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TSUDA

(54) **BATTERY PACK**

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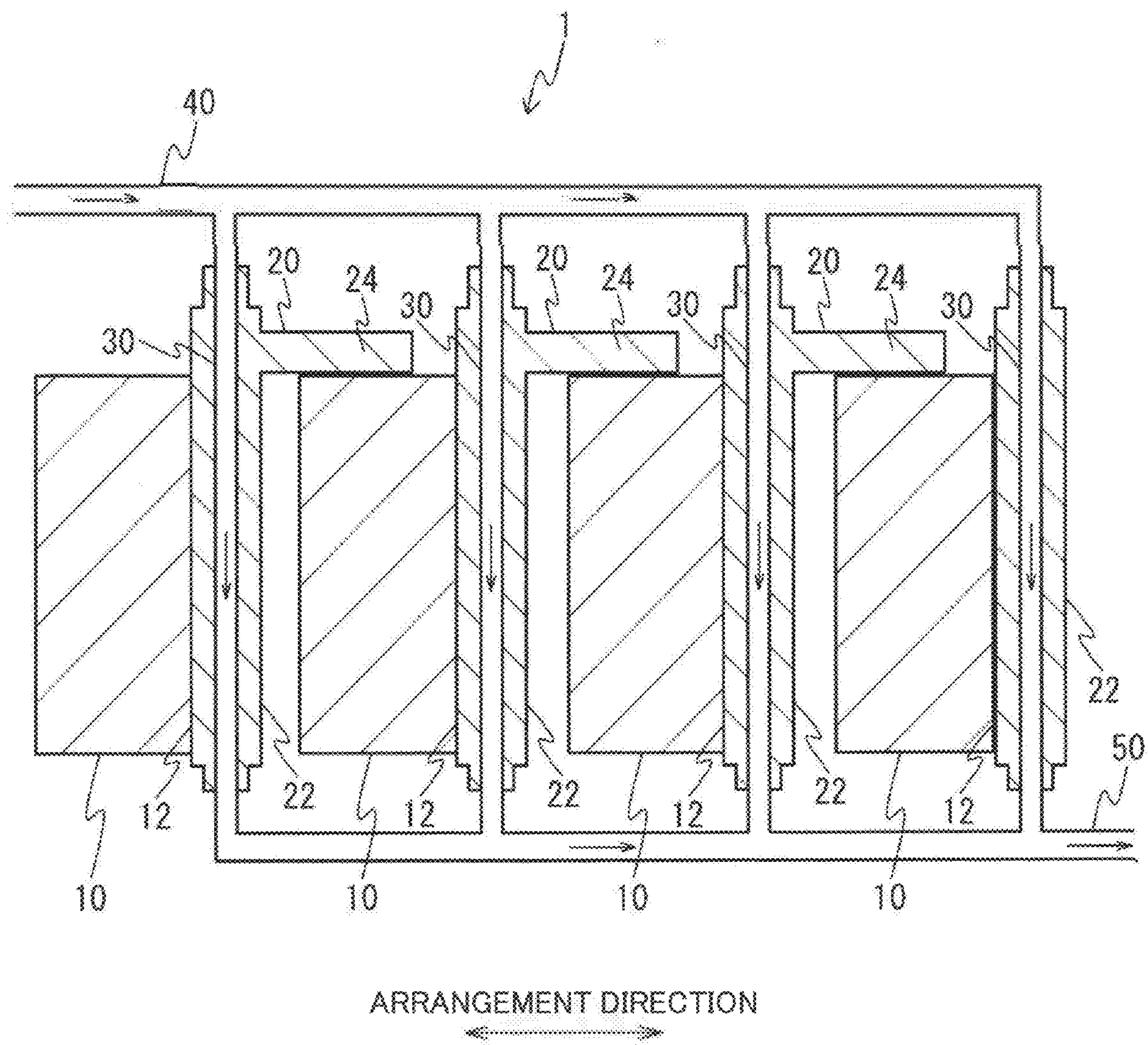
(57) **ABSTRACT**

A battery pack includes a plurality of battery cells, a tab that connects the battery cells, and a channel that is formed inside the tab and through which a refrigerant for cooling the battery cell flows.



