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Rechargeable battery pack

Abstract

A rechargeable battery pack may include: a battery housing including an inner space; a series of unit battery cells accommodated in the inner space; a first bus bar configured to electrically connect the unit battery cells above the unit battery cells; a second bus bar configured to electrically connect the unit battery cells under the unit battery cells and contact a bottom plate of the battery housing in the inner space; and a cooling unit in the battery housing under the second bus bar configured to accommodate a cooling medium to flow therein for cooling the unit battery cells.

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References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
2003/0134189	12/2002	Kanai	429/120	H01M 10/6563
2012/0003522	12/2011	Fuhr	429/120	H01M 10/6551
2014/0295240	12/2013	Takeda et al.	N/A	N/A
2018/0083328	12/2017	Schaefer	N/A	H01M 10/615
2019/0074557	12/2018	Shin et al.	N/A	N/A
2019/0173064	12/2018	Lee et al.	N/A	N/A
2019/0214694	12/2018	Yang	N/A	H01M 50/512
2019/0334134	12/2018	Reingruber et al.	N/A	N/A
2019/0372069	12/2018	Lee et al.	N/A	N/A
2020/0044227	12/2019	Ryu et al.	N/A	N/A
2020/0321590	12/2019	Park	N/A	H01M 10/0422
2021/0098845	12/2020	Desbois-Renaudin	N/A	H01M 50/502
2021/0184303	12/2020	Lee	N/A	H01M 50/276

FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC
107223290	12/2016	CN	N/A
108780862	12/2017	CN	N/A
3 651 236	12/2019	EP	N/A
2014-191968	12/2013	JP	N/A
2015-018643	12/2014	JP	N/A
2017-091989	12/2016	JP	N/A
2018-527705	12/2017	JP	N/A
10-2018-0117033	12/2017	KR	N/A
10-2019-0032887	12/2018	KR	N/A

10-2019-0042341	12/2018	KR	N/A
10-2019-0083533	12/2018	KR	N/A

OTHER PUBLICATIONS

Extended European Search Report for Application No. 21177655.4, mailed Nov. 4, 2021, 9 pages. cited by applicant
Chinese Office action for Application No. 202110623672.8 dated Jul. 19, 2023, 20 pages. cited by applicant
Chinese Office action for Application No. 202110623672.8, mailed Feb. 1, 2023, 19 pages. cited by applicant
Chinese Decision of Rejection for Application No. 202110623672.8, issued Jan. 2, 2024, 18 pages. cited by applicant
Office action for European Patent Application No. 21177655.4, dated Feb. 28, 2024, 6 pages. cited by applicant

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION

(1) This application claims priority to and the benefit of Korean Patent Application No. 10-2020-0068339, filed in the Korean Intellectual Property Office on Jun. 5, 2020, the entire contents of which are incorporated herein by reference.

BACKGROUND

1. Field

(2) The present disclosure relates to embodiments of a rechargeable battery pack with an increased cooling effect.

2. Description of the Related Art

(3) A rechargeable battery can be repeatedly charged and discharged, unlike a primary battery. Small-capacity rechargeable batteries are used in portable small electronic devices such as mobile phones, notebook computers, and camcorders, whereas large-capacity rechargeable batteries are used as power sources for driving motors such as electric bicycles, scooters, electric vehicles, and fork lifts for example.

(4) The rechargeable battery may be used as one unit battery cell, or it may be used as a rechargeable battery pack in which a plurality of unit battery cells are connected in parallel or in series in order to achieve a large capacity. For example, the rechargeable battery pack uses a tab for connecting the unit battery cells in series or in parallel, and may have a structure in which a current is drawn from one tab.

(5) In the case of using a plurality of unit battery cells, the rechargeable battery pack should have a structure capable of effectively dissipating heat generated during charging and discharging for high output response, and a structure capable of effectively fixing the unit battery cells in response to shock and vibration.

(6) On the other hand, since the rechargeable battery generates heat when charging and discharging operations are repeated, there is a problem in that the rechargeable battery may be damaged by

heat.
(7) The above information disclosed in this Background section is only for enhancement of understanding of the background of the invention and, therefore, it may contain information that does not form the prior art that is already known in this country to a person of ordinary skill in the art.

