

(43) International Publication Date
24 November 2011 (24.11.2011)(10) International Publication Number
WO 2011/144490 A1(51) International Patent Classification:
H02J 7/00 (2006.01)(21) International Application Number:
PCT/EP2011/057477(22) International Filing Date:
10 May 2011 (10.05.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10 2010 020 746.2 17 May 2010 (17.05.2010) DE(71) Applicant (for all designated States except US): **TYCO ELECTRONICS AMP GMBH** [DE/DE]; Ampere-strasse 12-14, 64625 Bensheim (DE).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **EINHORN, Joerg** [DE/DE]; Fachinger Strasse 27B, 13591 Berlin (DE).(74) Agent: **HEINZ-SCHAEFER, Marion**; Tyco Electronics UK LTD, European Patent Department, Faraday Road, Dorcan, Swindon Wiltshire SN3 5HH (GB).

(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, BR, BW, BY, BZ,

CA, CH, CL, CN, CO, CR, CU, CZ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, 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, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, 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, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- of inventorship (Rule 4.17(iv))

Published:

- with international search report (Art. 21(3))

(54) Title: METHOD AND CIRCUIT FOR INVERSE POLARITY PROTECTION CIRCUIT FOR A JUMP-START TERMINAL

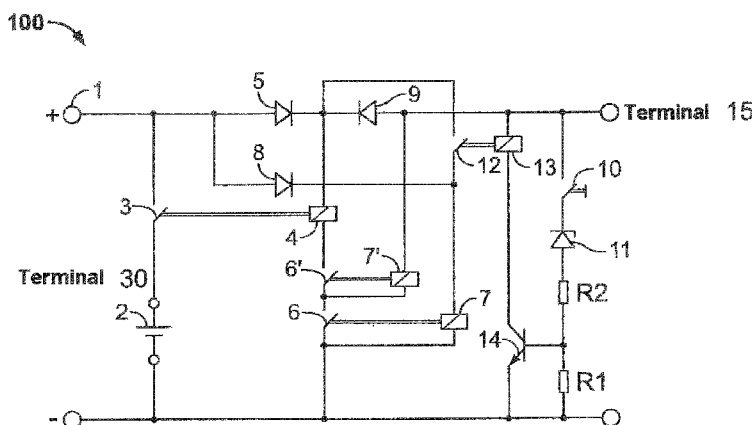


Fig. 1

(57) Abstract: The present invention relates to a polarity-reversal protection circuit for a jump-start terminal (1) in a motor vehicle, comprising a first switching element (3) arranged between the vehicle electrical system (2) and the jump-start terminal (1), a means for detecting a polarity of the voltage applied to the jump-start terminal (1), a first switching control element (4) adapted to control the first switching element (3), a second and third switching element (6, 6') operatively coupled to the first switching control element (4), a second and third switching control element (7, 7') adapted to control the second and third switching element (6, 6'), respectively in response to the detected polarity and a voltage applied by the vehicle electrical system (2). The polarity-reversal protection circuit comprises a pushbutton (10) adapted to cause closure of the second switching element (6), thereby closing the first switching element (3) if a voltage applied to the vehicle electrical system (2) is greater than a predetermined threshold value.

METHOD AND CIRCUIT FOR INVERSE POLARITY PROTECTION CIRCUIT FOR A JUMP-START TERMINAL

The present invention relates to a polarity-reversal protection circuit for a jump-start
5 terminal in a motor vehicle, the polarity-reversal protection circuit comprising a first
switching element which is arranged between a vehicle electrical system of the motor
vehicle and the jump-start terminal, a means for detecting a polarity of the voltage applied
to the jump-start terminal, and a first switching control element which is adapted to close
the first switching element in the case of a predetermined polarity. Furthermore, this
10 polarity-reversal protection circuit comprises a second switching element which is arranged
between the first switching control element and earth, and in the closed state connects the
first switching control element to earth, and a second switching control element which is
adapted to close the second switching element in the case of the predetermined polarity.

The polarity-reversal protection circuit furthermore comprises a third switching element
15 which is arranged between the first switching control element and the second switching
element and in the closed state connects the first switching control element to earth via the
second switching element, and a third switching control element which is adapted to close
the third switching element if the third switching control element is supplied with electricity
from the vehicle electrical system, which closes the first switching element, the third
20 switching control element furthermore being adapted to open the third switching element if
the electrical supply is switched off by the vehicle electrical system.

Such a polarity-reversal protection circuit is known from laid-open German patent
application DE 10 2008 018 065 A1. After a brief explanation of the principle of polarity-
reversal protection, this polarity-reversal protection circuit will be described, and its
25 advantages and disadvantages will be discussed, below.

It is known to associate a polarity-reversal protection with the individual electrical
components in a motor vehicle, which are highly sensitive to electrical reversals of polarity.
The polarity-reversal protection can be ensured in various ways. For example, mechanical
devices may be provided which ensure that electrical connections cannot be produced with

the incorrect polarity, such as an asymmetrically constructed plug which can be inserted only in one direction and thus prevents reversal of polarity of the connections. In the case of electrical polarity-reversal protection, it is ensured by means of suitable circuits and components, such as for example polarity-reversal protection diodes, that no damage is
5 caused in the connected device when electrical voltages are applied with the incorrect polarity.

Several simple circuit variants may be provided. For example, a diode may be connected in series with the supply voltage, so that the device no longer receives any current if the polarity is reversed. Alternatively, a diode may be connected in parallel to the supply
10 voltage. A relay which switches the supply voltage through to the consumer with the aid of a diode may also be used. However, these simple solutions cannot always be used. In a starter circuit of a vehicle, for example, the current is too high for a diode to be able to be connected in series with the supply voltage.

If a battery of a first motor vehicle is discharged, that is to say there is insufficient power
15 available, it is known to connect a battery of a second motor vehicle via the discharged battery in order to start the engine of the first vehicle. Such a technique is generally known as jump-starting. If the battery of a motor vehicle is arranged not in the engine compartment but elsewhere in the vehicle, it has become conventional practice to provide jump-start connections in the engine compartment which can be connected to a battery of a second
20 vehicle, should the battery of the first vehicle become discharged. If the second battery is not connected correctly to the jump-start connections, i.e. with the incorrect polarity, electrical components in the first vehicle may be damaged. This applies in particular to diodes which are connected to the generator of the first vehicle.

Laid-open German patent application DE 100 47 791 A1 describes a polarity-reversal
25 protection for a jump-start terminal in a motor vehicle, wherein a switching element is arranged between a vehicle electrical system of the motor vehicle and the jump-start terminal, with which element a means for detecting the polarity of the voltage applied to the jump-start terminal is associated, the otherwise open switching element being able to be closed by means of the means for detecting the polarity when the polarity is correct.

Such a polarity-reversal protection circuit makes it possible both to receive a jump-start from an external vehicle and to give a jump-start to an external vehicle. However, the vehicle electrical system of the motor vehicle which has broken down has to have a minimum residual vehicle system voltage available so that the diode is poled in the direction of flow and the relay contact closes. If on the other hand the vehicle system voltage has collapsed and does not have this residual vehicle system voltage available, the relay contact has to be closed manually in order to produce the electrical connection between the two vehicle electrical systems.

