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CN 207852857 U

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(54) Title of the Invention: **Battery case for a vehicle**
Abstract Title: **Vehicle battery pack housing and coolant lid arrangement**

(57) A battery case 300 for housing a plurality of cells (100, Fig 2) of a vehicle (1000, Fig 10) battery comprises a lower housing portion 320 and a lid portion 310. Lower housing portion 320 has a frame (400, Fig 4) for locating the plurality of cells (100) in the battery case (300) such that an upper surface of each of the plurality of cells is coplanar in a first plane. Lid portion 310 is arranged to co-operate with the lower housing portion 320 to encase the plurality of cells, and the lid portion 310 defines a cooling plate for circulating coolant to control a temperature of the plurality of cells. The lid portion comprises: a first layer (510, Fig 5B) arranged across the first plane, the first layer to be bonded in use to the upper surface of each of the plurality of cells encased by the battery case 300 to provide a thermal interface between the lid portion 310 and each of the plurality of cells; and a second layer (520) disposed on an opposite side of the first layer to the lower housing portion, wherein a periphery (522) of the second layer is bonded to the first layer to define a sub cavity (515) for the flow of coolant between the first layer and the second layer. The first layer extends beyond the periphery of the second layer to form a protruding rim (511) and in use, the lid portion is secured to the lower housing portion along the protruding rim of the first layer. The coolant lid arrangement is intended to reduce space occupied by a vehicle battery pack whilst increasing battery efficiency.

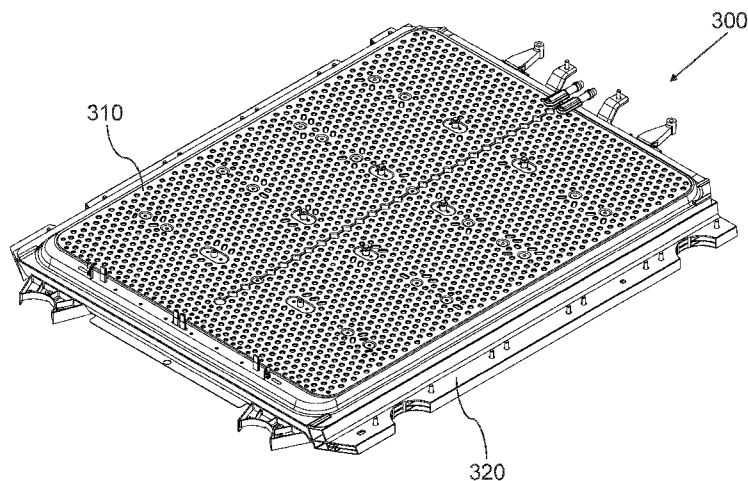


Figure 3

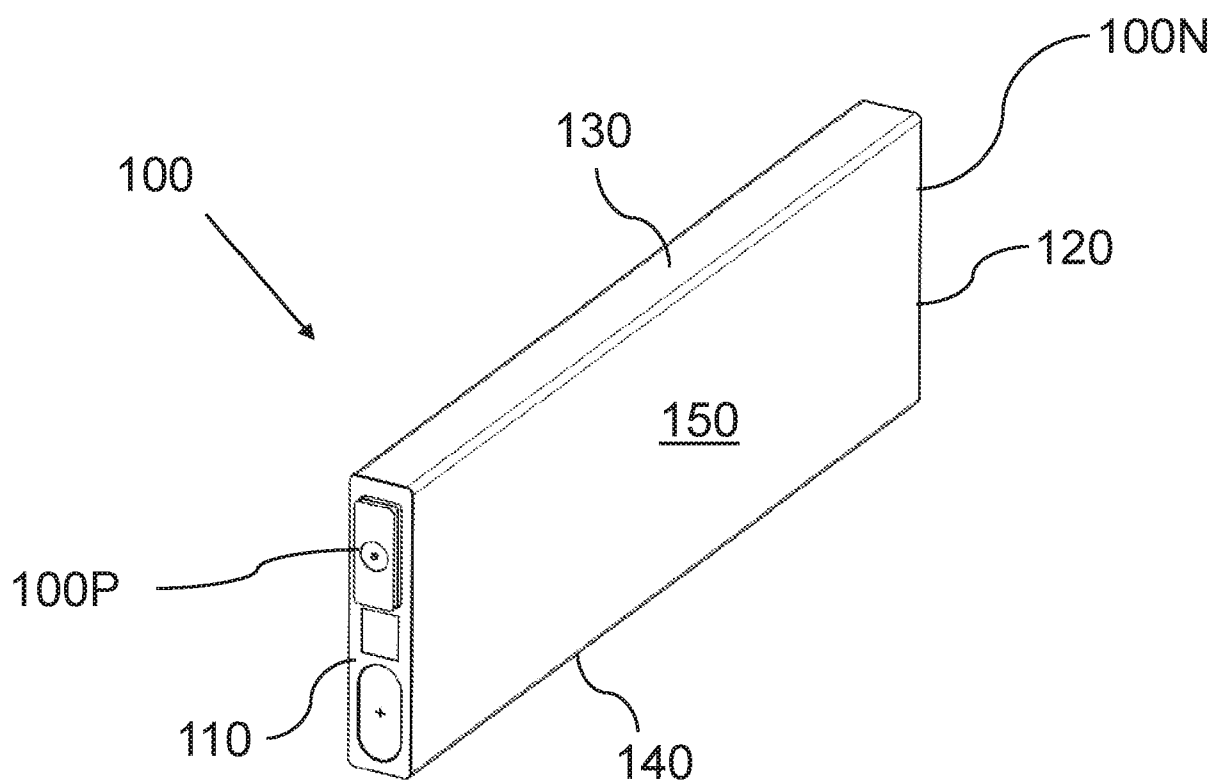


Figure 1
(PRIOR ART)

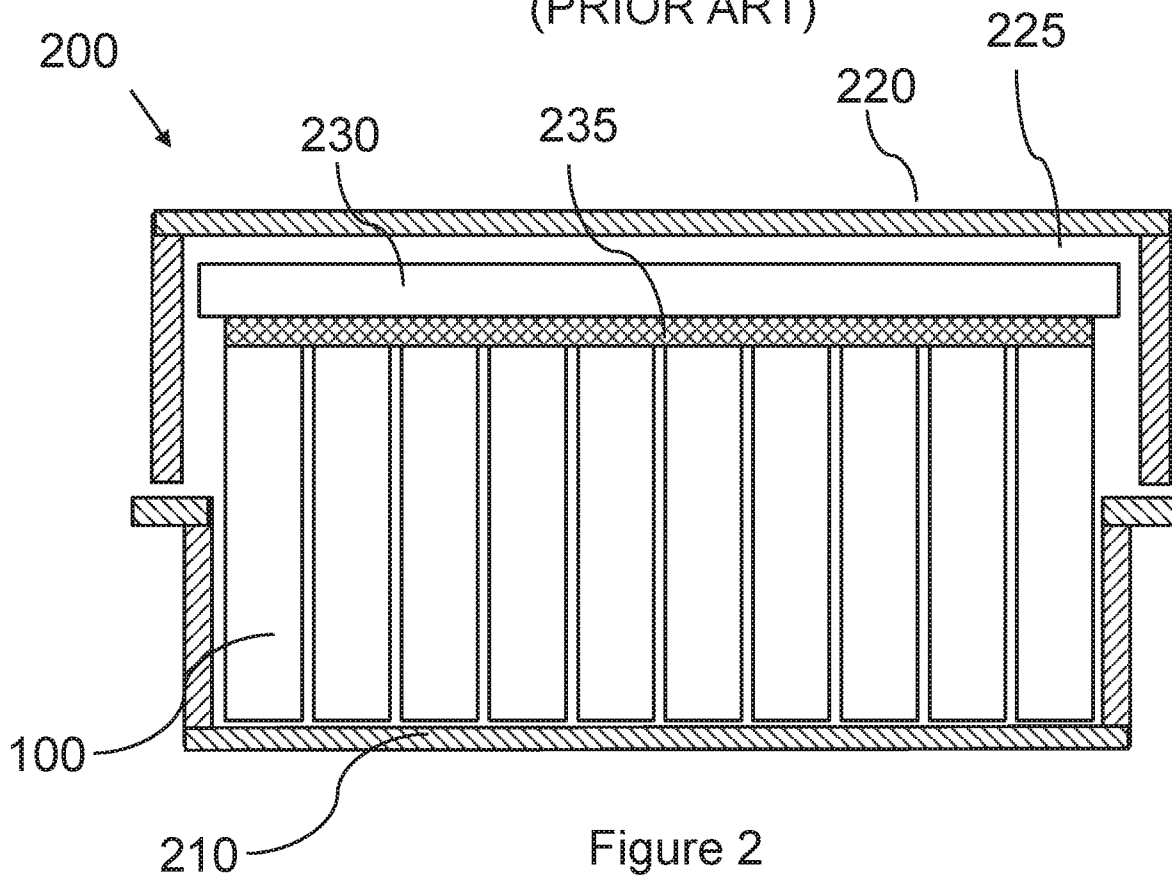


Figure 2
(PRIOR ART)

