** is a plate-shaped wall parallel to the YZ plane, protruding in the Y-axis negative direction from a position at an end of the spacer main body **210** in the X-axis positive direction, that is in the Z-axis negative direction relative to the wall **222** and in the Z-axis positive direction relative to the wall **223**. The wall **232** is opposed to the energy storage device **100** positioned in the Y-axis negative direction of the spacer main body **210** and the case wall **311**, in the X-axis direction. In the first spacer **201**, the wall **232** of the first spacer wall **230**A is opposed to the second energy storage device **102** in the X-axis direction, and in the second spacer **202**, the wall **232** of the second spacer wall **230**B is opposed to the first energy storage device **101** in the X-axis direction. The same applies to the third spacer **203**.

[0083] The wall **232** and the walls **222** and **223** are positioned at different positions in the X-axis direction, and at least a portion thereof is positioned at the same position in the Z-axis direction. Specifically, the wall **232** is positioned in the X-axis positive direction relative to the wall **222**, and an end of the wall **232** in the Z-axis positive direction is positioned at the same position in the Z-axis direction as an end of the wall **222** in the Z-axis negative direction. The wall **232** is positioned in the X-axis negative direction relative to the wall **223**, and an end of the wall **232** in the Z-axis negative direction is positioned at the same position in the Z-axis direction as an end of the wall **223** in the Z-axis positive direction. Accordingly, the wall **232** of the first spacer wall **230**A is positioned in the X-axis positive direction of the wall **222** of the third spacer wall **220**C and in the X-axis negative direction of the wall **223** of the third spacer wall **220**C, and at least a portion thereof overlaps the walls **222** and **223** in the X-axis direction. The same applies to the wall **232** of the second spacer wall **230**B and the walls **222** and **223** of the first spacer wall **220**A.

[0084] The wall **233** is a plate-shaped wall parallel to the YZ plane, protruding in the Y-axis negative direction from a position, at an end of the spacer main body **210** in the X-axis positive direction, that is in the Z-axis negative direction relative to the wall **223** and in the Z-axis positive direction relative to the wall **224**. The wall **233** is opposed to the energy storage device **100** positioned in the Y-axis negative direction of the spacer main body **210** and the case wall **311**, in the X-axis direction. In the first spacer **201**, the wall **233** of the first spacer wall **230**A is opposed to the second energy storage device **102** in the X-axis direction, and in the second spacer **202**, the wall **233** of the second spacer wall **230**B is opposed to the first energy storage device **101** in the X-axis direction. The same applies to the third spacer **203**.

[0085] The wall **233** and the walls **223** and **224** are positioned at different positions in the X-axis direction, and at least a portion thereof is positioned at the same position in the Z-axis direction. Specifically, the wall **233** is positioned in the X-axis negative direction relative to the wall **223**, and an end of the wall **233** in the Z-axis positive direction is positioned at the same position in the Z-axis direction as an end of the wall **223** in the Z-axis negative direction. The wall **233** is positioned in the X-axis positive direction relative to the wall **224**, and an end of the wall **233** in the Z-axis negative direction is positioned at the same position in the Z-axis direction as an end of the wall **224** in the Z-axis positive direction. Accordingly, the wall **233** of the first spacer wall **230**A is positioned in the X-axis negative direction of the wall **223** of the third spacer wall **220**C and in the X-axis positive direction of the wall **224** of the third spacer wall **220**C, and at least a portion thereof overlaps the walls **223** and **224** in the X-axis direction. The same applies to the wall **233** of the second spacer wall **230**B and the walls **223** and **224** of the first spacer wall **220**A.

[0086] The wall **223** is longer in the Z-axis direction than the walls **232** and **233**. In the present example embodiment, the walls **222** and **224** have lengths equal to those of the walls **232** and **233** in the Z-axis direction. However, the walls **222** and **224** may be longer than those of the walls **232** and **233**. The walls **232** and **233** have the same length in the Z-axis direction. However, the walls **232** and **233** may have different lengths in the Z-axis direction. The lengths of the walls **221**, **225**, **231**, and **234** in the Z-axis direction are not particularly limited.

[0087] The wall **223** is positioned in the Z-axis negative direction relative to the walls **221** and **222**, and is positioned in the Z-axis positive direction relative to the walls **224** and **225**. Accordingly, the wall **223** is positioned closer to the center position of the energy storage device **100** in the Z-axis direction than the walls **221**, **222**, **224**, and **225** are. The wall **223** is positioned closer to the terminal **140** of the energy storage device **100** than the walls **224** and **225** are. The walls **221** and **222** are positioned closer to the terminal **140** of the energy storage device **100** than the walls **223** to **225** are.

[0088] When viewed in the X-axis direction, the walls **222** to **224** are positioned such that edges thereof in the Y-axis positive direction overlap the energy storage devices **100** positioned in the Y-axis positive direction of the spacer main body **210**. That is, the walls **222** to **224** do not protrude in the Y-axis positive direction from a surface (the long side surface **111**) of the energy storage device **100** in the Y-axis positive direction. To be more specific, the lengths of the walls **222** to **224** in the Y-axis direction are shorter than the thickness of the energy storage device **100** in the Y-axis direction (the widths of the short side surfaces **112** in the Y-axis direction). The lengths of the walls **221** and **225** in the Y-axis direction are not particularly limited. Similarly, when viewed in the X-axis direction, the walls **232** and **233** are positioned such that edges thereof in the Y-axis negative direction overlap the energy storage devices **100** positioned in the Y-axis negative direction of the spacer main body **210**. That is, the walls **232** and **233** do not protrude in the Y-axis negative direction from a surface (the long side surface **111**) of the energy storage device **100** in the Y-axis negative direction. To be more specific, the lengths of the walls **232** and **233** in the Y-axis direction are shorter than the thickness of the energy storage device **100** in the Y-axis direction (the widths of the short side surfaces **112** in the Y-axis direction). The lengths of the walls **231** and **234** in the Y-axis direction are not particularly limited.

