

A METHOD FOR TRIPPING A RESIDUAL CURRENT DEVICE, A SECONDARY PROTECTION DEVICE FOR TRIPPING A RESIDUAL CURRENT DEVICE, AN ELECTRICAL PROTECTION UNIT AND A MOUNTING BRACKET

Technical Field

5 The present invention relates to electrical protection systems and in particular to an electrical protection system adapted for high earth impedance environments where conventional residual current protection devices often fail to protect.

The invention has been developed primarily for use with residual current devices (RCDs) or residual current devices with combined circuit break (RCBOs), and such arrangements will
10 be described hereinafter with reference to this application. However, it will be appreciated that the invention is not limited to this particular field of use.

Background

Referring to Fig. 1, there is shown a prior art electrical protection system 1 adapted for high
15 earth impedance environments.

The system 1 is adapted for delivering power from electrical power source 30 to load 31. A variation of the embodiment given in Fig. 1 (not shown) with diode 80 removed, operates in a multiple earth neutral (MEN), also known as a 'TN/TT network', electrical distribution system (EDS) environment in which the line side neutral is earthed. The embodiment given
20 in Fig. 1 can also operate in non-MEN EDS environment, also known as 'floating earth EDS' or 'IT network', and in this operating environment diode 80 is installed (as shown) and the line side neutral is not earthed.

Specifically, system 1 comprises a conventional residual current device 2 comprising current imbalance detection module 3 adapted for detecting a current imbalance between load side
25 active conductor 4 and load side neutral conductor 5. Such a current imbalance is indicative of a fault condition in certain conditions such as during short circuit conditions when current leaks from the load side active conductor 4 or the load side neutral conductor 5 to the frame/earth 6 (such as a metal chassis of certain equipment) or other reference frame.

Upon the detection of the imbalance, the current imbalance detection module 3, by operable connection with switching system 7, is adapted to disconnect active and neutral conductors 4, 5.

5 However, as alluded to above, such current imbalance detection is not suited for high earth impedance environments. For example, a person making accidental contact with active conductor 4 while standing on high earth impedance material such as sandy soil, hard rocky ground or the like, may be exposed to dangerous voltage levels without drawing the requisite current threshold level to trip the residual current device 2.

10 As such, the system 1 comprises secondary protection device 8 adapted for tripping the residual current device 2 in these high earth impedance environments.

Specifically, the secondary protection device 8 comprises sensor line 9 in electrical connection with earth/frame 6, in which earth/frame 6 may be a conventional earth conductor or other suitable reference including a metal chassis or otherwise conductive frame, especially for non-MEN applications where the line side neutral is not connected to earth (as
15 shown in Fig. 1).

During a fault condition, such as where a person inadvertently makes contact with the active conductor 4, a voltage would appear at the earth/frame and therefore at sensor line 9. Resistor 10 in conjunction with DC rectifier diodes 11 and 12 causes current to flow through the solenoid of a low-power trip relay 14 to the neutral conductor 5, the trip relay 14 having 12 V
20 over voltage protection on its solenoid by way of a Zener diode 13.

The consequential engaging of the trip relay 14 causes current to flow from the active conductor 4 through a trip solenoid 15 to the neutral conductor 5.

The system 1 comprises a mechanical coupling 16 between the trip solenoid 15 and the switching system 7. In practice, the secondary protection device 8 and the conventional
25 residual current device 2 physically are integrated on a common power board rail so as to allow the mechanical coupling 16 to extend between the two and hence enable the trip solenoid 15 to open the switching system 7 which disconnects load 31 from power source 30.

However, the system 1 of the prior art provided in Fig. 1 comprises several disadvantages.

30 Specifically, in certain embodiments, the secondary protection device 8 and the residual current device 2 are sold as an integral package. However, the residual current device 2 typically has various different possible combinations of load current ratings and fault current

ratings, and therefore the secondary protection device 8 requires configuration for each such set of current ratings. Furthermore, each integral package would require electrical certification for each set of ratings.

Furthermore, the mechanical coupling 16 may be prone to mechanical failure.

- 5 Furthermore, the mechanical coupling 16 maybe susceptible to mechanical forces such as vibration, inertial forces, and the like which may result in inadvertent tripping of the residual current device 2.

10 Furthermore, the failure of the mechanical coupling 16 may cause current to be maintained through the trip solenoid 15 resulting in a burnout of the trip solenoid 15 and hence posing a potential fire risk.

And furthermore again, on account of the residual current device 2 and the secondary protection device 8 being sold in combination, the failure of either the residual current device 2 or the secondary protection device 8 may require the replacement of the entire system 1, thereby being more expensive from a maintenance perspective.

- 15 As such, a need therefore exists for a protection system which will overcome or substantially ameliorate at least some of the deficiencies of the prior art, or to at least provide an alternative.

20 It is to be understood that, if any prior art information is referred to herein, such reference does not constitute an admission that the information forms part of the common general knowledge in the art, in Australia or any other country.

Summary of the Invention

25 According to a first aspect of the present invention, there is provided a method for tripping a residual current device comprising a detection of leakage characterised in that the detection of leakage creates a current imbalance between an active conductor and a neutral conductor of the residual current device.

Preferably, the detection of leakage comprises detection of leakage of current to a reference.

Preferably, the reference is a frame reference.

Preferably, the reference is an earth reference.

- 30 Preferably, the detection of leakage comprises detecting a voltage exceeding a voltage threshold at the reference.

Preferably, the voltage threshold is greater than 10 V.

Preferably, the voltage threshold is greater than 20 V.

Preferably, the voltage threshold is greater than 40 V.

Preferably, the voltage threshold is greater than 50 V.

- 5 Preferably, the detection of leakage comprises detecting a current greater than a current threshold.

Preferably, the current threshold is greater than 1 mA.

Preferably, the current threshold is greater than 5 mA.

Preferably, the current threshold is greater than 8 mA.

- 10 Preferably, the creation of the current imbalance comprises allowing current to flow from a line side to a load side of the residual current device.

Preferably, the creation of the current imbalance comprises providing a load resistance between the active conductor on the load side and the neutral conductor on the line side of the residual current device.

- 15 Preferably, the load resistance is selected to allow a current to flow from the active conductor on the load side to the neutral conductor on the line side of the residual current device of greater than 5 mA.

Preferably, the load resistance is selected to allow a current to flow from the active conductor on the load side to the neutral conductor on the line side of the residual current device of

- 20 greater than 15 mA.

Preferably, the load resistance is selected to allow a current to flow from the active conductor on the load side to the neutral conductor on the line side of the residual current device of greater than 30 mA.

- 25 Preferably, the creation of the current imbalance comprises maintaining the current imbalance using a latch.

Preferably, the latch is adapted to reset once the residual current device has tripped.

Preferably, the method further comprises providing an indication of the leakage of current to the reference.

Preferably, the indication comprises illumination.

- 30 According to a second aspect of the present invention, there is provided a secondary protection device for tripping a residual current device, the secondary protection device comprising a sensor line adapted for detection of leakage, and a switch means, characterised in that the switch means is adapted for creation of a current imbalance between an active conductor and a neutral conductor of the residual current device.

Preferably, the sensor line is connected to a reference so as to detect the leakage of current to the reference.

Preferably, the reference is a frame reference.

Preferably, the reference is an earth reference.

5 Preferably, the switch means is adapted for switching at a voltage threshold at the reference.

Preferably, the voltage threshold is greater than 10 V.

Preferably, the voltage threshold is greater than 20 V.

Preferably, the voltage threshold is greater than 40 V.

Preferably, the voltage threshold is greater than 50 V.

10 Preferably, the switch means is adapted for switching at a current threshold.

Preferably, the current threshold is greater than 1 mA.

Preferably, the current threshold is greater than 5 mA.

Preferably, the current threshold is greater than 8 mA.

15 Preferably, the switch means allows current to flow from a line side to a load side of the residual current device.

Preferably, the secondary protection device further comprises a load resistance in series with the switch means.

20 Preferably, the load resistance is selected to allow a current to flow from the active conductor on the load side to the neutral conductor on the line side of the residual current device of greater than 5 mA.

Preferably, the load resistance is selected to allow current to flow from the active conductor on the load side to the neutral conductor on the line side of the residual current device of greater than 15 mA.

25 Preferably, the load resistance is selected to allow current to flow from the active conductor on the load side to the neutral conductor on the line side of the residual current device of greater than 30 mA.

Preferably, the switch means is arranged to remain closed until the residual current device has tripped.

30 Preferably, the secondary protection device further comprises an indication means of the leakage of current to the reference.

Preferably, the indication means comprises illumination.

Preferably, the secondary protection device is located in an electrical protection unit together with the residual current device, with respective internal electrical connections provided between the secondary protection device and the residual current device.

5 Preferably, the electrical protection unit comprises a mounting means arranged to mount the residual current device and the secondary protection device side by side in a housing.

Preferably, the mounting means is a plastic moulded mounting bracket.

10 Preferably, the electrical protection unit also comprises a cover pivotably mounted to the housing which, when the cover is opened, provides visible and finger access to respective control panels of the residual current device and the secondary protection device for an operator.

Preferably, the electrical protection unit further comprises a power inlet lead extending from the housing and terminated at a plug.

Preferably, the electrical protection unit further comprises a power outlet lead extending from the housing and terminated at a socket.

15 Preferably, the sensor line is connected to an earth conductor in the power outlet lead.

20 According to a third aspect of the present invention, there is provided an electrical protection unit comprising a residual current device and a secondary protection device located in a housing, the secondary protection device arranged for tripping the residual current device and comprising a sensor line adapted for detecting current leakage to a reference and a switch means adapted for creating a current imbalance between an active conductor and a neutral conductor of the residual current device.

Preferably, the electrical protection unit further comprises respective internal electrical connections between the secondary protection device and the residual current device.

25 Preferably, the housing comprises a mounting means arranged to mount the residual current device and the secondary protection device side by side in the housing.

Preferably, the mounting means is a plastic moulded mounting bracket.

30 Preferably, the electrical protection unit further comprises a cover pivotably mounted to the housing which, when the cover is opened, provides visible and finger access to respective control panels of the residual current device and the secondary protection device for an operator.

Preferably, the electrical protection unit further comprises a power inlet lead extending from the housing and terminated at a plug.

Preferably, the electrical protection unit further comprises a power outlet lead extending from the housing and terminated at a socket.

5 Preferably, the sensor line is connected to an earth conductor in the power outlet lead.

According to a fourth aspect of the present invention, there is provided a mounting bracket arranged for mounting one or more DIN-rail mountable electrical devices in a housing of an electrical protection unit.

10 Preferably, said one or more DIN-rail mountable electrical devices comprises two or more DIN-rail mountable electrical devices mounted side by side in the housing.

