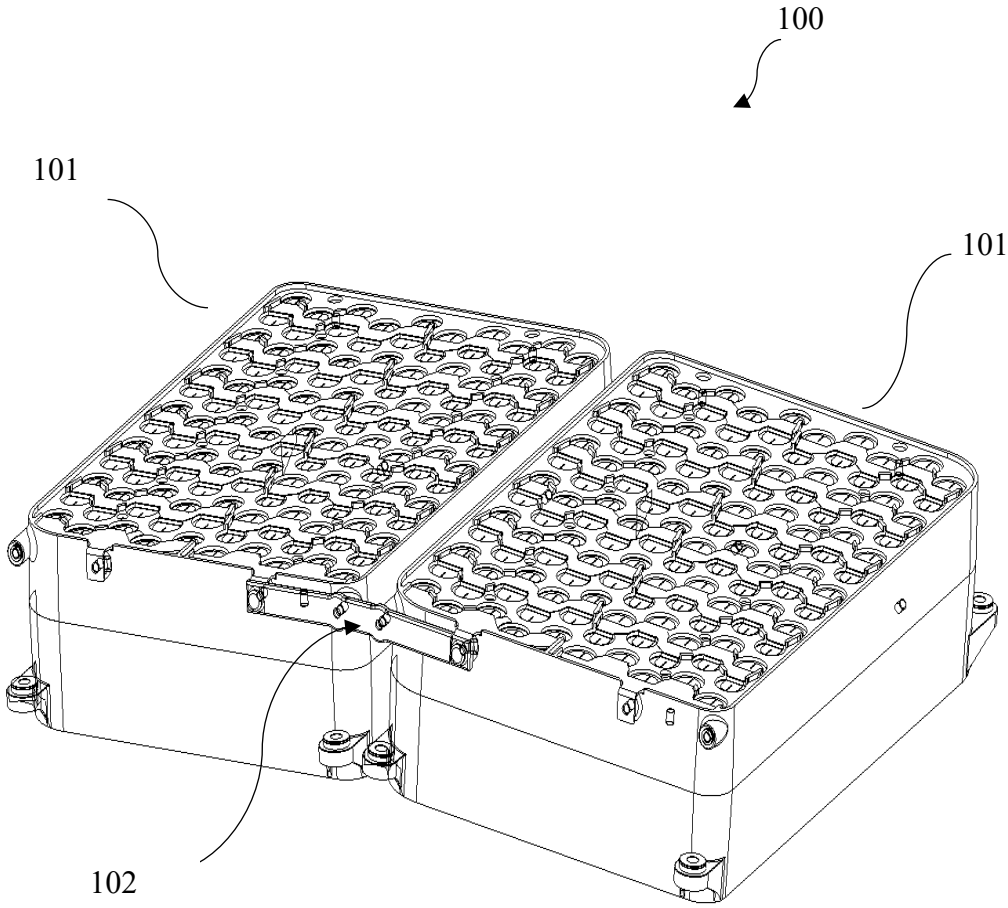


Fig.1

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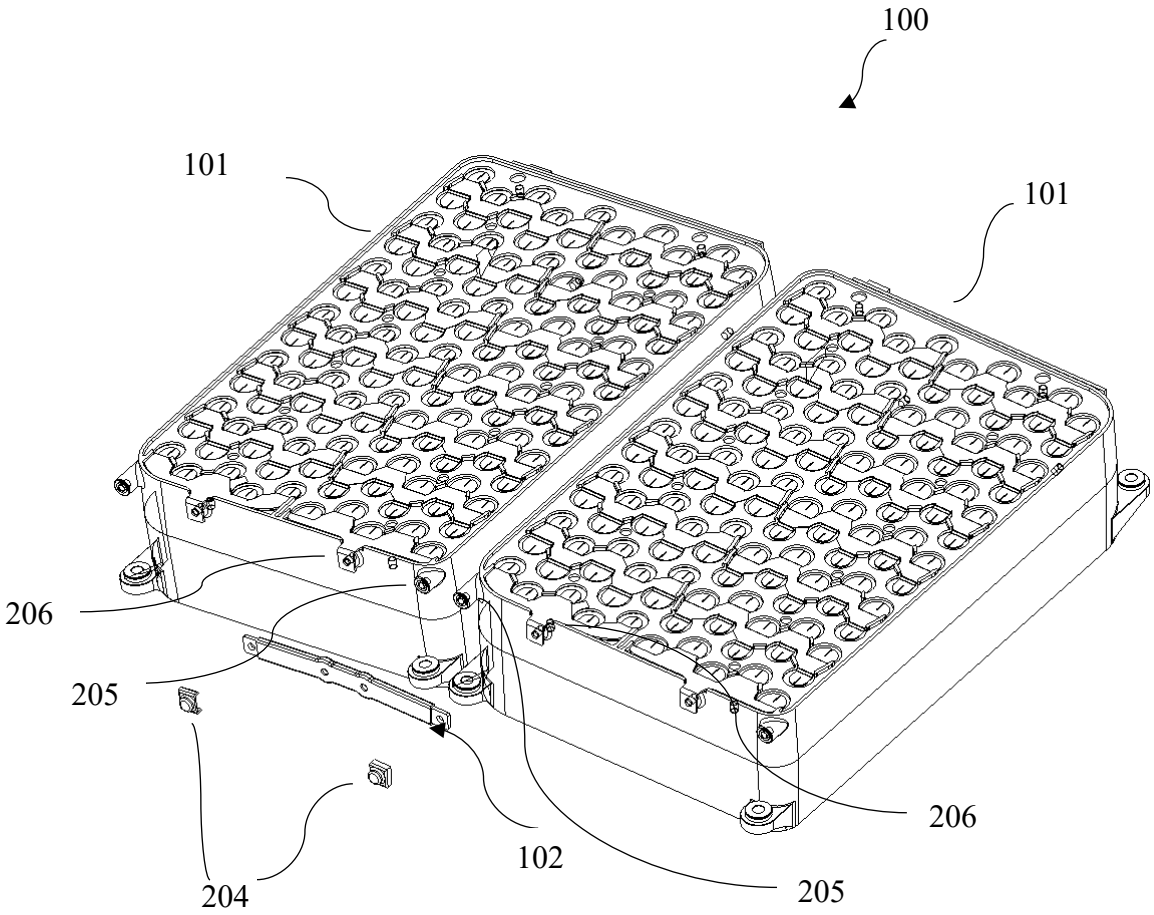


