(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 222 137 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
20.10.2010 Bulletin 2010/42

(51) Int Cl.:
H05B 37/03 *(2006.01)*

(21) Application number: **09002228.6**

(22) Date of filing: **18.02.2009**

(54) **System and method for automatic and safe detection of earth faults and interwire short circuits for DC lamp circuits**

System und Verfahren zur automatischen und sicheren Detektion von Erdschlüssen und Zwischenkabel-Kurzschlüssen für Gleichstromlampenschaltungen

Système et procédé de détection automatique et sécurisée des défauts à la terre et courts-circuits internes pour les circuits de lampe CC

(84) Designated Contracting States:
AT DE FR GB IT

(43) Date of publication of application:
25.08.2010 Bulletin 2010/34

(73) Proprietor: **Thales Security Solutions & Services GmbH**
70435 Stuttgart (DE)

(72) Inventor: **Altermann, Robert**
2020 Hollabrunn (AT)

(74) Representative: **Kohler Schmid Möbus**
Patentanwälte
Ruppmannstraße 27
70565 Stuttgart (DE)

(56) References cited:
US-A1- 2007 159 750
US-A1- 2008 231 198
US-A1- 2008 238 344

EP 2 222 137 B1

Printed by Jouve, 75001 PARIS (FR)

Description

Background of the invention

[0001] The invention relates to a driving circuit system for driving at least two DC signal lamps according to the preamble of claim 1.

[0002] Such a driving circuit system is known e.g. by US 2008/238344 A1.

[0003] In electronic interlockings signal lamps are normally controlled via a two-wire circuit. For safety reasons these wires have to be supervised whether there is a short circuit to earth or between two wires to avoid the unintended lightening of a signal lamp. Within conventional AC based lamp circuits, supervision of interwire short circuits has to be done periodically by supervision staff. Checking by staff is very expensive.

[0004] Although DC based signal lamp circuits have not been commonly used in the past, there is an increasing interest for using LEDs as signal lamps within interlocking.

[0005] US 2008/238344 A1 discloses a driving circuit system for driving LEDs of a light source block connected in series to each other. A resistor is connected in parallel with one or more of the LEDs and is connected to two detecting target portions in portions linked to respective electrodes of the LEDs. A ground fault detecting circuit is connected to one of the two detecting target portions disposed on a ground potential side. The light source block has one of its terminals connected to a power supply and its other terminal grounded. By detecting a change in the voltage through the ground fault detecting circuit, a ground fault can be detected.

Object of the invention

[0006] It is the object of the invention to further develop a system and a method for automatic and safe detection of earth faults and interwire short circuits within a driving circuit system for driving at least two DC signal lamps.

Short description of the invention

[0007] This object is achieved, in accordance with the invention, by a driving circuit system for driving at least two DC signal lamps, comprising:

a first DC power supply having a first voltage for driving the signal lamps,
a second DC power supply having a second voltage for driving only one of the signal lamps, the negative poles of the first and second power supplies being on different potentials,
a central amperemeter provided between the two power supplies,
and driving circuits for each signal lamp, each driving circuit comprising:

- a first two-way change-over switch connected to the positive pole of either the first or second power supply,
- a second two-way change-over switch connected to the negative pole of either the first or second power supply,
- a third two-way change-over switch connecting one wire of the signal lamp to either the first or the second switch,
- a fourth two-way change-over switch connecting the other wire of the signal lamp to either the first or second switch,
- two local amperemeters for measuring the current in both wires of the signal lamp,
- a control unit for controlling the four switches and for detecting both earth faults within a driving circuit and interwire short circuits between two driving circuits, based on the measured currents and voltages.

[0008] In a second aspect the above object is achieved, in accordance with the invention, by a method for detecting earth faults and interwire short circuits in the driving circuit system described above, wherein in a normal operation mode of the driving circuits, in which a signal lamp is turned on by connecting it to the positive and negative poles of the first power supply via the switches, an earth fault of a driving circuit is detected due to a leckage current measured by the central amperemeter, an interwire short circuit between wires of two driving circuits is detected due to a difference of the currents measured by the locals amperemeters of one of the two driving circuits, and an interwire short circuit between wires of one driving circuit is detected due to a comparison between the measured current and the expected current computed by both the measured voltage and the resistance of the wires and of the signal lamp.

[0009] According to the invention, a driving circuit system is provided which supports automatic supervision and detection of earth faults and interwire short circuits within safety-critical systems using DC current for switching electrical devices.