The weak battery must at least be strong enough to still be able to give out sufficient coil current to drive the power relay. A power relay which has to carry a starter current of the order of several hundreds of amperes requires a correspondingly high control current through the coil, which may be up to 500 mA. If the battery is however too weak for this, not enough coil current flows to drive the relay. In such a case, the polarity-reversal protection described in the above mentioned patent application provides for the relay to have to be manually operated. If, however, the external battery is connected in reverse, damage may occur in the electrical devices. Thus the polarity-reversal protection circuit published in the above mentioned patent application has the disadvantage that there is no longer any polarity-reversal protection if the battery of the external vehicle is discharged to too great an extent.

The disadvantages associated with the polarity-reversal protection circuit described in the above mentioned published patent application DE 100 47 791 A1 are overcome by the polarity-reversal protection circuit described in published German patent application DE 10 2007 052 847 A1. The polarity-reversal protection circuit described therein comprises a second switching element which is arranged between the first switching control element and earth, and which in the closed state connects the first switching control element to earth, and a second switching control element which is adapted to close the second switching element in the case of the predetermined polarity, the second switching control element and the second switching element being formed as an auxiliary relay, the second switching element being formed as a contact of the auxiliary relay.

Thus a discharged battery of an external vehicle does not have to be able to give out the high control current of the power relay, but only the lesser control current which flows through the auxiliary relay described in this patent application. Since this control current amounts to a range of a few milliamperes, even a very weak battery of an external vehicle
5 should be able to give out such a control current.

The polarity-reversal protection circuits described in the laid-open patent applications DE 100 47 791 A1 and DE 10 2007 052 847 A1 reliably protect against damage to vehicle electrical system components in the event of reversal of polarity of the external vehicle electrical system both in the case of giving a jump-start and in the case of receiving a jump-
10 start. One disadvantage of both polarity-reversal protection circuits is however a latching effect which leaves the load relay still switched on via its own contacts, even if the jump-start operation is at an end and the jumper cable has been removed. The load relay can therefore possibly remain switched on for years. In this state, there is no longer any polarity-reversal protection, since the jump-start point and the vehicle's own electrical
15 system remain electrically connected. Furthermore, during this time, the coil current of the load relay of the order of several hundred milliamperes flows permanently, which can completely discharge the battery during long-term parking.

In order to prevent this disadvantage, the polarity-reversal protection circuit described in the
20 laid-open patent application DE 10 2008 018 065 A1 furthermore comprises a third switching element which is arranged between the first switching control element and the second switching element, and in the closed state connects the first switching control element to earth via the second switching element, and a third switching control element which is adapted to close the third switching element if the third switching control element
25 is supplied with electricity from the vehicle electrical system, which closes the first switching element, the third switching control element furthermore being adapted to open the third switching element if the electrical supply is switched off by the vehicle electrical system.

Thus, if a jump-start operation is at an end, initially all three relays, i.e. the power relay, the
30 first and second auxiliary relays, remain switched on, since now also the first auxiliary relay is supplied by the vehicle's own electrical system when the generator is running via the

contacts of the power relay. This latching effect is however remedied as soon as the ignition of the vehicle electrical system is switched off by the third switching control element. First of all, the second auxiliary relay, which is supplied with electricity by the vehicle's own electrical system, drops out. Then the power relay and finally the first auxiliary relay drops
5 out. Thus the initial state is restored. Thereafter there is no more power consumption from the vehicle electrical system by the polarity-reversal protection circuit.

In the polarity-reversal protection circuit described in the laid-open patent application DE 10 2008 018 065 A1, the second auxiliary relay ensures that the latching of the polarity-reversal protection circuit is remedied after the removal of the jumper cable with the
10 switching-off of the terminal 15. Once the jump-start has taken place (giving or receiving) and the jumper cable has been removed, the latching of the load relay initially also persists, but as soon as the ignition, i.e. the terminal 15, is switched off by the vehicle electrical system, the second auxiliary relay opens and thus switches the power relay off. Thus the latching is reset and the polarity-reversal protection circuit is ready for use again for the
15 next jump-start.

However, the polarity-reversal protection circuit described in the laid-open patent application DE 10 2008 018 065 A1 has the disadvantage that it is not operational if, in the event of jump-starting vehicles, both vehicles have such a polarity-reversal protection circuit available. Namely, no connection is possible and therefore it is not possible to give
20 or receive a jump-start.

It is therefore the object of the present invention to devise a polarity-reversal protection circuit for a jump-start terminal in a motor vehicle which permits a jump-start operation even if the two vehicles are equipped with such a polarity-reversal protection circuit. Furthermore, the object consists of devising a corresponding method for providing polarity-reversal protection for a jump-start terminal in a motor vehicle.
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This object is achieved by a polarity-reversal protection circuit in accordance with the independent Claim 1, and a method for providing polarity-reversal protection in accordance with the independent Claim 15. Preferred embodiments are the subject of the dependent claims.

A polarity-reversal protection circuit for a jump-start terminal in a motor vehicle in accordance with the present invention comprises a first switching element which is arranged between a vehicle electrical system of the motor vehicle and the jump-start terminal, a means for detecting a polarity of the voltage applied to the jump-start terminal, a first
5 switching control element which is adapted to close the first switching element in the case of a predetermined polarity, a second switching element which is arranged between the first switching control element and earth and in the closed state connects the first switching control element to earth, a second switching control element which is adapted to close the second switching element in the case of the predetermined polarity, a third switching
10 element which is arranged between the first switching control element and the second switching element and in the closed state connects the first switching control element to earth via the second switching element, and a third switching control element which is adapted to close the third switching element if the third switching control element is supplied with electricity from the vehicle electrical system, which closes the first switching
15 element, the third switching control element furthermore being adapted to open the third switching element if the electrical supply is switched off by the vehicle electrical system. The polarity-reversal protection circuit furthermore comprises a pushbutton and is adapted to cause, by manual actuation of the pushbutton, if a voltage applied to the vehicle electrical system is greater than a predetermined threshold value, the third switching control element
20 to be supplied with electricity from the vehicle electrical system, so that the third switching element is closed, which closes the first switching element.

Due to the fact that the polarity-reversal protection circuit furthermore comprises a pushbutton and is adapted to cause, by manual actuation of the pushbutton, if a voltage applied to the vehicle electrical system is greater than a predetermined threshold value, the
25 third switching control element to be supplied with electricity from the vehicle electrical system, so that the third switching element is closed, which closes the first switching element, a jump-start operation between two vehicles which have such a polarity-reversal protection circuit can take place.

According to one embodiment of the present invention, the polarity-reversal protection
30 circuit furthermore comprises an evaluation unit for evaluating the voltage applied to the

vehicle electrical system, the evaluation unit furthermore being adapted to establish whether the voltage applied to the vehicle electrical system is greater than the predetermined threshold value.

5 According to one advantageous embodiment of the present invention, the evaluation unit is a Zener diode which is connected in the reverse direction between the vehicle electrical system and earth. Alternatively, the evaluation unit may consist of a comparator.