Preferably, at least one of said one or more DIN-rail mountable electrical devices comprises either a circuit breaker module, a residual current device (RCD), a residual voltage device (RVD), or a residual current device with a combined circuit break (RCBO).

Preferably, the mounting bracket is one-piece and manufactured from moulded plastic.

15 Preferably, the mounting bracket comprises a square or rectangular panel with a centrally located panel window and juxtaposed support pillars remotely extending from the rear of each side of the panel, the support pillars arranged for mounting a DIN-rail there between, such that said one or more DIN-rail mountable electrical devices are able to be supported on the DIN-rail in the housing with their respective one or more control panels visible to an
20 operator.

Preferably, the panel window is rectangular or square.

25 Preferably, the mounting bracket also comprises a short round tubular window surrounding the panel window and forwardly extending from the front of the panel such that finger access is provided through the tubular window to the respective one or more control panels for an operator.

Preferably, the mounting bracket comprises mounting holes arranged for securing the mounting bracket into the housing.

Other aspects of the invention are also disclosed.

Brief Description of the Drawings

Notwithstanding any other forms which may fall within the scope of the present invention, preferred embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

5 Fig. 1 shows a high earth impedance electrical protection system in accordance with the prior art;

Fig. 2 shows a MEN (also known as a 'TN/TT network') high earth impedance EDS in accordance with an embodiment of the first and second aspects of the present invention;

Fig. 3 shows a MEN (also known as a 'TN/TT network') high earth impedance EDS in accordance with another embodiment of the first and second aspects of the present invention;

10 Fig. 4 shows a MEN (also known as a 'TN/TT network') high earth impedance EDS in accordance with another embodiment of the first and second aspects of the present invention;

Fig. 5 shows a non-MEN (also known as floating earth EDS or IT network) high earth impedance EDS in accordance with another embodiment of the first and second aspects of the present invention;

15 Fig. 6 shows a non-MEN (also known as floating earth EDS or IT network) high earth impedance EDS in accordance with another embodiment of the first and second aspects of the present invention,

Fig. 7 shows electrically the load and frame/earth in a high earth impedance environment according to the first and second aspects of the present invention,

20 Fig. 8 shows an isometric view of an embodiment of an electrical protection unit, with the cover closed, in accordance with a third aspect of the present invention,

Fig. 9 shows an isometric view of the embodiment of the electrical protection unit shown in Fig. 8, but with the cover open,

25 Fig. 10 shows an isometric view of an embodiment of a mounting bracket for a housing of an electrical protection unit, viewed from the front, in accordance with a fourth aspect of the present invention, and

Fig. 11 shows an isometric view of the embodiment of the mounting bracket for a housing of an electrical protection unit shown in Fig. 10, but viewed from the rear.

Detailed Description of the Embodiments

It should be noted in the following description that like or the same reference numerals in different embodiments denote the same or similar feature.

5 The five embodiments respectively described herein in reference to Figs. 2 – 6 are all according to the first and second aspects of the present invention. The embodiments described in reference to Figs. 2, 3 and 4 are adapted for use in MEN EDS environments and those shown in Figs. 5 and 6 adapted for use in non-MEN EDS environments as will be described in further detail below.

10 These embodiments address or at least substantially ameliorate the deficiencies of the prior art including those discussed in the above “Background” section.

The embodiments are preferably adapted for use in 220V or 240V, 50Hz, AC applications. However, it should be appreciated that the embodiments described herein may be suited also for other EDSs, such as 60Hz, 110 V or 115V AC applications or even DC applications. Furthermore, the embodiments are disclosed as single phase applications, however it should
15 be appreciated that the embodiments may equally be adapted for use for multiphase (e.g. 3-phase) EDSs.

Referring now to Fig. 2, system 18 comprises the residual current device (RCD) 2, in this case a type of residual current device with a combined circuit break (RCBO), and a secondary protection device, herein referred to as a residual voltage device 17. As will be described in
20 further detail below, the residual voltage device 17 provides backup protection to the residual current device 2 in detecting fault conditions in high earth impedance environments. During these fault conditions, in the manner described below, the residual voltage device 17 is adapted for tripping the residual current device 2.

It should be appreciated that the nomenclature of the residual voltage device 17 should not be
25 construed with any particular technical limitation in mind, suffice to say that the residual voltage device 17 should be construed within the purposive scope of detecting leakage in high earth impedance environments where traditional residual current devices 2 (whether conventional RCDs or RCBOs) fail to detect a current imbalance.

Furthermore, the embodiment described herein comprises the residual voltage device 17 in an
30 interworking relationship with the residual current device 2. However, it would be realised by those skilled in the art that the residual voltage device 17 may be adapted for tripping other

electrical protection devices as opposed to residual current devices 2, and/or providing indications of relevant fault conditions.

As is immediately apparent from Fig. 2, the system 18 is distinguishable from the prior art system 1 in Fig. 1 by virtue of the omission of a mechanical coupling 16.

- 5 In this manner, the residual voltage device 17 may be located away from the residual current device 2 wherein the residual voltage device 17 only needs to be electrically coupled to the load side active conductor 4, the load side neutral conductor 5, and line side neutral conductor 28 of the residual voltage device 2.

As will become further apparent from the ensuing description, the system 18 is adapted for
10 high earth impedance environments (typically about 1,500 ohm). This environment is best shown electrically by the simplified load and frame/earth arrangement in Fig. 7 where the load resistor 49 (shown as a pure resistance for simplicity) is connected between the load side active conductor 4 and load side neutral conductor 5 and the frame/earth 6 (for example the metal chassis an electrical appliance) is diagrammatically shown as connected to electrical
15 true earth via the 1,500 ohm earth resistor 50 (shown as a simple resistor representing the high earth impedance environment). If leakage of current occurs from the load side active conductor 4 to the frame/earth 6, for example by water penetration into the appliance (electrically symbolised as leakage resistor 51 connecting the load side active conductor 5 to the frame/earth 6) then a “leakage voltage” will be generated at the frame/earth 6 and hence
20 sensed by sensor line 9 due to the voltage division effect of leakage resistor 51 and earth resistor 50.

Returning now to Fig. 2, via the use of sensor line 9, the residual voltage device 17 monitors this voltage leakage from the load side active conductor 4 to the frame/earth 6 or other reference frame of the appliance/equipment being protected. If a voltage leakage of greater
25 than substantially 42 V (and therefore current greater than substantially 8 mA given the component selection of the residual voltage device 17) is detected at the sensor line 9, and hence at the frame of the appliance via the sensor line 9, the residual voltage device 17 introduces a load between the line side neutral conductor 28 and the load side active conductor 4 of the residual current device 2 so as to effectively create a current imbalance
30 adapted for detection by current imbalance detection module 3 so as to cause the tripping of the residual current device 2 in the conventional manner.

The system 18 is adapted for use in MEN (also known as a 'TN/TT network') EDS environments. In such a MEN EDS environment, the power source neutral is earthed, and hence the line side neutral connector 28 of the residual current device 2 is also effectively earthed (as shown).

5 During installation, the sensor line 9 would be coupled to the frame/earth 6 (e.g. the metal chassis) of the load. During a fault condition, such as where a person makes accidental contact with the load side active conductor 4 and given the person's potentially high resistance (electrically represented as leakage resistance 51 in Fig. 7) and the high earth impedance environment (electrically represented by earth resistance 50 in Fig. 7), such
10 contact would introduce a voltage at the frame/earth 6, and therefore at the sensor line 9 also.

By introducing a voltage at the sensor line 9, in a similar manner as described with reference to the prior art embodiments given in Fig. 1, resistor 10 and DC rectifier diodes 12 and 11 cause current to flow through trip relay 14 causing the trip relay 14 to engage. Also, as before Zener diode 13 provides 12 V overvoltage protection for the trip relay 14.

15 Now, the engagement of trip relay 14 causes current to flow through fault relay 21, causing fault relay 21 to engage so as to introduce load resistor network 20 between the load side active conductor 4 and the line side neutral conductor 28 creating a current imbalance which is detected by the imbalance detection module 3 so as to cause the residual current device 2 to trip and disconnect supply power from the load.

20 Furthermore, fault relay 21 is configured as a latch wherein the engagement of the fault relay 21 maintains the current flow through the fault relay 21 between the active conductor 4 and the neutral conductor 5 so as to keep the fault relay 21 engaged despite the disengagement of the trip relay 14. In this manner, the fault relay 21 remains engaged until such time that the residual current device 2 trips removing the power to the load side.

25 It should be noted that while electromechanical relays are described herein, other switching mechanisms may be employed also, including solid-state relays, power transistors, silicon controlled rectifiers (SCRs), field effect transistors (FETs) and the like.

The combination of diode 11 and capacitor 19 convert the AC supply voltage to DC and the capacitor 19 also holds the trip relay 14 engaged for a few milliseconds, thereby eliminating
30 any race condition between the fault relay 21 and trip relay 14.

The component values selected for the residual voltage device 17 are such that the threshold voltage of the sensor line 9 to engage relay 14 is greater than 42 V. However, it should be

noted that variations to the threshold voltage may be implemented depending on the application. At these component values, the current flowing through the trip relay 14 should be greater than 8 mA to cause the trip relay 14 to engage.

5 Load resistor network 20 comprises a plurality of series power resistors (preferably each having a 3 W rating) primarily to manage the power dissipation.

Series power resistors also provide voltage division for powering light emitting diodes 22. Specifically, DC rectifier diode 23 and current limiting resistor 24 are adapted for powering light emitting diodes 22 for visual indication of a fault status. Preferably, the light emitting diodes 22 are placed so as to be visible, such as by way of protrusion through the housing of
10 the residual voltage device 17, or use of moulded light guide or the like.

The residual voltage device 17 further comprises test pushbutton 25 for testing the residual voltage device 17. Specifically, the test pushbutton 25 introduces, from the load side active conductor 4, current through the trip relay 14 to cause the trip relay 14 to engage.

15 In one embodiment, in MEN EDSs, the residual voltage device 17 further comprises a selectable secondary selectable switch 29 and, via fault relay contact 26, allowing a backup system for the tripping of the residual current device 2 by creating a neutral earth bond on the load side of the residual current device 2. When the residual current device 2 detects both the line side neutral bond to earth and load side neutral bond to earth, the residual current device 2 trips and disconnects supply power to the load.

20 There will now be described an exemplary walk-through of the functionality of system 18 in accordance with this embodiment. It should be noted that the walk-through is exemplary only and variations within the purposive scope of the embodiments described herein may be made accordingly.

25 As alluded to above, the residual voltage device 17 is used where the line side neutral conductor 28 is connected to the earth in a MEN EDS. The residual current device 2 (in the form of a RCBO in this case) works as normal however the electrically connected residual voltage device 17 unit is used for situations where the residual voltage device 17 does not detect a fault current between the load side active conductor 4 and earth or equipment frame.