SUMMARY

(8) An embodiment of the present disclosure has been made in an effort to provide a rechargeable battery pack that effectively cools and dissipates heat generated during charging and discharging of the rechargeable battery pack.
(9) An embodiment of the present disclosure provides a rechargeable battery pack including: a battery housing including an inner space; a series of unit battery cells accommodated in the inner space; a first bus bar configured to electrically connect the unit battery cells above the unit battery cells; a second bus bar configured to electrically connect the unit battery cells under the unit battery cells and contact a bottom plate of the battery housing in the inner space; and a cooling unit in the battery housing under the second bus bar configured to allow a cooling medium to flow therein for cooling the unit battery cells.
(10) The second bus bar may contact a lower surface of the unit battery cells.
(11) The second bus bar may include: a bus bar plate positioned on a bottom plate of the battery housing in the inner space; a series of terminal protrusions protruding from the bus bar plate and electrically connected to electrode terminals of the unit battery cells; and a rib protrusion protruding from an upper portion of the bus bar plate and contacting a portion of a side surface of the unit battery cells.
(12) The rechargeable battery pack may include at least one recess portion at a side surface of the rib protrusion that is in contact with the unit battery cells.
(13) The rib protrusion may be integrally formed with the bus bar plate.
(14) The rib protrusion may be coupled to the upper portion of the bus bar plate.
(15) The rib protrusion may have a lower surface that is coupled to the bus bar plate, and a first side thereof has a bent portion that is bent to contact the side surface of the unit battery cells.
(16) The unit battery cells may be fixed by a holder portion inside the battery housing.
(17) The holder portion may include a series of through holes penetrating upper and lower portions of the holder portion, and the unit battery cells are accommodated in the plurality of through holes in the holder portion.
(18) The second bus bar may include: a bus bar plate configured to face a bottom plate of the battery housing in the inner space; and a series of fixers protruding from a lower portion of the bus bar plate. The fixers include a series of interior spaces in which a lower surface and a portion of a side surface of each of the unit battery cells are positioned.
(19) Bottom surfaces of the fixers may be in contact with the bottom plate of the battery housing in the inner space.
(20) A filler may be filled between the bottom plate of the battery housing and the bus bar plate.
(21) The filler may include a thermal glue.
(22) The cooling unit may be a cooling channel formed inside the bottom plate of the battery housing.
(23) According to the exemplary embodiment of the present invention, high-temperature heat generated during an operation of the unit battery cells may be transferred to the cooling unit through the bus bar. Therefore, it is possible to effectively cool the heat generated during the operation of the unit battery cells by the heat transfer action through the bus bar.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIG. **1** illustrates a schematic perspective view showing a rechargeable battery pack according to a first embodiment of the present disclosure.

(2) FIG. **2** illustrates a schematic perspective view showing a state in which some unit battery cells of the rechargeable battery pack of FIG. **1** are inserted into a battery housing.

(3) FIG. **3** illustrates a cross-sectional view schematically showing a state in which the unit battery cells are connected to a second bus bar and positioned on an upper side of a cooling unit that is positioned on a lower surface of the battery housing according to the first embodiment of the present disclosure.

(4) FIG. **4** illustrates a schematic perspective view showing the second bus bar according to the first embodiment of the present disclosure.

(5) FIG. **5** illustrates a schematic perspective view of main parts of the second bus bar of FIG. **4**.

(6) FIG. **6** illustrates a schematic perspective view of main parts of a second bus bar according to a second embodiment of the present disclosure.

(7) FIG. **7** illustrates a schematic perspective view showing a rib protrusion of the second bus bar illustrated in FIG. **6**.

(8) FIG. **8** illustrates a schematic cross-sectional view of main parts of a second bus bar according to a third embodiment of the present disclosure.

(9) FIG. **9** illustrates a schematic perspective view showing a rechargeable battery pack according to a fourth embodiment of the present disclosure.

(10) FIG. **10** illustrates a schematic cross-sectional view showing a state in which unit battery cells of FIG. **9** are attached to a lower portion thereof fixed by a holder.

