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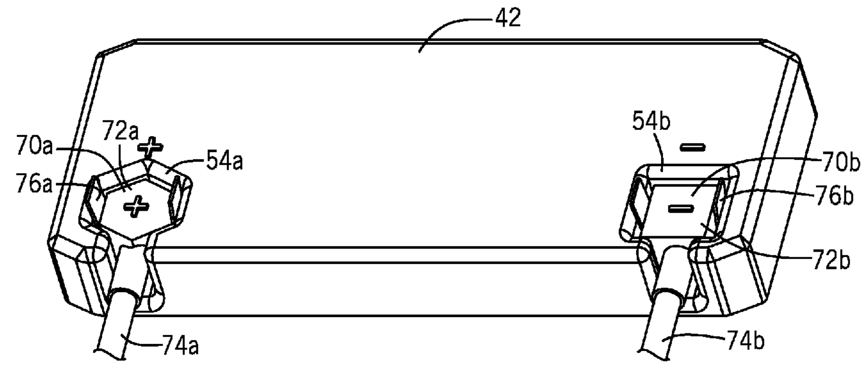

FIG. 4

(57) Abstract: A battery system includes a battery module housing cover having a recess in which a module terminal is positioned, the recess having a recess geometry; and a battery terminal connector having a terminal connector interface establishing an electrical and physical connection with the module terminal, and an insulative cover covering the terminal connector interface, wherein the insulative cover has a cover geometry, and the cover geometry matches the recess geometry.

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PUSH FIT MAIN BATTERY TERMINAL CONNECTORS WITH GEOMETRICAL LOCKOUT FEATURES

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from and the benefit of U.S. Provisional Application Serial No. 62/337,169, entitled "PUSH FIT MAIN BATTERY TERMINAL CONNECTORS WITH GEOMETRICAL LOCKOUT FEATURES", filed May 16, 2016, which is hereby incorporated by reference.

BACKGROUND

[0002] The present disclosure relates generally to the field of batteries and battery modules. More specifically, the present disclosure relates battery module terminals.

[0003] This section is intended to introduce the reader to various aspects of art that may be related to various aspects of the present disclosure, which are described below. This discussion is believed to be helpful in providing the reader with background information to facilitate a better understanding of the various aspects of the present disclosure. Accordingly, it should be understood that these statements are to be read in this light, and not as admissions of prior art.

[0004] A vehicle that uses one or more battery systems for providing all or a portion of the motive power for the vehicle can be referred to as an xEV, where the term "xEV" is defined herein to include all of the following vehicles, or any variations or combinations thereof, that use electric power for all or a portion of their vehicular motive force. For example, xEVs include electric vehicles (EVs) that utilize electric power for all motive force. As will be appreciated by those skilled in the art, hybrid electric vehicles (HEVs), also considered xEVs, combine an internal combustion engine propulsion system and a battery-powered electric propulsion system, such as 48 Volt (V) or 130V systems.

[0005] The term HEV may include any variation of a hybrid electric vehicle. For example, full hybrid systems (FHEVs) may provide motive and other electrical power to the vehicle using one or more electric motors, using only an internal combustion engine, or using both. In contrast, mild hybrid systems (MHEVs) disable the internal combustion engine when the vehicle is idling and utilize a battery system to continue powering the air conditioning unit, radio, or other electronics, as well as to restart the engine when propulsion is desired. The mild hybrid system may also apply some level of power assist, during acceleration for example, to supplement the internal combustion engine. Mild hybrids are typically 96V to 130V and recover braking energy through a belt or crank integrated starter generator.

[0006] Further, a micro-hybrid electric vehicle (mHEV) also uses a “Stop-Start” system similar to the mild hybrids, but the micro-hybrid systems of a mHEV may or may not supply power assist to the internal combustion engine and operates at a voltage below 60V. For the purposes of the present discussion, it should be noted that mHEVs typically do not technically use electric power provided directly to the crankshaft or transmission for any portion of the motive force of the vehicle, but an mHEV may still be considered as an xEV since it does use electric power to supplement a vehicle’s power needs when the vehicle is idling with internal combustion engine disabled and recovers braking energy through an integrated starter generator.

[0007] In addition, a plug-in electric vehicle (PEV) is any vehicle that can be charged from an external source of electricity, such as wall sockets, and the energy stored in the rechargeable battery packs drives or contributes to drive the wheels. PEVs are a subcategory of EVs that include all-electric or battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), and electric vehicle conversions of hybrid electric vehicles and conventional internal combustion engine vehicles.

[0008] xEVs as described above may provide a number of advantages as compared to more traditional gas-powered vehicles using only internal combustion engines and traditional electrical systems, which are typically 12V systems powered by a lead acid battery. For example, xEVs may produce fewer undesirable emission products and may exhibit greater fuel efficiency as compared to traditional internal combustion vehicles and, in some cases, such xEVs may eliminate the use of gasoline entirely, as is the case of certain types of EVs or PEVs.

[0009] As technology continues to evolve, there is a need to provide improved power sources, particularly battery modules, for such vehicles and other implementations. For example, certain batteries or battery modules include externally-accessible terminals that enable the battery or battery module to connect to a load. These terminals are usually fastened to the housing of the battery using fasteners that require the use of certain tools. Further, such terminals may be subject to corrosion, and may not be readily replaced.

[0010] In view of these and other considerations, it is now recognized that a need exists for battery terminals that can be secured to a battery with minimal use of tools. It is also now recognized that a need exists for battery terminals that are able to better resist corrosion, and are more readily replaceable.

SUMMARY

[0011] A summary of certain embodiments disclosed herein is set forth below. It should be understood that these aspects are presented merely to provide the reader with a brief summary of these certain embodiments and that these aspects are not intended to limit the scope of this disclosure. Indeed, this disclosure may encompass a variety of aspects that may not be set forth below.

[0012] The present disclosure relates to a battery system having a battery module housing cover having a recess in which a module terminal is positioned, the recess having a recess geometry; and a battery terminal connector having a terminal connector interface establishing an electrical and physical connection with the module terminal, and an insulative cover covering the terminal connector interface, wherein the insulative cover has a cover geometry, and the cover geometry matches the recess geometry.

[0013] The present disclosure also relates to a battery terminal connector including a terminal connector interface configured to establish an electrical and physical connection with a terminal of a battery module by acting as a receptacle for the terminal; an insulative cover covering the terminal connector interface except for an opening configured to receive the terminal of the battery module; and a retention clip coupled to the insulative cover, wherein the retention clip comprises a clip opening that is coaxial with the opening of the insulative cover.

[0014] The present disclosure further relates to a battery terminal connector assembly for an automotive battery having a positive terminal connector having a first terminal connector interface configured to establish an electrical and physical connection with a positive terminal post of the automotive battery, and a first insulative cover covering the first terminal connector interface except for a first opening configured to receive the positive terminal post of the battery module, wherein the first insulative cover has a first cover geometry. The battery terminal connector assembly also includes a negative terminal connector having a second terminal connector interface configured to establish an electrical and physical connection with a negative terminal post of a battery module, and a second insulative cover covering the second terminal connector interface except for a second opening configured to receive the negative terminal post of the automotive battery, wherein the second insulative cover has a second cover geometry that is different than the first cover geometry.

