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(71) Applicant (for all designated States except US): **JTM POWER LIMITED** [IE/IE]; 20 Village Mill, Enterprise Park, Rathnew, County Wicklow (IE).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **TRACEY, James** [IE/IE]; 8 Sandy Lane, Ballymoney, Gorey, County Wexford (IE). **MAGUIRE, Damien** [IE/IE]; 26 Burnaby Court, Greystones, County Wicklow (IE). **O'DONOVAN, John** [IE/IE]; Siochain, Kilmurray, Gorey, County Wexford (IE).

(74) Agents: **O'BRIEN, John, A.** et al.; c/o John A. O'Brien & Associates, Third Floor, Duncairn House, 14 Carysfort Avenue, Blackrock, County Dublin (IE).

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(54) Title: A JUMP STARTER

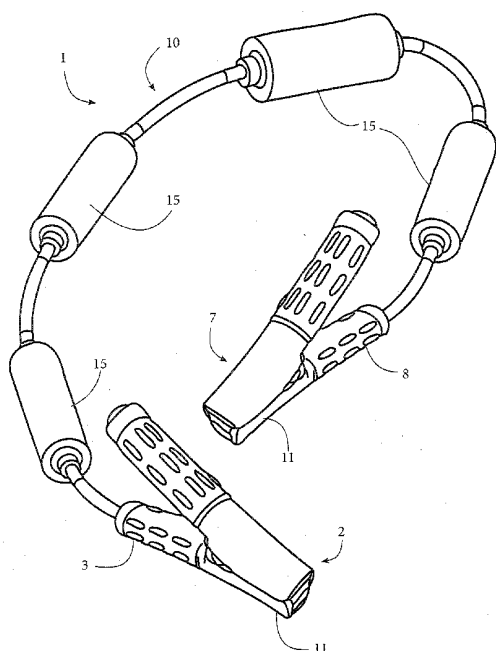


Fig.1

(57) Abstract: A jump starter (1, 30, 50) for a flat battery, such as a vehicle battery has a first clip (2, 20) having a first handle (3, 25) for connection to one terminal (4) of a battery (5); a second clip (7, 21) having a second handle (15, 25) for connection to a second terminal of a battery. The clips are interconnected (10, 28, 53) and on-board starter batteries (15, 26) are provided along the interconnecting cable (10) and/or at least one of the clips (20, 21). The on-board starter battery (15, 26) may comprise a lithium iron phosphate battery. There may be a control circuit (100, 200) to prevent damage from events such as accidental shorting of the clips.



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"A Jump Starter"INTRODUCTION5 Field of the Invention

This invention relates to a jump starter system for a battery, especially a vehicle battery.

Prior Art Discussion

10

Jump starter systems for jump starting a flat vehicle battery comprise a pair of leads, each with a clip such as a crocodile clip at each end to connect with the terminals of the flat battery and a charged battery of another vehicle. One lead connects the positive terminal of the flat battery to the positive terminal of a charged battery and a second lead connects the negative terminal of the flat battery to the negative terminal of the charged battery.

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Such systems are effective. However in many cases a vehicle with a charged battery is required and it is often difficult to arrange the vehicles to allow the leads to safely extend between the batteries.

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It is also known to provide starter packs comprising a lead acid battery within a battery housing and leads for extending from the battery housing to the terminal of the flat battery. Such units are costly, bulky, and heavy, and can generally only be used for large scale commercial applications. Very often, the unit is not used for some time and the battery charge diminishes so that it is not effective when required.

25

US5607794, US6002235, US2006/0128209, and US2008/0241653 describe various portable starter systems. In these arrangements, starter cables are connected to a battery.

30 This invention is directed towards providing an engine jump starter system which will address these issues.

SUMMARY OF THE INVENTION

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According to the invention, there is provided a jump starter for a battery such as a vehicle battery, the jump starter comprising:-

5 a first clip having a first handle for connection to one terminal of a battery;

a second clip having a second handle for connection to a second terminal of a battery;

an interconnection means extending between the first clip and the second clip; and

10 an on-board starter battery means provided along the interconnection means and/or adjacent at least one of the clips.

In one embodiment, the on-board starter battery means comprises a lithium iron phosphate battery.

15

In one embodiment, there is a plurality of on-board starter batteries along the interconnection means.

In one embodiment, the on-board starter battery means comprises a plurality of separate batteries
20 which are electrically interconnected.

In one embodiment, at least some of the battery means comprises batteries housed within at least one of the first and second handles.

25 Preferably, said batteries are housed within both the first handle and the second handle.

In one embodiment, the first clip and the second clip are configured to nest together for storage in compact manner.

30 In one embodiment, the first clip has a housing within which there is a battery, and a pair of jaws linked with the housing; and the second clip is configured to fit alongside the jaws of the first clip in a manner without protruding parts.

Preferably, the first clip has a groove to accommodate the interconnection means during storage.

In one embodiment, the jump starter further comprises a control circuit having positive and negative leads connected between the on-board starter battery and the clips, and protection means to provide over-voltage and/or over-current protection.

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In one embodiment, the protection means comprises a current-limiting component.

In one embodiment, the control circuit further comprises a switch in the negative lead which is turned on for use. In one embodiment, the switch is a solid state switch. In one embodiment, the switch comprises a MOSFET switch. In one embodiment, the switch is an SCR. In one embodiment, there is a plurality of switches arranged in parallel.

10

In one embodiment, a gate of the switch is connected to the positive lead by a user-activated switch. In one embodiment, the user-activated switch is of the type for momentary closing. In one embodiment, the user-activated switch is connected to the gate via a diode, preferably a Zener diode. In one embodiment, the switch is solid state and is reverse biased to prevent current flow if a system to which the clamps are connected attempts to return charge.

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In one embodiment, the protection means comprises a circuit to short gate current to ground in the event of accidental reverse polarity connection.

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In one embodiment, the positive lead includes one or more positive thermal coefficient fuses protecting against short circuit conditions and excessive power demands by achieving a very high resistance, thus limiting current flow, and once normal conditions are restored dropping to a low resistance.

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In one embodiment, there is a resistor and an LED in parallel with the fuse such that if the fuse resistance goes high almost all of the battery voltage will appear across the resistor thus providing a current flow to illuminate the LED, and when the fuse is in a low resistance state and operating normally the resistor and the fuse are effectively short circuited, providing a visual indication of overload conditions.

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In one embodiment, the positive lead includes a bank of switches connected in such a way as to utilise their intrinsic diodes for the purposes of reverse blocking of current, in which gate to source is short circuited, thus holding the switches in a permanent OFF state.

- 5 In one embodiment, an RC time constant circuit is linked with the negative lead switch or switches, said time constant circuit being arranged to set the run time of the jump starter and preventing the jump starter from being left in a constant ON condition.

- 10 In one embodiment, the time constant circuit is arranged to provide a soft turn on of the jump starter power, preventing transient voltage damage as a result of arcing or high di/dt induced voltages in an electrical system to which the starter is connected.

DETAILED DESCRIPTION OF THE INVENTION

15 Brief Description of the Drawings

The invention will be more clearly understood from the following description of some embodiments thereof, given by way of example only with reference to the accompanying drawings in which:-

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Fig. 1 is a perspective view of an engine jump starter system according to the invention;

Fig. 2 is an elevational view of the jump starter system of Fig. 1, in use;

25

Fig. 3 is a perspective view of another engine jump starter system according to the invention;

Fig. 4 is an enlarged view of the battery connection clips of the jump starter system of Fig. 3;

30

Fig. 5 is an elevational view of the starter system of Figs. 3 and 4, in use;

Figs. 6 and 7 are perspective views of an alternative starter system ready for use;

Figs. 8 and 9 are perspective views of this system when in the storage position; and

Figs. 10 to 12 are circuit diagrams for circuits of starter systems of various embodiments.