[0089] The wall **221** includes a convex portion **221***a* protruding toward the case wall **311**. The convex portion **221***a* is a convex portion (rib) with a substantially cylindrical shape and protruding in the X-axis positive direction, and has a truncated conical shape in which an end (base) in the X-axis negative direction has a larger diameter toward the X-axis negative direction, to ensure strength, and the like. The convex portion **221***a* is positioned at an end of the wall **221** in the Y-axis negative direction and at a central portion thereof in the Z-axis direction. The convex portion **221***a* does not overlap the spacer main body **210** when viewed in the X-axis direction. The convex portion **221***a* is separated (with a gap) from the case wall **311**.

[0090] The wall **223** includes a convex portion **223***a* protruding toward the case wall **311**. The convex portion **223***a* is a convex portion (rib) with a substantially rectangular parallelepiped shape protruding in the X-axis positive direction, and has a truncated quadrangular pyramid shape in which an end (base) in the X-axis negative direction has a larger diameter toward the X-axis negative direction, to ensure strength, and the like. The convex portion **223***a* is positioned at an end of the wall **223** in the Y-axis positive direction and at a central portion thereof in the Z-axis direction. The convex portion **223***a* does not overlap the spacer main body **210** when viewed in the X-axis direction. The convex portion **223***a* is separated (with a gap) from the case wall **311**.

[0091] The wall **225** includes a convex portion **225***a* protruding toward the case wall **311**. The convex portion **225***a* is a convex portion (rib) with a substantially rectangular parallelepiped shape protruding in the X-axis positive direction, and has a truncated quadrangular pyramid shape in which an end (base) in the X-axis negative direction has a larger diameter toward the X-axis negative direction, to ensure strength, and the like. The convex portion **225***a* is positioned at an end of the wall **225** in the Y-axis positive direction and an end thereof in the Z-axis negative direction. The convex portion **225***a* does not overlap the spacer main body **210** when viewed in the X-axis direction. The convex portion **225***a* is separated (with a gap) from the case wall **311**.

[0092] The convex portion **223***a* is smaller in size than the convex portion **225***a* when viewed in the X-axis direction. To be specific, the convex portion **223***a* has an area when viewed in the X-axis direction (or a minimum cross-sectional area in the YZ plane) which is smaller than that of the convex portion **225***a*. The convex portion **221***a* is smaller in size than the convex portions **223***a* and **225***a* when viewed in the X-axis direction. To be specific, the convex portion **221***a* has an area when viewed in the X-axis direction (or a minimum cross-sectional area in the YZ plane) which is smaller than the convex portion **223***a* and the convex portion **225***a*.

[0093] The tip end of the convex portion **223***a* is positioned in the X-axis positive direction relative to the tip end of the convex portion **225***a* (refer to FIGS. **4**A, **4**B, **5**A, and **5**B). That is, the convex portion **223***a* protrudes in the X-axis positive direction relative to the convex portion **225***a*. In the present example embodiment, the protruding amount of the convex portion **223***a* is substantially the same level as the protruding amount of the convex portion **225***a* or smaller than the protruding amount of the convex portion **225***a*. However, since the wall **223** is positioned in the X-axis positive direction relative to the wall **225**, the tip end of the convex portion **223***a* is positioned in the X-axis positive direction relative to the tip end of the convex portion **225***a*. The protruding amount of the convex portion **223***a* may be larger than the protruding amount of the convex portion **225***a*. The tip end of the convex portion **221***a* is positioned in the X-axis positive direction relative to the tip ends of the convex portions **223***a* and **225***a* (refer to FIGS. **4**A, **4**B, **5**A, and **5**B). That is, the convex portion **221***a* protrudes further in the X-axis positive direction than the convex portions **223***a* and **225***a*. In the present example embodiment, since the wall **221** is in a position substantially the same level as that of the wall **225** in the X-axis direction, the protruding amount of the convex portion **221***a* is larger than the protruding amount of the convex portion **225***a*. Since the wall **221** is positioned in the X-axis negative direction relative to the wall **223**, the protruding amount of the convex portion **221***a* is larger than the protruding amount of the convex portion **223***a*.

[0094] The wall **222** includes a reinforcing rib **222***a* inside a position (base) to be bent from the spacer main body **210** (refer to FIGS. **5**A and **5**B). The wall **223** includes a reinforcing rib **223***b* inside a position (base) to be bent from the spacer main body **210** (refer to FIGS. **5**A and **5**B). The wall **224** includes a reinforcing rib **224***a* inside a position (base) to be bent from the spacer main body **210** (refer to FIGS. **5**A and **5**B). The wall **231** includes a reinforcing rib **231***a* inside a position (base) bent from the spacer main body **210** (refer to FIGS. **4**A and **4**B). The wall **234** includes a reinforcing rib **234***a* inside a position (base) to be bent from the spacer main body **210** (refer to FIGS. **4**A and **4**B).

[0095] That is, the reinforcing ribs **222***a*, **224***a*, **231***a*, and **234***a* are provided on the walls **222**, **224**, **231**, and **234** to hold the energy storage devices **100**. In addition, a reinforcing rib **223***b* is provided on the wall **223** including the convex portion **223***a*. Because the walls **221** and **225**, including the convex portions **221***a* and **225***a*, are coupled to the walls **222** and **224**, no reinforcing rib is provided on the walls **221** and **225**. However, the walls **221** and **225** may also include reinforcing rib(s). The walls **232** and **233** may also include with reinforcing rib(s).

[0096] The walls **222** to **224** protrude only in the Y-axis positive direction in the Y-axis direction. Therefore, as illustrated in FIG. **7** and FIG. **8**, openings **21**, **23**, and **25** are provided in the Y-axis negative direction of the walls **222** to **224**. The openings **21**, **23**, and **25** are openings which are positioned at a boundary between an internal space and an external space of the energy storage assembly **10**, and are provided in the energy storage assembly **10** when viewed in the X-axis direction, in order to connect the internal space to the external space of the energy storage assembly **10**. The openings **21**, **23**, and **25** are provided between the spacer main body **210** and the energy storage device **100** positioned in the Y-axis negative direction of the spacer main body **210**, by separating a portion of a surface of the spacer main body **210** in the Y-axis negative direction and a portion of the energy storage device **100**. The openings **21**, **23**, and **25** are positioned at different positions in the Z-axis direction.