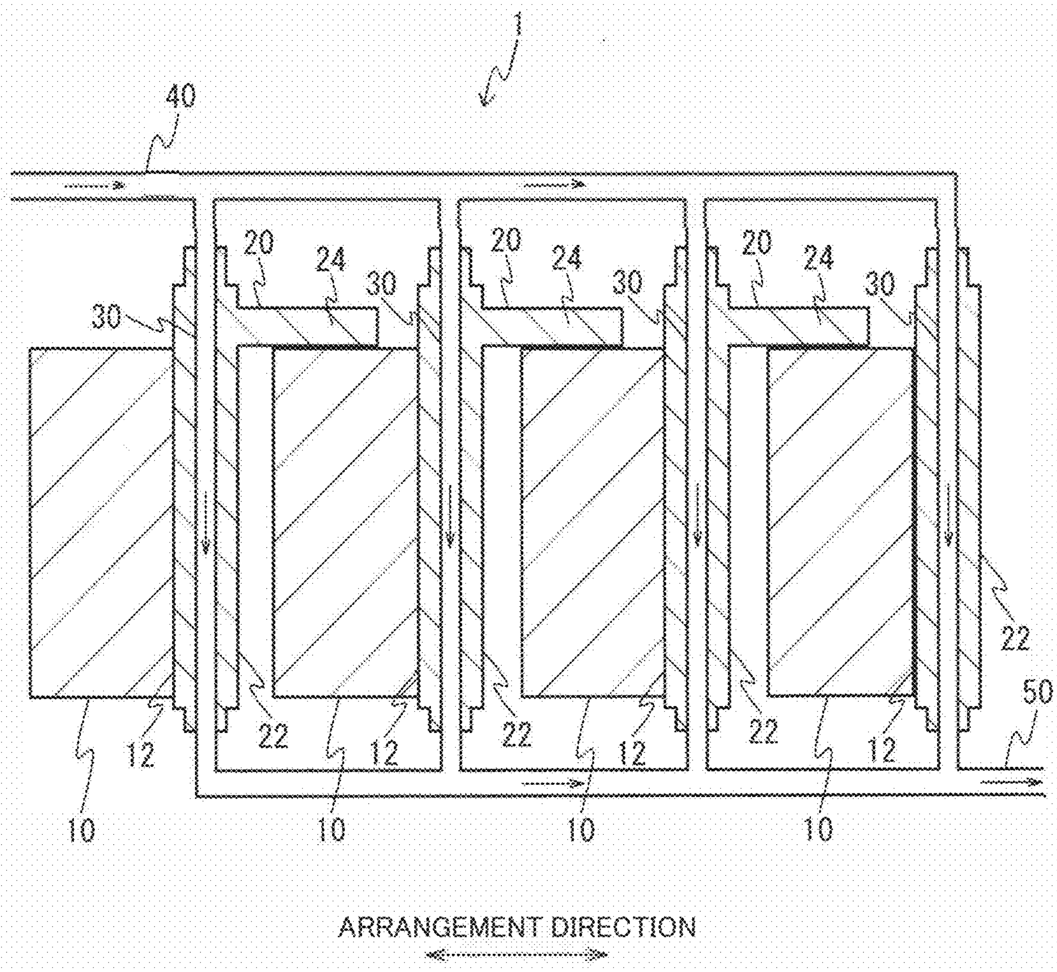


FIG. 1

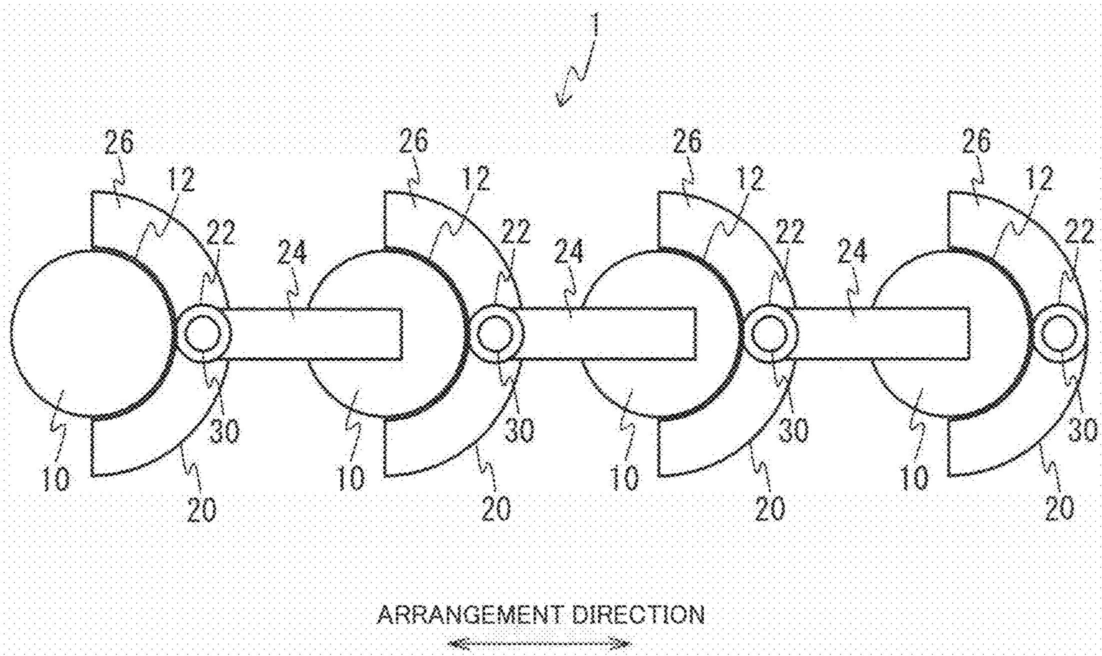