30 The residual voltage device 17 provides a backup to the residual current device 2, in the situation in which the residual voltage device 17 detects a current of greater than appropriately 8 mA flowing from the load side active conductor 4, through to the residual

voltage device 17 sensor line 9 connection, which is connected to the device chassis or frame/earth 6 through the residual voltage device 2, to the load side neutral conductor 5.

In other words if the load side active conductor 5 somehow makes contact with the frame of device being powered, for example a device fault or a human touching the load side active with one hand and the device frame or earth with the other, the residual voltage device 17 will trip the residual current device 2 by placing load resistors between the residual current device 2 load side active conductor 4 and line side neutral conductor 28, which in turn creates an approximately 31 mA imbalance between the current in load side active conductor 4 and the current in load side neutral conductor 5 of the residual current device 2, which in turn trips the residual current device 2 and disconnects the voltage supply from the load, saving the human from electric shock or equipment being burnt out.

The residual voltage device 17 operation is as follows, when a current of greater than appropriately 8 mA at a voltage greater than 42 VAC flows from the sensor line 9 to the load side neutral conductor 5 (via fault relay contact 26, resistor 10, diodes 11 and 12), the trip relay 14 engages and closes the trip relay 14 contact. The closing of the trip relay 14 contact applies the voltage in the load side active conductor 4 onto the fault relay 21 solenoid coil causing the fault relay 21 to engage. As the other side of the fault relay 21 solenoid coil is connected to the load side neutral connector 5, and also to one side of the load resistor network 20, this places the load resistor network 20 between the load side active conductor 4 and line side neutral conductor 28 creating the approximate 31 mA imbalance current flow through the residual current device 2.

The current flowing through the four 1,800 ohm load resistors creates approximately 52 VAC across each resistor. The 52 VAC across one of the resistors is used to provide power to illuminate the two red light emitting diodes 22 via the 6,800 ohm resistor 24 which reduces the circuit current through the light emitting diodes 22 and the diode 23. The diode 23 provides reverse voltage protection to the light emitting diodes 22.

With the fault relay 21 engaged as detailed above, the fault relay 21 contacts (contacts 21 and 26) change state. The changing of the contact 21 of fault relay 21 from open to close, holds the connection of the load side active conductor 5 to both the fault relay 21 solenoid coil, keeping it engaged, and to one side of the load resistor network 20, keeping the current imbalance until the residual current device 2 trips. The changing of the contact 26 of fault relay 21 from closed to open, removes the fault current from the sensor line 9 to the load side

neutral conductor 5, protecting resistor 10, diode 11, Zener diode 13 and diode 12 from a continuous fault condition.

System 18 is also adapted for protection during inadvertent swapping of the line side active and neutral. Specifically, if the line side active conductor 4 and the line side neutral conductor 5 were inadvertently swapped the active 4 would become the new neutral and the neutral 5 would become the new active. Because in MEN EDSs the line supply neutral is connected to earth and sensor line 9 is tied to frame/earth 6 (or the chassis of the device being protected or other reference frame), now that the line supply is swapped there is an electrical pathway from the new active conductor, through the neutral connection of the residual voltage device neutral 17, via diode 12, trip relay 14 solenoid, diode 11 and resistor 12 that would effectively create an earth point at the load side neutral conductor of the residual current device 2, causing the residual current device to sense an earth connection on both the line side neutral and load side neutral conductors causing the residual current device 2 to trip and disconnect power from the load.

Fig. 3 shows another embodiment of system 18 for use in MEN EDS environments. The only difference between the embodiment described in reference to Fig. 2 and this new embodiment in Fig. 3 is the simplified arrangement of the load resistor network 20 in Fig. 3 in which two of the 1,800 ohm 3 W resistors in the embodiment in Fig. 2 are replaced with a diode. The embodiment of system 18 shown in Fig. 3 is similarly adapted for protection during inadvertent swapping of the line side active and neutral as described in reference to the embodiment of system 18 shown in Fig. 2.

Fig. 4 shows yet another embodiment of system 18 for use in MEN EDS environments. This arrangement is similar to the embodiment described in reference to Fig. 3 except that there is now only two electrical connections between the residual current device 2 and the residual voltage device 17. The connection of the residual voltage device 17 to the load side neutral conductor 5 is no longer required as a result of the rearrangement of the electrical connection of the load resistor network 20 in the residual voltage device 17 which is now in parallel with the solenoid coil of the fault relay 21. The embodiment of system 18 shown in Fig. 4 is similarly adapted for protection during inadvertent swapping of the line side active and neutral as described in reference to the embodiment of system 18 shown in Fig. 2.

Fig. 5 shows the electrical protection system, this time system 19 configured for a non-MEN EDS environment where the line side neutral conductor 28 is not connected to earth.

- The residual current device 2 works as normal, however the electrically connected residual voltage device 17 is used for situations where the residual current device 2 does not detect a fault current between the load side active conductor 4 or load side neutral conductor 5 and the device chassis or frame/earth 6. The residual voltage device 17 provides a backup as if the residual voltage device 17 detects a current of greater than appropriately 8 mA, flowing from either the load side active conductor 4 or load side neutral conductor 5 through the residual voltage device 17 sensor line 9 connection, which is connected to the device chassis or frame/earth 6, through the residual voltage device 17 to the load side active conductor 4 or load side neutral conductor 5.
- 10 In other words if the load side active conductor 4 or load side neutral conductor 5 somehow makes contact with the frame of device being powered, for example a device fault or a human touching the load side active or neutral with one hand and the device frame or earth with the other hand, then residual voltage device 17 will trip the residual current device 2 by placing load resistor network 20 between the residual current device 2 load side active conductor and
- 15 line side neutral conductor 28, which in turn creates an approximate 31 mA imbalance between the current in load side active conductor 4 and the current in the load side neutral conductor 5 of the residual current device 2, which trips the residual current device 2 and disconnects the voltage supply to the load, saving the human from electric shock or equipment being burnt out.
- 20 There will now similarly be described an exemplary walk-through of the functionality of system 19 in accordance with this embodiment. It should be noted that the walk-through is exemplary only and variations within the purposive scope of the embodiments described herein may be made accordingly.
- 25 When a current of greater than appropriately 8 mA at a voltage greater than 42 VAC flows from the sensor line 9 to the load side neutral conductor 5 via contact 26 of fault relay 21, resistor 10, diodes 11 and 12, and trip relay 14 engage. Alternatively, when a current of greater than appropriately 8 mA at a voltage greater than 42 VAC flows from the sensor line 9 to the load side active conductor 4 via contact 26 of fault relay 21, resistor 10, diodes 11 and 27 the trip relay 14 also engages.
- 30 The closing of the contacts of the trip relay 14 places the voltage of load side active conductor 4 onto the fault relay 21 solenoid coil causing fault relay 21 to engage (as the other

side of the solenoid coil 21 is connected to the load side neutral conductor 5) and this voltage to be applied to one side of the load resistor network 20 which places the load resistor network 20 between the load side active conductor 4 and line side neutral conductor 28 creating the approximate 31 mA imbalance current flow through the residual current device

5 2. The current flowing through the four 1,800 ohm load resistors 20 creates approximately 52 VAC across each resistor. The 52 VAC across one of the resistors is used to provide power to illuminate the two red light emitting diodes 22 via the 6,800 ohm resistor 24 which reduces the circuit current through the light emitting diodes 22 and diode 23. The diode 23 provides reverse voltage protection to the light emitting diodes 22.

10 With the fault relay 21 engaged as detailed above, the contacts of fault relay 21 (contacts 21 and 26) change state. The changing of the contacts 21 of fault relay 21 from open to close holds the load side active conductor to both the solenoid coil of fault relay 21 keeping the solenoid coil of fault relay 21 engaged and to one side of the load resistor network 20 maintaining the current imbalance. The changing of the contact 26 of fault relay 21 from
15 closed to open, removes the fault current from the sensor line 9 to the load side neutral conductor 5 or load side active conductor 4, protecting resistor 10, diodes 11, 12 and 27 and trip relay 14.

Fig. 6 shows another embodiment of system 19 again configured for a non-MEN EDS environment where the line side neutral conductor 28 is not connected to earth. This
20 arrangement is similar to the embodiment described in reference to Fig. 5 except that there is now only two electrical connections between the residual current device 2 and the residual voltage device 17. The connection of the residual voltage device 17 to the load side neutral conductor 5 is no longer required as a result of the rearrangement of the electrical connection of the load resistor network 20 in the residual voltage device 17 which is now in parallel with
25 the solenoid coil of the fault relay 21.

Figs. 8 and 9 show isometric views of an embodiment of an electrical protection unit in accordance with a third aspect of the present invention. This embodiment may be employed, for example, when connecting a caravan or recreational vehicle (RV) to a mains power source at a camp site or trailer park or, alternatively, to a power lead from a generator or AC
30 inverter (for sites with no mains power). This embodiment may also be employed in numerous other applications, including industrial applications where AC equipment is required to be field tested off-line via connection with a generator or an AC inverter. The

electrical protection unit 60 comprises residual current device 61 and a secondary protection device in the form of residual voltage device 62, both integrated into housing 64. The residual voltage device 62 is arranged for tripping the residual current device 61. Electrical protection unit 60 also comprises a power inlet lead 66 terminated at a male plug (not shown) for line side connection to a mains power source, generator or AC inverter (not shown), and a power outlet lead 67 terminated at a female socket (not shown) for load side connection to, for example, a caravan or an RV male wall-mounted plug, or a piece of AC industrial equipment as mentioned above. For 240 V, 50 Hz single phase applications, the power inlet lead 66 and the male plug (not shown) are usually either rated at 10 A and used in combination with a residual current device 2 of the RCBO type which is rated at 10 A or, alternatively, rated 15 A and used in combination with a residual current device 2 of the RCBO type which is rated at 16A. The power outlet lead 67 and the female socket (not shown) are usually rated at 15 A for such 240 V, 50 Hz single phase applications.

As earlier described in reference to Figs. 2 – 7 for the first and second aspect of the present invention, the residual voltage device 62 comprises a sensor line (not shown) which in this case is connected to the earth conductor of the outlet lead 67 which, in turn in use, connects to the chassis or frame of the load, for example the metal chassis of a caravan or RV, or the metal housing of a piece of AC industrial equipment (as mentioned above). The residual voltage device 62 is thereby adapted for detecting current leakage from active to this metal chassis/housing. The residual voltage device also comprises a switch means adapted for creating a current imbalance between the active conductor and a neutral conductor of the residual current device 61, and thereby trip the residual current device 61 and isolate line side power (i.e. for example, power from a camp site power box or from a generator or AC inverter) from the load side (i.e. for example, the caravan or RV, or piece of AC industrial equipment) in event of detection of such leakage current to the chassis/housing.