[0097] To be specific, the opening **21** which connects the space **211***a* (refer to FIGS. **4**A and **4**B) to an external space S (refer to FIG. **7**), which is a space outside the energy storage assembly **10**, is provided in the Y-axis negative direction of the wall **222**. The external space S is a space positioned in the X-axis positive direction of the energy storage assembly **10** (the energy storage devices **100** and the spacer **200***a*). An opening **23** which connects the space **211***b* (refer to FIGS. **4**A and **4**B) to the external space S of the energy storage assembly **10** is provided in the Y-axis negative direction of the wall **223**. An opening **25** which connects the space **211***d* (refer to FIGS. **4**A and **4**B) to the external space S of the energy storage assembly **10** is provided in the Y-axis negative direction of the wall **224**. The wall **222** protrudes in the Y-axis positive direction from the position of the opening **21** in the spacer main body **210**. The wall **223** protrudes in the Y-axis positive direction from the position of the opening **23** in the spacer main body **210**. The wall **224** protrudes in the Y-axis positive direction from the position of the opening **25** in the spacer main body **210**. As described above, the spaces **211***a* to **211***d* are each a flow path for a fluid that flows between the spacer main body **210** and the energy storage device **100**, and the openings **21**, **23**, and **25** are outlets of the flow path. Therefore, the energy storage assembly **10** includes, in addition to the openings **21**, **23**, and **25** defining the outlets of the flow paths, an opening defining an inlet of the flow path at an end in the Z-axis negative direction (refer to FIGS. **4**A and **4**B).

[0098] The walls **232** and **233** protrude only in the Y-axis negative direction in the Y-axis direction. Therefore, as illustrated in FIG. **7** and FIG. **8**, openings **22** and **24** are provided in the Y-axis positive direction of the walls **232** and **233**. The openings **22** and **24** are openings which are positioned at a boundary between an internal space and an external space of the energy storage assembly **10** and are provided in the energy storage assembly **10** when viewed in the X-axis direction, in order to connect the internal space and the external space of the energy storage assembly **10**. The openings **22** and **24** are provided by separating a portion of a surface of the spacer main body **210** in the Y-axis positive direction and a portion of the energy storage device **100**, between the spacer main body **210** and the energy storage device **100** positioned in the Y-axis positive direction of the spacer main body **210**. The openings **22** and **24** are positioned at different positions in the Z-axis direction. The openings **22** and **24** are positioned at positions different from the openings **21**, **23**, and **25** in the Z-axis direction.

[0099] To be specific, the opening **22** connecting the space **215***a* (refer to FIGS. **5**A and **5**B) to the external space S, which is a space outside the energy storage assembly **10**, is provided in the Y-axis positive direction of the wall **232**. An opening **24** which connects the space **215***a* (refer to FIGS. **5**A and **5**B) to an external space S, which is a space outside the energy storage assembly **10**, is provided in the Y-axis positive direction of the wall **233**. The wall **232** protrudes in the Y-axis negative direction from the position of the opening **22** in the spacer main body **210**. The wall **233** protrudes in the Y-axis negative direction from the position of the opening **24** in the spacer main body **210**.

[0100] In the above-described configuration, the wall **223** of the first spacer wall **220**A of the first spacer **201** is an example of a first wall. That is, the wall **223** (first wall) is a wall protruding from the spacer main body **210** in the Y-axis positive direction or the Y-axis negative direction (one side or an other side in the first direction), and is opposed to the case wall **311** in the X-axis direction (second direction). In the present example embodiment, the wall **223** (first wall) protrudes from the spacer main body **210** only in the Y-axis positive direction (to the one side in the first direction) in the Y-axis direction (first direction). The wall **223** (first wall) protrudes from the spacer main body **210** in the Y-axis positive direction (the one side in the first direction) without protruding in the Y-axis negative direction (the other side in the first direction), and is opposed to the first energy storage device **101** in the X-axis direction (a second direction intersecting the first direction). The wall **223** (first wall) is positioned in a position at which an edge thereof in the Y-axis positive direction (the one side in the first direction) overlaps the first energy storage device **101** when viewed in the X-axis direction (second direction).

[0101] The wall **232** on the first spacer wall **230**A of the first spacer **201** is an example of a second wall. That is, the wall **232** (second wall) protrudes from the spacer main body **210** in the Y-axis negative direction (the other side in the first direction), and is opposed to the second energy storage device **102** in the X-axis direction (second direction). The wall **232** (second wall) is positioned in the Z-axis positive direction (one side in a third direction intersecting the first direction and the second direction) relative to the wall **223** (first wall). The wall **223** (first wall) and the wall **232** (second wall) are positioned in different positions in the X-axis direction (second direction). The wall **223** (first wall) and the wall **232** (second wall) include at least a portion thereof at the same position in the Z-axis direction (third direction). The length in the Z-axis direction (third direction) of the wall **223** (first wall) is greater than that of the wall **232** (second wall).

[0102] The space **215***a* and the opening **22** defined by the first spacer **201** are an example of a first space and a first opening, respectively. The space **211***b* and the opening **23** defined by the first spacer **201** are an example of a second space and a second opening, respectively. That is, the energy storage assembly **10** includes an opening **22** (first opening) which connects the space **215***a* (first space) between the second surface **215** and the first energy storage device **101** to an external space S, which is an outside space, being positioned in the X-axis direction (second direction) of the energy storage assembly **10**. The first surface **214** is opposed to the first energy storage device **101**. The energy storage assembly **10** further includes an opening **23** (second opening) which connects the space **211***b* (second space) between the spacer main body **210** and the second energy storage device **102**, to the external space S, by being positioned in the Y-axis negative direction (the other side in the first direction) of the wall **223** (first wall), and in a position different from that of the opening **22** (first opening). The space **211***b* (second space) is a flow path for a fluid that flows between the spacer main body **210** and the second energy storage device **102**. The wall **232** (second wall) protrudes in the Y-axis negative direction (the other side in the first direction) from the position of the opening **22** (first opening) of the spacer main body **210**.