(11) FIG. **11** illustrates a schematic perspective view showing a second bus bar according to a fifth embodiment of the present disclosure.

(12) FIG. **12** illustrates a schematic side view showing a state in which lower portions of the unit battery cells are inserted into the second bus bar of FIG. **11**.

(13) FIG. **13** illustrates a schematic cross-sectional view showing a state in which the lower portions of the unit battery cells are inserted into the second bus bar of FIG. **12** and positioned above a cooling unit of a battery housing.

DETAILED DESCRIPTION

(14) Hereinafter, the present invention will be described more fully with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown. As those skilled in the art would realize, the described embodiments may be modified in various different ways, all without departing from the spirit or scope of the present invention. The drawings and description are to be regarded as illustrative in nature and not restrictive. Like reference numerals designate like elements throughout the specification.

(15) FIG. **1** illustrates a schematic perspective view showing a rechargeable battery pack according to a first embodiment of the present disclosure, FIG. **2** illustrates a schematic perspective view showing a state in which some unit battery cells of the rechargeable battery pack of FIG. **1** are inserted into a battery housing, and FIG. **3** illustrates a cross-sectional view schematically showing a state in which the unit battery cells are connected to a second bus bar and positioned on an upper side of a cooling unit that is positioned on a lower surface of the battery housing according to the first exemplary of the present disclosure.

(16) As illustrated in FIG. **1** to FIG. **3**, the rechargeable battery pack **100** according to the first embodiment of the present disclosure includes: a battery housing **10** configured to have an inner space **11** formed therein; a plurality of unit battery cells **20** inserted into (accommodated in) the inner space **11**; a first bus bar **40** configured to electrically connect the unit battery cells **20** at upper portions of the unit battery cells **20**; a second bus bar **50** configured to electrically connect the unit battery cells **20** at lower portions of the unit battery cells **20**; and a cooling unit **30** formed inside

the battery housing **10** at a lower portion of the second bus bar **50** to cool the unit battery cells **20**.
(17) In the present embodiment, the battery housing **10** may have a rectangular parallelepiped shape, and an inner space **11** may be formed to have a corresponding parallelepiped shape. The battery housing **10** is described as having the rectangular parallelepiped shape in the present embodiment, but is not limited thereto, and may be changed into various shapes, such as a cylindrical shape.
(18) The unit battery cells **20** may be accommodated in the inner space **11** of the battery housing **10**.
(19) The battery housing **10** may be sealed by using a cover unit (not illustrated) while accommodating the unit battery cells **20** therein.
(20) The cooling unit **30** may be formed in the battery housing **10**.
(21) The cooling unit **30** may be formed inside the battery housing **10** at a lower portion of the inner space **11** of the battery housing **10**. The cooling unit **30** may be formed as a cooling channel in the battery housing **10** such that a cooling medium (e.g., water) for cooling the unit battery cells **20** flows therein to properly cool and dissipate heat generated during operation of the unit battery cells **20**.
(22) The cooling unit **30** may be formed inside the battery housing **10** to have a lattice shape having a series of openings or channels in self-communication. The cooling unit **30** is not necessarily limited to the lattice shape, and the shape of the cooling unit **30** may be appropriately changed in according to an arrangement of the unit battery cells **20**.
(23) A bottom plate of the battery housing **10** may be formed as a bottom plate **31** made of aluminum. Cooling energy of the cooling unit **30** may be transferred to the second bus bar **50** in contact with a surface of the bottom plate **31** to achieve effective cooling of the unit battery cells **20** in contact with the second bus bar **50**.
(24) In one or more embodiments, each of the unit battery cells **20** may be formed as a conventional cylindrical rechargeable battery that is configured to repeatedly perform charging and discharging.
(25) The unit battery cells **20** may be electrically connected through the first bus bar **40** at an upper position of the battery housing **10** in a state of being arranged in a plurality of columns and rows inside the battery housing **10**.
(26) The first bus bar **40** is located at a position between the unit battery cells **20** at an upper side of the unit battery cell **20**, and a lead unit **41** connected to an electrode terminal may obliquely protrude from a side surface thereof.
(27) The lead unit **41** may be electrically connected to the electrode terminal by a wire member **43**.
(28) Additionally, the unit battery cells **20** may be electrically connected through the second bus bar **50** at a lower position of the battery housing **10** in a state of being arranged in a plurality of columns and rows inside the battery housing **10**.
(29) The second bus bar **50** may be installed to be electrically connected to the unit battery cells **20** inserted into the inner space **11** of the battery housing **10**. In the illustrated embodiment, the second bus bar **50** is in contact with not only bottom surfaces of the unit battery cells **20** but also a portion of the side surfaces of the unit battery cells **20**, and thus the unit battery cells **20** may be effectively cooled by a cooling action of the cooling unit **30** installed under the bottom plate **31** of the inner space **11** of the battery housing **10**.
(30) FIG. **4** illustrates a schematic perspective view showing the second bus according to the first embodiment of the present disclosure, and FIG. **5** illustrates a schematic perspective view of main parts of the second bus bar of FIG. **4**.
(31) As illustrated in FIG. **4** and FIG. **5**, the second bus bar **50** includes a bus bar plate **51** positioned in the inner space **11** of the battery housing **10**, a series of terminal protrusions **52** protruding upward from the bus bar plate **51** and electrically connected to the electrode terminals of the unit battery cells **20**, and a rib protrusion **53** protruding upward from the bus bar plate **51** to

