(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
16 September 2021 (16.09.2021)

WIPO | PCT

(10) International Publication Number
WO 2021/181404 A1

(51) International Patent Classification:
H01H 71/00 (2006.01) *H02H 3/093* (2006.01)
H01H 83/00 (2006.01) *H02H 7/00* (2006.01)
H02H 3/02 (2006.01)

(21) International Application Number:
PCT/IN2020/050634

(22) International Filing Date:
22 July 2020 (22.07.2020)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
202041010508 12 March 2020 (12.03.2020) IN

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, IT, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,

(54) Title: RELAY ASSEMBLY

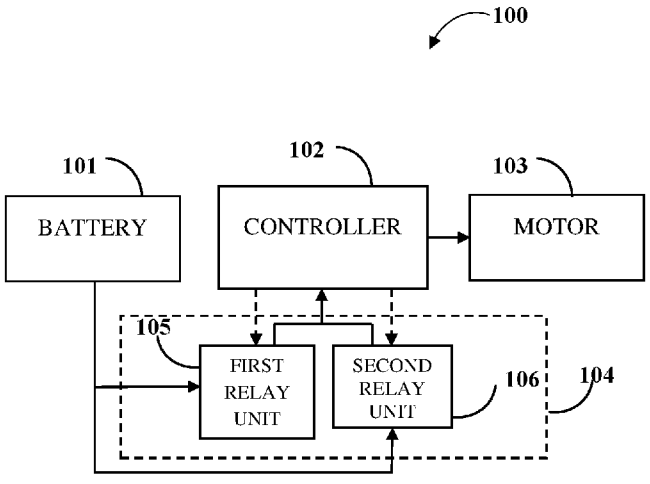

Fig. 1

(57) Abstract: A relay assembly (104) connecting a power source (101) to an electronic component (102) in a high voltage system (100). The relay assembly (104) comprises a first relay unit (105), a second relay unit (106) positioned perpendicular to the first relay unit (105), and a relay mounting bracket (204) with at least one locator (404 and 405) for positioning the first relay unit (105) and the second relay unit (106) proximal to the electronic component (102) using a locking pin (501). The first relay unit (105) and the second relay unit (106) are electrically connected in parallel. The relay assembly (104) can be mounted in proximity to the electronic component for easy manufacturability, assembly, and serviceability of the high voltage system (100).

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TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to the identity of the inventor (Rule 4.17(i))*
— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

RELAY ASSEMBLY

TECHNICAL FIELD

[0001] The present subject matter relates to a high voltage system. More particularly, to an isolation of a power supply in the high voltage system for safety of electrical loads in the high voltage system.

BACKGROUND

[0002] Existing high voltage systems include a high voltage power source, an inverter, a low voltage DC-DC converter, and a high voltage electrical load, such as a motor. Such high voltage systems find applications in electric vehicles, hybrid electric vehicles, ships, etc. In the design of the high voltage systems, the high voltage power source, such as, batteries represent multiple challenges for safety. Fuses are provided within the batteries on one or both of the positive terminal and the negative terminal of the batteries to protect them from excessive currents. The interconnecting wires between the batteries and the motor witness high currents and voltage spikes. A protection device that breaks the circuit, in case of occurrence of a fault in the interconnecting wires is needed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] The detailed description is described with reference to the accompanying figures. The same numbers are used throughout the drawings to reference like features and components.

[0004] Fig. **1** exemplarily illustrates a schematic diagram of a high voltage system in an embodiment of the present invention;

[0005] Fig. **2** exemplarily illustrates an exploded partial perspective view of a few systems of a vehicle showing mounting locations of components of the high voltage system onto a vehicle frame;

[0006] Fig. **3** exemplarily illustrates a partial perspective view of a relay mounting bracket mounted on the vehicle frame showing positioning of a relay assembly proximal to an electronic component;

[0007] Fig. **4** exemplarily illustrates a perspective view of a relay mounting bracket of the relay assembly, in an embodiment of the present invention;

[0008] Figs. **5A-5B** exemplarily illustrates a perspective view and an exploded view of a relay unit, respectively; and

[0009] Fig. **6** exemplarily illustrates a flowchart depicting a logic of controlling operation of each of the relay units of the relay assembly by the electronic component.

DETAILED DESCRIPTION OF THE INVENTION

[00010] One of the protection devices used in the interconnecting wires of the high voltage systems is a contactor switch that is designed for isolating the power supply, that is, the battery from loads in the high-power line. The contactor switch can withstand high amount of current and high arcing voltage spikes, while providing separation of contacts in them. However, the life expectancy of the contactors is reduced due to frequent operation of the contacts in them and opening and closing of the contacts creates electric arc which generates additional heat. Also, the contactors are larger and heavier, making their mounting in the high voltage systems e.g. an electric vehicle with space constraint; difficult in terms of packaging and assembly. If mounted using mounting screws in a desired location in the product, device or a vehicle, manufacturability and serviceability of the product will be difficult.

[00011] In the high voltage system used to power a product or a device, voltage levels of about 400 volts and 800 volts generate sufficient power to run the product. The high voltage systems include multiple batteries, traction motors, controllers, interconnecting wiring, etc. In order to mount the high voltage systems on to a dynamic or mobile product e.g. an electric vehicle to achieve better vehicle handling characteristics, compact packaging of the high voltage systems is needed. However, the compact packaging of the high voltage system in transportation product like a two or three-wheeled electric vehicle may pose a threat to the rider of the vehicle, such as, short circuit, arcing between the terminals of the batteries,

overcurrent in electronic components associated with the batteries, causing frequent failures. There exists a need for one or more protection devices with reduced size and weight that can withstand high currents and voltage spikes for isolating the power supply from the loads, in case of a fault, while permitting compact packaging of components in the high voltage systems.