Fig.2

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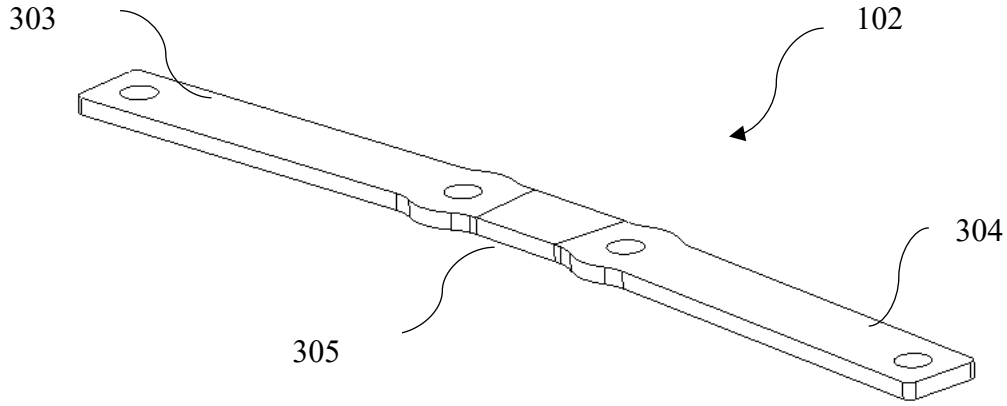


Fig.3 (a)