contact a portion of a side surface of the unit battery cells **20**.
(32) The bus bar plate **51** may be formed to have a plate shape (e.g., a planar shape) at opposite sides of the rib protrusion **53** positioned therebetween.
(33) The bus bar plate **51** may be installed in surface contact with (e.g., direct surface contact) the bottom plate **31** installed along a bottom portion of the inner space **11** of the battery housing **10**.
(34) The terminal protrusions **52**, which are electrically connected to the electrode terminals of the unit battery cells **20**, may protrude from an upper surface of the bus bar plate **51**.
(35) A plurality of terminal protrusions **52** may protrude from the surface of the bus bar plate **51**, and may be electrically connected to electrode terminals of the unit battery cells **20**.
(36) The rib protrusion **53** may protrude between the terminal protrusions **52** of the bus bar plate **51** (e.g., the rib protrusion **53** may extend between a first set of the terminal protrusions **52** and a second set of the terminal protrusions **52**).
(37) The rib protrusion **53**, which protrudes above the bus bar plate **51** and to a position between the unit battery cells **20** so as to partially contact the side surface of the unit battery cells **20**, may be integrally formed with the bus bar plate **51**.
(38) The rib protrusion **53** may be formed from a length-direction portion of the bus bar plate **51** being bent upward (protruding upward) and inserted into a position between the unit battery cells **20**.
(39) In one or more embodiments, the rib protrusion **53** may protrude from the upper side of the bus bar plate **51** such that a first side of the rib protrusion **53** contacts a side surface of one unit battery cell **20** and a second side of the rib protrusion **53** contacts a side surface of another unit battery cell **20**.
(40) A series of recess portion **53***a* may be formed on side surfaces of the rib protrusion **53** to accommodate portions of the unit battery cells **20**.
(41) The recess portions **53***a* may be formed at opposite sides of the rib protrusion **53** such that the rib protrusion **53** has an undulating (e.g., serpentine) shape along a longitudinal direction thereof. For example, as illustrated in FIG. **4** and FIG. **5**, the recess portions **53***a* may be alternately formed at different positions along opposite sides of the rib protrusion **53** along the longitudinal direction of the rib protrusion **53**. Accordingly, the rib protrusion **53** may be formed to have a meandering shape (e.g., an undulating or serpentine shape) along the longitudinal direction of the rib protrusion **53**.
(42) As such, the rib protrusion **53** has a series of concave portions **53***a* formed at the side surfaces thereof, and thus the cooling energy of the cooling unit **30** may be effectively transferred to the unit battery cells **20** by increasing an area that is in surface contact with the side surface of the unit battery cells **20**.
(43) A protruding portion of the rib protrusion **53** may protrude to a height in contact with a portion of the side surface of the unit battery cells **20**.
(44) Accordingly, high-temperature heat generated during the operation of the unit battery cells **20** may be transferred to the cooling unit **30** through the bus bar plate **51** and the rib protrusion **53**. As a result, the heat generated during the operation of the unit battery cells **20** may be effectively cooled by a heat transfer action between the bus bar plate **51** and the rib protrusion **53**.
(45) FIG. **6** illustrates a schematic perspective view of main parts of a second bus bar according to a second embodiment of the present disclosure, and FIG. **7** illustrates a schematic perspective view showing a rib protrusion of the second bus bar illustrated in FIG. **6**. The same reference numerals as those of FIG. **1** to FIG. **5** denote the same or similar members having the same or similar functions. Hereinafter, detailed descriptions of the same reference numerals will be omitted.
(46) As illustrated in FIG. **6** and FIG. **7**, according to the second embodiment of the present disclosure, a rib protrusion **153** of the rechargeable battery pack may be coupled to the bus bar plate **51** of the second bus bar **50** (e.g., the rib protrusion **153** may be formed separate from the bus bar plate **51** and then subsequently coupled to the bus bar plate **51**).