DRAWINGS

[0015] Various aspects of this disclosure may be better understood upon reading the following detailed description and upon reference to the drawings in which:

[0016] FIG. 1 is a perspective view of an xEV having a battery system configured in accordance with present embodiments to provide power for various components of the xEV, in accordance with an aspect of the present disclosure;

[0017] FIG. 2 is a cutaway schematic view of an embodiment of the xEV having a start-stop system that utilizes the battery system of FIG. 1, the battery system having a lithium ion battery module, in accordance with an aspect of the present disclosure;

[0018] FIG. 3 is a perspective view of the top of a battery module having terminal posts positioned within recesses configured to receive battery terminal connectors push fit into place;

[0019] FIG. 4 is a perspective view of the top of the battery module of FIG. 3, with the battery terminal connectors installed or push fit into place;

[0020] FIG. 5 is an expanded cross-sectional view of the top of the battery module and the positive connector of FIG. 4;

[0021] FIG. 6 is an overhead perspective view of the positive connector of FIG. 4;

[0022] FIG. 7 is a bottom perspective view of the positive connector of FIG. 6;

[0023] FIG. 8 is an overhead perspective view of the negative connector of FIG. 4; and

[0024] FIG. 9 is a bottom perspective view of the negative connector of FIG. 8.

DETAILED DESCRIPTION

[0025] One or more specific embodiments will be described below. In an effort to provide a concise description of these embodiments, not all features of an actual implementation are described in the specification. It should be appreciated that in the development of any such actual implementation, as in any engineering or design project, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which may vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure.

[0026] The battery systems described herein may be used to provide power to various types of electric vehicles (xEVs) and other high voltage energy storage/expending applications (e.g., electrical grid power storage systems). Such battery systems may include one or more battery modules, each battery module having a housing and a number of battery cells (e.g., lithium-ion (Li-ion) electrochemical cells) arranged within the housing to provide particular voltages and/or currents useful to power, for example, one or more components of an xEV. As another example, battery modules in accordance with present embodiments may be incorporated with or provide power to stationary power systems (e.g., non-automotive systems).

[0027] Based on the advantages over traditional gas-power vehicles, manufactures that generally produce traditional gas-powered vehicles may desire to utilize improved vehicle technologies (e.g., regenerative braking technology) within their vehicle lines. Often, these manufactures may utilize one of their traditional vehicle platforms as a starting point. Accordingly, since traditional gas-powered vehicles are designed to utilize 12 V battery systems, a 12 V lithium ion battery may be used to supplement a 12 V lead-acid battery. More specifically, the 12 V lithium ion battery may be used to more efficiently capture electrical energy generated during regenerative braking and subsequently supply electrical energy to power the vehicle's electrical system. Additionally, in a mHEV, the internal combustion engine may be disabled when the vehicle is idle. Accordingly, the 12 V lithium ion battery may be used to crank (e.g., restart) the internal combustion engine when propulsion is desired.

[0028] However, as advancements are made in vehicle technologies, high voltage electrical devices may be included in the vehicle's electrical system. For example, the lithium ion battery may supply electrical energy to an electric motor in a FHEV. Often, these high voltage electrical devices utilize voltages greater than 12 V, for example, up to 48, 96, or 130 V. Accordingly, in some embodiments, the output voltage of a 12 V lithium ion battery may be boosted using a DC-DC converter to supply power to the high voltage devices. Additionally or alternatively, a 48 V lithium ion battery may be used to supplement a 12 volt lead-acid battery. More specifically, the 48 V lithium ion battery may be used to more efficiently capture electrical energy generated during regenerative braking and subsequently supply electrical energy to power the high voltage devices.

[0029] As set forth above, certain batteries or battery modules include externally-accessible terminals that enable the battery or battery module to connect to a load. These terminals are usually fastened to the housing of the battery using fasteners that require the use of certain tools. Further, such terminals may be subject to corrosion, and may not be readily replaced.

[0030] With the foregoing in mind, present embodiments relate to a quick connection for a low voltage battery (e.g., less than 60 V) that makes consistently good connections. In accordance with present embodiments, the positive and negative leads of a battery module are removable and replaceable, and have different geometric shapes that index and fit within corresponding recesses in a top (e.g., terminal side) surface of the battery, thus avoiding improper connections. In certain embodiments, each of the connectors pushes onto a copper post of the battery to make a high current, low resistance connection. Further, certain embodiments of the connectors use a beryllium copper interface. This interface provides a relatively low resistance, corrosion-resistant connection that does not require tools to make or break the connection.

[0031] Generally, the battery terminal connectors of the present disclosure push on and, further, they may interface with plastic retention or locking clips that keep the connectors from disconnecting unless the clips are squeezed and then pulled on to remove the cable from the battery. In this way, no tools are required to install or remove the battery connections. The push-fit terminal connectors of the present disclosure may be applied to any battery or battery system, and may be particularly useful in battery systems employed in an xEV. For example, FIG. 1 is a perspective view of an embodiment of a vehicle 10, which may utilize a regenerative braking system. Although the following discussion is presented in relation to vehicles with regenerative braking systems, the terminal connectors described herein are usable in other vehicles that capture/store electrical energy with a battery, which may include electric-powered and gas-powered vehicles. Indeed, the vehicle 10 may utilize a battery, as described below, which includes the terminal connectors as described herein.

[0032] As discussed above, it would be desirable for a battery system 12 to be largely compatible with traditional vehicle designs. Accordingly, the battery system 12 may be placed in a location in the vehicle 10 that would have housed a traditional battery system. For example, as illustrated, the vehicle 10 may include the battery system 12 positioned similarly to a lead-acid battery of a typical combustion-engine vehicle (e.g., under the hood of the vehicle 10). Furthermore, as will be described in more detail below, the battery system 12 may be positioned to facilitate managing temperature of the battery system 12. For example, in some embodiments, positioning the battery system 12 under the hood of the vehicle 10 may enable an air duct to channel airflow over the battery system 12 and cool the battery system 12.

[0033] A more detailed view of the battery system 12 is described in FIG. 2. As depicted, the battery system 12 includes an energy storage component 14 coupled to an ignition system 16, an alternator 18, a vehicle console 20, and optionally to an electric motor 22. Generally, the energy storage component 14 may capture/store electrical energy generated in the vehicle 10 and output electrical energy to power electrical devices in the vehicle 10.

[0034] In other words, the battery system 12 may supply power to components of the vehicle's electrical system, which may include radiator cooling fans, climate control systems, electric power steering systems, active suspension systems, auto park systems, electric oil pumps, electric super/turbochargers, electric water pumps, heated windscreen/defrosters, window lift motors, vanity lights, tire pressure monitoring systems, sunroof motor controls, power seats, alarm systems, infotainment systems, navigation features, lane departure warning systems, electric parking brakes, external lights, or any combination thereof. Illustratively, in the depicted embodiment, the energy storage component 14 supplies power to the vehicle console 20 and the ignition system 16, which may be used to start (e.g., crank) the internal combustion engine 24.

[0035] Additionally, the energy storage component 14 may capture electrical energy generated by the alternator 18 and/or the electric motor 22. In some embodiments, the alternator 18 may generate electrical energy while the internal combustion engine 24 is running. More specifically, the alternator 18 may convert the mechanical energy produced by the rotation of the internal combustion engine 24 into electrical energy. Additionally or alternatively, when the vehicle 10 includes an electric motor 22, the electric motor 22 may generate electrical energy by converting mechanical energy produced by the movement of the vehicle 10 (e.g., rotation of the wheels) into electrical energy. Thus, in some embodiments, the energy storage component 14 may capture electrical energy generated by the alternator 18 and/or the electric motor 22 during regenerative braking. As such, the alternator and/or the electric motor 22 are generally referred to herein as a regenerative braking system.

