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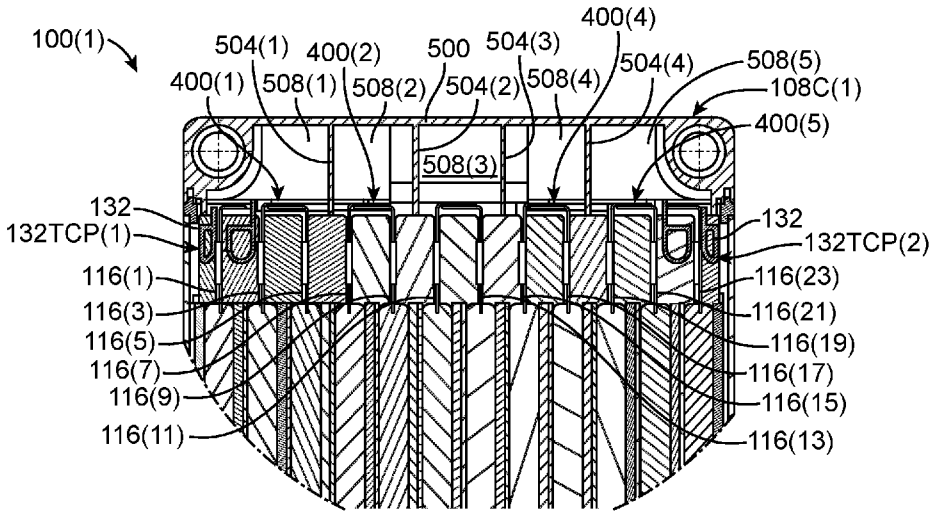

FIG. 5

(57) Abstract: Multicell battery modules in which at least some immediately adjacent ones of the pole tabs of the cells are directly electrically and mechanically connected to one another to form pole-tab pairs. In some embodiments, the pole tabs of each pole-tab pair are bent toward one another and welded together. In some embodiments, lightweight, e.g., foam, electrical insulation is placed in the inter-tab spaces between immediately adjacent pairs of pole tabs. In some embodiments, an end closure having an end wall is provided with spacing tabs that extend from the end wall to the inter-tab insulation so as to isolate immediately adjacent pole tabs from one another, for example, to inhibit or prevent electrical creepage. In some embodiments, a flexible printed circuit is directly electrically and mechanically connected to the pole-tab pairs via contacts welded to the pole-tab pairs. Simple electrical lead-out arrangements and communication port-connector arrangements are also disclosed.

WO 2024/108466 A1

[Continued on next page]

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MULTICELL BATTERY MODULES HAVING DIRECT POLE-TAB TO POLE-TAB CONNECTIVITY AND RELATED FEATURES

FIELD OF THE INVENTION

[0001] The present invention generally relates to the field of pouch-type multicell battery modules. In particular, the present invention is directed to multicell battery modules having direct pole-tab to pole-tab connectivity and related features.

BACKGROUND

[0002] Batteries are becoming more and more ubiquitous as combustion-engine-powered vehicles and corded devices are being replaced by battery-powered equivalents and as power storage demands grow as renewable energy sources are becoming more prevalent. In many applications, batteries for these applications are based on electrochemical cells, such as lithium-metal and lithium-ion cells, and it is common for these cells to be of the pouch type, which generally have a rectangular form factor. Because the individual cells are limited by the relevant chemistry to provide relatively low voltages and relatively low currents, multiple individual cells for power-intensive applications are packaged together and electrically connected to one another to form a battery module having a higher output voltage and/or a higher output current. If energy requirements are greater than a single module can provide, then multiple individual modules are grouped and/or packaged together and electrically connected to one another to form a battery pack having the requisite energy requirements and output voltage and current characteristics needed for the particular application at issue.

[0003] In many cases the construction of a pouch-type multicell battery module utilizes busbars to electrically connect the cells to one another via the cells' pole tabs present at one or both ends of the module depending on cell design. A common technique for installing the busbars is to first install a plastic busbar support structure that generally has the same areal size as a transverse cross-section of the module. After installing the busbar support, the busbars are installed and then welded to the pole tabs of the relevant ones of the cells.

[0004] A drawback of this type of module construction is that the plastic busbar support must be fairly robust to function as a welding fixture, and this means that the busbar support is relatively large and relatively heavy. The relatively large size and relatively large weight reduce, respectively,

the volumetric and gravimetric energy densities of the modules so constructed. In addition, this construction provides relatively high rigidity as between the cells' pole tabs, the busbars, and the busbar support. This, in combination with the relatively high mass of the busbar support and the busbars themselves that increases the inertial forces, increases the likelihood of damage from shock and vibration during use that can lead to internal failures, such as twisting pole tabs and inducing stress cracks in tab welds and other components, such as flexible printed circuits used for module performance and health monitoring.

SUMMARY OF THE DISCLOSURE

[0005] In an implementation, the present disclosure is directed to a battery module, which includes a cell stack comprising a plurality of cells stacked with one another along a stacking direction, wherein: each of the cells has first and second ends spaced from one another in a direction perpendicular to the stacking direction and including first and second pole tabs of opposite polarities located at corresponding respective ones of the first and second ends; each pair of immediately adjacent ones of the first pole tabs forming a first inter-tab space; at least some of immediately adjacent ones of the first pole tabs are fastened to one another to form at least one corresponding first pole-tab pair; and an electrically insulating material disposed in each of the first inter-tab spaces; a middle shell comprising walls parallel to the stacking direction; and a first end closure secured to the middle shell and covering the first pole tabs and the electrically insulating material in the first inter-tab spaces.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] For the purpose of illustration, the accompanying drawings show aspects of one or more embodiments of the invention(s). However, it should be understood that the invention(s) of this disclosure is/are not limited to the precise arrangements and instrumentalities shown in the drawings, wherein:

[0007] FIG. 1A is a perspective view of an example battery module made in accordance with aspects of the present disclosure;

[0008] FIG. 1B is a partially exploded view of the module of FIG. 1A;

[0009] FIG. 2A is a perspective view of the lead-out arrangement of FIG. 1B in isolation from other components of the module of FIGS. 1A and 1B;

[0010] FIG. 2B is an enlarged top view of the lead-out arrangement of FIG. 2A;

[0011] FIG. 2C is a cross-sectional view of the lead-out arrangement as taken along line 2C-2C of FIG. 2B;

[0012] FIG. 3A is a perspective view of the port-connector arrangement of FIG. 1B in isolation from other components of the module of FIGS. 1A and 1B;

[0013] FIG. 3B is an enlarged top view of the port-connector arrangement of FIG. 3A;

[0014] FIG. 3C is a cross-sectional view of the port-connector arrangement as taken along line 3C-3C of FIG. 3B;

[0015] FIG. 4 is an enlarged end view of the module of FIGS. 1A and 1B showing the first end closure at the lead-out end of the module removed;

[0016] FIG. 5 is an enlarged partial cross-sectional view of the module of FIGS. 1A and 1B at the lead-out end of the module;

[0017] FIG. 6 is an enlarged end view of the module of FIGS. 1A and 1B showing the second end closure at the data-connection end of the module removed; and

[0018] FIG. 7 is an enlarged end view of the module of FIGS. 1A and 1B showing the second end closure at the data-connection end of the module installed.

