ABSTRACT OF THE DISCLOSURE

This disclosure relates to a door alarm having a normally closed detection switch connected in a voltage dividing network circuit with a diode. A normally open security switch is connected in parallel with the first branch. A current balancing resistor and an oppositely polarized diode is parallel with the first and second branches. A day-night switch applies a direct current (D.C.) signal of a polarity biasing the first diode to conduct during the night and of a polarity biasing the opposite diode of the by-pass circuit to conduct during the day. A balanced differential amplifier is connected to the D.C. leads and through a transistor amplifier operates a pair of relays. The output signal normally maintains the transistor amplifier conducting whereby the control relays are energized to deactivate the alarm. Either switch when activated unbalances the amplifier unit to activate the alarm.

This invention relates to a condition detection device and particularly to a switch device responsive to opening of a door, window or the like to form an alarm switch employed in home and commercial installations.

Alarm systems are widely employed to protect against unauthorized entry into buildings. In one system, protection against entry through doors, windows, and the like is established by magnetically actuated door switches which respond to the opening to trigger an alarm. Generally, such systems include a switching sensor connected adjacent the door frame and an actuator mounted upon the door. Although simple magnetic door switches are available, external magnets and the like may be employed to defeat their operation. More sophisticated balanced magnetic switches have been devised for higher security applications. In these systems, a balanced magnetic circuit is established to control the switching circuit such that an external magnet will upset the balance condition and trigger the system in the same manner as opening of the door or window. In order to conveniently allow normal use of the door or window during the day or when the security is not desired, a shunting switch is normally applied across the magnetic door switch to operably disconnect it from the circuit. The circuit is thereby completely disconnected during the day or access mode. As a result, someone can tamper with the system to effectively disconnect the alarm system even when reset. The security therefore depends upon a proper check being made each time the system is re-established.

The present invention is particularly directed to an improved system and switch structure which is essentially tamper-proof and which maintains continuous supervision of the circuit during both the night or detecting mode connection and the day or access mode connection.

Although the present invention is particularly useful in connection with magnetic switches and magnetic actuators and is hereinafter described with a magnetic sensor and actuator, any other energy field system may be employed within the broadest concept of the present invention. For example, a photoelectric or radiant energy field may be employed as the operating source for a properly responsive switch mechanism. The radiant energy may be visible light energy, infrared or near infrared energy or even some higher or lower frequencies of electromagnetic radiation. Further, a radioscopelike field and sensor might be employed for very high security. The latter has the distinct advantage that a person would not normally have available or even desire to carry a radioactive source of sufficient intensity to penetrate the shielding which can be applied to the sensor.

Generally, the present invention employs a plurality of switching mechanisms forming a field sensor mounted in the field of the actuator. One of the switch mechanisms constitutes the normal alarm switch. The opposite switch mechanism constitutes an interlocking supervisory switch such that if an external magnetic field is employed to neutralize or otherwise disturb the normal magnetic field required to hold the alarm switch in the open or actuated position, one of the other of the two switch mechanisms will always be actuated to cause actuation of the alarm. The actuation is created whether the tampering occurs during the day mode or the night mode setting. To prevent physical tampering or attack to the unit, it is preferably totally encapsulated such that direct physical attack will actually cause disruption of the system.

The encapsulation by proper selection of plastic or the like will also make it essentially impervious to chemical attack over any reasonable length of time. If a chemical sufficient to provide a quick destruction is provided, certain of the internal parts will also be attacked with a consequent actuation of the alarm.

In accordance with the present invention, a continuous supervisory circuit is established by providing a system of blocking diodes with proper polarity power interconnected into the circuit through a day-night switching means which controls the polarity of the signal applied to the door switch. In this manner, the door switch is maintained in the circuit but is normally bypassed or effectively disconnected during the day period by the door switch.