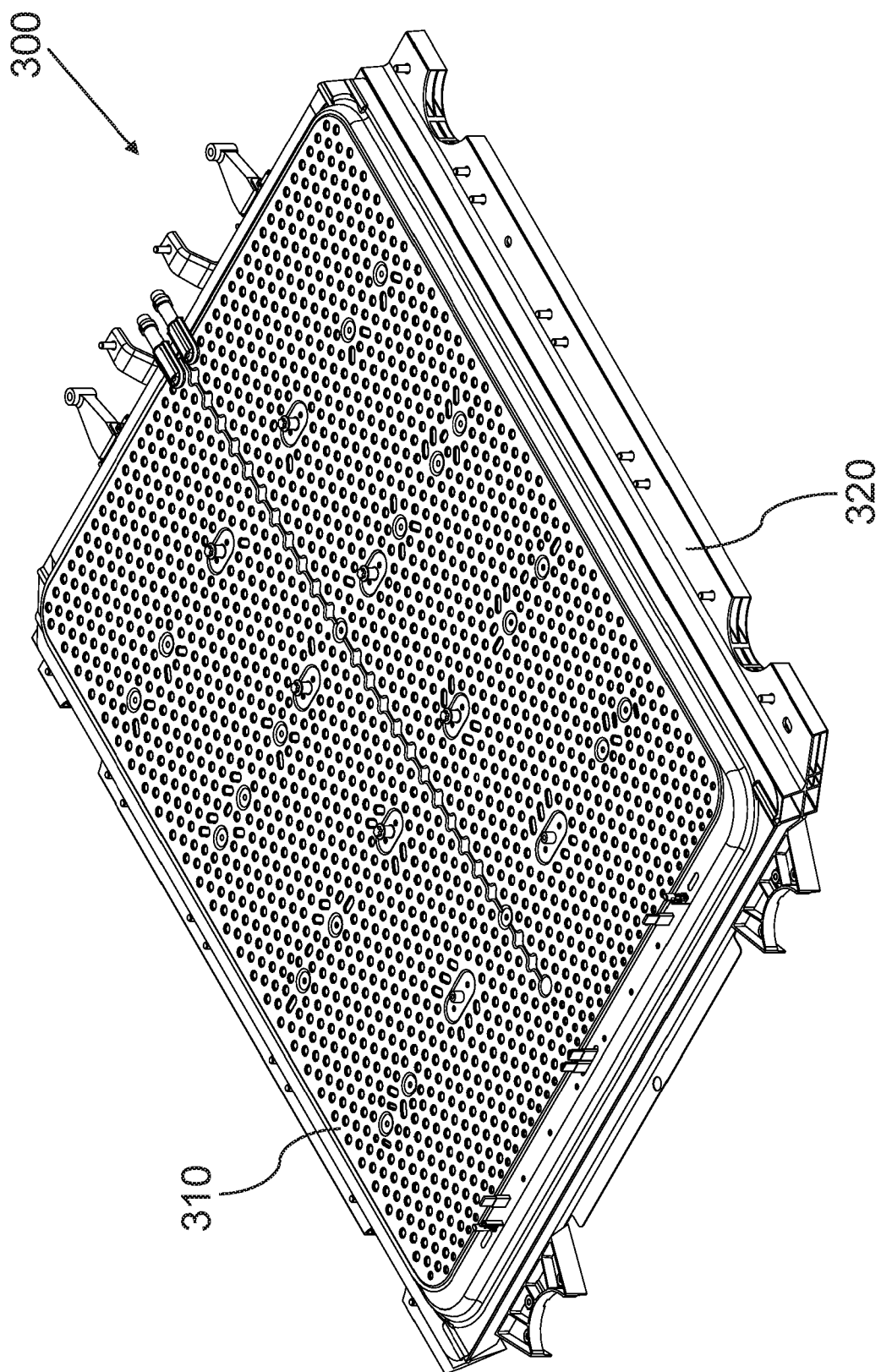


Figure 3

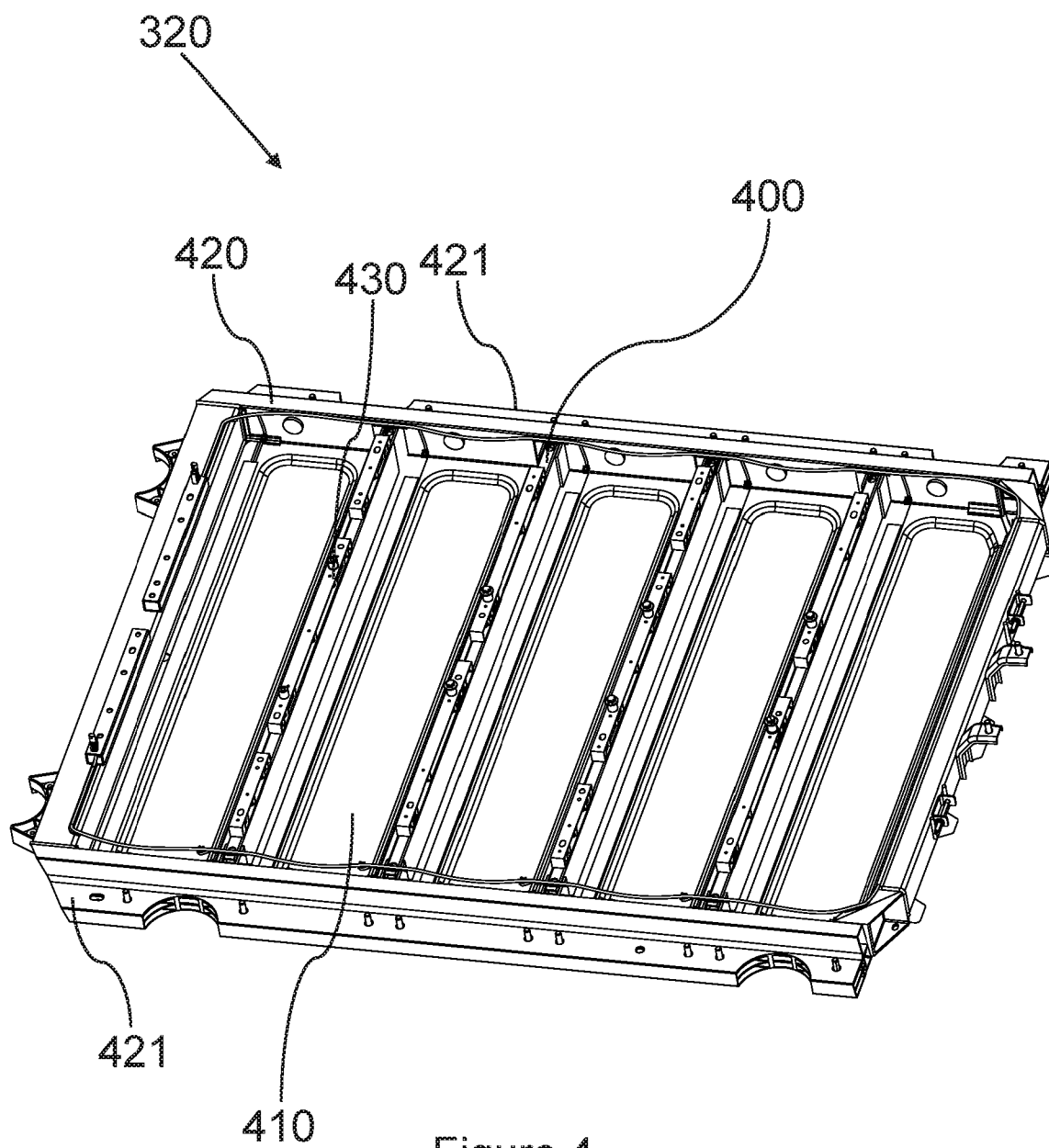


Figure 4

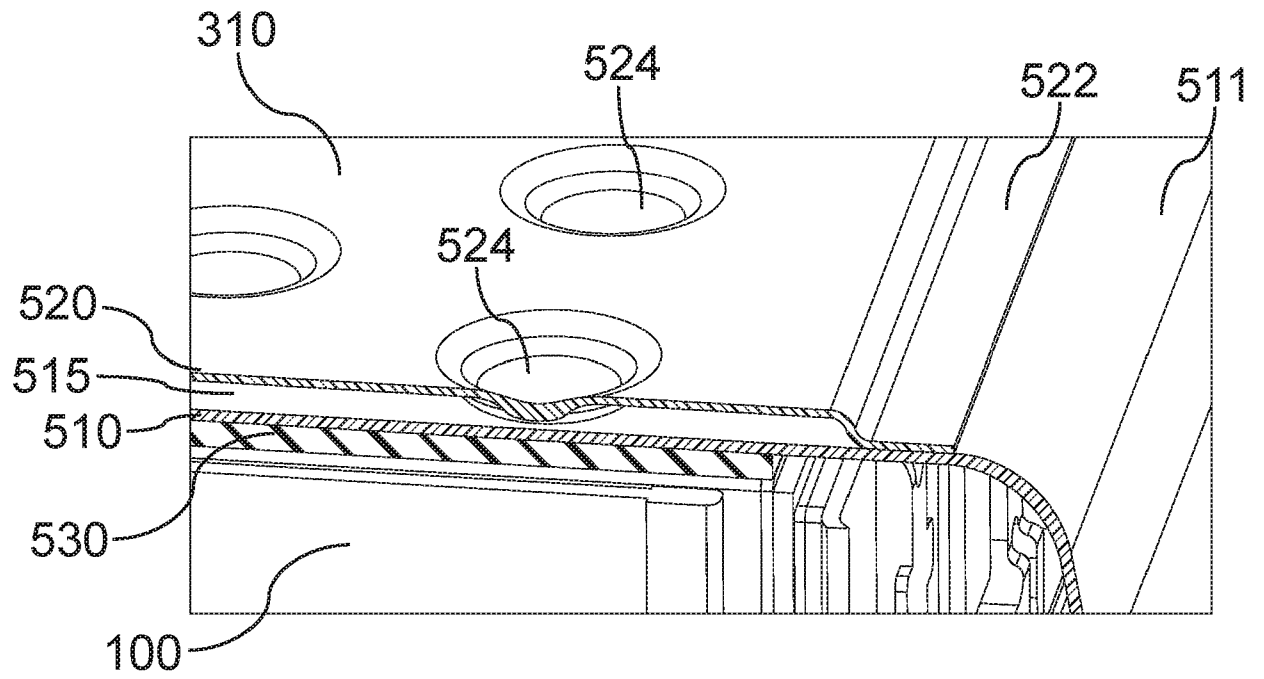