[0036] To facilitate capturing and supplying electric energy, the energy storage component 14 may be electrically coupled to the vehicle's electric system via a bus 26. For example, the bus 26 may enable the energy storage component 14 to receive electrical energy generated by the alternator 18 and/or the electric motor 22. Additionally, the bus may enable the energy storage component 14 to output electrical energy to the ignition system 16 and/or the vehicle console 20. Accordingly, when a 12 volt battery system 12 is used, the bus 26 may carry electrical power typically between 8-18 V.

[0037] Additionally, as depicted, the energy storage component 14 may include multiple battery modules. For example, in the depicted embodiment, the energy storage component 14 includes a lithium ion (e.g., a first) battery module 28 and a lead-acid (e.g., a second) battery module 30, which each includes one or more battery cells. In other embodiments, the energy storage component 14 may include any number of battery modules. Additionally, although the lithium ion battery module 28 and lead-acid battery module 30 are depicted adjacent to one another, they may be positioned in different areas around the vehicle. For example, the lead-acid battery module 30 may be positioned in or about the interior of the vehicle 10 while the lithium ion battery module 28 may be positioned under the hood of the vehicle 10. Either or both of the battery modules 28, 30 may utilize the push fit terminal connectors described herein.

[0038] In some embodiments, the energy storage component 14 may include multiple battery modules to utilize multiple different battery chemistries. For example, when the lithium ion battery module 28 is used, performance of the battery system 12 may be improved since the lithium ion battery chemistry generally has a higher coulombic efficiency and/or a higher power charge acceptance rate (e.g., higher maximum charge current or charge voltage) than the lead-acid battery chemistry. As such, the capture, storage, and/or distribution efficiency of the battery system 12 may be improved.

[0039] To facilitate controlling the capturing and storing of electrical energy, the battery system 12 may additionally include a control module 32. More specifically, the control module 32 may control operations of components in the battery system 12, such as relays (e.g., switches) within energy storage component 14, the alternator 18, and/or the electric motor 22. For example, the control module 32 may regulate amount of electrical energy captured/supplied by each battery module 28 or 30 (e.g., to de-rate and re-rate the battery system 12), perform load balancing between the battery modules 28 and 30, determine a state of charge of each battery module 28 or 30, determine temperature of each battery module 28 or 30, control voltage output by the alternator 18 and/or the electric motor 22, and the like.

[0040] Accordingly, the control unit 32 may include one or more processors 34 and one or more memory units 36. More specifically, the one or more processors 34 may include one or more application specific integrated circuits (ASICs), one or more field programmable gate arrays (FPGAs), one or more general purpose processors, or any combination thereof. Additionally, the one or more memory 36 may include volatile memory, such as random access memory (RAM), and/or non-volatile memory, such as read-only memory (ROM), optical drives, hard disc drives, or solid-state drives. In some embodiments, the control unit 32 may include portions of a vehicle control unit (VCU) and/or a separate battery control module. Furthermore, as depicted, the lithium ion battery module 28 and the lead-acid battery module 30 are connected in parallel across their terminals. In other words, the lithium ion battery module 28 and the lead-acid module 30 may be coupled in parallel to the vehicle's electrical system via the bus 26.

[0041] As set forth above, either or both of the lithium ion battery module 28 and the lead-acid battery module 30 may utilize the terminal connectors described herein. To facilitate discussion, the present embodiments are described in the context of the lithium ion battery module 28. Referring now to FIG. 3, an embodiment of the lithium ion battery module 28 is shown as including a module housing 40 and a housing cover 42 that interface with one another to form an enclosure 44 of the battery module 28. The enclosure 44 seals a variety of components from the external environment, including a plurality of battery cells 46, one or more bus bars 48, and various electronics 50. The battery cells 46 may include lithium ion battery cells having any shape and configuration (e.g., cylindrical, prismatic, pouch), and are coupled to one another using one or more of the bus bars 48. The bus bars 48 also electrically connect the battery cells 46 to the electronics 50, which may include the control module 32 of FIG. 2.

[0042] The bus bars 48 may also electrically couple the battery cells 46 and the electronics 50 to terminal posts 52 (e.g., including a positive or first terminal post 52a and a negative or second terminal post 52b) positioned in the housing cover 42. As an example, the illustrated housing cover 42 may be formed of a polymeric material, and the terminal posts 52 may be molded into the housing cover 42. However, other securement methods may be used to secure the terminal posts 52 to the housing cover 42 in other embodiments. In the illustrated embodiment, the terminal posts 52 are positioned in recesses 54 formed in the housing cover 42 (e.g., formed during molding). Although the terminal posts 52 are illustrated as having a cylindrical geometry, the terminal posts 52 may have other geometries, such as geometries that are different from one another, to facilitate proper connection to a corresponding connector.

[0043] Specifically, the illustrated recesses 54 include a first recess 54a and a second recess 54b where the positive terminal post 52a and the negative terminal post 52b are positioned, respectively. In the illustrated embodiment, the recesses 54 are formed in a top surface 56 of the housing cover 42, the top surface 56 being positioned opposite of a base 58 of the module housing 40 when the cover 42 is secured to the housing 40. The recesses 54a, 54b are also each associated with notches 60a, 60b, respectively, formed into a side surface 62 of the housing cover 42. The side surface 62 is contiguous with the top surface 56, and the notches 60 are formed to be contiguous with the recesses 54. The side surface in which each of the notches 60 is formed may be the same or different. As discussed below, the recesses 54 are configured to receive (e.g., sized and shaped to receive) a corresponding terminal connector, and the notches 60 enable portions of the terminal connector to extend outwardly for ready connection with a load (e.g., cables).

[0044] In the illustrated embodiment, the recesses 54a, 54b have geometries that are different from one another, as defined by internal recess walls 64a, 64b, respectively. Specifically, the first recess 54a has a hexagonal geometry defined by first internal recess walls 64a, and the second recess 54b has a square geometry defined by second internal recess walls 64b. In addition, certain of the internal recess walls 64 may include mating features 66, such as additional recesses, that enable mating with and securement of the terminal connectors of the present disclosure.

[0045] FIG. 4 illustrates an embodiment of the housing cover 42 in having a positive terminal connector 70a installed in the first recess 54a and a negative terminal connector 70b installed in the second recess 54b. As shown, the positive and negative terminal connectors 70a, 70b have geometries that match the geometries of the first and second recesses 54a, 54b, respectively (e.g., the terminal connectors 70 are indexed to the recesses 54). In particular, the positive and negative terminal connectors 70a, 70b include insulative covers 72a, 72b that are formed (e.g., molded) to have the corresponding geometries to appropriately interface with the recesses 54. In addition, the insulative covers 72a, 72b may extend to cover a portion of respective terminal extensions 74a, 74b that interface with a load (e.g., the xEV 10). In still further embodiments, the terminal extensions 74a, 74b may be connected to (e.g., welded to, soldered to, crimped to) cables associated with the xEV 10, or may be the battery cables themselves.

[0046] In certain embodiments, the insulative covers 72 may be sized and shaped so as to fasten the terminal connectors 70 to the housing cover 42 via an interference fit in which the insulative covers 72 directly contact the inner recess walls 64.