10 According to one embodiment of the present invention, the polarity-reversal protection circuit furthermore comprises a fourth switching element which is adapted that the third switching control element in the closed state of the fourth switching element is supplied with electricity from the vehicle electrical system, and a fourth switching control element which is adapted to close the fourth switching element if the voltage applied to the vehicle electrical system is greater than the predetermined threshold value.

15 According to one embodiment of the present invention, the fourth switching control element and the fourth switching element are formed as an auxiliary relay, the fourth switching element being formed as a contact of the auxiliary relay and the fourth switching control element furthermore comprising an NPN bipolar transistor, the fourth switching control element being inserted between the collector of the NPN bipolar transistor and the vehicle electrical system, and the base of the NPN bipolar transistor being connected to the evaluation unit, so that the NPN bipolar transistor is switched to conducting if the voltage
20 applied to the vehicle electrical system is greater than the predetermined threshold value, which supplies the fourth switching control element with electricity from the vehicle electrical system and closes the fourth switching element.

25 Although the fourth switching control element in the above-mentioned embodiment is described as an NPN bipolar transistor, a transistor of a different type may also be used, such as an N-channel field-effect transistor.

According to one embodiment of the present invention, the fourth switching element and the fourth switching control element are formed as an NPN bipolar transistor, the third switching control element being inserted between the collector of the NPN bipolar transistor

and the vehicle electrical system, and the base of the NPN bipolar transistor being connected to the evaluation unit, so that the NPN bipolar transistor is switched to conducting if the voltage applied to the vehicle electrical system is greater than the predetermined threshold value, which supplies the third switching control element with
5 electricity from the vehicle electrical system.

According to one embodiment of the present invention, the second switching control element and the second switching element are formed as an auxiliary relay, the second switching element being formed as a contact of the auxiliary relay.

According to an alternative embodiment of the present invention, the second switching
10 control element and the second switching element are formed as an NPN bipolar transistor.

According to one embodiment of the present invention, the third switching control element and the third switching element are formed as an auxiliary relay, the third switching element being formed as a contact of the auxiliary relay.

According to a further embodiment of the present invention, the third switching control
15 element is electrically connected to a point which is located between the second switching element and the third switching element, the third switching control element closing the third switching element if the second switching element is in the closed state.

According to one embodiment of the present invention, the means for detecting a polarity of the voltage applied to the jump-start terminal comprises a first diode which is connected
20 from the jump-start terminal in the direction of flow to the second switching control element and allows the current from the jump-start terminal through to the second switching control element only in the case of the predetermined polarity.

According to one embodiment of the present invention, the first switching control element and the first switching element are formed as a power relay, the first switching element
25 being formed as a contact of the power relay.

According to one embodiment of the present invention, the polarity-reversal protection circuit furthermore comprises a disconnection means for disconnecting the jump-start terminal from the vehicle electrical system, the disconnection means being adapted to allow through the current from the jump-start terminal or vehicle electrical system which
5 corresponds to the greater voltage of the voltage applied to the jump-start terminal and the voltage applied to the vehicle electrical system.

According to one embodiment of the present invention, the disconnection means comprises a second diode and a third diode, the second diode being connected in the direction of flow from the jump-start terminal to the first switching control element and the third diode being
10 connected in the direction of flow from the vehicle electrical system to the first switching control element.

A method for providing polarity-reversal protection for a jump-start terminal in a motor vehicle in accordance with the present invention comprises the arranging of a first switching element between a vehicle electrical system of the motor vehicle and the jump-start
15 terminal, the detecting of a polarity of the voltage applied to the jump-start terminal, the closing, by a first switching control element, of the first switching element in the case of a predetermined polarity, the arranging of a second switching element between the first switching control element and earth, the second switching element in the closed state connecting the first switching control element to earth, the closing, by a second switching
20 control element, of the second switching element in the case of the predetermined polarity, the arranging of a third switching element between the first switching control element and the second switching element, the third switching element in the closed state connecting the first switching control element to earth via the second switching element, the closing, by a third switching control element, of the third switching element if the third switching control
25 element is supplied with electricity from the vehicle electrical system, which closes the first switching element, and the opening, by the third switching control element, of the third switching element if the electrical supply is switched off by the vehicle electrical system. The polarity-reversal protection circuit furthermore comprises a pushbutton and the method furthermore comprises the causing, by manual actuation of the pushbutton, if a voltage
30 applied to the vehicle electrical system is greater than a predetermined threshold value, of

the third switching control element to be supplied with electricity from the vehicle electrical system, so that the third switching element is closed, which closes the first switching element.

The invention will be explained in greater detail below with reference to the configurations illustrated in the appended drawings. Similar or corresponding details of the polarity-reversal protection circuit according to the invention are provided with the same reference numerals in the figures. These show:

Fig. 1 a view of a first embodiment of a polarity-reversal protection circuit in accordance with the present invention;

10 Fig. 2 a view of a second embodiment of a polarity-reversal protection circuit in accordance with the present invention;

Fig. 3 a view of a third embodiment of a polarity-reversal protection circuit in accordance with the present invention;

15 Fig. 4 a view of a fourth embodiment of a polarity-reversal protection circuit in accordance with the present invention; and

Fig. 5 a flow diagram which illustrates the conditions for carrying out a jump-start operation.

A first embodiment of the present invention is explained in detail below with reference to Fig. 1. Fig. 1 shows a polarity-reversal protection circuit 100 for a jump-start terminal 1 in a motor vehicle. The polarity-reversal protection circuit 100 comprises a first switching element 3 which is arranged between a vehicle electrical system 2 of the motor vehicle and the jump-start terminal 1. Furthermore, the polarity-reversal protection circuit 100 comprises a first switching control element 4 which controls the switching of the switching element 3.

25 According to a preferred embodiment of the present invention, the first switching control element 4 and the first switching element 3 are formed as a power relay. The first switching

element 3 in this case is formed as a contact of the power relay, and the switching control element 4 is formed as the coil of the power relay. The contact is open in the normal state.

The polarity-reversal protection circuit 100 furthermore comprises a second switching element 6 and a third switching element 6', which are arranged between the first switching control element 4 and earth, the second switching element 6 and the third switching element 6' in the closed state connecting the first switching control element 4 to earth. The polarity-reversal protection circuit 100 furthermore comprises a second switching control element 7 which controls the switching of the second switching element 6, and a third switching control element 7' which controls the switching of the third switching element 6'.

10 The third switching element 6' is arranged between the first switching control element 4 and the second switching element 6 and in the closed state connects the first switching control element 4 to earth via the second switching element 6. The third switching control element 7' is electrically connected to the vehicle electrical system 2 via the terminal 15 and is connected to a point which is located between the second switching element 6 and the 15 third switching element 6'.

The second switching control element 7 is formed as an auxiliary relay. The second switching element 6 is formed as a contact of the auxiliary relay 7, the contact being open in the normal state. The auxiliary relay 7 switches the second switching element 6 to conducting if a predetermined polarity of the voltage applied to the jump-start terminal 1 is detected, i.e. if the polarity at the jump-start terminal 1 is correct, and the voltage at the 20 jump-start terminal 1 is greater than a predetermined voltage.