[00012] With the above objective in view, this invention discloses a relay assembly that addressed all problems cited above & other problems of known art.

[00013] Another objective of the present invention is to provide a relay assembly that can be mounted in proximity to an electronic component, for example, a controller in manner to facilitate easy manufacturability, assembly, and serviceability of the high voltage system in applications, such as, a vehicle. Another objective of the present invention is to provide a relay assembly that is lighter in weight, cost-effective, and accessible in installation in applications, such as, a vehicle.

[00014] The relay assembly as per an aspect of the present invention connects a power source to an electronic component in the high voltage system. The relay assembly comprises a first relay unit, a second relay unit positioned perpendicular to the first relay unit, and a relay mounting bracket with at least one locator for positioning the first relay unit and the second relay unit proximal to the electronic component. The first relay unit and the second relay unit comprise a locking pin proximal to a mounting end for positioning the first relay unit and the second relay unit in the locators. The first relay unit and the second relay unit are electrically connected in parallel sharing equal input current. The mounting end of each of the first relay unit and the second relay unit is connected to a positive terminal of the power source and the mounting end of the each of the first relay unit and the second relay unit is connected to the electronic component.

[00015] The locking pin is rotated by a predetermined angle, inserted into the locators of the relay mounting bracket, and rotated in a reverse direction by the predetermined angle to lock the first relay unit and the second relay unit in the locators of the relay mounting bracket. The first relay unit and the second relay unit comprise a first cap, a second cap, and a relay enclosed between the first cap and the second cap. The electronic component determines occurrence of a pre charge in the high voltage system and controls timing of making and breaking of each of the first relay unit and the second relay unit.

[00016] In an embodiment of the present invention, a relay mounting bracket is disclosed. The relay mounting bracket comprises a first surface comprising at least one guide hole for mounting an electronic component and a second surface, perpendicular to the first surface, comprising at least one locator and at least one raised flange for positioning at least one relay unit proximal to the electronic component.

[00017] Summary provided above explains the basic features of the invention and does not limit the scope of the invention. The nature and further characteristic features of the present invention will be made clearer from the following description made with reference to the accompanying drawings.

[00018] Fig. **1** exemplarily illustrates a schematic diagram of a high voltage system **100** in an embodiment of the present invention. The high voltage system **100** includes a power source, for example, a battery **101** that sources power to high voltage loads, such as, a motor **103**, and an electronic component, such as, a controller **102**. The controller **102** controls the operation of the motor **103**. A relay assembly **104** is provided connecting the power source, that is, the battery **101** to the controller **102** in the high voltage system **100**. The relay assembly **104** comprises a first relay unit **105**, a second relay unit **106**, and a relay mounting bracket (not shown in Fig. 1) with locators for positioning the first relay unit **105** and the second relay unit **106** proximal to the controller **102**. The first relay unit

105 and the second relay unit **106** separate the battery **101** from the motor **103** and the controller **102**.

[00019] As exemplarily illustrated, power supply from the battery **101** is split into two paths and connects to the two identical relay units. **105** and **106** The incoming current from the battery **101** is split equally between the relay units **105** and **106** with the same electrical specification, such as, switching voltage, switching current, carry current, resistance, etc. The first relay unit **105** and the second relay unit **106** are connected in parallel sharing equal input current. Using such relay units **105** and **106** connected in parallel, the relay assembly **104** is capable of catering to the high currents and high voltages of the high voltage systems, such as, **100**. The two relay units **105** and **106** carry large currents that a high voltage system **100** is expected to carry. Each of the relay units **105** and **106** includes a relay enclosed within a first cap **505** and a second cap **506** as exemplarily illustrated in Fig. **5**. The relay is a 4-pin relay or a 5-pin relay. The pins of the relay pierce through the second cap to form contacts of the relay units. Each relay unit **105** and **106** has coil contacts and switch contacts. In a 4-pin relay unit, there are 2 coil contacts and 2 switch contacts. In the 5-pin relay unit, there are 2 coil contacts and 3 switch contacts. The coil contacts energize the coil of the relay. One of the coil contacts can be connected to power supply and the other coil contact is connected to ground. The switch contacts are connected to the battery **101** and the controller **102**.

[00020] The switch contacts of the relay units **105** and **106** are connected to each other, and in turn connected to the controller **102**. One of the switch contacts of each of the first relay unit **105** and the second relay unit **106** is connected to a positive terminal of the battery **101** and the other switch contact of each of the first relay unit **105** and the second relay unit **106** is connected to the controller **102**. The controller **102** controls the timing of making and breaking of contact between the switch contacts of the relay units **105** and **106** as shown by dashed lines. The power lines to source power to the motor **103** are connected to the controller **102**. An inverter (not shown) of the controller **102** converts the DC voltage supplied to the

controller **102** from the relay units **105** and **106** to AC voltage and the AC voltage drives the motor **103**. The controller **102** regenerates DC power back to the battery **101**, in case of regenerative operation of the motor **103**. In an embodiment, the controller **102** determines occurrence of a pre-charge in the high voltage system **100** and then, controls timing of making and breaking of contact of the switch contacts of each of the first relay unit **105** and the second relay unit **106**. The first relay unit **105** and the second relay unit **106** act as a pair of isolation switches between the power source and the electrical load, such as, battery **101** and the motor **103**, in case of occurrence of a fault in the high voltage system **100**.

