United States Patent

Samm et al.

[15] **3,660,720**

[45] **May 2, 1972**

[54] AUTOMATIC GROUNDING SWITCH

[72] Inventors: **Ralph W. Samm,** Greensburg; **E. Robert Perry,** Scottdale; **David S. Dodge,** Greensburg, all of Pa.

[73] Assignee: **I-T-E Imperial Corporation,** Philadelphia, Pa.

[22] Filed: **Oct. 20, 1970**

[21] Appl. No.: **82,310**

[52] **U.S. Cl.** .....**317/16,** 200/61.08, 317/33 C, 317/33 SC

[51] **Int. Cl.** **H02h 3/08**

[58] **Field of Search**.....317/13 R, 16, 18 R, 18 D, 33 SC, 317/33 C, 151; 200/61.08; 337/401, 220

[56] **References Cited**

UNITED STATES PATENTS

3,296,494	1/1967	Stenger et al.	317/18 X
3,238,321	3/1966	Lawwill et al.	200/61.08
3,448,341	6/1969	Casey	317/16 X

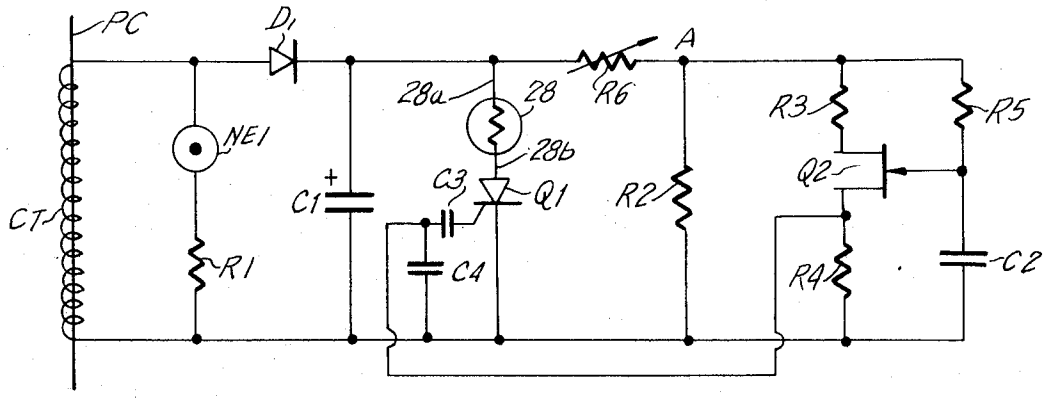
Primary Examiner—James D. Trammell

Attorney—Ostrolenk, Faber, Gerb & Soffen

[57] **ABSTRACT**

Designed for use with electrically grounded power distribution systems, the switch is operable with replaceable propellent cartridges in association with a current limiting fuse. Upon receipt of an electrical signal indicating the presence of an overcurrent fault, a small surge of energy is provided to fire the cartridge and, in turn, propel its plunger into direct contact with a "hot" terminal of the switch, establishing a conducting path to ground. The magnitude of the resulting short circuit currents to ground are limited by the current limiting fuse.