The electrical protection unit 60 also incorporates the necessary internal electrical connections (not shown) between the residual voltage device 62 and the residual current device 61. Housing 64 may comprise a moulded plastic mounting bracket 70 (refer below to Figs. 10 and 11 in reference to the fourth aspect of the present invention) arranged to mount the residual current device 61 and the residual voltage device 62 side by side in the housing 64 (as shown in Figs. 8 and 9). Alternatively the housing 64 may comprise other mounting means to mount the residual current device 61 and the residual voltage device 62 side by side in the housing 64. The electrical protection unit 60 also includes a cover 65 pivotably

mounted (via a hinge) to the housing 64 which, when the cover 65 is opened, provides visible and finger access to respective control panels of residual current device 61 and residual voltage device 62. When the cover 65 is closed water and humidity (and other foreign material) cannot penetrate into the housing 64 of electrical protection unit 60, and specifically into the residual voltage device 62 and the residual current device 61 contained therein.

Figs. 10 and 11 show isometric views of an embodiment of a mounting bracket for a housing of an electrical protection unit in accordance with a fourth aspect of the present invention. Mounting bracket 70 is arranged for mounting two DIN-rail mountable electrical devices side by side in a housing of an electrical protection unit. Such DIN-rail mountable electrical devices typically comprise circuit breaker modules, residual current devices (RCDs), residual voltage devices (RVDs), and residual current devices with a combined circuit break (RCBOs), but there are many other such types of devices available. Typical combinations might be an RCBO side by side with an RVD, or a circuit breaker side by side with an RCD.

Mounting bracket 70 is preferably of one-piece construction and manufactured from injected moulded plastic. It includes a substantially square or rectangular panel 71 with a centrally located panel window 72 and juxtaposed support pillars 73 remotely extending from the rear of each side of the panel 71. The remote ends 77 of the support pillars 73 are arranged for mounting there between an aluminium or steel DIN-rail (not shown), secured to the respective remote ends 77 of the support pillars 73 by screws (not shown) inserted into pre-moulded screw holes 76 in respective support pillars 73. This enables the above mentioned DIN-rail mountable electrical devices to be supported on the DIN-rail side by side in the housing of the electrical protection unit with their respective control panels visible through the panel window 72. Ideally the panel window 72 is rectangular or square, and the mounting bracket 70 also incorporates a short tubular window 74 surrounding the panel window and forwardly extending from the front of panel 71. Through the tubular window 74 an operator can finger access the respective control panels of the DIN-rail mountable electrical devices. The forward-most circular surface 78 of the tubular window 74 provides a sealing surface for an O-ring or square-section sealing ring retained in a matching circular groove on the inside of a cover (not shown) which is pivotably mounted to the housing (via a hinge) such that, when the cover is closed and the sealing ring in the cover engages with circular surface 78 of mounting bracket 70, water and humidity (and other foreign material) cannot penetrate into the electrical protection unit and specifically into the one or more DIN-rail mountable electrical devices contain therein. Mounting bracket 70 also incorporates pre-moulded

mounting holes 75 arranged for securing mounting bracket 70 into the housing of the electrical protection unit.

The above embodiment of the mounting bracket 70 is described as providing mounting for two DIN-rail mountable electrical devices side by side. But as would be appreciated by those skilled in the art, other embodiments of the mounting bracket are possible. For example the mounting bracket may provide mounting for only one DIN-rail mountable electrical device in the housing of the electrical protection unit or, alternatively, depending on the geometry of the mounting bracket and the length of the DIN-rail, 3, 4, 5 or even 6 DIN-rail mountable electrical devices could be mounted side by side in the housing of the electrical protection unit.

Interpretation

Embodiments:

Reference throughout this specification to “one embodiment” or “an embodiment” means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, appearances of the phrases “in one embodiment” or “in an embodiment” in various places throughout this specification are not necessarily all referring to the same embodiment, but may. Furthermore, the particular features, structures or characteristics may be combined in any suitable manner, as would be apparent to one of ordinary skill in the art from this disclosure, in one or more embodiments.

Similarly it should be appreciated that in the above description of example embodiments of the invention, various features of the invention are sometimes grouped together in a single embodiment, figure, or description thereof for the purpose of streamlining the disclosure and aiding in the understanding of one or more of the various inventive aspects. This method of disclosure, however, is not to be interpreted as reflecting an intention that the claimed invention requires more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive aspects lie in less than all features of a single foregoing disclosed embodiment. Thus, the claims following the Best Mode of Carrying Out the Invention are hereby expressly incorporated into this Best Mode of Carrying Out the Invention, with each claim standing on its own as a separate embodiment of this invention.

Furthermore, while some embodiments described herein include some but not other features included in other embodiments, combinations of features of different embodiments are meant

to be within the scope of the invention, and form different embodiments, as would be understood by those in the art. For example, in the following claims, any of the claimed embodiments can be used in any combination.

Different Instances of Objects

- 5 As used herein, unless otherwise specified the use of the ordinal adjectives “first”, “second”, “third”, etc., to describe a common object, merely indicate that different instances of like objects are being referred to, and are not intended to imply that the objects so described must be in a given sequence, either temporally, spatially, in ranking, or in any other manner.

Specific Details

- 10 In the description provided herein, numerous specific details are set forth. However, it is understood that embodiments of the invention may be practiced without these specific details. In other instances, well-known methods, structures and techniques have not been shown in detail in order not to obscure an understanding of this description.

Terminology

- 15 In describing the preferred embodiment of the invention illustrated in the drawings, specific terminology will be resorted to for the sake of clarity. However, the invention is not intended to be limited to the specific terms so selected, and it is to be understood that each specific term includes all technical equivalents which operate in a similar manner to accomplish a similar technical purpose. Terms such as "forward", "rearward", "radically", "peripherally",
20 "upwardly", "downwardly", and the like are used as words of convenience to provide reference points and are not to be construed as limiting terms.

Comprising and Including

- In the claims which follow and in the preceding description of the invention, except where the context requires otherwise due to express language or necessary implication, the word
25 “comprise” or variations such as “comprises” or “comprising” are used in an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments of the invention.

Any one of the terms: including or which includes or that includes as used herein is also an open term that also means including at least the elements/features that follow the term, but not excluding others. Thus, including is synonymous with and means comprising.

Scope of Invention

5 Thus, while there has been described what are believed to be the preferred embodiments of the invention, those skilled in the art will recognize that other and further modifications may be made thereto without departing from the spirit of the invention, and it is intended to claim all such changes and modifications as fall within the scope of the invention. For example, any formulas given above are merely representative of procedures that may be used. Functionality
10 may be added or deleted from the block diagrams and operations may be interchanged among functional blocks. Steps may be added or deleted to methods described within the scope of the present invention.

Although the invention has been described with reference to specific examples, it will be appreciated by those skilled in the art that the invention may be embodied in many other
15 forms.

Industrial Applicability

It is apparent from the above, that the arrangements described are applicable to the electrical protection industries.

Claims

1. A method for tripping a residual current device comprising a detection of leakage characterised in that the detection of leakage creates a current imbalance between an active conductor and a neutral conductor of the residual current device.
- 5 2. A method as claimed in claim 1, wherein the detection of leakage comprises detection of leakage of current to a reference.
3. A method as claimed in claim 2, wherein the reference is a frame reference.
4. A method as claimed in claim 2, wherein the reference is an earth reference.
5. A method as claimed in claim 2, wherein the detection of leakage comprises detecting
10 a voltage exceeding a voltage threshold at the reference.
6. A method as claimed in claim 5, wherein the voltage threshold is greater than 10 V.
7. A method as claimed in claim 5, wherein the voltage threshold is greater than 20 V.
8. A method as claimed in claim 5, wherein the voltage threshold is greater than 40 V.
9. A method as claimed in claim 5, wherein the voltage threshold is greater than 50 V.
- 15 10. A method as claimed in claim 1, wherein the detection of leakage comprises detecting a current greater than a current threshold.
11. A method as claimed in claim 10, wherein the current threshold is greater than 1 mA.
12. A method as claimed in claim 10, wherein the current threshold is greater than 5 mA.
13. A method as claimed in claim 10, wherein the current threshold is greater than 8 mA.
- 20 14. A method as claimed in claim 1, wherein the creation of the current imbalance comprises allowing current to flow from a line side to a load side of the residual current device.
15. A method as claimed in claim 14, wherein the creation of the current imbalance comprises providing a load resistance between the active conductor on the load side and the
25 neutral conductor on the line side of the residual current device.
16. A method as claimed in claim 15, wherein the load resistance is selected to allow a current to flow from the active conductor on the load side to the neutral conductor on the line side of the residual current device of greater than 5 mA.
17. A method as claimed in claim 15, wherein the load resistance is selected to allow a
30 current to flow from the active conductor on the load side to the neutral conductor on the line side of the residual current device of greater than 15 mA.

18. A method as claimed in claim 15, wherein the load resistance is selected to allow a current to flow from the active conductor on the load side to the neutral conductor on the line side of the residual current device of greater than 30 mA.
19. A method as claimed in claim 1, wherein the creation of the current imbalance
5 comprises maintaining the current imbalance using a latch.
20. A method as claimed in claim 19, wherein the latch is adapted to reset once the residual current device has tripped.
21. A method as claimed in claim 2, wherein the method further comprises providing an indication of the leakage of current to the reference.
- 10 22. A method as claimed in claim 21, wherein the indication comprises illumination.
23. A secondary protection device for tripping a residual current device, the secondary protection device comprising a sensor line adapted for detection of leakage, and a switch means, characterised in that the switch means is adapted for creation of a current imbalance between an active conductor and a neutral conductor of the residual current device.
- 15 24. A secondary protection device as claimed in claim 23, wherein the sensor line is connected to a reference so as to detect the leakage of current to the reference.
25. A secondary protection device as claimed in claim 24, wherein the reference is a frame reference.
26. A secondary protection device as claimed in claim 24, wherein the reference is an
20 earth reference.
27. A secondary protection device as claimed in claim 24, wherein the switch means is adapted for switching at a voltage threshold at the reference.
28. A secondary protection device as claimed in claim 27, wherein the voltage threshold is greater than 10 V.
- 25 29. A secondary protection device as claimed in claim 27, wherein the voltage threshold is greater than 20 V.
30. A secondary protection device as claimed in claim 27, wherein the voltage threshold is greater than 40 V.
31. A secondary protection device as claimed in claim 27, wherein the voltage threshold
30 is greater than 50 V.
32. A secondary protection device as claimed in claim 23, wherein the switch means is adapted for switching at a current threshold.
33. A secondary protection device as claimed in claim 32, wherein the current threshold is greater than 1 mA.