(47) The bus bar plate **51** may be installed in a state of being in surface contact with the bottom plate **31** (see FIG. **3**).
(48) The terminal protrusions **52**, which are electrically connected to the electrode terminals of the unit battery cells **20**, may protrude from an upper surface of the bus bar plate **51**.
(49) A plurality of terminal protrusions **52** may protrude from the surface of the bus bar plate **51**, and may be electrically connected to electrode terminals of the unit battery cells **20**.
(50) The rib protrusion **153** may be coupled to the bus bar plate **51** between the terminal protrusions **52** of the second bus bar **50** (e.g., the rib protrusion **153** may be coupled to the bus bar plate **51** between a first set of the terminal protrusions **52** and a second set of the terminal protrusions **52**).
(51) The rib protrusion **153** may be welded at a position between the terminal protrusions **52** of the bus bar plate **51**. The rib protrusion **153** is not necessarily limited to being welded to the bus bar plate **51**, and may be bonded thereto by an adhesive or coupled in any other suitable manner.
(52) Accordingly, the rib protrusion **153** may be coupled in a protruding state to an appropriate position (an appropriate height) on the upper surface of the bus bar plate **51**, and thus may stably contact a portion of the side surface of the unit battery cells **20** to perform a cooling action of the unit battery cells **20**.
(53) FIG. **8** illustrates a schematic cross-sectional view of main parts of a second bus bar according to a third embodiment of the present disclosure. The same reference numerals as those of FIG. **1** to FIG. **7** denote the same or similar members having the same or similar functions. Hereinafter, detailed descriptions of the same reference numerals will be omitted.
(54) As illustrated in FIG. **8**, according to the third embodiment of the present disclosure, a rib protrusion **253** of a second bus bar **250** of the rechargeable battery pack may have a bent portion **254** that is formed to be bent such that a lower surface thereof is coupled to an upper surface of the bus bar plate **51** and a first side thereof projects upward and is inserted into a position between the unit battery cells **20**.
(55) That is, the rib protrusion **253** may have an 'L'-shaped cross-section in a plane that is perpendicular to the longitudinal direction of the rib protrusion **253**. In the illustrated embodiment, the rib protrusion **253** includes a horizontal leg that is coupled to the upper side of the bus bar plate **51** and a bent portion **254** (e.g., a vertical leg) extending upward from the horizontal leg. The bent portion **254** may be inserted into a position between the unit battery cells **20**.
(56) Accordingly, the bent portion **254** may be in contact with a portion of the side surface of the unit battery cells **20**, and thus the unit battery cells **20** may be effectively cooled by a heat exchange action with the cooling unit **30**.
(57) Recess portions **53***a* may be formed on a side surface of the bent portion **254** to be in surface contact with a side surface of the round unit battery cells **20** as in the above-described exemplary embodiment.
(58) FIG. **9** illustrates a schematic perspective view showing a rechargeable battery pack according to a fourth embodiment of the present disclosure, and FIG. **10** illustrates a schematic cross-sectional view showing a state in which unit battery cells of FIG. **9** are attached to a lower portion of the rechargeable battery pack fixed by a holder. The same reference numerals as those of FIG. **1** to FIG. **8** denote the same or similar members having the same or similar functions. Hereinafter, detailed descriptions of the same reference numerals will be omitted.
(59) As illustrated in FIG. **9** and FIG. **10**, according to the fourth embodiment of the present disclosure, in the rechargeable battery pack **300**, the unit battery cells **20** may be fixed by a holder portion **310** inside the inner space **11** of the battery housing **10**.
(60) The holder portion **310** may have a plurality of through-holes **311** in which a plurality of unit battery cells **20** are disposed (or accommodated). These through-holes **311** may be formed to extend through upper and lower portions of the holder portion **310** so that the unit battery cells **20** may be inserted therein. The through-holes **311** may be independent (e.g., separate) of each other or