FIG. 2

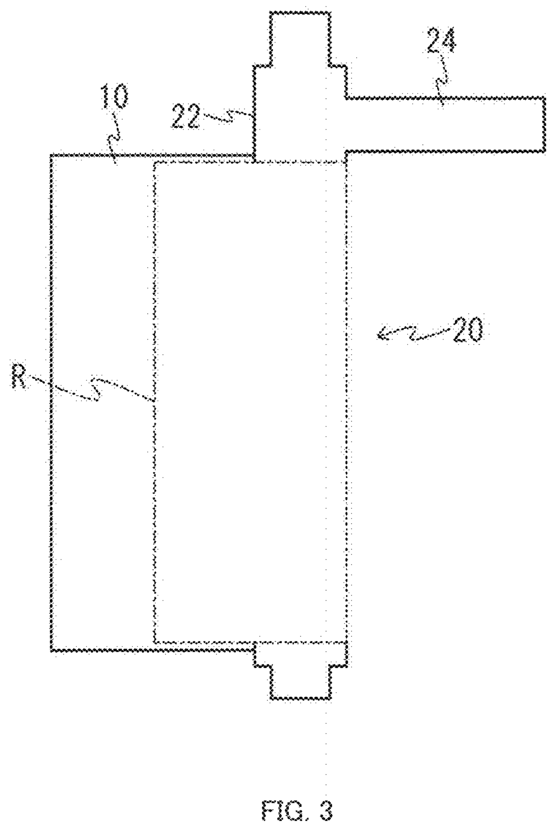
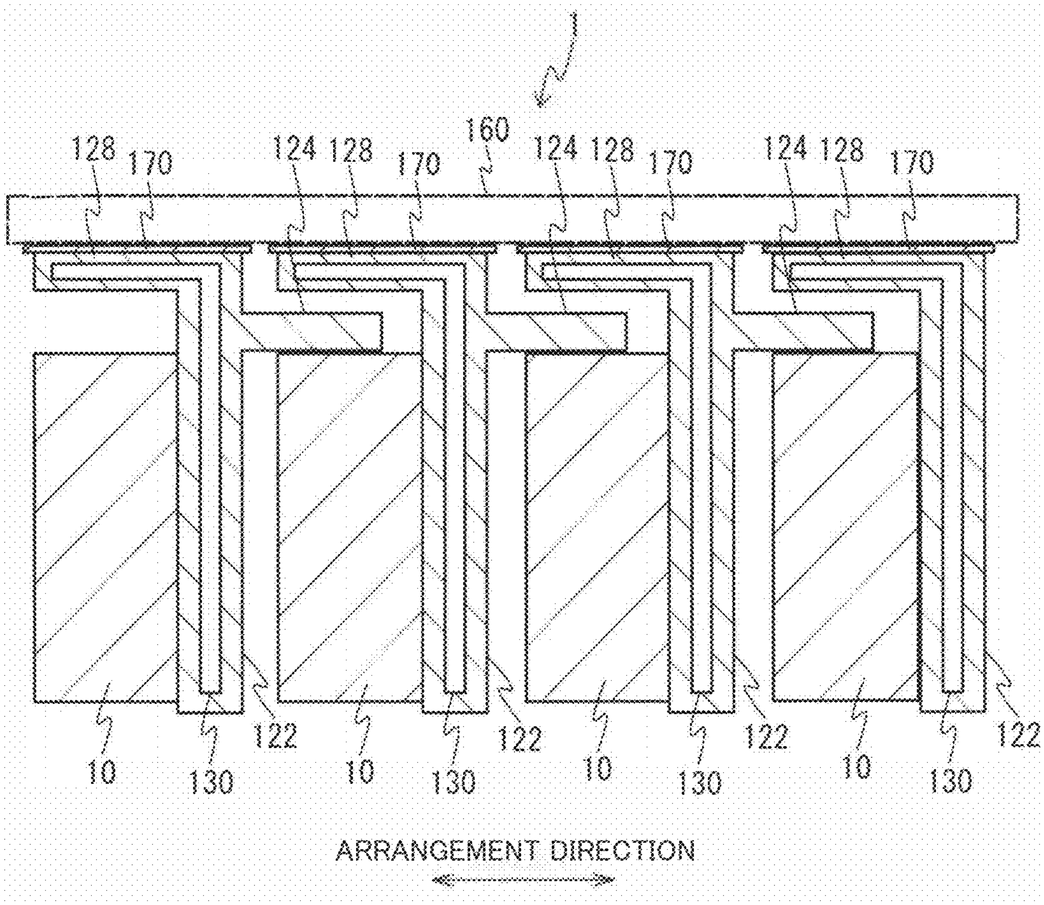