[0010] Further advantages can be extracted from the description and the enclosed drawing. The features mentioned above and below can be used in accordance with the invention either individually or collectively in any combination. The embodiments mentioned are not to be understood as an exhaustive enumeration but rather have - exemplary character for the description of the invention.

Drawing

[0011] The invention is shown in the drawing, in which:

Fig. 1 shows schematically a driving circuit system for driving two DC signal lamps.

[0012] As shown in **Fig. 1,** the driving circuit system **1**

for driving two DC signal lamps **2a, 2b** comprises:

- a first DC power supply **3** having a first voltage $\mathbf{U_1}$ for driving both signal lamps 2a, 2b, here formed as LEDs,
- a second DC power supply **4** having a second voltage $\mathbf{U_2}$ for driving only one of the signal lamps 2a, 2b, the negative poles of the first and second power supplies 3, 4 being on different potentials, wherein the negative pole of the second power supply 4 is connected to earth **5** and the second voltage U_2 is less than the first voltage U_1,
- a central amperemeter **6** provided between the two power supplies 3, 4, for measuring a leckage current $\mathbf{I_E}$ between the two power supplies 3,4,
- a switch $\mathbf{S_E}$ for connecting the negative pole of the first power supply 3 to the negative pole 4 of the second power supply 4, i.e. to earth 5.
- driving circuits **10a**, **10b** for each signal lamp 2a, 2b, and
- a master control 7 controlling the driving circuits 10a, 10b.

[0013] First power supply 3 is powerful enough to supply all signal lamps 2a, 2b simultaneously. Second power supply 4 may to be less powerful because it has to supply one signal lamp only. Power supply $\mathbf{U_E}$ resulting from the different potentials can be very weak because it is used for earth fault detection only. The central amperemeter 6 is placed between the two power supplies 3,4 to check earth faults. Periodical testing of the central amperemeter 6 is done by closing the switch S_E. In other words, the driving circuit system 1 specifies three voltages: U_1 and U_2 for signal lamp supply and U_E for earth fault detection.

[0014] Each driving circuit 10a, 10b comprises:

- a first two-way change-over switch $\mathbf{S_1}$ connected to either the positive pole of the first or second power supply 3, 4,
- a second two-way change-over switch $\mathbf{S_2}$ connected to either the negative pole of the first or second power supply 3, 4,
- a third two-way change-over switch $\mathbf{S_3}$ connecting one supply wire **11** of the signal lamp 2a, 2b to either the first or second switch S_1, S_2,
- a fourth two-way change-over switch $\mathbf{S_4}$ connecting the other supply wire 11 of the signal lamp 2a, 2b to either the first or second switch S_1, S_2,
- a DC-DC converter or voltage regulator **12** connecting the first and third switches S_1, S_3, for generating a variable output voltage for the signal lamp 2a, 2b, - two local amperemeters **13** for measuring the current $\mathbf{I_H}$, $\mathbf{I_R}$ in both wires 11 of the signal lamp 2a, 2b,
- a local voltmeter **14** for measuring the voltage $\mathbf{U_A}$ applied to the signal lamp 2a, 2b,
- further local voltmeters $\mathbf{15_1}$-$\mathbf{15_4}$ for measuring the voltages $\mathbf{V_1}$-$\mathbf{V_4}$ between the connections of each of the four switches S_1-S_4,
- two diodes **16** connected in parallel to the signal lamp 2a, 2b, and
- a control unit **17** for controlling the four switches S_1-S_4 and for detecting both earth faults **EF** within a driving circuit 10a, 10b and interwire short circuits ISC between two driving circuits 10a, 10b, based on the measured currents and voltages.

[0015] Each signal lamp 2a, 2b is connected with the switches S_3, S_4 by a two- wire cable, wherein the resistance of the signal lamp 2a, 2b is represented by $\mathbf{R_V}$ and the resistance of one wire 11 is represented by $\mathbf{R_L}$. The switches S_1-S_4 can be implemented by relays or any semiconductor switch. The correct working of the switches S_1-S_4 is checked by measuring the voltage $\mathbf{V_1}$-$\mathbf{V_4}$ between the connections of the switches S_1-S_4 and the occurrence of the expected current and is done by the control unit 17. All local amperemeters 13 and voltmeters 15_1-15_4 are provided with low-pass filters (not shown). In addition to the diodes 16, further protective components (not shown) can be provided to avoid distortion caused by inductive load switching.