5 Description of the Embodiments

Referring to Figs. 1 and 2 there is illustrated a jump starter system 1 according to the invention. The jump starter system comprises a first crocodile clip 2 having a first handle 3 for connection to one terminal 4 of a flat vehicle battery 5. The system also comprises a second crocodile clip 7
10 having a second handle 8 for connection to another terminal 9 of the flat vehicle battery 5. An electrical interconnection lead 10 extends between the first clip 2 and the second clip 7. Each clip has spring biased jaws 11. In the invention there is an on-board starter battery which comprises a plurality of interconnected batteries 15 which may be of the lithium iron phosphate type. The battery cells can be of either cylindrical, prismatic or pouch type. The voltage is between 3.2 and
15 3.7 V nominal and of lithium iron chemistry.

As illustrated, the on-board starter batteries 15 extend along the interconnection lead 10. They are relatively small and lightweight and can be readily interconnected to form the jump starter system as illustrated.

20

To jump start a flat battery only one jump lead is required with two simple clip connections 2, 7 to the flat battery 5. Immediate power is supplied to the flat battery 5 without the requirement of another vehicle with a charged battery. The unit is lightweight and easily stored, for example, in a vehicle boot or glove compartment. The system has superior starting ability, lifespan, and
25 energy retention than other jump starter systems.

Referring now to Figs. 3 to 5 there is illustrated another jump starter system, 30, according to the invention. In this case, clips 20, 21 have the clip jaws 11 and have handles 25 of cylindrical shape. In this embodiment there are two batteries 26 housed within each handle 25, and finger-
30 gripping features 27 are provided to aid user operation. The clips are interconnected by a cable 28, with no need for batteries along the length of the cable in this case.

Referring to Figs. 6 to 9 an alternative jump starter, 50, is shown. The jump starter 50 comprises a first clip 51 and a second clip 52 interconnected by a power cable 53. The first clip 51 has a

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housing 55 for a battery of sufficient capacity to provide the full starting power, in this embodiment of the lithium iron phosphate type. Also, the first clip 51 comprises a pair of jaws 56 having finger grips 57 for pressing together for opening and closing. The housing 55 has a groove along one side to accommodate the cable 53 during storage. The clip 52 has a similar pair of jaws 56 with finger grips 57.

The starter 50 is used with the clips 51 and 52 separate as shown in Figs. 6 and 7. Power is provided by the batteries within the housing 55. When not being used, the second clip 52 nests into the first clip 51 alongside the jaws 56 of the first clip 51, as shown in Figs. 8 and 9.

The jump starter 50 involves use of close-proximity high-power batteries of the lithium iron phosphate type. In this case it is more important to provide safety controls, and this is achieved by use of a control circuit in the housing 55. Figs. 10, 11, and 12 illustrate circuits 100, 200, and 300 respectively which may be used in the starter of any embodiment. In this case the starter 50 employs the circuit 300, however it may employ a different circuit depending on the safety requirements and battery types and capacities.

Referring to Fig. 10 the circuit 100 comprises batteries 102, a positive lead 103 with a clamp conductor 104, and a negative lead 105 with a clamp conductor 106. In the positive lead there is a light emitting diode LED2 and a resistor R3 in parallel with a positive thermal coefficient (PTC) resettable fuse 110.

An integrated circuit IC1 is connected via a resistor R2 to the positive lead 103 and is connected to the negative lead 105 via reverse polarity indicator (LED1). Also, a manual contact switch 115 (SW1) is connected on one side to the positive lead 3, and on the other to a Zener diode ZD1, a resistor R1, in turn linked with a bank of MOSFET switches Q1, Q2, and Q3.

The circuit of the jump starter circuit 100 protects from voltage mismatch, reverse polarity, short circuit, over-discharge, and over-use.

The over-current protection element PTC 110 comprises a number of parallel connected positive thermal coefficient PCB mounted resettable fuses. The number and type thereof is determined by the power output requirement. The PTC 110 enables normal usage but protects against short circuit conditions and excessive power demands by achieving a very high resistance, thus

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limiting current flow. Once normal conditions are restored, the PTC 110 drops to a low resistance. Light emitting diode LED2 and 1k 0.25w resistor R3 provide an over-current indicator. When the PTC 110 goes high resistance, almost all of the jump starter battery 102 voltage will appear across this device thus providing a current flow to illuminate LED2. When the PTC 110 is in a low resistance state and operating normally, R3 and LED2 are effectively short circuited.

The battery 102 positive terminal is also connected to the momentary action single pole normally open switch SW1 115. This switch, the Zener diode ZD1, the resistor R1 and Metal Oxide Semiconductor Field Effect Transistors (MOSFETS) Q1 to Q3 comprise the power-switching and over-discharge elements.

To activate the jump-starter system it must be connected to a vehicle battery by means of the positive and negative jaws 56 linked to the conductors 104 and 106. The activation switch 115 (SW1) is then briefly depressed. This switch may be located at any convenient location of the housing Current flows from the battery (BAT) via ZD1 and R1 to the gates of International Rectifier IRF1324s MOSFETS (or alternates) Q1, Q2 and Q3 via their respective gate resistors R4, R5 and R6. Capacitor C1 is also charged. Once a Vgs of 10V is applied to the MOSFETS Q1, Q2, and Q3 they begin conducting from drain to source with a very low ON state resistance, typically about 0.00033 Ohms for three parallel connected parts.

After the PTC, the positive supply lead 103 is connected to another trio of International Rectifier IRF1324s MOSFETS (or alternates) Q4, Q5 and Q6. These devices are connected in such a way as to utilise their intrinsic diodes for the purposes of reverse blocking of current. The gate to source is short circuited, thus holding the devices in a permanent OFF state. Should the jump starter circuit 100 be connected to a vehicle with a greater voltage than the unit is intended for, the diodes become reverse biased and no current may flow. This feature protects the jump-starter's internal battery 102 from potentially dangerous overcharge conditions.

Once a successful start has been achieved, the vehicle alternator or charging system will attempt to return charge to the still-connected jump-starter battery 102 (BAT) via the crocodile clamp jaws 56. This could be undesirable for certain battery types. Should this situation occur, the intrinsic diodes in Q4, Q5 and Q6 will become reverse biased, thus preventing this condition

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A resistor R7 and a capacitor C1 form an RC time constant circuit. When the switch 15 (SW1) is depressed, C1 rapidly charges via R1. Once in an ON state the gate to source resistance of the MOSFETS is very high, in the order of tens of mega Ohms. Thus the run time of the jump starter circuit 100 can be configured by choice of C1 and R7. Once SW1 is released, C1 begins to
5 discharge via R7. When the voltage across C1 drops below the gate threshold voltage of the MOSFETS, they will rapidly come out of conduction and switch off the output. This auto – off feature prevents the unit from being left in a constant ON condition with resultant live crocodile clamps.

10 The RC circuit of R7 and C1 provides another important element. As the voltage across C1 will require a certain time to reach the gate threshold voltage of the MOSFETS Q1, Q2, and Q3, they will spend a small amount of time in their active region and provide a soft turn on of the jump starter circuit 100 power. This prevents transient voltage damage as a result of arcing or high di/dt induced voltages in the vehicle electrical system.