FIG. 3


1
160
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122
ARRANGEMENT DIRECTION

FIG. 4

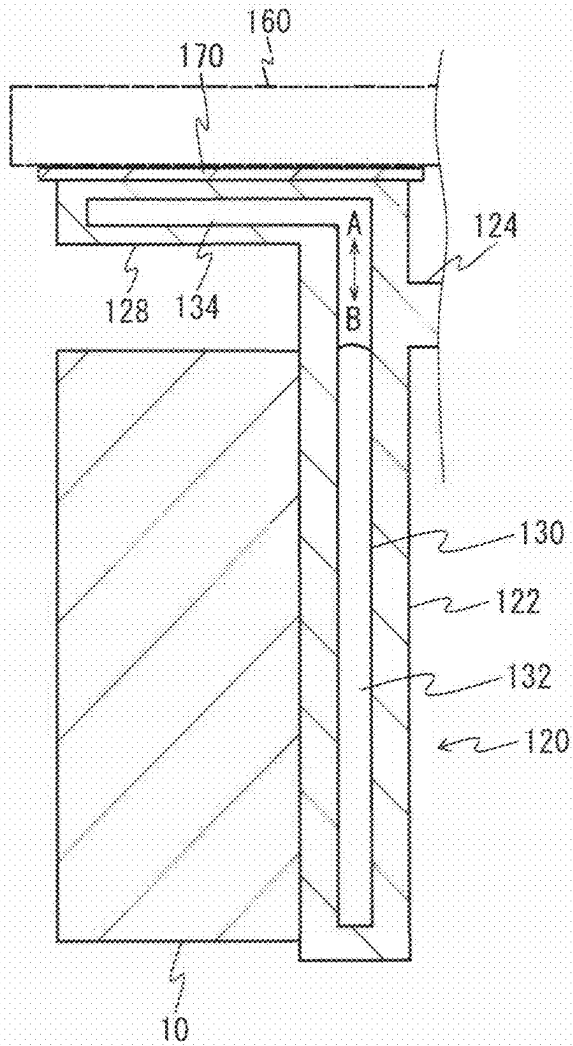

FIG. 5

BATTERY PACK

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority to Japanese Patent Applications number 2024-21934, filed on Feb. 16, 2024 contents of which are incorporated herein by reference in their entirety.