[0103] As described above, according to the energy storage apparatus **1** of the present example embodiment, the spacer main body **210** of the spacer **200***a* includes a second surface **215** in a position of the first surface **214** opposed to the first energy storage device **101**, and recessed relative to the first surface **214** in the X-axis direction (second direction). The energy storage assembly **10** includes an opening **22** (first opening) which connects a space **215***a* (first space) between the second surface **215** and the first energy storage device **101** to an external space S of the energy storage assembly **10**. As described above, since the spacer main body **210** includes, in addition to the first surface **214** opposed to the first energy storage device **101**, the second surface **215** in a position of the first surface **214**, which is recessed relative to the first surface **214** in the X-axis direction (second direction), swelling of the first energy storage device **101** is restrained by the first surface **214**, and the space **215***a* (first space) is defined by the second surface **215**. Since the energy storage assembly **10** includes the opening **22** (first opening) which connects the space **215***a* (first space) (the internal space of the energy storage assembly **10**) to the external space S of the energy storage assembly **10**, the first energy storage device **101** is held by inserting a jig into the space **215***a* (first space) from the opening **22** (first opening), and therefore, workability during manufacturing is improved. Furthermore, since the spacer **200***a* includes the wall **223** (first wall) opposed to the first energy storage device **101** in the X-axis direction (second direction), insulation of first energy storage device **101** in the X-axis direction (second direction) (high-voltage protection and improvement in insulative properties) is ensured using the wall **223** (first wall). Since the spacer **200***a* includes the wall **223** (first wall), vibration resistance and shock resistance of the first energy storage device **101** in the X-axis direction (second direction) are also improved. Accordingly, in the energy storage apparatus **1**, it is possible to ensure maintenance of the performance while improving the workability during manufacturing.

[0104] In particular, the energy storage apparatus **1** includes a non-restraint type energy storage assembly **10** which does not include any restraint member (such as end plate and side plate) to restrain the plurality of energy storage devices **100** and the spacers **200**. Therefore, when vibration, shock, or the like, is applied to the energy storage apparatus **1** from outside, the energy storage devices **100** and the spacers **200** easily move within the case **300**, and the energy storage devices **100** and the spacers **200** easily approach the case wall **311**. Even when the spacers **200** are separated from the case wall **311** (with a gap therebetween), the spacers **200** easily move and easily come into contact with the case wall **311**. Therefore, the effect of improving the insulative properties of the energy storage device **100** is high.

[0105] In the spacer **200***a*, since the first surface **214** is larger in area than the second surface **215**, even when the spacer main body **210** is recessed to provide the second surface **215** that defines the space **215***a* (first space), swelling of the first energy storage device **101** is effectively restrained by the first surface **214**.

[0106] In the spacer **200***a*, the spacer main body **210** includes the third surface **216** that is recessed relative to the first surface **214** toward the Y-axis negative direction, and the second surface **215** is recessed relative to the third surface **216** toward the Y-axis negative direction. Accordingly, the first surface **214** protrudes from the third surface **216**, and the second surface **215** is recessed from the third surface **216** toward the Y-axis negative direction. Therefore, since the first surface **214** which reduces or prevents swelling of the first energy storage device **101** protrudes from the third surface **216**, and the second surface **215** which defines the space **215***a* (first space) is recessed from the third surface **216**, the first surface **214** and the second surface **215** can be configured in desired shapes at desired positions.

[0107] Since the spacer **200***a* includes a wall **232** (second wall), the wall **232** (second wall) ensures insulation of an other energy storage device **100** (second energy storage device **102**) positioned in the Y-axis negative direction (the other side in the first direction) of the spacer main body **210** in the X-axis direction (second direction) (high-voltage protection and improvement in insulative properties). Since the spacer **200***a* includes a wall **232** (second wall), such other energy storage device **100** (second energy storage device **102**) has improved vibration resistance and shock resistance in the X-axis direction (second direction).

[0108] An edge (tip end) of the wall **223** (first wall) of the spacer **200***a* in the Y-axis positive direction (one side in the first direction) overlaps the first energy storage device **101** when viewed in the X-axis direction (second direction), such that the wall **223** (first wall) does not protrude from the first energy storage device **101**. Therefore, it is possible to restrain the wall **223** (first wall) from becoming an obstacle when a jig is inserted in the Y-axis positive direction (one side in the first direction) of the first energy storage device **101**.

[0109] The energy storage assembly **10** includes an opening **23** (second opening) which connects a space **211***b* (second space) (an internal space of the energy storage assembly **10**) between the spacer main body **210** of the spacer **200***a* and the second energy storage device **102** to an external space S of the energy storage assembly **10**. The space **211***b* (second space) is a flow path for a fluid that flows between the spacer main body **210** and the second energy storage device **102**. Accordingly, by using, as the space **211***b* (second space), a flow path for a fluid (a refrigerant such as air) that flows between the spacer main body **210** and the second energy storage device **102**, a jig can be inserted into the flow path (the space **211***b*) (second space) from the opening **23** (second opening), and therefore the second energy storage device **102** can be held with a simple configuration.