However, in the illustrated embodiment, the terminal connectors 70 are fastened to the housing cover 42 via retention clips 76 (including a first retention clip 76a for the positive terminal connector 70a and a second retention clip 76b for the negative terminal connector 70b). The insulative covers 72 may be sized and shaped to index to the recesses 54. Furthermore, in certain embodiments, the polymeric material forming the insulative covers 72 may be blended with a colorant to allow the positive and negative terminal connectors to be distinguished. For example, the insulative cover 72a of the positive terminal connector 70a may be colored red, while the insulative cover 72b of the negative terminal connector 70b may be colored black.

[0047] The interface between the terminal posts 52 and the terminal connectors 70 may be further appreciated with respect to FIG. 5, which is a cross-sectional expanded view of the positive terminal connector 70a installed in the first recess 54a. As illustrated, the positive terminal post 52a, which is positioned inside the recess 54a, extends into a corresponding opening 80a of a terminal connector interface 81a such that the terminal post 52 contacts the interface 81a. Because this forms an electrical connection between the terminal post 52a and the terminal connector 70a, the terminal post 52a and the terminal connector interface 81a may be formed from electrically compatible materials (e.g., being able to electrically connect without appreciable Galvanic corrosion). In accordance with an embodiment, the terminal post 52a may be made of copper, and the terminal connector interface 81a may be formed from or include beryllium copper, which is a copper base alloy with beryllium. In certain embodiments, the beryllium copper may also include nickel and cobalt. The terminal extensions 74a, 74b may be formed from copper, or beryllium copper

[0048] As noted above, the terminal connectors 70 are retained in the recesses 54 using retention clips 76. In FIG. 5, the first retention clip 76a includes tabs 82a, 82b that protrude outwardly from the recess 54a. The tabs 82a, 82b are situated at opposing sides of the terminal connector 70a, which enables the tabs 82a, 82b to be biased inwardly toward one another and toward the terminal connector 70a by a squeezing force (e.g., by a human operator, technician, a robot, or the like). When the first retention clip 76a is positioned within the recess 54a, the tabs 82a, 82b are biased outwardly by the natural spring force created by the material composition of the first retention clip 76a, as well as the shape of the first retention clip 76a.

[0049] The tabs 82a, 82b extend from a clip body 84a that partially wraps around the terminal connector 70a. Specifically, the clip body 84a surrounds the terminal connector 70a on at least two sides that are aligned with the terminal post 52a, and partially surrounds a bottom side 86a of the terminal connector 70a through which the terminal post 52a protrudes. The retention clip 76a includes an opening 88a at the bottom side 86a, and a flange 90a of the insulative cover 72a protrudes through the opening 88a to secure the terminal connector 70a to the retention clip 76a.

[0050] The clip body 84 also includes at least one mating protrusion 92 configured to retain the retention clip 76a and the terminal connector 70a in the first recess 54a. Specifically, in the illustrated embodiment, the clip body 84a includes two mating protrusions 92a, 92b positioned adjacent to the tabs 82. The mating protrusions 92a, 92b are configured to protrude into the additional recesses 66 when the terminal connector 70a and the retention clip 76a are installed in the housing cover 42. As also illustrated, the mating protrusions 92a, 92b taper outwardly away from the terminal connector interface 81a in a direction extending from the bottom side 88a toward the tabs 82a, 82b. The mating protrusions 92a, 92b also each include a shelf 94, which abuts against a top surface 96 of the additional recesses to prevent movement in the axial direction 98 of the terminal post 52a. Preventing such movement also prevents inadvertent disconnection of the terminal connector 70a from the terminal post 52a.

[0051] The taper and the shelves 94 of the mating protrusions 92a, 92b allow the terminal connector 70a to be push-fit into the first recess 54a. Because the retention clip 76a has a natural spring force that biases the tabs 82 away from the terminal connector 70a, pushing the terminal connector 70a and the retention clip 76a into the first recess 54a causes the mating protrusions 92a, 92b to snap the terminal connector 70a into place once the mating protrusions 92a, 92b reach the additional recesses 66.

[0052] To perform a disconnection, a user would squeeze the tabs 82a, 82b toward one another, causing the shelves 94 of the mating protrusions 92a, 92b to disengage from the additional recesses 66. This disengagement then allows the terminal connector 70a to be pulled out of the first recess 54a in the axial direction 98 to disconnect the terminal connector 70a without the use of tools or specialized equipment.

[0053] As shown in FIGS. 4 and 5, a substantial portion of the conductive portions of the terminal connectors 70 are surrounded by the insulative covers 72, which helps prevent inadvertent electrical contact with external features. To accomplish such electrical isolation, the terminal connector interfaces 81 may be overmolded with the insulative covers 72 using an appropriate mold geometry. Further details relating to the positive and negative terminal connectors 70a, 70b may be appreciated with reference to FIGS. 6-9, which are perspective views of the terminal connectors 70 and associated retention clips 76.

[0054] In particular, FIGS. 6 and 7 respectively depict overhead and bottom perspective views of the positive terminal connector 70a interfacing with the first retention clip 76a, and FIGS. 8 and 9 respectively depict overhead and bottom perspective views of the negative terminal connector 70b interfacing with the second retention clip 76b. As shown in FIGS. 6 and 8, the retention clips 76 include tabs 82 82 disposed at opposing sides of the terminal connectors 70. In the illustrated embodiments, the tabs 82 form two sides of the retention clips 76, and the protrusions 92 extend from the tabs 82 to form the shelves 94. As also illustrated, the protrusions 92 only extend through a portion of the tabs 82. However, other embodiments of the protrusions 92 may be such that the taper of the protrusions extends substantially the entire length of the tabs 82.

[0055] The terminal connectors 70 each include two main conductive portions – the terminal connector interface 81, and the terminal extension 74. The terminal connector interface 81 is configured to be positioned within the corresponding recess 54 of the housing cover 42, and the terminal extension 74 extends away from the terminal connector interface 81 and is configured to extend away from the module housing 40 and housing cover 42. The terminal extension 74 is configured to be accessible for ready electrical connection to external connectors, such as a battery cable connected to the xEV 10 (see FIGS. 1 and 2).

[0056] In certain embodiments, the terminal connector interface 81 and the terminal extension 74 may be integral. In such embodiments, the terminal connector interface 81 is configured to mate with a respective terminal of the module (e.g., terminal post 52), while the terminal extension 74 provides a more readily accessible connection feature that is a high current, low resistance connection to the battery module 28. The terminal extension 74, in certain embodiments, may be a hollow extension that allows conductors (e.g., wires) to be inserted for crimping. Again, the terminal extension 74, in other embodiments, may simply be a cable.

[0057] The insulative cover 72, which electrically insulates portions of the terminal connector 70, includes a first insulting portion 98 and a second insulating portion 100. The first insulating portion 98 may be considered to cover the terminal connector interface 81, except for the opening 80, which is shown in FIG. 7 for the positive terminal connector 70a and FIG. 9 for the negative terminal connector 70b. The second insulating portion 100 extends from the first insulating portion 98, and only partially covers the terminal extension 74 to allow for ready electrical connection.

[0058] As set forth above, the insulative covers 72 may be indexed to their respective recesses 54 in the housing cover 42 (see, e.g., FIG. 4). Accordingly, the first insulating portion 98a of FIG. 6 includes a geometry (e.g., shape and size) that is indexed to the first recess 54a of the housing cover 42, and the first insulation portion 98b of FIG. 8 includes a geometry that is indexed to the second recess 54b of the housing cover 42. The first insulating portions 98 may also each include a marking 102, such as a "+" sign, as shown in FIG. 6, denoting that the terminal connector is a positive terminal connector, or a "-" sign, as shown in FIG. 8, denoting that the terminal connector is a negative terminal connector.