7 Claims, 10 Drawing Figures



Patented May 2, 1972 3,660,720

2 Sheets-Sheet 1

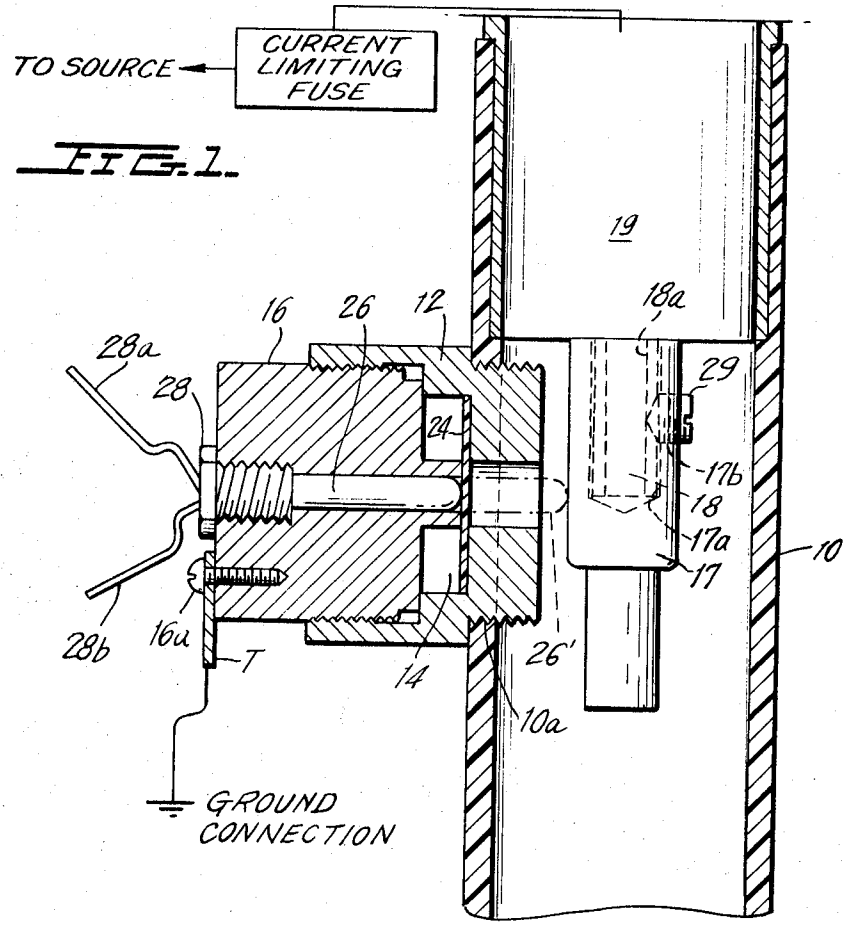


FIG. 1.

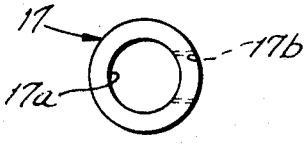


FIG. 5a.

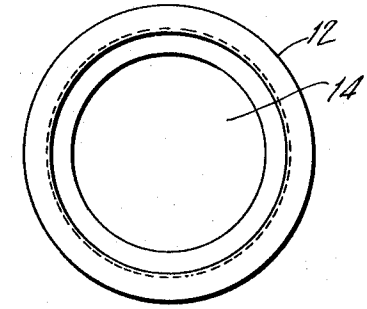


FIG. 3a.

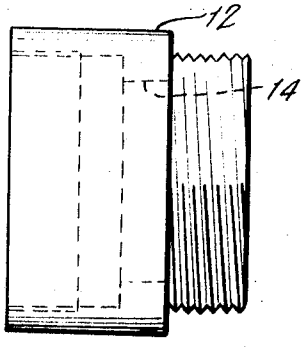


FIG. 3b.

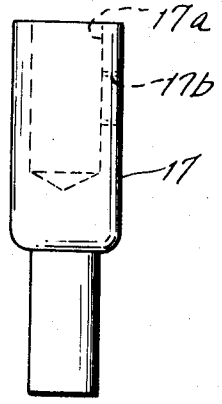


FIG. 5b.

INVENTORS
RALPH W. SAMM
E. ROBERT PERRY
BY DAVID S. DODGE
Ostrolenk, Faber, Gerb & Soffen
ATTORNEYS

FIG. 2a.

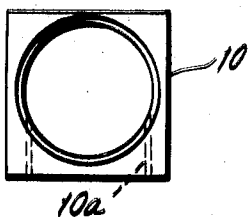


FIG. 2b.

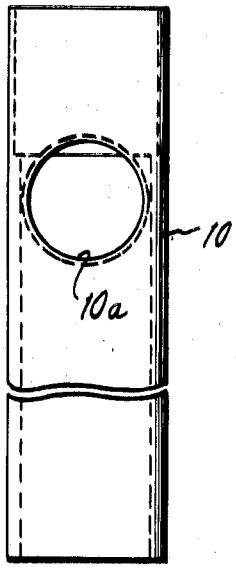


FIG. 4a.

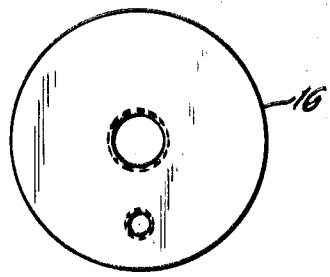
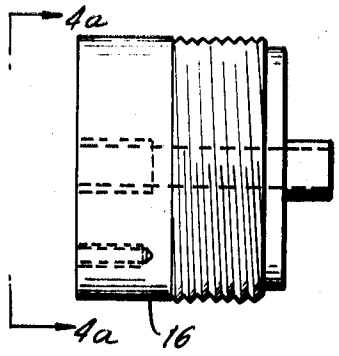


FIG. 4b.



