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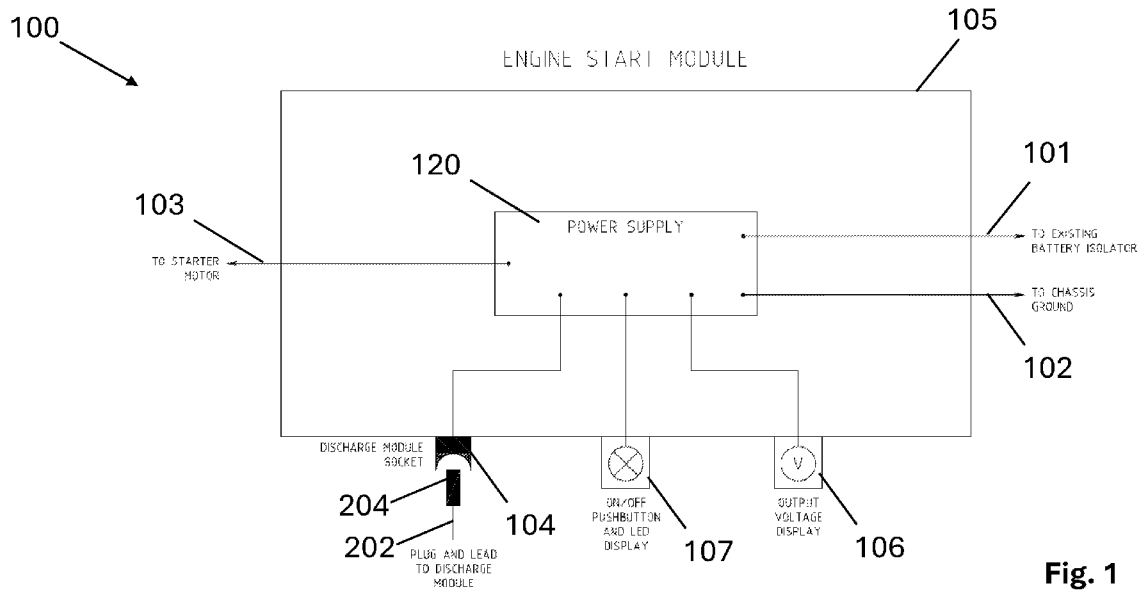

Fig. 1

(57) Abstract: A system is disclosed comprising: an engine start module comprising: one or more capacitors configured to provide power to start a vehicle; and a socket providing for electrical connection to the capacitors; a discharge module comprising: a plug configured to connect to the socket of the engine start module and form an electrical connection with the capacitors; and an energy dissipation device providing an electrical load to dissipate electrical energy received from the capacitors via the plug. The engine start module, the discharge module and a method are also disclosed.

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ENGINE START MODULE AND DISCHARGE DEVICE

1. FIELD OF THE TECHNOLOGY

The present technology relates to engine start modules and devices for discharging engine start modules. In some forms, the present technology relates to engine start modules comprising one or more capacitors and discharge devices for discharging them, for example when vehicle maintenance is required.

2. BACKGROUND TO THE TECHNOLOGY

Large vehicles such as road trucks, heavy mobile equipment (HME) such as mining haul trucks, excavators, loaders, bulldozers and the like, as well as fixed machines such as drilling rigs, generators, pumps etc. including petrol or diesel engines often, or typically, use lead-acid batteries to provide electrical power for cranking and running. Lead-acid batteries can discharge over time while the engine of the vehicle or machine is powered off, especially when connected to many different electrical components in or on a vehicle that may draw parasitic current. Additionally, workers operating loads such as lights, air conditioning or the like when the vehicle's engine is not running, or omitting to turn them off, may inadvertently discharge the batteries excessively. The voltage available from a lead-acid battery can also be reduced at cold temperatures. A battery discharged to the point that the engine cannot be started is a problem in any vehicle and especially so in HMEs as, in some machines, a jump start can take an hour or more, which can present significant disruption and lost productivity.

3. BRIEF SUMMARY OF THE TECHNOLOGY

It is an object of the technology to provide an engine start module which may help a vehicle start more reliably. Alternatively, it is an object of the technology to provide a device that can assist in safely and/or quickly discharging an engine start module.

Alternatively, it is an object of the technology to at least provide the public with a useful choice.

According to one aspect of the present technology there is provided an engine start module (ESM) for a vehicle, the engine start module comprising:

one or more capacitors, being chargeable to a charged state and configured to provide power to start a vehicle when in the charged state;

one or more connectors for forming a first set of electrical connections between the one or more capacitors and at least one starter motor of the vehicle;

a socket configured to receive a plug of a discharge module configured to discharge the one or more capacitors to a substantially uncharged state, the socket providing for electrical connection between the discharge module and the one or more capacitors, the socket being connectable to the plug of the discharge module without disconnection of the first set of electrical connections.

In some examples, the engine start module comprises a housing, the one or more capacitors of the engine start module being housed in the housing and the socket being located on or outside of the housing.

In some examples, the engine start module comprises multiple banks of capacitors in parallel.

In some examples, the engine start module comprises a voltmeter configured to measure a voltage of the engine start module and a display device to display the voltage measured by the voltmeter. In some examples, the display device is a digital display to display a number of volts. In some examples, the voltmeter is activated by a switch.

In some examples, the engine start module is connectable to one or more vehicle running batteries to enable the vehicle running batteries to charge the one or more capacitors. In some examples, the vehicle running batteries are charged by an alternator of the vehicle and power a running circuit separate to a cranking circuit powered by the engine start module.

Alternatively, the engine start module comprises one or more vehicle running batteries configured to charge the one or more capacitors. In some examples, the vehicle running batteries are connectable to an alternator of the vehicle for charging of the vehicle running batteries and power a running circuit separate to a cranking circuit powered by the engine start module.

In some examples, the one or more capacitors of the engine start module are connected to the starter motor via an isolation station on the vehicle.

In some examples, the socket forms part of a switch-rated connector assembly with the plug.

According to another aspect of the present technology there is provided a discharge module for discharging an engine start module of a vehicle, the discharge module comprising:

a plug configured to connect to a socket of the engine start module and form an electrical connection with the engine start module;

an energy dissipation device providing an electrical load to dissipate electrical energy received from the engine start module via the plug to allow for discharge of the engine start module.

In some examples, the plug forms part of a switch-rated connector assembly with the socket.

In some examples, the discharge module comprises a housing, the energy dissipating device of the discharge module being housed in the housing, and the plug being on a lead extending from the housing.

In some examples, the energy dissipating device of the discharge module is configured to dissipate the energy as heat. In some examples, the energy dissipating device comprises a resistor. In some examples, the energy dissipating device comprises a grid resistor. In some examples, the energy dissipating device is configured to discharge the capacitors in under 10 minutes, preferably under 7 minutes, preferably in or under 5 minutes.

In some examples, the discharge module comprises a switch to complete the electrical connection between the engine start module and the energy dissipating device.

In some examples, the discharge module comprises a voltmeter configured to measure a voltage of the engine start module indicating a level of charge of the engine start module, and further comprises a display device configured to display the voltage measured by the voltmeter to a user of the discharge module. In some examples, the voltmeter is powered by a power source other than the engine start module. In some examples, the voltmeter is self-powered by a voltmeter battery. In some examples, the voltmeter is activated by a switch.

According to another aspect of the present technology there is provided a discharge module for discharging an engine start module, the discharge module comprising:

an energy dissipation device electrically connectable to the engine start module and providing an electrical load to dissipate electrical energy to discharge the engine start module;

a voltmeter configured to measure a voltage of the engine start module indicating a level of charge of the engine start module;

a display device configured to display the voltage measured by the voltmeter to a user of the discharge module.

In some examples, the discharge module further comprises a plug configured to connect to a socket of the engine start module and form an electrical connection with the engine start module.

In some examples, the discharge module comprises a housing, the energy dissipating device of the discharge module being housed in the housing, and the plug being on a lead extending from the housing.

In some examples, the energy dissipating device of the discharge module is configured to dissipate the energy as heat. In some examples, the energy dissipating device is a resistor. In some examples, the energy dissipating device is a grid resistor. In some examples, the energy dissipating device is configured to discharge the capacitors in under 10 minutes, preferably under 7 minutes, preferably in or under 5 minutes.

In some examples, the discharge module comprises a switch to complete the electrical connection between the engine start module and the energy dissipating device.

In some examples, the voltmeter is self-powered by a voltmeter battery. In some examples, the voltmeter is activated by a switch. In some examples, the display device is a digital display.

According to another aspect of the present technology there is provided a method of discharging one or more capacitors of an engine start module, the method comprising:

connecting a discharge module to the engine start module, the discharge module providing an electrical load to discharge the one or more capacitors;

actuating a discharge switch to complete an electrical connection between the one or more capacitors and the electrical load in the discharge module;

reading a voltage displayed on the discharge module to confirm that the one or more capacitors are substantially discharged, the voltage indicating a level of charge of the capacitors.

In some examples, the discharge module comprises the discharge switch.

In some examples, the method comprises connecting a plug of the discharge module to a socket of the engine start module to form an electrical connection with the one or more capacitors of the engine start module. In some examples, the method comprises disconnecting the plug of the discharge module from the socket of the engine start module after confirming that the one or more capacitors are substantially discharged. In some examples, the method comprises discharging the one or more capacitors without making any electrical connections other than connecting the plug to the socket.

In some examples, prior to reading the voltage displayed on the discharge module the method comprises a step of powering-on a voltmeter of the discharge module by actuating a voltmeter switch. In some examples, the step of actuating the voltmeter switch enables power to be provided from a voltmeter battery to the voltmeter.

In some examples, the step of reading the voltage comprises reading a digital display indicating a number of volts. In some examples, the step of reading the voltage comprises reading an initial voltage indicating that the capacitors are not discharged, waiting for the capacitors to discharge and reading a final voltage indicating that the capacitors are substantially discharged. In some examples, the step of reading a final voltage comprises reading a voltage of 3V or less, preferably 2V or less, preferably 1V or less, preferably 0V.

In some examples, the method comprises leaving the plug of the discharge module connected to the socket of the engine start module while work is conducted on a vehicle in which the engine start module is installed.