Figure 5A

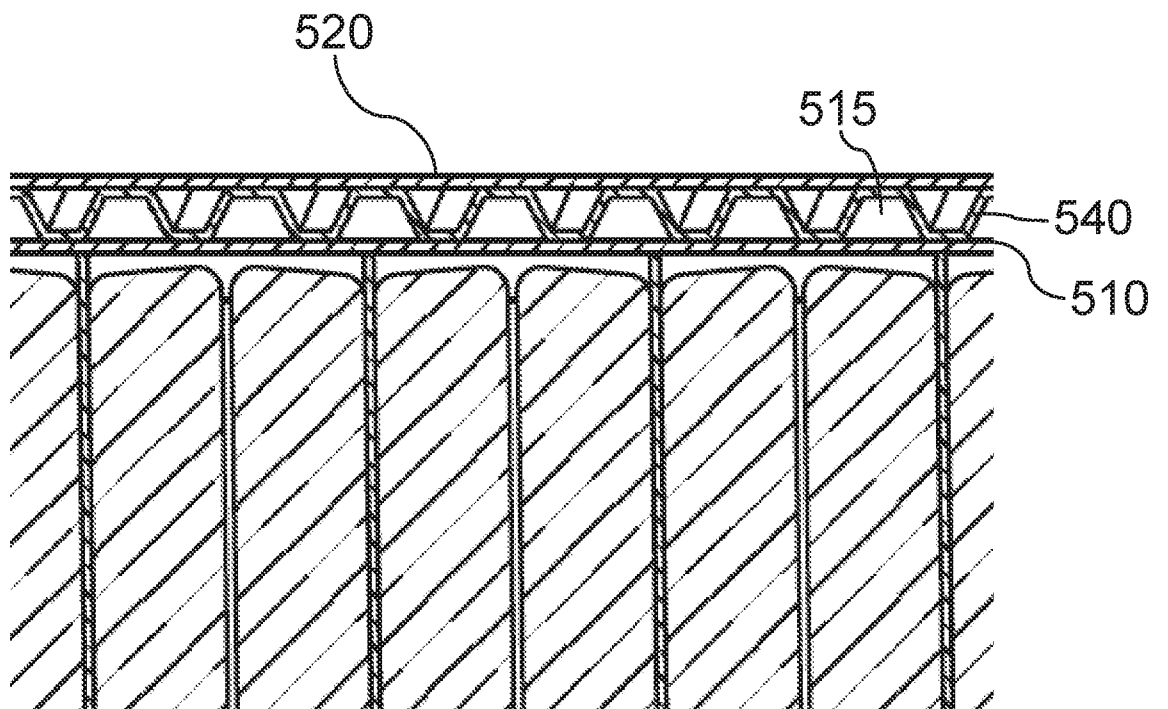


Figure 5B

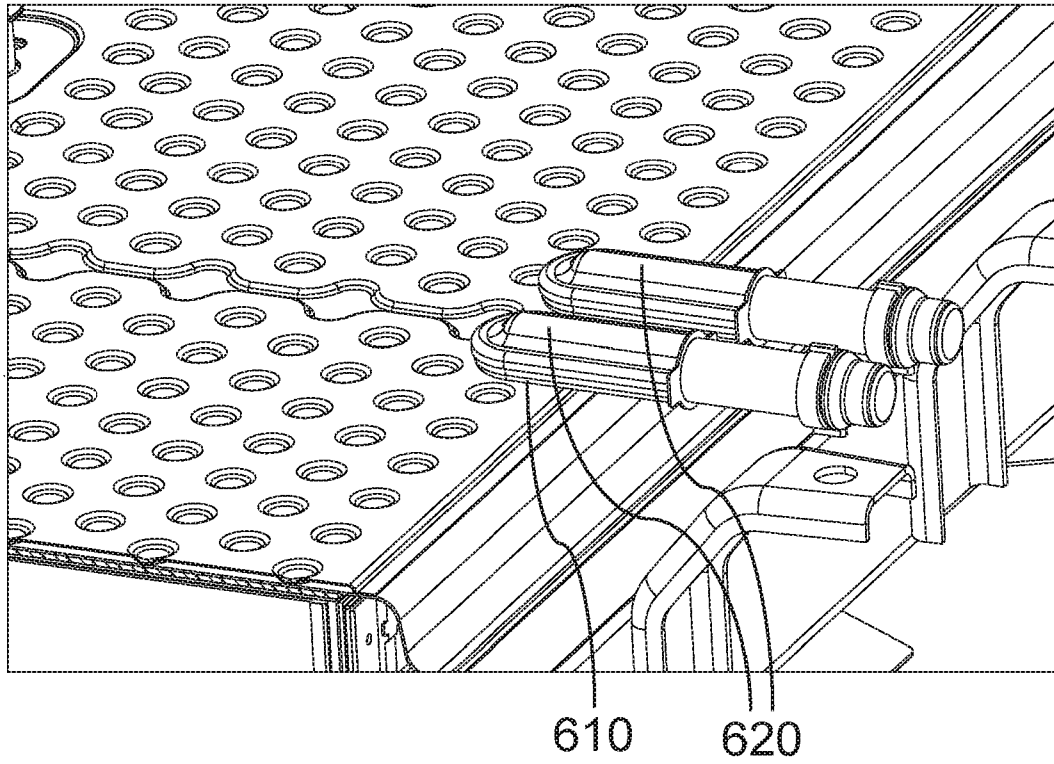


Figure 6A

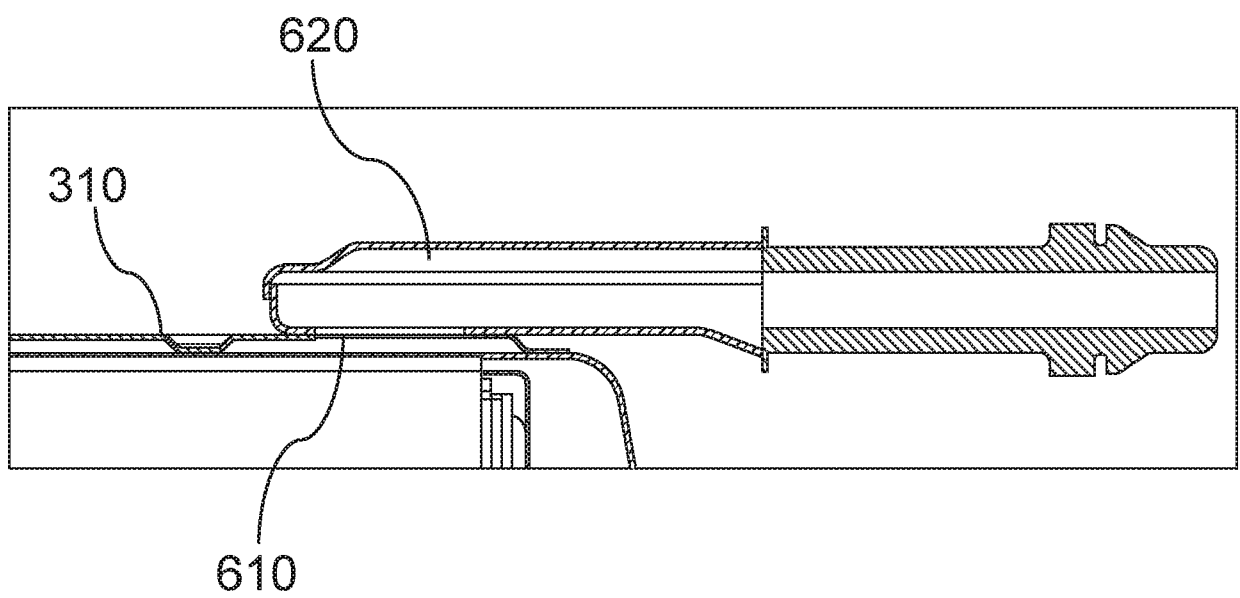