may overlap each other.
(61) Portions of the unit battery cells **20** may be inserted into the through holes **311** of the holder portion **310**, and the others of the unit battery cells **20** may be fixed in a state of protruding from an upper portion of the through holes **311**.
(62) The holder portion **310** may be mounted on a second bus bar **350** while the unit battery cells **20** are fixed in position. In such an embodiment, the lower portion of the holder portion **310** may be coupled to the second bus bar **350**.
(63) The second bus bar **350** may be electrically connected to an electrode terminal of the unit battery cells **20** inserted into the through holes **311** through welding or the like.
(64) The second bus bar **350** may be mounted in surface contact with a bottom plate **31** of the inner space **11** of the battery housing **10** in a state of being coupled (or integrally formed) to the holder portion **310** and the unit battery cells **20**.
(65) Accordingly, high-temperature heat of the unit battery cells **20** may be cooled by heat exchange with the cooling unit **30** through the second bus bar **350**. In addition, the row of the unit battery cells **20** may be fixed in position through the holder portion **310** to facilitate a welding operation between the second bus bar **350** and the unit battery cells **20**. In addition, the unit battery cells **20**, the holder portion **310**, and the second bus bar **350** may be integrated to improve an assembling property of the rechargeable battery pack.
(66) FIG. **11** illustrates a schematic perspective view showing a second bus bar **450** according to a fifth embodiment of the present disclosure, FIG. **12** illustrates a schematic side view showing a state in which lower portions of the unit battery cells **20** are inserted into the second bus bar **450** of FIG. **11**, and FIG. **13** illustrates a schematic cross-sectional view showing a state in which the lower portions of the unit battery cells **20** are inserted into the second bus bar **450** of FIG. **12** and positioned above a cooling unit **30** of a battery housing. The same reference numerals as those of FIG. **1** to FIG. **10** denote the same or similar members having the same or similar functions. Hereinafter, detailed descriptions of the same reference numerals will be omitted.
(67) As illustrated in FIG. **11** to FIG. **13**, according to the fifth embodiment of the present disclosure, the second bus bar **450** of the rechargeable battery pack may include: a bus bar plate **451** facing a bottom plate **31** of the inner space **11** of the battery housing **10**; and a plurality of fixers **453** protruding downward away from a lower portion of the bus bar plate **451** and having interior spaces in which a bottom surface and a side surface of the unit battery cells **20** are partially positioned (or accommodated).
(68) The bus bar plate **451** may be spaced apart from the bottom plate **31** of the inner space **11** of the battery housing **10** by a protruding distance of the fixers **453**, and a plurality of fixers **453** into which the unit battery cells **20** are inserted (or accommodated) may be integrally formed with the bus bar plate **451**.
(69) The fixers **453** may be formed in a plurality of columns and rows in the bus bar plate **451**, and may be formed in a pocket type configuration by punching the bus bar plate **451** or by any other suitable process.
(70) That is, the fixers **453** may be formed to protrude from a lower portion of the bus bar plate **451** in a pocket type configuration, so that the lower portions of the unit battery cells **20** may be partially inserted or accommodated therein.
(71) The fixers **453** may protrude from the lower portion of the bus bar plate **451** such that the lower portions of the unit battery cells **20** are inserted or accommodated therein. Lower surfaces of the fixers **453** may be in surface contact (e.g., direct surface contact) with the bottom plate **31** of the inner space **11** of the battery housing **10**.
(72) Accordingly, the high-temperature heat of the unit battery cells **20** may be readily transferred to the cooling unit **30** through the bottom plate **31** of the inner space **11** of the battery housing **10** in surface contact with the fixers **453**, thereby achieving effective cooling of the unit battery cells **20**.
(73) Additionally, in one or more embodiments, a filler **460** may be filled between the bus bar plate