In some examples, the method comprises, after confirming that the one or more capacitors are substantially discharged, disconnecting the plug of the discharge module from the socket of the engine start module and connecting a temporary plug to the socket. The temporary plug may comprise a shorting wire configured to keep the one or more capacitors of the engine start module discharged. The temporary plug may comprise an indicator configured to provide an indication that the one or more capacitors of the engine start module are not discharged.

According to another aspect of the present technology there is provided a system comprising:

an engine start module comprising:

one or more capacitors, being chargeable to a charged state and configured to provide power to start a vehicle when in the charged state;

a socket providing for electrical connection to the one or more capacitors;

a discharge module comprising:

a plug configured to connect to the socket of the engine start module and form an electrical connection with the one or more capacitors;

an energy dissipation device providing an electrical load to dissipate electrical energy received from the capacitors of the engine start module via the plug to allow for discharge of the one or more capacitors.

In some examples, the plug and socket form a switch-rated connector assembly.

In some examples, the engine start module comprises a housing, the one or more capacitors of the engine start module being housed in the housing and the socket being located on or outside of the housing.

In some examples, the engine start module comprises a voltmeter configured to measure a voltage of the engine start module and a display device to display the voltage measured by the voltmeter. In some examples, the display device is a digital display to display a number of volts. In some examples, the voltmeter is activated by a switch.

In some examples, the engine start module is connectable to one or more vehicle running batteries to enable the vehicle running batteries to charge the one or more capacitors. In some examples, the vehicle running batteries are charged by an alternator of the vehicle and power a running circuit separate to a cranking circuit powered by the engine start module.

In some examples, the discharge module comprises a housing, the energy dissipating device of the discharge module being housed in the housing, and the plug being on a lead extending from the housing.

In some examples, the energy dissipating device of the discharge module is configured to dissipate the energy as heat.

In some examples, the discharge module comprises a switch to complete the electrical connection between the engine start module and the energy dissipating device.

In some examples, the discharge module comprises a voltmeter configured to measure a voltage of the engine start module indicating a level of charge of the engine start module, and further comprises a display device configured to display the voltage measured by the voltmeter to a user of the discharge module. The voltmeter of the discharge module may be powered by a power source other than the engine start module.

In some examples, the system further comprises a temporary plug configured to be connected to the socket in place of the discharge module plug after the one or more capacitors are substantially discharged, the temporary plug comprising a shorting wire configured to keep the one or more capacitors of the engine start module discharged. The temporary plug may comprise an indicator configured to provide an indication that the one or more capacitors of the engine start module are not discharged.

Further aspects of the technology, which should be considered in all its novel aspects, will become apparent to those skilled in the art upon reading of the following description which provides at least one example of a practical application of the technology.

4. BRIEF DESCRIPTION OF THE DRAWINGS

One or more embodiments of the technology will be described below by way of example only, and without intending to be limiting, with reference to the following drawings, in which:

Fig. 1 is a schematic diagram of an engine start module according to one example of the present technology;

Fig. 2 is a schematic diagram of a discharge module according to one example of the present technology;

Fig. 3 is a simplified schematic diagram of the engine start module of Fig. 1 installed in a vehicle;

Fig. 4 is a simplified schematic diagram of the engine start module of Fig. 1 showing some internal components;

Fig. 5 is a simplified schematic diagram of the discharge module of Fig. 2 showing some internal components;

Fig. 6 is a view of a user interface of the discharge module of Fig. 2;

Fig. 7 is a front view of the discharge module of Fig. 2; and

Fig. 8 is an energy dissipating device of the discharge module of Fig. 2.

5. DETAILED DESCRIPTION OF EXEMPLARY FORMS OF THE TECHNOLOGY

5.1. Engine Start Module

Fig. 1 shows a schematic diagram of an engine start module (ESM) 100 according to one form of the present technology. The ESM 100 is configured for starting an engine (such as a diesel engine) of a heavy vehicle such as a haul truck used in mining. However, in other examples, the ESM 100 may be configured for starting an engine of another vehicle or machine, such as other heavy mobile equipment (HME). ESMs according to examples of the present technology may be configured to start engines in excavators, bulldozers, loaders and the like. In some forms the ESM 100 may be configured to start an engine that is not in a vehicle, such as the engine of a generator, pump, drilling rig or a fixed machine. In the following description the ESM 100 will be described in the context of use in a vehicle such as a haul truck used in mining, but it is to be understood that the ESM 100 may be applied to start engines in other vehicles or machines, mobile or fixed.

The ESM 100 comprises one or more capacitors. In some examples, the ESM 100 comprises multiple banks of capacitors in parallel. In Fig. 1 the capacitors are represented by a power supply 120, which may comprise multiple capacitors arranged in capacitor banks. Fig. 4 shows another schematic diagram of the ESM 100 with additional detail of the capacitors. In this example the capacitors are arranged in a plurality of capacitor banks 110. There are four capacitors banks 110 in this example, each comprising one or more capacitors. In other examples, the ESM 100 may comprises a different number of capacitor banks 110 depending on the amperage, e.g. cold cranking amps (CCA), required by the engine of the vehicle or machine to be started by the ESM 100. In some examples the ESM 100 may comprise one, two, three, five or more capacitor banks 110. It is also to be understood that the number of capacitors and/or capacity of each, within each capacitor bank 110, may be varied in examples of the present technology to arrive at the required overall capacity. The capacitors may be identified as supercapacitors or ultracapacitors, in examples.

The ESM 100 is configured to replace one or more conventional (e.g. lead-acid) batteries in a vehicle. Advantageously, the capacitors in the ESM 100 may be more reliable than traditional lead-acid batteries because they may be less likely discharge over time, less affected by temperature and/or may be able to be charged and discharged more times than a conventional lead-acid battery before becoming unreliable. A large vehicle such as a mining haul truck may have traditionally had several conventional lead-acid batteries installed in parallel (e.g. either multiple 24V batteries in parallel or pairs of 12V batteries arranged in series and then in parallel with other pairs). The conventional batteries have in the past been used to both start the engine and provide power during running. The ESM 100 may be installed in the vehicle so that the ESM 100 provides power for starting the vehicle (cranking the engine), while other conventional batteries in the vehicle provide power for running electronics and/or electrical systems in the vehicle. The conventional batteries may be charged by the vehicle's alternator and in turn may charge the capacitors of the ESM 100. The arrangement also allows for electrical components in the vehicle, which may draw power while the engine is not running, to draw power only from the conventional batteries, leaving the capacitors of the ESM 100 charged so as to not affect the ability to start the engine of the vehicle.

With reference to Figs. 1 and 4, the ESM 100 may comprise three electrical connectors for connecting to electrical components of the vehicle, including a battery positive (BAT+) connector 101, a battery negative (BAT-)/ground connector 102 and a starter positive (STR+) connector 103. The STR+ connector 103 and the BAT- connector 102 may be used to form a circuit powered by the capacitors of the ESM 100. The BAT+ connector 101 and the BAT- connector 102 may be used to connect the ESM 100 to conventional batteries to charge the capacitors of the ESM 100. Each capacitor bank 110 may itself have a BAT+ terminal connected to the BAT+ connector 101 of the ESM 100, a BAT- terminal connected to the BAT- connector 102 of the ESM 100 and a STR+ terminal connected to the STR+ connector 103 of the ESM 100. Each capacitor bank 110 may, as an example only, be a commercially available capacitor or capacitor bank which has a positive and negative terminal for charging and a separate positive terminal for providing power output.

Fig. 3 is a simplified diagram showing how the ESM 100 may be connected within the electrical system of a vehicle such as a mining haul truck.

The starter motor(s), prelube pump, and any other motors or pumps required during starting are represented by numeral 111 in the system shown in Fig. 3. Hereafter these components will be referred to as a starter motor 111 but it is to be understood that depending on the vehicle, there may also be a

prelube pump and/or other components drawing power from the ESM 100 at the same time as the starter motor 111. It is also to be understood that some vehicles may comprise more than one starter motor, such as two starter motors, and a reference to the starter motor 111 is to be understood to be a reference to the one or more starter motors that a vehicle may have.

The starter motor 111 may be connected to the STR + connector 103 and the BAT- connector 102 to draw power from the capacitors for starting. Accordingly, the STR+ connector 103 and BAT- connector 102 may form a first set of electrical connections between the one or more capacitors and at least one starter motor 111 of the vehicle. In some examples of the present technology, the ESM100 may comprise two STR+ connectors 103, to provide two starter motor connections for vehicles with two starter motors. In such examples the STR+ terminal on each capacitor bank 110 may be connected to both STR+ connectors 103. In other examples two starter motors may be connected to a single STR+ connector 103 of the ESM 100.

As noted above, a vehicle in which the ESM 100 is installed may comprise conventional (e.g. lead-acid) batteries for providing power during running and to loads other than the starter motor 111. The conventional batteries may be identified as vehicle running batteries 108 as shown in Fig. 3. The ESM 100 is connectable to one or more of the vehicle running batteries 108 to enable the vehicle running batteries 108 to charge the one or more capacitors. In particular, one or more vehicle running batteries 108 may be connected between the BAT+ connector 101 and BAT- connector 102. It will be appreciated that the negative terminal of each vehicle running battery 108 may be connected to the BAT- connector 102 either directly or via ground (e.g. a busbar and/or vehicle chassis, frame etc.) and/or via an isolation station 112. Each vehicle running battery 108 may be a 24V battery or may be a pair of 12V batteries connected in series. In vehicles with a 12V system, the vehicle running battery 108 or batteries 108, as the case may be, may be 12V batteries.

The vehicle running batteries 108 may be charged by an alternator 109 of the vehicle, which may be connected in parallel to the batteries 108. The vehicle running batteries 108 are then able to charge the capacitors of the ESM 100 as they are connected across the BAT+ connector 101 and BAT- connector 102 (in this example via both an isolation station 112 and ground). The vehicle running batteries 108 may power a running circuit separate to a cranking circuit powered by the ESM 100. In particular, the starter motor 111 is not connected across the vehicle running batteries 108. Instead, the starter motor 111 is connected between the STR+ connector 103 of the ESM 100 and ground to form a cranking circuit separate from the running circuit energised by the vehicle running batteries 108. In this way, when the

starter motor 111 draws power it does so from the capacitors of the ESM 100, to receive the benefits provided by capacitors (e.g. consistent voltage and/or reliable availability of power).