DETAILED DESCRIPTION

[0019] In some aspects, the present disclosure is directed to battery modules comprising a plurality of pouch-type electrochemical cells (hereinafter, simply "cells") electrically connected with one another and packaged within a housing using manufacturing techniques and structures disclosed herein that either avoid using busbars and any associated busbar support(s) or reduce the number of busbars and extent of busbar support(s), depending on the electrical connectivity of the cells in the module at issue. These benefits stem from directly electrically and mechanically connecting together pertinent ones of the pole tabs instead of providing busbars as is customary. In some embodiments: a relatively lightweight dielectric material, such as a dielectric foam, is placed between adjacent pole-tabs; pole-tabs of various ones of the cells in a module are directly fastened to one another to create both mechanically connected and an electrically connected pole-tab pairs; a flexible printed circuit is electrically coupled to the pole-tab pairs, for example, for monitoring module performance and/or module health; and/or an end closure having spacing ribs is provided to create individual pole-tab-pair isolation chambers.

[0020] In some embodiments, one end of a module of the present disclosure may be the electrical lead-out end and/or one end may be the data-connection end. In some embodiments, the electrical lead-out end and the data-connection end may be at opposite ends of the module. When one end of the module is the lead-out end, the module may include a dielectric internal lead support that supports the positive and negative electrical leads that connect internal terminals to external terminals. In some embodiments, the lead support may be attached to dielectric insulation placed between the pole tabs on that end of the module. When one end of the module is the data-connection end, the module may include a data-port connector and a connector support that fixedly supports the data-port connector. In some embodiments, the connector support is secured to dielectric insulation placed between the pole tabs on that end of the module. These and other features and embodiments are described below in connection with the example embodiments illustrated in the drawings.

[0021] Referring now to the drawings, FIGS. 1A and 1B illustrate an example battery module 100 (hereinafter, simply "module") made in accordance with the present disclosure. In this example, the module 100 has first and second ends 100(1) and 100(2), respectively, with the first end 100(1) being an electrical lead-out end and the second end 100(2) being a data-connection end. The module 100 includes a stack 104 of individual cells, here twelve cells 104(1) to 104(12) (only a few labeled to avoid clutter) stacked with one another along a stacking axis 104SA. As those skilled in the art will readily appreciate, the number of cells need not be twelve. Indeed, the number of cells may be any number needed to suit a particular requirement for the module and based on the relevant cell size and chemistry. Not shown, but which may be present in some embodiments, is wrapping wrapped around the stack. The stack 104 is contained within a housing 108 having a middle shell 108B and first and second end closures 108C(1) and 108C(2) that close and seal the housing at, respectively, the first and second ends 100(1) and 100(2) of the module 100.

[0022] As discussed below in detail, in this example the cells 104(1) to 104(12) are all electrically connected in series with one another. However, in other embodiments the cells 104(1) to 104(12), or whatever cells are present, may be electrically connected in another manner, for example, with some of the cells being connected in series with one another and some of the cells being connected in parallel with one another, depending on the particular requirements for the module at issue.

[0023] In this example, the first end 100(1) of the module 100 is an electrical lead-out end of the module at which output terminals 112(1) and 112(2) (see FIG. 4) are electrically connected,

respectively, to the relevant output pole-tabs of the stack 104, here pole tabs 116(1) and 116(23) (see FIGS. 4 and 5) on the fully series connected cells 104(1) to 104(12), by corresponding electrical leads 120(1) and 120(2) (see FIGS. 2A-2C and 4). To this end, the example module 100 includes a lead-out arrangement 124 of structures, which in this example include electrical insulation 128(1) and a lead support structure 132 for supporting the electrical leads 120(1) and 120(2). Details of the example lead-out arrangement 124 are described below in connection with FIGS. 2A-2C, 4, and 5.

[0024] Also in this example, the second end 100(2) of the module 100 is a data-connection end of the module that includes a data-port connector 136. To this end, the example module 100 includes a port-connector arrangement 140 of structures, which in this example includes electrical insulation 128(2) and a connector support 144 that supports the data-port connector 136. Details of the example port-connector arrangement 140 are described below in connection with FIGS. 3A-3C, 6, and 7.

[0025] This embodiment also includes a flexible printed circuit 148 that is electrically connected to the data-port connector 136 and to other components of the module 100 as described below in connection with FIGS. 4-6. As alluded to above, the data-port connector 136 allows the module 100 to communicate data offboard the module, for example, for performance and/or health monitoring purposes. Regarding the type of the data-port connector 136, those skilled in the art will understand that its type may be any suitable type, such as a standard type (e.g., RS-232, DE-9, DE 15, etc.) or a custom type. In some embodiments, the physical data-port connector 136 may be eliminated and replaced by a wireless data port (not shown).

[0026] FIGS. 2A-2C illustrate the lead-out arrangement 124 of FIG. 1B in isolation from other components of the example module 100 (FIGS. 1A and 1B) to aid the reader's understanding of the construction of the module. As seen in FIGS. 2A-2C, the lead-out arrangement 124 includes the electrical insulation 128(1) and the lead support structure 132, which in this example are secured together to provide a unitary structure. If secured together, the electrical insulation 128(1) and the lead support structure 132 may be secured to one another either before or after engagement with the rest of the module 100 (FIGS. 1A and 1B) and in any suitable manner, such as using an adhesive, mechanical fastening, overmolding, etc., or any combination of these, among others. The electrical insulation 128(1) is a physical structure (as opposed, for example, to a vacuum or air and/or other gas) that may be made of any suitable dielectric material(s). Because it is often desirable to make a battery module, such as module 100, as lightweight as possible, dielectric foam(s) is/are a good

choice for the dielectric material(s). Examples of foams suitable for the inter-tab insulation 128(1) include, but are not limited to, polyurethane (PU), silicone rubber, and polyethylene (PE), among others. Material(s) other than foam(s) can be used, too, as long as it/they provide the necessary electrical insulation.