15 The circuit also protects against accidental reverse polarity connection. Should the operator inadvertently connect the jump starter circuit 100 backwards to the vehicle battery (i.e. positive clamp 4 to negative terminal and vice versa), the system offers two levels of protection. The first level is passive. As the MOSFETS Q1 through Q3 are non-conductive, no current flow takes
20 place upon connection. This eliminates any potentially dangerous and destructive electrical arcing at the vehicle battery terminals. Such arcing conditions have been linked with the destruction of modern vehicle electronic controls. Secondly, current from the vehicle battery flows via the resistor R2, reverse polarity indicator LED1 and the input side of the semiconductor photo-relay type TLP222 (IC1) thus illuminating LED1 and the input photo LED
25 in IC1. Even if the vehicle battery is severely discharged, the current requirement of IC1 is very small and will in most cases be less than 5 mA. Should the user ignore the reverse polarity indicator LED1 and depress SW1, MOSFET gate current is shunted to ground via an output MOSFET in IC1 thus preventing the successful triggering of Q1-Q3 and damage to the vehicle or to the jump starter 1.

30 The Zener diode ZD1 in the gate trigger circuit protects against excessive discharge of the jump starter battery 102 (BAT). If the battery has been drained past an acceptable point its potential is no longer sufficient to overcome ZD1 and thus no gate current reaches the MOSFETS Q1-Q3.

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The jump starter circuit 100 may not then be used until it has been recharged, thus preserving the life of the battery 102.

Unlike other jump starter protection circuits that require a vehicle battery to be present for correct operation, this jump starter circuit 100 can operate with a completely dead battery or none at all. However in this case, reverse polarity detection is not available.

The following are advantageous aspects of the invention.

- Solid state switching. There are no contacts to weld, burn out, or arc.
- 10 - Soft switching.
- Electrical transient protection for modern motor vehicle electronics.
- Operator protection from arcing, explosion etc.
- Jump starter product protection from misuse.
- Battery protection. Ensures long life.
- 15 - Low component count
- Cost effective
- Passive safety
- Visual indicators of fault conditions
- No possibility of damage through operator error such as short circuit etc.
- 20 - Low power dissipation. Can be used with traditional lead acid batteries without power loss.

In other embodiments the role of the switches Q1-Q3 may alternatively be performed by a device such as a silicon controlled rectifier for example. This is a simpler circuit, and also would have the benefit of automatic power off upon disconnection and automatic reverse blocking. Referring to Fig. 11 a circuit 200 has a positive lead 203 with a clamp conductor 204 and a negative lead 205 with a clamp conductor 206. There are a PTC fuse 210, a battery 212, and a momentary switch 215 for performing the same functions as for the circuit 100. However, in this case the switch 215 is linked with an SCR. Other alternatives may include use of insulated gate bipolar transistors (IGBTs) or standard bipolar transistors.

In a still further embodiment, referring to Fig. 12, a 4-cell Lithium iron battery is connected to a positive jump-starter clamp by means of a number of parallel connected positive thermal coefficient (PTC) type resettable fuses. The negative battery lead is directly connected to the

- 10 -

negative jump starter clamp. A warning light emitting diode LED1 and its associated series limiting resistor are connected in parallel with the PTC devices. During normal engine starting operation the PTC devices are cold and exhibit a low resistance thus permitting normal current flow. As there is little voltage drop across the devices in this state, LED1 is extinguished.

5

Should any of the following fault conditions occur: clamp short circuit, reverse connection to vehicle or incorrect voltage selection, then a larger than normal current flow will result causing the PTC devices to rapidly warm up and exhibit a high resistance thus limiting current flow to a very low level and preventing damage to the jump starter unit or the flat battery. As most of the battery (BAT1) voltage will now be developed across the PTC devices, LED1 is illuminated thus informing the user that a fault condition has occurred. Once the fault is removed, LED1 is extinguished and after a short delay the PTCs return to normal temperature and resistance and normal operation is resumed.

10

15 Transient voltage suppression diodes (TVS) D1 and D2 are connected across the output leads. These devices (typical rating of 5kW each) prevent any transient or induced voltages from damaging the vehicle or the starter. Unlike the typical surge protection employed in a traditional jump starter which employs voltage dependent resistor (VDR) type devices, the TVS can respond much quicker and quench much more energy thus providing a better solution.

20

It will be appreciated that the invention provides for much more convenient jump starting. It allows a user to carry the starter in the vehicle, and avoids need to hook up to another vehicle and all of the attendant disadvantages.

25 The invention is not limited to the embodiments described but may be varied in construction and detail.

Claims

1. A jump starter for a battery such as a vehicle battery, the jump starter comprising:-
 - 5 a first clip (2, 20) having a first handle (3, 25) for connection to one terminal (4) of a battery (5);
 - a second clip (7, 21) having a second handle (15, 25) for connection to a second terminal of a battery;
 - 10 an interconnection means (10, 28) extending between the first clip and the second clip; and
 - an on-board starter battery means (15, 26) provided along the interconnection means (10) and/or adjacent at least one of the clips (20, 21).
 - 15
2. A jump starter as claimed in claim 1, wherein the on-board starter battery means (15, 26) comprises a lithium iron phosphate battery.
- 20 3. A jump starter as claimed in claims 1 or 2, wherein there is a plurality of on-board starter batteries (15) along the interconnection means.
4. A jump starter as claimed in claim 1 or 2 or 3, wherein the on-board starter battery means (15, 26) comprises a plurality of separate batteries which are electrically interconnected.
- 25 5. A jump starter as claimed in claim 4, wherein at least some of the battery means comprises batteries (26) housed within at least one of the first and second handles.
6. A jump starter as claimed in claim 5, wherein said batteries are housed within both the first handle (25) and the second handle (25).
- 30 7. A jump starter as claimed in claims 5 or 6, wherein the first clip (56) and the second clip (56) are configured to nest together for storage in compact manner.

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8. A jump starter as claimed in claim 7, wherein the first clip (51) has a housing (55) within which there is a battery, and a pair of jaws (56) linked with the housing; and the second clip (52) is configured to fit alongside the jaws of the first clip in a manner without protruding parts.
- 5
9. A jump starter as claimed in claim 8, wherein the first clip (51) has a groove (60) to accommodate the interconnection means (53) during storage.
10. A jump starter as claimed in any preceding claims, further comprising a control circuit having positive and negative leads connected between the on-board starter battery and the clips, and protection means to provide over-voltage and/or over-current protection.
- 10
11. A jump starter as claimed in claim 10, wherein the protection means comprises a current-limiting component.
- 15
12. A jump starter as claimed in claims 10 or 11, wherein the control circuit further comprises a switch (Qi-Q3) in the negative lead which is turned on for use.
13. A jump starter as claimed in claim 12, wherein the switch is a solid state switch.
- 20
14. A jump starter as claimed in claims 12 or 13, wherein the switch comprises a MOSFET switch.
15. A jump starter as claimed in claim 13, wherein the switch is an SCR.
- 25
16. A jump starter as claimed in any of claims 12 to 15, wherein there is a plurality of switches (Q1-Q3) arranged in parallel.
17. A jump starter as claimed in any of claims 12 to 16, wherein a gate of the switch is connected to the positive lead by a user-activated switch (115, 215).
- 30
18. A jump starter as claimed in claim 17, wherein the user-activated switch is of the type for momentary closing.

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19. A jump starter as claimed in claims 17 or 18, wherein the user-activated switch is connected to the gate via a diode (ZD1), preferably a Zener diode.
- 5 20. A jump starter as claimed in any of claims 12 to 19, wherein the switch is solid state and is reverse biased to prevent current flow if a system to which the clamps are connected attempts to return charge.
- 10 21. A jump starter as claimed in any of claims 17 to 20, wherein the protection means comprises a circuit to short gate current to ground in the event of accidental reverse polarity connection.
- 15 22. A jump starter as claimed in any of claims 10 to 21, wherein the positive lead includes one or more positive thermal coefficient fuses (10, 110) protecting against short circuit conditions and excessive power demands by achieving a very high resistance, thus limiting current flow, and once normal conditions are restored dropping to a low resistance.
- 20 23. A jump starter as claimed in claim 22, wherein there is a resistor and an LED in parallel with the fuse such that if the fuse resistance goes high almost all of the battery voltage will appear across the resistor thus providing a current flow to illuminate the LED, and when the fuse is in a low resistance state and operating normally the resistor and the fuse are effectively short circuited, providing a visual indication of overload conditions.
- 25 24. A jump starter as claimed in any of claims 10 to 23, wherein the positive lead includes a bank of switches connected in such a way as to utilise their intrinsic diodes for the purposes of reverse blocking of current, in which gate to source is short circuited, thus holding the switches in a permanent OFF state.
- 30 25. A jump starter as claimed in any of claims 10 to 24, wherein an RC time constant circuit is linked with the negative lead switch or switches, said time constant circuit being arranged to set the run time of the jump starter and preventing the jump starter from being left in a constant ON condition.