34. A secondary protection device as claimed in claim 32, wherein the current threshold is greater than 5 mA.
35. A secondary protection device as claimed in claim 32, wherein the current threshold is greater than 8 mA.
- 5 36. A secondary protection device as claimed in claim 23, wherein the switch means allows current to flow from a line side to a load side of the residual current device.
37. A secondary protection device as claimed in claim 36, wherein the secondary protection device further comprises a load resistance in series with the switch means.
38. A secondary protection device as claimed in claim 37, wherein the load resistance is
10 selected to allow a current to flow from the active conductor on the load side to the neutral conductor on the line side of the residual current device of greater than 5 mA.
39. A secondary protection device as claimed in claim 37, wherein the load resistance is selected to allow current to flow from the active conductor on the load side to the neutral conductor on the line side of the residual current device of greater than 15 mA.
- 15 40. A secondary protection device as claimed in claim 37, wherein the load resistance is selected to allow current to flow from the active conductor on the load side to the neutral conductor on the line side of the residual current device of greater than 30 mA.
41. A secondary protection device as claimed in claim 23, wherein the switch means is arranged to remain closed until the residual current device has tripped.
- 20 42. A secondary protection device as claimed in claim 24, wherein the secondary protection device further comprises an indication means of the leakage of current to the reference.
43. A secondary protection device as claimed in claim 42, wherein the indication means comprises illumination.
- 25 44. A secondary protection device as claimed in claim 23, wherein the secondary protection device is located in an electrical protection unit together with the residual current device, with respective internal electrical connections provided between the secondary protection device and the residual current device.
45. A secondary protection device as claimed in claim 44, wherein the electrical
30 protection unit comprises a mounting means arranged to mount the residual current device and the secondary protection device side by side in a housing.
46. A secondary protection device as claimed in claim 45, wherein the mounting means is a plastic moulded mounting bracket.

47. A secondary protection device as claimed in claim 45, wherein the electrical protection unit also comprises a cover pivotably mounted to the housing which, when the cover is opened, provides visible and finger access to respective control panels of the residual current device and the secondary protection device for an operator.
- 5 48. A secondary protection device as claimed in claim 44, wherein the electrical protection unit further comprises a power inlet lead extending from the housing and terminated at a plug.
49. A secondary protection device as claimed in claim 44, wherein the electrical protection unit further comprises a power outlet lead extending from the housing and
10 terminated at a socket.
50. A secondary protection device as claimed in claim 49, wherein the sensor line is connected to an earth conductor in the power outlet lead.
51. An electrical protection unit comprising a residual current device and a secondary protection device located in a housing, the secondary protection device arranged for tripping
15 the residual current device and comprising a sensor line adapted for detecting current leakage to a reference and a switch means adapted for creating a current imbalance between an active conductor and a neutral conductor of the residual current device.
52. An electrical protection unit as claimed in claim 51, further comprising respective internal electrical connections between the secondary protection device and the residual
20 current device.
53. An electrical protection unit as claimed in claim 51, wherein the housing comprises a mounting means arranged to mount the residual current device and the secondary protection device side by side in the housing.
54. An electrical protection unit as claimed in claim 53, wherein the mounting means is a
25 plastic moulded mounting bracket.
55. An electrical protection unit as claimed in claim 51, further comprising a cover pivotably mounted to the housing which, when the cover is opened, provides visible and finger access to respective control panels of the residual current device and the secondary protection device for an operator.
- 30 56. An electrical protection unit as claimed in claim 51, further comprising a power inlet lead extending from the housing and terminated at a plug.

57. An electrical protection unit as claimed in claim 51, further comprising a power outlet lead extending from the housing and terminated at a socket.
58. An electrical protection unit as claimed in claim 57, wherein the sensor line is connected to an earth conductor in the power outlet lead.
- 5 59. A mounting bracket arranged for mounting one or more DIN-rail mountable electrical devices in a housing of an electrical protection unit.
60. A mounting bracket as claimed in claim 59, wherein said one or more DIN-rail mountable electrical devices comprises two or more DIN-rail mountable electrical devices mounted side by side in the housing.
- 10 61. A mounting bracket as claimed in claim 59, wherein at least one of said one or more DIN-rail mountable electrical devices comprises either a circuit breaker module, a residual current device (RCD), a residual voltage device (RVD), or a residual current device with a combined circuit break (RCBO).
62. A mounting bracket as claimed in claim 59, wherein the mounting bracket is one-
15 piece and manufactured from moulded plastic.
63. A mounting bracket as claimed in claim 59, comprising a square or rectangular panel with a centrally located panel window and juxtaposed support pillars remotely extending from the rear of each side of the panel, the support pillars arranged for mounting a DIN-rail there between, such that said one or more DIN-rail mountable electrical devices are able to be
20 supported on the DIN-rail in the housing with their respective one or more control panels visible to an operator.
64. A mounting bracket as claimed in claim 63, wherein the panel window is rectangular or square.
65. A mounting bracket as claimed in claim 63, also comprising a short round tubular
25 window surrounding the panel window and forwardly extending from the front of the panel such that finger access is provided through the tubular window to the respective one or more control panels for an operator.
66. A mounting bracket as claimed in claim 59, comprising mounting holes arranged for securing the mounting bracket into the housing.

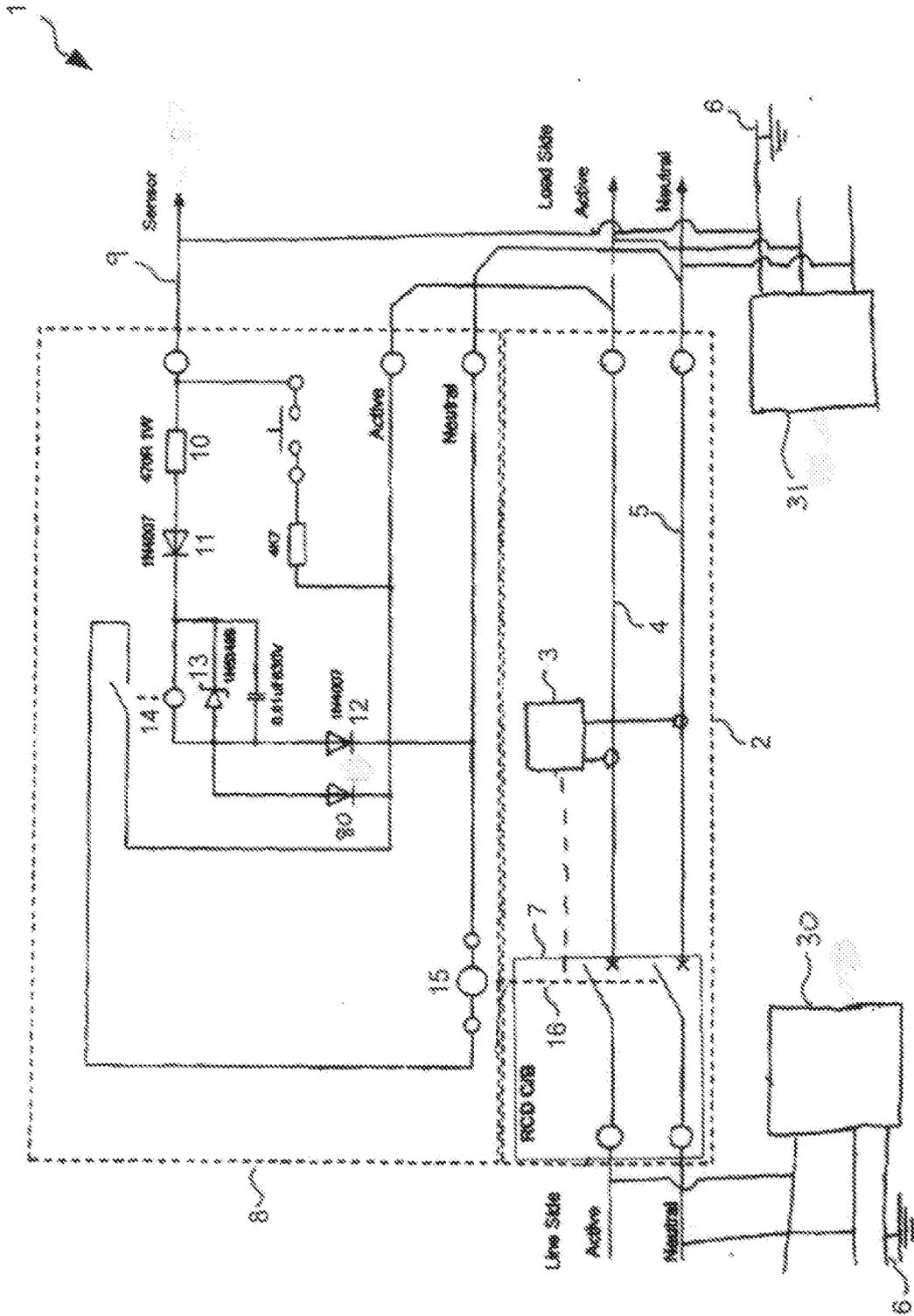


Figure 1 (PRIOR ART)