[0027] The lead support structure 132 may have any suitable shape to suit, for example, the locations of the output terminals 112(1) and 112(2) (FIG. 4) and the corresponding pole tabs of the stack 104 (here, pole tabs 116(1) and 116(23) (FIG. 5)), the shapes and configurations of the electrical leads 120(1) and 120(2), and the internal space available within the module 100 (FIGS. 1A and 1B). The lead support structure 132 may be made of any one or more suitable materials, such as one or more dielectric thermoset plastics and/or thermoplastics, among others.

[0028] FIGS. 3A-3C illustrate the port-connector arrangement 140 of FIG. 1B in isolation from other components of the example module 100 (FIGS. 1A and 1B) to aid the reader's understanding of the construction of the module. As seen in FIGS. 3A-3C, the port-connector arrangement 140 includes the electrical insulation 128(2), the connector support 144, and the data-port connector 136. Like the electrical insulation 128(1) of FIGS. 2A-2C, the electrical insulation 128(2) may be made of any suitable dielectric material(s), such as any one or more of the dielectric materials noted above relative to the electrical insulation 128(1) of FIGS. 2A-2C.

[0029] The connector support 144 may have any suitable shape to suit, for example, the size, shape, and mounting requirements of the data-port connector 136, the configuration of the electrical insulation 128(2), and the internal space available within the module 100 (FIGS. 1A and 1B), among other things. The connector support 144 may be made of any one or more suitable materials, such as one or more dielectric thermoset plastics and/or thermoplastics, among others. In this example, the connector support 144 includes a pair of nuts 300(1) and 300(2) overmolded into it. These nuts 300(1) and 300(2) receive corresponding screws 700(1) and 700(2) (FIG. 7) that secure the second end closure 108C(2) to connector support 144 and, in this example, the entire port-connector arrangement 140.

[0030] FIG. 4 shows the lead-out end (first end) 100(1) of the module 100 with the first end closure 108C(1) (FIGS. 1A, 1B, and 5) removed to be able to view internal components and electrical connections. FIG. 5 shows the lead-out end 100(1) in cross-section but with the first end closure 108C(1) installed. Referring to both FIGS. 4 and 5 for ease of understanding, these figures show pole tabs 116(3) + 116(5), 116(7) + 116(9), 116(11) + 116(13), 116(15) + 116(17),

and 116(19) + 116(21), respectively, bent toward one another and fastened together so as to form five pole-tab pairs 400(1) to 400(5). As mentioned above, the fastening may be accomplished in any suitable manner that both mechanically and electrically connects the pole tabs 116(3) + 116(5), 116(7) + 116(9), 116(11) + 116(13), 116(15) + 116(17), and 116(19) + 116(21), respectively, to one another. As also mentioned above, such fastening may be performed in any suitable manner, such as welding, mechanical fastening, brazing, bonding using an electrically conductive adhesive, co-melting, and any suitable combination thereof, among others. Fundamentally, there is no limitation on the fastening as long as the fastening meets the electrical requirements and mechanical robustness requirements for the intended service. As noted above, in the example module 100 all of the cells 104(1) to 104(12) are electrically connected in series with one another. Therefore, in each of the pole-tab pairs 400(1) to 400(5) the pole tabs 116(3) to 116(21) are of opposite polarity from one another. Similarly, pole tabs 116(1) and 116(23) are of opposite polarities from one another.

[0031] As best seen in FIG. 5, pole tabs 116(1) and 116(23) are the end pole tabs of the series-connected cells 104, and these pole tabs are electrically connected to the electrical leads 120(1) and 120(2) and are captured, respectively, within tab-capturing portions 132TCP(1) and 132TCP(2) of the lead support structure 132. Referring to FIG. 4, the electrical leads 120(1) and 120(2) are connected at their other ends to the output terminals 112(1) and 112(2). FIG. 4 also shows that the flexible printed circuit 148 is electrically connected to each of the electrical leads 120(1) and 120(2) and each of the pole-tab pairs 400(1) to 400(5) by a corresponding electrical contact 404(1) to 404(7).

[0032] Referring again to FIG. 5, the first end closure 108C(1) of this example module 100 includes an end wall 500 that is spaced from the pole-tab pairs 400(1) to 400(5) to provide headspace between the end wall and the free surfaces of the electrical insulation 128(1) that is present in the spaces between adjacent ones of the pole tabs 116(1) to 116(23) as well as adjacent to the outside-facing sides of the end pole tabs 116(1) and 116(23). In this example, the first end closure 108C(1) also includes spacing ribs 504(1) to 504(4) that extend from the end wall 500 to the electrical insulation 128(1) to form pole-tab-pair isolation chambers 508(1) to 508(5) that electrically isolate the pole-tab pairs 400(1) to 400(5) from one another and inhibit electrical creepage between immediately adjacent ones of the pole-tab pairs. Although not illustrated, the spacing ribs 504(1) to 504(4) may extend the full length of the first end closure 108C(1) (into and out of the page of FIG. 5) or may extend only part of the length, for example, extend only where needed relative to the pole-tab pairs 400(1) to 400(5). Generally, each spacing rib 504(1) to 504(4) should firmly engage

the electrical insulation 128(1) so as to block electrical creepage. If foam is used for the electrical insulation 128(1) and if the foam is compressible enough, the spacing ribs 504(1) to 504(4) may be sized so that when the first end closure 108C(1) is fully engaged with the module 100, they compress the foam to a desired extent.

[0033] FIG. 6 shows the data-connection end (second end) 100(2) of the module 100 with the second end closure 108C(2) (FIGS. 1A, 1B, and 7) removed to be able to view internal components and electrical connections. FIG. 7 shows the data-connection end 100(2) (FIG. 1) with the second end closure 108C(2) installed. Referring to FIGS. 6, this figure shows pole tabs 116(2) + 116(4), 116(6) + 116(8), 116(10) + 116(12), 116(14) + 116(16), 116(18) + 116(20), and 116(22) + 116(24), respectively, bent toward one another and fastened together so as to form six pole-tab pairs 600(1) to 600(6). As mentioned above, the fastening may be accomplished in any suitable manner that both mechanically and electrically connects the pole tabs 116(2) + 116(4), 116(6) + 116(8), 116(10) + 116(12), 116(14) + 116(16), 116(18) + 116(20), and 116(22) + 116(24), respectively, to one another. As also mentioned above, such fastening may be performed in any suitable manner, such as welding, mechanical fastening, brazing, bonding using an electrically conductive adhesive, co-melting, and any suitable combination thereof, among others. Fundamentally, there is no limitation on the fastening as long as the fastening meets the electrical requirements and mechanical robustness requirements for the intended service. As noted above, in the example module 100 all of the cells 104(1) to 104(12) are all electrically connected in series with one another. Therefore, in each of the pole-tab pairs 600(1) to 600(6) the pole tabs 116(2) to 116(24) are of opposite polarity.