[0016] Each control unit 17 of the driving circuit 10a, 10b is controlled by the master control 7 and can be realized for example by a microcontroller. Each control unit 17 supervises the voltages U_A ,V_1-V_4 and currents I_E, I_H, I_R, actuates the switches S_1-S_4 and defines the output voltage of the DC-DC converter 12. The master control 7 commands a control unit 17 to switch on or off the signal lamp 2a, 2b, determines an operation mode of a control unit 17 and organizes the process of measurement of earth faults EF and interwire short circuits ISC. Errors which have been detected by control units 17 are reported to the master control 7 immediately.

[0017] In safety critical systems the master control, the control unit, voltmeters, amperemeters have to be duplicated to accomplish the requirements of such a system (two channels supervising each other). In this case, switching on signal lamps 2a, 2b can only be executed if both channels give the command for switching on (logical multiplication).

[0018] The driving circuits 10a, 10b can be operated in a "normal operation mode" and a "test operation mode".

1. Normal operation mode:

[0019] In the normal operation mode of the driving circuits 10a, 10b, a signal lamp 2a, 2b is turned on by connecting it to the positive and negative poles of the first power supply 3 via the switches S_1-S_4. If a signal lamp 2a, 2b has to be turned on switches S_1 and S_2 are in position 1, SH is in position 1 and S_R in position 2. If a signal lamp has to be turned off switches S_{EH} and S_{ER} are in position 1, switches S_H and SR in position 2.

[0020] If an earth fault EF occurs leckage current I_E is caused and can be detected by every control units 17. If signal lamp 2a, 2b is turned on an interwire short circuit

ISC between wires 11 of different driving circuits 10a, 10b may be detected due to a difference of I_H and I_R. There is no guarantee of detection however because the potential difference between the two connection points of interwire short circuit ISC may be too small depending on the position within the wires 11. Therefore a special test is necessary, which is explained hereinbelow.

[0021] Interwire short circuits ISC between the two wires 11 of one driving circuits 10a, 10b can be deduced by measurement of U_A and knowledge of I_H and Rv and R_L. The expected value of I_H can be calculated. $I_H = U_A/(R_v + 2 R_L)$. A deviation is an evidence for the occurrence of a short circuit or a wire breaking. R_L of wire 11 may however alter depending on temperature influences R_L can be measured in the test operation mode which is explained hereinafter. RL has to be known for the detection.

2. Test operation mode:

[0022] At any time exactly one of the driving circuits 10a, 10b can be in that operation mode. The master control 7 regulates the permission of a driving circuit 10a, 10b to switch into the test operation mode. If a driving circuit 10a, 10b has finished the test master control 7 is informed accordingly.

[0023] If, for example, driving circuit 10a is in the test operation mode the switches S_1, S_2 move into position 2 and the driving circuit 10a is connected to second power supply 4. If its signal lamp 2a was turned on it still remains turned on except for the short moment of alternating the power supply.

[0024] Now the electrical potential of the driving circuit 10a is below that of driving circuit 10b, i.e. of all other driving circuits. Any possible interwire short circuits ISC between this unit 10a and the others will lead to a leckage current I_E. The potential difference at least amounts to voltage U_E. Additionally the leakage current I_E can be detected by calculating the difference of I_H and I_R if its signal lamp 2a is turned on. If signal lamp 2a is turned off, leakage current I_E leads to values of I_H and I_R unequal to zero.

[0025] Earth fault detection is not guaranteed at all in this operation mode. This operation mode takes a short time though. If signal lamp 2a is turned off a further test step happens: The output of DC-DC converter 12 is reduced and S_4 changes into position 1 so that the signal lamp 2a is provided with reduced inverted voltage. The diode 16 with a low voltage drop (for example: Shottky diode) is connected in parallel to the signal lamp 2a. Taking into account the voltage drop, R_L can be calculated by measurement of U_A and I_H. The knowledge of value of R_L has been known for the detection of an interwire short circuit within one driving circuit 10a (see normal operation mode).

[0026] At the end a further test step is carried out: Switch S_E is closed and I_E must arise, otherwise a fault of switch SE, of amperemeter IE or ground connection must be supposed.

[0027] At the end of the test operation mode of a driving circuit 10a all switches S_1-S_4 and the voltage of DC-DC converter 12 regain the original state as defined in the normal operation mode.