[0110] The spacer **200***a* includes a wall **223** (first wall) opposed to the first energy storage device **101** in the X-axis direction (second direction), and a wall **232** (second wall) opposed to the second energy storage device **102** in the X-axis direction (second direction). Accordingly, the wall **223** (first wall) of the spacer **200***a* ensures insulation of first energy storage device **101** in the X-axis direction (second direction) (high-voltage protection and improvement in insulative properties). The wall **232** (second wall) of the spacer **200***a* ensures insulation of second energy storage device **102** in the X-axis direction (second direction) (high-voltage protection and improvement in insulative properties). The energy storage assembly **10** includes, in the Y-axis negative direction (the other side in the first direction) of the wall **223** (first wall), an opening **23** which connects a space **211***b* between the spacer main body **210** and the second energy storage device **102** to an external space S of the energy storage assembly **10**. Accordingly, the opening **23** secures a flow path for a fluid (a refrigerant such as air) that flows through a space **211***b* (an internal space of the energy storage assembly **10**) between the spacer main body **210** and the second energy storage device **102**, and the external space S of the energy storage assembly **10**. Therefore, it is possible to improve the insulative properties while cooling the energy storage device **100**. In particular, as described above, since the energy storage assembly **10** is of a non-constrained type, the energy storage devices **100** and the spacers **200** easily approach the case wall **311**. Therefore, the effect of improving the insulative properties of the energy storage device **100** is high. Since the spacer **200***a* includes the wall **223** (first wall) and the wall **232** (second wall), it is also possible to improve vibration resistance and shock resistance of the first energy storage device **101** and the second energy storage device **102** in the X-axis direction (second direction).

[0111] The wall **223** (first wall) and the wall **232** (second wall) of the spacer **200***a* are positioned at different positions in the X-axis direction (second direction). Accordingly, during assembly of the energy storage assembly **10**, or the like, it is possible to restrain the wall **223** (first wall) of one spacer **200***a*, of the two spacers **200***a* sandwiching the energy storage device **100**, and the wall **232** (second wall) of the other spacer **200***a* from coming into contact with each other.

[0112] The wall **223** (first wall) and the wall **232** (second wall) of the spacer **200***a* are positioned at least partially at the same position in the Z-axis direction (third direction). Accordingly, the wall **223** (first wall) of one spacer **200***a*, of the two spacers **200***a* sandwiching an energy storage device **100**, and the wall **232** (second wall) of the other spacer **200***a* are overlapped. Therefore, improved insulative properties (high-voltage protection and improvement in insulative properties) of the energy storage device **100** in the X-axis direction (second direction) is further achieved. It is also possible to further improve vibration resistance and shock resistance of the energy storage device **100** in the X-axis direction (second direction).

[0113] By increasing the length of the wall **223** (first wall) of the spacer **200***a* in the Z-axis direction (third direction), the length of the opening **23** in the Z-axis direction (third direction), which is positioned in the Y-axis negative direction (the other side in the first direction) of the wall **223** (first wall), is increased. Accordingly, a flow path for a fluid (a refrigerant such as air) that flows between the space **211***b* and the external space S is secured to be relatively large.

[0114] The spacer **200***a* further includes a wall **222** opposed to the first energy storage device **101** in the X-axis direction (second direction). Accordingly, the first energy storage device **101** is further insulated (high-voltage protection and improvement in insulative properties can be achieved) in the X-axis direction (second direction) by the wall **222** of the spacer **200***a*. The energy storage assembly **10**

further includes, in the Y-axis negative direction (the other side in the first direction) of the wall **222**, an opening **21** which connects a space **211*a*** between the spacer main body **210** and the second energy storage device **102** to an external space S of the energy storage assembly **10**. Accordingly, the opening **21** secures a flow path for a fluid (a refrigerant such as air) that flows through a space **211*a*** (an internal space of the energy storage assembly **10**) between the spacer main body **210** and the second energy storage device **102**, and the external space S of the energy storage assembly **10**. Since the spacer **200*a*** further includes the wall **222**, vibration resistance and shock resistance of the first energy storage device **101** in the X-axis direction (second direction) are also further improved.

[0115] An edge (tip end) of the wall **223** (first wall) of the spacer **200*a*** in the Y-axis positive direction (one side in the first direction) overlaps the first energy storage device **101** when viewed in the X-axis direction (second direction), such that the wall **223** (first wall) does not protrude from the first energy storage device **101**. Therefore, it is possible to restrain the wall **223** (first wall) from closing a flow path for a fluid (refrigerant such as air) in the Y-axis positive direction (one side in the first direction) of the first energy storage device **101**.

[0116] Since the spacer **200*a*** includes the wall **223** (first wall) opposed to the case wall **311** in the X-axis direction (second direction), the insulative properties between the energy storage device **100** and the case wall **311** are improved by the wall **223** (first wall). However, when the wall **223** (first wall) is in surface contact with the case wall **311**, a creepage distance between the energy storage device **100** and the case wall **311** may be reduced. Therefore, by providing the wall **223** (first wall) with a convex portion **223*a*** (first convex portion) protruding toward the case wall **311**, the wall **223** (first wall) is restrained from being in surface contact with the case wall **311**. Accordingly, since the creepage distance between the energy storage device **100** and the case wall **311** can be increased, the insulative properties between the energy storage device **100** and the case wall **311** is further improved. In particular, as described above, since the energy storage assembly **10** is of a non-constrained type, the spacers **200** easily moves and tends to be in contact with the case wall **311**. Therefore, the effect of increasing the creepage distance between the energy storage device **100** and the case wall **311** is high.

[0117] When the spacer **200*a*** does not include the wall **223** (first wall), it is necessary to position the convex portion **223*a*** to overlap the spacer main body **210** when viewed in the X-axis direction (second direction), and therefore, a region in which the convex portion **223*a*** can be positioned is narrow, and it is difficult to position the convex portion **223*a***. In contrast, since the convex portion **223*a*** is positioned on the wall **223** (first wall), the convex portion **223*a*** does not overlap the spacer main body **210** when viewed in the X-axis direction (second direction). Therefore, the convex portion **223*a*** can be easily positioned on the spacer **200*a***.