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26. A jump starter as claimed in claim 25, wherein the time constant circuit is arranged to provide a soft turn on of the jump starter power, preventing transient voltage damage as a result of arcing or high di/dt induced voltages in a electrical system to which the starter is connected.

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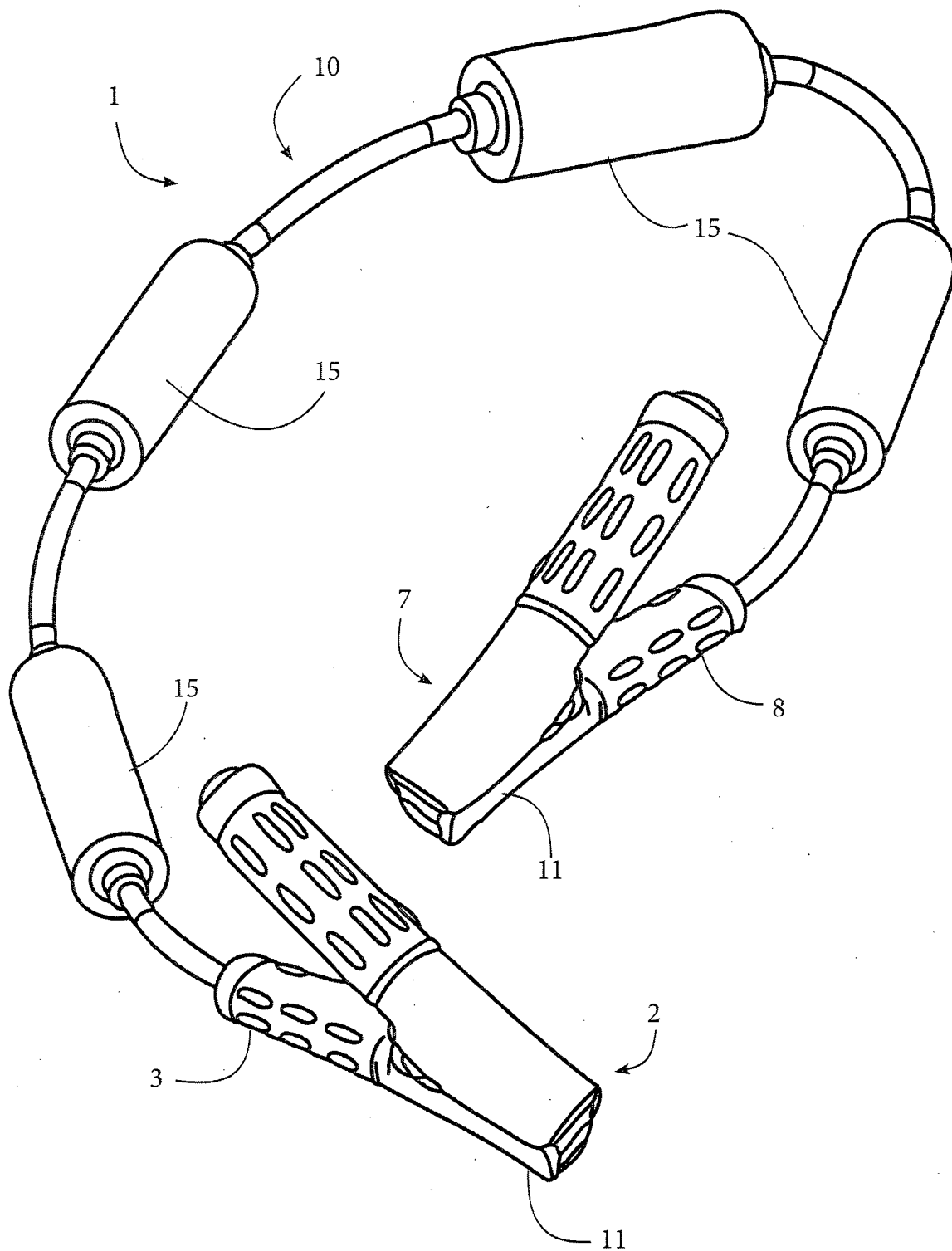


Fig.1

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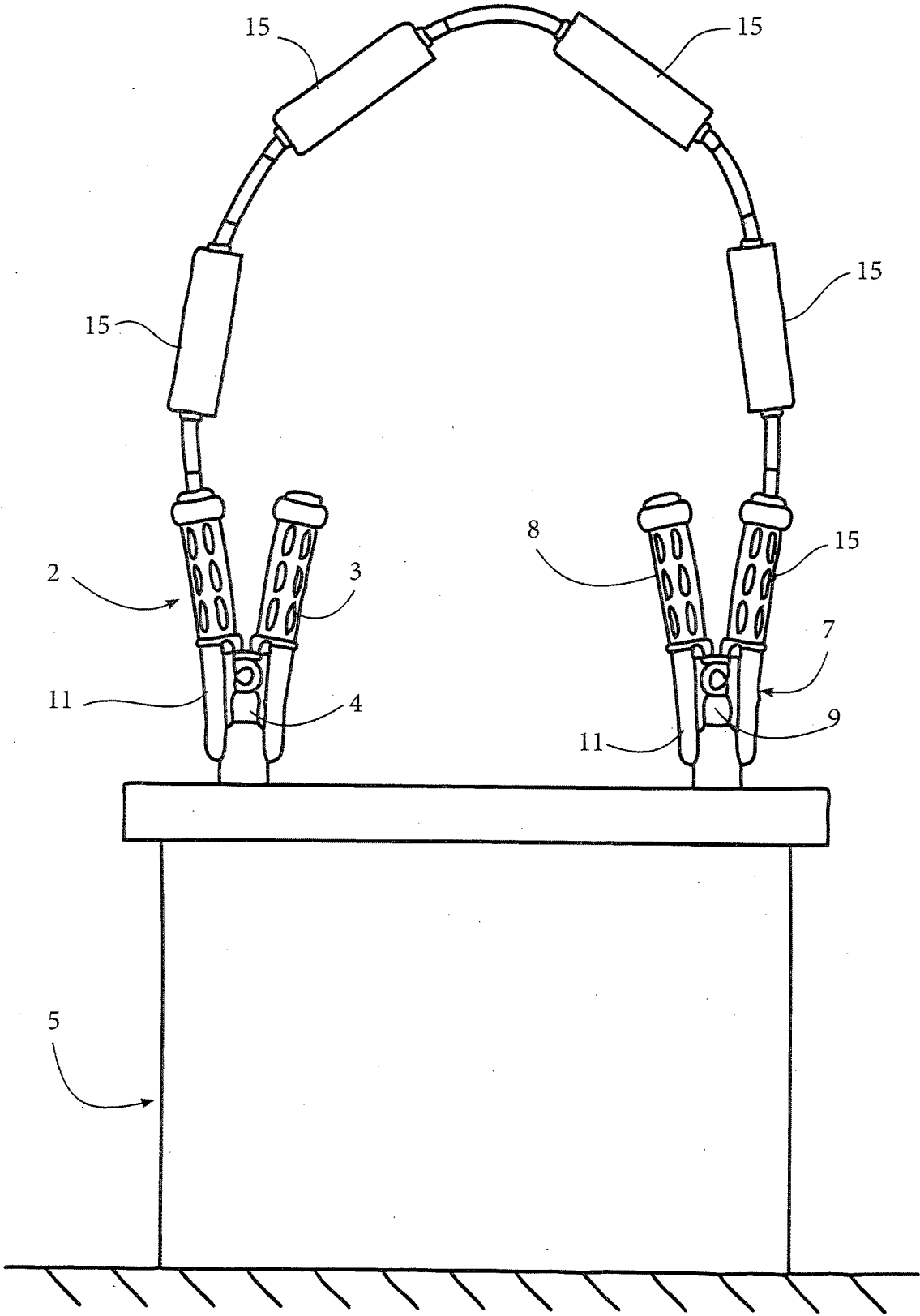