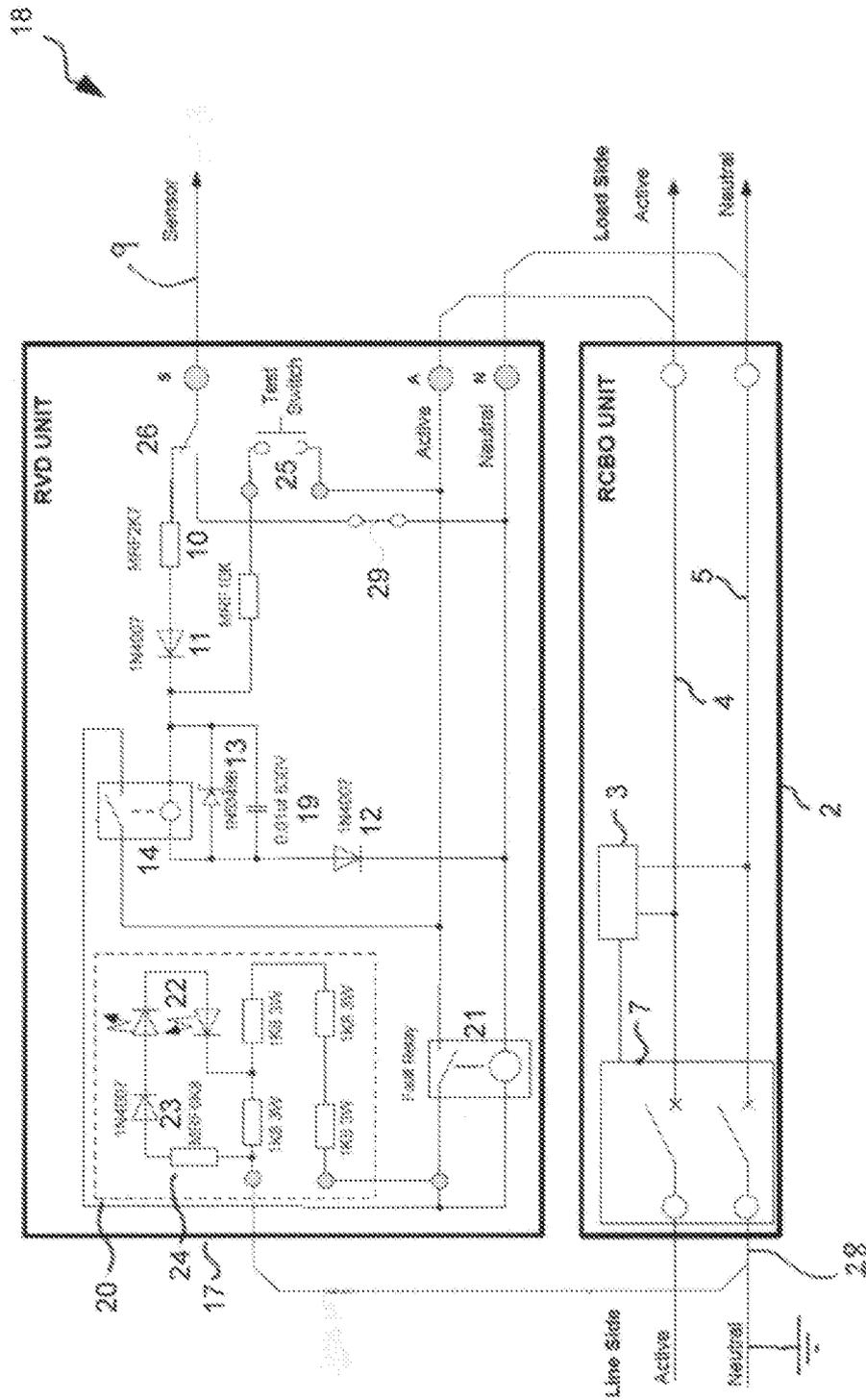


Figure 2

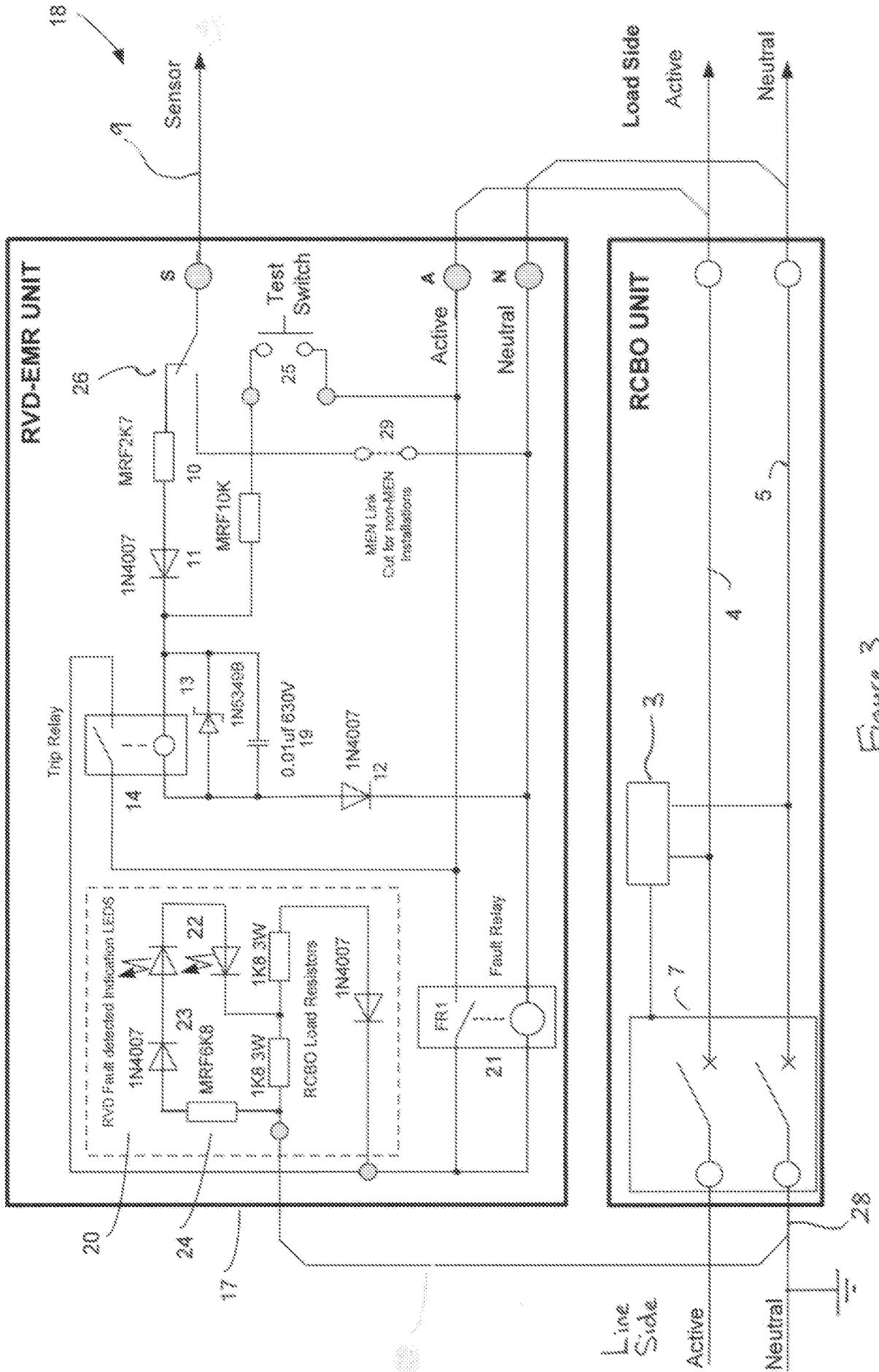


Figure 3

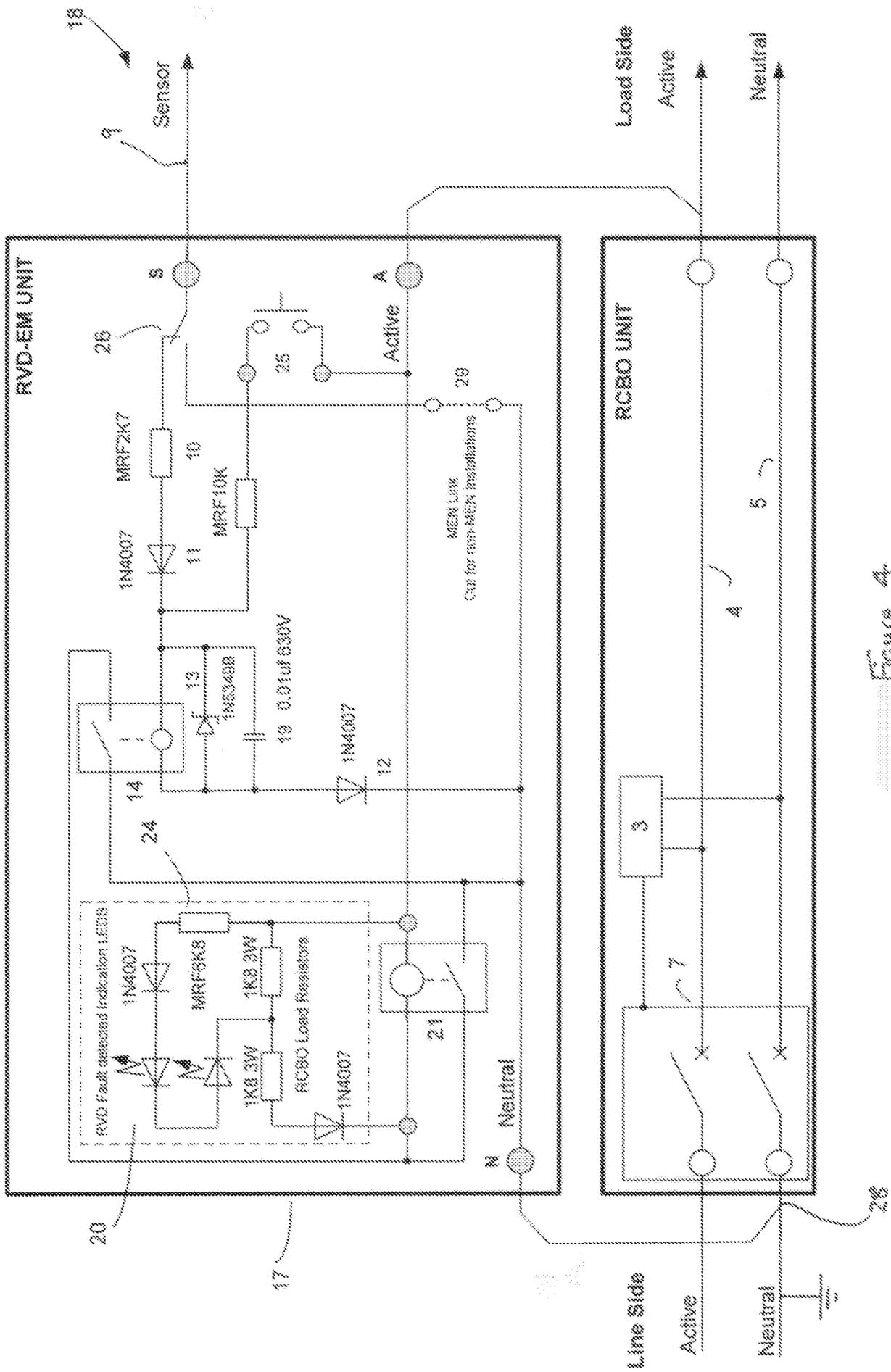


Figure 4

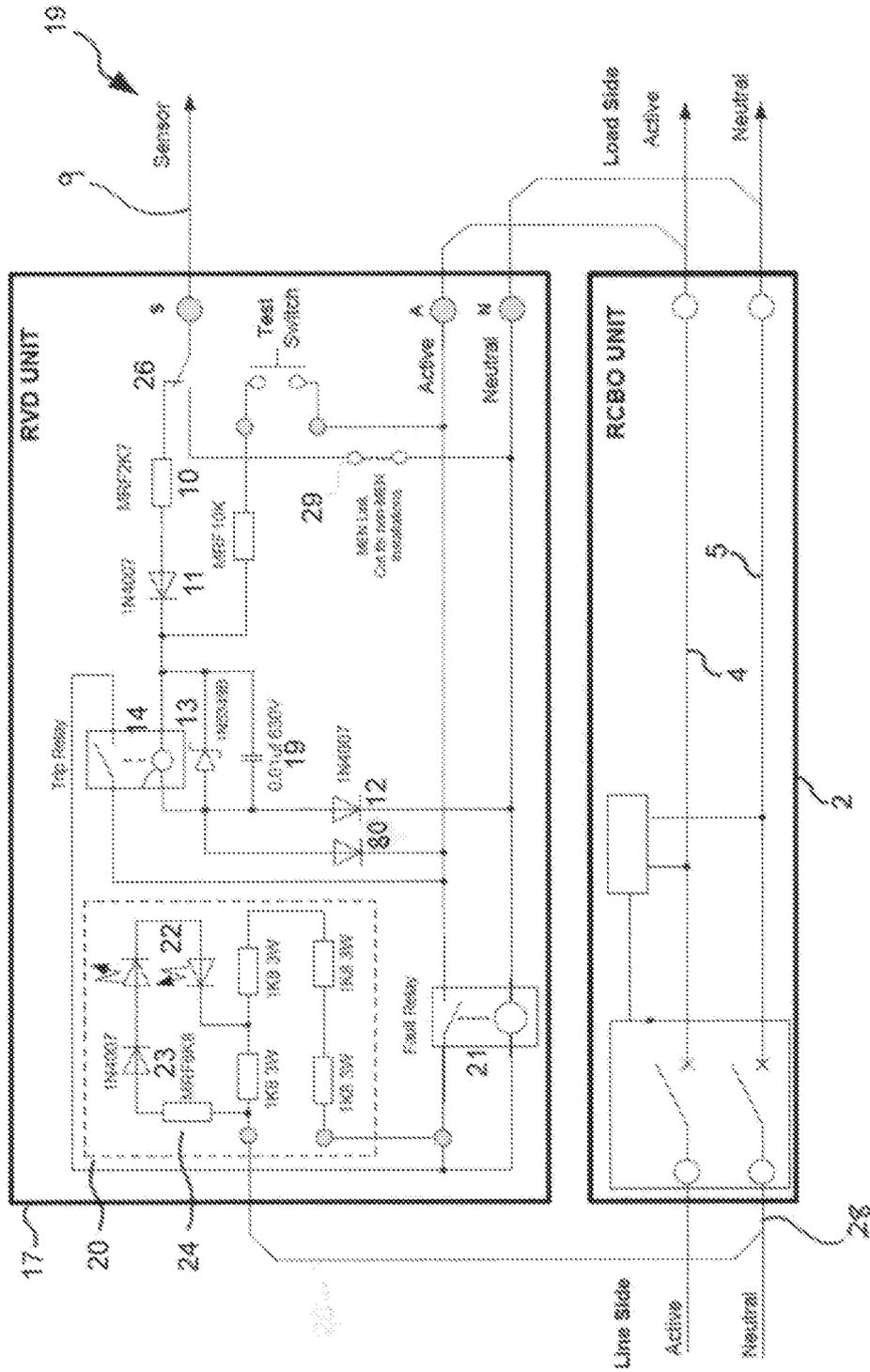