In an alternative example of the present technology, the ESM 100 itself comprises one or more vehicle running batteries 108 configured to charge the one or more capacitors. That is, the one or more vehicle running batteries 108 may be integrated into the ESM 100 such that the ESM 100 does not need to be connected to other batteries in the vehicle and the ESM 100 can replace all of the conventional vehicle running batteries 108 of the vehicle. In such an example, the vehicle running batteries 108 would be connectable to an alternator 109 of the vehicle for charging of the vehicle running batteries 108. The vehicle running batteries 108 would also still power a running circuit separate to a cranking circuit powered by the ESM 100.

In some examples, the one or more capacitors of the ESM 100 are connected to the starter motor 111 via an isolation station 112 on the vehicle. As shown in Fig. 3, the connection between the STR+ connector 103 and the starter motor 111 passes through an isolation station 112. Similarly, the connections to ground of the batteries 108 and starter motor 111 pass through the isolation station 112. The isolation station 112 may comprise switches allowing these connections to be interrupted and/or locked out during maintenance and repair and may also comprise other components such as indicator lights, as is known the art.

The diagram of Fig. 3 is simplified to show how the ESM 100 may be integrated into a system together with conventional batteries 108, an alternator 109 and starter motor(s)/prelube pump 111 and it is to be understood that there will in practice be many other electrical components forming the electrical system of a vehicle as is known the art, such as fuses, busbars, switches, relays, sensors, control units, loads etc. In some examples, substantially all of the electrical components, e.g. all of the loads, other than the starter motor 111, prelube pump and any other components required for starting, are connected to and powered by the vehicle running batteries 108, optionally via an the isolation station 112, so that only the starter motor 111, prelube pump and other components required for starting are powered by the capacitors of the ESM 100.

With reference to Figs. 1 and 4, in this example, the ESM 100 may comprise a housing, which may be identified as an ESM housing 105. The one or more capacitors of the ESM 100 may be housed in the ESM housing 105. The ESM housing 105 may be shaped and sized to fit onto a battery shelf of the vehicle in which it is to be installed. In some examples the ESM housing 105 may have a shape and size

corresponding to one or more conventional batteries 108 that the ESM 100 is replacing. The housing 105 may be formed from any suitable material, including plastic or steel.

In some examples of the present technology, the ESM 100 comprises a voltmeter. The voltmeter may be identified as an ESM voltmeter 106 as shown in Fig. 1. The ESM voltmeter 106 may be configured to measure a voltage of the ESM 100 indicating a level of charge of the ESM 100 (e.g. of the capacitors). The ESM 100 may further comprise a display device to display the voltage measured by the ESM voltmeter 106. In this example the display device is a digital display to display a number of volts. In other examples the display device may be an analogue gauge or other display indicating a level of charge. The ESM voltmeter 106 may be activated by a switch, which may be a flip switch or push button.

The ESM voltmeter 106 may be used to confirm the voltage available from the capacitors of the ESM 100 and so may itself be powered by the capacitors in the ESM 100. In other examples, the ESM voltmeter 106 is self-powered, for example by a battery (e.g. a 9V battery), so that it is able to function whether the capacitors in the ESM 100 are charged or not. The ESM voltmeter 106 indicating whether the capacitors are charged or not may advantageously provide a safety feature enabling a user or technician to confirm that the capacitors are discharged prior to maintenance.

The ESM 100 may also comprise a control panel 111, shown in Fig. 4 which includes a button for each capacitor bank 110. Each button may be configured to switch a respective one of the capacitor banks 110 on and off. Each button may include an indicator light, for example an LED light, to display a status of the respective capacitor bank 110. For example, each button may indicate whether the respective capacitor bank 110 is on, off or charging.

5.2. Discharge Module

The capacitors of the ESM 100 may have large amounts of stored energy and are also able to provide high current for starting large engines. As will be described below, another form of the present technology is a discharge module (DM) 200, shown in Fig. 2, 5, 6 and 7, configured to discharge the one or more capacitors of the ESM 100 to a substantially uncharged state. This may be necessary during maintenance, repair, testing or replacement of the ESM 100 or electrical components of the vehicle.

The ESM 100 may comprise a socket 104 configured to receive a plug 204 of the DM 200. The socket 104 is shown in Figs. 1 and 4 for example, and provides for an electrical connection between the DM 200 and

the one or more capacitors of the ESM 100. The plug 204 is configured to connect to the socket 104 to form an electrical connection with the ESM 100. As noted above, the ESM 100 comprises connectors (e.g. the STR+ connector 103 and BAT- connector 102) forming a first set of electrical connections between the one or more capacitors of the ESM 100 and the starter motor 111 of the vehicle. The socket 104 is connectable to the plug 204 of the DM 200 (e.g. by receiving the plug 204) without disconnection of the first set of the electrical connections to the ESM 100. Advantageously, this means that the DM 200 can be connected to the ESM 100 without a user or technician being required to touch any terminals or disconnect or add to any existing electrical connections, until the ESM 100 is safely discharged. The socket 104 may comprise two pin sockets, each connected to one of the STR+ and BAT- terminals of the capacitor banks 110.

As represented in Figs 1 and 4, the socket 104 may be located on or outside of the housing 105 of the ESM 100. In some examples the socket 104 is fixed in place on the housing 105, while in other examples the socket 104 may be attached to a lead which can be extended away from the housing 105 when required. In some examples, the control panel 111 comprises the socket 104. In the example shown in Fig. 4 the socket 104 is provided on a different side of the ESM housing 105 than the control panel 104.

Each of the socket 104 of the ESM 100 and the plug 204 of the DM 200 may be configured to form part of a switch-rated connector assembly. For example, the connector assembly may function to both mechanically connect the plug 204 to socket 104 and also provide an electrical switch which interrupts any electrical connection between plug 204 and socket 104 until the mechanical connection is completed. This may provide for a safe way for a user or technician to make the connection between the ESM 100 and DM 200. The plug 204 and socket 104 may be provided by a Decontactor™ connector from Marechal Electric Group.

The DM 200 may comprise an energy dissipation device 201 providing an electrical load to dissipate electrical energy received from the ESM 100 to the allow for discharge of the ESM 100. The electrical energy may be received via the plug 204.

As shown Figs. 2, 5 and 7 in particular, the DM 200 may comprise a housing, which may be identified as a DM housing 205. The energy dissipating device 201 of the DM 200 is in this example housed in the DM housing 205. In this example, the plug 204 is on a lead 202 extending from the DM housing 205. The plug 204 and lead 202 are not shown in Figs. 2 or 7. As shown in Fig. 7, the DM 200 may comprise a

handle 211 connected to the housing 205 to allow a user to carry the DM 200 to the vehicle or machine they will be working on.

The electrical energy received by the energy dissipating device 201 may be dissipated as a different form of energy. In DM 200 shown in Figs. 2, 5 and 7, the energy dissipating device 201 is configured to dissipate the energy as heat. The energy dissipating device 201 may comprise a resistor (or one or more resistors. In this particular example the energy dissipating device 201 comprises a grid resistor. In other examples a different type of resistor, or different type of electrical load, may be used to form the energy dissipating device 201. In some examples the DM 200 may comprise a blower to cool the energy dissipating device 201 to help dissipate the heat. The blower may itself be powered via the plug 204 and therefore draw power from, and help discharge, the capacitors of the ESM 100. Fig. 8 shows an example of an energy dissipating device 201 in the form of a grid resistor. In this example the grid resistor comprises terminals 212 and a body 213. The body 213 is depicted as a block and in practice is the grid of the grid resistor.

In some examples, the energy dissipating device 201 is configured to discharge the capacitors in under 10 minutes. Preferably the energy dissipating device 201 is configured to discharge the capacitors in under 7 minutes and, more preferably, in or under 5 minutes. This can be accomplished by ensuring the energy dissipating device draws and can handle sufficient current/power to extract enough energy from the capacitors in the desired length of time. For example, if the capacitor banks 110 of the ESM 100 have a combined capacity of 128 Wh (as an example only), the energy dissipating device 201 would need to dissipate energy at a rate of 1.54 kW to deplete the capacitors in 5 minutes. If the output voltage of each capacitor bank 110 is 26.2V then the energy dissipating device would need to take about 58.9A of current and would therefore need an overall/equivalent resistance of 0.44Ω to draw 1.54 kW of power. Advantageously, the ability to discharge the ESM 100 safely in under 5 minutes may provide of increased productivity during maintenance or repair procedures and reduced machine downtime. The energy dissipation device 201, the DM 200 and any cooling system may be configured to discharge the ESM 100 quickly and safely without unacceptable heat or safety risk.

In this example the discharge module comprises a discharge switch 203 to complete the electrical connection between the ESM 100 and the energy dissipating device 201 of the DM 200. The provision of a switch allows the user of the DM 200 to begin the discharge procedure only when ready, after the plug 204 has been safely received in socket 104 and the DM 200 is positioned safely and securely.

Fig. 6 shows a control panel 214, which provides a user interface of the DM 200. In this example the discharge switch 203 is provided on the control panel 214 although in other examples the switch may be provided elsewhere on the DM 200, for example elsewhere on the housing 205.

The DM 200 may also comprise a voltmeter, which may be identified as a DM voltmeter 206, configured to measure a voltage of the ESM 100 indicating a level of charge of the ESM 100 (e.g. the level of charge of the capacitors). The DM 200 in this example also comprises a display device 207 configured to display the voltage measured by the DM voltmeter 206 to a user of the DM 200. In this example the display device 207 is a digital display to display a number of volts, as shown in Fig. 6. In other examples the display device may be an analogue gauge or other display indicating a level of charge. The DM voltmeter 206 may be activated by a switch, which may be a flip switch or push button. In the examples shown in Figs. 6 and 7 the switch is in the form of a push button 209 to power on and power off the DM voltmeter 206 and display device 207.

In some examples, the DM voltmeter 206 is powered by a power source other than the ESM 100, e.g. a power source that is not the capacitors of the ESM 100, such as a separate battery. In the illustrated example the DM voltmeter 206 is self-powered, for example by a battery (e.g. a 9V battery). Advantageously, this allows the DM voltmeter 206 to function whether the capacitors in the ESM 100 are charged or not. That is, the DM voltmeter 206 will work even when there is no power in the capacitors of the ESM 100 (e.g. when they are completely discharged). This allows the user to see the voltage reading go all the way to zero, since the DM voltmeter 206 is not relying on power from the ESM 100. This may advantageously provide a safety feature enabling a user or technician to confirm that the capacitors are discharged prior to maintenance.