BACKGROUND OF THE INVENTION

[0002] The present disclosure relates to a battery pack to which a plurality of battery cells are connected.

[0003] Japanese Unexamined Patent Application Publication No. 2019-110003 discloses a battery to which a plurality of cells are electrically connected via a bus bar. A lower case of the battery has a channel through which a refrigerant flows to cool the battery.

[0004] However, in the battery described above, the cell cannot be effectively cooled because the lower case with the channel is located away from a connecting portion between the cell, which tends to generate heat, and the busbar. In addition, a space is required for the lower case, which hinders achieving space savings for the battery.

BRIEF SUMMARY OF THE INVENTION

[0005] The present disclosure focuses on this point, and an object thereof is to appropriately cool a cell while achieving space savings for a battery pack.

[0006] An aspect of the present disclosure provides a battery pack that includes a plurality of battery cells, a tab that connects the battery cells, and a channel that is formed inside the tab and through which a refrigerant for cooling the battery cell flows.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. **1** schematically shows a battery pack **1** according to the first embodiment.

[0008] FIG. **2** schematically shows a configuration of the battery pack **1** with fins **26**.

[0009] FIG. **3** schematically illustrates a position of the fin **26**.

[0010] FIG. **4** schematically shows the battery pack **1** according to the second embodiment.

[0011] FIG. **5** schematically shows an aspect of a flow of a refrigerant in a channel **130**.

DETAILED DESCRIPTION OF THE INVENTION

[0012] Hereinafter, the present disclosure will be described through exemplary embodiments of the present disclosure, but the following exemplary embodiments do not limit the disclosure according to the claims, and not all of the combinations of features described in the exemplary embodiments are necessarily essential to the solution means of the disclosure.

First Embodiment

[0013] FIG. **1** schematically shows a battery pack **1** according to the first embodiment.

[0014] The battery pack **1** has a configuration to which a plurality of battery cells (simply referred to as cells), which are secondary batteries capable of being charged and discharged, are connected. The battery pack **1** is a storage battery mounted on a vehicle, for example. The battery pack **1** includes a plurality of cells **10**, a plurality of tabs **20**, a channel **30**, a first pipe **40**, and a second pipe **50**.

[0015] The plurality of cells **10** are provided at predetermined intervals along the arrangement direction in FIG. **1**. The plurality of cells **10** may also be provided at predetermined intervals in a direction orthogonal to the arrangement direction (the depth direction of FIG. **1**). Here, the shape of the cell **10** is a cylinder. However, the present disclosure is not limited thereto, and the shape of the cell **10** may be a prism. In the cell **10**, the upper surface is a positive electrode, and an outer circumferential surface **12** is a negative electrode.

[0016] The plurality of tabs **20** are members connecting the plurality of cells **10**. The plurality of tabs **20** are also provided at predetermined intervals along the arrangement direction. Specifically, the tab **20** is provided between the two cells **10** in the arrangement direction. The tab **20** connects a) the outer circumferential surface **12** which is the negative electrode of one cell **10** and b) the upper surface which is the positive electrode of a cell **10** adjacent to the one cell **10**. As shown in FIG. **1**, the tab **20** includes a shaft portion **22** and an extending portion **24**. In the present embodiment, the shaft portion **22** corresponds to a main body of the tab **20**.

[0017] The shaft portion **22** is located parallel to the cylindrical cell **10**. A circumferential surface of the shaft portion **22** is in contact with the negative electrode formed on the outer circumferential surface **12** of the cell **10**. For example, the circumferential surface of the shaft portion **22** is in contact with the outer circumferential surface **12** of the cell **10** from one axial end to the other axial end. The diameter of the shaft portion **22** is smaller than the diameter of the cell **10**. On the other hand, the axial length of the shaft portion **22** is larger than the axial length of the cell **10**. Specifically, the shaft portion **22** extends outward beyond both axial end portions of the cell **10**.