Figure 6B

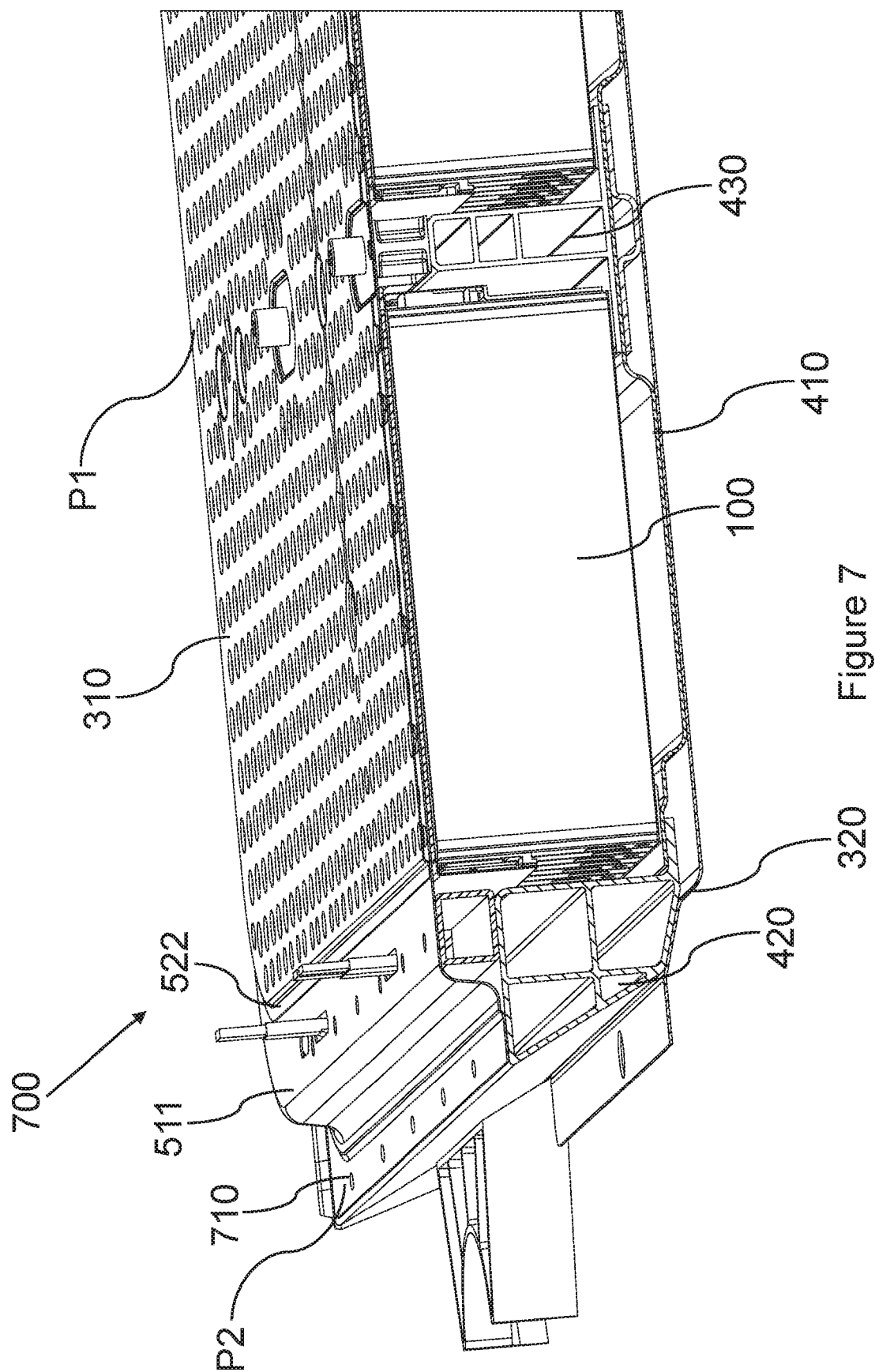
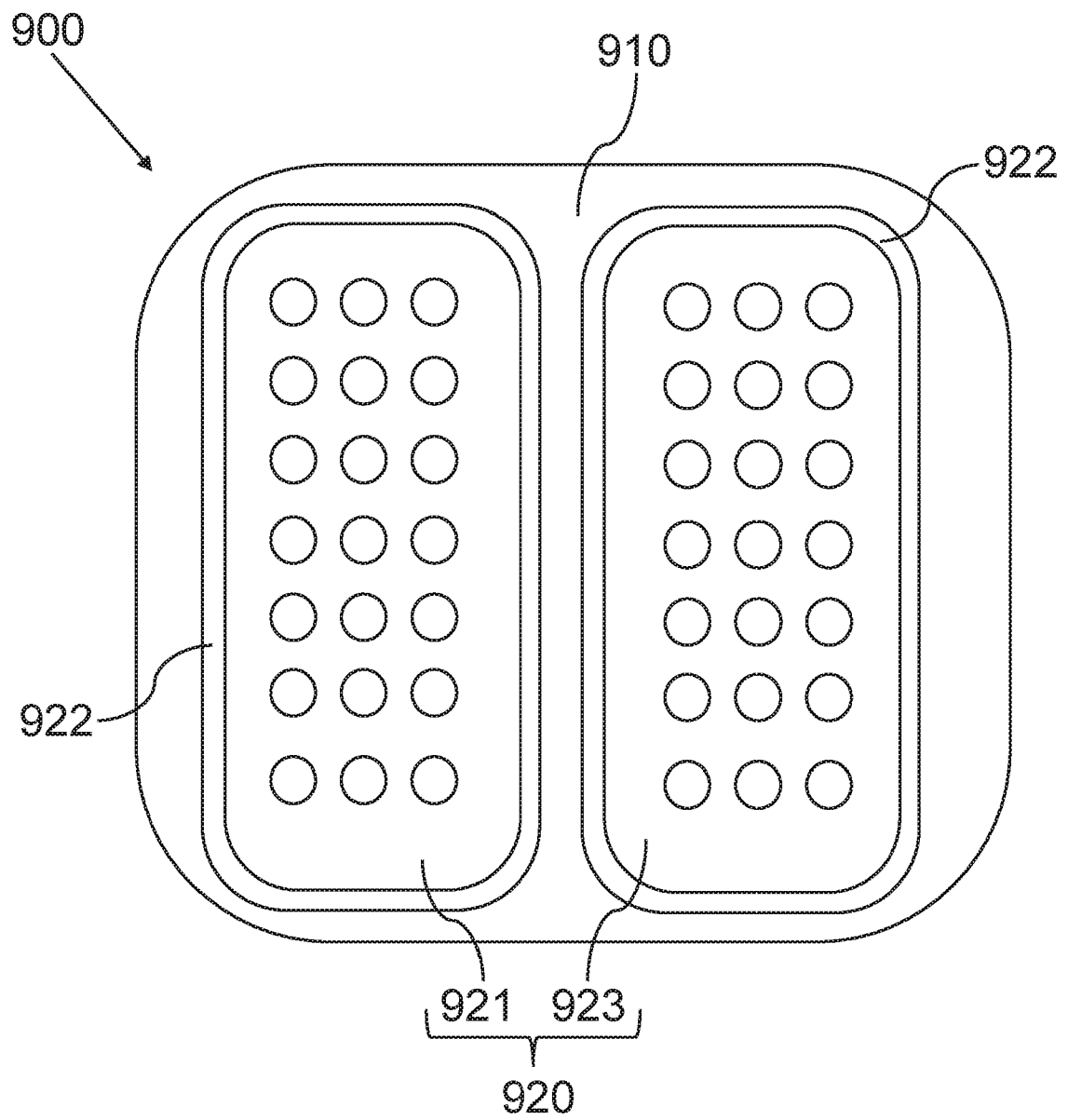
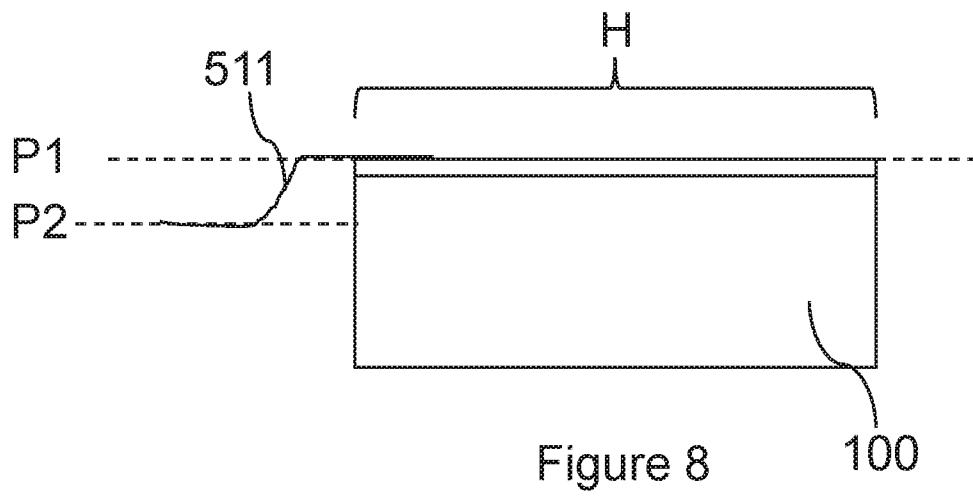