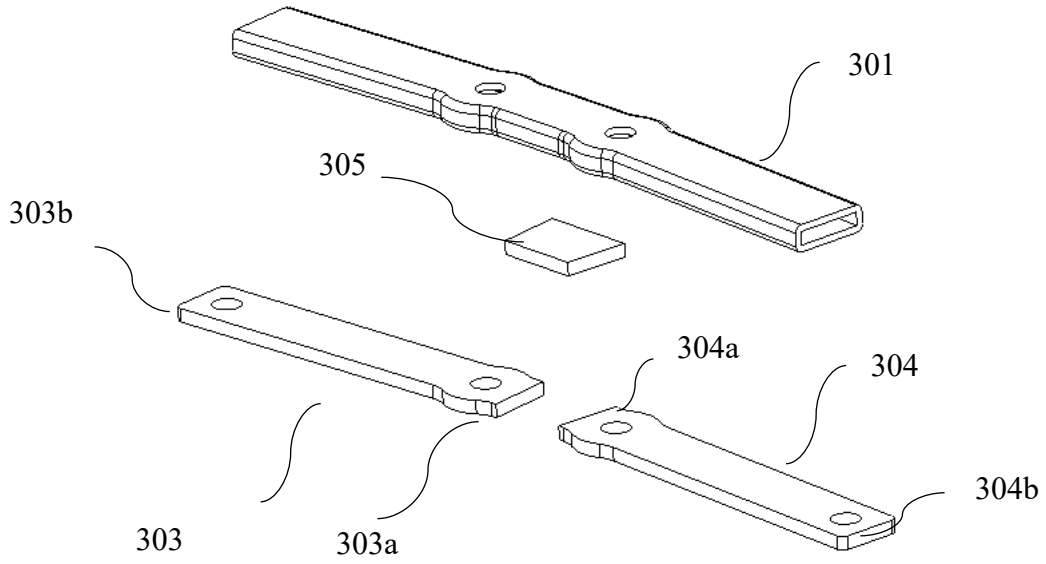


Fig.3 (b)

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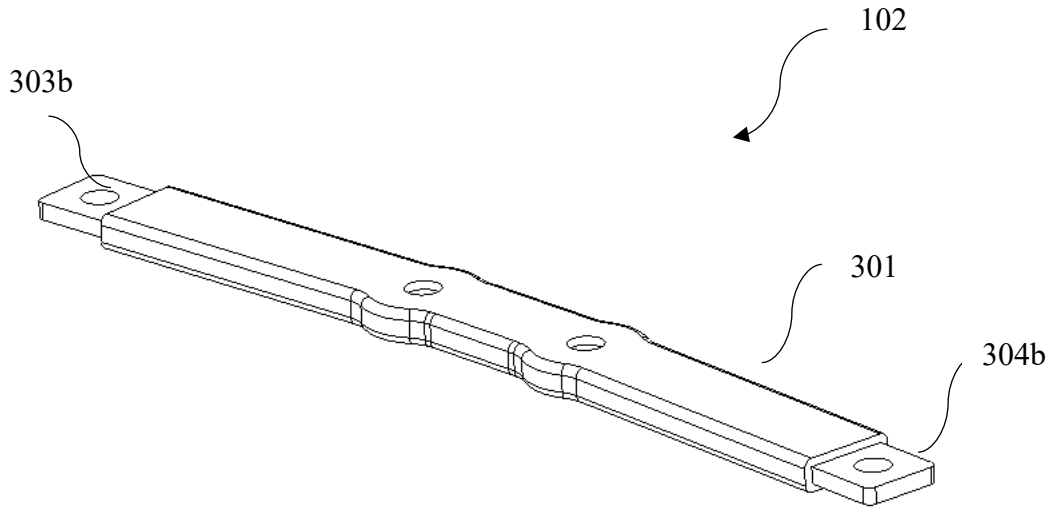


Fig.4

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FORM 2

THE PATENTS ACT, 1970

(39 of 1970)

&

THE PATENTS RULES, 2003

COMPLETE SPECIFICATION

(See Section 10 and Rule 13)

A BATTERY PACK

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The following specification particularly describes the invention and the manner it is to be performed.