[0034] FIG. 6 also shows the electrical insulation 128(2) present in the inter-tab spaces between adjacent ones of the pole tabs 116(2) to 116(24) and adjacent to the outside faces of the end pole tabs 116(2) and 116(24). FIG. 6 further shows that the flexible printed circuit 148 is electrically connected to each of the pole-tab pairs 600(1) to 600(6) via a corresponding electrical contact 604(1) to 604(6). Although not illustrated, in this example the flexible printed circuit 148 extends within the middle shell 108B (FIGS. 1A and 1B) between the first and second ends 100(1) and 100(2) of the module. As noted above, FIG. 7 shows the screws 700(1) and 700(2) that threadedly engage, respectively, the nuts 300(1) and 300(2) (FIG. 6) of the port-connector arrangement 140.

[0035] Various modifications and additions can be made without departing from the spirit and scope of this invention. Features of each of the various embodiments described above may be combined with features of other described embodiments as appropriate in order to provide a

multiplicity of feature combinations in associated new embodiments. Furthermore, while the foregoing describes a number of separate embodiments, what has been described herein is merely illustrative of the application of the principles of the present invention. Additionally, although particular methods herein may be illustrated and/or described as being performed in a specific order, the ordering is highly variable within ordinary skill to achieve aspects of the present disclosure. Accordingly, this description is meant to be taken only by way of example, and not to otherwise limit the scope of this invention.

[0036] Exemplary embodiments have been disclosed above and illustrated in the accompanying drawings. It will be understood by those skilled in the art that various changes, omissions and additions may be made to that which is specifically disclosed herein without departing from the spirit and scope of the present invention.

What is claimed is:

1. A battery module, comprising:
   a cell stack comprising a plurality of cells stacked with one another along a stacking direction, wherein:
   each of the cells has first and second ends spaced from one another in a direction perpendicular to the stacking direction and including first and second pole tabs of opposite polarities located at corresponding respective ones of the first and second ends;
   each pair of immediately adjacent ones of the first pole tabs forming a first inter-tab space;
   at least some of immediately adjacent ones of the first pole tabs are fastened to one another to form at least one corresponding first pole-tab pair; and
   an electrically insulating material disposed in each of the first inter-tab spaces;
   a middle shell comprising walls parallel to the stacking direction; and
   a first end closure secured to the middle shell and covering the first pole tabs and the electrically insulating material in the first inter-tab spaces.

2. The battery module of claim 1, wherein the first pole tabs in each first pole-tab pair are bent toward one another and fastened to one another.

3. The battery module of claim 1, wherein the first pole tabs in each first pole-tab pair are bent toward one another and welded to one another.

4. The battery module of claim 1, wherein the cell stack includes a plurality of the first pole-tab pairs and the first end closure provides a first headspace between the first end closure and the cell stack, the battery module further comprising a flexible printed circuit at least partially contained within the first headspace.

5. The battery module of claim 4, wherein the flexible printed circuit is electrically connected to each of the first pole-tab pairs by a corresponding electrical contact.

6. The battery module of claim 5, further comprising:
   a data-port connector; and
   a connector support that fixedly supports the data-port connector;
   wherein the flexible printed circuit is electrically connected to the data-port connector.

7. The battery module of claim 6, wherein the connector support is secured to the electrically insulating material in the first inter-tab spaces.

8. The battery module of claim 1, wherein the cell stack includes a plurality of the first pole-tab pairs and the first end closure includes a plurality of spacing ribs that engage the electrically insulating material present in the first inter-tab spaces between adjacent ones of the first pole-tab pairs so as to form individual pole-tab-pair isolation chambers.

9. The battery module of claim 1, further comprising:
internal module terminals electrically coupled to ones of the first and second pole terminals;
external module terminals electrically coupled to corresponding respective ones of the internal module terminals via corresponding leads; and
a lead-terminal support made of a dielectric material and supporting each of the internal module terminals and the leads.

10. The battery module of claim 9, wherein the lead-terminal support is secured to the electrically insulating material in the first inter-tab spaces.

11. The battery module of claim 1, wherein the electrically insulating material comprises a dielectric foam.

12. The battery module of claim 1, wherein:
each pair of immediately adjacent ones of the second pole tabs form a second inter-tab space;
at least some of immediately adjacent ones of the second pole tabs are mechanically and electrically connected with one another to form at least one corresponding second pole-tab pair;
an electrically insulating material disposed in each of the second inter-tab spaces;

13. The battery module of claim 12, wherein:
the cell stack includes a plurality of the first pole-tab pairs and a plurality of the second pole-tab pairs;
the first end closure provides a first headspace between the first end closure and the cell stack;
the second end closure provides a second headspace between the second end closure and the cell stack; and

the battery module further comprising a flexible printed circuit at least partially contained within each of the first and second headspaces.

14. The battery module of claim 13, wherein the flexible printed circuit is electrically connected to each of the first pole-tab pairs and each of the second pole-tab pairs by a corresponding electrical contact.

15. The battery module of claim 14, further comprising:

a data-port connector extending through the first end closure; and

a connector support that fixedly supports the data-port connector;

wherein the flexible printed circuit is electrically connected to the data-port connector.

16. The battery module of claim 15, wherein the connector support is secured to the electrically insulating material in the first inter-tab spaces.

17. The battery module of claim 12, wherein:

the cell stack includes a plurality of the first pole-tab pairs;

the first end closure includes a plurality of first spacing ribs that engage the electrically insulating material present in the first inter-tab spaces between adjacent ones of the first pole-tab pairs so as to form individual first pole-tab-pair isolation chambers;

the cell stack includes a plurality of the second pole-tab pairs; and

the second end closure includes a plurality of second spacing ribs that engage the electrically insulating material present in the second inter-tab spaces between adjacent ones of the second pole-tab pairs so as to form individual second pole-tab-pair isolation chambers.