[0059] FIGS. 7 and 9, which are perspective bottom views of the positive terminal connector 70a and the negative terminal connector 70b, provide a more detailed view of the manner in which the retention clips 76 interface with the terminal connectors 70. Specifically, the tabs 82 are connected to one another by a bottom piece 110 having the opening 88 through which the flange 90 protrudes to mechanically couple the retention clips 76 and the terminal connectors 70.

[0060] One or more of the disclosed embodiments, alone or on combination, may provide one or more technical effects including the manufacture of battery terminal connectors that are able to readily connect and disconnect to battery terminals without the use of tools or specialized equipment. Further, the battery terminal connectors may be formed from materials that are resistant to corrosion, while also enabling a very low resistance connection to the battery terminal. The technical effects and technical problems in the specification are exemplary and are not limiting. It should be noted that the embodiments described in the specification may have other technical effects and can solve other technical problems.

[0061] The specific embodiments described above have been shown by way of example, and it should be understood that these embodiments may be susceptible to various modifications and alternative forms. It should be further understood that the claims are not intended to be limited to the particular forms disclosed, but rather to cover all modifications, equivalents, and alternatives falling within the spirit and scope of this disclosure.

CLAIMS:

What is claimed is:

1. A battery system, comprising:

a battery module housing cover having a recess in which a module terminal is positioned, the recess having a recess geometry; and

a battery terminal connector having a terminal connector interface establishing an electrical and physical connection with the module terminal, and an insulative cover covering the terminal connector interface, wherein the insulative cover has a cover geometry, and the cover geometry matches the recess geometry.

2. The battery system of claim 1, comprising a retention clip secured to the battery terminal connector via the insulative cover, wherein the retention clip is positioned between the insulative cover and an internal recess wall of the recess.

3. The battery system of claim 2, wherein the retention clip comprises a protrusion positioned within an additional recess of the recess to prevent inadvertent disconnection of the battery terminal interface from the module terminal.

4. The battery system of claim 3, wherein the protrusion prevents movement of the terminal connector interface in an axial direction away from the module terminal.

5. The battery system of claim 3, wherein the retention clip comprises a pair of tabs each positioned at opposite sides of the battery terminal connector, wherein the protrusion is configured to move out of the additional recess upon application of a sufficient amount of force applied to the tabs such that the tabs are biased toward one another.

6. The battery system of claim 5, wherein the protrusion is a tapered projection formed on at least one tab of the pair of tabs, the tapered projection forming a shelf

that abuts a surface of the additional recess thereby preventing removal of the battery terminal connector from the recess.

7. The battery system of claim 2, wherein the retention clip is physically secured to the insulative cover via a flange of the insulative cover projecting through an opening of the retention clip.

8. The battery system of claim 2, wherein the retention clip and the insulative cover are both polymeric.

9. The battery system of claim 1, wherein the module terminal is a terminal post, and the terminal connector interface is receptacle for the terminal post.

10. The battery system of claim 1, wherein the module terminal is made of copper, and the terminal connector interface is made of beryllium copper.

11. The battery system of claim 1, wherein the battery terminal connector comprises a terminal extension portion that is electrically and physically connected to the terminal connector interface, wherein the terminal extension portion projects in a direction that is oriented crosswise relative to the module terminal.

12. The battery system of claim 1, wherein the module housing cover comprises an additional recess in which an additional module terminal is positioned, the additional recess having a different geometry than the recess geometry such that the battery terminal connector cannot readily connect with the additional module terminal.

13. The battery system of claim 12, comprising an additional battery terminal connector having an additional terminal connector interface establishing an electrical and physical connection with the additional module terminal, and having an additional insulative cover covering the additional terminal connector interface, wherein the

additional insulative cover has a geometry that matches a respective geometry of the additional recess.

14. The battery system of claim 13, wherein the insulative cover is colored with a first color, and the additional insulative cover is colored with a second color different than the first color.

15. A battery terminal connector comprising:

a terminal connector interface configured to establish an electrical and physical connection with a terminal of a battery module by acting as a receptacle for the terminal;

an insulative cover covering the terminal connector interface except for an opening configured to receive the terminal of the battery module; and

a retention clip coupled to the insulative cover, wherein the retention clip comprises a clip opening that is coaxial with the opening of the insulative cover.

16. The battery terminal connector of claim 15, wherein the insulative cover comprises a flange having the opening, wherein the flange extends through the clip opening and secures the retention clip to the insulative cover.

17. The battery terminal connector of claim 15, wherein the terminal connector interface is formed from beryllium copper.

18. The battery terminal connector of claim 15, wherein the retention clip comprises tabs that are positioned on opposite sides of the insulative cover, wherein the tabs each comprise a protrusion.

19. A battery terminal connector assembly for an automotive battery comprising:

a positive terminal connector comprising a first terminal connector interface configured to establish an electrical and physical connection with a positive terminal post of the automotive battery, and a first insulative cover covering the first terminal connector interface except for a first opening configured to receive the positive terminal post of the battery module, wherein the first insulative cover has a first cover geometry; and

a negative terminal connector comprising a second terminal connector interface configured to establish an electrical and physical connection with a negative terminal post of a battery module, and a second insulative cover covering the second terminal connector interface except for a second opening configured to receive the negative terminal post of the automotive battery, wherein the second insulative cover has a second cover geometry that is different than the first cover geometry.

20. The battery terminal connector assembly for an automotive battery of claim 19, wherein the positive terminal connector interface and the negative terminal connector interface are each made from beryllium copper, and the terminal post is made from copper.