[00021] In an embodiment, the high voltage system **100** constitutes a propulsion system of a vehicle. In an embodiment, the vehicle is an electric vehicle or a hybrid electric vehicle. In an embodiment, the vehicle may be a saddle type vehicle. In the electric vehicle, one or more power sources, such as, batteries **101** supply voltage and current to high power consuming loads and to one or more electronic components, such as, controllers. A high-power consuming load is, for example, a traction motor that draws about 30V AC from the batteries. One of the controllers, for example, a motor control unit, controls the operation of the traction motor. The controller is thus connected between the batteries and the traction motor. The interconnecting wires between the batteries, the controller, and the traction motor form a part of a high voltage wiring harness running along the length of the vehicle. The present subject matter, in this embodiment, discloses a relay assembly positioned between the batteries, such as, **101** and the controller **102** to isolate the controller **102** and subsequently the traction motor, such as, the motor **103** from the batteries **101**, in case of occurrence of a fault. The high voltage wiring harness and the components such as **101**, **102**, and **103** connected by the high voltage wiring harness constitutes the high voltage system **100**.

[00022] Fig. **2** exemplarily illustrates an exploded partial perspective view of a few systems of a vehicle **200** showing mounting locations of the components such as **102**, **105**, and **106** of the high voltage systems onto a vehicle frame **201**. As

exemplarily illustrated, a wiring harness **203** of the vehicle **200** catering to high voltage loads and low voltage loads extends from the head pipe of the vehicle **200** towards the tail lamp of the vehicle **200** along the length of the vehicle **200**. The part of the wiring harness **203** that caters to the high voltage loads constitutes the interconnecting wires of the high voltage system **100** of the vehicle **200**. The relay units **105** and **106** of the relay assembly **104**, shown in Fig. 1, form a part of the high voltage system **100**. The relay units **105** and **106** are connected between the battery **101** and the controller **102**. Multiple brackets **202** and **204** are provided to mount the batteries **101** and the relay units **105** and **106** are mounted onto the vehicle frame **201**. Such mounting brackets are centrally located to maintain the center of gravity of the vehicle **200**. The traction motor as per an embodiment may be mounted onto the rear wheel of the vehicle **200**. In an embodiment, the relay mounting bracket **204** is centrally located in the vehicle **200** and mounted over the battery mounting bracket **202**. The relay units **105** and **106** are positioned in the relay mounting bracket **204**. The relay assembly **104** is located proximal to the controller **102**. In an embodiment, the controller **102** may be positioned in a separate mounting bracket. As exemplarily illustrated, the controller **102** may be mounted on the same relay mounting bracket **204** as the mounting brackets used for mounting relay units **105** and **106**. The relay units **105** and **106** are positioned in locators (not shown) of the relay mounting bracket **204**, as will be described in Fig. **4**. The controller **102** is also mounted to a vertical planar surface of the relay mounting bracket **204**. The relay units **105** and **106** are in close proximity of the controller **102**. The relay units **105** and **106** are assembled along with the high voltage wiring harness **203** of the high voltage system **100**.

[00023] Fig. **3** exemplarily illustrates a partial perspective view of a relay mounting bracket **204** mounted on the vehicle frame **201**, showing positioning of the relay assembly **104** proximal to the controller **102**. The first relay unit **105** and the second relay unit **106** are positioned perpendicular to each other. That is, the major length dimensions of the two relay units **105** and **106** are substantially orthogonally disposed with respect to each other. At a mounting end of the relay

units **105** and **106**, the coil contacts and the switch contacts are located. The mounting end may be a top end or a bottom end of the relay units **105** and **106**. As exemplarily illustrated, in an embodiment, the mounting end is the bottom end of the relay units **105** and **106**. The bottom end is one end surface of each of the relay units **105** and **106** which is orthogonal to the major length dimension of the relay units **105** and **106** respectively. A power line **301** originating from a positive terminal of the battery **101** is split into two lines **302a** and **303a** and fed at the mounting end of the first relay unit **105** and the second relay unit **106**. The power lines **302a** and **303a** are connected to a coil contact and a switch contact of each of the first relay unit **105** and the second relay unit **106**. That is, the power line **302a** is connected to a coil contact and a switch contact of the first relay unit **105**. The power line **303a** is connected to a coil contact and a switch contact of the second relay unit **106**. Another power line **302b** and **303b** originating from the mounting end of the first relay unit **105** and the second relay unit **106** respectively is joined together into a power line **304** and connected to a positive terminal **305** of the controller **102**.

[00024] A power line **306** originating from a negative terminal of the battery **101** is directly connected to the negative terminal **307** of the controller **102**. The signal wires for controlling the operation of the first relay unit **105** and the second relay unit **106** are output from the controller **102**. The power lines **302b** and the **303b** to the controller **102** are bundled together using a hole clip **308**. The signal lines (not shown) are also bundled together using another hole clip (not shown). The signal lines and the power lines **309** are connected to the high voltage wiring harness **203** of the vehicle **200** using components such as couplers **310**. In an embodiment, an additional controller in communication with the controller **102** provides the signal to control the first relay unit **105** and the second relay unit **106**.

[00025] Fig. **4** exemplarily illustrates a perspective view of a relay mounting bracket **204** of the relay assembly **104**, in an embodiment of the present invention. As exemplarily illustrated, the relay mounting bracket **204** has a first planar surface

401 with guide holes **409** for mounting the controller **102** and an extension portion **406** with guide holes **406a** for mounting the interconnecting wire connected to the traction motor, such as, **103**. Further, the relay mounting bracket **204** has a second surface **402** with locators **404** for positioning the first relay unit **105** and the second relay unit **106**.