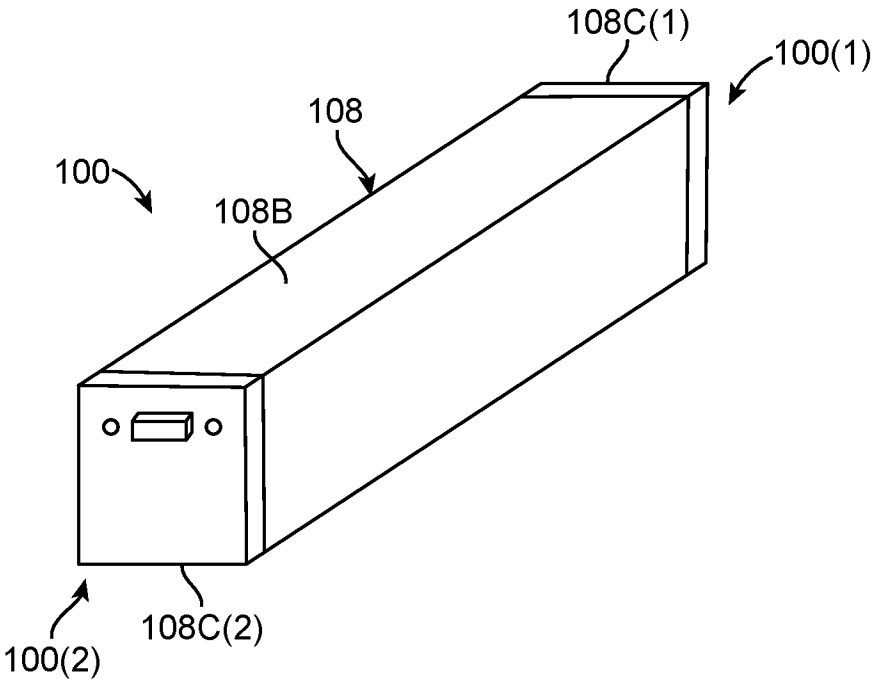
18. The battery module of claim 12, further comprising:

internal module terminals electrically coupled to ones of the first and second pole terminals, wherein the internal module terminals are located in the second headspace;

external module terminals electrically coupled to corresponding respective ones of the internal module terminals via corresponding leads; and

a lead-terminal support made of a dielectric material and supporting each of the internal module terminals and the leads.

19. The battery module of claim 18, wherein the lead-terminal support is secured to the electrically insulating material in the second inter-tab spaces.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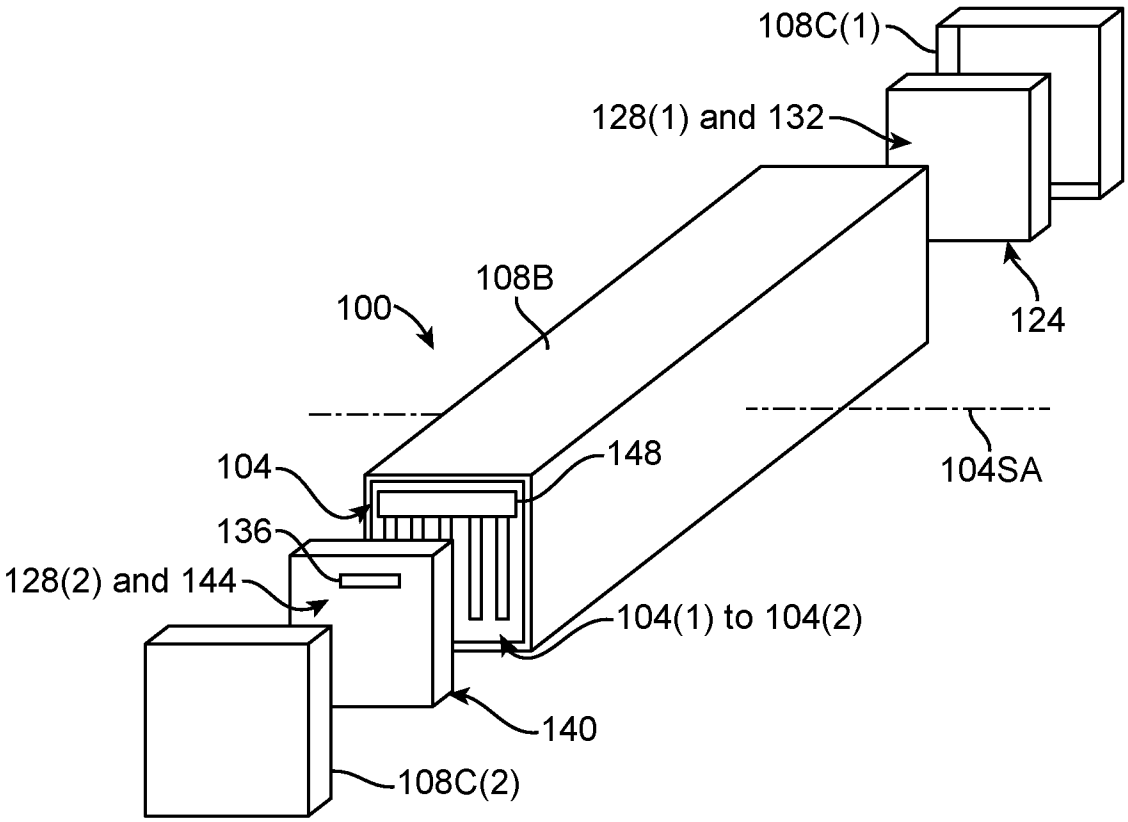
100(1)
108
100
108B
100(2)
108C(2)

FIG. 1A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128(1) and 132
108B
100
124
104SA
148
104
136
128(2) and 144
104(1) to 104(2)
140
108C(2)