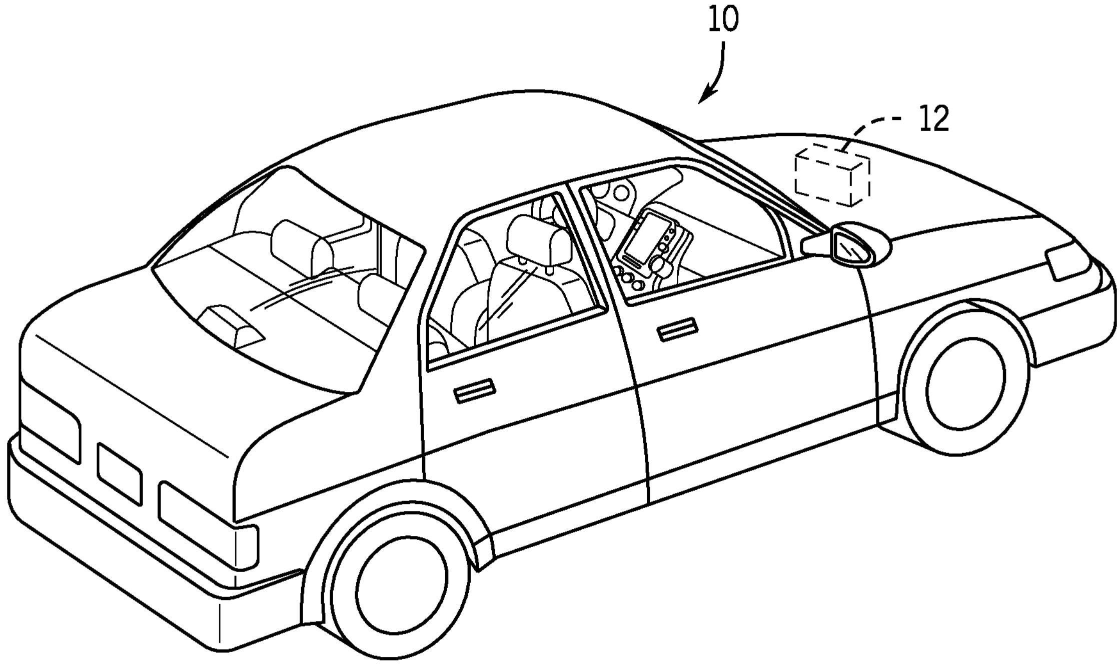

10
12

FIG. 1

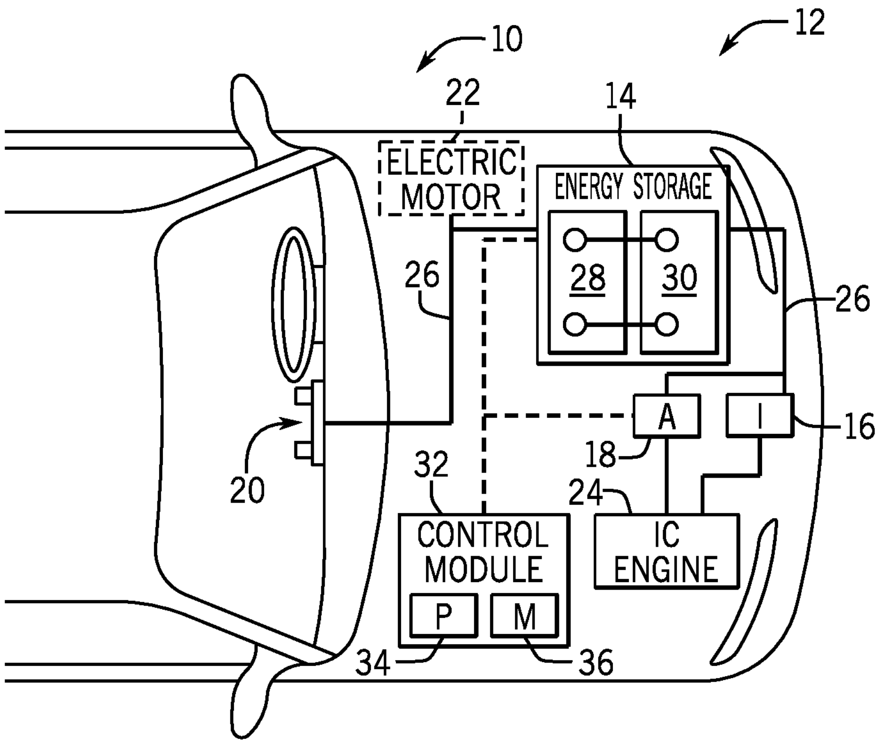

10
12
22
ELECTRIC MOTOR
14
ENERGY STORAGE
28
30
26
26
A
I
16
18
24
20
32
CONTROL MODULE
IC ENGINE
P
M
34
36

FIG. 2

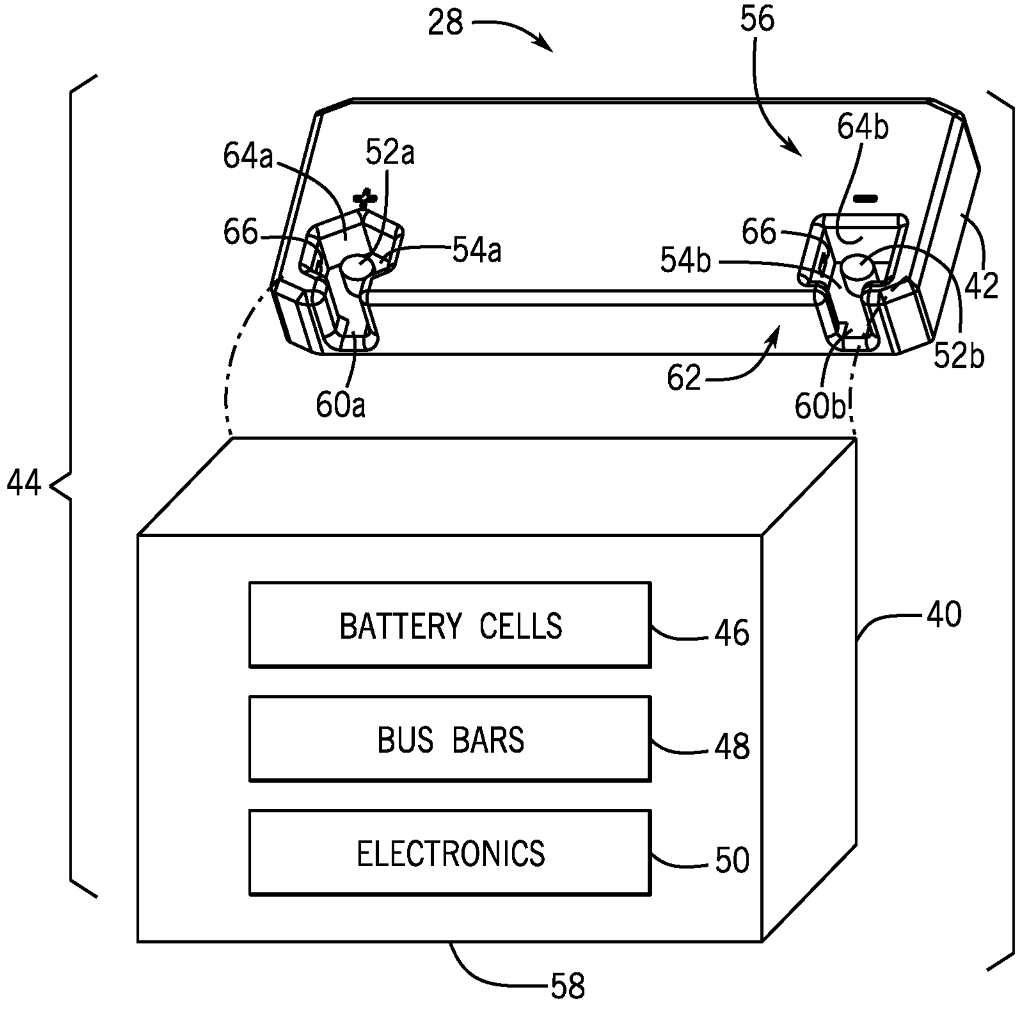
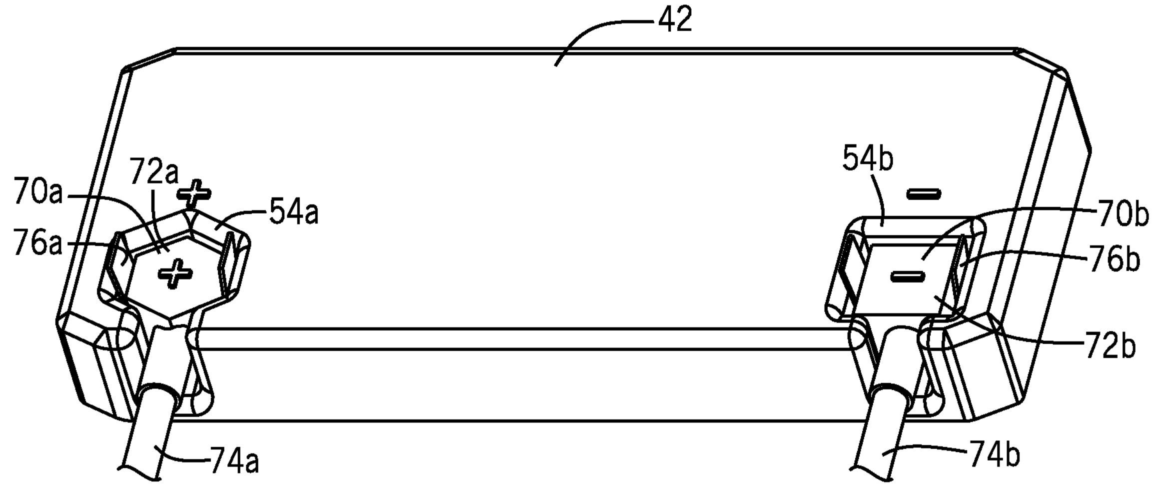