TECHNICAL FIELD

[0001] The present subject matter generally relates to battery packs, and more particularly, but not exclusively, to interconnections within such battery packs.

BACKGROUND

[0002] Electric vehicles differ from conventional motor vehicles because electric vehicles are selectively driven using one or more electric machines powered by a battery pack. Electric machines drive the electric vehicles instead of, or in addition to, an internal combustion engine. Examples of such electric vehicles include hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), fuel cell vehicles (FCVs), and battery electric vehicles (BEVs).

[0003] A battery pack of the electric vehicles can include a plurality of battery cells assemblies arranged in one or more battery arrays. Conventional rechargeable batteries may be arranged as small sets of batteries coupled to one or more conductors at either end of the sets of batteries, thereby coupling each set of batteries in parallel. The small sets of batteries may be coupled to one another in series to generate higher voltages than the voltages of the batteries themselves. The series-coupled sets of batteries may be provided in a single pack for ease of handling. However, it may be desirable to couple two or more of these packs to one another in series to generate higher voltages or in parallel to generate higher currents, or a combination of series and parallel couplings to achieve both a higher current and a higher voltage.

[0004] Typically, electrical conductors are used to distribute power to and from the battery cell assemblies or within one or battery modules, and to and from the battery packs. Examples of electrical conductors includes either wires or solid metal connectors namely busbars. Conventionally, busbars act as a conductor or a group of conductors and is used for collecting electric power from one battery cell assembly or modules and distributes them to the other battery cell assembly or modules. In other words, it is a type of electrical junction in which all the incoming and outgoing electrical current meets. Thus, the electrical busbar collects the electric power at one location. Such busbars are typically made of copper and

aluminium and tends to add significant weight to the electric vehicles. Another widely used electrical conductor are conventional wires that are used as conductors, as long as the wires have sufficient current carrying capacity.

BRIEF DESCRIPTION OF DRAWINGS

[0005] The detailed description is described with reference to the accompanying figures, which is related to a battery pack in a vehicle being one embodiment of the present subject matter. However, the present subject matter is not limited to the depicted embodiment(s) and is applicable to all kinds of battery packs in vehicles such as two-wheeled vehicle, three-wheeled vehicle, four-wheeled vehicle and the like. In the figures, the same or similar numbers are used throughout to reference features and components.

[0006] **Fig. 1** depicts an isometric view of a battery pack in accordance with an embodiment of the present subject matter.

[0007] **Fig. 2** illustrates an isometric view of the battery pack along with an integrated electrical interconnection assembly in accordance with an embodiment of the present subject matter.

[0008] **Fig. 3 (a)** illustrates a magnified view of the integrated electrical interconnection assembly in accordance with an embodiment of the present subject matter.

[0009] **Fig. 3 (b)** illustrates an exploded view of the integrated electrical interconnection assembly along with a non-conducting sleeve in accordance with an embodiment of the present subject matter.

[00010] **Fig. 4** illustrates an assembled view of the integrated electrical interconnection assembly enclosed withing the non-conducting sleeve in accordance with an embodiment of the present subject matter.

DETAILED DESCRIPTION

[00011] Various features and embodiments of the present subject matter here will be discernible from the following further description thereof, set out hereunder.

[00012] Conventionally, all battery packs in electrical vehicles employ either electrical wires or bus bars to connect two or more battery packs together. However, usage of conventional electric wires poses certain problems that are undesirable. In a high-current environment, such electrical wires must have sufficient thickness to carry the current required. However, with this thickness comes stiffness. In a high vibration environment, such as an electric or hybrid vehicle like a car, the wires or thick pieces of metal coupled to battery packs that are moving relative to one another as the vehicle flexes, could cause stresses on the metal conductors, the packs or the terminals connecting the packs to the wires or metal conductors. The stress could cause cracks in the conductors or the packs or cause a loosening at the terminals, leading to premature failure of the entire assembly, sparks, or changes to the electrical characteristics of the battery pack.