In accordance with a preferred construction of the present invention providing access security with continuous day and night supervision, a normally closed switch is connected in a voltage dividing network circuit with a steering diode to form a detection circuit connected in parallel with a normally open security switch and in parallel with a day bypass circuit which includes a current balancing resistor and a diode oppositely polarized with respect to the detection branch diode. A day-night switch applies a direct current (D.C.) signal of one polarity during the night, biasing the detection diode to conduct. During the day mode, the switch reverses the polarity and provides a direct current path through the opposite diode of the bypass circuit. Connected across the D.C. power leads is a suitable supervisory or monitoring circuit which may include a balanced differential amplifier for operating a pair of relays connected in series with a transistor amplifier. Under either the day or night setting and with the switches in the normal standby position, the differential amplifier provides an output signal to maintain the transistor amplifier conducting whereby the control relays are energized and deactivate the alarm.

The one control relay is connected in the alarm circuit and maintains the alarm circuit in open circuit condition and the second relay has contacts connecting the power supply circuit to the detection sensing circuit. If either of the switches is moved from its normal position, it unbalances the signal applied to the one side of the differential amplifier and results in de-energization of
the relays. As a result, the power supply opens and prevents re-energization of the relays. Simultaneously, the other relay closes the alarm circuit and energizes the alarm system.

In accordance with another aspect of this invention, the alarm circuit includes a timing means having contacts parallel with the disconnect power contacts of the first relay. After a selected time period, the relay contacts will close to again supply power to the power system and if the switches of the detection unit have reverted to the normal position, the circuit again supplies power to energize the relays, close the relay power contacts and open the alarm circuit contacts to return the circuit to standby. Such a feature might be desirable where the system is employed to detect the entrance of personnel at any given time for supervisory purposes only; for example, in a college dormitory or the like.

The present invention thus provides an improved condition detection system particularly for access control where a relatively high degree of security is involved and continuous supervision of the system is needed or desired.

The drawing furnished herewith illustrates a preferred construction of the present invention in which the above advantages and features are clearly disclosed as well as others which will be clear from the following description thereof.

In the drawing:

FIG. 1 is a diagrammatic view showing the installation of a door switch unit in accordance with the present invention;

FIG. 2 is an enlarged diagramatic view of the actuator shown in FIG. 1;

FIG. 3 is a schematic circuit diagram of a single door switch system; and

FIG. 4 is an enlarged diagramatic view of a sensor shown in FIG. 1.

Referring to the drawings and particularly to FIG. 1, a door alarm system is shown applied to a conventional door 1 mounted within a wall 2. A field sensor 3 is mounted on the casing 4 immediately adjacent to the door 1 and a suitable actuator 5 is mounted on the door to establish a related field coupled to the sensor 3 with the door closed. Supervisory and power signal leads 6 extend from the sensor 3 preferably through a suitable conduit to a remote supervisory control station 7. In the illustrated embodiment of the invention, an alarm such as a bell 8 is shown at the supervisory station to indicate the abnormal condition and a day-night switch 9 is provided for connecting the supervisory control station 7 to the sensor 3 for either a night detecting mode or a day access mode.

Sensor 3 and actuator 5 may be of any suitable field variety employing a magnetic energy, radiant energy or the like as previously noted. Actuator 5 is shown in FIG. 2 including a suitable permanent magnet 10 embedded within a housing for securement to the door 1 in position to control the sensor 3.

The sensor 3 is a magnetically responsive switching unit which is schematically shown in FIG. 3.

Referring particularly to FIG. 3, the sensor 3 includes three paralleled branches identified respectively as a night or detection branch 12, a day bypass branch 13 and a security or tamper branch 14. The branches are connected in parallel between the control leads 6 and provide parallel current level control branches for controlling the current supplied to a supervisory or monitoring circuit 15 which is connected to control the alarm shown in FIG. 4.

The alarm detection branch 12 particularly includes a normally open switch 16 connected in parallel with a control resistor 17 and held closed by the presence of the field of magnet 10. The parallel switch 16 and resistor 17 are connected in series with a current balance resistor 18 and a diode 19 between the control lead 6.

The diode 19 restricts conduction through the circuit 12 from the lower lead to the upper lead of leads 6 and the day-night switch 9 must be positioned to apply the corresponding polarity during the detection period, as subsequently described. In operation, normally closed switch 16 bypasses resistor 18 and maintains a bias on the supervisory circuit 15 to hold the alarm in the off condition. However, if switch 16 opens as a result of the removal of the magnetic actuator 5, the resistor 17 is inserted into the circuit, changes the current level and voltage signal applied to the supervisory circuit 15 to trigger the circuit and sound the alarm 8.