The polarity-reversal protection circuit 100 furthermore comprises a first diode 8 which is connected in the direction of flow from the jump-start terminal 1 to the second switching control element 7. The first diode 8 serves for detecting the polarity of the voltage applied 25 to the jump-start terminal 1, in that the first diode 8 allows the current through from the jump-start terminal 1 to the second switching control element 7 only if the polarity at the jump-start terminal 1 is correct.

The third switching control element 7' closes the third switching element 6' if two conditions are met. Firstly, the external battery must have the correct polarity at the jump-

start terminal 1, so that the first diode 8 is connected in the direction of flow from the jump-start terminal 1 to the second switching control element 7 and the second switching element 6 is thus in the closed state. Further, the third switching control element 7' must be supplied with electricity from the vehicle electrical system 2 (terminal 15), i.e. the ignition must be
5 switched on. The third switching control element 7' opens the third switching element 6' if the electrical supply is switched off by the vehicle electrical system 2.

The third switching control element 7' is preferably a second auxiliary relay, in addition to the first auxiliary relay which comprises the second switching element 6. The second auxiliary relay is connected such that coil current flows through the second auxiliary relay
10 only when the first auxiliary relay is also switched on owing to a vehicle electrical system of the correct polarity at the jump-start terminal 1. Thus in a normal case, i.e. no jump-start, the vehicle's own electrical system 2 is not loaded with any coil current, neither from the 2 auxiliary relays nor from the power relay.

The polarity-reversal protection circuit 100 according to this embodiment of the present
15 invention furthermore comprises a second diode 5, which is connected in the direction of flow from the jump-start terminal 1 to the first switching control element 4, and a third diode 9, which is connected in the direction of flow from the vehicle electrical system 2 (terminal 15) to the first switching control element 4. The second diode 5 and third diode 9 serve to disconnect the jump-start terminal 1 from the vehicle electrical system 2, and
20 ensure that the first switching control element 4 is supplied by the greater voltage of the voltage applied to the jump-start terminal 1 and the voltage applied to the vehicle electrical system 2. The advantages of such a disconnection means will be explained in detail below.

The polarity-reversal protection circuit 100 according to this embodiment of the present invention furthermore comprises an evaluation unit 11 for evaluating the voltage applied to
25 the vehicle electrical system 2 (terminal 15). In particular, the evaluation unit 11 is adapted to establish whether the voltage applied to the vehicle electrical system 2 (terminal 15) is greater than a predetermined threshold value. The evaluation unit 11 is intended to establish which vehicle should give a jump-start, since only this vehicle can switch its battery to the jump-start point without polarity checking without damage occurring. In particular, the

evaluation unit 11 establishes whether the voltage applied to the vehicle electrical system 2 is greater than 13 V.

Preferably the evaluation unit 11 is realised in the form of a Zener diode which is connected in the reverse direction between the vehicle electrical system 2 and earth. Alternatively, the
5 evaluation unit may consist of a comparator.

The polarity-reversal protection circuit 100 according to this embodiment of the present invention furthermore comprises a pushbutton 10 which is arranged between the vehicle electrical system 2 and the Zener diode 11.

10 The polarity-reversal protection circuit 100 furthermore comprises a fourth switching control element 13 and a fourth switching element 12, which are formed as an auxiliary relay, the fourth switching element 12 being formed as a contact of the auxiliary relay. The fourth switching element 12 is inserted between a first point, which is arranged between the second diode 5 and the third diode 9, and a second point, which is arranged between the first diode 8 and the second switching control element 7.

15 The fourth switching control element 13 is furthermore driven by an NPN bipolar transistor 14. The fourth switching control element 13 of the auxiliary relay is inserted between the vehicle electrical system 2 and the collector of the NPN bipolar transistor 14. The base of the NPN bipolar transistor 14 is connected to earth via the resistor R1, and to the series connection of the evaluation unit 11 and the pushbutton 10 via the resistor R2. The emitter
20 of the NPN bipolar transistor 14 is connected to earth. The NPN bipolar transistor 14 is switched to conducting if the voltage applied to the vehicle electrical system 2 is greater than the predetermined threshold value. Thus the fourth switching control element 13 is supplied with electricity from the vehicle electrical system 2 (terminal 15), and the fourth switching control element 13 closes the fourth switching element 12.

25 Due to the fact that the fourth switching element 12 is closed, the second switching control element 7 is supplied with electricity from the vehicle electrical system 2 (terminal 15) via the third diode 9 and the closed switching element 12. This causes the second switching control element 7 to close the second switching element 6. Since the second switching element 6 is now closed, the third switching control element 7' is supplied with electricity

from the vehicle electrical system 2 (terminal 15) and the third switching control element 7' closes the third switching element 6'. This means that the first switching control element 4, upon the giving of a jump-start, is supplied with electricity from the terminal 15 via the third diode 9, since the voltage at the terminal 15 is higher, and closes the first switching
5 element 3. Upon the receiving of a jump-start, the supply is effected via the second diode 5 from the external vehicle, since the voltage there is higher. Therefore a jump-start operation takes place.

Thus the third switching control element 7' in the closed state of the fourth switching element 12 is supplied with electricity from the vehicle electrical system 2 (terminal 15).

10 The fourth switching control element 13 closes the fourth switching element 12 if the voltage applied to the vehicle electrical system 2 is greater than the predetermined threshold value and the pushbutton 10 has been manually actuated. By manual actuation of the pushbutton 10, the polarity-reversal protection circuit 100 causes, if a voltage applied to the vehicle electrical system 2 (terminal 15) is greater than a predetermined threshold value, the
15 third switching control element 7' to be supplied with electricity from the vehicle electrical system 2 (terminal 15), so that the third switching element 6' is closed, which closes the first switching element 3. Thus the jump-start operation takes place.

Although the fourth switching control element in the above-mentioned embodiment is described as an NPN bipolar transistor, a transistor of a different type may also be used,
20 such as an N-channel field-effect transistor.

A second embodiment of a polarity-reversal protection circuit 200 according to the present invention is explained in detail below with reference to Fig. 2. The elements provided with the same reference numerals as in Fig. 1 correspond to the elements described in Fig. 1, and the description thereof will therefore be omitted in discussing the polarity-reversal
25 protection circuit 200 in accordance with the second embodiment.

The polarity-reversal protection circuit 200 according to the second embodiment comprises, as in the first embodiment, a fourth switching control element 13 and a fourth switching element 12, which are formed as an auxiliary relay, the fourth switching element 12 being formed as a contact of the auxiliary relay. The polarity-reversal protection circuit 200 in

accordance with the second embodiment differs from the polarity-reversal protection circuit 100 in accordance with the first embodiment in that the fourth switching element 12 is arranged at a different point in the circuit.

The fourth switching element 12 is inserted between a point which is arranged between the third switching element 6' and the second switching element 6, and earth. If the voltage applied to the vehicle electrical system 2 is greater than the predetermined threshold value and the pushbutton 10 has been manually actuated, the third switching control element 7' is supplied with electricity from the vehicle electrical system 2 (terminal 15), and the third switching control element 7' closes the third switching element 6'.