[0018] The extending portion **24** extends from the upper end portion of the shaft portion **22** in a direction orthogonal to the axial direction. The extending portion **24** is located above the upper surface of the cell **10**. The extending portion **24** is in contact with the positive electrode formed on the upper surface of the cell **10**. Specifically, the extending portion **24** is in contact with the central portion of the upper surface of the cell **10**. The shape of the extending portion **24** in a plan view is rectangular, but is not limited thereto.

[0019] The channel **30** is formed inside the tab **20**, and is a portion through which a refrigerant for cooling the cell **10** flows. As indicated by arrows in FIG. **1**, the refrigerant flows from an upper portion (one axial end portion) to a lower portion (the other axial end portion) of the channel **30**. The upper portion of the channel **30** is connected to the first pipe **40**, and the lower portion of the channel **30** is connected to the second pipe **50**. Therefore, the refrigerant flows into the channel **30** from the first pipe **40**, and flows out from the channel **30** to the second pipe **50**.

[0020] The channel **30** is formed inside the shaft portion **22** of the tab **20** in contact with the outer circumferential surface **12** of the cell **10**. In other words, the channel **30** is formed around a connecting portion between the cell **10**, which tends to concentrate current and generate heat, and the shaft portion **22**. Thus, the outer circumferential surface **12** of the cell **10** is cooled by the refrigerant flowing through the channel **30** in the shaft portion **22**. The channel **30** is formed along the axial direction at a central portion of the shaft portion **22**. The diameter of the channel **30** is ⅓ to ½ of the diameter of the shaft portion, for example, but is not limited thereto.

[0021] The channel **30** penetrates the shaft portion **22**, and is formed in the shaft portion **22** from one axial end to the other axial end. In other words, the channel **30** is formed from one axial end portion to the other axial end portion of the cell **10**. Accordingly, the refrigerant flowing through the channel **30** can cool a wide area of the outer circumferential surface **12** of the cell **10**.

[0022] The first pipe **40** is a channel through which the refrigerant flows toward the channel **30**. The first pipe **40** functions as a supply channel for supplying the refrigerant to each of the channels **30** formed inside the plurality of tabs **20**. The refrigerant flowing through the first pipe **40** has an insulating property. The first pipe **40** is provided with a pump that pressure-feeds the refrigerant, for example, and the refrigerant can be constantly supplied to the channel **30**.

[0023] The second pipe **50** is a channel through which the refrigerant flowing out from the channel **30** of each tab **20** flows. The second pipe **50** is connected to the first pipe **40**, and forms, together with the first pipe **40**, a circulation channel through which the refrigerant circulates. The circulation channel is provided with a heat exchanger that cools the refrigerant. The heat exchanger may cool the refrigerant with air or may cool the refrigerant with a cooler refrigerant. Accordingly, the refrigerant cooled by the heat exchanger flows through the channel **30**, and thus the low-temperature refrigerant can cool the cell **10** via the channel **30**.

[0024] The tab **20** may have a fin **26** to improve the efficiency of cooling the cell **10**.

[0025] FIG. **2** schematically shows a configuration of the battery pack **1** with the fins **26**. FIG. **3** schematically illustrates a position of the fin **26**. A region R indicated by a chain line in FIG. **3** is a position where the fin **26** is provided.

[0026] As shown in FIG. **2**, the fins **26** are respectively provided to the cells **10**, but the configuration of the fin **26** of each cell **10** is the same. Therefore, the configuration of one fin **26** will be described below.

[0027] The fins **26** are formed in a plate shape, for example, and are provided in plural at predetermined intervals in the axial direction within the region R shown in FIG. **3**. As shown in FIG. **2**, each of the plurality of fins **26** is in contact with the outer circumferential surface **12** of the cell **10**. Specifically, the fin **26** is in contact with the outer circumferential surface **12** of the cell **10** along the circumferential direction of the cell **10**. This facilitates the conduction of heat from the cell **10** to the fin **26**, thereby facilitating more effective cooling of the cell **10**.

[0028] As shown in FIG. **2**, the fin **26** extends from the shaft portion **22** of the tab **20**. Specifically, the fin **26** extends from the shaft portion **22** along the outer circumferential surface **12** of the cell **10** with a predetermined curvature. The width of the fin **26** is constant here, but it is not limited thereto. This facilitates the heat conducted from the cell **10** to the fin **26** to be cooled by the refrigerant flowing through the channel **30**.