Figure 7



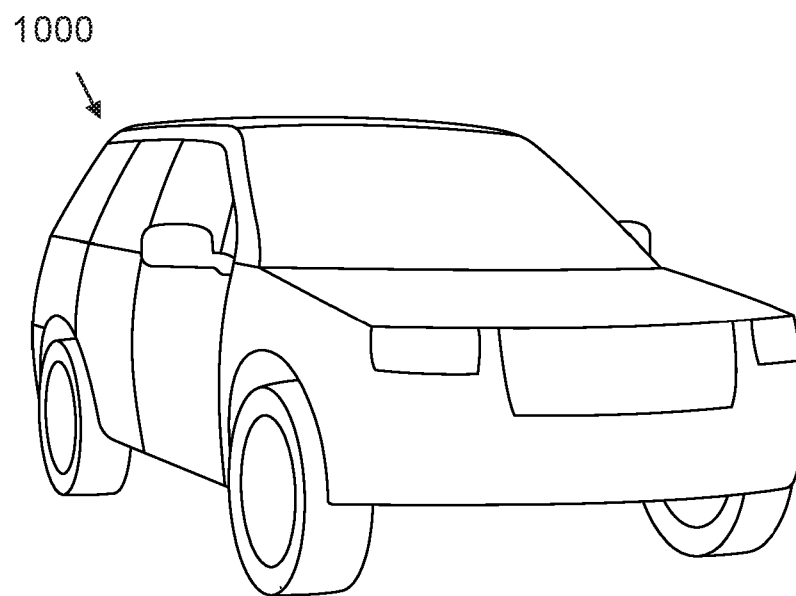


Figure 10

BATTERY CASE FOR A VEHICLE

TECHNICAL FIELD

5 The present disclosure relates to a battery case for a vehicle. Aspects of the invention relate to a battery case, to a battery pack, and to a vehicle.

BACKGROUND

10 A traction battery pack comprises a plurality of electrical cells connected to provide power to an electric motor of an electric vehicle (EV), for example a battery electric vehicle (BEV) or hybrid electric vehicle (HEV). Typical traction battery packs comprise a cooling plate arranged internal to the battery pack to extend over the electrical cells to provide thermal management for the cells. Battery packs are also typically provided with a housing formed from an upper and lower portion arranged to co-operate to encase the contents of the battery pack and provide a controlled environment for the cells. A clearance gap is typically provided between
15 the cooling plate and the upper portion of the housing in order to protect the components from damage and to allow for build tolerance.

It is desirable to keep the amount of additional space used in the battery pack to a minimum, in order to maximally utilise the available space to increase the energy density of the battery pack.

20 It is an aim of the present invention to address one or more of the disadvantages associated with the prior art.

SUMMARY OF THE INVENTION

25 Aspects and embodiments of the invention provide a battery case, a battery pack and a vehicle as claimed in the appended claims.

According to a first aspect there is provided a battery case for housing a plurality of cells of a vehicle battery, the battery case comprising: a first housing portion and a second housing portion arranged to co-operate to encase the plurality of cells in the battery case such that a
30 first surface of each of the plurality of cells is coplanar in a first plane, the first housing portion defining a cooling plate for circulating coolant to control a temperature of the plurality of cells, the first housing portion comprising: a first layer arranged across the first plane, the first layer to be bonded in use to the first surface of each of the plurality of cells encased by the battery case to provide a thermal interface between the first housing portion and each of the plurality
35 of cells; and a second layer disposed on an opposite side of the first layer to the second housing portion, wherein a periphery of the second layer is bonded to the first layer to define

a cavity for the flow of coolant between the first layer and the second layer; wherein the first layer extends beyond the periphery of the second layer to form a protruding rim; and wherein, in use, the first housing portion is secured to the second housing portion along the protruding rim of the first layer.

5

According to another aspect there is provided a battery case for housing a plurality of cells of a vehicle battery, the battery case comprising: a lower housing portion comprising a frame for locating the plurality of cells in the battery case such that an upper surface of each of the plurality of cells is coplanar in a first plane; and a lid portion arranged to co-operate with the lower housing portion to encase the plurality of cells, the lid portion defining a cooling plate for circulating coolant to control a temperature of the plurality of cells, the lid portion comprising: a first layer arranged across the first plane, the first layer to be bonded in use to the upper surface of each of the plurality of cells encased by the battery case to provide a thermal interface between the lid portion and each of the plurality of cells; and a second layer disposed on an opposite side of the first layer to the lower housing portion, wherein a periphery of the second layer is bonded to the first layer to define a cavity for the flow of coolant between the first layer and the second layer; wherein the first layer extends beyond the periphery of the second layer to form a protruding rim; and wherein, in use, the lid portion is secured to the lower housing portion along the protruding rim of the first layer.

20

Advantageously, integration of the cooling plate with the lid portion saves space in the vehicle battery because it removes the need for a clearance gap to be situated between the cooling plate and lid, and further removes the need for the lid portion to be provided with additional swaging for support, because the cooling plate itself provides support for the lid. Thus, height savings of between 5mm and 10mm can be made to the battery. Furthermore, locating cooling plate above rather than below the pack (i.e., integrated with the lid portion rather than the frame) is beneficial because then the cooling plate is protected from damage to the vehicle externals such as via mud packing or jacking. Furthermore, securing only the first layer to the lower housing portion reduces a risk of leakage from the cavity. In contrast, if the lid portion were to be secured through both layers, this would introduce a risk of coolant leakage through the holes.

30

In some embodiments, the battery case comprises fixing means arranged to secure the lid portion to the lower housing portion through the protruding rim. That is, secure bolted connections may be provided through holes or gaps in the rim without providing an increased leakage risk of coolant fluid. Optionally, the fixing means may be bolted connections.

35

Optionally, the second layer extends across the extent of a cell housing region in which the plurality of cells are located in use. That is, the cooling plate extends across all cells of the battery because the cavity extends across all cells of the battery. Thus, temperature of all the cells can be managed.

5

Optionally, the first layer is a unitary component, thereby providing structural support for the battery case.

10 In some embodiments, the second layer comprises at least two sections, wherein each section of the second layer is bonded along its periphery to a respective section of the first layer to define a respective sub-cavity for the flow of coolant between the first layer and the second layer. Thus, the lid portion can be used to define any number of independent coolant flow channels, thereby improving the flexibility of the pack design. In some embodiments, each section may be a separate sheet of material in the second layer, or each section may be part
15 of one continuous sheet.

Optionally, the protruding rim extends to a second plane offset from the first plane to partially surround the plurality of cells, wherein the protruding rim is secured to the lower housing portion along the second plane. The second plane may intersect the plurality of cells in use.
20 Advantageously, securing the rim along the second plane ensures better structural integrity of the lid. Furthermore, the lid portion extending down to the second plane along the protruding rim provides additional height for the case without extending the height of the lower housing portion. Extending the height of the lower housing portion is more costly and results in a heavier pack as the lower housing portion is more substantial as it defines the frame.
25 Optionally, the protruding rim of the first layer forms a curvilinear surface between the periphery of the second layer and a rim of the lower housing portion.

In some embodiments, the lid portion comprises two or more apertures to the cavity for providing an inlet and outlet for coolant fluid into the cavity. The cavity may be sealed apart
30 from at the apertures. Thus, the cavity provides a sealed coolant flow path between the apertures. Optionally, each aperture to the cavity is disposed in the second layer. The apertures being in the second layer is beneficial as it means the connections are external to the battery case, thus protecting the electrical cells from potential coolant fluid leakage.

35 Optionally, the battery case comprises a connector sealed to the lid portion at each aperture for connecting the cavity to a coolant conduit arrangement for circulating the coolant fluid to and from the cavity.

Optionally, the second layer is shaped to provide a fluctuating distance between the first and second layers across the lid portion. The second layer may comprise a plurality of depressions. For example, the depressions may be dimples or corrugations. This shaping
5 beneficially provides guidance for the coolant fluid along a path, provides pressure control for the cooling plate and also provides structural integrity for the lid.