FIG. 1B

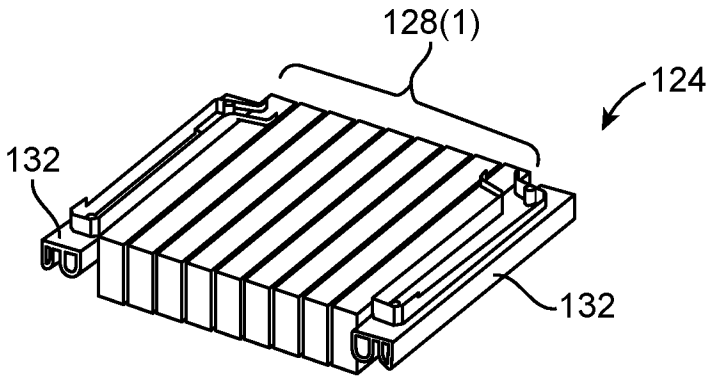


FIG. 2A

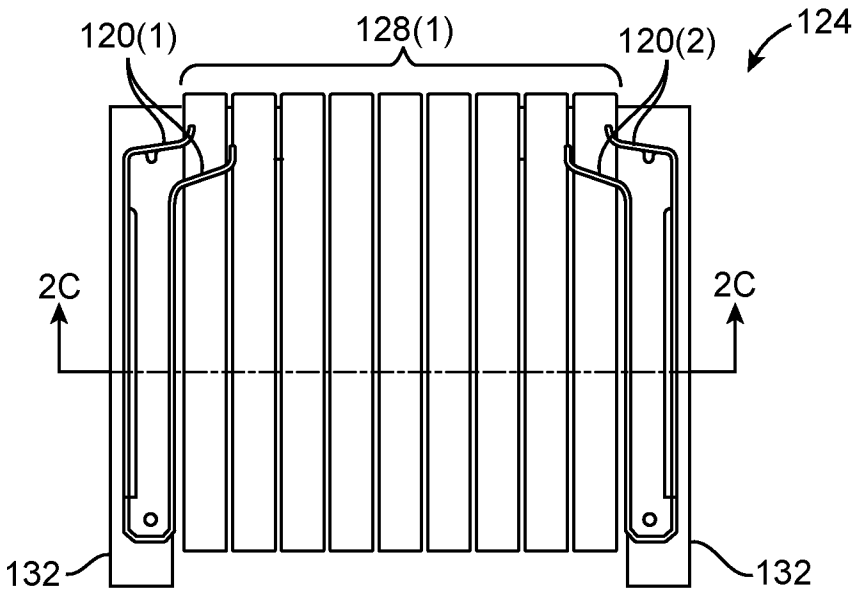


FIG. 2B

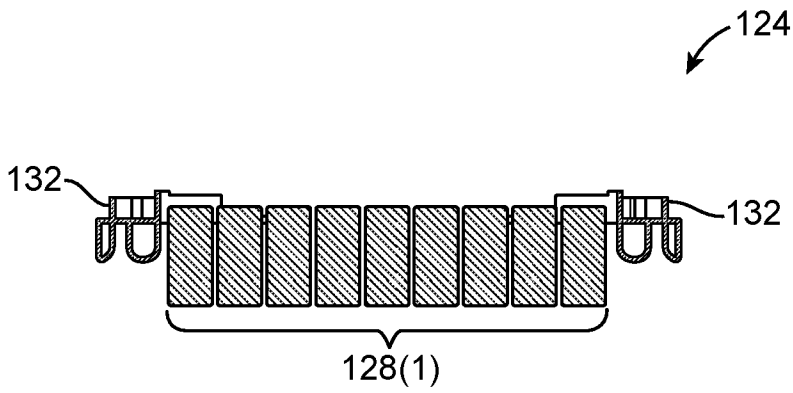


FIG. 2C

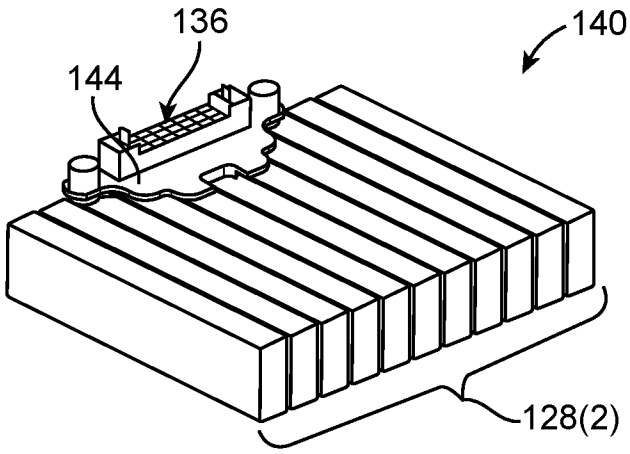


FIG. 3A

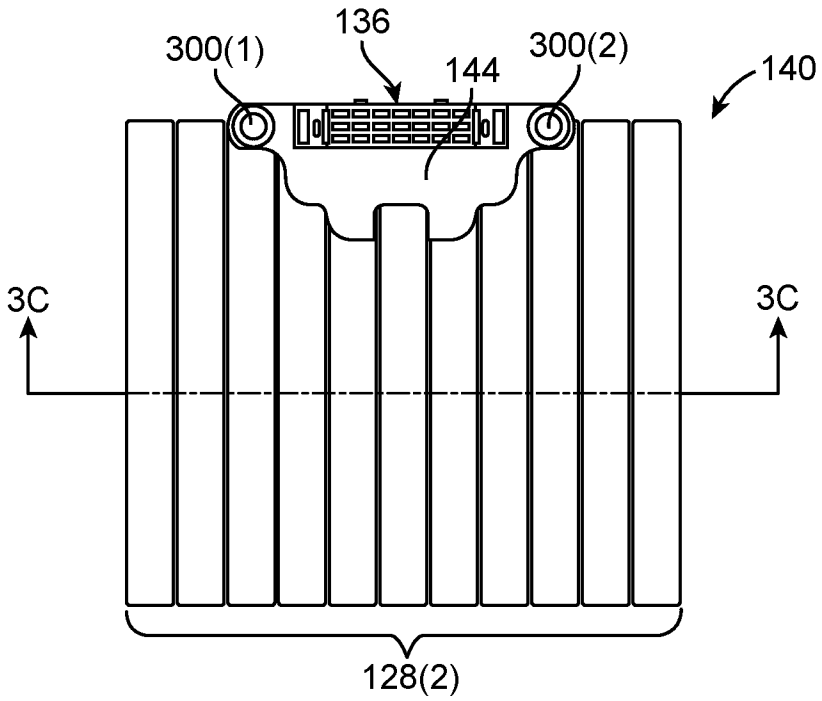


FIG. 3B

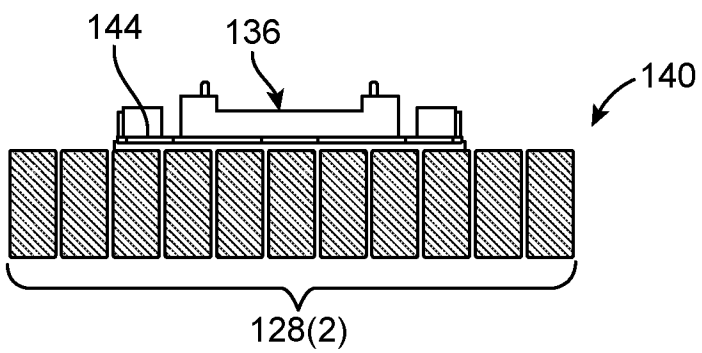
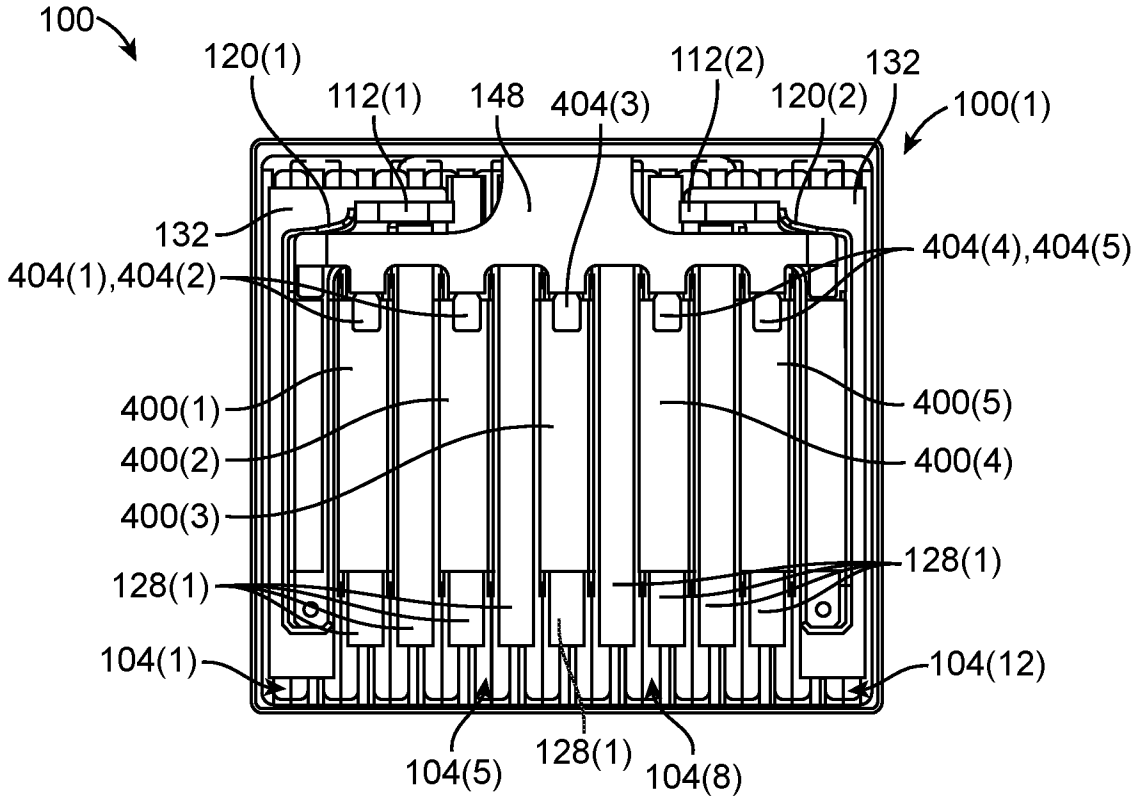