Claims

1. Driving circuit system (1) for driving at least two DC signal lamps (2a, 2b), comprising:

   a first DC power supply (3) having a first voltage (U_1) for driving the signal lamps (2a, 2b), **characterized by**:

   - a second DC power supply (4) having a second voltage (U_2) for driving only one of the signal lamps (2a, 2b), the negative poles of the first and second power supplies (3, 4) being on different potentials,
   - a central amperemeter (6) provided between the two power supplies (3, 4), and driving circuits (10a, 10b) for each signal lamp (2a, 2b), each driving circuit (10a, 10b) comprising:
   - a first two-way change-over switch (S_1) connected to the positive pole of either the first or second power supply (3, 4),
   - a second two-way change-over switch (S_2) connected to the negative pole of either the first or second power supply (3, 4),
   - a third two-way change-over switch (S_3) connecting one wire (11) of the signal lamp (2a, 2b) to either the first or the second switch (S_1, S_2),
   - a fourth two-way change-over switch (S_4) connecting the other wire (11) of the signal lamp (2a, 2b) to either the first or second switch (S_1, S_2),
   - two local amperemeters (13) for measuring the current (I_H, I_R) in both wires (11) of the signal lamp (2a, 2b),
   - a local voltmeter (14) for measuring the voltage (U_A) applied to the signal lamp (2a, 2b), and
   - a control unit (17) for controlling the four switches (S_1-S_4) and for detecting both earth faults (EF) within a driving circuit (10a, 10b) and interwire short circuits (ISC) between two driving circuits (10a, 10b), based on the measured currents and voltages.

2. Driving circuit system according to claim 1, **characterized by** a DC-DC converter (12) connecting the first and third switches (S_1, S_3), for generating a variable output voltage for the signal lamp (2a, 2b).

3. Driving circuit system according to claim 1 or 2, **characterized by** further local voltmeters (15_1-15_4) for measuring the voltages (V_1-V_4) between the connections of each of the four switches (S_1-S_4).

4. Driving circuit system according to any one of the preceding claims, **characterized in that** each driving circuit (10a, 10b) comprises at least one diode (16) connected in parallel to the signal lamp (2a, 2b).

5. Driving circuit system according to any one of the preceding claims, **characterized in that** the negative pole of the second power supply (4) is connected to earth (5).

6. Driving circuit system according to any one of the preceding claims, **characterized in that** the second voltage (U_2) is less than the first voltage (U_1).

7. Driving circuit system according to any one of the preceding claims, **characterized by** a master control (7) controlling the control units (17) of all driving circuits (10a, 10b).

8. Driving circuit system according to any one of the preceding claims, **characterized in that** a switch (S_E) is provided for connecting the negative pole of the first power supply (3) to the negative pole of the second power supply (4).

9. Method for detecting earth faults (EF) and interwire short circuits (ISC) in a driving circuit system (1) according to any one of the preceding claims, wherein in a normal operation mode of the driving circuits (10a, 10b), in which a signal lamp (2a, 2b) is turned on by connecting it to the positive and negative poles of the first power supply (3) via the switches (S_1-S_4),
an earth fault (EF) of a driving circuit (1a, 1 b) is detected due to a leckage current (I_E) measured by the central amperemeter (6),
an interwire short circuit (ISC) between wires (11) of two driving circuits (10a, 10b) is detected due to a difference of the currents (I_H, I_R) measured by the locals amperemeters (13) of one of the two driving circuits (10a, 10b), and
an interwire short circuit (ISC) between wires (11) of one driving circuit (10a, 10b) is detected due to a comparison between the measured current (I_H, I_R) and the expected current computed by both the measured voltage (U_A) and the resistance (R_L, R_V) of the wires (11) and of the signal lamp (2a, 2b).

10. Method according to claim 9, **characterized in that** in a test operation mode of one driving circuit (10a, 10b), in which only one signal lamp (2a, 2b) is connected to the second power supply (4) via the switches (S_1-S_4), an interwire short circuit (ISC) between the driving circuit (10a) and another driving circuit (10b) is detected due to a leckage current (I_E) measured by the central amperemeter (6) and, if the signal lamp (2a, 2b) is turned on, due to a difference of the currents (I_H, I_R) measured by the locals amperemeters (13) of the driving circuit (10a, 10b), and, if the signal lamp (2a, 2b) is turned off, due to currents (I_H, I_R) measured by the locals amperemeters (13) being unequal to zero.

11. Method according to claim 10, **characterized in that** in the test operation mode of one driving circuit (10a, 10b), a reduced inverted voltage is applied to the signal lamp (2a, 2b), when turned off, the resistance (R_L) of the wires (11) of the signal lamp (2a, 2b) is calculated by measuring U_A and I_H and taking into account the voltage drop at a diode (16) connected in series to the signal lamp (2a, 2b).

12. Method according to one of the claims 9 to 11, **characterized in that**, in particular at the end of the test operation mode of one driving circuit (10a, 10b), the negative pole of the first power supply (3) and the negative pole of the second power supply (4) are connected which causes the leckage current (I_E) measured by the central amperemeter (6) to arise.