The control panel 214 may also comprise a cable hole 210. In use the lead 202 may extend from this cable hole, optionally through a waterproof fitting such as an IP67 cable gland or other suitable fitting. In other examples the cable hole 210 may be replaced by a plug to which a socket on the lead 202 (at the opposite end of the lead 202 to the plug 204) may be connected. The control panel 214 or at least the voltmeter 206 may itself be provided in an IP67 enclosure.

Fig. 5 shows a simplified system diagram of the DM 200. As noted above and as shown in Fig. 4, the socket 104 comprises two pin sockets, one connected to the STR+ terminals of the capacitor banks 110 and one connected to the BAT- terminals of the capacitor banks 110. The plug 204 of the DM 200 may comprise two pins, and positive pin configured to be electrically connected to the STR+ terminals of the

capacitor banks 110 in the ESM 100 via the socket 104 and a negative pin configured to be electrically connected to the BAT- terminals of the capacitor banks 110 of the ESM 100 via the socket 104. As shown in Fig. 5, the energy dissipating device 201 is provided across the positive pin and negative pin to draw power from the capacitor banks 110 when the circuit is completed. Discharge switch 203 is depicted in series with the energy dissipating device 201 to interrupt power supply to the energy dissipating device 201 until the user is ready to begin discharge. The DM voltmeter is also shown in Fig. 5 and, as illustrated, is powered by a voltmeter battery 208 when push button, depicted as a switch, is actuated to complete the circuit.

5.3. System and method

The ESM 100 and DM 200, as described above including all of the variations, may together form a system. The system may therefore comprise an engine start module 100 comprising one or more capacitors, being chargeable to a charged state and configured to provide power to start a vehicle when in the charged state, and a socket 104 providing for electrical connection to the one or more capacitors. The system may further comprise a discharge module (DM) comprising a plug 204 configured to connect to the socket 104 of the engine start module 100 and form an electrical connection with the one or more capacitors, and an energy dissipation device 201 providing an electrical load to dissipate electrical energy received from the capacitors of the engine start module 100 via the plug 204 to allow for discharge of the capacitors.

Another form of the present technology is a method, such as a method of discharging one or more capacitors of an engine start module. The engine start module may be the ESM 100 as described above including any of the variations. The method may comprise using the DM 200 as described above including any of the variations. The method may be performed by a user or technician of the vehicle or machine in which the ESM 100 is installed and the user or technician may use the DM 200 to discharge the ESM 100 prior to commencing work on the vehicle or machine, as a safety precaution.

The method may therefore comprise connecting the DM 200 to the ESM 100 so that the DM 200 provides an electrical load to discharge the one or more capacitors. The method may then comprise actuating the discharge switch 203 to complete an electrical connection between the one or more capacitors and the electrical load in the DM 200. The method may then comprise a step of reading a voltage displayed on the DM 200 to confirm that the one or more capacitors are substantially

discharged, where the voltage indicates a level of charge of the capacitors. The DM 200 may comprise the discharge switch 203, for example on a control panel 214 thereof.

In some examples, the method may also comprise connecting the plug 204 of the DM 200 to the socket 104 of the ESM 100 to form an electrical connection with the one or more capacitors of the ESM 100. After discharge is complete, the method may further comprise disconnecting the plug 204 of the DM 200 from the socket 104 of the ESM 100 after confirming that the one or more capacitors are substantially discharged.

In preferred examples, the method may comprise discharging the one or more capacitors without making any electrical connections other than connecting the plug 204 to the socket 104. This may advantageously provide for safe discharge able to be performed by a user or technician with fewer qualifications that may otherwise be required.

Prior to reading the voltage displayed on the DM 200, the method may comprise a step of powering-on a voltmeter 206 of the DM 200 by actuating a voltmeter switch 209. The step of actuating the voltmeter switch 209 may enable power to be provided from a voltmeter battery 208 to the voltmeter 206.

In some examples, the step of reading the voltage comprises reading a digital display indicating a number of volts. The step of reading the voltage may comprise reading an initial voltage indicating that the capacitors are not discharged, waiting for the capacitors to discharge and reading a final voltage indicating that the capacitors are substantially discharged. The step of reading a final voltage may comprise reading a voltage of 3V or less, preferably 2V or less, preferably 1V or less, preferably 0V. In some scenarios, less than 2V or 3V may be considered safe. In other scenarios it may be considered necessary to wait for the capacitors to have a voltage of no more than 1V or 0V.

In some examples, the method may comprise leaving the plug 204 of the DM 200 connected to the socket 104 of the ESM 100 while work is conducted on a vehicle in which the ESM 100 is installed. If, for whatever reason, the capacitors inadvertently began to be energised, the DM 200 may advantageously dissipate that energy.

In some examples, the method comprises, after confirming that the one or more capacitors are substantially discharged, disconnecting the plug 204 of the DM 200 from the socket 104 of the ESM 100 and connecting a temporary plug to the socket 104. The temporary plug may comprise a shorting wire

configured to keep the one or more capacitors of the ESM 100 discharged. In some examples, the temporary plug 104 may comprise an indicator (e.g. an indicating device) configured to provide an indication (e.g. an alarm/alert) that the one or more capacitors of the ESM 100 are not substantially discharged. The indication provided by the temporary plug may prompt a worker to check the ESM 100 and discharge the capacitors as required, for example using the DM 200. The indication may be provided if the shorting wire of the temporary plug becomes open-circuited and the capacitors become at least partially energised (e.g. due to a fault or inadvertent recharging), which may generate the alert. If the capacitors are discharged, there may be no voltage available that can energise the indicator to generate the alert. Alternatively, the temporary plug may provide an indication that the capacitors are (or remain) discharged.

Unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise", "comprising", and the like, are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense, that is to say, in the sense of "including, but not limited to".

The entire disclosures of all applications, patents and publications cited above and below, if any, are herein incorporated by reference.

Reference to any prior art in this specification is not, and should not be taken as, an acknowledgement or any form of suggestion that that prior art forms part of the common general knowledge in the field of endeavour in any country in the world.

The technology may also be said broadly to consist in the parts, elements and features referred to or indicated in the specification of the application, individually or collectively, in any or all combinations of two or more of said parts, elements or features.

Where in the foregoing description reference has been made to integers or components having known equivalents thereof, those integers are herein incorporated as if individually set forth.

It should be noted that various changes and modifications to the presently preferred embodiments described herein will be apparent to those skilled in the art. Such changes and modifications may be made without departing from the spirit and scope of the technology and without diminishing its attendant advantages. It is therefore intended that such changes and modifications be included within the present technology.

CLAIMS

1. An engine start module (ESM) for a vehicle, the engine start module comprising:

one or more capacitors, being chargeable to a charged state and configured to provide power to start a vehicle when in the charged state;

one or more connectors for forming a first set of electrical connections between the one or more capacitors and at least one starter motor of the vehicle;

a socket configured to receive a plug of a discharge module configured to discharge the one or more capacitors to a substantially uncharged state, the socket providing for electrical connection between the discharge module and the one or more capacitors, the socket being connectable to the plug of the discharge module without disconnection of the first set of electrical connections.

2. The engine start module of claim 1, wherein the engine start module comprises a housing, the one or more capacitors of the engine start module being housed in the housing and the socket being located on or outside of the housing.

3. The engine start module of claim 1 or claim 2, wherein the engine start module comprises multiple banks of capacitors in parallel.

4. The engine start module of any one of claims 1-3, wherein the engine start module comprises a voltmeter configured to measure a voltage of the engine start module and a display device to display the voltage measured by the voltmeter.

5. The engine start module of claim 4, wherein the display device is a digital display to display a number of volts.

6. The engine start module of claim 4 or claim 5, wherein the voltmeter is activated by a switch.

7. The engine start module of any one of claims 1-6, wherein the engine start module is connectable to one or more vehicle running batteries to enable the vehicle running batteries to charge the one or more capacitors.

8. The engine start module of claim 7, wherein the vehicle running batteries are charged by an alternator of the vehicle and power a running circuit separate to a cranking circuit powered by the engine start module.

9. The engine start module of any one of claims 1-6, wherein the engine start module comprises one or more vehicle running batteries configured to charge the one or more capacitors.

10. The engine start module of claim 9, wherein the vehicle running batteries are connectable to an alternator of the vehicle for charging of the vehicle running batteries and power a running circuit separate to a cranking circuit powered by the engine start module.

11. The engine start module of any one of claims 1-10, wherein the one or more capacitors of the engine start module are connected to the starter motor via an isolation station on the vehicle.

12. The engine start module of any one of claims 1-11, wherein the socket forms part of a switch-rated connector assembly with the plug.

13. A discharge module for discharging an engine start module of a vehicle, the discharge module comprising:

a plug configured to connect to a socket of the engine start module and form an electrical connection with the engine start module;

an energy dissipation device providing an electrical load to dissipate electrical energy received from the engine start module via the plug to allow for discharge of the engine start module.

14. The discharge module of claim 13, wherein the plug forms part of a switch-rated connector assembly with the socket.

15. The discharge module of claim 13 or claim 14, wherein the discharge module comprises a housing, the energy dissipating device of the discharge module being housed in the housing, and the plug being on a lead extending from the housing.

16. The discharge module of any one of claims 13-15, wherein the energy dissipating device of the discharge module is configured to dissipate the energy as heat.

17. The discharge module of claim 16, wherein the energy dissipating device comprises a resistor.

18. The discharge module of claim 17, wherein the energy dissipating device comprises a grid resistor.

19. The discharge module of any one of claims 13-18, wherein the energy dissipating device is configured to discharge the capacitors in under 10 minutes.

20. The discharge module of claim 19, wherein the energy dissipating device is configured to discharge the capacitors in under 7 minutes.

21. The discharge module of claim 20, wherein the energy dissipating device is configured to discharge the capacitors in under 5 minutes.

22. The discharge module of any one of claims 13-21, wherein the discharge module comprises a switch to complete the electrical connection between the engine start module and the energy dissipating device.

23. The discharge module of any one of claims 13-22, wherein the discharge module comprises a voltmeter configured to measure a voltage of the engine start module indicating a level of charge of the engine start module, and further comprises a display device configured to display the voltage measured by the voltmeter to a user of the discharge module.

