ELECTRICAL GROUND DETECTOR

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1. This invention relates to an electrical ground detector.

A general object of the invention is to provide a safety ground detector which will indicate the grounding of an electrical current.

Another object is to provide a safety ground detector which has been designed particularly for use in hospital operating rooms or industrial plants and which includes an audible or visible signal which will be rendered active when the electrical conductor in said room or plant has become grounded and the leakage is sufficient to cause muscular reflex in a human body when the current is conducted through the body to the ground.

Still another object is to provide a resistor to limit the flow of electric energy which might pass through the body of one or more persons becoming grounded, said current energy measuring less than 375 microamperes, eliminating danger of electric shock, muscular reflex and electric sparks, to protect against the ignition of explosive gases when a secondary wire from the isolation transformer becomes grounded.

A further object of the invention is to provide a sensitive detector of the character described which will eliminate the accumulation of negative and positive static electricity on ungrounded conductors, which prevents the possibility of the danger of explosions due to static discharges in hazardous places such as hospital operating rooms, chemical and petroleum refineries and similar places where explosive gases are present.

Other objects and advantages will be apparent from the following specification which is illustrated by the accompanying drawing, wherein:

The figure is a diagrammatic view of the detector.

Referring more particularly to the drawing the numerals 1, 1a are the electrical conductors leading from the source of energy.

A transformer, as 2, must be employed to deliver the electrical current from conductors 1, 1a to the electrical conductors 3, 4 which lead to the equipment to be used in a hospital operating room or in an industrial plant.

The ground detector is connected into the circuit through the ungrounded conductors 3, 4. As shown, there are suitable resistor units 5, 6 connected into the respective conductors 3, 4 and also connected with the corresponding rectifiers 7 and 8.

Current may then flow through resistor 9 to relay 10 and thence to ground 11. The rectifiers 7, 8 produce direct current rectifier impulses to actuate relay 10. These rectifiers are connected into a common point by an electrical conductor 12 so that current can flow through these blocking rectifier elements toward the common point only. Conductor 12a connects with conductor 10 and conductor 3 and leads to resistor 35 thence through the resistor to the fixed contact 13 and hand electrode 45. There is also a moveable contact 44 which, when closed with contact 13, will form a circuit from the common point in 12a to ground 15, ground 14, relay 16, through resistor 9 and conductor 12. This, in turn, energizes relay 10. The purpose is to test light signals and audible signal.

There is also a fixed contact 16, and the moveable contact 14 may be closed with this fixed contact 16.

The moveable contact, as shown, is of the self-centering type and may be moved into closed position with either contact 13 or 16.

There are the electrical conductors 17, 18 which lead from the respective conductors 3 and 4. The conductor 17 terminates in a fixed contact 19, and opposing this fixed contact 19 there is a fixed contact 20.

The conductor 18 terminates in a moveable contact 21 which may be closed with either of the contacts 19 or 20.

The relay 16 is positioned to actuate the moveable contact 21, and when it is energized, as above explained, it will move contact 21 from contact 19 into closed position with contact 29.

Incorporated into conductor 17 there is a light globe 22, in the present instance green, and also, preferably, a resistor 23. The resistor 23 is provided to reduce voltage of the filament of lights 22 and 41 and increase the life of the filaments. Of course, other types of electrical signal may be employed. When the contacts 19, 21 are closed the signals 22 and 41 will be energized. When contacts 14, 13 are closed and relay 16 energized and contact 21 moved from contact 19 and closed with contact 20, as above explained, the signals 22 and 41 will be extinguished, or rendered inactive.

Leading from contact 20 and connected into conductor 17 there is an electrical conductor 17a, and in this conductor there are light globes 24 and 42, in the present instance red and green, or other selected electrical signals. These signals will be energized when contacts 21, 20 are closed and signals 22 and 41 extinguished.

An audible signal may also be provided to take the place of, or to operate in conjunction with, the signal 24. In the present illustration, this is
shown as an alarm bell 23, which is in an electrical conductor 26 leading from conductor 17 and terminating in a fixed contact 27 which opposes and is spaced from a fixed contact 28. An electrical conductor 29 extends from contacts 18 and 28. There is a relay 30 in the electrical conductor 31, which conductor leads from conductor 17 to conductor 29, and when contacts 20, 21 are closed the current flows from conductor 17a to contact 32, which is in contact with contact point 27 and thence through conductor 26 to operate signal 25. This contact 32 is moveable and is connected into conductor 17a so as to electrically connect the conductors 26, 29, alternatively, with conductor 17a. When contacts 14 and 16 are closed, the relay 30 then becomes energized and closes contacts 32, 28, thus de-energizing signal 25, and upon closing switch 14 with contact point 13 signal 24 is energized and signal 22 is de-energized.