Patentansprüche

1. Steuerschaltungssystem (1) zum Ansteuern von mindestens zwei Gleichstrom-Signallampen (2a, 2b), umfassend:

eine erste Gleichstromversorgung (3) mit einer ersten Spannung (U_1) zum Ansteuern der Signallampen (2a, 2b),
gekennzeichnet durch:

- eine zweite Gleichstromversorgung (4) mit einer zweiten Spannung (U_2) zum Ansteuern von nur einer der Signallampen (2a, 2b), wobei die Minuspole der ersten und zweiten Stromversorgung (3, 4) auf unterschiedlichen Potentialen liegen,
- ein zentrales Amperemeter (6), das zwischen den zwei Stromversorgungen (3, 4) vorgesehen ist, und Steuerschaltungen (10a, 10b) für jede Signallampe (2a, 2b), wobei jede Steuerschaltung (10a, 10b) umfasst:
- einen ersten Zwei-Wege-Umschalter (S_1), der mit dem Pluspol entweder der ersten oder zweiten Stromversorgung (3, 4) verbunden ist,
- einen zweiten Zwei-Wege-Umschalter (S_2), der mit dem Minuspol entweder der ersten oder zweiten Stromversorgung (3, 4) verbunden ist,

- einen dritten Zwei-Wege-Umschalter (S_3), der einen Draht (11) der Signallampe (2a, 2b) entweder mit dem ersten oder zweiten Schalter (S_1, S_2) verbindet,
- einen vierten Zwei-Wege-Umschalter (S_4), der den anderen Draht (11) der Signallampe (2a, 2b) entweder mit dem ersten oder zweiten Schalter (S_1, S_2) verbindet,
- zwei lokale Amperemeter (13) zum Messen des Stroms (I_H, I_R) in beiden Drähten (11) der Signallampe (2a, 2b),
- ein lokales Voltmeter (14) zum Messen der Spannung (U_A), die an die Signallampe (2a, 2b) angelegt wird, und
- eine Steuereinheit (17) zum Steuern der vier Schalter (S_1-S_4) und zum Detektieren sowohl von Erdschlüssen (EF) innerhalb einer Steuerschaltung (10a, 10b) als auch von Zwischendraht-Kurzschlüssen (ISC) zwischen zwei Steuerschaltungen (10a, 10b) auf der Basis der gemessenen Ströme und Spannungen.

2. Steuerschaltungssystem nach Anspruch 1, **gekennzeichnet durch** einen Gleichstrom-Gleichstrom-Wandler (12), der den ersten und dritten Schalter (S_1, S_3) verbindet, um eine variable Ausgangsspannung für die Signallampe (2a, 2b) zu erzeugen.

3. Steuerschaltungssystem nach Anspruch 1 oder 2, **gekennzeichnet durch** weitere lokale Voltmeter (15_1-15_4) zum Messen der Spannungen (V_1-V_4) zwischen den Verbindungen jedes der vier Schalter (S_1-S_4).

4. Steuerschaltungssystem nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** jede Steuerschaltung (10a, 10b) mindestens eine Diode (16) aufweist, die mit der Signallampe (2a, 2b) parallel geschaltet ist.

5. Steuerschaltungssystem nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der Minuspol der zweiten Stromversorgung (4) mit der Erde (5) verbunden ist.

6. Steuerschaltungssystem nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die zweite Spannung (U_2) kleiner als die erste Spannung (U_1) ist.

7. Steuerschaltungssystem nach einem der vorhergehenden Ansprüche, **gekennzeichnet durch** eine Hauptsteuerung (7), die die Steuereinheiten (17) aller Steuerschaltungen (10a, 10b) steuert.

8. Steuerschaltungssystem nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** ein Schalter (S_E) vorgesehen ist, um den Minuspol der ersten Stromversorgung (3) mit dem Minuspol der zweiten Stromversorgung (4) zu verbinden.