24. The discharge module of claim 23, wherein the voltmeter is powered by a power source other than the engine start module.

25. The discharge module of claim 24, wherein the voltmeter is self-powered by a voltmeter battery.

26. The discharge module of any one of claims 23-25, wherein the voltmeter is activated by a switch.

27. A discharge module for discharging an engine start module, the discharge module comprising:

an energy dissipation device electrically connectable to the engine start module and providing an electrical load to dissipate electrical energy to discharge the engine start module;

a voltmeter configured to measure a voltage of the engine start module indicating a level of charge of the engine start module;

a display device configured to display the voltage measured by the voltmeter to a user of the discharge module.

28. The discharge module of claim 27, wherein the discharge module further comprises a plug configured to connect to a socket of the engine start module and form an electrical connection with the engine start module.

29. The discharge module of claim 28, wherein the discharge module comprises a housing, the energy dissipating device of the discharge module being housed in the housing, and the plug being on a lead extending from the housing.

30. The discharge module of any one of claims 27-29, wherein the energy dissipating device of the discharge module is configured to dissipate the energy as heat.

31. The discharge module of claim 30, wherein the energy dissipating device is a resistor.

32. The discharge module of claim 31, wherein the energy dissipating device is a grid resistor.

33. The discharge module of any one of claims 27-32, wherein the energy dissipating device is configured to discharge the capacitors in under 10 minutes.

34. The discharge module of claim 33, wherein the energy dissipating device is configured to discharge the capacitors in under 7 minutes.

35. The discharge module of claim 34, wherein the energy dissipating device is configured to discharge the capacitors in under 5 minutes.

36. The discharge module of any one of claims 27-35, wherein the discharge module comprises a switch to complete the electrical connection between the engine start module and the energy dissipating device.

37. The discharge module of any one of claims 27-36, wherein the voltmeter is self-powered by a voltmeter battery.

38. The discharge module of any one of claims 27-37, wherein the voltmeter is activated by a switch.

39. The discharge module of any one of claims 27-38, wherein the display device is a digital display.

40. A system comprising:

an engine start module comprising:

one or more capacitors, being chargeable to a charged state and configured to provide power to start a vehicle when in the charged state;

a socket providing for electrical connection to the one or more capacitors;

a discharge module comprising:

a plug configured to connect to the socket of the engine start module and form an electrical connection with the one or more capacitors;

an energy dissipation device providing an electrical load to dissipate electrical energy received from the capacitors of the engine start module via the plug to allow for discharge of the one or more capacitors.

41. The system of claim 40, wherein the plug and socket form a switch-rated connector assembly.

42. The system of claim 40 or claim 41, wherein the engine start module comprises a housing, the one or more capacitors of the engine start module being housed in the housing and the socket being located on or outside of the housing.

43. The system of any one of claims 40-42, wherein the engine start module comprises a voltmeter configured to measure a voltage of the engine start module and a display device to display the voltage measured by the voltmeter

44. The system of any one of claims 40-43, wherein the engine start module is connectable to one or more vehicle running batteries to enable the vehicle running batteries to charge the one or more capacitors.

45. The system of claim 44, wherein the vehicle running batteries are charged by an alternator of the vehicle and power a running circuit separate to a cranking circuit powered by the engine start module.

46. The system of any one of claims 40-45, wherein the discharge module comprises a housing, the energy dissipating device of the discharge module being housed in the housing, and the plug being on a lead extending from the housing.

47. The system of any one of claims 40-46, wherein the energy dissipating device of the discharge module is configured to dissipate the energy as heat.

48. The system of any one of claims 40-47, wherein the discharge module comprises a switch to complete the electrical connection between the engine start module and the energy dissipating device

49. The system of any one of claims 40-48, wherein the discharge module comprises a voltmeter configured to measure a voltage of the engine start module indicating a level of charge of the engine start module, and further comprises a display device configured to display the voltage measured by the voltmeter to a user of the discharge module.

50. The system of claim 49, wherein the voltmeter of the discharge module is powered by a power source other than the engine start module.

51. The system of any one of claims 40-49, comprising a temporary plug configured to be connected to the socket in place of the discharge module plug after the one or more capacitors are substantially discharged, the temporary plug comprising a shorting wire configured to keep the one or more capacitors of the engine start module discharged.

52. The system of claim 51, wherein the temporary plug comprises an indicator configured to provide an indication that the one or more capacitors of the engine start module are not discharged.

53. A method of discharging one or more capacitors of an engine start module, the method comprising:

connecting a discharge module to the engine start module, the discharge module providing an electrical load to discharge the one or more capacitors;

actuating a discharge switch to complete an electrical connection between the one or more capacitors and the electrical load in the discharge module;

reading a voltage displayed on the discharge module to confirm that the one or more capacitors are substantially discharged, the voltage indicating a level of charge of the capacitors.

54. The method of claim 53, wherein the discharge module comprises the discharge switch.

55. The method of claim 53 or claim 54, wherein the method comprises connecting a plug of the discharge module to a socket of the engine start module to form an electrical connection with the one or more capacitors of the engine start module.

56. The method of claim 55, wherein the method comprises disconnecting the plug of the discharge module from the socket of the engine start module after confirming that the one or more capacitors are substantially discharged.

57. The method of claim 55 or claim 56, wherein the method comprises discharging the one or more capacitors without making any electrical connections other than connecting the plug to the socket.

58. The method of any one of claims 55-57, wherein prior to reading the voltage displayed on the discharge module the method comprises a step of powering-on a voltmeter of the discharge module by actuating a voltmeter switch.

59. The method of claim 58, wherein the step of actuating the voltmeter switch enables power to be provided from a voltmeter battery to the voltmeter.

60. The method of any one of claims 55-59, wherein the step of reading the voltage comprises reading a digital display indicating a number of volts.

61. The method of claim 60, wherein the step of reading the voltage comprises reading an initial voltage indicating that the capacitors are not discharged, waiting for the capacitors to discharge and reading a final voltage indicating that the capacitors are substantially discharged.

62. The method of claim 61, wherein the step of reading a final voltage comprises reading a voltage of 1V or less.

63. The method of claim 62, wherein the step of reading a final voltage comprises reading a voltage of 0V.

64. The method of any one of claims 56-63, wherein the method comprises leaving the plug of the discharge module connected to the socket of the engine start module while work is conducted on a vehicle in which the engine start module is installed.

65. The method of any one of claims 56-63, wherein the method comprises, after confirming that the one or more capacitors are substantially discharged, disconnecting the plug of the discharge module from the socket of the engine start module and connecting a temporary plug to the socket.

66. The method of claim 65, wherein the temporary plug comprises a shorting wire configured to keep the one or more capacitors of the engine start module discharged.

67. The method of claim 65 or claim 66, wherein the temporary plug comprises an indicator configured to provide an indication that the one or more capacitors of the engine start module are not discharged.

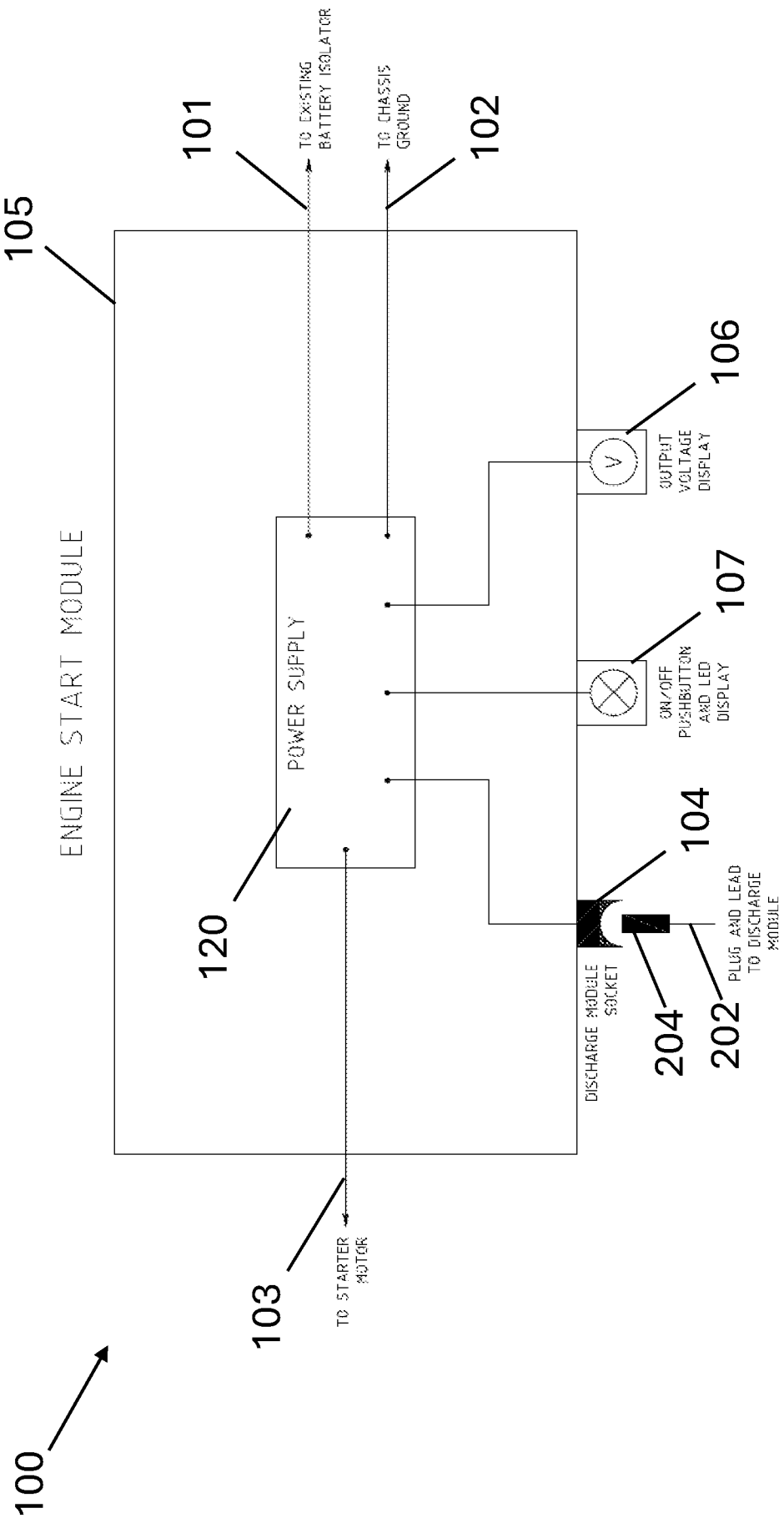
100
105
ENGINE START MODULE
101
TO EXISTING BATTERY ISOLATOR
102
TO CHASSIS GROUND
106
V
OUTPUT VOLTAGE DISPLAY
107
ON/OFF PUSHBUTTON AND LED DISPLAY
120
POWER SUPPLY
104
DISCHARGE MODULE SOCKET
204
202
PLUG AND LEAD TO DISCHARGE MODULE
103
TO STARTER MOTOR