[0118] In the spacer **200*a***, even in a configuration in which the wall **223** (first wall) protrudes from the spacer main body **210** only in the Y-axis positive direction (to one side in the first direction), as long as the wall **223** (first wall) is provided, the convex portion **223*a*** can be positioned on the wall **223** (first wall). Therefore, the convex portion **223*a*** can be easily positioned on the spacer **200*a***.

[0119] The spacer **200*a*** further includes a wall **225** opposed to the case wall **311** in the X-axis direction (second direction), in a position different from that of the wall **223** (first wall) in the Z-axis direction (third direction). Accordingly, even in a position different from that of the wall **223** (first wall) in the Z-axis direction (third direction), the insulative properties between the energy storage device **100** and the case wall **311** are improved by the wall **225**.

[0120] Since the wall **223** (first wall) provided with the convex portion **223*a*** is positioned closer to the center position of the energy storage device **100** than the wall **225**, the creepage distance between the energy storage device **100** and the case wall **311** can be increased in a well-balanced manner by the convex portion **223*a***. Since the wall **223** (first wall) is positioned close to the center position of the energy storage device **100**, it is possible to restrain the energy storage assembly **10** from being inclined when the convex portion **223*a*** is brought into contact with the case wall **311**, and therefore, it is possible to restrain an occurrence of deviation in distances between the energy storage assembly **10** and the case wall **311**. Accordingly, the creepage distance between the energy storage devices **100** and the case wall **311** can be increased in a well-balanced manner.

[0121] Since the convex portion **225*a*** is provided on the wall **225** of the spacer **200*a***, it is possible to restrain both the wall **223** (first wall) and the wall **225** from being in surface contact with the case wall **311**. Accordingly, the creepage distance between the energy storage device **100** and the case wall **311** can be further increased.

[0122] In the energy storage device **100**, since various structural elements, such as a bus bar, a sensor, a substrate, and wiring, are positioned close to the terminals **140**, it is difficult to completely cover the energy storage device **100** with the spacer **200*a***, and there is a concern that insulative properties may deteriorate. On the other hand, as the size of the convex portion provided on the wall of the spacer **200*a*** (the size when viewed from the X-axis direction (second direction)) is smaller, the creepage distance between the energy storage device **100** and the case wall **311** is larger. Therefore, the wall **223** (first wall) is positioned closer to the terminals **140** of the energy storage devices **100** than the wall **225**, and the size of the convex portion **223*a*** provided on the wall **223** (first wall) is smaller than that of the convex portion **225*a*** when viewed in the X-axis direction (second direction). Accordingly, it is possible to increase a creepage distance between the energy storage device **100** and the case wall **311** in a position close to the terminal **140** of the energy storage device **100**, at which there is a concern that insulative properties may deteriorate.

[0123] In the energy storage apparatus **1**, since various structural elements such as a bus bar, a sensor, a substrate, and wiring are positioned close to the opening **310*a*** of the case main body **310**, it is difficult to completely cover the energy storage device **100** with the spacer **200*a***, and there is a concern that insulative properties may deteriorate. On the other hand, when the convex portion provided on the wall of the spacer **200*a*** protrudes, the creepage distance between the energy storage device **100** and the case wall **311** increases. Therefore, the wall **223** (first wall) is positioned in the Z-axis positive direction (one side in the third direction) relative to the wall **225**, and the tip end of the convex portion **223*a*** provided on the wall **223** (first wall) is positioned in the X-axis positive direction (one side in the second direction) relative to the tip end of the convex portion **225*a***. That is, the wall **223** (first wall) is positioned closer to the opening **310***a* of the case main body **310** than the wall **225**, and the convex portion **223***a* protrudes beyond the convex portion **225***a*. Accordingly, a creepage distance between the energy storage device **100** and the case wall **311** can be increased in a position close to the opening **310***a* of the case main body **310**, at which there is a concern that insulative properties may deteriorate.

[0124] Since the convex portion **223***a* close to the opening **310***a* of the case main body **310** protrudes beyond the convex portion **225***a*, it is easy to insert the energy storage assembly **10** into the case main body **310**. In particular, when the case wall **311** is inclined by an angle, or the like, since the convex portion **223***a* protrudes beyond the convex portion **225***a*, the energy storage assembly **10** can be easily inserted into the case main body **310**, and the tip ends of the convex portion **223***a* and the convex portion **225***a* can be positioned along the case wall **311**.

[0125] Although the effect of a portion of the walls included in the spacer **200***a* has been described above, the same effect is achieved for the other walls. Further, although the effect of a portion of the spacers **200***a* included in the energy storage assembly **10** has been described, the same effect is achieved for the other spacers **200***a*.

[0126] Thus far, an energy storage apparatus **1** according to an example embodiment of the present invention has been described. However, the present: limited to the above-described example embodiment. All of the example embodiments disclosed herein are illustrative, and the scope of the present invention includes all modifications within the meaning and scope of equivalence with the scope of claims.

[0127] In the above-described example embodiment, the spacer walls **220** and **230** (the walls **221** to **225**, and **231** to **234**) of the spacer **200***a* are opposed to the short side surface **112** of the container **110** of the energy storage device **100**. However, the spacer walls **220** and **230** (the walls **221** to **225**, and **231** to **234**) may be opposed to the bottom surface **113** or the container lid portion **130** of the container **110**. The case wall **311**, to which the spacer walls **220** and **230** (the walls **221** to **225**, and **231** to **234**) oppose, is a side wall of the case main body **310**. However, the case wall **311** may be a bottom wall of the case main body **310**, or may be a side wall, an upper wall, or the like, of the lid **320**.

[0128] In the above-described example embodiment, the wall **223** of the spacer **200***a* is an example of the first wall, and the wall **232** is an example of the second wall. However, the present invention is not limited thereto. The wall **223** may be an example of the first wall, and the wall **233** may be an example of the second wall. The wall **222** or **224** may be an example of the first wall, or any other wall may be an example of the first wall.