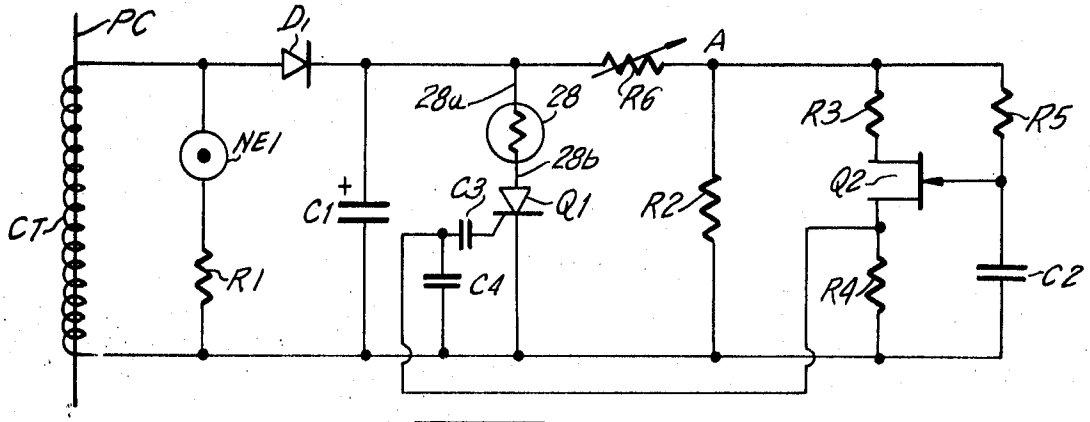


FIG. 6.

INVENTORS
RALPH W. SAMM
E. ROBERT PERRY
BY DAVID S. DODGE
Ostrolenk, Faber, Gerb & Soffen
ATTORNEYS

AUTOMATIC GROUNDING SWITCH

BACKGROUND OF THE INVENTION

1. Field Of The Invention

The present invention relates to electrical power distribution systems, in general, and to an automatic grounding switch for use in such systems to protect against the generation of small overload currents.

2. Description Of The Prior Art

As will be appreciated by those skilled in the art, there exists many instances in the distribution of electrical power where the equipment employed cannot readily be fused to adequately protect against small overload currents. One such particular instance arises with underground transmission systems, which are increasingly playing a larger role in present distribution design. Not only does a need exist in such instances to so protect the equipment employed, but the protective arrangement most desirable is one which is at the same time small, compact and inexpensive to produce. Due to its relatively inaccessible emplacement, it also is apparent that the device selected should be reliable in its operation and easy to maintain although integrated into an incarcerated installation.

Recognition of the need to protect fused electrical equipment against small overloads has been appreciated. One such device in use has been known to incorporate a solid state relaying scheme employing a vacuum interrupter. Also employed in known arrangements are circuit breaker assemblies with their associated relay equipment. Such designs, however, have either high initial cost or limited current ratings, or are, by and large, quite bulky and difficult to maintain.

SUMMARY OF THE INVENTION

As will become clear hereinafter, the switch of the instant invention is designed for use in an electrically grounded transmission system and is selected to operate in the manner disclosed with small propellent cartridges (or squibs) which are easily attainable, replaceable, inexpensive and safe to use. When designed for use in association with a current limiting fuse, the arrangement is selected to be one in which the small overload current is sensed either by a thermal switch, relay, or similar such apparatus capable of generating a small surge of energy. This surge is restricted to pass through the firing circuit of the cartridge, and thus propel its plunger into direct contact with a "hot" terminal of a current carrying line to establish a short circuit directly to ground. Currents flowing to ground are limited in magnitude and interrupted by the current limiting fuse to provide the needed system protection. By being able to simply replace the plunger and propellent cartridge, a configuration is provided which is reusable and, at the same time, small enough for adaptation into an in-line operation, or a variety of circuit protective equipment configurations.

Accordingly, it is an object of the present invention to provide an automatic grounding switch to protect against small overload currents in electrical power distribution systems.

It is another object of the invention to provide such a switch for use in conjunction with a current limiting fuse;

It is a further object of the invention to provide such a switch which can be used at a minimum of expense and difficulty.

These and other objects of the instant invention will be apparent from a consideration of the following detailed description of preferred embodiments thereof in which:

FIG. **1** is a sectional view of one embodiment of an automatic grounding switch constructed in accordance with the principles of the present invention;

FIGS. **2***a* and **2***b* show top and elevational views of the acrylic mounting tube element of the automatic grounding switch of FIG. **1**;

FIGS. **3***a* and **3***b* illustrates top and side views of the mounting plug and bushing assembly employable in the grounding switch construction of the invention;

FIGS. **4***a* and **4***b* show top and end views of the mounting tube and steel switch body of FIG. **1**;

FIGS. **5***a* and **5***b* show end and side views of the copper adapter of FIG. **1**; and

FIG. **6** is a schematic diagram showing one example of a sensing circuit for use in conjunction with which the automatic grounding switch of the invention which initiates the firing of the propellent cartridge in providing the desired protection.