10 Since the second switching control element 7 is supplied with electricity from the external vehicle electrical system via the second diode 8 before the switching element 3 is switched in, the second switching control element 7 closes the second switching element 6. Since both the second switching element 6 and the third switching element 6' are closed, the first switching control element 4, upon the giving of a jump-start, is supplied with electricity from the terminal 15 via the third diode 9, since the voltage at the terminal 15 is higher, and closes the first switching element 3. Upon the receiving of a jump-start, the supplying takes place via the second diode 5 from the external vehicle, since the voltage there is higher. Therefore a jump-start operation takes place.

20 A third embodiment of a polarity-reversal protection circuit 300 according to the present invention is explained in detail below with reference to Fig. 3. The elements provided with the same reference numerals as in Figs. 1 and 2 correspond to the elements described in Figs. 1 and 2, and the description thereof will therefore be omitted in discussing the polarity-reversal protection circuit 300 in accordance with the third embodiment.

The polarity-reversal protection circuit 300 in accordance with the third embodiment comprises, as in the first and second embodiment, a fourth switching control element and a fourth switching element which, in contrast to the first and second embodiments, are not formed as an auxiliary relay but as an NPN bipolar transistor 14. In this case, the NPN bipolar transistor 14 is connected differently from in the first and second embodiments in Figs. 1 and 2. Whereas the base of the NPN bipolar transistor 14, as in Figs. 1 and 2, is connected to earth via the resistor R1 and is connected via the resistor R2 to the series

connection of the evaluation unit 11 and the pushbutton 10, the collector of the NPN bipolar transistor 14 is connected to the point which is arranged between the second switching element 6 and the third switching element 6'. As in Figs. 1 and 2, the emitter of the NPN bipolar transistor 14 is connected to earth.

5 The NPN bipolar transistor 14 is switched to conducting if the voltage applied to the terminal 15 is greater than the predetermined threshold value and the pushbutton 10 has been actuated. Thus the third switching control element 7' is supplied with electricity from the terminal 15 and the third switching control element 7' closes the third switching element 6'. Since the second switching control element 7 is supplied with electricity from the
10 external vehicle electrical system via the second diode 8, the second switching control element 7 closes the second switching element 6. Since both the second switching element 6 and the third switching element 6' are closed, the first switching control element 4 is supplied with electricity either from the external vehicle electrical system (receiving of a jump-start) or from the terminal 15 (giving of a jump-start) via the second diode 5, and
15 closes the first switching element 3. Therefore a jump-start operation takes place.

A fourth embodiment of a polarity-reversal protection circuit 400 in accordance with the present invention is explained in detail below with reference to Fig. 4. The elements provided with the same reference numerals as in Fig. 3 correspond to the elements described in Fig. 3, and the description thereof will therefore be omitted in discussing the
20 polarity-reversal protection circuit 400 in accordance with the fourth embodiment.

The polarity-reversal protection circuit 400 in accordance with the fourth embodiment comprises, as in the third embodiment, a fourth switching control element and a fourth switching element in the form of an NPN bipolar transistor 6". The polarity-reversal protection circuit 400 in accordance with the fourth embodiment differs from the polarity-reversal protection circuit 300 in accordance with the third embodiment in that the second
25 switching element and second switching control element are not in the form of an auxiliary relay, but the NPN bipolar transistor 6'' takes over this function.

In the polarity-reversal protection circuit 400 in accordance with the fourth embodiment, the base of the NPN bipolar transistor 6", as in Fig. 3, is connected to earth via the resistor R1
30 and is connected via the resistor R2 to the series connection of the evaluation unit 11 and

the pushbutton 10, a fourth diode 15 being arranged between the evaluation unit 11 and the pushbutton 10. The collector of the NPN bipolar transistor 6" is connected to the third switching element 6'. As in Fig. 3, the emitter of the NPN bipolar transistor 6" is connected to earth. A resistor R3 is inserted between the first diode 8 and the base.

- 5** The NPN bipolar transistor 6" is switched to conducting if the voltage applied to the vehicle electrical system 2 is greater than the predetermined threshold value and pushbutton 10 has been actuated. Thus the third switching control element 7' is supplied with electricity from the terminal 15 and the third switching control element 7' closes the third switching element 6'. Since both the fourth switching element 6" and the third switching element 6' are closed,
- 10** the first switching control element 4 is supplied with electricity either from the external vehicle electrical system (receiving of a jump-start) or from the terminal 15 (giving of a jump-start) via the second diode 5, and closes the first switching element 3. Therefore a jump-start operation takes place.

The method of operation of the present invention will be described below.

- 15** A polarity-reversal protection circuit in accordance with one of the embodiments of the present invention described above permits jump-starting of vehicles which are both equipped with a polarity-reversal protection circuit, i.e. if both have an intelligent polarity-reversal protection switch. In the case of a vehicle giving a jump-start, i.e. the vehicle which gives a jump-start and the battery of which has sufficient charge to switch on the main relay
- 20** in the polarity-reversal protection circuit of the external vehicle, the polarity-reversal protection circuit is switched on without checking the correct polarity. Any incorrect polarity cannot cause any damage. In fact, if the vehicle receiving the jump-start does not have a polarity-reversal protection circuit, then all the individual components are protected against reversal of polarity. If the vehicle receiving the jump-start is equipped with a
- 25** polarity-reversal protection circuit, then the vehicle receiving the jump-start would not switch in in the event of a reversal of polarity.

- Due to the fact that the polarity-reversal protection circuit comprises a pushbutton 10 which only has to be actuated when giving a jump-start if no connection occurs between two vehicles, it is made possible for the polarity-reversal protection circuit to be switched on
- 30** only on the vehicle giving the jump-start without checking the correct polarity, which

permits the jump-start operation. As described above in relation to the four embodiments of the present invention, the polarity-reversal protection circuit is only switched on without checking polarity if the vehicle system voltage has reached the specified threshold value. This is only the case for the vehicle giving the jump-start, since the engine is running
5 therein. The pushbutton 10 offers the advantage that no additional cable installation is necessary. The pushbutton 10 is simple for the user to operate since the user only has to actuate the pushbutton 10 in the exceptional case that no jump-start connection occurs.

Fig. 5 shows a flow diagram which illustrates the conditions for carrying out a jump-start operation. It is assumed that the non-external vehicle has a polarity-reversal protection circuit. In step S1, the jump-start operation is initiated. In step S2, a differentiation is made
10 between the case of giving and of receiving a jump-start. Steps S3 to S9 relate to the case of receiving a jump-start, whereas steps S3' to S9' relate to the case of giving a jump-start.

A polarity check takes place in step S4/S4'. If the polarity is correct, it is determined in step S5/S5' whether the vehicle giving the jump-start has a polarity-reversal protection circuit. If
15 not, coupling of the vehicles and the jump-start are possible. If yes, then both vehicles are equipped with the polarity-reversal protection circuit and the pushbutton 10 is actuated in step S6/S6' in order to permit the jump-start. If the polarity is incorrect, it is determined in step S8/S8' whether the vehicle giving the jump-start has a polarity-reversal protection circuit. In both cases, coupling of the vehicles and the jump-start are not possible.