The second layer may be bonded to the first layer at one or more bonding locations inside the periphery. For example, the second layer may be bonded to the first layer at a base of each
10 of the depressions. Advantageously, the additional bonding locations provide additional structural integrity for the lid portion.

Optionally, the first layer and the second layer are each formed of the same material. For example, the first layer and second layer may each be formed of steel or aluminium. This
15 ensures the layers have equivalent thermal properties such that they can be reliably bonded.

Optionally, the first layer and the second layer are separated by a third layer, wherein the third layer is shaped to provide a fluctuating distance between the first and third layers and between the second and third layers, wherein the cavity extends between the first and third layers and
20 between the second and third layers. Where connectors are connected to the second layer, a fluid path is defined in the third layer to unite in a single said cavity the cavities between the first and third layers and between the second and third layers.

According to another aspect, there is provided a battery pack for a vehicle, the battery pack
25 comprising the battery case of the above aspects, and a plurality of cells located in the lower housing portion of the battery case such that an upper surface of each of the plurality of cells is coplanar in a first plane, wherein the first layer of the lid portion is bonded to the upper surface of each of the plurality of cells, and wherein the lower housing portion and the lid portion co-operate to encase the plurality of cells. Optionally, each of the plurality of cells is a
30 pouch cell or a prismatic cell. Optionally, each of the plurality of cells comprises a positive and a negative electrical terminal, and the upper surface of each of the plurality of cells is devoid of said electrical terminals. The battery pack may comprise a layer of thermal interface material between the first layer and the upper surface of each cell.

35 According to another aspect, there is provided a vehicle comprising a battery case or a battery pack according to the above aspects.

Within the scope of this application, it is expressly intended that the various aspects, embodiments, examples, and alternatives set out in the preceding paragraphs, in the claims and/or in the following description and drawings, and in particular the individual features thereof, may be taken independently or in any combination. That is, all embodiments and/or features of any embodiment can be combined in any way and/or combination, unless such features are incompatible. The applicant reserves the right to change any originally filed claim or file any new claim accordingly, including the right to amend any originally filed claim to depend from and/or incorporate any feature of any other claim although not originally claimed in that manner.

BRIEF DESCRIPTION OF THE DRAWINGS

One or more embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 shows an electrical cell for use in a traction battery according to the prior art;
Figure 2 shows an example battery pack according to the prior art;
Figure 3 shows a battery case according to an embodiment of the invention;
Figure 4 illustrates a lower housing portion of the battery case;
Figure 5A shows a cross-sectional view of a lid portion in a first example;
Figure 5B shows a cross-sectional view of a lid portion in a second example;
Figure 6A shows the lid portion having connectors for circulating coolant;
Figure 6B shows the lid portion and a connector in a cross-sectional view;
Figure 7 shows a cross-sectional view of a battery pack;
Figure 8 shows a schematic illustration of the planar arrangement of the lid portion;
Figure 9 shows a lid portion according to an embodiment; and
Figure 10 illustrates a vehicle.

DETAILED DESCRIPTION

The present invention relates to a traction battery pack for use in a vehicle and to a battery case for the traction battery pack. A traction battery pack comprises a plurality of electrical cells connected to provide power to an electric motor of an electric vehicle (EV), for example a battery electric vehicle (BEV) or hybrid electric vehicle (HEV).

Figure 1 illustrates an example electrical cell 100 according to the prior art for use in a traction battery for a vehicle. The cell 100 comprises a positive electrical terminal 100P and a negative electrical terminal 100N. In this example, the electrical cell 100 is a prismatic cell 100 having a first end face 110 and a second end face 120. The positive terminal 100P is provided on the

first end face 110 and the negative terminal 100N is provided on the second end face 120. The prismatic cell 100 comprises an upper face 130, a lower face 140 and two side faces 150 each extending between the first end face 110 and the second end face 120. Other electrical cell types may alternatively be used in a traction battery pack, such as pouch cells or cylindrical cells.

Cells 100 such as shown in Figure 1 may be grouped together to create a battery pack. A cross-section of an example prior art battery pack 200 is illustrated in Figure 2.

The prior art battery pack 200 comprises a plurality of cells 100 electrically connected by a busbar assembly (not shown). Cooling of the cells 100 is provided by a cooling plate 230, which is arranged internally to the prior art battery pack 200. The cooling plate 230 is arranged in the prior art battery pack 200 to extend over the cells 100 of the prior art battery pack 200 and to be in contact with the upper face 130 of each cell 100 via a layer of thermal interface material 235. Thermal contact with the upper face 130 of each cell 100 is required to provide sufficient thermal conductivity to control the temperature of the cells 100. The upper face 130 of each cell 100 is devoid of cell terminals, as the positive and negative cell terminals, and associated connections to the terminals, would reduce the efficacy of thermal contact between the cooling plate 230 and the cells 100. Thus, the type of cell 100 used in the prior art battery pack 200 may impact the location of the cooling plate 230. If the cell terminals are located on the upper face 130 of each cell, the cooling plate 230 can alternatively be disposed at a base of the pack in thermal contact with a lower face 140 of each cell. The cooling plate 230 comprises a plurality of channels through which a liquid coolant may flow, thereby cooling the cells 100. The cooling plate 230 may also be used to heat the cells 100 if the temperature of the prior art battery pack 200 is low. This may be achieved by heating the coolant prior to circulation through the channels of the cooling plate 230. The cooling plate 230 is provided with at least an inlet for receiving coolant fluid and an outlet for expelling coolant fluid (not shown). Each of the inlet and outlet are connected via a conduit arrangement to a thermal management system for circulating and controlling the temperature of the coolant fluid. In use for cooling the cells, chilled coolant fluid is provided to the inlet of the cooling plate 230. The chilled coolant fluid flows through the channels between the inlet and the outlet and is warmed by the heat emitted from the cells 100. The warmed coolant fluid is emitted from the outlet and directed away by the thermal management system in order to dissipate the heat from the prior art battery pack 200. The heat flow may be reversed for heating the cells.

The components of the prior art battery pack 200 including the cells 100 and cooling plate 230 are located in a housing formed from at least an upper portion 220 and a lower portion 210. The housing 210, 220 provides a frame for locating the cells 100 within the prior art battery

pack 200 and provides structural support for the prior art battery pack 200. The upper portion 220 and lower portion 210 of the housing are arranged to co-operate to encase the contents of the battery pack and to at least partially seal the contents of the battery pack to provide a controlled environment for the cells 100.

- 5 As shown in Figure 2, in the prior art a clearance gap 225 is typically provided between the cooling plate 230 and the upper portion 220 of the housing. Such a clearance gap 225 may be in the order of 3mm to 10mm. A clearance gap 225 is required between components of the prior art battery pack 200 which are not secured together, in order to protect the components from damage due to flexing of the cooling plate 230 and/or upper portion 220 of the housing
10 during use, and to allow for build tolerance in these components and assembly.

The upper portion 220 of the housing extends over the full extent of the prior art battery pack 200 to form a lid for the pack 200. In order to provide sufficient structural support for the prior art battery pack 200, the upper portion 220 should therefore be patterned with corrugations or other swaging to provide sufficient stiffness across the upper portion 220. This swaging is
15 necessary because a flat sheet extending across the entire width of the pack would be susceptible to collapse. This swaging can add additional height to the battery pack such that a total height of the upper portion 220 is significantly higher than the thickness of the material from which the upper portion 220 is formed. The swaging can add between 3mm to 6mm additional height to the pack.

- 20 It is desirable to keep the amount of additional space used in the battery pack 200 to a minimum, in order to maximally utilise the available space to increase the energy density of the battery pack 200. Furthermore, fluid connections internal to the battery pack 200 for connecting the cooling plate 230 to the conduit arrangement of the thermal management system provide a risk of fluid leakage which may damage the cells 100.

- 25 To address one or more of the problems associated with the prior art battery pack 200, according to the present invention there is provided a battery case 300 for an improved battery pack 700, as will be explained with reference to Figures 3 to 10.

In accordance with an embodiment of the present invention, there is provided a battery case 300 for a vehicle battery as shown in Figure 3. The battery case 300 may be implemented to
30 encase a plurality of cells 100 to form an improved battery pack 700 in accordance with the present invention. An improved battery pack 700 according to an embodiment will be described with reference to Figures 7 and 8.

With reference again to Figure 3, the battery case 300 effectively acts to replace the housing 210, 220 and cooling plate 230 of the prior art battery pack 200. The battery case 300 comprises a lid portion 310 for the housing which comprises an integrated cooling plate. This integration provides a space efficient battery pack 700 having a reduced height compared to the prior art battery pack 200 and thus a higher energy density. Furthermore, the design of the battery case 300 is such that the risk of damage to the cells from coolant leakage is significantly reduced, as will be explained.