[0029] Here, as shown in FIG. **2**, the fin **26** covers half of the outer circumferential surface **12** of the cell **10**, but it is not limited thereto, and may cover the entire outer circumferential surface **12** of the cell **10**. In this way, it is desirable that the fin **26** covers at least half of the outer circumferential surface **12** of the cell **10**. Further, as shown in FIG. **3**, the fin **26** is provided from one axial end portion to the other axial end portion of the cell **10**. Providing the fin **26** with the above-described configuration enables the fin **26** to come into contact with a wide area of the outer circumferential surface **12** of the cell **10**, thereby facilitating more effective cooling of the cell **10**.

Second Embodiment

[0030] A configuration of the battery pack **1** according to the second embodiment will be described with reference to FIGS. **4** and **5**.

[0031] FIG. **4** schematically shows the battery pack **1** according to the second embodiment. FIG. **5** schematically shows an aspect a flow of the refrigerant in the channel **130**.

[0032] In the first embodiment described above, the channel **30** formed in the tab **20** connects the first pipe **40** and the second pipe **50** provided outside the tab **20**, the refrigerant flows into the channel **30** from the first pipe **40**, and the refrigerant in the channel **30** flows out to the second pipe **50**. In contrast, the channel **130** of the second embodiment is closed off by the tab **120**, allowing no additional refrigerant to flow into the channel **130**. Detailed configurations of the tab **120** and the channel **130** will be described below.

[0033] As shown in FIG. **5**, the tab **120** includes a shaft portion **122**, a first extending portion **124**, and a second extending portion **128**. The shaft portion **122** and the first extending portion **124** have the same configuration as the shaft portion **22** and the extending portion **24** described above. The second extending portion **128** extends from the upper end portion of the shaft portion **122** in a direction orthogonal to the axial direction. The extending direction of the second extending portion **128** is opposite to the extending direction of the first extending portion **124**.

[0034] As shown in FIG. **4**, the channel **130** is formed in the shaft portion **122** and the second extending portion **128**. The channel **130** is formed in an L-shape along the shapes of the shaft portion **122** and the second extending portion **128**. The refrigerant in the channel **130** is non-insulating. The channel **130** is closed off by the end portions of the shaft portion **122** and the second extending portion **128**. Accordingly, it is possible to prevent the surrounding members from being damaged by electric leakage through the refrigerant.

[0035] As shown in FIG. **5**, the channel **130** includes a first accommodation section **132** and a second accommodation section **134**.

[0036] The first accommodation section **132** is located at the same position as the outer circumferential surface **12** of the cell **10** in the up-down direction. The first accommodation section **132** is provided parallel to the outer circumferential surface **12** of the cell **10**. The first accommodation section **132** accommodates a liquid refrigerant. When cooling the outer circumferential surface **12** of the cell **10**, a portion of the refrigerant in the first accommodation section **132** is vaporized (evaporated) by the heat of the cell **10**.

[0037] As shown in FIG. **5**, the second accommodation section **134** is provided above the cell **10**. Specifically, the second accommodation section **134** is located directly above the upper surface of the cell **10**. The second accommodation section **134** communicates with the first accommodation section **132**, and is orthogonal to the first accommodation section **132**. The second accommodation section **134** accommodates the refrigerant vaporized in the first accommodation section **132**.

[0038] As shown in FIG. **4**, the battery pack **1** of the second embodiment includes a heat exchanger **160** for cooling a gaseous refrigerant in the second accommodation section **134**. The heat exchanger **160** is provided so as to face the second accommodation section **134**. Specifically, the heat exchanger **160** is located above the second extending portion **128** in which the second accommodation section **134** is formed. An insulating member **170** is interposed between the heat exchanger **160** and the second extending portion **128**.

[0039] A refrigerant having a temperature lower than that of the refrigerant in the second accommodation section **134** flows inside the heat exchanger **160**, and the refrigerant in the second accommodation section **134** is cooled by that refrigerant. The refrigerant in the second accommodation section **134** is condensed and liquefied upon cooling. The liquefied refrigerant moves to the first accommodation section **132** located below the second accommodation section **134**.