The signals 24, 25 remain active until the moveable contact 14, which is self-centering, assumes its normal, open position. Upon contact 14 moving to open position, the contact between the moveable contact 23 and the fixed contact 27 will be broken and the contacts 32 and 28 will be closed, thereby silencing the signal 25. Therefore stated, the alarm contact 14 is self-centering, and, therefore, to close contacts 14, 13 or 14, 16 it is necessary to move said moveable contact 14 in an appropriate direction. In accordance with the illustration, when the moveable contact 14 is moved to the right the signals 24, 25 and 28 may be tested, sine they become energized upon closing of the switches 14, 13. When this contact is broken, the signals 24, 25 and 42 become inoperative and the signal 22 and 41 is re-energized.

The conductors 1, 16 are provided with over-current protecting devices 33, 34 which are provided to protect the primary circuit of the isolation transformer 2 from over-current supply, and incorporated into the secondary conductors 3, 4 there are over-current protecting devices 35, 36 to similarly protect the secondary winding. These over-current protecting devices may be ordinary fuse plugs, if desired, or similar devices.

During the normal operation of the protected equipment the green light 22 will be eliminated or be active, and it may be here stated that the switch 14 will also flow the impulse current indicated in the drawing, that is, connected with the respective contacts 15, 27, and so maintained by the customary spring or similar device for such purpose.

When a pulsating direct current passes through the body of one or more persons from the line 3 or 4, such persons will be protected against electric shock through the resistor 9 and the relay winding 16, to the ground as the circuit will pass only sufficient current to activate said relay and give warning signals, this current being not more than 400 microamperes.

Should an accidental ground occur on conductor 3 or 4 current will pass through resistor 9 and relay 10 to ground 11, and the current from ground 11 will pass back to conductor 3 or 4, which causes one becomes grounded. This will operate relay 10, and switch 21 will be moved into contact with contact 20, and the green light 22 will be extinguished and current will be conducted through 17a to illuminate the red light 24 and, the switch 32 still being closed with point 27, current will also flow through the conductor 26 to render the signal 25 active. There is a condenser 37 for the purpose of eliminating the alternating current component of the pulsating direct current connected across winding of relay 10.

There is a resistor 38 placed in conductor 12 to limit the flow of current to the contact 13 and hand electrode 40 to protect the excessive or dangerous flow of current from the contact point 13 to ground 16 through the switch 14 when closed in the event lines 3 or 4 should become permanently grounded. Electrode 40 and foot electrode 39 located outside the operating room, are for the purpose of making a momentary test of the conductivity of personnel before entering the operating room. A red light indicating danger signifies no current is flowing through the body from hand electrode 40 to foot electrode 39. When current flows through the body from electrode 40 to 33, a circuit is established from the common point between rectifiers 1 and 5, through the resistance 3, the relay 10, ground 16, ground 14, 500, electrode 39 through the body to hand electrode 40, through resistance 31 and conductor 12 to conductor 13 and ungrounded conductor 3. Establishment of this circuit causes energization of the relay 10 which de-energizes the red light 41 and energizes the green light 22. As before stated, the alarm contact 14 is moveable and, therefore, to move the signal 24, 25 and 28 current into the body from hand electrode 40 to foot electrode 39. It also enables the electro-static potential which may accumulate on the body of a person to flow to the grounded terrazzo floor in the operating room through the conductive sole of shoes required by hospital personnel and surgeons to equalize the electro-static potential that may form on the body which would prevent the possibility of forming a spark or are which could ignite explosive, anesthetic gases.

In order to silence the audible signal 25 the operator may throw switch 14 in contact with contact 16 which will energize relay 30, thus throwing the switch 32 into contact with point 28 thereby silencing the signal. The switch 15, being a self-centering switch, will immediately move to open position, and point 27 and 28 will remain in contact due to the holding coil action of the relay 30. This indicates that a conductor 3 or 4 is grounded, and this defect should be removed by the electrician, and when rectify has the current flowing to the ground 16 stopped, and the relay 16 is de-energized, and thereupon switch 21 will move into contact with point 13 and the green light 22 and red light 41 is illuminated. At the same time, current through conductor 20, 31 is broken, and the relay 50 is de-energized, and switch 22 moves to normal position into contact with contact point 27. It may be here stated that direct current may be used, and the circuits may be single- or multi-phase alternating current circuits.

What Has Been Done

1. A system for use in areas where explosive gases are present comprising an isolation transformer, a plurality of ungrounded conductors connected to the secondary of the transformer and adapted for supplying energy to electrical equipment blocks. This will operate rectifier elements so connected between each of said conductors and a common point that current can flow through said elements toward the common point only, said common point being connected to ground through a resistance; said resistance being sufficiently high to limit the current passing through a person, who may come in contact with one
of said ungrounded conductors, to an amount insufficient to cause muscular reflex or electric shock, said resistance also being sufficiently high to eliminate the occurrence of an explosion producing electric spark should one of the ungrounded conductors accidentally become grounded, a relay coil connected between said common point and said ground and in series with said resistance, and signal means controlled by the relay coil for indicating the presence of said current.

2. A system as set forth in claim 1, said signal means including a signal device, conductors normally connecting the signal device across said ungrounded conductors, a warning signal, conductors for connecting the warning signal across said ungrounded conductors, and means associated with said relay coil for rendering said first mentioned signal device inactive and for rendering said warning signal active when one of said ungrounded conductors becomes accidentally grounded.

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