DETAILED DESCRIPTION OF THE INVENTION

As shown in FIGS. **1–5**, the automatic grounding switch of the invention includes an acrylic mounting tube **10**, a mounting plug **12** and a bushing **14** which screws into the mounting tube **10**, and a steel switch body **16** which screws into the mounting plug **12**. A switch **19** is provided with a downwardly extending stud **18** which engages an opening **17***a* in a copper adapter **17** which is located in the vicinity of the grounding device (and which is fixed to stud **18** by a set screw **19** through hole **17***b*). An acrylic insulating disc **24** is shown, along with a copper plunger **26** together with a firing squib **28**. (A suitable squib is available as Holex catalog part No. 1196B). These latter items **24**, **26** and **28** are replaceable after each switch operation wherein the copper plunger **26** is propelled by the explosive charge contained in squib **28** to complete a short circuit including switch stub **18**, adapter **17**, plunger **26'** (shown in dotted fashion), conductive switch body **16**, and terminal T (held by screw **16***a*) to the ground as a result of the sensing of a critical current level. The described assembly is arranged so as to threadedly engage the tapped opening **10***a* in acrylic mounting tube **10** to enable it to be easily removed when the mounting tube is in an inconvenient location so as to make the disposable items listed above replaceable while the unit remains in the operators hands. It should be understood that insulating disc **24** maintains plunger **26** in place and is ruptured by plunger **26** when it is propelled by the explosive contained in squib **28**. Adapter **17** is used to provide a mating surface for plunger **26** as stud **18** is normally covered by a cable terminal **18***a*. FIG. **6** shows a sensing circuit employable to fire the firing squib **28** and basically comprises a temperature compensated electronic overcurrent relay having an adjustable firing point. This point will be understood to constitute that value of primary system current which will cause the electronic overcurrent relay to fire. The circuit has been found to be extremely well adapted for a wide variety of applications since it is adjustable over a 50 to 150 RMS amperes primary current range.

As shown in FIG. **6**, the arrangement includes a current transformer CT inductively coupled to primary conductor PC. A series coupled neon lamp NE1 and a fixed resistor R1 are connected across transformer CT. Also shown are semiconductor diode D1, a silicon controlled rectifier Q1, ignition primer cartridge squib **28**, and four capacitors C1–C4. In particular, the anode electrode of the diode D1 is connected to one terminal of current transformer CT, while the cathode electrode of the diode is coupled in common to one terminal **28***a* of firing squib **28** and capacitor C1, which is a high grade electrolytic unit. Lead **28***b* of firing squib **28** is connected to silicon controlled rectifier Q1, which serially connected elements are coupled across the electrolytic capacitor C1, with the cathode electrode of the rectifier being coupled to the lower terminal of current transformer CT. Note leads **28***a* and **28***b* of squib **28** which are also shown in FIG. **1**. Five additional resistors R2 – R6 and a uni-junction transistor Q2 are shown, with resistor R6 being an adjustable element serially coupled between the cathode electrode of the semiconductor diode D1 and the cathode electrode of the silicon controlled rectifier Q1 by means of resistor R2. Resistors R3 and R4 similarly couple the base electrodes of the uni-junction transistor Q2 across resistor R2. The common junction between the time constant elements R5 and C2 is directly coupled to the emitter of transistor Q2. As will be understood, the sensing circuit of FIG. **6** obtains its energy from current transformer CT which surrounds and is inductively coupled to the primary system current conductor PC. The energy storing

electrolytic capacitor C1 is charged through the semiconductor diode D1 to the peak value of the highly saturated output of this transformer.

In operation, the voltage at point A of the voltage divider formed by variable resistor R6 and fixed resistor R2 sets the firing point for the circuit. The circuit formed by the components including resistors, R3, R4 and R5, capacitor C2 and uni-junction transistor Q2 form a relaxation oscillator having a very stable firing voltage over a wide temperature range. Once the voltage at point A exceeds the starting voltage of the oscillator for a definite time interval (determined by the time constant of resistor R5 and capacitor C2), the relaxation oscillator undergoes cyclic operation to feed a "Turn-On" pulse to the gate electrode of the silicon controller rectifier Q1 through lead 31. In response, rectifier Q1 conducts, enabling the charge stored by capacitor C1 to be discharged through low resistance firing squib 28. The energy passing through the squib is selected to be more than sufficient to cause it to ignite, and thereby activate explosive material to propel plunger 26 towards the right (relative to FIG. 1) to rupture disc 24 and establish a short circuit path between the "hot" terminal 18 (of switch 19) and ground.