28
56
64b
64a
52a
66
54a
66
54b
42
52b
62
60a
60b
44
BATTERY CELLS
46
40
BUS BARS
48
ELECTRONICS
50
58

FIG. 3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70a
72a
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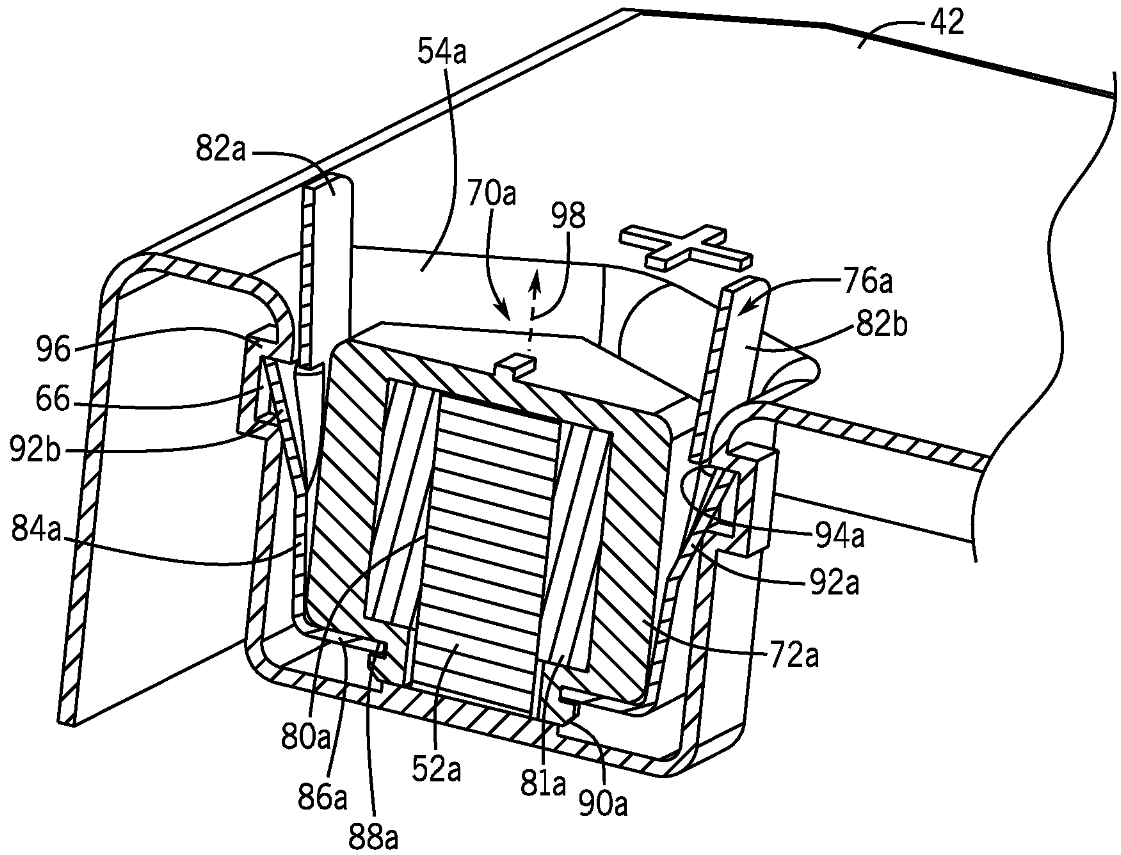
76a
76b
72b
74a
74b

FIG. 4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54a
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98
76a
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72a
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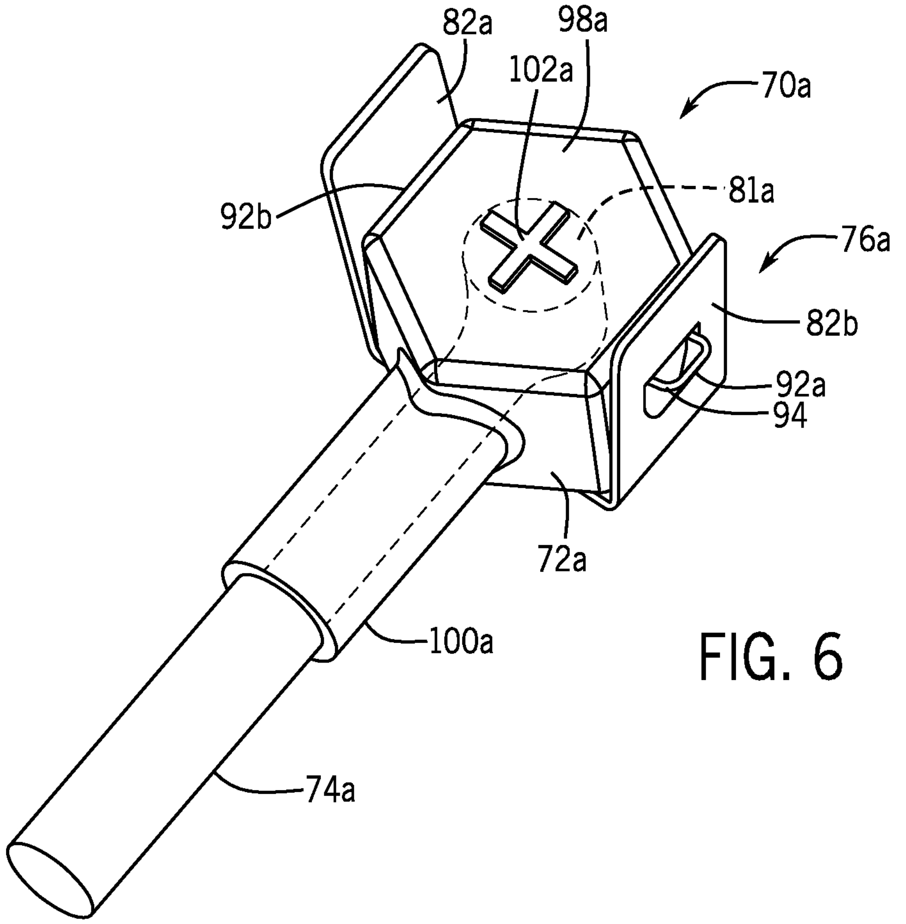
52a
81a
90a
88a