With reference to Figure 3, the battery case 300 comprises a lower housing portion 320 and a lid portion 310. The lower housing portion 320 and the lid portion 310 are arranged to cooperate to encase a plurality of cells 100 to form a battery pack, such as the battery pack 700 shown in Figure 7.

A lower housing portion 320 according to an embodiment is illustrated in isolation in Figure 4. The lower housing portion 320 comprises a frame 400 for locating the plurality of cells 100. The frame 400 comprises a base plate 410 for supporting the lower face 140 of the plurality of cells 100, a side frame 420, and one or more central dividing beams 430 for defining a plurality of channels 440 for housing the cells 100. The cells 100 may be arranged in a plurality of sub-assemblies, wherein each sub-assembly comprises a plurality of the cells 100 stacked side face to side face, as well as interconnected end to end. Each channel 440 may thus be shaped to locate a respective sub-assembly. The side frame 420 comprises protruding flanges 421 for securing the lower housing portion 320 to the vehicle carriage.

The lid portion 310 defines a cooling plate for circulating coolant to control a temperature of the plurality of cells 100. By integrating the cooling plate with the lid portion 310 of the battery case, advantageously fewer layers of material are required, and no clearance gap is necessary between the cooling plate and the lid. Thus, an overall height of the battery pack is reduced. In use, the cells are arranged within the lower housing portion 320 such that the upper surface of each of the plurality of cells is coplanar in a first plane. The lid portion 310 may then be arranged across (that is, lying on and parallel) the first plane across the extent of the plurality of cells 100 such that the cooling plate is in thermal contact with the upper surface 130 of each cell 100. A periphery of the lid portion 310 may then be secured to the side frame 420 of the lower housing portion 320 to seal the battery case 300.

Example lid portions 310 according to two embodiments are illustrated in a cross-sectional view in Figures 5A and 5B. In each embodiment, the lid portion 310 comprises at least a first layer 510 and a second layer 520 which together define the cooling plate of the battery pack. The first layer 510 and the second layer 520 are bonded together around a periphery 522 of

the second layer 520, as shown in Figure 5A, to define at least one cavity 515 for the flow of coolant between the first layer 510 and the second layer 520.

In the second embodiment illustrated in Figure 5B, the lid portion 310 comprises a third layer 540 disposed between the first layer 510 and second layer 520. Thus, the at least one cavity 515 can be formed between the first layer 510 and the third layer 540 and/or between the third layer 540 and the second layer 520.

With reference again to Figure 5A, the first layer 510 defines a base of the cooling plate and forms an internal surface of the lid portion 310. In use, the first layer 510 is thus on the first plane and is in thermal contact with the upper surface of each of the plurality of cells encased by the battery case 300. A layer of thermal interface material 530 may be disposed between the first layer 510 and the upper surface of each of the plurality of cells 100 to provide a thermal interface between the cooling plate and the cells 100. In some embodiments the thermal interface material 530 bonds the first layer 510 to the cells 100. In some embodiments there may be other layers of material between the first layer 510 and the plurality of cells 100, such as the casing of a battery subassembly or module, but the principle of a thermal interface between the cooling plate and the cells 100 would still apply.

The first layer 510 is a unitary component, i.e., a single continuous layer. Providing a unitary component as the internal surface of the lid portion 310 provides structural support for the battery case and also facilitates a more robust and continuous seal for the interior of the battery case 300 to control the surrounding environment of the cells 100.

The second layer 520 defines a top surface of the cooling plate. The second layer 520 may be formed from a unitary component or may be formed from multiple components, as will be explained. The second layer 520 is disposed, in use, on an opposite side of the first layer 510 to the lower housing portion 320 and thus forms an external surface of the battery pack 300. The first layer 510 and the second layer 520 are each formed of the same material, such that the layers may be readily welded or brazed together to seal the cavity 515 and have corresponding thermal properties. The layers 510, 520 may be made of steel or aluminium, for example.

The cavity 515 defined by the first layer 510 and the second layer 520 extends across the extent of the plurality of cells 100 such that each cell 100 in the battery pack may be effectively cooled by the coolant fluid flowing through the cavity 515.

As shown in Figure 5A, the second layer 520 may be shaped to provide a fluctuating distance between the first and second layers 510, 520 across the extent of the lid portion 310. This

shaping provides multiple functions. Firstly, the fluctuating distance between the first and second layers 510, 520 provides a fluctuating width for the cavity 515. Shaping of the cavity 515 can be used to direct the flow of coolant fluid to achieve uniform cooling across the extent of the battery pack and avoid stagnation in the flow. Furthermore, the shaping of the second layer 520 provides the requisite stiffness such that the cavity 515 can maintain its structural integrity under pressure from the coolant fluid. The stiffness provided by the shaping also provides structural integrity for the lid portion 310 such that the cells 100 may be adequately protected, i.e., the shaping serves the same purpose as the swaging discussed with reference to Figure 2. The second layer 520 may be shaped by comprising a plurality of depressions 524. In the illustrated embodiment the depressions 524 comprise a plurality of dimples 524, however in other embodiments, the depressions 524 may comprise corrugations or other elongate shapes. The depressions 524 are arranged across the lid portion 310 to provide a coolant flow path for the coolant fluid across the extent of the battery pack.

In some embodiments, the first layer 510 and second layer 520 are bonded together at one or more bonding locations inside the periphery 522 of the second layer 520. The bonding locations may be at the base of each of the depressions 524 as shown in Figure 5A. Providing additional bonding locations beneficially helps to define the coolant flow path through the interior of the cooling plate and also improves the structural integrity of the lid portion 310.

As shown in Figure 5B, in some embodiments this shaping may alternatively be provided by the third layer 540. In the illustrated embodiment of Figure 5B, the first layer 510 and the second layer 520 are each substantially planar. The third layer 540 is shaped with corrugations to provide a fluctuating distance between the first and third layers 510, 540 and between the second and third layers 520, 540. The shaping of the third layer 540 in Figure 5B is used to define coolant flow channels within the cavity 515 to direct the flow of coolant, and also provide the requisite stiffness for the lid portion 310. In this case, a fluid connection may be required through or around the third layer to interconnect the cavities between the first and third layers 510, 540 and between the second and third layers 520, 540.

With reference to Figures 6A and 6B, the lid portion 310 comprises at least two apertures 610 providing an inlet and an outlet for coolant fluid into the cavity 515. Connections for two apertures 610 are shown in Figure 6A. Figure 6B illustrates one of the apertures 610 of Figure 6A in cross-sectional view to show a path of the coolant fluid through the aperture 610. The cavity 515 is sealed between the inlet and the outlet and is shaped to provide a coolant flow path across each of the plurality of cells 100. In use, heated or chilled coolant fluid flows into the cavity 515 through the inlet. The heated or chilled coolant fluid flows through the coolant flow path defined by the cavity 515 between the inlet and the outlet and is either warmed by

the heat emitted from the cells 100 or cooled by emitting heat to warm the cells 100. The coolant fluid is emitted from the outlet 260 and directed away by a thermal management system.

In some embodiments, two apertures 610 to the cavity are disposed in the second layer 520, that is the top surface of the cooling plate on the external surface of the lid portion 310. A connector 620 is sealed to the external surface of the lid portion 310 at each aperture 610 for connecting the inlet and the outlet of the cavity 515 to a coolant conduit arrangement for circulating the coolant fluid to and from the cavity. It is beneficial to provide the apertures 610 and connectors 620 on the second layer 520 as the fluid connections are external to the battery case 300, i.e., the connections are disposed on the opposite side of the lid portion 310 to the cells 100. Thus, the cells 100 will be protected from any potential leak at either of the connectors 620 and/or the apertures 610 of the lid portion 310.

As mentioned, the battery case 300 as described with reference to Figures 3 to 6B can be used to encase a plurality of cells 100 to provide an improved battery pack 700. With reference to Figure 7, there is illustrated a cross-section of an example battery pack 700 according to an embodiment of the invention. The battery pack 700 comprises the battery case 300 including the plurality of cells 100 located in the lower housing portion 320. The upper surface of each cell 100 is bonded to the lid portion 310 to provide a thermal interface between the cavity 515 and each cell 100.

The first layer 510 of the lid portion 310 extends beyond the periphery 522 of the second layer 520 to form a protruding rim 511. The protruding rim 511 is arranged flush with the side frame 420 of the lower housing portion. The lid portion 310 can thus be secured to the lower housing portion 320 along the protruding rim 511 to seal the battery case 300. The battery pack 700 is provided with fixing means 710 to secure the lid portion 310 to the lower housing portion 320 along the protruding rim. The fixing means 710 comprise bolted connections in the illustrated embodiment, wherein corresponding holes or gaps are provided along the side frame 420 and the protruding rim 511. The bolting mechanism 710 may then be secured through the corresponding holes to fix the lid portion 310 to the lower housing portion 320. In other embodiments, it can be envisaged that other fixing means 710 may be utilised, such as adhesive or a welded connection.