Figure 5

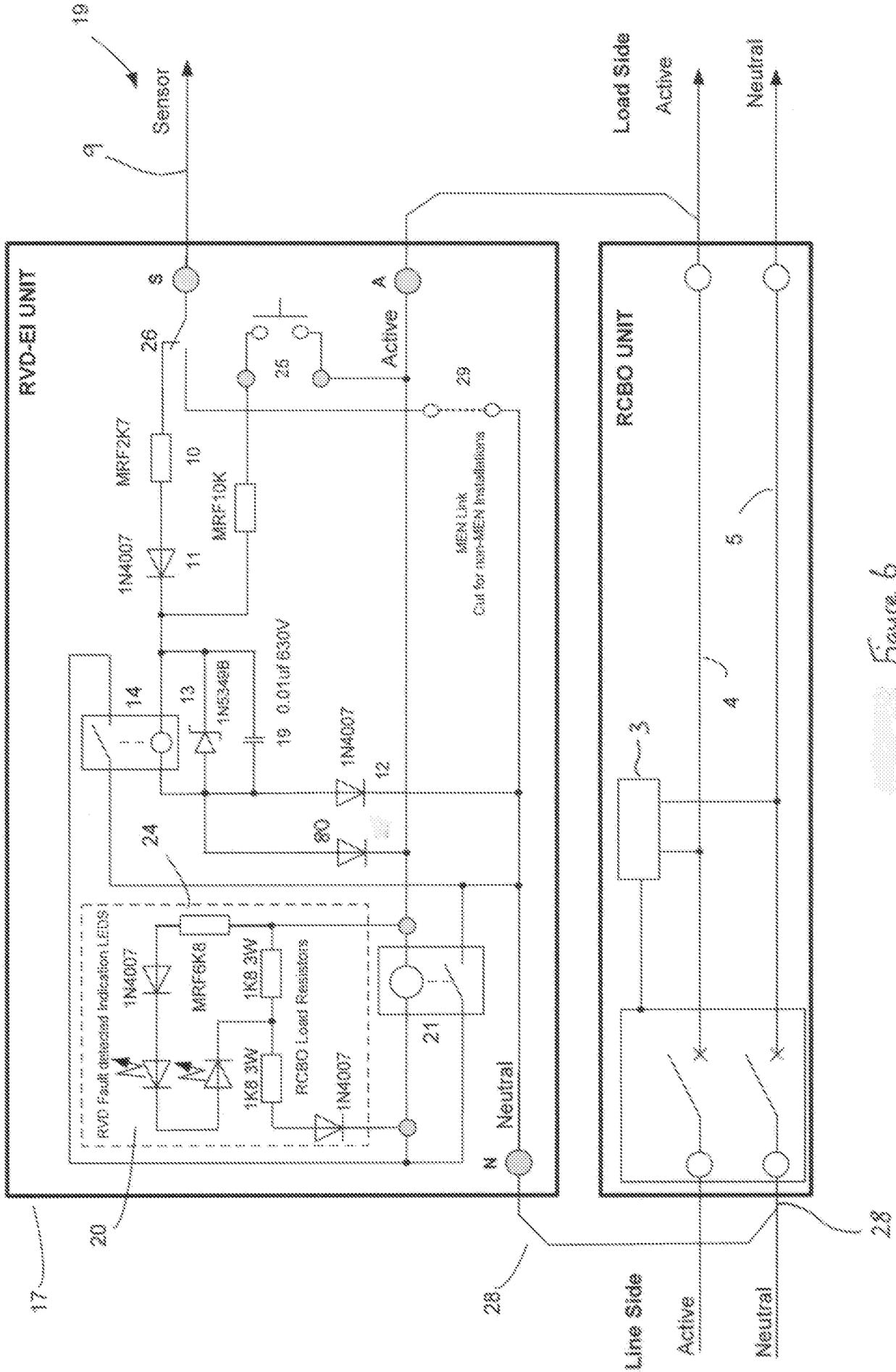


Figure 6

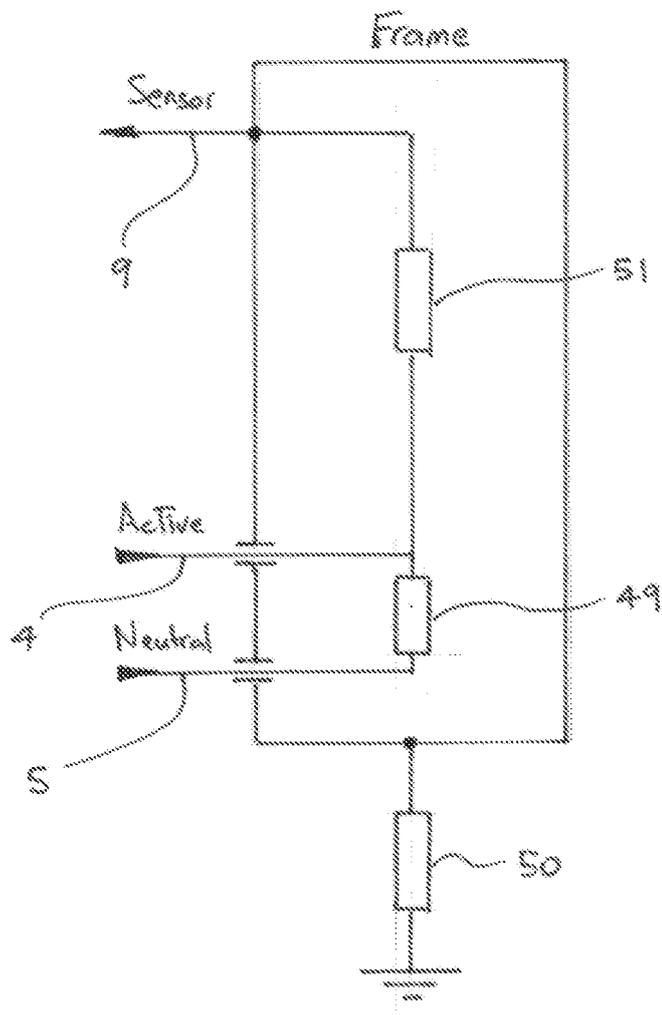


Figure 7

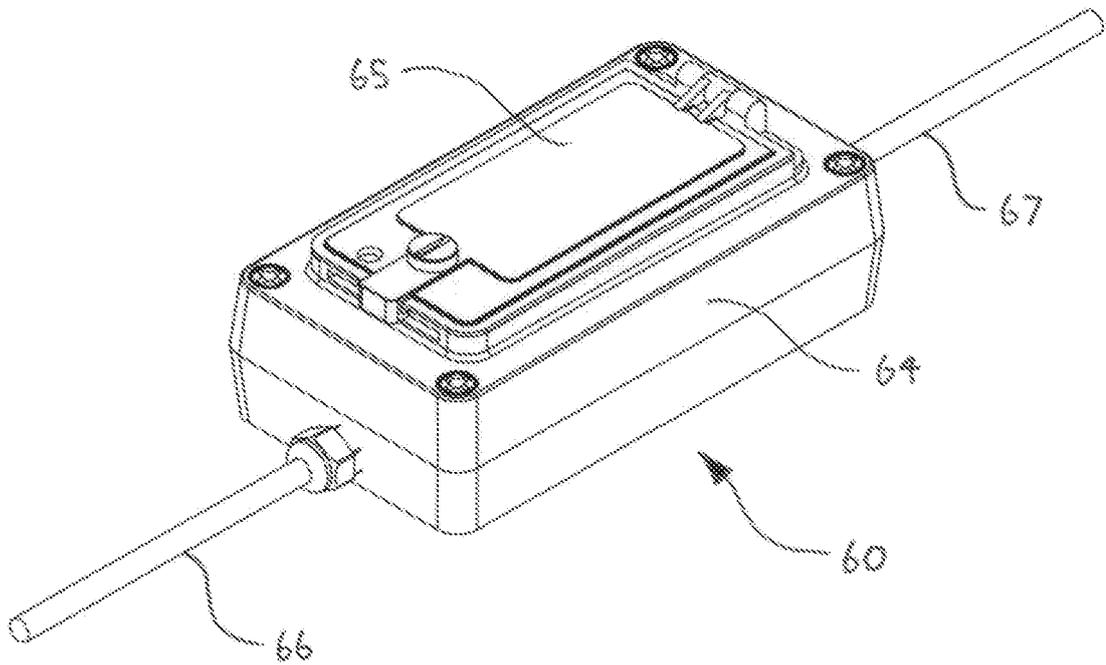