Fig. 1

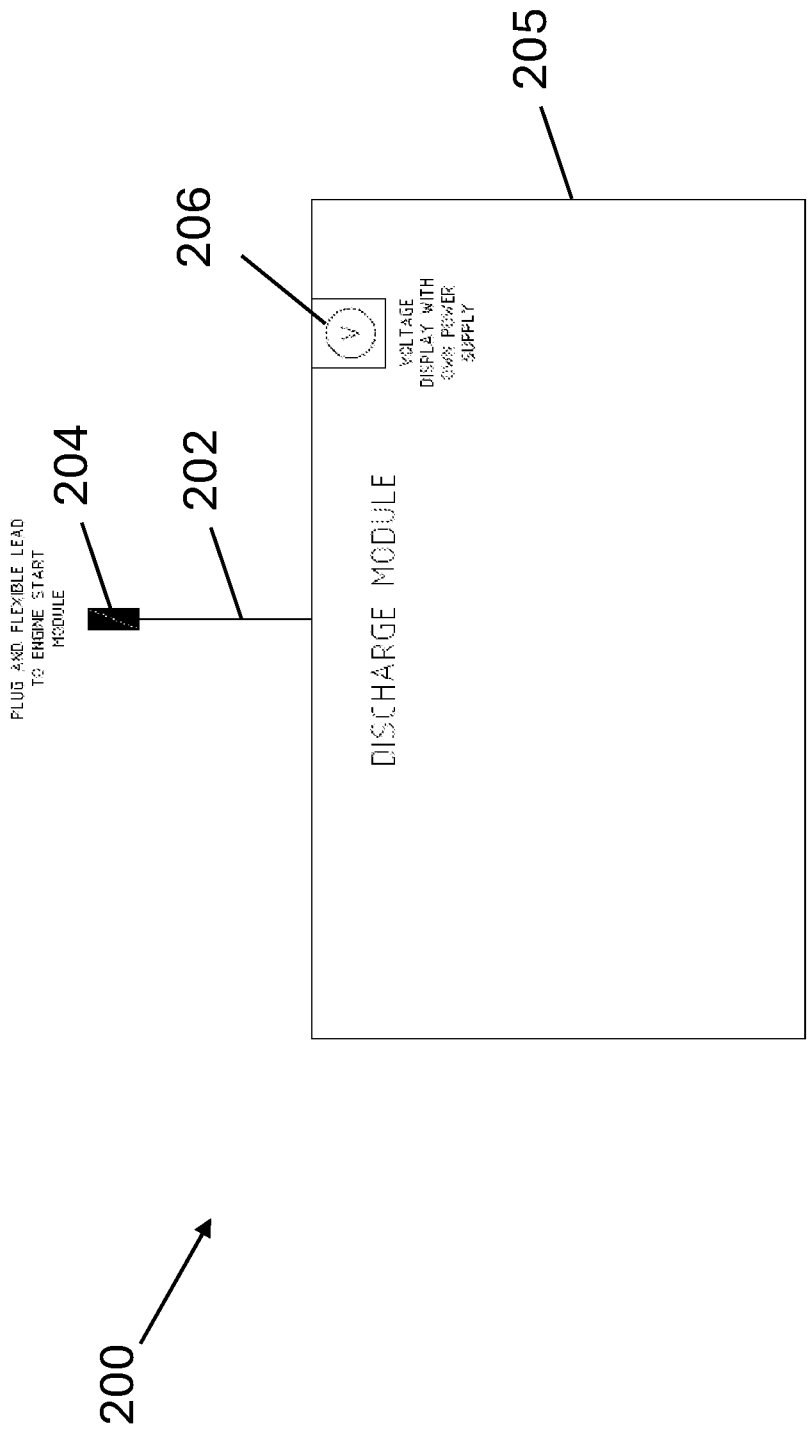
205
206
V
VOLTAGE
DISPLAY WITH
OWN POWER
SUPPLY
204
202
PLUG AND FLEXIBLE LEAD
TO ENGINE START
MODULE
DISCHARGE MODULE
200

Fig. 2

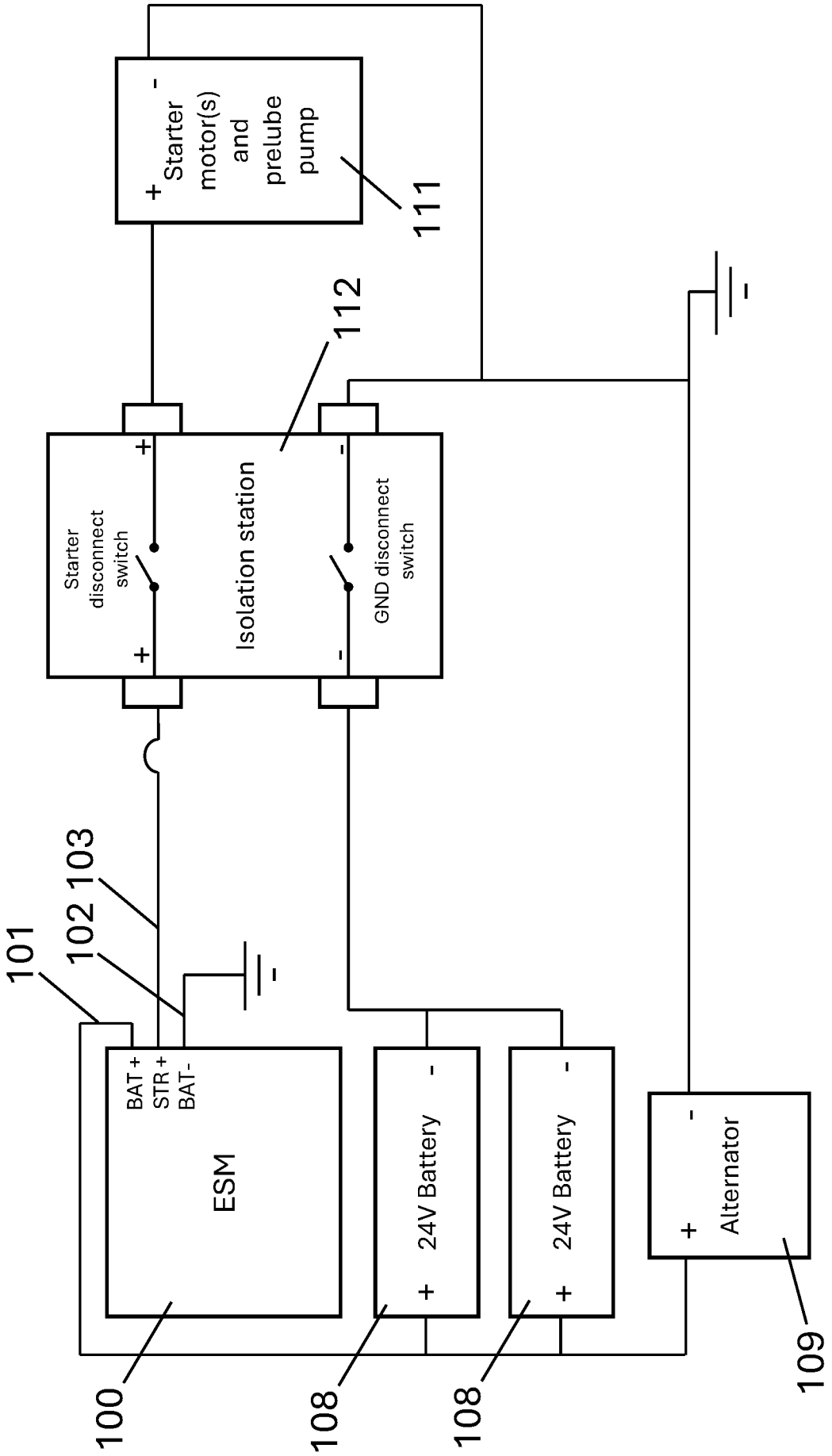
Starter motor(s) and prelube pump
111
112
Starter disconnect switch
Isolation station
GND disconnect switch
101
102
103
BAT +
STR +
BAT-
ESM
24V Battery
24V Battery
Alternator
100
108
108
109