[00026] The controller **102** is fastened to the first planar surface **401** with fasteners inserted through the guide holes **409**. The second surface **402** has raised flanges **403** and **408** with a locator **405** each for each relay unit **105** and **106** at predetermined locations. Apart from the locators **405**, the raised flanges **403** and **408** have guide holes **403a** for mounting a protective device, such as, a fuse for the protection of the controller **102**. A raised flange **403** for positioning the first relay unit **105** is perpendicular to a raised flange **408** for positioning the second relay unit **106**. The locators **404** on the second surface **402** are depressions with a predetermined depth corresponding to the contour of the mounting end of the first relay unit **105** and the second relay unit **106**. The second surface **402** is mounted to the vehicle frame **201** using fasteners engaging with an extension member **407**.

[00027] The locators **405** on the raised flanges **403** and **408** receive a locking pin of the first relay unit **105** and the second relay unit **106** respectively. The locators **404** and **405** on the second surface **402** and the raised flanges **403** may be circular, rectangular, square, etc., in shape. Correspondingly, the shape of the mounting end of the first relay unit **105** and the second relay unit **106** and the locking pin of the relay units **105** and **106** are circular, rectangular, square, etc. The dimensions of the locators **404** on the second surface **402**, such as, length, width, diameter, etc., are corresponding to the dimensions of the mounting end of the first relay unit **105** and the second relay unit **106**. The placing of the first relay unit **105** and the second relay unit **106** at substantially 90 degrees to each other results in compact assembly of the relay units **105** and **106** in the vehicle **200**. The mounting of the relay assembly **104** above the battery mounting bracket **202** utilizes space efficiently in the vehicle **200** and reduces the length of interconnecting wires

running between the battery **101**, the relay units **105** and **106**, and the controller **102**. The fastening of the relay mounting bracket **204** using fasteners is a sturdy mounting and is not susceptible to failure due to vibrations.

[00028] Figs. **5A-5B** exemplarily illustrates a perspective view and an exploded perspective view of a relay unit, for example, a first relay unit **105** respectively. The first relay unit **105** comprises a locking pin **501** extending from a side surface **502** proximal to the mounting end **503**. The locking pin **501** is a protrusion that engages with the locator **405**. To place the first relay unit **105** on the second surface **402** of the relay mounting bracket **204**, the mounting end **503** of the first relay unit **105** is positioned in the locator **404** of the second surface **402**. Further, the locking pin **501** engages with the locator **405** in the raised flange **408**. The locking pin **501** is rotated by a predetermined angle, inserted into the locator **405** of the raised flange **408**, and rotated in a reverse direction by the same predetermined angle to lock the first relay unit **105**.

[00029] The relay unit, for example, the first relay unit **105** is constituted by a first cap **505**, a relay **504**, and second cap **506** as exemplarily illustrated in Fig. **5B** The first cap **505** and the second cap **506** enclose the relay **504**. The relay **504** is an electromechanical switch or a solid state based. The first cap **505** and the second cap **506** are fastened together by fastening means, such as, a snap fit or attached by a suitable attachment means. On a first side **507** of the first relay unit **105**, the fastening mean is an external locking element inserted between the extensions **508a** and **508b** from the first cap **505** and the second cap **506**. On a second side **508**, the fastening mean is a tongue **509** extending from the second cap **506** that locks with the slot **509** in the first cap **505**. As exemplarily illustrated, the locking pin **501** is located on the second cap **506** of the first relay unit **105**. The first cap **505** is hollow while the second cap **506** is solid. The first cap **505** has a vent for venting of heat generated while making or breaking the contacts of the relay **504**. The second cap **506** has internal electrical connections that connect the contacts of the relay **504** to the mounting end **503** of the first relay unit **105**. The switch contacts

and the coil contacts of the relay **504** end at the mounting end **503** of the first relay unit **105**. A power line extends from a switch contact of the relay **504** to the positive terminal of the battery **101** through the mounting end **503** of the first relay unit **105**. Another power line extends from another switch contact of the relay **504** to the controller **102** through the mounting end **503** of the first relay unit **105**.

[00030] Fig. **6** exemplarily illustrates a flow chart depicting a logic of controlling operation of each of the relay units, such as, **105** and **106** implemented & executed by the controller **102**. As exemplarily illustrated, the controller **102** determines if ignition of the vehicle **200** is turned ON at step **601**. In case the ignition is turned ON, during power up procedure, the high voltage system **100** of the vehicle **200** may be exposed to high inrush current. This inrush current may cause damage to the electronic components and high voltage loads in the vehicle **200**. A pre-charge circuit is provided as a part of the high voltage system **100**. The pre-charge circuit limits the magnitude of the in-rush current in the high voltage system **100**, during power up procedure. The controller **102**, at step **602**, determines if the pre-charge circuit is in operation prior to making or breaking the contacts in the relay units **105** and **106**. Based on the input from the pre-charge circuit, the controller **102** sends control signals to the relay units **105** and **106** on the signal wires. If pre-charge is performed, the controller **102**, at step **604**, actuates the relay units **105** and **106** to make a contact. If the controller **102** determines that pre-charge is not performed, the controller **102**, at step **603**, does not actuate the relay units **105** and **106** to make a contact. The controller **102** waits for pre-charging to happen before actuating the relay units **105** and **106**.