[0129] In the above-described example embodiment, the positions of the walls **221** to **225** and **231** to **234** of the spacer **200***a* in the X-axis direction and the Z-axis direction are not limited to the above, and can be positioned at various positions. The lengths of the walls **221** to **225** and **231** to **234** in the Y-axis direction and the Z-axis direction are also not limited to the above, and can have various lengths. Any of the walls **221** to **225** and **231** to **234** does not necessarily have to be provided, or any wall other than the walls **221** to **225** and **231** to **234** may be provided. Additionally, the sizes, shapes, positioned positions, numbers, and the like, of the spaces **211***a* to **211***d*, and **215***a*, and the openings **21** to **25** are not limited to those described above.

[0130] In the above-described example embodiment, the convex portions **221***a*, **223***a*, and **225***a* are provided on the walls **221**, **223**, and **225** of the spacer **200***a*. However, it is not always necessary to provide any convex portion on any of the walls **221**, **223**, and **225**. A convex portion may be provided on any of the walls **222**, **224**, and **231** to **234**. The positioned position, shape, size of the convex portion provided on the wall are not limited to those described above. From the viewpoint of ensuring strength, or the like, the convex portion may elongate in the Y-axis direction, the Z-axis direction, or a direction inclined from these directions, over a portion (half, or the like) or all of the wall, in these directions.

[0131] In the above-described example embodiment, in the spacer **200***a*, the tip end of the convex portion **223***a* protrudes beyond the tip end of the convex portion **225***a*, and the tip end of the convex portion **221***a* protrudes beyond the tip end of the convex portion **223***a*. However, the present invention is not limited thereto. The tip end of the convex portion **225***a* may protrude beyond the tip end of the convex portion **223***a*, and the tip end of the convex portion **223***a* may protrude beyond the tip end of the convex portion **221***a*, and the tip end positions of these convex portions are not particularly limited, and are appropriately determined according to the shape of the case **300**, or the like. When the convex portion **221***a* is opposed to the wall of the lid **320**, the tip end position of the convex portion **221***a* is determined according to the position of the wall of the lid **320**, and the tip end of the convex portion **221***a* does not necessarily have to protrude beyond the tip end of the side wall of the convex portion **223***a*.

[0132] In the above-described example embodiment, the wall **223** of the spacer **200***a* protrudes only in the Y-axis positive direction. However, the wall **223** of the spacer **200***a* may protrude only in the Y-axis negative direction, or may protrude in both the Y-axis positive direction and the Y-axis negative direction. When the wall **223** protrudes in both the Y-axis positive direction and the Y-axis negative direction, a through hole as the opening **23** may be provided in the wall **223**. However, it is preferable that the wall **223** protrudes only in the Y-axis positive direction, because no through hole needs to be provided in the wall **223**, and thus the spacer **200***a* can be easily manufactured (the mold structure can be simplified). The same applies to the other walls.

[0133] In the above-described example embodiment, the spaces **211***a* to **211***d* provided in the spacer main body **210** of the spacer **200***a* are partitioned from each other by the ribs. However, the present invention is not limited thereto. Any spaces among the spaces **211***a* to **211***d* may be connected to each other without being partitioned by ribs, such as the space **211***a* and the space **211***b* being connected to each other without being partitioned by ribs.

[0134] In the above-described example embodiment, the spaces **211***a* to **211***d* provided in the spacer main body **210** of the spacer **200***a* is a flow path for a fluid that flows between the spacer main body **210** and the energy storage device **100**. However, the spaces **211***a* to **211***d* do not necessarily have to be the flow path for the fluid.

[0135] In the above-described example embodiment, the spacer main body **210** of the spacer **200***a* includes the third surface **216** in a position recessed relative to the first surface **214**, and the second surface **215** is recessed relative to the third surface **216**. However, the present invention is not limited thereto. As long as the second surface **215** is recessed relative to the first surface **214**, the second surface **215** may protrude from the third surface **216**, or the first surface **214** may be recessed relative to the third surface **216**. The spacer main body **210** does not necessarily include the third surface **216**, and the second surface **215** may be recessed from the first surface **214**. The first surface **214** has been described to be larger than the second surface **215** and the third surface **216**. However, the first surface **214** may be smaller in area than either the second surface **215** or the third surface **216**.

[0136] In the above-described example embodiment, on the surface of the spacer main body **210** of the spacer **200***a* in the Y-axis positive direction, the space **215***a* is not a flow path for a fluid that flows between the spacer main body **210** and the energy storage device **100**. However, the space **215***a* may be that flow path. That is, also on the surface of the spacer main body **210** in the Y-axis positive direction, a space (flow path) such as the space **211***a* to **211***d* may be provided at the position of the space **215***a*, similarly to the surface of the spacer main body **210** in the Y-axis negative direction. According to this configuration, since a flow path through which a fluid (refrigerant) flows can be provided on both surfaces of the spacer main body **210** in the Y-axis direction, two energy storage devices **100** positioned on both sides of the spacer **200***a* in the Y-axis direction can be cooled. Further, both surfaces of the energy storage device **100** in the Y-axis direction can be cooled by the two spacer **200***a* sandwiching one energy storage device **100**. Accordingly, the cooling efficiency of the energy storage device **100** can be improved.

[0137] In the above-described example embodiment, the spacer **200***a* includes the spacer walls **220** to **250**. However, the spacer **200***a* does not necessarily have to include one of these spacer walls. In this case, the spacer **200***a* does not have to be a holder that holds the energy storage device **100**.

[0138] In the above-described example embodiment, all of the spacers **200***a* have the above-described configuration. However, any of the spacers **200***a* does not necessarily have the above-described configuration.

[0139] In the above-described example embodiment, the spacer **200***b* or the spacer **200***c* may have a configuration similar to that of the spacer **200***a*. That is, any spacer **200** among the plurality of spacers **200** may have the above-described configuration similar to that of the spacer **200***a*.

[0140] In the above-described example embodiment, the spacers **200** (the spacers **200***a*, **200***b*, and **200***c*) are alternately positioned with the energy storage devices **100** in the Y-axis direction. However, a configuration in which any of the spacers **200** is not positioned may be used. A configuration in which only one spacer **200** (spacer **200***a*, **200***b*, or **200***c*) is positioned may be used.