Fig. 3

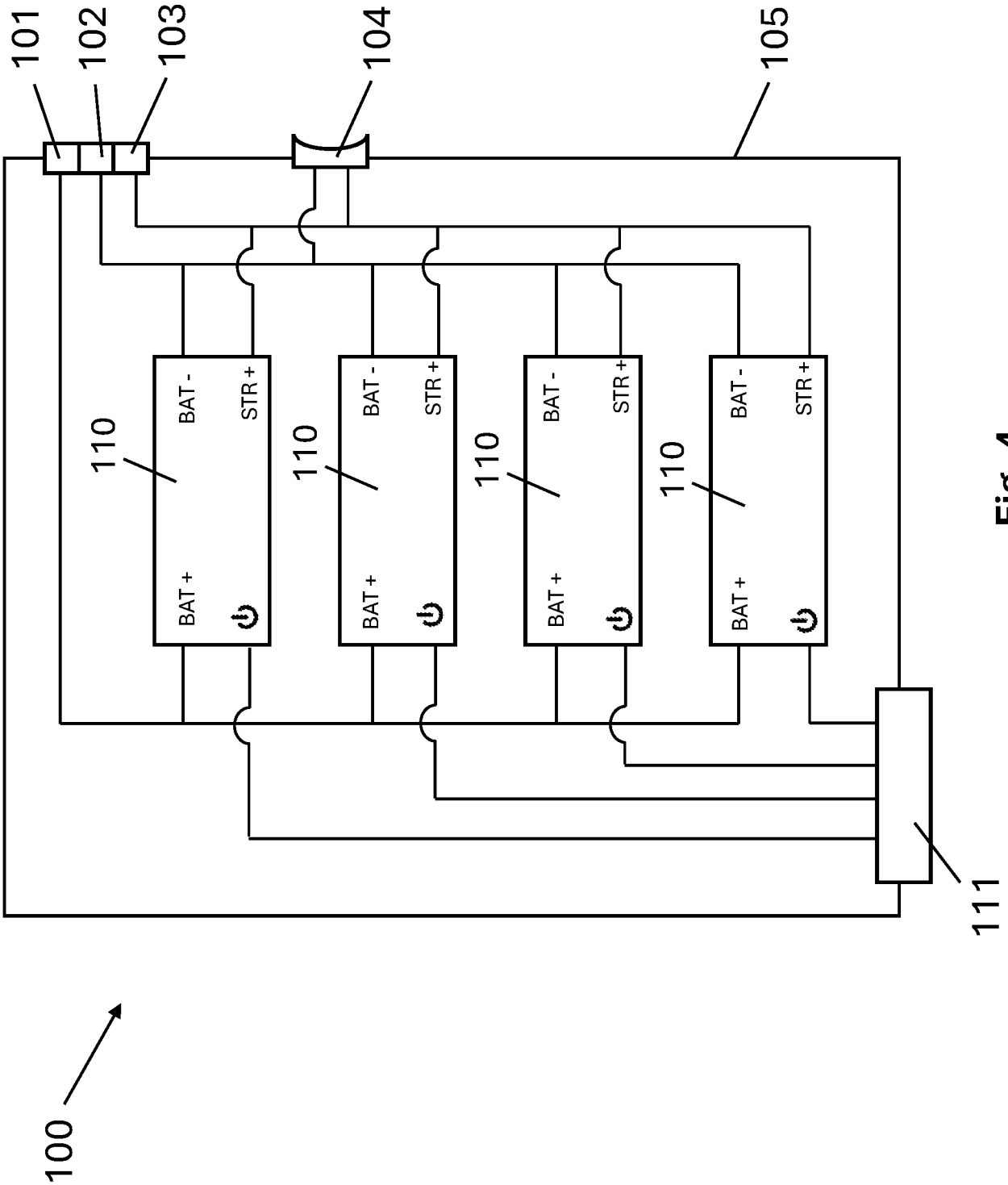

Fig. 4

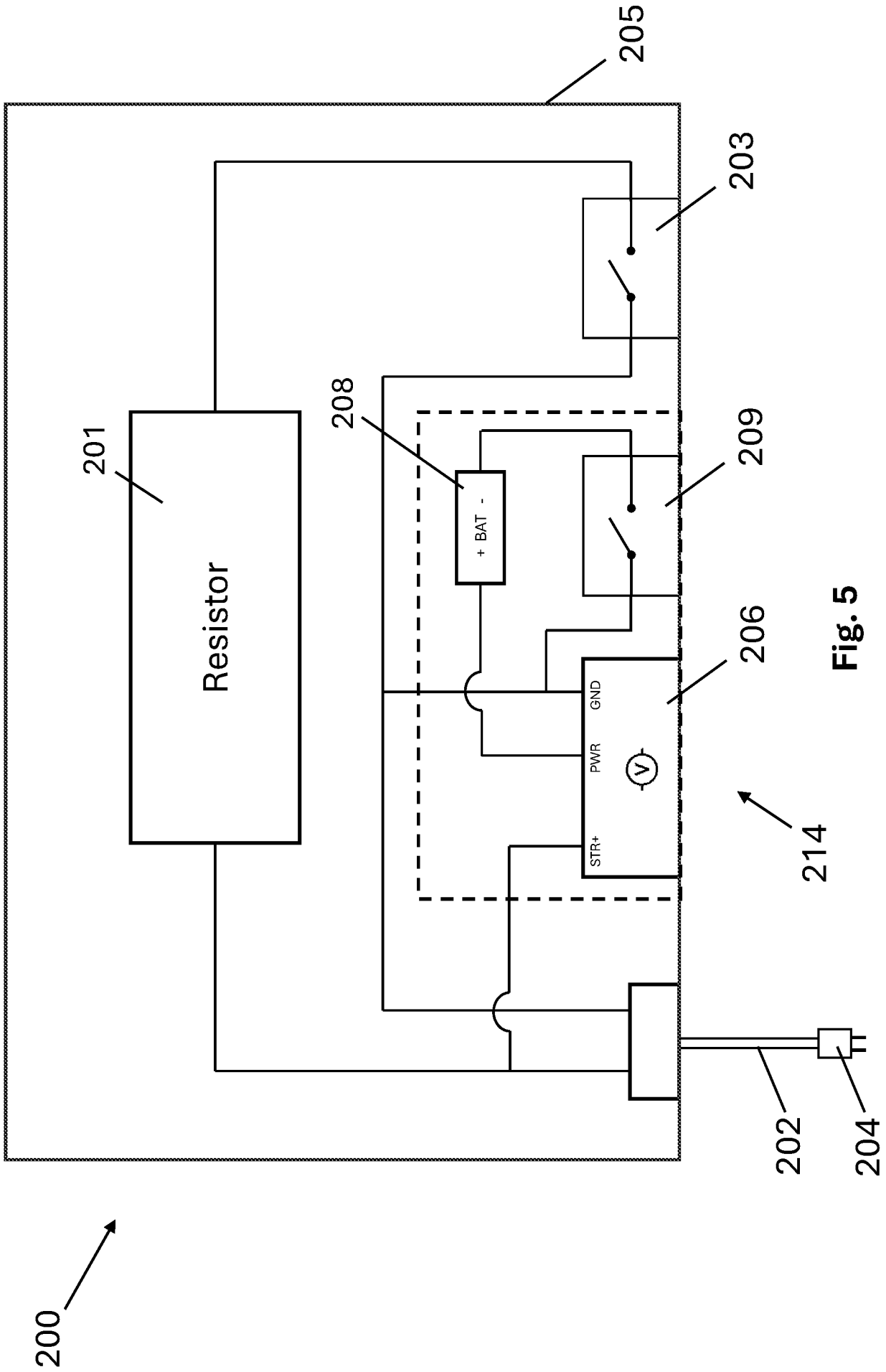
205
203
208
201
209
Resistor
+ BAT -
206
GND
PWR
V
STR+
214
202
204
200