Fig.2

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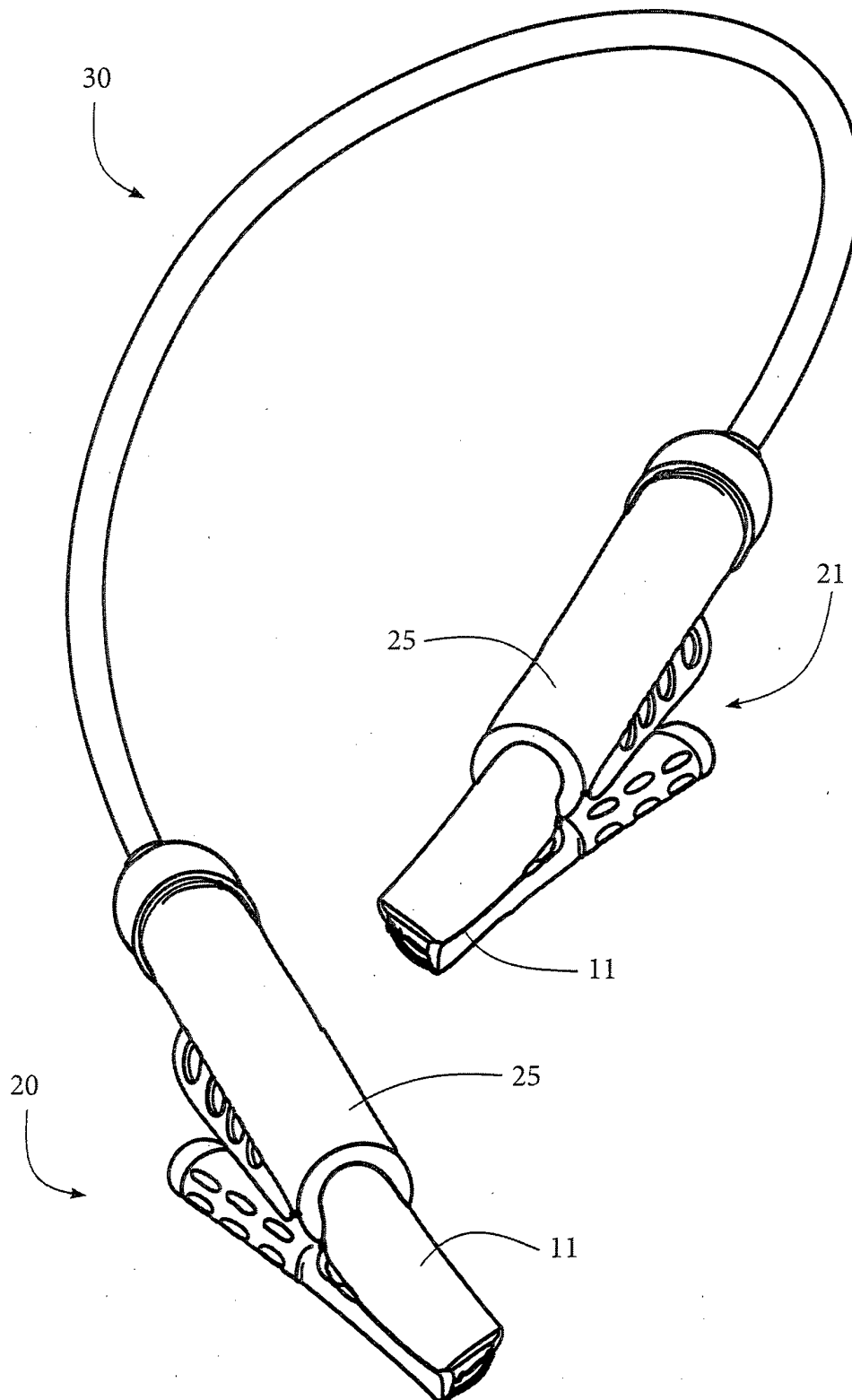


Fig.3

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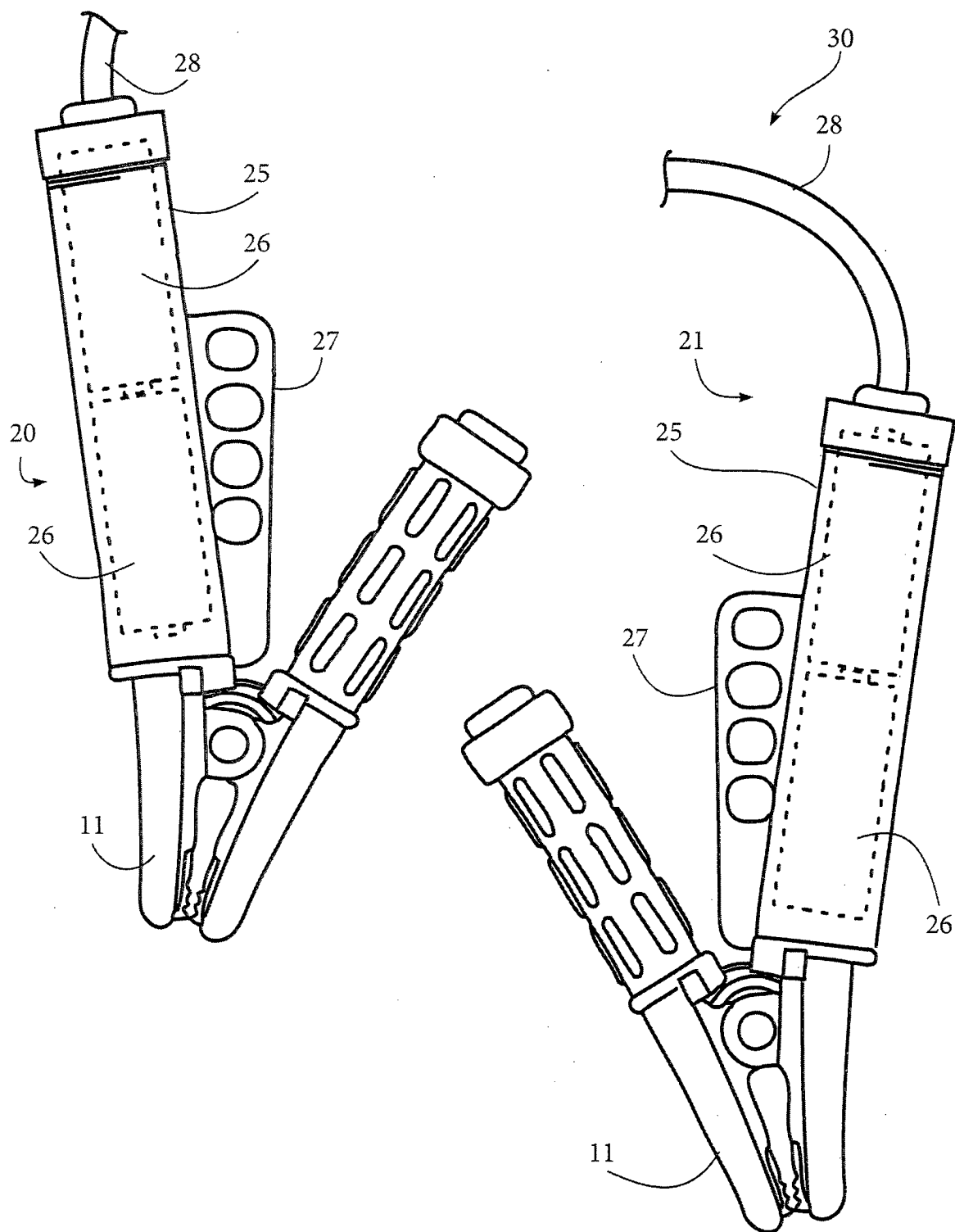