9. Verfahren zum Detektieren von Erdschlüssen (EF) und Zwischendraht-Kurzschlüssen (ISC) in einem Steuerschaltungssystem (1) nach einem der vorhergehenden Ansprüche, wobei in einem normalen Betriebsmodus der Steuerschaltungen (10a, 10b), in welchem eine Signallampe (2a, 2b) angeschaltet wird, indem sie mit dem Plus- und Minuspol der ersten Stromversorgung (3) über die Schalter (S_1-S_4) verbunden ist, ein Erdschluss (EF) einer Steuerschaltung (10a, 10b) aufgrund eines von dem zentralen Amperemeter (6) gemessenen Leckstroms (I_E) detektiert wird, ein Zwischendraht-Kurzschluss (ISC) zwischen Drähten (11) zweier Steuerschaltungen (10a, 10b) aufgrund einer von den lokalen Amperemetern (13) einer der zwei Steuerschaltungen (10a, 10b) gemessenen Differenz der Ströme (I_H, I_R) detektiert wird und ein Zwischendraht-Kurzschluss (ISC) zwischen Drähten (11) einer Steuerschaltung (10a, 10b) aufgrund eines Vergleichs zwischen dem gemessenen Strom (I_H, I_R) und dem erwarteten Strom, berechnet sowohl durch die gemessene Spannung (U_A) als auch den Widerstand (R_L, R_V) der Drähte (11) und der Signallampe (2a, 2b), detektiert wird.

10. Verfahren nach Anspruch 9, **dadurch gekennzeichnet, dass** in einem Testbetriebsmodus einer Steuerschaltung (10a, 10b), in welchem nur eine Signallampe (2a, 2b) mit der zweiten Stromversorgung (4) über die Schalter (S_1-S_4) verbunden ist, ein Zwischendraht-Kurzschluss (ISC) zwischen der Steuerschaltung (10a) und einer anderen Steuerschaltung (10b) detektiert wird aufgrund eines von dem zentralen Amperemeter (6) gemessenen Leckstroms (I_E) und, wenn die Signallampe (2a, 2b) angeschaltet ist, aufgrund einer von den lokalen Amperemetern (13) der Steuerschaltung (10a, 10b) gemessenen Differenz der Ströme (I_H, I_R) und, wenn die Signallampe (2a, 2b) ausgeschaltet ist, aufgrund der von den lokalen Amperemetern (13) gemessenen Ströme (I_H, I_R), die ungleich Null sind.

11. Verfahren nach Anspruch 10, **dadurch gekennzeichnet, dass** in dem Testbetriebsmodus einer Steuerschaltung (10a, 10b) eine reduzierte Inversionsspannung an die Signallampe (2a, 2b) im ausgeschalteten Zustand angelegt wird, der Widerstand (R_L) der Drähte (11) der Signallampe (2a, 2b) berechnet wird durch Messen von U_A und I_H und Berücksichtigen des Spannungsabfalls an einer Diode (16), die mit der Signallampe (2a, 2b) in Reihe geschaltet ist.

12. Verfahren nach einem der Ansprüche 9 bis 11, **dadurch gekennzeichnet, dass,** insbesondere am Ende des Testbetriebsmodus einer Steuerschaltung (10a, 10b), der Minuspol der ersten Stromversorgung (3) und der Minuspol der zweiten Stromversorgung (4) verbunden werden, wodurch der von dem zentralen Amperemeter (6) gemessene Leckstrom (I_E) ansteigt.

Revendications

1. Système de circuit d'attaque (1) destiné à attaquer au moins deux lampes de signalisation à courant continu (2a, 2b), comprenant :

une première alimentation à courant continu (3) ayant une première tension (U_1) pour attaquer les lampes de signalisation à courant continu (2a, 2b),
caractérisé par :

- une deuxième alimentation à courant continu (4) ayant une deuxième tension (U_2) pour attaquer une seule des lampes de signalisation (2a, 2b), les pôles négatifs des première et deuxième alimentations (3, 4) étant à des potentiels différents,
- un ampèremètre central (6) prévu entre les deux alimentations (3, 4) et des circuits d'attaque (10a, 10b) pour chaque lampe de signalisation (2a, 2b), chaque circuit d'attaque (10a, 10b) comprenant :
- un premier commutateur bidirectionnel (S_1) relié au pôle positif soit de la première, soit de la deuxième alimentation (3, 4),
- un deuxième commutateur bidirectionnel (S_2) relié au pôle négatif soit de la première, soit de la deuxième alimentation (3, 4),
- un troisième commutateur bidirectionnel (S_3) reliant un fil (11) de la lampe de signalisation (2a, 2b) soit au premier, soit au deuxième commutateur (S_1, S_2),
- un quatrième commutateur bidirectionnel (S_4) reliant l'autre fil (11) de la lampe de signalisation (2a, 2b) soit au premier, soit au deuxième commutateur (S_1, S_2),
- deux ampèremètres locaux (13) destinés à mesurer le courant (I_H, I_R) dans les deux fils (11) de la lampe de signalisation (2a, 2b),
- un voltmètre local (14) destiné à mesurer la tension (U_A) appliquée à la lampe de signalisation (2a, 2b), et
- une unité de commande (17) destinée à commander les quatre commutateurs (S_1-S_4) et à détecter à la fois des défauts à la terre (EF) dans un circuit d'attaque (10a, 10b) et des courts-circuits entre fils (ISC) entre deux circuits d'attaque (10a, 10b), sur la base des courants et des tensions mesurés.