CLAIMS

1. A polarity-reversal protection circuit for a jump-start terminal (1) in a motor vehicle, the polarity-reversal protection circuit (10) comprising:
 - a first switching element (3) which is arranged between a vehicle electrical system (2) of the motor vehicle and the jump-start terminal (1),
 - a means for detecting a polarity of the voltage applied to the jump-start terminal (1),
 - a first switching control element (4) which is adapted to close the first switching element (3) in the case of a predetermined polarity,
 - a second switching element (6, 6'') which is arranged between the first switching control element (4) and earth and in the closed state connects the first switching control element (4) to earth, and
 - a second switching control element (7, 6'') which is adapted to close the second switching element (6, 6'') in the case of the predetermined polarity,the polarity-reversal protection circuit furthermore comprising the following:
 - a third switching element (6') which is arranged between the first switching control element (4) and the second switching element (6, 6'') and in the closed state connects the first switching control element (4) to earth via the second switching element (6, 6''), and
 - a third switching control element (7') which is adapted to close the third switching element (6') if the third switching control element (7') is supplied with electricity from the vehicle electrical system (2), which closes the first switching element (3),the third switching control element (7') furthermore being adapted to open the third switching element (6') if the electrical supply is switched off by the vehicle electrical system (2),

characterised in that

the polarity-reversal protection circuit furthermore comprises a pushbutton (10) and is adapted to cause, by manual actuation of the pushbutton (10), if a voltage applied to the vehicle electrical system (2) is greater than a predetermined threshold value, the third switching control element (7') to be supplied with electricity from the vehicle electrical system (2), so that the third switching element (6') is closed, which closes the first switching element (3).

2. A polarity-reversal protection circuit according to Claim 1, furthermore comprising an evaluation unit (11) for evaluating the voltage applied to the vehicle electrical system (2), the evaluation unit (11) furthermore being adapted to establish whether the voltage applied to the vehicle electrical system (2) is greater than the predetermined threshold value.
3. A polarity-reversal protection circuit according to Claim 2, the evaluation unit (11) being a Zener diode which is connected in the reverse direction between the vehicle electrical system (2) and earth.
4. A polarity-reversal protection circuit according to one of Claims 1 to 3, furthermore comprising a fourth switching element (12, 14, 6'') which is adapted that the third switching control element (7') in the closed state of the fourth switching element (12, 14, 6'') is supplied with electricity from the vehicle electrical system (2), and a fourth switching control element (13, 14, 6'') which is adapted to close the fourth switching element (12, 14, 6'') if the voltage applied to the vehicle electrical system (2) is greater than the predetermined threshold value.
5. A polarity-reversal protection circuit according to Claim 4, the fourth switching control element (13, 14) and the fourth switching element (12) being formed as an auxiliary relay, the fourth switching element (12) being formed as a contact of the auxiliary relay and the fourth switching control element (13, 14) furthermore comprising an NPN bipolar transistor (14), the fourth switching control element (13) being inserted between the collector of the NPN bipolar transistor (14) and the vehicle electrical system (2), and the base of the NPN bipolar transistor (14) being connected to the evaluation unit (11), so that the NPN bipolar transistor (14) is switched to conducting if the voltage applied to the vehicle electrical system (2) is

greater than the predetermined threshold value, which supplies the fourth switching control element (13) with electricity from the vehicle electrical system (2) and closes the fourth switching element (12).

6. A polarity-reversal protection circuit according to Claim 4, the fourth switching element and the fourth switching control element being formed as an NPN bipolar transistor (14, 6''), the third switching control element (7') being inserted between the collector of the NPN bipolar transistor (14, 6'') and the vehicle electrical system (2), and the base of the NPN bipolar transistor (14, 6'') being connected to the evaluation unit (11), so that the NPN bipolar transistor (14, 6'') is switched to conducting if the voltage applied to the vehicle electrical system (2) is greater than the predetermined threshold value, which supplies the third switching control element (7') with electricity from the vehicle electrical system (2).
7. A polarity-reversal protection circuit according to one of Claims 1 to 6, the second switching control element (7) and the second switching element (6) being formed as an auxiliary relay, the second switching element (6) being formed as a contact of the auxiliary relay.
8. A polarity-reversal protection circuit according to one of Claims 1 to 6, the second switching control element and the second switching element being formed as an NPN bipolar transistor (6'').
9. A polarity-reversal protection circuit according to one of Claims 1 to 8, the third switching control element (7') and the third switching element (6') being formed as an auxiliary relay, the third switching element (6') being formed as a contact of the auxiliary relay.
10. A polarity-reversal protection circuit according to one of Claims 1 to 9, the third switching control element (7') being electrically connected to a point which is located between the second switching element (6, 6'') and the third switching element (6'), the third switching control element (7') closing the third switching element (6') if the second switching element (6, 6'') is in the closed state.

11. A polarity-reversal protection circuit according to one of Claims 1 to 10, the means for detecting a polarity of the voltage applied to the jump-start terminal (1) comprising a first diode (8) which is connected from the jump-start terminal (1) in the direction of flow to the second switching control element (7, 6") and allows the current from the jump-start terminal (1) through to the second switching control element (7, 6") only in the case of the predetermined polarity.
12. A polarity-reversal protection circuit according to one of Claims 1 to 11, the first switching control element (4) and the first switching element (3) being formed as a power relay, the first switching element (3) being formed as a contact of the power relay.
13. A polarity-reversal protection circuit according to one of Claims 1 to 12, furthermore comprising a disconnection means for disconnecting the jump-start terminal (1) from the vehicle electrical system (2), the disconnection means being adapted to allow through the current from the jump-start terminal (1) or vehicle electrical system (2) which corresponds to the greater voltage of the voltage applied to the jump-start terminal (1) and the voltage applied to the vehicle electrical system (2).
14. A polarity-reversal protection circuit according to Claim 13, the disconnection means comprising a second diode (5) and a third diode (9), the second diode (5) being connected in the direction of flow from the jump-start terminal (1) to the first switching control element (4) and the third diode (9) being connected in the direction of flow from the vehicle electrical system (2) to the first switching control element (4).
15. A method for providing polarity-reversal protection for a jump-start terminal (1) in a motor vehicle, the method comprising the following steps:

arranging a first switching element (3) between a vehicle electrical system (2) of the motor vehicle and the jump-start terminal (1),

detecting a polarity of the voltage applied to the jump-start terminal (1),

closing, by a first switching control element (4), the first switching element (3) in the case of a predetermined polarity,

arranging a second switching element (6, 6'') between the first switching control element (4) and earth, the second switching element (6, 6'') in the closed state connecting the first switching control element (4) to earth, and

closing, by a second switching control element (7, 6''), the second switching element (6, 6'') in the case of the predetermined polarity,

the method furthermore comprising the following steps:

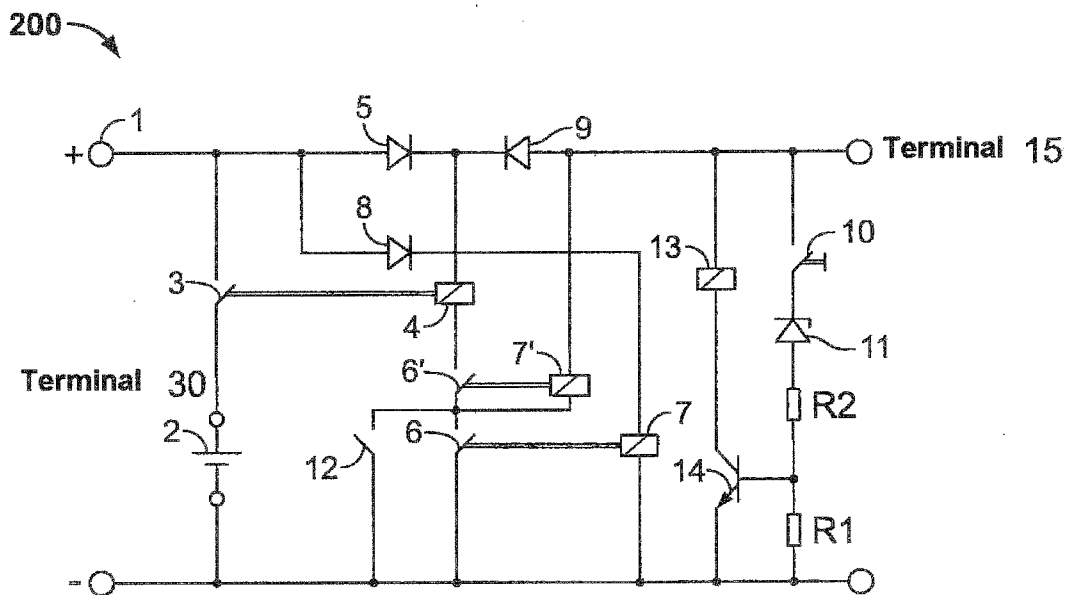
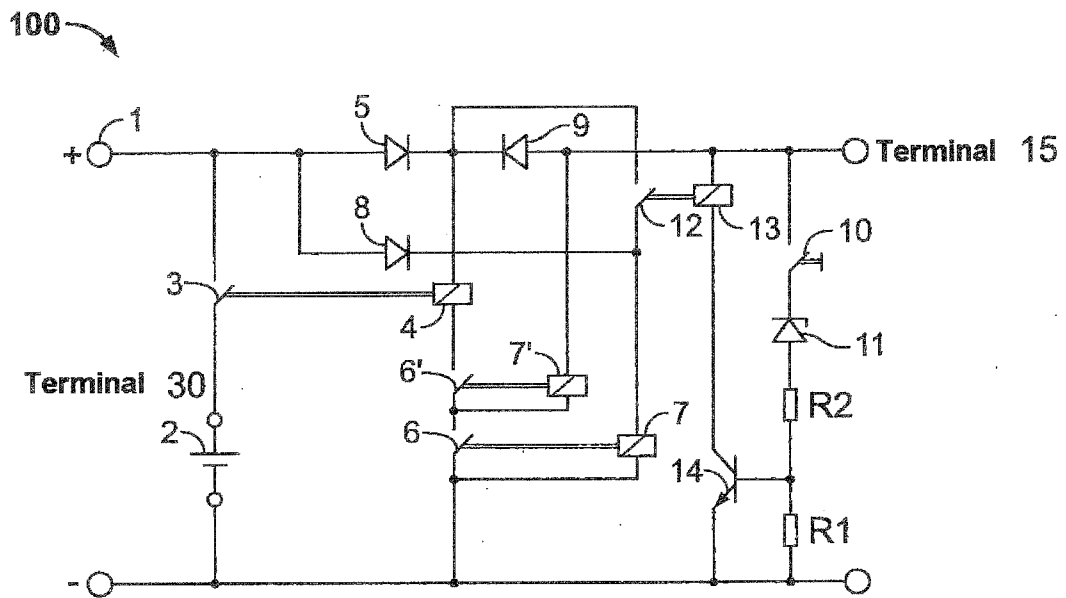
the arranging of a third switching element (6') between the first switching control element (4) and the second switching element (6, 6''), the third switching element (6') in the closed state connecting the first switching control element (4) to earth via the second switching element (6, 6''),

the closing, by a third switching control element (7'), of the third switching element (6') if the third switching control element (7') is supplied with electricity from the vehicle electrical system (2), which closes the first switching element (3), and

the opening, by the third switching control element (7'), of the third switching element (6') if the electrical supply is switched off by the vehicle electrical system (2),

characterised in that

the polarity-reversal protection circuit furthermore comprises a pushbutton (10) and the method furthermore comprises the causing, by manual actuation of the pushbutton (10), if a voltage applied to the vehicle electrical system (2) is greater than a predetermined threshold value, of the third switching control element (7') to be supplied with electricity from the vehicle electrical system (2), so that the third switching element (6') is closed, which closes the first switching element (3).