[00031] The relay assembly **104** provides a technical advancement in functioning as a protection device in a high voltage system as follows: The relay assembly comprising the two relay units, such as the first relay unit and the second relay unit replaces contactors that are typically used in high voltage systems. The two relay units function in parallel and receive equal currents from the power source. The relay units are lighter in weight and can be both mounted on the relay

mounting bracket. The relay units are positioned substantially perpendicular to each other in the relay mounting bracket, allowing compact packaging of relay units in different applications, such as, in a vehicle. The locking pin on the relay unit aids in tight locking and easy positioning of the relay units in the relay mounting bracket. The manhours of manufacturing and assembly are reduced due to the simple mechanism of mounting the relay units to the relay mounting bracket. Also, the structure of the relay mounting bracket allows for the mounting of the controller to it. Thus, the relay units are in close proximity to the controller, thereby resulting in same resistance to the current flowing from the relay units to the controller. In vehicles, mounting of the relay assembly in the centre of the vehicle maintains the center of gravity of the vehicle substantially in the centre of the vehicle and closer to ground. The hole clips in the relay mounting brackets allows neat, clean, and easily accessible routing of the power lines and signal lines in the high voltage system.

We claim:

1. A relay assembly (104) connecting a power source (101) to an electronic component (102) in a high voltage system (100) comprising:
   a first relay unit (105),
   a second relay unit (106) positioned substantially perpendicular to the first relay unit (105), and
   a relay mounting bracket (204) with at least one locator (404 and 405) for positioning the first relay unit (105) and the second relay unit (106) proximal to the electronic component (102).

2. The relay assembly (104) as claimed in claim 1, wherein each of the first relay unit (105) and the second relay unit (106) comprises a locking pin (501) proximal to a mounting end (503) for positioning the first relay unit (105) and the second relay unit (106) in the locators (405) of the relay mounting bracket (204).

3. The relay assembly (104) as claimed in claim 1,

   wherein the first relay unit (105) and the second relay unit (106) are connected in parallel sharing equal input current, and
   wherein a mounting end (503) of each of the first relay unit (105) and the second relay unit (106) is connected to a positive terminal of the power source (101) and the mounting end (503) of the each of the first relay unit (105) and the second relay unit (106) is connected to the electronic component (102).

4. The relay assembly (104) as claimed in claim 1, wherein the electronic component (102) determines occurrence of a pre charge in the high voltage system (100) and controls timing of making and breaking of each of the first relay unit (105) and the second relay unit (106).

5. The relay assembly (104) as claimed in claim 1, wherein a locking pin (501) of each of the first relay unit (105) and the second relay unit (106) is rotated by a predetermined angle, inserted into the locators (405) of the relay mounting bracket (204), and rotated in a reverse direction by the predetermined angle to lock the first relay unit (105) and the second relay unit (106) in the locators (405) of the relay mounting bracket (204).

6. The relay assembly (104) of claim 1, wherein each of the first relay unit (105) and the second relay unit (106) comprises a first cap (505), a second cap (506), and a relay (504) enclosed between the first cap (505) and the second cap (506).

7. A vehicle (200) comprising a high voltage system (100) comprising:

at least one controller (102) for controlling power supply from one or more power sources (101) to a traction motor (103); and

a relay assembly (104) mounted onto a vehicle frame (201), proximal to one of the at least one controller (102) for connecting the one of the at least one controller (102) to the one of the one or more power sources (101).

8. The vehicle (200) as claimed in claim 7, wherein the relay assembly comprises:

a first relay unit (105),

a second relay unit (106) positioned substantially perpendicular to the first relay unit (105), and

a relay mounting bracket (204) mounted to the vehicle frame (201) with at least one locator (404 and 405) for positioning the first relay unit (105) and the second relay unit (106) substantially perpendicular to each other.

9. The vehicle (200) as claimed in claim 7, wherein the each of the first relay unit (105) and the second relay unit (106) comprises a locking pin (501) at a mounting end (503) for positioning the first relay unit (105) and the second relay unit (106) in the at least one locator (405) of the relay mounting bracket (204).

10. The vehicle (200) as claimed in claim 7,

wherein the first relay unit (105) and the second relay unit (106) are connected in parallel, and

wherein a mounting end (503) of each of the first relay unit (105) and the second relay unit (106) is connected to a positive terminal of the one of the power sources (101) and the mounting end (503) of the each of the first relay unit (105) and the second relay unit (106) is connected to the one of the at least one controller (102).

11. The vehicle (200) as claimed in claim 7, wherein the one of the at least one controller (102) determines an occurrence of a pre-charge in the high voltage system (100) and controls timing of making and breaking of contacts of each of the first relay unit (105) and the second relay unit (106).

12. The vehicle (200) as claimed in claim 7, wherein the locking pin (501) is rotated by a predetermined angle, inserted into the at least one locator (405) of the relay mounting bracket, and rotated in a reverse direction by the predetermined angle to lock the first relay unit (105) and the second relay unit (106) in the at least one locator (405) of the relay mounting bracket (204).

13. A relay mounting bracket (204) comprising:

a first surface (401) comprising at least one guide hole (409, 406a) for mounting an electronic component (102); and

a second surface (402), perpendicular to the first surface (401), comprising at least one locator (405) and at least one raised flange (403,408) for positioning at least one relay unit (105, 106) proximal to the electronic component (102).