[00013] Therefore, single busbars are now widely used to connect such battery packs together. Typically, in such electric vehicles, in which the battery is mounted on the vehicle, the battery pack is normally subjected to mechanical repetitive vibrations. The vibration of the battery results in a physical load of the connections of the bus bars, which leads to breakage of the connections. In particular, in the case where a battery assembly formed of a plurality of cells and a bus bar holder having a plurality of bus bars are mounted in a storage case, the battery assembly and the busbar holder vibrate independently in response to the vibration of the storage case voltages are exerted on the connections of the electrode strips with the busbars and this leads to the instability of the connections. Moreover, due to such external vibration generated by motor operation or the like is transmitted to the motor drive device, or vibration generated by an electronic component or the like in the motor drive device is transmitted, which vibrates the single busbars, noises are generated, parts around the single busbar are deteriorated, and the single busbar itself is

deteriorated. For this reason, in a motor drive device having a bus bar, vibration countermeasures are a problem.

[00014] Currently, smaller busbars are being used in existing battery packs, so there is no chance of overhanging of busbar or stress on busbar. However, with increased requirement of electric vehicles and different configurations of battery packs being introduced in such vehicles, battery pack capacities have been increased significantly around ~400 volts. Thus, the size of the battery pack has also increased, therefore number of battery modules per pack has also increased, thereby requiring longer bus bars to connect such large number of battery modules. However, utilizing such longer busbars results in more amount of stress being transferred to such busbars, thereby requiring dampening materials to be added into the battery pack to eliminate the stress due to load or vibrations of the battery pack.

[00015] Thus, it is clearly established that a single long busbar connecting two battery modules may get damaged in the form of electrical connections might come off due to vibration and stress during the operation of the vehicle. Hence, resulting into loosening of the end connection of the single busbar, ultimately leading to short circuiting which is not safe for the battery pack to operate. Moreover, if a single long busbar is used, then dampening members need to be placed inside the battery pack to dampen the stress and vibration. This results into increased weight of the battery pack, which is undesirable.

[00016] Another possible solution is to keep busbars as short as possible. Short busbars have low impedances, reducing losses and minimizing the electrical reaction of the busbars in response to power fluctuations in power being supplied by the batteries. One potential solution towards keeping the busbars short is to use two sets of battery packs that “mirror” one another, allowing busbars to be placed adjacent to each other, for example, to reduce the length of the busbars that run between them. However, using different battery packs can increase the complexity of manufacturing and maintenance, as twice as many parts must be stocked and maintained as spares. Additionally, having mirror image battery packs may allow

the wrong pack to be at least partially installed, requiring removal of the wrong pack and installation of the proper pack.

[00017] Hence, there arises a need for a system that can allow for interconnections of battery packs, for example, with each pack containing multiple sets of parallel connected batteries, and each set connected in series, that can carry large amounts of currents in a high vibration environment, without damaging the packs or the interconnections, and without inducing stresses that would loosen the connections between the interconnecting busbars and the packs, or cause sparks or change the electrical characteristics, without requiring lengthy interconnections.

[00018] To this end, the present subject matter discloses a battery pack with an integrated electrical interconnection assembly with an improved structure of a battery pack that ensure proper connection of bus bars with the one or more battery modules, such that loosening of the end connections of the bus bars is prevented due to vibrations of the moving electric vehicles.

[00019] Another objective of the present subject matter is to provide insulated bus bars to prevent sparks or fire incidents while assembling the battery pack or while the battery pack is operational.

[00020] It is yet another objective of the present subject matter to provide insulated bus bars that prevents accidental short circuits due to contact of metal tools during assembling.

[00021] Thus, the present subject matter aims to provide a battery pack with a braided busbar so that stress and vibrations arising out of the huge size battery packs can be dampened, and the electrical connections are safe, secured, and flexible during the operation of the battery pack while being placed on the vehicle.