Figure 8

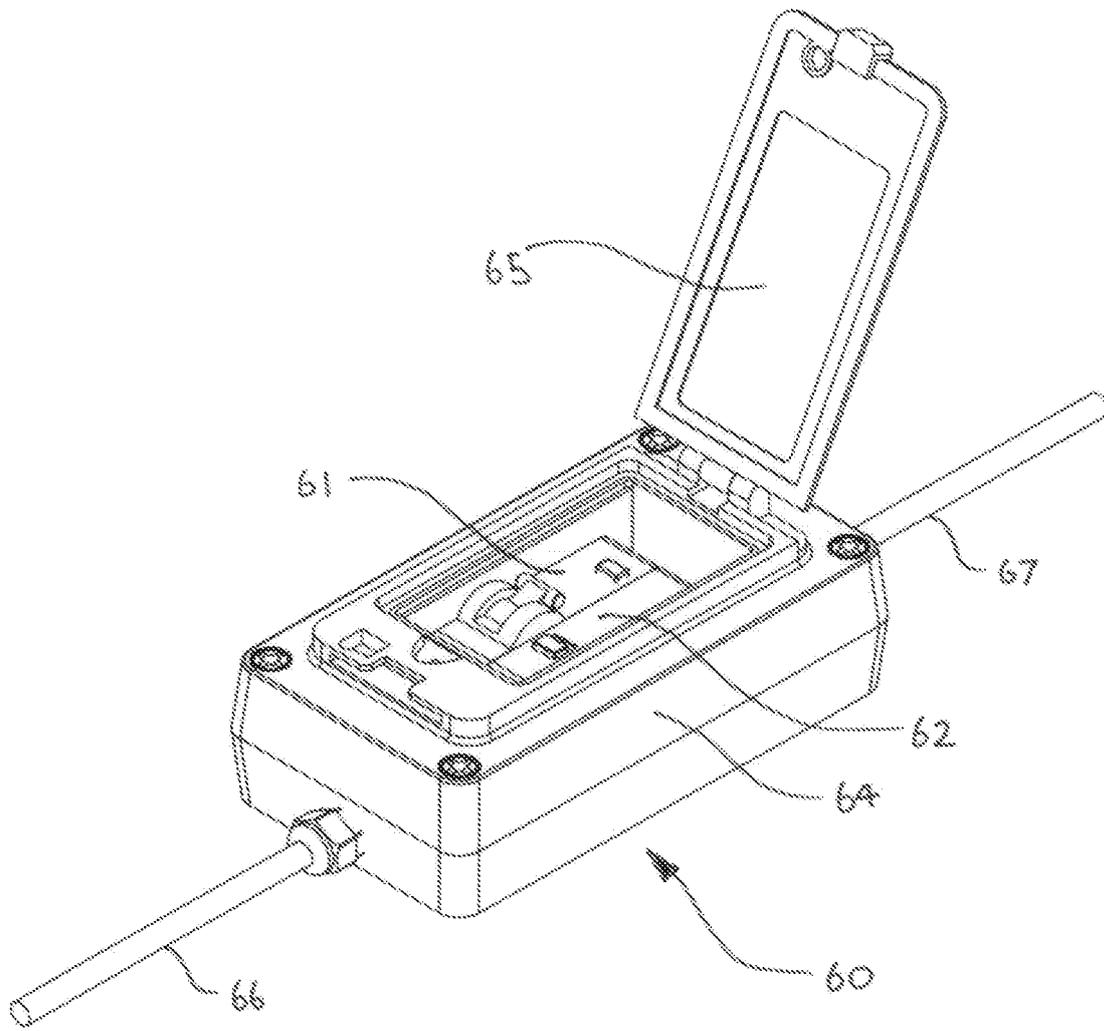


Figure 9

To be continued

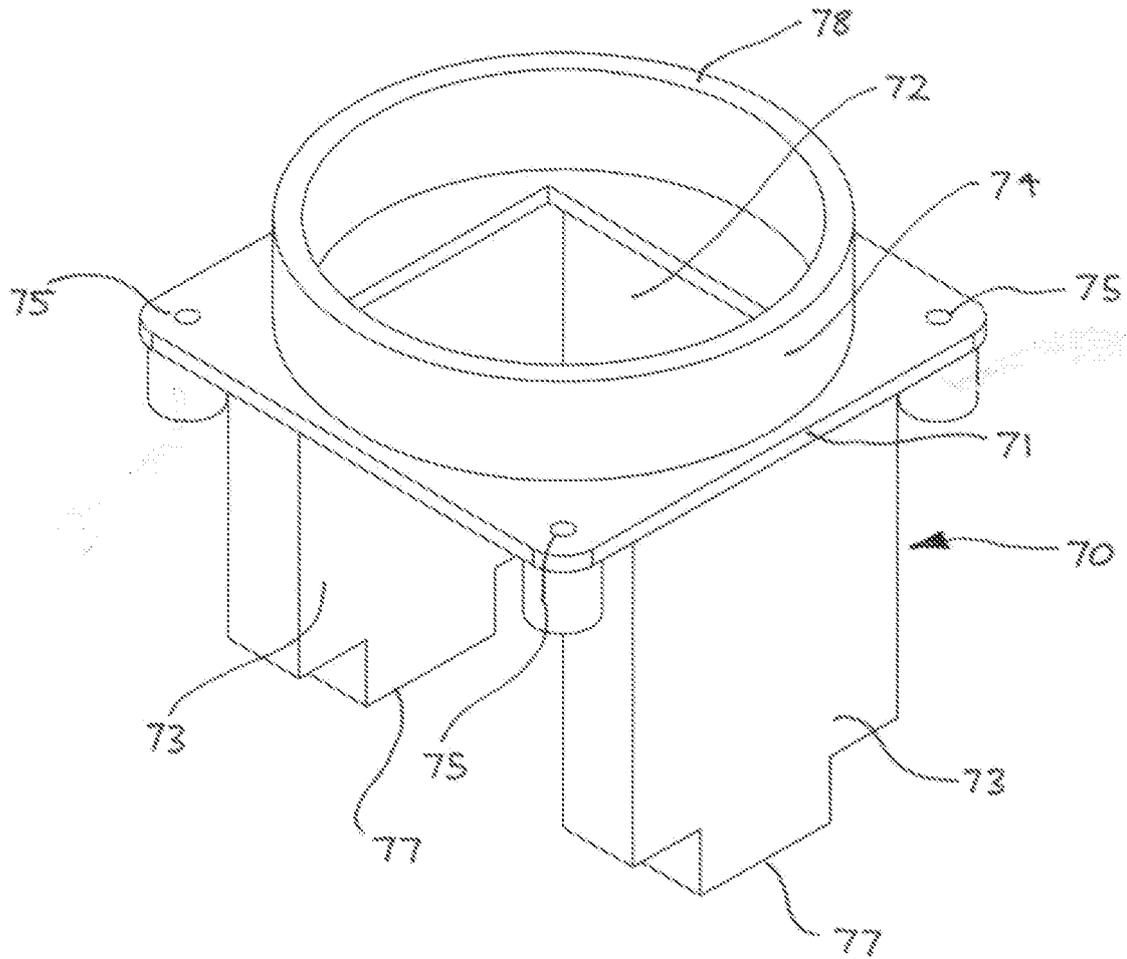


Figure 10

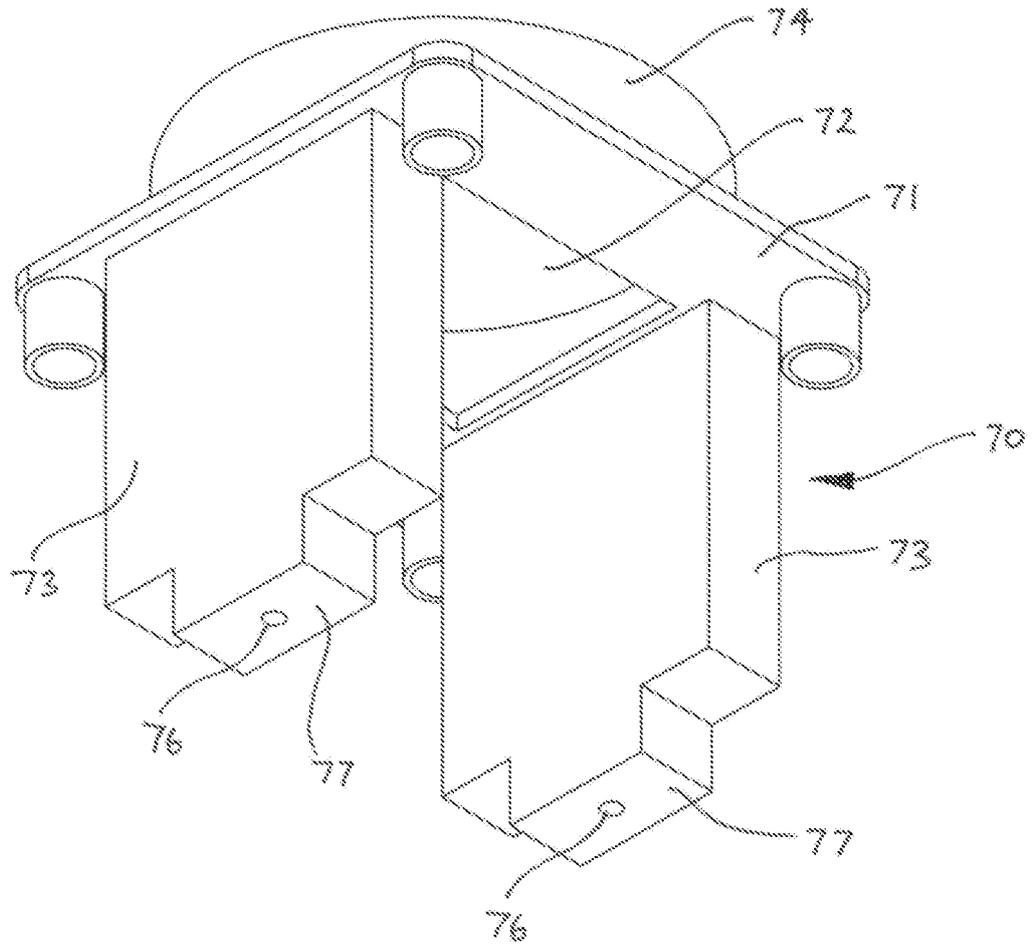


Figure 11