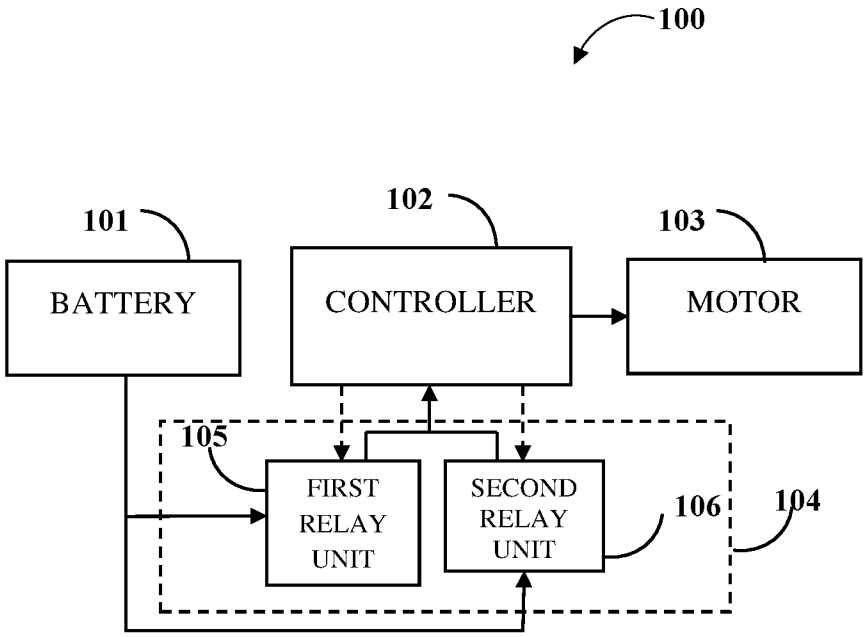
100
101
BATTERY
102
CONTROLLER
103
MOTOR
105
FIRST RELAY UNIT
SECOND RELAY UNIT
106
104

Fig. 1

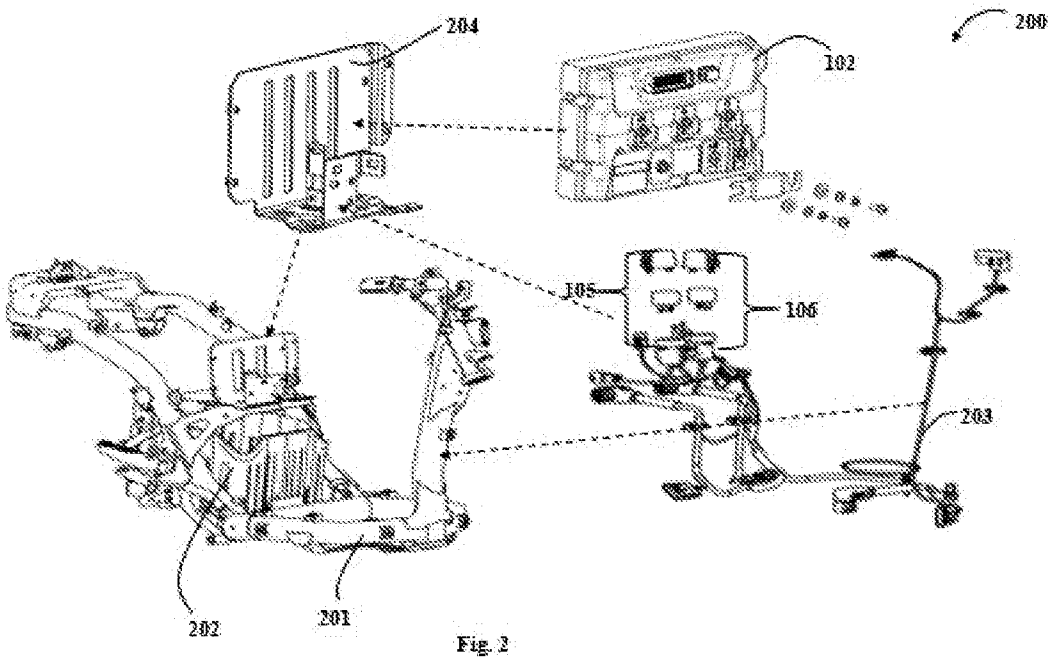

Fig. 2

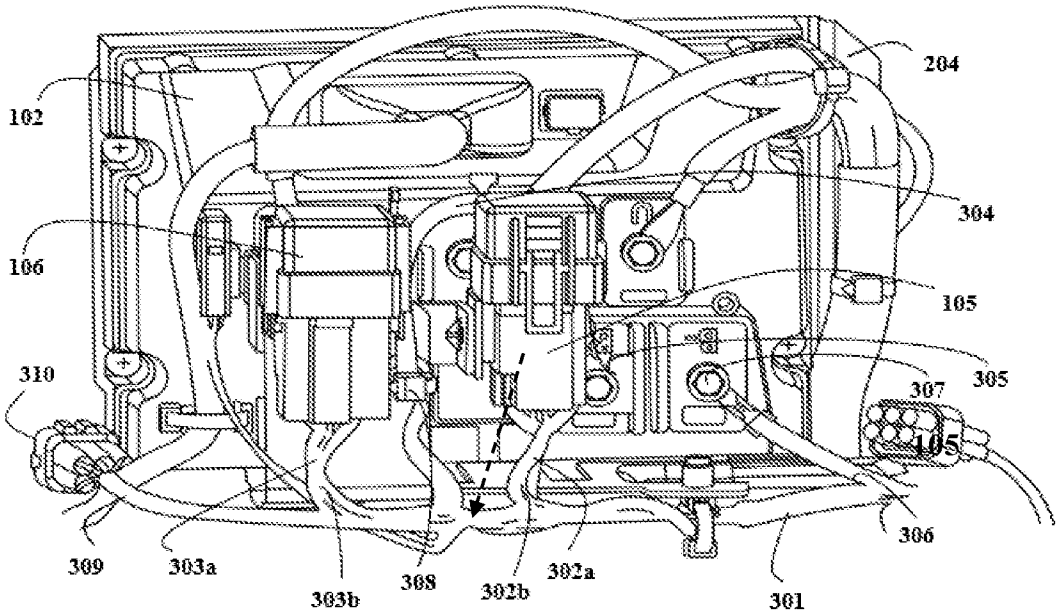
102
204
304
106
105
310
307
305
105
306
309
303a
303b
308
302b
302a
301