451 and the bottom plate **31** of the inner space **11** of the battery housing **10**.
(74) That is, the filler **460** may be filled between the bus bar plate **451**, the bottom plate **31** of the inner space **11** of the battery housing **10**, and outer surfaces of the fixers **453** protruding downward of the bus bar plate **451**.
(75) The filler **460** may be formed by using an adhesive material that facilitates heat transfer and undergoes curing by heat. In the present embodiment, the filler **460** may be formed by using a thermal glue, but is not limited thereto, and the filler **460** may be changed to a predetermined adhesive material such as a silicone adhesive.
(76) As such, the filler **460** is filled between the bus bar plate **451** and the bottom plate **31** of the inner space **11** of the battery housing **10**, and thus the high-temperature heat of the unit battery cell **20** is transferred to the cooling unit **30** through the filler **460** to enable effective cooling of the unit battery cells **20**.
(77) While this invention has been described in connection with what is presently considered to be practical exemplary embodiments, it is to be understood that the invention is not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.
DESCRIPTION OF SYMBOLS
(78) TABLE-US-00001 10 battery housing 11 inner space 20 unit battery cell 30 cooling unit 31 bottom base plate 40 first bus bar 43 wire member 50 second bus bar 51 bus bar plate 52 terminal protrusion 53a recess portion 53, 153, 253 rib protrusion 254 bent portion 310 holder portion 311 through-hole 350, 450 second bus bar 451 bus bar plate 453 fixer 460 filler

Claims

1. A rechargeable battery pack comprising: a battery housing comprising an inner space; a plurality of unit battery cells accommodated in the inner space; a first bus bar configured to electrically connect the unit battery cells above the unit battery cells; a second bus bar configured to electrically connect the unit battery cells under the unit battery cells and contact a bottom plate of the battery housing in the inner space; and a cooling unit in the battery housing under the second bus bar configured to accommodate a cooling medium to flow therein for cooling the unit battery cells, wherein the second bus bar contacts lower surfaces of the unit battery cells, wherein the second bus bar includes a rib protrusion comprising a plurality of recesses alternately curving in opposite directions and contacting a plurality of side portions of a plurality of side surfaces of the unit battery cells, wherein a height of the rib protrusion is greater than a width of the rib protrusion, wherein the rib protrusion extends lengthwise and has an undulating shape along a longitudinal direction of the rib protrusion, wherein the second bus bar includes a plurality of terminal protrusions electrically connected to electrode terminals of the unit battery cells, and wherein the plurality of terminal protrusions is arranged in staggered rows and the plurality of terminal protrusions in one of the staggered rows is aligned with the plurality of recesses in the rib protrusion.
2. The rechargeable battery pack of claim 1, wherein the second bus bar includes: a bus bar plate positioned on the bottom plate of the battery housing in the inner space; and wherein the plurality of terminal protrusions protrudes from the bus bar plate, wherein the rib protrusion protrudes from an upper portion of the bus bar plate.
3. The rechargeable battery pack of claim 2, wherein the rib protrusion is integrally formed with the bus bar plate.
4. The rechargeable battery pack of claim 2, wherein the rib protrusion is coupled to the upper portion of the bus bar plate.
5. The rechargeable battery pack of claim 2, wherein the rib protrusion has a lower surface that is coupled to the bus bar plate, and wherein a first side of the rib protrusion has a bent portion that is

bent to contact the plurality of side portions of the plurality of side surfaces of the plurality of unit battery cells.

6. The rechargeable battery pack of claim 1, wherein the cooling unit is a cooling channel formed inside the bottom plate of the battery housing.