[00022] The present subject matter discloses a battery pack having one or more modules and an integrated electrical interconnection assembly. Such integrated electrical interconnection assembly includes a first electrically conducting metallic strip, a second electrically conducting metallic strip and a third electrically conducting metallic strip. Herein, a first end of the third electrically conducting

metallic strip is interconnected to one end of the first electrically conducting metallic strip and a second end of the third electrically conducting metallic strip is interconnected to one end of the second electrically conducting metallic strip. Further, the third electrically conducting metallic strip is of a braided shape.

[00023] In another embodiment of the present subject matter, the integrated electrical interconnection assembly is enclosed within a non-conducting sleeve.

[00024] In yet another embodiment, the integrated electrical interconnection assembly is fastened at a first set of two points in the one or more modules.

[00025] In another embodiment, the one or more battery modules includes a second set of two points for electrical connections with the integrated electrical interconnection assembly.

[00026] In yet another embodiment, the second set of two points being configured to be connected to a second end of the first electrically conducting strip and a second end of the second electrically conducting strip.

[00027] In another embodiment, the third electrically conducting metallic strip is electrically coupled with the first electrically conducting metallic strip and the second electrically conducting metallic strip by clamping.

[00028] In another embodiment, the first electrically conducting metallic strip and said second electrically conducting metallic strip is of a longer length than that of the third electrically conducting metallic strip.

[00029] In yet another embodiment, the length of the first electrically conducting metallic strip and the second electrically conducting metallic strip is equal.

[00030] In another embodiment, the integrated electrical interconnection assembly is enclosed within the non-conducting sleeve such that a second end of the first electrically conducting strip and a second end of the second electrically conducting strip extends outwardly from the non-conducting sleeve.

[00031] In yet another embodiment, the second end of the first electrically conducting strip and the second end of the second electrically conducting strip being covered with one or more masking caps.

[00032] The present subject matter along with all the accompanying embodiments and their other advantages would be described in greater detail in conjunction with the figures in the following paragraphs.

[00033] The present subject matter is further described with reference to accompanying figures. It should be noted that the description and figures merely illustrate principles of the present subject matter. Various arrangements may be devised that, although not explicitly described or shown herein, encompass the principles of the present subject matter. Moreover, all statements herein reciting principles, aspects, and examples of the present subject matter, as well as specific examples thereof, are intended to encompass equivalents thereof.

[00034] The battery pack may be implemented in any type of electric and hybrid electric vehicle which is using battery pack as a power source. However, for the purpose of explanation and by no limitation, the battery pack, and corresponding additional advantages and features are described through the following embodiments.

[00035] The aforesaid and other advantages of the present subject matter would be described in greater detail in conjunction with the figures in the following description.

[00036] Referring to Fig. 1 and Fig. 2, which illustrates an isometric view of a battery pack and an exploded view of the battery pack along with an integrated electrical interconnection assembly are described hereinafter. A battery pack (100) comprises one or more modules (101) and an integrated electrical interconnection assembly (102). The one or more battery modules (101) are configured to hold one or more battery cells. The integrated electrical interconnection assembly (102) is configured to be fastened at a first set of two points (205) onto the one or more battery modules (101). The integrated electrical interconnection assembly (102)

further includes a second set of two points (206) for electrical connections with the one or more battery modules (102). Herein, the one or more battery modules (101) include a second set of two points (206) for electrical connections with said integrated electrical interconnection assembly (102). Further, the second set of two points (206) being configured to be connected to a second end (303b) of the first electrically conducting strip (303) and a second end (304b) of the second electrically conducting strip (304). Moreover, the third electrically conducting metallic strip (305) is electrically coupled with the first electrically conducting metallic strip (303) and the second electrically conducting metallic strip (304) by clamping. Further, the second end (303b) of the first electrically conducting strip (303) and the second end (304b) of the second electrically conducting strip (304) being covered with one or more masking caps (204).