Fig. 3

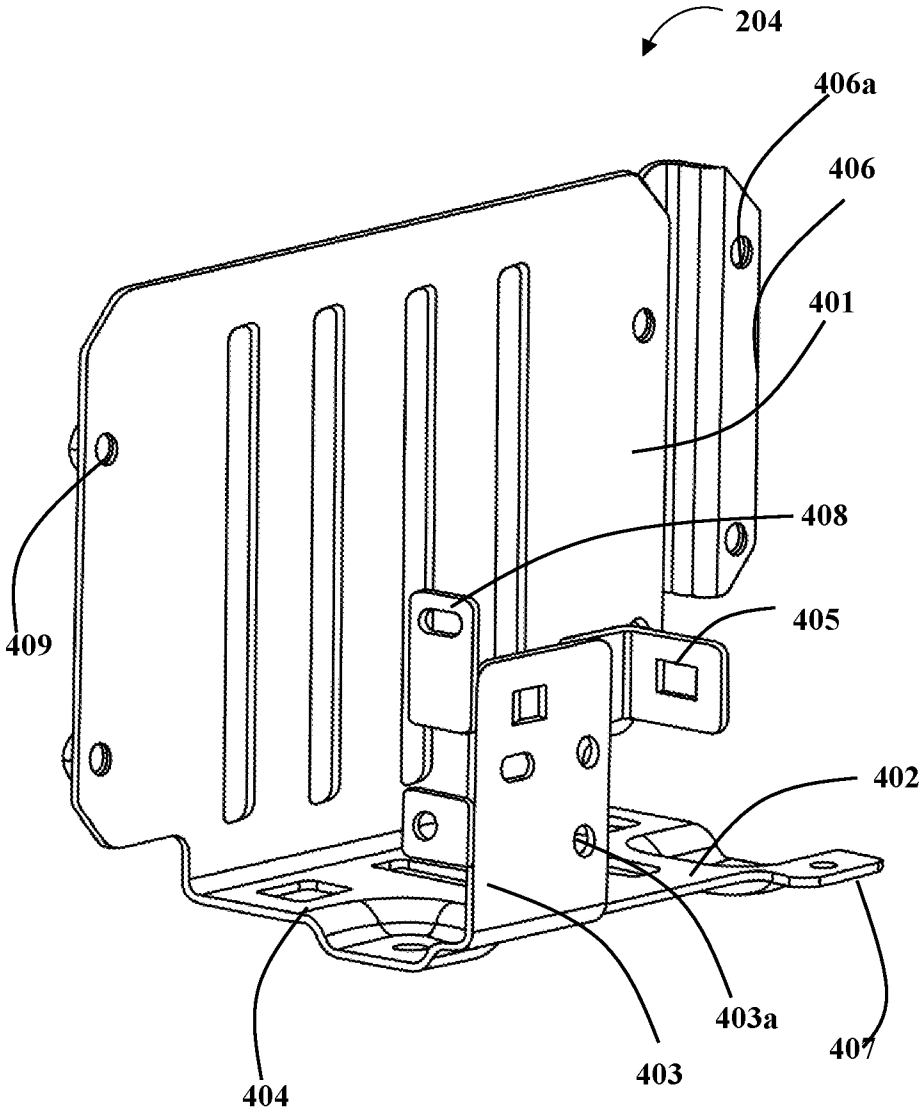

Fig. 4

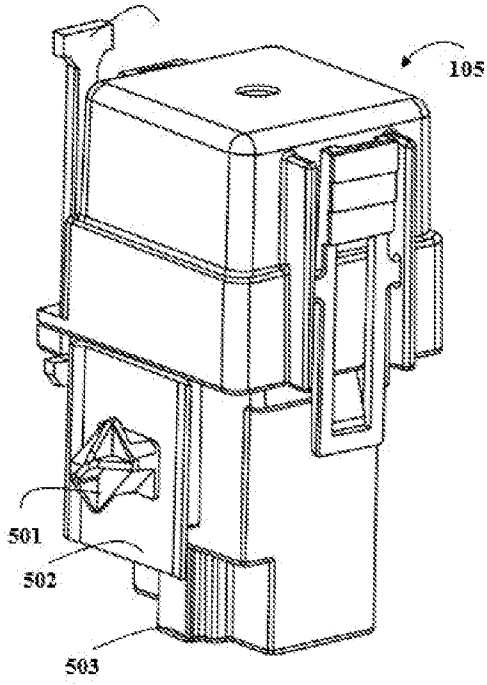

Fig. 5A

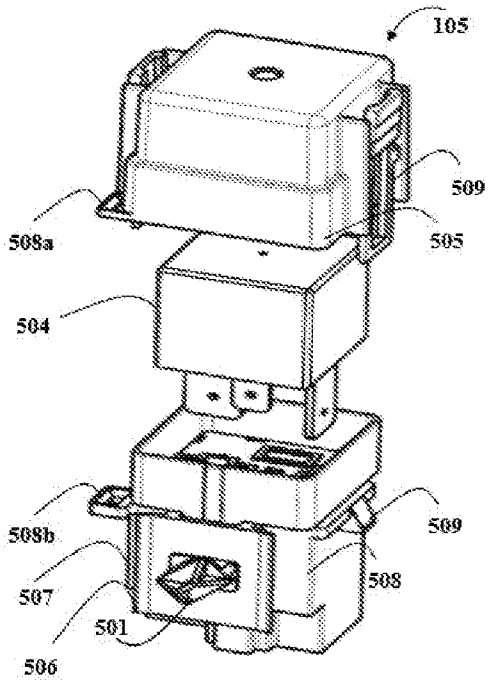

Fig. 5B

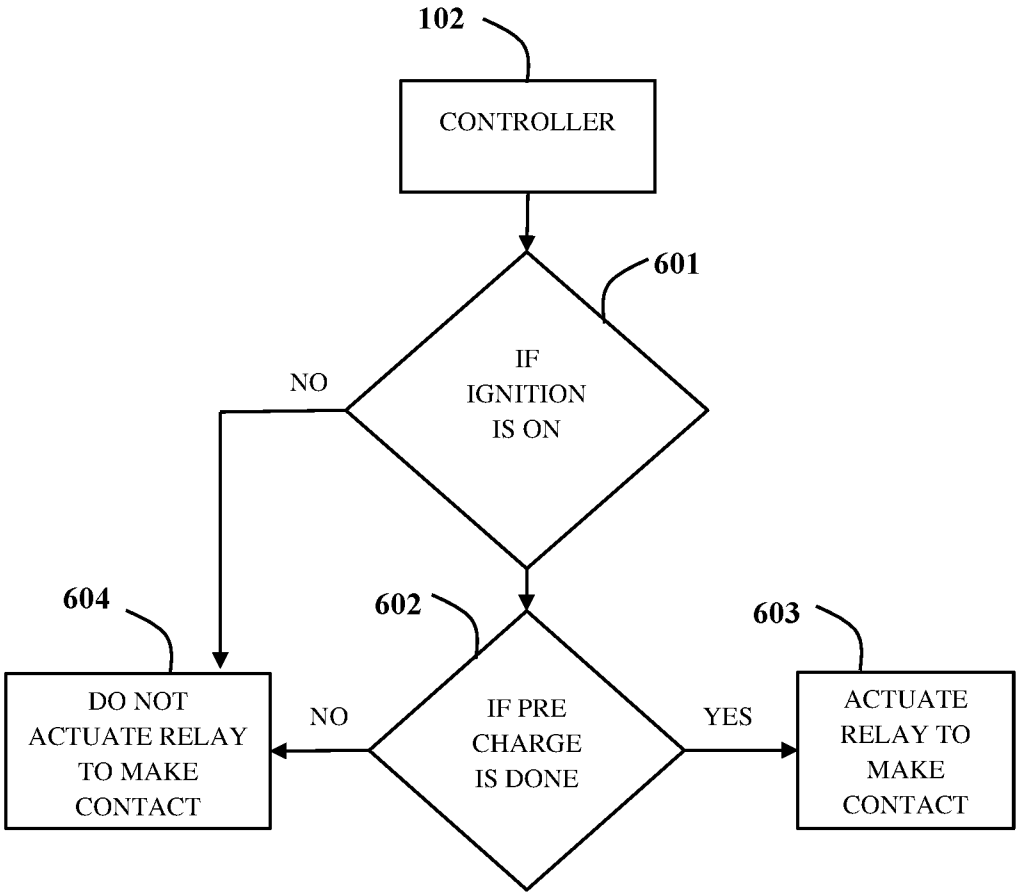
102
CONTROLLER
601
IF
IGNITION
IS ON
NO
604
DO NOT
ACTUATE RELAY
TO MAKE
CONTACT
602
IF PRE
CHARGE
IS DONE
NO
YES
603
ACTUATE
RELAY TO
MAKE
CONTACT

Fig. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2020/050634

A. CLASSIFICATION OF SUBJECT MATTER
H01H71/00,H01H83/00,H02H3/02,H02H3/093,H02H7/00 Version=2020.01

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)

H01H, H02H

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)

DATABASES: TotalPatent One, IPO Internal Database, Google Patents.
KEYWORDS:relay,locking,angle,locator,timing,precharge,vehicle,parallel.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US7593198B2 (P G DRIVES TECHNOLOGY LTD.) 22 SEPTEMBER 2009 (22-09-2009) ABSTRACT; COLUMN 1, LINES 28-57; COLUMN 2, LINES 28-30; COLUMN 3, LINES 60-66; FIGURES 2-3.	7
Y	CLAIMS 1-11.	1-6, 8-13
X	US2019/0140245A1 (EATON INTELLIGENT POWER LIMITED) 09 MAY 2019 (09-05-2019) ABSTRACT; PARAGRAPHS [0010], [0018], [0030], [0134]-[0138].	7
Y	FIGURES 1-63.	2-6, 8-12
Y	CN204242951U (SHANDONG IRON AND STEEL CO. LTD.) 01 APRIL 2015(01-04-2015) WHOLE DOCUMENT.	1-6, 8-13

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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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
27-11-2020	27-11-2020
Name and mailing address of the ISA/ Indian Patent Office Plot No.32, Sector 14,Dwarka,New Delhi-110075 Facsimile No.	Authorized officer Rahul Dhakad Telephone No. +91-1125300200

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IN2020/050634

Citation	Pub.Date	Family	Pub.Date
US 7593198 B2	22-09-2009	GB 2438253 B	14-09-2011
US 20190140245 A1	09-05-2019	CN 111448731 A	24-07-2020
		WO 2019092103 A2	16-05-2019
		US 20200114776 A1	16-04-2020