The response time of the circuit for a particular value of fault current is dependent on the charging time of the capacitor C1 and upon the R5, C2 time constant of the relaxation oscillator. The minimum response time for heavy faults is primarily determined by the R5, C2 time constant, and is selected to coordinate with the minimum melt characteristic of the current limiting fuse employed (not shown). In this manner, it is possible to adjust the long time interrupting characteristic of a fuse precisely with the use of the sensing circuit. As a result, precise overload protection of many circuits with current limiting fuses is possible.

The circuit is protected, furthermore, against transients and very heavy primary system faults by the use of the neon lamp NE1 and resistor R1 combination, connected across the output terminal of the current transformer CT. Due to the relatively slow minimum response time of the circuit (typically a few tenths of a second), normal system transients will not generally affect the operation of the circuit.

It will thus be seen, that the automatic ground switch sensing circuit effectively operates to provide a continuously adjustable overcurrent sensing circuit operable between 50 and 150 RMS amperes with a fixed minimum response time. At the same time, it will be seen that the sensing circuit can be made very accurate simply by using high grade components such as the capacitor C1. The unit can be completely self-contained and hermetically sealed making it both reliable and inexpensive. At the same time, the circuit is temperature compensated and is completely adjustable with simple recalibration procedures. One important feature, again, is its immunity to normal systems transients and overloads.

By employing such a sensing circuit, the automatic grounding switch of the invention can be seen to be compact, easy to maintain and inexpensive to install. Moreover, the switch is reliable, safe, and inexpensive to maintain. It will thus be seen that the automatic grounding switch protects the fused equipment against small overloads by activating the associated current limiting fuse when dangerous conditions exist. Such current limiting fuse technology is well known in the art and needs no further discussion at this time.

In the foregoing, the present invention has been described in connection with specific illustrative embodiments. It is intended that the scope of invention be determined not by the specific disclosures herein contained, however, but only by the appended claims.

The embodiments of the invention in which an exclusive privilege or property is claimed are defined as follows:

1. In conjunction with an electrical power distribution system having a primary current carrying conductor, the combination comprising:

a current limiting fuse coupled to said conductor;

an electrically conductive striker operatingly cooperative with one terminal of said current limiting fuse;

rupturable means for electrically insulating said striker and said one terminal;

first means coupled to said power distribution system conductor for storing a voltage representative of the peak current value in said conductor;

second means coupled to said first means for generating a firing signal;

delay means coupled to said first means for activating said second means after a predetermined time delay which is inversely proportional to the magnitude of current in said conductor;

ignition means coupled to said first means and responsive to said firing signal for firing said conductive striker to rupture said rupturable means and make electrical contact with said current carrying conductor to effect current limiting flow through said cooperative fuse and to automatically ground said fuse in the presence of overcurrent conditions; said first and second means and said ignition means all being powered exclusively by the current in the conductor being monitored.

2. The combination of claim 1 wherein said current carrying conductor is maintained in a first housing, and wherein said conductive striker is maintained in a second housing in alignment with an aperture of said first housing but which is normally closed off therefrom by said rupturable means which is comprised of an insulating disc included within said second housing, and through which said striker is propelled in response to said electrical signal generation to contact said current carrying conductor to effect said current limiting action.

3. The combination of claim 1 wherein said first housing and said insulating disc are constructed of acrylic material and said second housing is constructed of a steel component.

4. The combination of claim 2 wherein said first means comprises an electronic overcurrent relay circuit adjustable to provide at least the value of signal current needed to fire the electrically conductive striker to contact said current carrying conductor and wherein said relay circuit includes a toroidal current transformer inductively coupled to said primary current conductor; a capacitor and a diode coupled across said transformer for storing the peak value of the voltage developed by said transformer.

5. The combination of claim 4 in which said second means further includes a relaxation oscillator coupled to said transformer for generating the ignition firing signal and having an adjustable conduction point so as to vary the response time of the oscillator to meet different anticipated overcurrent conditions.

6. The combination of claim 5 in which there is also included neon tube means coupled across said toroidal current transformer to protect the overcurrent relay circuit against transients and heavy primary system current faults.

7. The combination of claim 5 wherein said delay means further comprises a resistor-capacitor circuit including an adjustable resistor for adjustably controlling the time delay.

* * * * *