FIG. 3C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112(1)
148
404(3)
112(2)
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400(3)
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400(4)
128(1)
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104(1)
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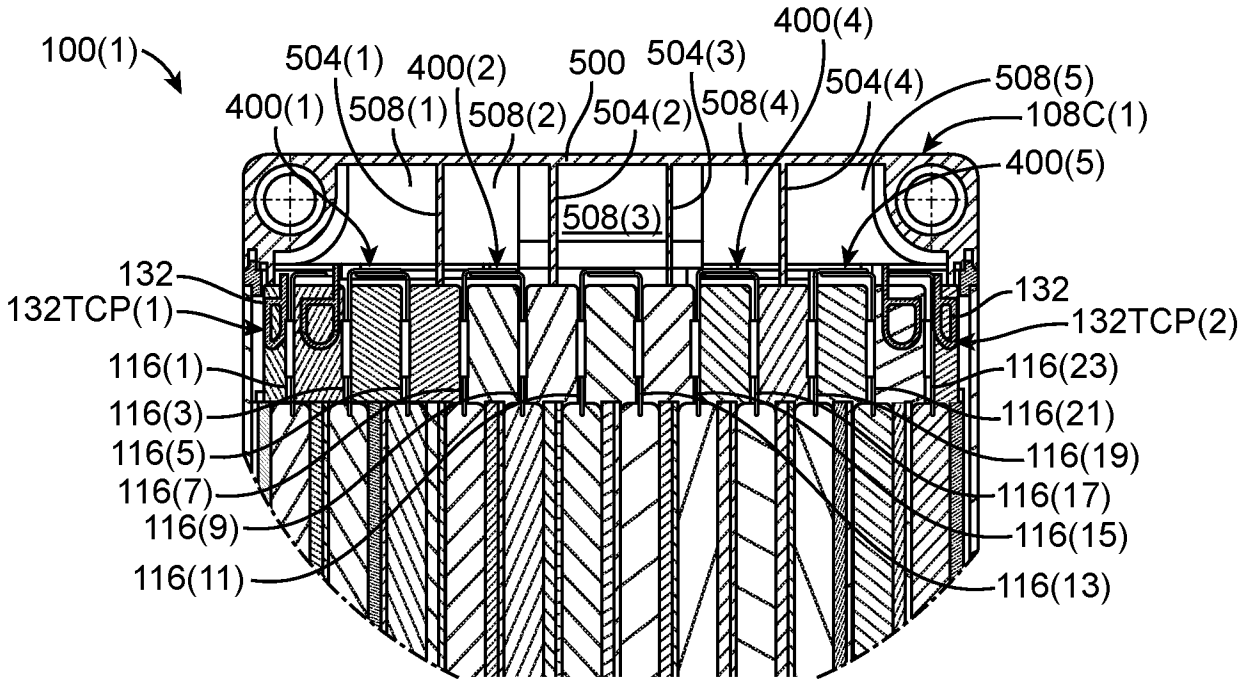
104(5)
128(1)
104(8)