Fig.4

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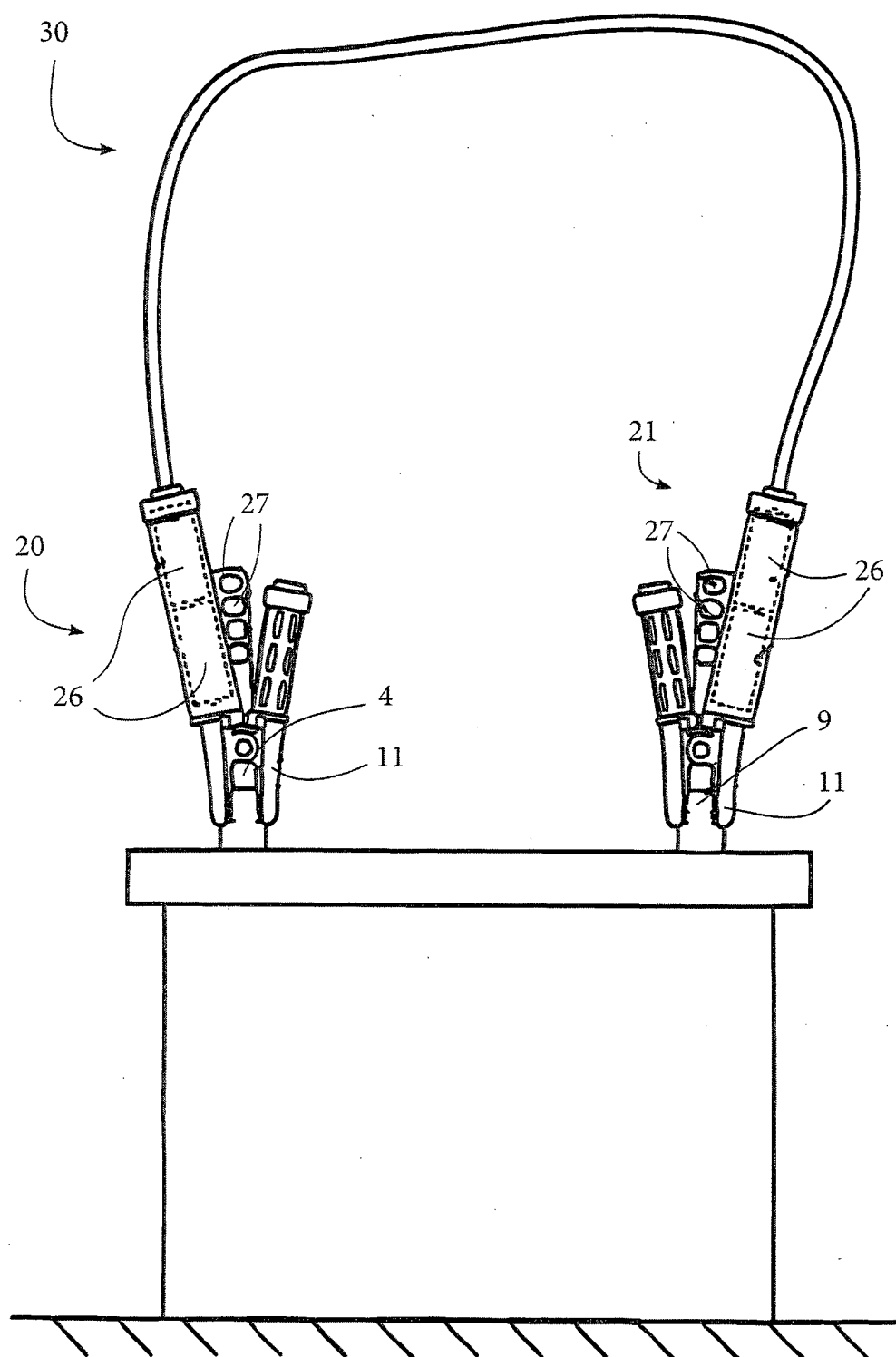


Fig.5

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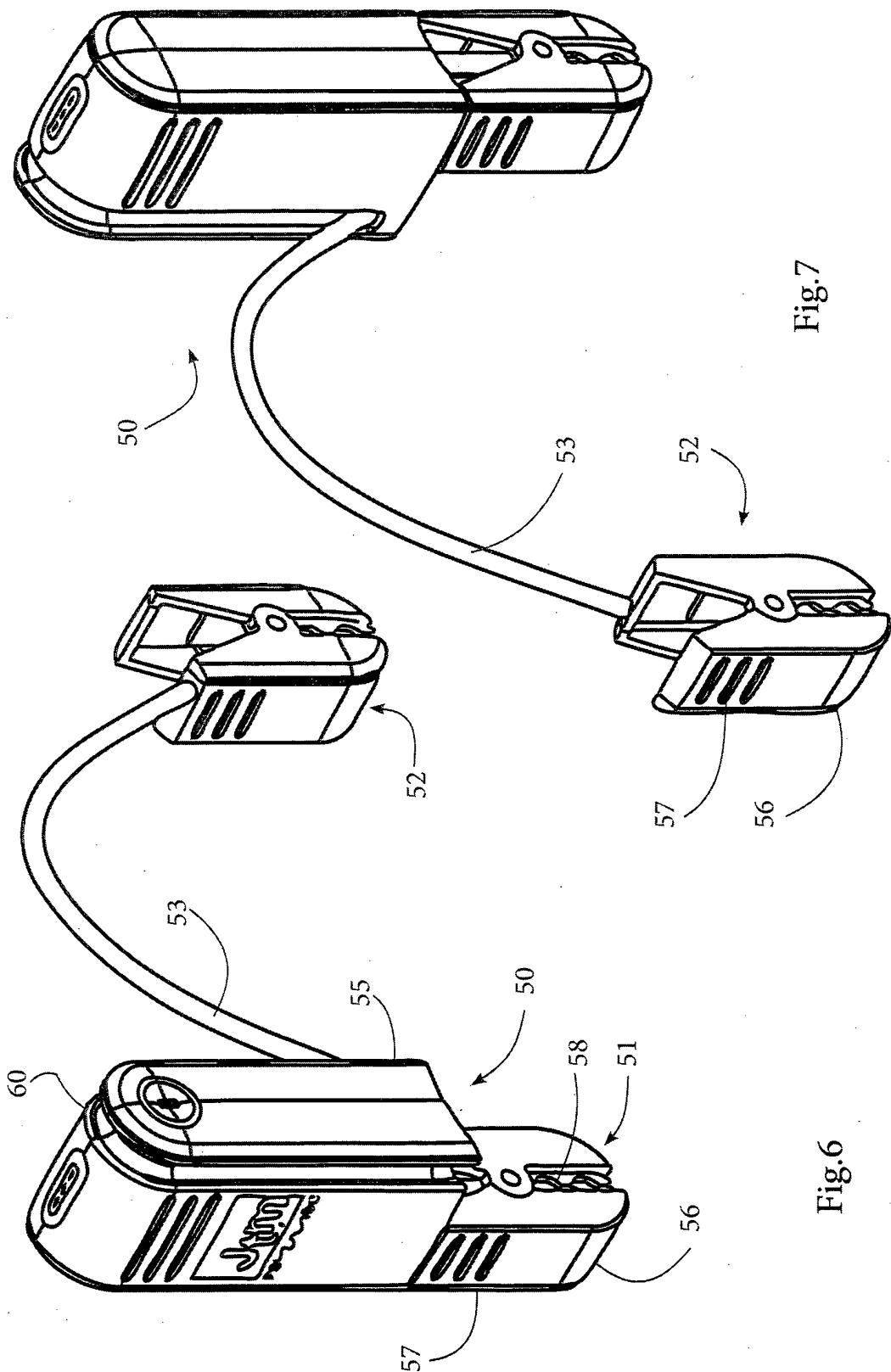