In order to bypass circuit 12 during the day period, such that the door 1 may be opened and closed with the resulting opening and closing of the switch 16 but without sounding the alarm, the day bypass branch 13 is connected in parallel with the detection branch 12 and includes a diode 20 in series with a resistor 21. The diode 20 is polarized in the opposite direction with respect to the diode 21.

The day-night switch 9 is placed in the opposite position to reverse the polarity of the leads 6 and therefore the polarity across the alarm detection branch 12 and the day bypass branch 13. The resistor 21 is of the same order as the resistor 18 of the detection branch 12 and thus holds the supervisory circuit 15 in the off condition during the day period.

The security control branch 14 is connected in parallel with both the branches 12 and 13 and includes a normally open switch 22 in series with a separate security switch 23. The switch 22 is mounted as a part of the sensor 3 and in particular in relationship to switch 16 such that it is maintained in this position in the presence and absence of the magnetic actuator 5. However, any separate magnetic field over and above that established by actuator 5 which is sufficient to hold the switch 16 closed and permit opening of the door without opening of switch 16 will also close the switch 22, change the input level to the supervisory circuit 15 and operate the alarm 8.

The security control branch 14 is independent of the polarity of the leads 6 whereas both the detection branch and the day bypass branch 13 are polarity sensitive and thus provides a very simple and reliable means for controlling day-night operation while maintaining continuous monitoring and supervision of the condition of the circuit.

Although the sensor 3 may be constructed as desired, an extremely satisfactory construction is a potted construction such as shown in FIG. 4. The switches 16 and 22 are small glass enclosed reed switches of the well known leaf-spring type. The switches 16 and 20 and associated resistors and diodes are connected and embedded within a suitable plastic body with the leads 6 protruding therefrom. The reed switches 16 and 22 are spaced within the plastic body such that the field of the magnetic actuator 5 is sufficient to operate contacts or switch 16 but not switch 22. However, if a second or additional field is impressed upon the sensor 3 in the presence of actuator 5, the reed switch 22 is actuated.

In the illustrated embodiment of the invention, day-night switch 9 is shown as a double-pole, double-throw switch connected between a pair of D.C. power leads 24 and 25 and the related control leads 6.

The illustrated day-night switch 9 includes a first contact arm 26 adapted to alternately engage a day contact 28 and a night contact 29. Arm 26 is connected to the upper control lead 6. Day contact 27 is connected to lead 25 via a common switch lead 29 and night contact 28 is similarly connected through a common lead 30 to the opposite power lead 24.

The switch 9 further includes a second contact arm 31 connected to the opposite lead 6 and ganged to the arm 26 for simultaneous and corresponding positioning to a day contact 32 or a night contact 33. The day contact 32 is connected to the common lead 30 and the night contact 33 is connected to common lead 29. In the night position, the upper lead 6 is connected to the negative power lead 24 via night contact 32 and the common lead 30 whereas the lower lead 6 is connected to the positive power lead 25 through the contact arm 31, the night contact 33 and common lead 29.
An adjustable resistor 34 and a polarity sensing diode 34 are connected in series in the negative lead immediately adjacent the common lead 30. The adjustable resistor 34 allows adjustment of the current through the system in accordance with the particular components of the supervisory circuit 15 and the polarity sensing diode 34 assures that the leads 24 and 25 are properly connected to a suitable low voltage D.C. source, not shown.

The common lead 29 is connected to the positive lead 25 and to the supervisory circuit 15 in series with a normally closed tamper switch 36. The relay 30 forms a part of a voltage dividing network for controlling the operation of the supervisory circuit 15 which in the illustrated embodiment of the invention includes a differential balanced amplifier employing a pair of PNP type transistors 37 and 38, each of which is similarly constructed and connected in the circuit. The transistor components are similarly numbered, with those of transistor 38 distinguished by using primed numbers. The transistors 37 and 38 have the emitters 39 and 39' connected to the positive lead 25 in series with similar resistors 40 and 40' and the collectors 41 and 41' connected to the negative lead 24 in series with corresponding resistors 42 and 42'. A common emitter resistor 43 is interconnected directly between the two emitters 39 and 39'. The collectors 41 and 41' are also connected together by a pair of series connected resistors 44 and 45 and by a pair of series connected diodes 46 and 47. The diodes 46 and 47 are connected in back-to-back relation and the junction therebetween is connected to the collector of the transistor 38. If by a common jumper lead 48, an output lead 49 is also connected to the common lead 48 and connected, as hereinafter described to control the alarm 50. The base 50' of the transistor 38 is connected to the junction of a pair of voltage dividing resistors 51 and 52 which are interconnected directly across the D.C. leads 24 and 25 and provides a bias on the transistor 38 establishing a selected conducting level. The base 50 of the opposite transistor 37 is connected to the positive lead 25 through a resistor 53 and to the sensor through lead 29 such that its bias is controlled by the sensor.