[0040] It should be noted that, in FIG. **4**, one heat exchanger **160** faces four tabs **120**, but it is not limited thereto. For example, the heat exchanger **160** may be provided for each tab **120**.

[0041] In the second embodiment, the refrigerant in the channel **130** flows between the first accommodation section **132** and the second accommodation section **134** as follows.

[0042] Specifically, the liquid refrigerant in the first accommodation section **132** is vaporized by the heat when cooling the cell **10**. Then, the vaporized gaseous refrigerant moves to the second accommodation section **134** located above the first accommodation section **132** (specifically, the refrigerant moves in the direction indicated by an arrow A in FIG. **5**). The gaseous refrigerant that has moved to the second accommodation section **134** is condensed by being cooled by the heat exchanger **160**. Then, the condensed liquid refrigerant moves to the first accommodation section **132** located below the second accommodation section **134** (specifically, the refrigerant moves in a direction indicated by an arrow B in FIG. **5**).

[0043] As described above, the refrigerant continues to flow between the first accommodation section **132** and the second accommodation section **134** by alternately repeating vaporization and condensation in the channel **130**. As a result, the temperature of the refrigerant accommodated in the first accommodation section **132** located at the same position as the outer circumferential surface **12** of the cell **10** can be maintained at a low temperature, and so even without the need for a new supply of refrigerant to the channel **130** from the outside, cooling of the cell **10** can continue.

Effects of Embodiments

[0044] The battery pack **1** of the above-described embodiment includes the tab **20** connecting the plurality of cells **10**. The channel **30** through which the refrigerant for cooling the cell **10** flows is formed inside the tab **20**.

[0045] Accordingly, the channel **30** formed in the tab **20** connecting the cells **10** can effectively cool the cells **10**. In particular, the channel **30** is provided around the connection portion between the cell **10**, which tends to concentrate current and generate heat, and the tab **20**, thereby cooling the cell **10** more effectively. In addition, since the channel **30** is formed in the tab **20**, there is no need to provide additional space for installing a cooling structure to cool the cell **10**. As a result, it is possible to appropriately cool the cells while achieving space savings for the battery pack **1**.

[0046] The present disclosure is explained on the basis of the exemplary embodiments. The technical scope of the present disclosure is not limited to the scope explained in the above embodiments and it is possible to make various changes and modifications within the scope of the disclosure. For example, all or part of the apparatus can be configured with any unit which is functionally or physically dispersed or integrated. Further, new exemplary embodiments generated by arbitrary combinations of them are included in the exemplary embodiments of the present disclosure. Further, effects of the new exemplary embodiments brought by the combinations also have the effects of the original exemplary embodiments.

1. A battery pack comprising:
a plurality of battery cells;
a tab that connects the battery cells; and
a channel that is formed inside the tab and through which a refrigerant for cooling the battery cell flows.

2. The battery pack according to claim **1**, wherein
the channel is formed inside the tab in contact with an outer circumferential surface of the battery cell.

3. The battery pack according to claim **2**, wherein
the channel is formed from one axial end portion to the other axial end portion of the battery cell.

4. The battery pack according to claim **2**, wherein
the tab includes:
a main body in which the channel is formed, and
a fin extending from the main body and is in contact with the outer circumferential surface.

5. The battery pack according to claim **4**, wherein
the fin covers at least half of the outer circumferential surface.

6. The battery pack according to claim **4**, wherein
the fins are provided in plural at predetermined intervals in the axial direction of the battery cell.

7. The battery pack according to claim **1**, further comprising:
a supply pipe that supplies the refrigerant having an insulation property to each of the channels formed inside the plurality of tabs.

8. The battery pack according to claim **1**, wherein
the refrigerant is non-insulating, and
both ends of the channel are closed off by the tab.

9. The battery pack according to claim **8**, wherein
the channel includes:
a first accommodation section that is located at the same position as the outer circumferential surface of the battery cell in the up-down direction and accommodates the liquid refrigerant, and
a second accommodation section that is provided above the battery cell and communicates with the first accommodation section, wherein
the second accommodation section accommodates the refrigerant that has been vaporized in the first accommodation section.

10. The battery pack according to claim **9**, further comprising:

a heat exchanger that is provided to face the second accommodation section and cools the refrigerant accommodated in the second accommodation section.

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