2. Système de circuit d'attaque selon la revendication 1, **caractérisé par** un convertisseur courant continu-courant continu (12) reliant les premier et troisième commutateurs (S_1, S_3), destiné à générer une tension de sortie variable pour la lampe de signalisation (2a, 2b).

3. Système de circuit d'attaque selon la revendication 1 ou 2, **caractérisé par** d'autres voltmètres locaux (15_1-15_4) destinés à mesurer les tensions (V_1-V_4) entre les connexions de chacun des quatre commutateurs (S_1- S_4).

4. Système de circuit d'attaque selon l'une quelconque des revendications précédentes, **caractérisé en ce que** chaque circuit d'attaque (10a, 10b) comprend au moins une diode (16) reliée en parallèle à la lampe de signalisation (2a, 2b).

5. Système de circuit d'attaque selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le pôle négatif de la deuxième alimentation (4) est relié à la terre (5).

6. Système de circuit d'attaque selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la deuxième tension (U_2) est inférieure à la première tension (U_1).

7. Système de circuit d'attaque selon l'une quelconque des revendications précédentes, **caractérisé par** une commande principale (7) commandant les unités de commande (17) de tous les circuits d'attaque (10a, 10b).

8. Système de circuit d'attaque selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**un commutateur (S_E) est prévu pour relier le pôle négatif de la première alimentation (3) au pôle négatif de la deuxième alimentation (4).

9. Procédé de détection des défauts à la terre (EF) et des courts-circuits entre fils (ISC) dans un système de circuit d'attaque (1) selon l'une quelconque des revendications précédentes, dans lequel, dans un mode de fonctionnement normal des circuits d'attaque (10a, 10b), dans lequel une lampe de signalisation (2a, 2b) est activée en la reliant aux pôles positif et négatif de la première alimentation (3) par le biais des commutateurs (S_1-S_4), un défaut à la terre (EF) d'un circuit d'attaque (1a, 1b) est détecté en raison d'un courant de fuite (I_E) mesuré par l'ampèremètre centrale (6), un court-circuit entre fils (ISC) entre les fils (11) des deux circuits (10a, 10b) est détecté en raison d'une différence entre les courants (I_H, I_R) mesurés par les ampèremètre locaux (13) de l'un des deux circuits d'attaque (10a, 10b), et un court-circuit entre fils (ISC) entre les fils d'un circuit d'attaque (10a, 10b) est détecté en raison d'une comparaison entre le courant mesuré (I_H, I_R) et le courant attendu calculé avec à la fois la tension mesurée (U_A) et la résistance (R_L, R_V) des fils (11) et de la lampe de signalisation (2a, 2b).

10. Procédé selon la revendication 9, **caractérisé en ce que**, dans un mode de fonctionnement d'essai d'un circuit d'attaque (10a, 10b), dans lequel une seule lampe de signalisation (2a, 2b) est reliée à la deuxième alimentation (4) par le biais des commutateurs (S_1- S_4), un court-circuit entre fils (ISC) entre le circuit d'attaque (10a) et un autre circuit d'attaque (10b) est détecté en raison d'un courant de fuite (I_E) mesuré par l'ampèremètre central (6) et, si la lampe de signalisation (2a, 2b) est activée, en raison d'une différence entre des courants (I_H, I_R) mesurés par les ampèremètre locaux (13) du circuit d'attaque (10a, 10b), et, si la lampe de signalisation (2a, 2b) est désactivée, en raison des courants (I_H, I_R) mesurés par les ampèremètre locaux (13) qui sont différents de zéro.

11. Procédé selon la revendication 10, **caractérisé en ce que** dans le mode de fonctionnement d'essai d'un circuit d'attaque (10a, 10b), une tension inversée réduite est appliquée à la lampe de signalisation (2a, 2b), lorsqu'elle est désactivée, la résistance (R_L) des fils de la lampe signalisation (2a, 2b) est calculée en mesurant U_A et I_H et en prenant en compte la chute de tension au niveau d'une diode (16) reliée en série à la lampe de signalisation (2a, 2b).