The base of the transistor 37 has a voltage applied thereto which is determined by the voltage dividing network including the adjustable resistor 34, the resistors inserted by the sensor 3 and the resistor 53.

The differential amplifier of circuit 45 thus has a fixed bias on transistor 38 and a condition sensitive bias on transistor 39. If the condition sensitive bias is increased or decreased, the negative signal at the lead 48 and the output lead 49 becomes more negative. Under normal standby conditions during either day or night detection, the circuit is unbalanced to a selected degree and establishes a relatively negative voltage at output lead 49; for example, the voltage in an actual device has been held at approximately 6 volts negative. When either of switches 16 or 17 is actuated to detect an abnormal condition, the bias on the transistor 37 is reduced as a result of the insertion of the resistor 17 or 23. This reduces the conductivity of the transistor 37 and causes the balance point lead 48 and the connected output lead 49 to swing down or more negative.

The output lead 49 is connected to control a transistor 54 connected to operate the alarm circuit. The illustrated transistor 54 is an NPN variety having a base 55 connected to the output lead 49 and having an emitter 56 connected in series with a pair of diodes 57 to the negative power lead 24. The collector 58 is connected in series with a pair of relays 59 and 60 to the positive power lead 25. A control resistor 61 is connected between emitter 56 and the positive lead 25 and a protective diode 62 is connected in parallel with the relays 59 and 60.

Under normal conditions, the condition sensitive signal applied to the base 55 of the NPN transistor 54 is sufficiently positive relative to the negative potential of the emitter 56 to maintain the transistor turned on. As a result, relays 59 and 60 are energized.

The relay 59 includes a set of normally closed contacts 59-1 which are connected in series with the alarm bell across a suitable set of power lines; for example, the conventional 115 volt A.C. power distribution lines 63. A time delay relay 64 is connected in parallel with the bell 8 and thus in series with the normally open contacts 59-1. As long as the transistor 54 is maintained conducting, which in turn indicates that the supervisory or detection circuit has not been triggered, the contacts 59 are held open and prevent energization of the bell 8 or the time delay reset relay 64, as shown in FIG. 3.

The relay 60 includes a set of normally open contacts 60-1 which are connected in the negative power lead 24. As long as the transistor 54 is conducting the negative lead is also maintained closed to provide the necessary power to the sensor 3, supervisory circuit 15 and the relays 59 and 60. However, if the transistor 54 is turned off for any reason including actuation of detection switches 16 or 21 of the sensor 3 relay 60 is de-energized, opens the associated contacts 60-1 and removes the negative power supply. Simultaneously, relay 59 is actuated to sound the alarm bell 8 and energize the reset relay 64.

In the illustrated embodiment of the invention, the timing contacts 64-1 of the relay 64 are normally open and 60-1 are connected in parallel with the relay contact 60-1. A predetermined time after energization, the contacts 60-1 close again supplying negative power to the supervisory circuit 15. If the actuated door switch 16 or 21 has reset to a proper condition, the differential amplifier is partially rebalanced, the transistor 58 turned on and the relays 59 and 60 again energized to reset the circuit to the standby position shown in the drawings.

In summary, the day-night switch 9 establishes alternate input polarities to sensor 3 corresponding to the night detection mode and day access mode. During the day access mode, the bypass branch 13 inserts the proper resistor 21 into the circuit to maintain the differential amplifier of circuit 15 properly balanced with a sufficiently small negative signal on the power transistor 54 to hold it conducting, whereby the alarm circuit is held deactivated.