[00037] Referring to Fig. 3(a), 3(b) and Fig. 4, a magnified view of the integrated electrical interconnection assembly (102) in accordance with an embodiment of the present subject matter is disclosed. The integrated electrical interconnection assembly (102) includes a first electrically conducting metallic strip (303), a second electrically conducting metallic strip (304) and a third electrically conducting metallic strip (305). Herein, the first electrically conducting metallic strip (303) and the second electrically conducting metallic strip (304) are solid busbars. Further, the third electrically conducting metallic strip (305) is a flexible braided shape busbar. Herein, a first end of said third electrically conducting metallic strip (305) is interconnected to a first end (303a) of said first electrically conducting metallic strip (303) and a second end of said third electrically conducting metallic strip (305) is interconnected to a first end (304a) of said second electrically conducting metallic strip (304). Therefore, it can be understood that two busbars are attached through a braided busbar to form a single busbar.

[00038] Moreover, the third electrically conducting metallic strip (305) is of a braid shape. Such third electrically conducting metallic strip (305) is made up of the same material as that of the first electrically conducting metallic strip (303) and the second electrically conducting metallic strip (304). Herein, copper or aluminum or

any metal conductor can be used for manufacturing of the first electrically conducting metallic strip (303), the second electrically conducting metallic strip (304) and the third electrically conducting metallic strip (305).

[00039] The third electrically conducting metallic strip (305) acts as a dampener to dampen the stress and vibration coming to the integrated electrical interconnection assembly (102) where such vibrations and stress are created by the movement of the electric vehicles. Thus, the third electrically conducting material (305) provides a sturdy connection between the first electrically conducting metallic strip (303) and the second electrically conducting metallic strip (304). Since the third electrically conducting metallic strip (305) is flexible in nature, it allows moving part to move independently and hence stress from the battery pack or vibrations from the battery pack or electric vehicle will not be transferred to the integrated electrical interconnection assembly due to movement of moving parts surrounding the battery pack.

[00040] Further, the first electrically conducting metallic strip (303) and the second electrically conducting metallic strip (304) is of a longer length than that of the third electrically conducting metallic strip (305). Also, the length of the first electrically conducting metallic strip (303) and the second electrically conducting metallic strip (304) is equal. Further, integrated electrical interconnection assembly (102) is enclosed within the non-conducting sleeve (301) such that a second end (303b) of the first electrically conducting strip (303) and a second end (304b) of the second electrically conducting strip (304) extends outwardly from the non-conducting sleeve (301). Herein, the non-conducting sleeve (301) is an insulation cover that can be polyurethane based or a silicone-based material or any other type of material that can act as an insulator. It is to be understood that the non-conducting sleeve and one or more masking caps that are made of polymer ensures that the three electrically conducting metallic strips are insulated and is safe to touch.

[00041] Herein, the braided third electrically conducting metallic strip (305) in between the first electrically conducting metallic strip (303) and the second electrically conducting metallic strip (304) increases the durability and flexibility

of the integrated electrical interconnection assembly (102) and effectively dampens the stress and vibrations being generated by the movement of the electric vehicles. Therefore, the dampening effect provided by the integrated electrical interconnection assembly as provided by the present invention is more effective due to the presence of braided third electrically conducting metallic strip between the first electrically conducting metallic strip and the second electrically conducting metallic strip as compared to a single busbar. Also, such integrated electrical interconnection assembly is capable of being compactly packed as compared to wire connections where entanglement of such wires is a major concern, which might lead to short circuit of the battery packs.

[00042] Since the integrated electrical interconnection assembly will carry large amounts of current but can physically flex, it will not induce stresses in a high vibration environment that can cause a failure of the battery pack, sparking or changes to the electrical characteristics of the pack. The battery packs themselves can use an arrangement of the series-connected sets of batteries that allows the bus bars to be short, yet avoids the use of mirror-image or other types of different battery packs.

[00043] While certain features of the claimed subject matter have been illustrated and described herein, many modifications, substitutions, changes, and equivalents will now occur to those skilled in the art. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes that fall within the true spirit of the claimed subject matter.