Fig.7

Fig.6

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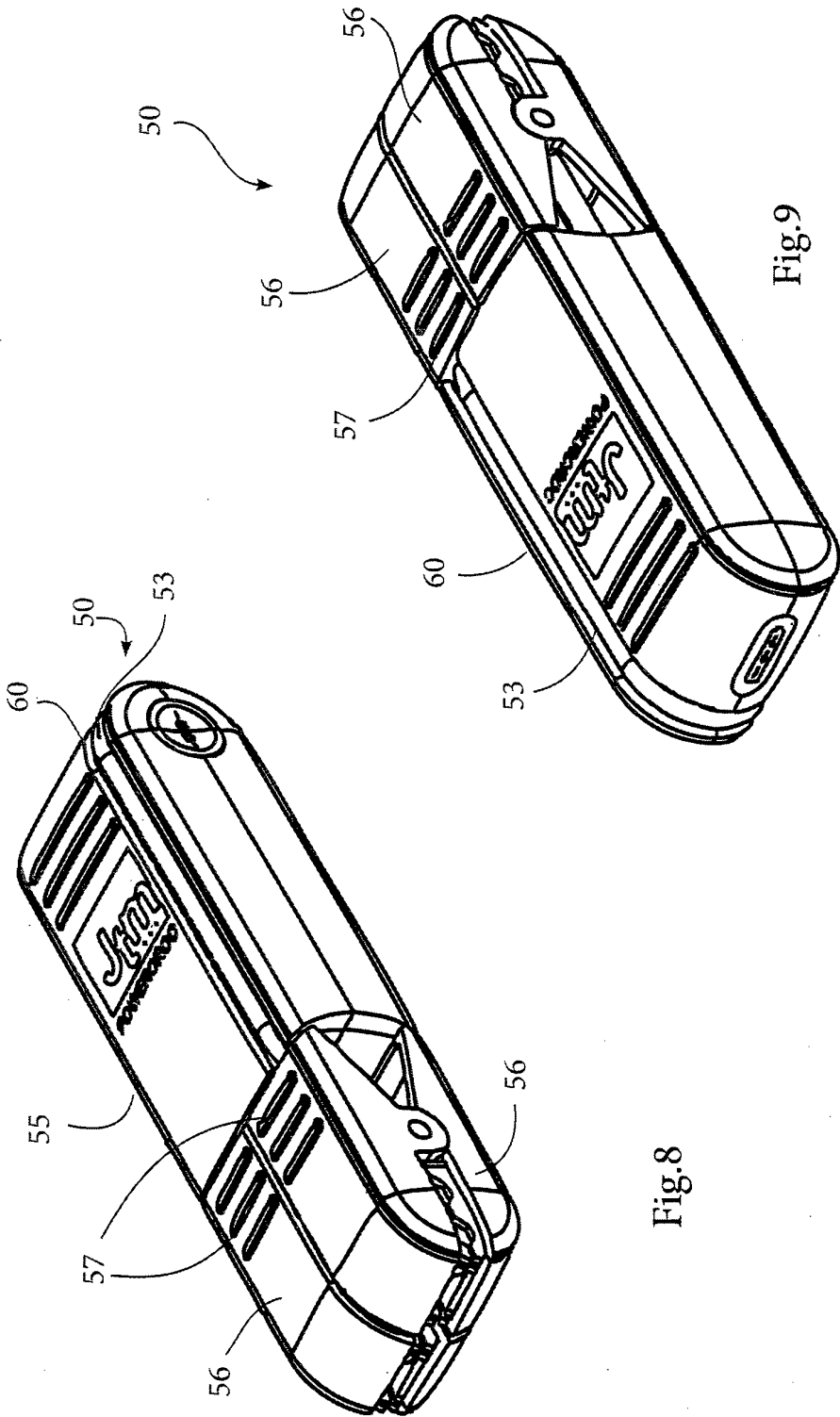


Fig.9

Fig.8

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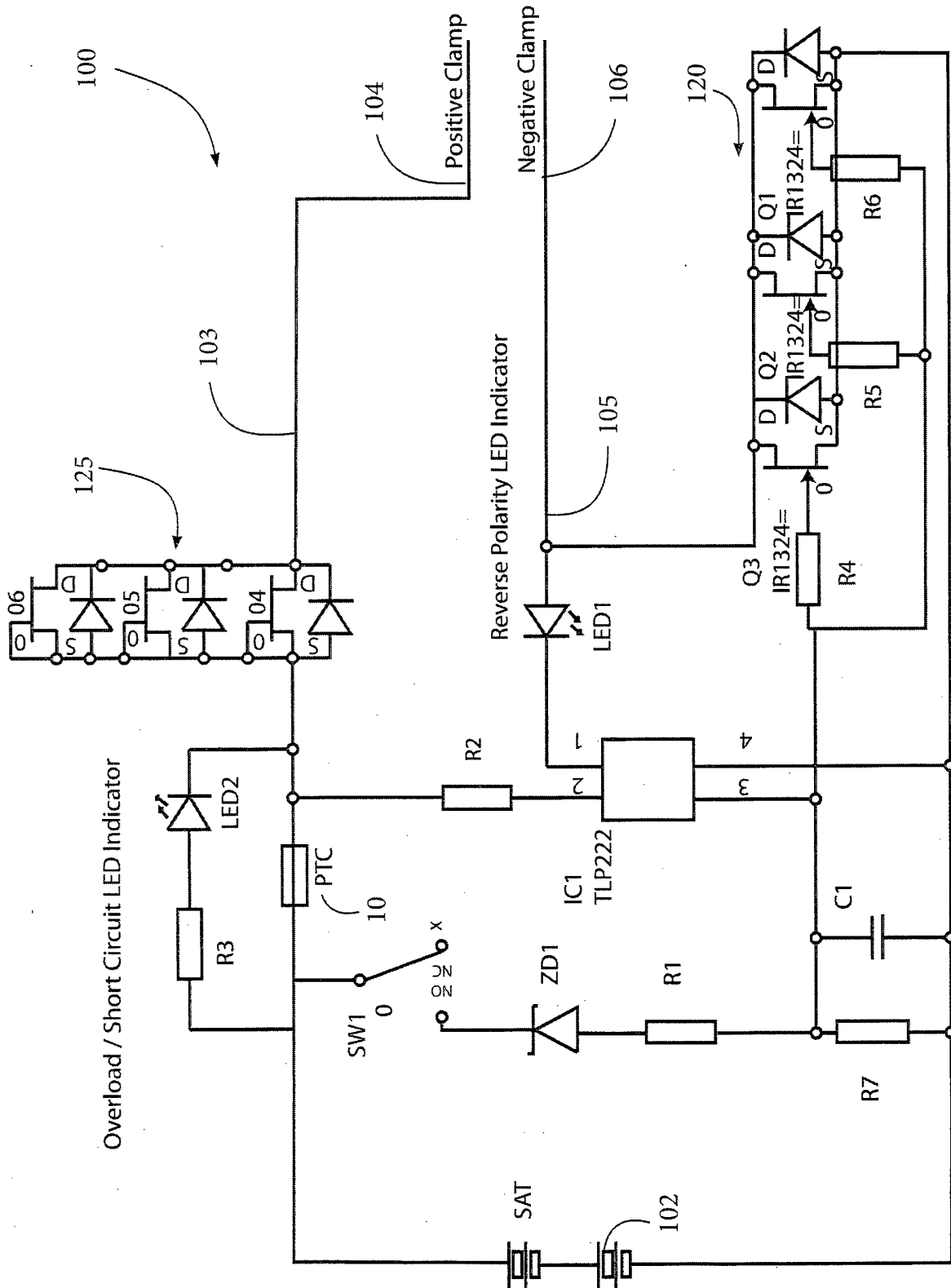