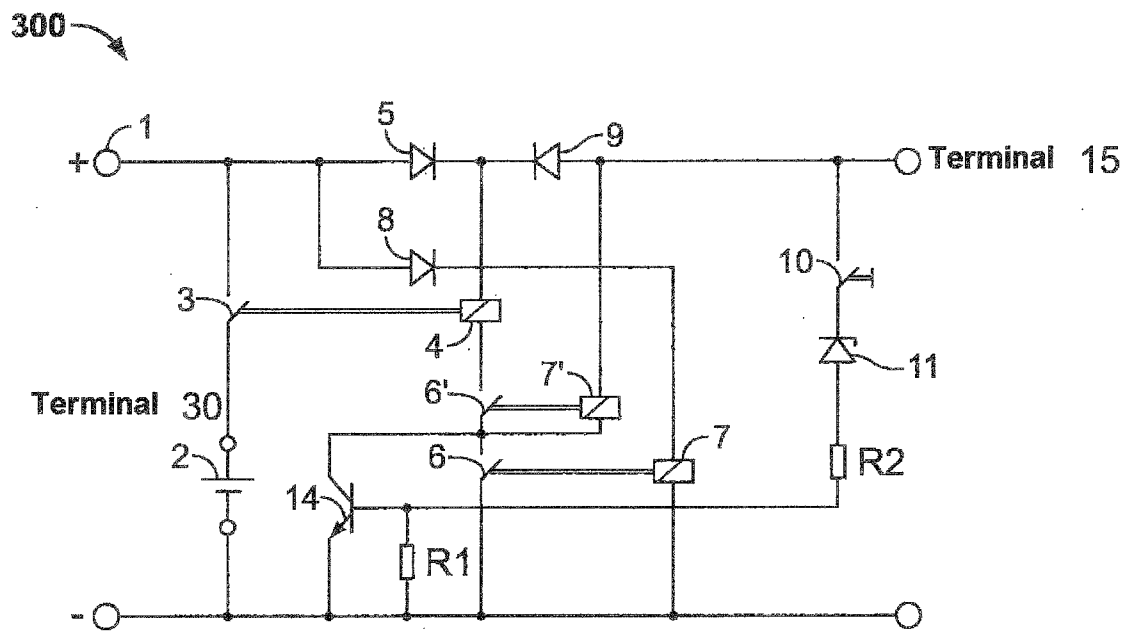


Fig. 3

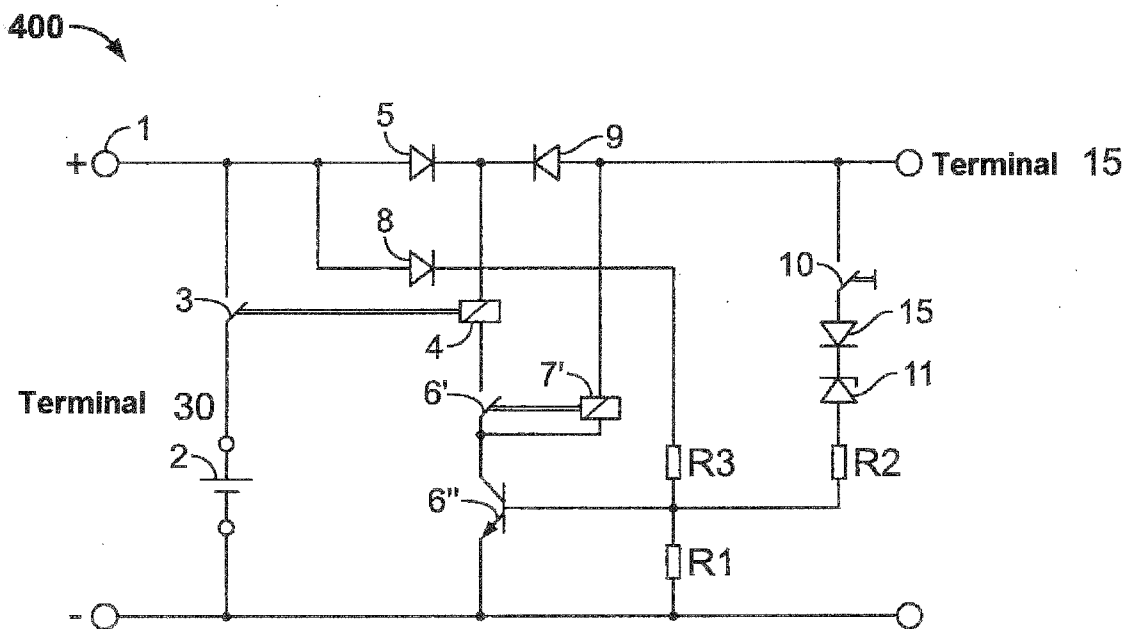


Fig. 4

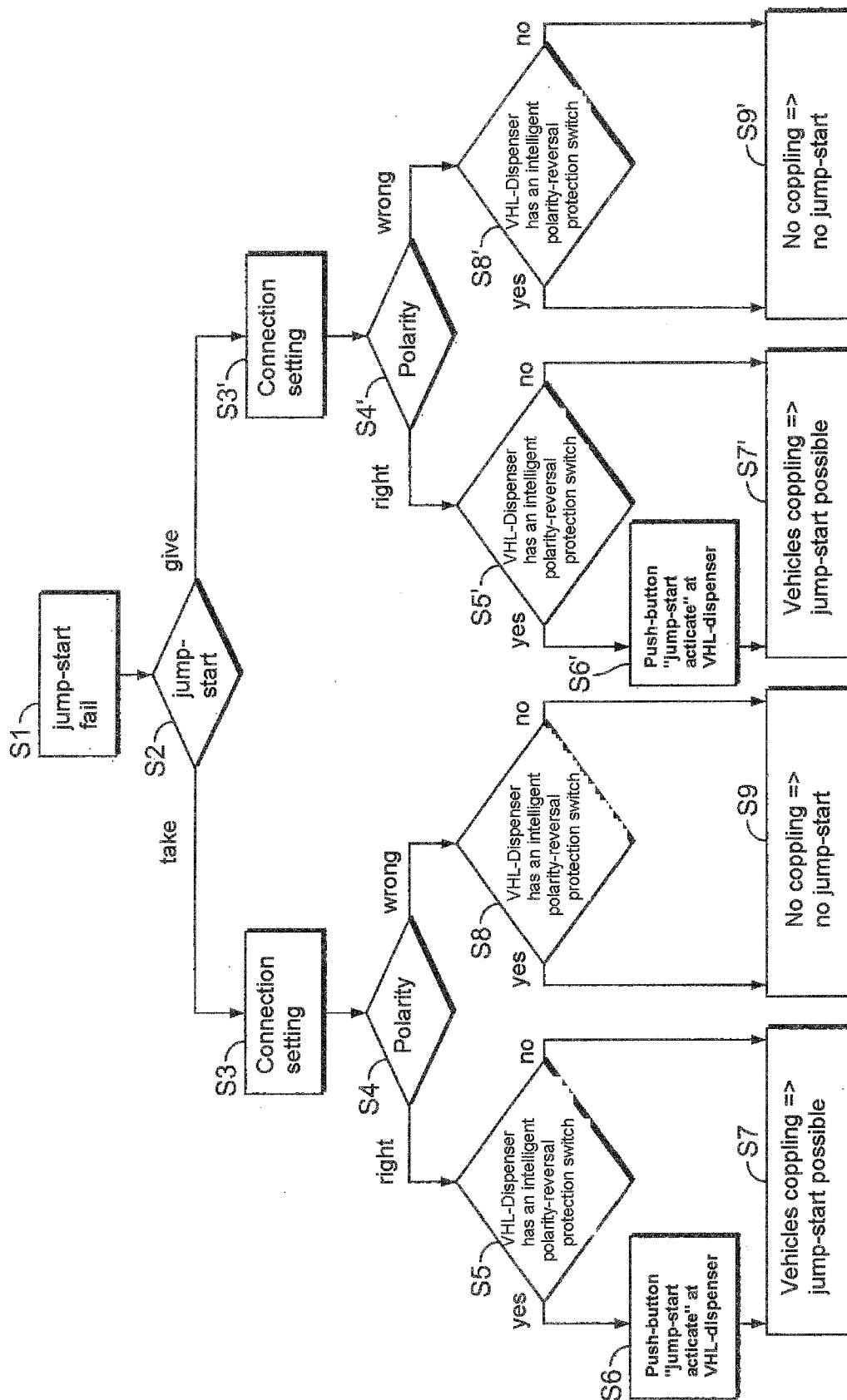


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/057477

A. CLASSIFICATION OF SUBJECT MATTER INV. H02J7/00 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) H02J B60R 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 practical, search terms used) EP0-Internal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 10 2008 018065 A1 (TYCO ELECTRONICS AMP GMBH [DE]) 22 October 2009 (2009-10-22) the whole document -----	1-15
A	WO 01/24341 A1 (TYCO ELECTRONICS LOGISTICS AG [CH]; SAMRAY BICAN [DE]) 5 April 2001 (2001-04-05) page 4, line 31 - page 7, line 5; figure 1 page 1, lines 12-19 -----	1-15
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A	EP 1 067 648 A2 (DEERE & CO [US]) 10 January 2001 (2001-01-10) paragraphs [0017], [0023]; figures 2,3 -----	1-15
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☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
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"A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document 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 13 July 2011	Date of mailing of the international search report 22/07/2011	
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Wilhelm, Gunther	

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2011/057477

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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