FIG. 4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508(5)
108C(1)
400(5)
508(3)
132
132TCP(1)
116(1)
116(3)
116(5)
116(7)
116(9)
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132TCP(2)
116(23)
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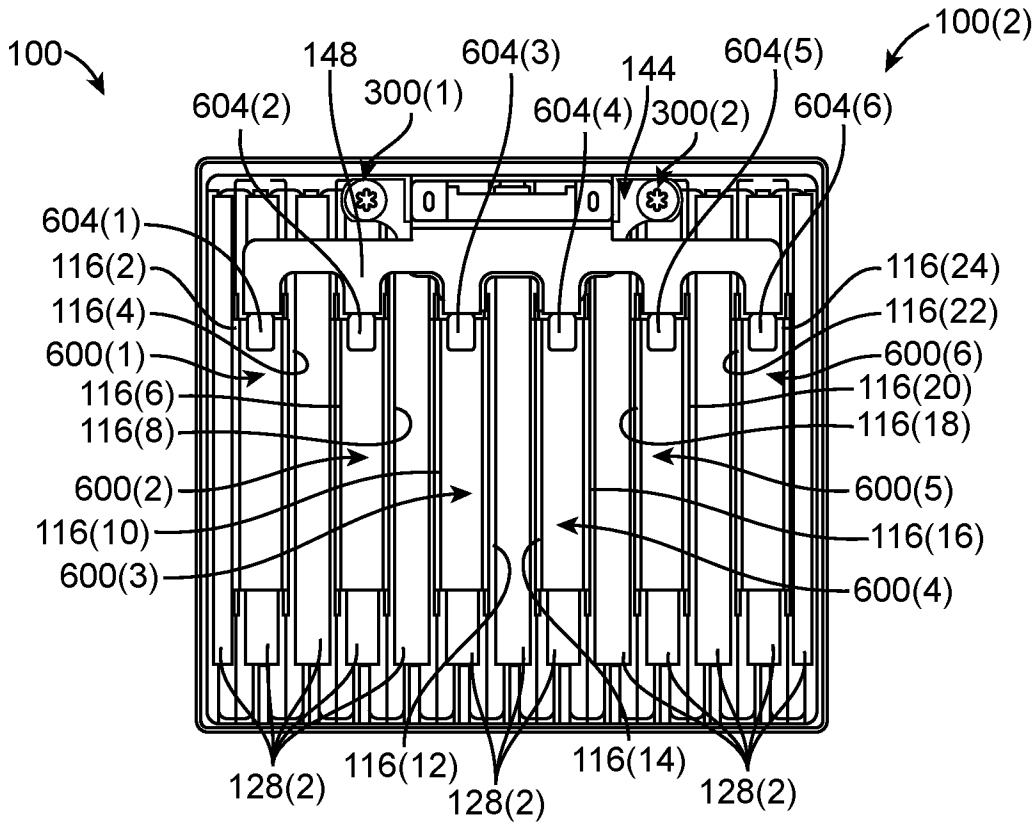
116(17)
116(15)
116(13)

FIG. 5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600(1)
116(6)
116(8)
600(2)
116(10)
600(3)
116(24)
116(22)
600(6)
116(20)
116(18)
600(5)
116(16)
600(4)
128(2)
116(12)
128(2)
116(14)
128(2)

FIG. 6

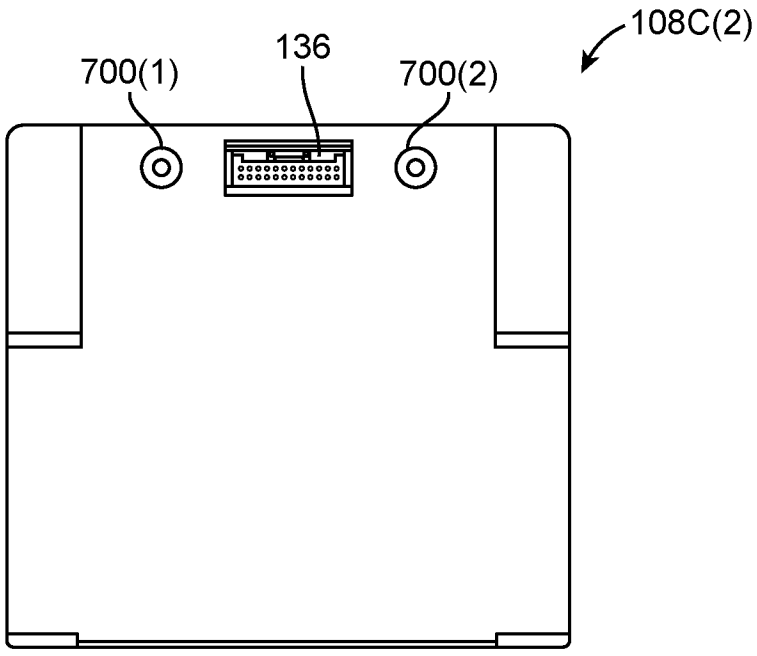
108C(2)
136
700(1)
700(2)

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2022/133908

A. CLASSIFICATION OF SUBJECT MATTER

H01M50/502(2021.01)i; H01M50/514(2021.01)i; H01M50/519(2021.01)i; H01M50/531(2021.01)i; H01M50/50(2021.01)i; H01M50/103(2021.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC:H01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNTXT,CNKI,DWPI,ENTXT,ENTXTC:battery,module,cell,terminal,tab,pair,adjacent,insulated,insulating,insulator, electrically,connected

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 113594618 A (DONGGUAN POWERAMP TECHNOLOGY LTD) 02 November 2021 (2021-11-02) description, paragraphs 51-91, figures 1-16	1-19
X	CN 102349176 A (JOHNSON CONTROLS SAFT ADVANCED POWER SOL) 08 February 2012 (2012-02-08) description, paragraphs 48-130, figures 1-34	1-19
A	JP 2003346780 A (FUJI HEAVY IND LTD) 05 December 2003 (2003-12-05) the whole document	1-19
A	JP 2012038495 A (HITACHI MAXELL ENERGY LTD) 23 February 2012 (2012-02-23) the whole document	1-19
A	US 2017062780 A1 (SAMSUNG SDI CO LTD) 02 March 2017 (2017-03-02) the whole document	1-19

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 July 2023	**03 August 2023**

Name and mailing address of the ISA/CN	Authorized officer
CHINA NATIONAL INTELLECTUAL PROPERTY ADMINISTRATION **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088, China**	**YIN,ChaoLi** Telephone No. **(+86) 010-62411670**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2022/133908

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				WO	2010085636	A3	28 October 2010
				CN	102349176	B	03 February 2016
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				CN	102013509	A	13 April 2011
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				US	8568915	B2	29 October 2013
				EP	2172994	A1	07 April 2010
				EP	2172994	B1	04 July 2012
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JP	2012038495	A	23 February 2012		None		
US	2017062780	A1	02 March 2017	US	10236485	B2	19 March 2019
				KR	20170024725	A	08 March 2017
				KR	102397122	B1	12 May 2022
				CN	106486634	A	08 March 2017
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