Fig. 5

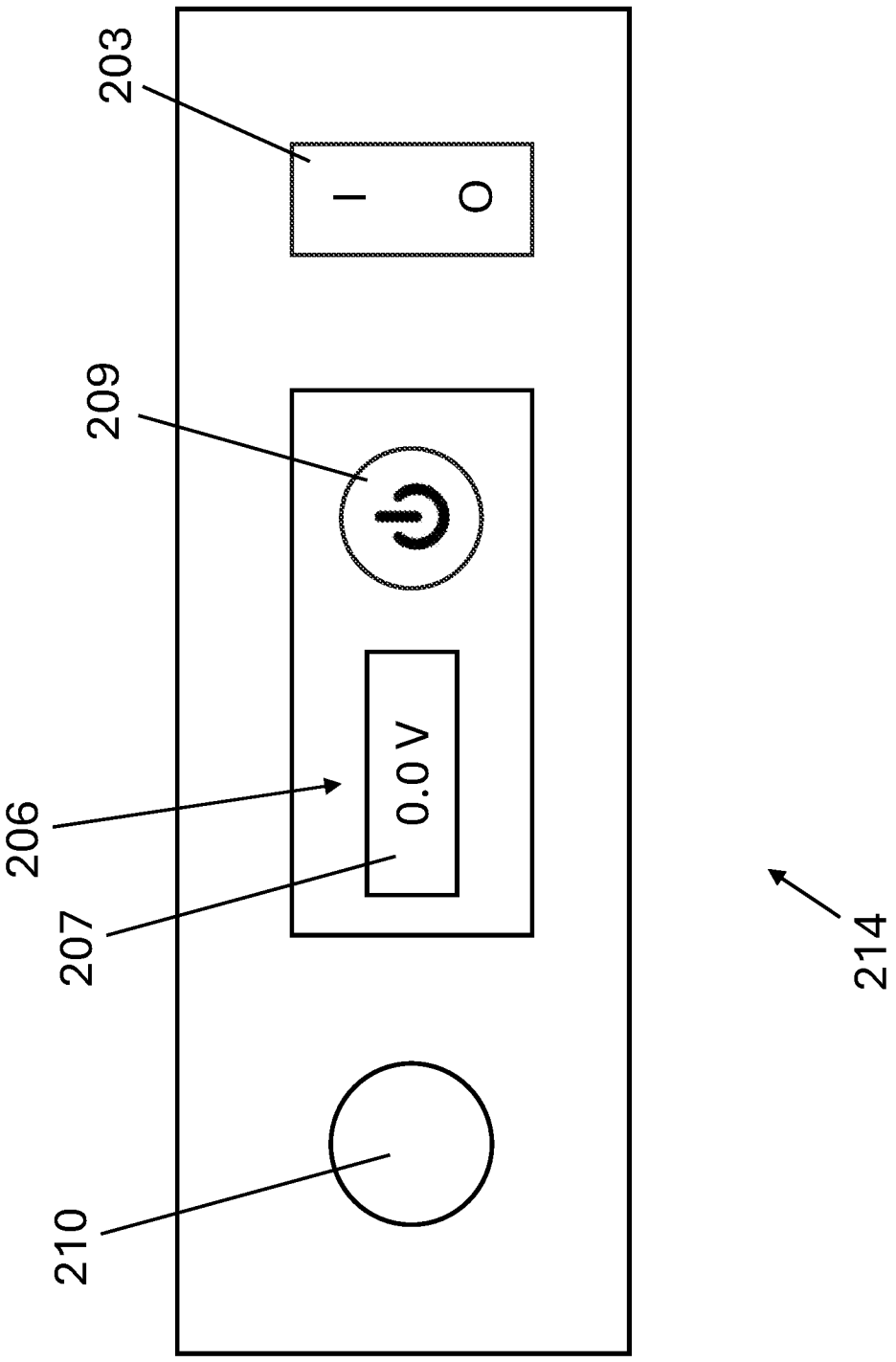

Fig. 6

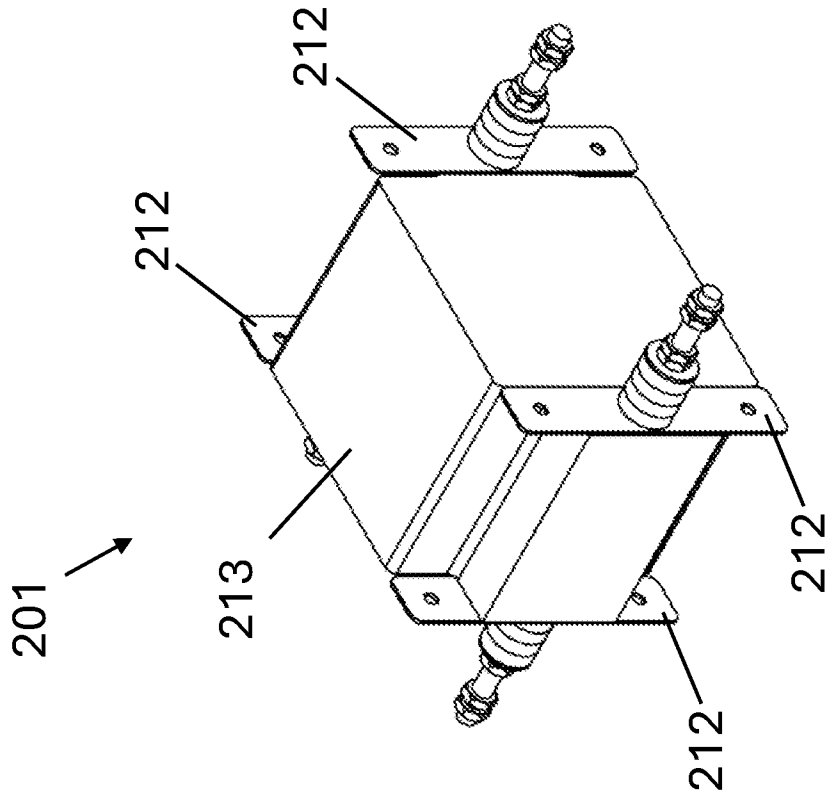

Fig. 8

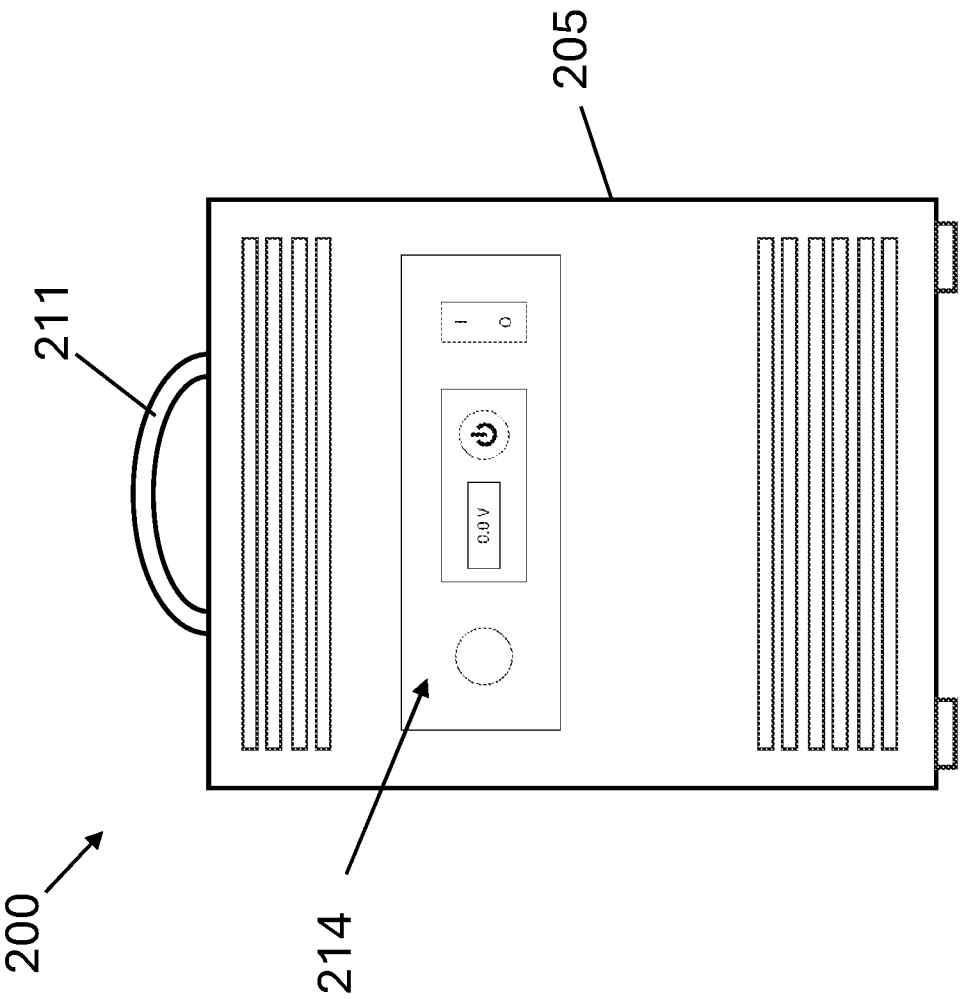

Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2024/051095

A. CLASSIFICATION OF SUBJECT MATTER

F02N 11/08 (2006.01) B60R 16/03 (2006.01) H02J 7/00 (2006.01) H02J 7/34 (2006.01)

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)

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)

PATENW: CPC IPC H01G11/78, H01G9/08, H01G4/224, H01G2/10, F02N19/00, F02N11/0862, F02N2011/0881, F02N15/00, B60R16/033, H02J7/007 with keywords: remove, detach, connect, attach, mount, exterior, external, outside, casing, housing, encapsulation, bleed, resistor, leak, discharge and similar terms/combinations.

Google Patents: Keywords as above. **Espacenet:** Keywords as above.

PATENW, GOOGLE, AUSPAT & IP Australia Internal Systems: Applicant and Inventor Search

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

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

"D" document cited by the applicant in the international application

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"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 February 2025	21 February 2025
Name and mailing address of the ISA/AU	**Authorised officer**
AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaustralia.gov.au	Mukunthan Krishnapillai AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. +61 2 6285 0739

INTERNATIONAL SEARCH REPORT C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		International application No. **PCT/AU2024/051095**
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KR 101729632 B1 (NUINTEK CO., LTD.) 02 May 2017 fig. 1, 3-4	1-12
X	KR 101436787 B1 (NUINTEK CO., LTD.) 11 September 2014 fig. 1-2	1-3, 7-11
A	CN 114883111 A (CHINA FAW GROUP CORPORATION) 09 August 2022 whole document.	
A	CN 209544163 U (ANHUI HANYU ELECTRIC CO., LTD.) 25 October 2019 whole document.	
A	US 2014/0049205 A1 (CURIEL) 20 February 2014 whole document.	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2024/051095

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
the subject matter listed in Rule 39 on which, under Article 17(2)(a)(i), an international search is not required to be carried out, including

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See Supplemental Box for Details

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-12

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Supplemental Box

Continuation of: **Box III**

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art. When there is no special technical feature common to all the claimed inventions there is no unity of invention.

This Authority has found that there are different inventions based on the following features that separate the claims into distinct groups:

Group 1

Claims **1-12** are directed to an engine start module (ESM).

The claims define the features of the ESM including:

- one or more capacitors;
- one or more connectors;
- a socket configured to receive a plug of a discharge module.

The claims do not define any features of the discharge module beyond the plug.

Group 2

Claims **13-26** are directed to a discharge module (DM).

The claims define the features of the DM including:

- a plug configured to connect to a socket of the engine start module;
- an energy dissipation device.

The claims do not define any features of the ESM beyond the socket and also does not define other features of the DM defined in other Groups (e.g. voltmeter, display device etc)

Group 3

Claims **27-39** are directed to a discharge module (DM).

The claims define the features of the DM including:

- an energy dissipation device electrically connectable to the engine start module;
- a voltmeter;
- a display device.

Supplemental Box

The claims do not define any features of the ESM beyond being electrically connected to the energy dissipation device.

Group 4

Claims **40-52** are directed to a system comprising an engine start module (ESM) and a discharge module (DM) comprising.

The claims define the feature of the ESM and DM including:

- one or more ESM capacitors,
- an ESM socket;
- a DM plug configured to connect to the socket of the ESM;
- a DSM energy dissipation device.

The claims do not define the ESM connectors or some of the DM features defined in other Groups (e.g. voltmeter, display device etc).

Group 5

Claims **53-67** are directed to a method of discharging one or more capacitors of an engine start module (ESM).

The claims define the feature of:

- connecting a discharge module (DM) to the engine start module;
- one or more capacitors;
- actuating a discharge switch;
- reading a voltage displayed on the discharge module.

The claims do not define features of the ESM beyond its capacitors. The claims also do not define some of the features of the DM defined in other Groups (e.g. energy dissipation device etc).

In the above groups of claims, the identified features may have the potential to make a contribution over the prior art but are not common to all the claimed inventions and therefore cannot provide the required technical relationship. The only features common to **all of the claimed inventions** and which provides a technical relationship among them is:

a discharge module connected to an engine start module.

However this feature does not make a contribution over the prior art because it is disclosed in:

KR 101729632 B1 (NUINTEK CO., LTD.) 02 May 2017

Therefore, in the light of this document the common features cannot be a special technical feature. Therefore, there is no special technical feature common to all the claimed inventions and the requirements for unity of invention are consequently not satisfied ***a posteriori***.

INTERNATIONAL SEARCH REPORT	International application No. PCT/AU2024/051095

Supplemental Box

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2024/051095**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
KR 101729632 B1	02 May 2017	KR 101729632 B1	02 May 2017
KR 101436787 B1	11 September 2014	KR 101436787 B1	11 Sep 2014
		WO 2015102195 A1	09 Jul 2015
CN 114883111 A	09 August 2022	CN 114883111 A	09 Aug 2022
		CN 114883111 B	10 May 2024
CN 209544163 U	25 October 2019		
US 2014/0049205 A1	20 February 2014	US 2014049205 A1	20 Feb 2014
		US 10361030 B2	23 Jul 2019
		MX 2012009622 A	25 Feb 2014
		MX 338053 B	31 Mar 2016

End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.