[0141] In the above-described example embodiment, the case **300** is made of metal. However, the case **300** may be made of a material with insulative properties, such as any resin material that can be used for the spacer **200**. Even in this case, since various structural elements made of metal may be positioned in the case **300**, it is important to improve the insulative properties of the energy storage device **100**.

[0142] In the above-described example embodiment, the case main body **310** has a sufficient height in the Z-axis direction to accommodate therein the energy storage assembly **10**, and is configured such that the energy storage assembly **10** is hardly exposed when viewed from the XY plane. However, this is not essential. The case main body **310** may have a height of about two thirds or about a half of the energy storage assembly **10** in the Z-axis direction, accommodate therein a portion of the energy storage assembly **10** in the Z-axis negative direction, and expose a portion of the energy storage assembly **10** in the Z-axis positive direction without accommodating the portion therein. In this case, the lid **320** may have a height of about one third or about a half of the energy storage assembly **10** in the Z-axis direction, and accommodate a portion of the energy storage assembly **10** in the Z-axis positive direction. In this case, as described above, the convex portion **221***a* of the wall **221** of the spacer **200***a* may be opposed to the wall of the lid **320**.

[0143] In the above-described example embodiment, the case **300** includes the case main body **310** and the lid **320**. However, the case **300** does not necessarily include the lid **320**. In the above-described example embodiment, two energy storage assemblies **10** positioned in the X-axis direction are accommodated inside the case **300**. However, three or more energy storage assemblies **10** positioned in the X-axis direction may be accommodated inside the case **300**, or only one energy storage assembly **10** may be accommodated inside the case **300**. A plurality of energy storage assemblies **10** positioning in the Y-axis direction may be accommodated inside the case **300**. In the above-described example embodiment, the energy storage assembly **10** may include a restraint (end plate, side plate, or the like) that restrains the plurality of energy storage devices **100** and the spacers **200**, or the like.

[0144] Additional example embodiments including combinations and modifications of elements features, characteristics, etc., included in the above-described example embodiment and the modification examples thereof are also included in the scope of the present invention.

[0145] The present invention can be applied to an energy storage apparatus, etc., including an energy storage device such as a lithium-ion secondary battery.

[0146] While example embodiments of the present invention have been described above, it is to be understood that variations and modifications will be apparent to those skilled in the art without departing from the scope and spirit of the present invention. The scope of the present invention, therefore, is to be determined solely by the following claims.

What is claimed is:

1. An energy storage apparatus comprising:
an energy storage assembly including:
a spacer including a spacer main body; and
a first energy storage device positioned on one side in a first direction of the spacer main body; wherein
the spacer main body includes:
a first surface opposed to the first energy storage device; and
a second surface at a position in a second direction of the first surface intersecting the first direction, the position being recessed relative to the first surface;
the energy storage assembly includes a first opening which connects a first space between the second surface and the first energy storage device to an external space, and being positioned in the second direction of the energy storage assembly; and
the spacer protrudes on the one side in the first direction from the spacer main body, and includes a first wall opposed to the first energy storage device in the second direction.

2. The energy storage apparatus according to claim **1**, wherein an area of the first surface is larger than an area of the second surface.

3. The energy storage apparatus according to claim **1**, wherein

the spacer main body further includes a third surface recessed relative to the first surface; and

the second surface is recessed relative to the third surface.

4. The energy storage apparatus according to claim **1**, wherein the spacer further includes a second wall which protrudes on an other side in the first direction from a position of the first opening in the spacer main body.

5. The energy storage apparatus according to claim **1**, wherein the first wall is positioned such that an edge thereof on the one end in the first direction overlaps the first energy storage device, when viewed from the second direction.

6. The energy storage apparatus according to claim **1**, wherein

the energy storage assembly further includes:

a second energy storage device positioned on an other side in the first direction of the spacer main body; and

a second opening positioned on the other side in the first direction of the first wall and in a position different from the first opening, the second opening connecting a second space between the spacer main body and the second energy storage device to the external space; and

the second space is a flow path for a fluid to flow between the spacer main body and the second energy storage device.

7. The energy storage apparatus according to claim **1**, further comprising:

a case including a case wall on one side in the second direction; wherein

the case accommodates the energy storage assembly therein; and

the first wall includes a first convex portion protruding toward the case wall.

8. The energy storage apparatus according to claim **7**, wherein the first convex portion does not overlap the spacer main body when viewed in the second direction.

9. The energy storage apparatus according to claim **1**, wherein the first space defines a flow path for fluid to flow between the spacer main body and the first energy storage device.

10. The energy storage apparatus according to claim **1**, wherein the first space is a space in a groove portion defined by a plurality of ribs provided on a surface of the spacer main body.

11. The energy storage apparatus according to claim **1**, wherein the first space includes an elongated portion and a curved portion.

12. The energy storage apparatus according to claim **6**, wherein the second space is a space in a groove portion defined by a plurality of ribs on a surface of the spacer main body.

13. The energy storage apparatus according to claim **6**, wherein the second space includes an elongated portion and a curved portion.

14. The energy storage apparatus according to claim **1**, wherein the first wall includes a reinforcing rib.

15. The energy storage apparatus according to claim **6**, wherein the second wall includes a reinforcing rib.

16. The energy storage apparatus according to claim **1**, wherein no restraint is provided to restrain the first storage device and the spacer.

17. The energy storage apparatus according to claim **6**, wherein no restraint is provided to restrain the first and second energy storage devices and the spacer.

18. The energy storage apparatus according to claim **1**, wherein the spacer is movable within the case.

19. The energy storage apparatus according to claim **7**, wherein the first wall is not in surface contact with the case wall.

20. The energy storage apparatus according to claim **1**, wherein the first wall protrudes in the first direction from the spacer main body on only the one side in the first direction.

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