12. Procédé selon l'une quelconque des revendications 9 à 11, **caractérisé en ce que**, en particulier à la fin du mode de fonctionnement d'essai d'un circuit d'attaque (10a, 10b), le pôle négatif de la première alimentation (3) et le pôle négatif de la deuxième alimentation (4) sont reliés ce qui provoque l'apparition du courant de fuite (I_E) mesuré par l'ampèremètre central (6).

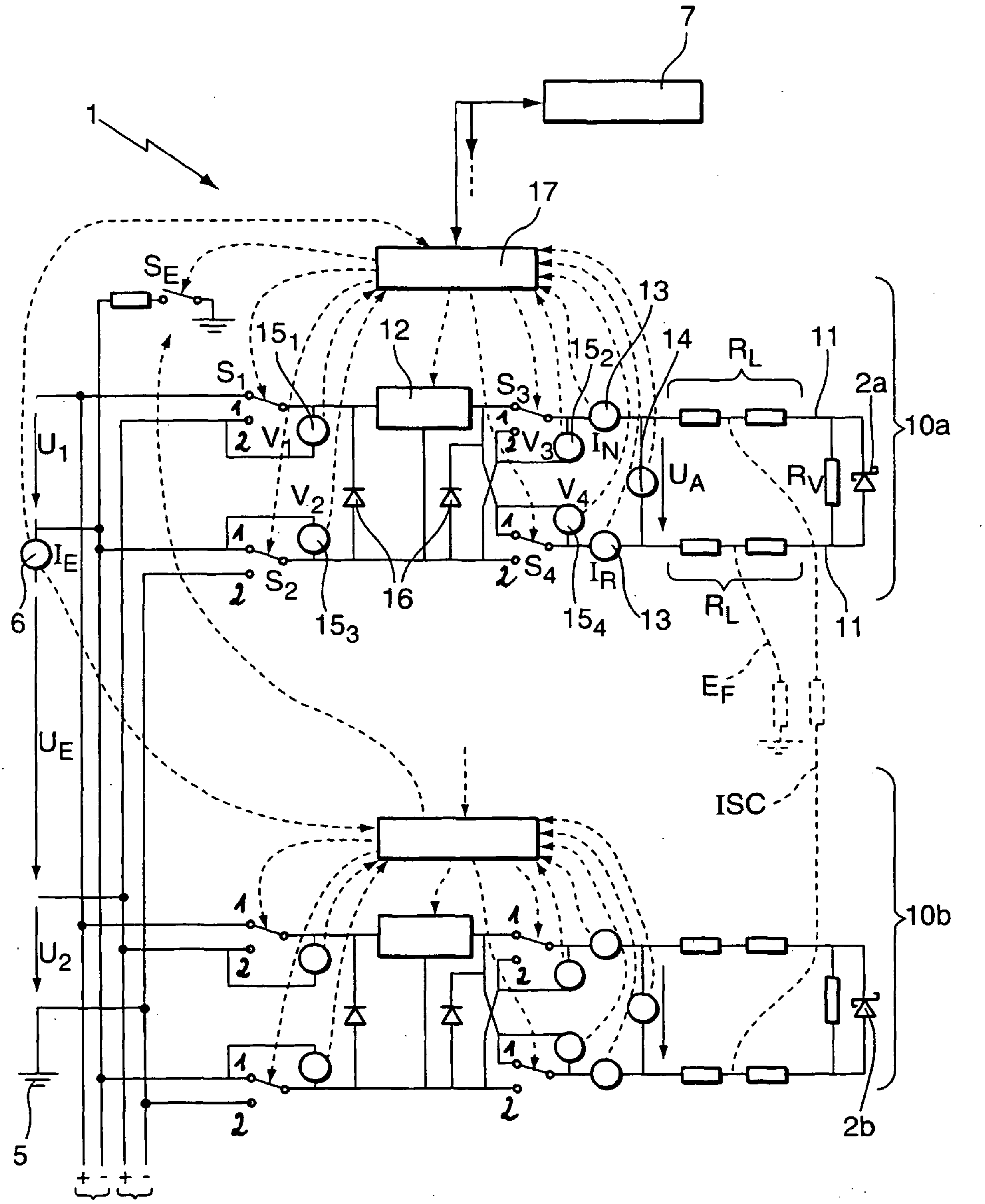
7
1
17
SE
151
12
13
152
14
RL
11
2a
10a
S1
S3
U1
V1
V3
IN
UA
RV
V2
V4
IE
S2
S4
16
IR
153
154
13
11
6
RL
EF
UE
ISC
10b
U2
2b
5
3
4

Fig. 1

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 2008238344 A1 **[0002] [0005]**