List of reference signs:

100 battery pack

101 one or more modules

102 integrated electrical interconnection assembly

204 masking caps

205 first set of two points

206 second set of two points

301 non-conducting sleeve

303 first electrically conducting metal strip

303a first end of first electrically conducting metal strip

303b second end of first electrically conducting metal strip

304 second electrically conducting metal strip

304a first end of second electrically conducting metal strip

304 b second end of second electrically conducting metal strip

305 third electrically conducting metal strip

We claim:

1. A battery pack (100) comprising:

one or more battery modules (101), said one or more battery modules (101) being configured to hold one or more battery cells; and

at least one integrated electrical interconnection assembly (102), said integrated electrical interconnection assembly (102) being configured to connect said one or more battery modules (102), and said integrated electrical interconnection assembly (102) comprising:

a first electrically conducting metallic strip (303);

a second electrically conducting metallic strip (304); and

a third electrically conducting metallic strip (305);

wherein a first end of said third electrically conducting metallic strip (305) being interconnected to a first end (303a) of said first electrically conducting metallic strip (303) and a second end of said third electrically conducting metallic strip (305) being interconnected to a first end (304a) of said second electrically conducting metallic strip (304); and

wherein said third electrically conducting metallic strip (305) being of a braided shape.

2. The battery pack (100) as claimed in claim 1, wherein said integrated electrical interconnection assembly (102) being enclosed within a non-conducting sleeve (301).

3. The battery pack (100) as claimed in claim 1, wherein said integrated electrical interconnection assembly (102) being configured to be fastened at a first set of two points (205) in said one or more modules (101).

4. The battery pack (100) as claimed in claim 1, wherein said one or more battery modules (101) comprising plurality of second set of points (206) for electrical connections with said integrated electrical interconnection assembly (102).

5. The battery pack (100) as claimed in claim 4, wherein said second set of two points (206) being configured to be connected to a second end (303b) of first electrically conducting strip (303) and a second end (304b) of second electrically conducting strip (304).

6. The battery pack (100) as claimed in claim 1, wherein said third electrically conducting metallic strip (305) being electrically coupled with said first electrically conducting metallic strip (303) and said second electrically conducting metallic strip (305) by clamping.

7. The battery pack (100) as claimed in claim 1, wherein said first electrically conducting metallic strip (303) and said second electrically conducting metallic strip (304) being of a longer length than that of said third electrically conducting metallic strip (305).

8. The battery pack (100) as claimed in claim 1, wherein length of said first electrically conducting metallic strip (303) and said second electrically conducting metallic strip (305) being equal.

9. The battery pack (100) as claimed in claim 2, wherein said integrated electrical interconnection assembly (102) being enclosed within said non-conducting sleeve (301) such that a second end (303b) of a first electrically conducting strip (303) and a second end (304b) of a second electrically conducting strip (304) extending outwardly from said non-conducting sleeve (301).

10. The battery pack (100) as claimed in claim 9, wherein said second end (303b) of said first electrically conducting strip (303) and said second end (304b) of said second electrically conducting strip (304) being covered with one or more masking caps (204).

Dated on this 05th day of February 2023

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ABSTRACT

A BATTERY PACK

The present subject matter discloses a battery pack (100) that comprises one or more battery modules (101) and an integrated electrical interconnection assembly (102) to connect such one or more battery modules (101). The integrated electrical interconnection assembly (102) includes a first electrically conducting metallic strip (303), a second electrically conducting metallic strip (304) and a third electrically conducting metallic strip (305). The third electrically conducting metallic strip (305) is electrically coupled with the first electrically conducting metallic strip (303) and the second electrically conducting metallic strip (304). Herein, the third electrically conducting metallic strip (305) in between the first electrically conducting metallic strip (303) and the second electrically conducting metallic strip (304) increases the durability and flexibility of the integrated electrical interconnection assembly (102) and effectively dampens the stress and vibrations being generated by the movement of the electric vehicles.

<To be published with Fig. 3b>