FIG. 5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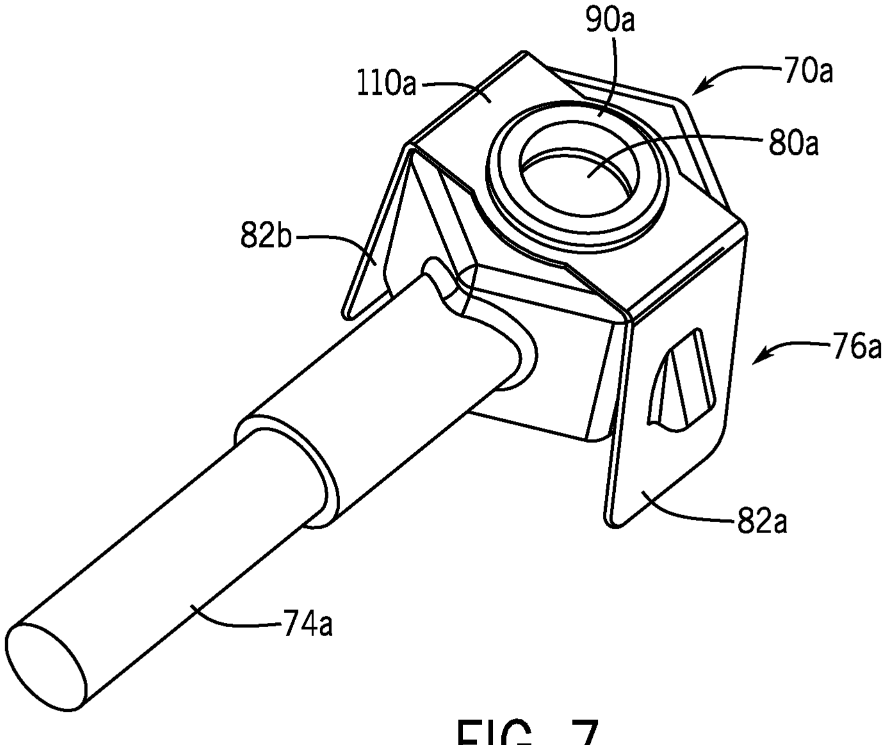
72a
100a
74a

FIG. 6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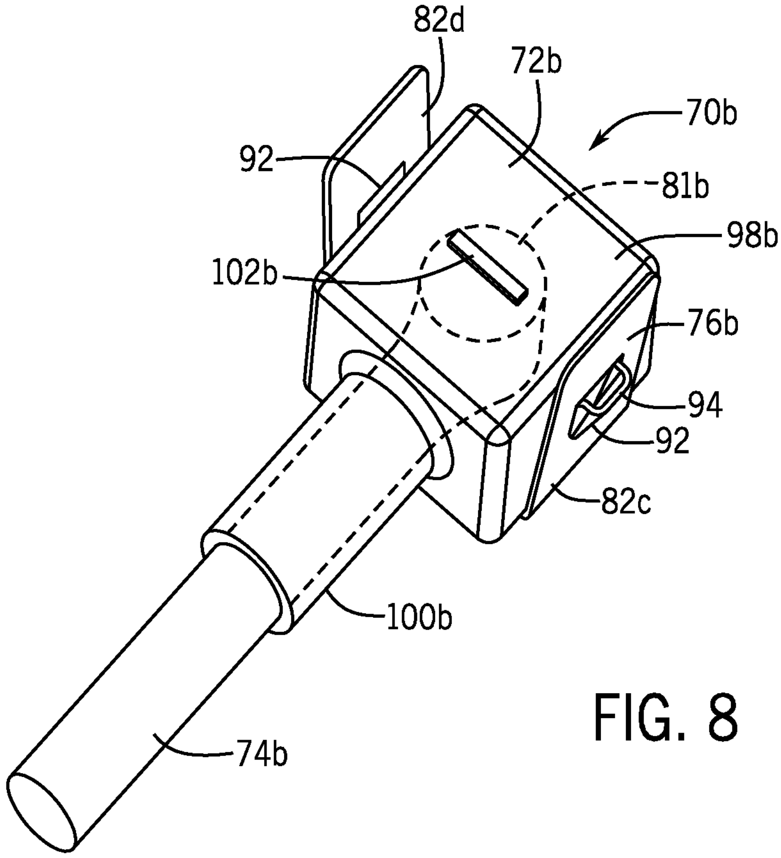
74a

FIG. 7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94
92
82c
100b
74b

FIG. 8

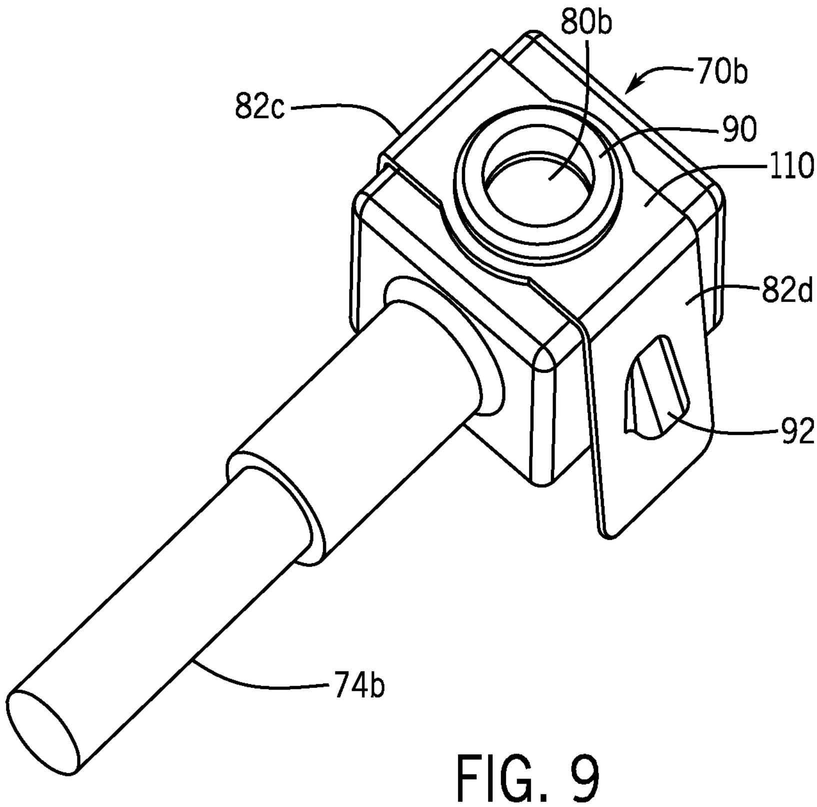
80b
70b
82c
90
110b
82d
92
74b

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2017/032885

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01M2/30 H01M2/34 H01R11/28 H01R13/642
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01M H01R

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	US 2013/034765 A1 (KOWALSKI GERALD A [US]) 7 February 2013 (2013-02-07) claim 1 figures 1-6 paragraph [0002] paragraph [0018] paragraph [0023] paragraph [0026] -----	1-14 15-20
X	EP 1 133 007 A1 (SUMITOMO WIRING SYSTEMS [JP]) 12 September 2001 (2001-09-12) figures 2-4, 6, 7 paragraph [0006] -----	1,9,11
X	WO 2008/049112 A2 (AMPHENOL CORP [US]; PETERSEN RICHARD W [US]) 24 April 2008 (2008-04-24) figures 1-9 ----- -/--	15-18

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 June 2017	30/06/2017

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Topak, Eray

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2001/053636 A1 (TAMAI YASUHIRO [JP] ET AL) 20 December 2001 (2001-12-20) figures 1-3 paragraph [0002] -----	19,20

2

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2017/032885

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