Fig.10

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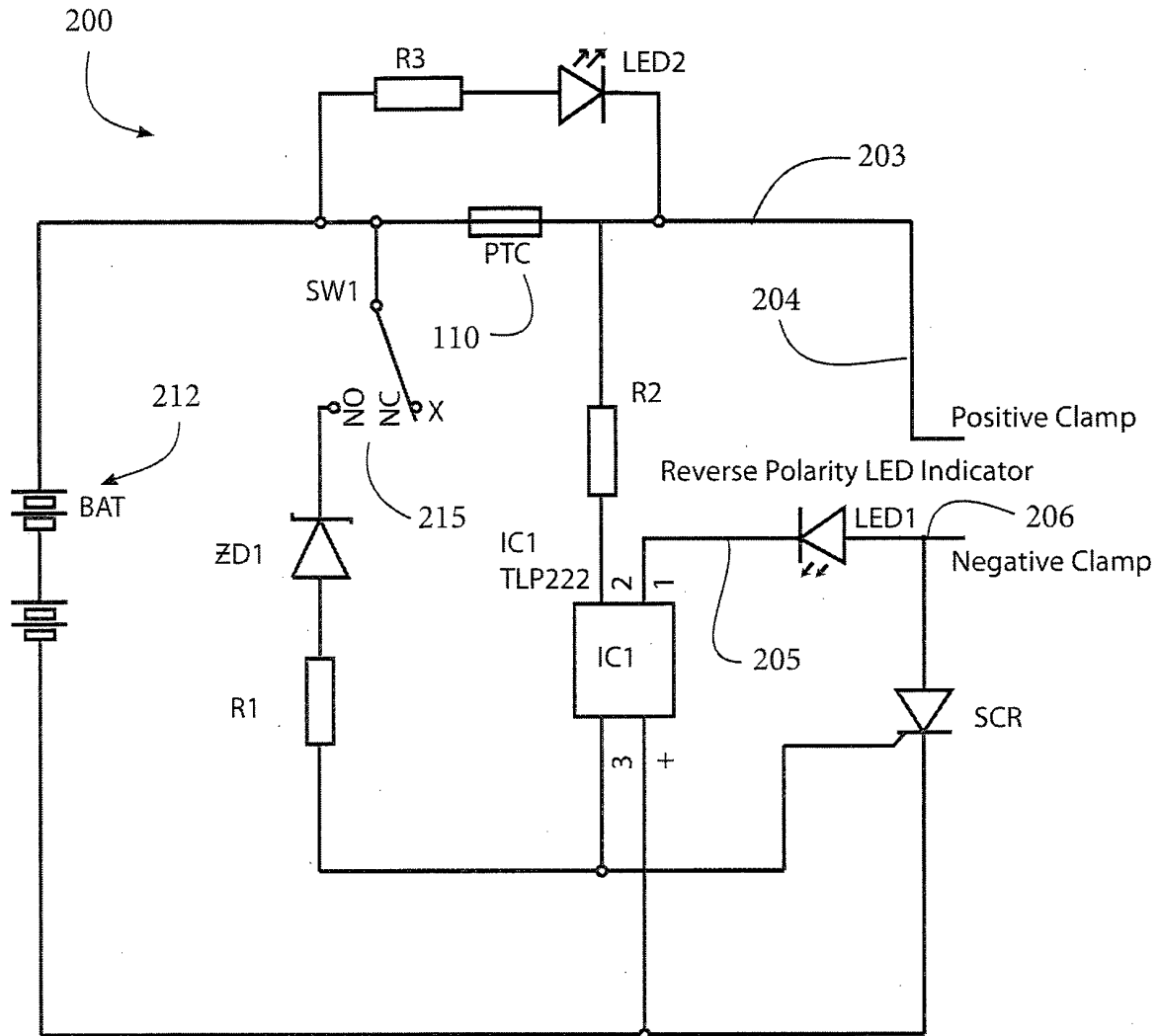


Fig.11

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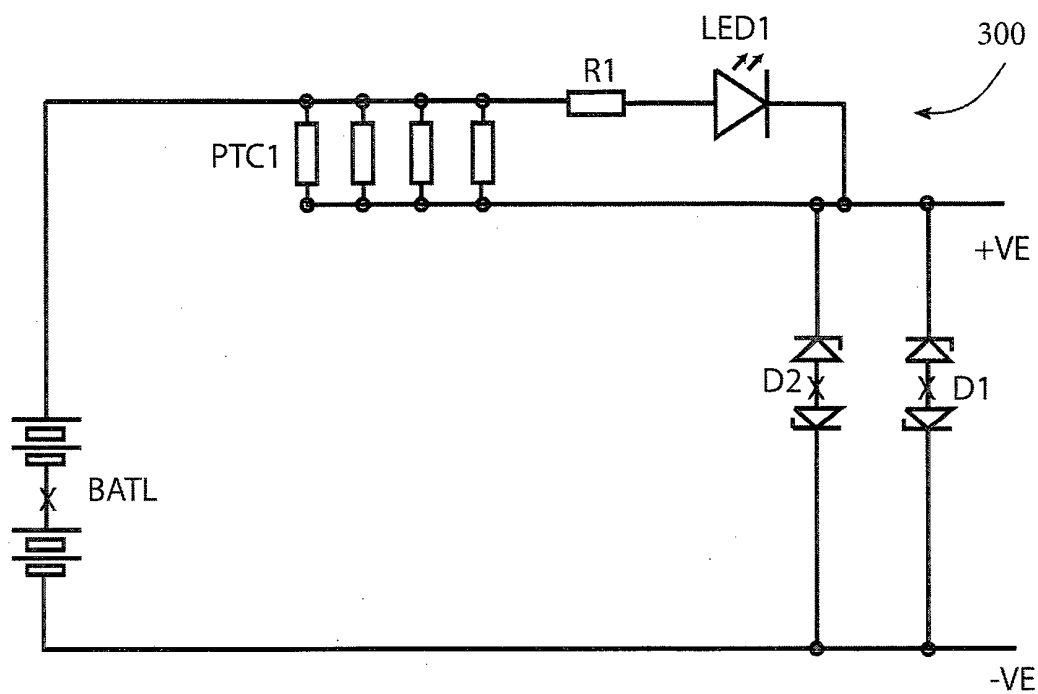


Fig.12

INTERNATIONAL SEARCH REPORT

International application No

PCT/IE2011/000066

A. CLASSIFICATION OF SUBJECT MATTER

INV. H01M2/20 H01M10/44 H01M10/46 H01M10/052 H01R11/24
H01M4/58

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)

H01R H01M

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.
X	US 6 002 235 A (CLORE KEVIN L [US]) 14 December 1999 (1999-12-14) cited in the application	1-4, 10-26
A	abstract column 2, lines 23-59 figures 1-6 -----	5-9
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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

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