Advantageously, by securing along the protruding rim 511, only the first layer 510 of the lid portion 310 receives the fixing means 710. Securing only the first layer 510 to the lower housing 320 reduces any risk of the coolant fluid leaking from the cavity 515, as the securing is performed beyond the periphery of the cavity seal. If the fixing means 710 were arranged to

penetrate both the first layer 510 and the second layer 520, this would introduce a risk of coolant leakage through the hole or gap for the fixing means 710.

With reference to Figure 8, the cells 100 are arranged in the battery pack 700 such that the upper face 130 of each cell 100 is coplanar in a first plane P1. The cells 100 are located in a cell housing region H of the battery pack 700. The first layer 510 of the lid portion 310 extends across the extent of the cell housing region H along the first plane P1 and is in thermal contact and/or bonded to the upper surface of each cell 100, as explained. Beyond the cell housing region H, the protruding rim 511 extends to a second plane P2 offset from the first plane to partially surround the plurality of cells 100. The protruding rim 511 may form a curvilinear surface between the first plane P1 and the second plane P2. With reference again to Figure 7, the protruding rim 511 is secured to the lower housing portion 320 along the second plane P2. By securing the lid portion 310 to the lower housing portion 320 along the second plane, the battery case 300 is provided with improved structural integrity due to providing the join in the middle of the pack 700 rather than at the top. Furthermore, the lid 310 itself is shaped to provide additional height to the battery case 300 without necessitating increasing the height of the frame 400, which is heavier and costlier to extend. Yet further, the curvilinear form of the protruding rim 511 provides a stiffening effect for the lid portion 310, thereby stiffening the battery case 300 and the vehicle 1000 to which the lid portion 310 is attached.

As discussed previously, the first layer 510 of the lid portion 310 is a unitary component which extends at least across a cell housing region H of the battery pack 700 and is bonded to an upper surface of each cell of the battery pack 700. The second layer 520 is bonded to the first layer 510 around a periphery 522 and optionally at one or more bonding locations inside the periphery 522. The second layer 520 is bonded to the first layer 510 to define a cavity 515 for the flow of coolant fluid across the cell housing region H. In some embodiments, the bonding is arranged such that a single cavity 515 is defined between the first layer 510 and the second layer 520 and thus the lid portion 310 functions as a unitary cooling plate.

With reference to Figure 9, there is illustrated a view of a lid portion 900 according to another embodiment of the invention. The lid portion 900 comprises a unitary first layer 910 as described with reference to the preceding figures. The lid portion 900 comprises a second layer 920 having at least two sections 921, 923. Each section 921, 923 of the second layer 920 is bonded along its periphery 922 to a respective section of the first layer 910 to define a respective sub-cavity for the flow of coolant. Thus, the lid portion 900 is arranged to define two individual cooling plates for the battery pack. The sections 921, 923 of the second layer may be separate components or may be formed from a single unitary sheet.

Beneficially, the lid portion 900 can thus be divided to define any number of independent cooling plates to improve the flexibility of the pack design. Use of a unitary first layer 910 ensures that the lid portion 900 comprises sufficient structural and sealing integrity even if the second layer 920 is divided into sections.

5 With reference to Figure 10, the battery case 300 or battery pack 700 may be implemented in a vehicle 1000. The vehicle 1000 is an electric vehicle (EV), for example a battery electric vehicle (BEV) or hybrid electric vehicle (HEV). The cells 100 of the battery pack 700 can be arranged to provide power to a traction motor of the vehicle 1000. The vehicle 1000 illustrated is an automobile, but it will be appreciated that the battery case 300 or battery pack 700 may
10 be implemented in any other electric vehicle.

The present invention thus provides a battery case 300 and battery pack 700 having an improved energy density compared to the prior art. Integrating the cooling plate with a lid of the battery pack advantageously makes a space saving in the height of the battery pack. Such
15 an integration removes the need for an additional layer of material to define the lid, a clearance gap between the cooling plate and lid, and swaging height to provide structural integrity for the lid. Thus, fewer materials are required to manufacture the pack and a total height reduction in the order of 5mm to 10mm may be achieved compared to the prior art. Furthermore, connections to a thermal management system for circulating coolant fluid may be retained
20 entirely on an exterior of the lid, reducing the risk of damage to the cells of the battery pack should leakage arise at the connections to the thermal management system.

It will be appreciated that various changes and modifications can be made to the present invention without departing from the scope of the present application.

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CLAIMS

1. A battery case for housing a plurality of cells of a vehicle battery, the battery case comprising:

5 a lower housing portion comprising a frame for locating the plurality of cells in the battery case such that an upper surface of each of the plurality of cells is coplanar in a first plane; and

a lid portion arranged to co-operate with the lower housing portion to encase the plurality of cells, the lid portion defining a cooling plate for circulating coolant to control a
10 temperature of the plurality of cells, the lid portion comprising:

a first layer arranged across the first plane, the first layer to be bonded in use to the upper surface of each of the plurality of cells encased by the battery case to provide a thermal interface between the lid portion and each of the plurality of cells; and

15 a second layer disposed on an opposite side of the first layer to the lower housing portion, wherein a periphery of the second layer is bonded to the first layer to define a cavity for the flow of coolant between the first layer and the second layer;

wherein the first layer extends beyond the periphery of the second layer to form a protruding rim; and

20 wherein, in use, the lid portion is secured to the lower housing portion along the protruding rim of the first layer.

2. The battery case of claim 1, wherein the battery case comprises fixing means arranged to secure the lid portion to the lower housing portion through the protruding rim.

25 3. The battery case of any preceding claim, wherein the second layer extends across the extent of a cell housing region in which the plurality of cells are located in use.

30 4. The battery case of any preceding claim, wherein the first layer is a unitary component.

5. The battery case of any preceding claim, wherein the second layer comprises at least two sections, wherein each section of the second layer is bonded along its periphery to a respective section of the first layer to define a respective sub-cavity for the flow of coolant
35 between the first layer and the second layer.

6. The battery case of any preceding claim, wherein the protruding rim extends to a second plane offset from the first plane to partially surround the plurality of cells, wherein the protruding rim is secured to the lower housing portion along the second plane.
- 5 7. The battery case of claim 6, wherein the protruding rim of the first layer forms a curvilinear surface between the periphery of the second layer and a rim of the lower housing portion.
- 10 8. The battery case of any preceding claim, wherein the lid portion comprises two or more apertures to the cavity for providing an inlet and outlet for coolant fluid into the cavity and wherein each aperture to the cavity is disposed in the second layer.
- 15 9. The battery case of claim 8, comprising a connector sealed to the lid portion at each aperture for connecting the cavity to a coolant conduit arrangement for circulating the coolant fluid to and from the cavity.
10. The battery case of any preceding claim, wherein the second layer is shaped to provide a fluctuating distance between the first and second layers across the lid portion.
- 20 11. The battery case of claim 10, wherein the second layer is bonded to the first layer at one or more bonding locations inside the periphery.
- 25 12. The battery case of claim 11, wherein the second layer comprises a plurality of depressions and wherein the second layer is bonded to the first layer at a base of each of the depressions.
- 30 13. The battery case of any of claims 1 to 9, wherein the first layer and the second layer are separated by a third layer, wherein the third layer is shaped to provide a fluctuating distance between the first and third layers and between the second and third layers, wherein the cavity extends between the first and third layers and between the second and third layers.
- 35 14. A battery pack for a vehicle, the battery pack comprising the battery case of any preceding claim, and a plurality of cells located in the lower housing portion of the battery case such that an upper surface of each of the plurality of cells is coplanar in a first plane, wherein the first layer of the lid portion is bonded to the upper surface of each of the plurality of cells, and wherein the lower housing portion and the lid portion co-operate to encase the plurality of cells.

15. A vehicle comprising a battery case according to any of claims 1 to 13 or a battery pack according to claim 14.



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Claims searched: 1-15

Date of search: 22 June 2023

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-15	GB 2555826 A (JAGUAR LAND ROVER) whole document of interest, especially see figures 4 & 5, page 5 lines 22-3 and page 9 line 27-35 discussing battery pack lid reinforcement members within the battery support frame utilised as ducts for cooling fluids.
X	1-15	WO 2022/244569 A1 (NIPPON STEEL CORP) see figures 1 & 5 as well as translated description paragraphs [0010]-[0012] and [0021]-[0024].
X	1-15	CN 207852857 U (DONGGUAN MAITAI HEAT TRANSFER TECHNOLOGY) see figure 2 and brief translated description describing battery pack cover with cooling means.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^X :

Worldwide search of patent documents classified in the following areas of the IPC

H01M

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC, INTERNET



International Classification:

Subclass	Subgroup	Valid From
H01M	0010/60	01/01/2014
H01M	0010/61	01/01/2014
H01M	0010/613	01/01/2014
H01M	0010/617	01/01/2014
H01M	0010/62	01/01/2014
H01M	0010/625	01/01/2014
H01M	0010/6554	01/01/2014
H01M	0010/6556	01/01/2014
H01M	0010/656	01/01/2014