If during the day access mode, a magnetic means is added to the actuator 5 in an attempt to defeat a subsequent detection mode setting, the switch 22 will close and change the resistance of the sensor 3 inserted as a part of the voltage dividing network to bias transistor 37. The differential amplifier is unbalanced to establish a larger negative signal at the output lead 49. This in turn de-energizes the relays 59 and 60 with the consequent de-energization of the bell 8 and removal of the power from the sensor 3 and supervisory circuit 15. After a selected period, the time delay relays 64 closes contacts 64-1 and resets the sensor 3 and supervisory circuit 15. The alarm circuit however is only reset if the switch 22 has been returned to the normally open position.

During the night detection mode, switch 9 establishes a polarity at lead 6 to insert the detection branch 12. With the switch 16 held closed, the differential amplifier output holds transistor 54 conducting and relays 59 and 60 energized. If the door is opened with the magnetic field removed from sensor 3 switch 16 opens the reverse 17 in the voltage dividing network to transistor 37 such that the differential amplifier is unbalanced to increase the negative signal to transistor 54 which turns off and de-energizes relays 59 and 60 to sound the alarm bell 8 first timing relay 64 and open the negative power lead, similar to the functioning described above for actuation of the security switch.

Further, if while in the night mode, a field is established to hold switch 16 closed independently of actuator 5, the security switch 22 is closed to actuate the alarm bell 8 as previously described.

The day-night switch 9 may be manually operated or in certain applications provided with a suitable motorized control for timed positioning. Thus, in the illustrated embodiment of the invention, the switch 9 is shown diagram-
naturally connected to a suitable time control 65 which establishes the night detection mode during given time periods and the day access mode therebetween.

The present invention thus provides an improved balanced detection system including means to produce continuous supervision of the circuit.

1. A device for actuation in response to relative change between a pair of members wherein an energy field actuator is coupled to one member and an actuated unit responsive to said energy field is coupled to the second member, the improvement in the actuated unit comprising a pair of control switch means connected in parallel, one of said switch means being actuated in response to positioning adjacent the actuator and the second of which is not, said second control switch means being actuated in response to an energy field differing from that of the actuator by a selected magnitude,
a supervisory control means separate from the actuated unit and having power supply means connected to the control switch means for conditioning said first and second control switch means for operation, and
bypass circuit means independent of said pair of switch means and connected in parallel with said pair of switch means and including means in said bypass circuit means and in said first control switch means to transfer power from the circuit of the first control switch means to the bypass circuit means but not the circuit of said second control switch means.

2. The device of claim 1 wherein said supervisory control means are polarity sensitive switching circuit means responsive to positioning adjacent the actuator, the supervisory control means includes circuit means having a pair of direct current power leads, and a preset polarity switch means connects said power leads to said circuit means whereby the supervisory circuit is selectively completed through the first control switch means and the bypass circuit means.

3. The device of claim 1 wherein an operating power source is connected to the supervisory control means and having an output means responsive to said control means, said output means including an output condition detecting means and power source control means to remove power from the supervisory control means.

4. The control means of claim 1 wherein a pair of control leads connects said supervisory control means to said control switch means and said bypass circuit means, said control means comprising individual elements responsive to electrical power of different characteristics, and
said supervisory control means having output means to respond to the change in the state of said switch means and including preset switch means connected to the control leads to selectively connect power of either of said different characteristics to both of said control means and said bypass means and thereby having only the first control switch means or the bypass means operable with the second control switch means at any one time to selectively and operably disconnect the detection means from the control means.

5. A control means for actuation in response to relative movement between a pair of members, which comprises an actuator mounted on one of said members and including means to control an energy field, a pair of control leads, a controlled device mounted on the other of said members and disposed in operative alignment with the actuator, said controlled device includes a pair of circuit branches connected in parallel to said pair of control leads, only one of said branches including a detection switch means having a first position and
responsive to the energy field to establish a second position, diode means connected in each of said branches whereby one polarity of the control leads causes the one branch to conduct and on opposite polarity causes the other of said branches to conduct, and
a supervisory circuit connected to said control leads and having output means to respond to the change in the state of said detection means and including preset polarity reversing switch means connected between the control leads and a source of direct current power means to selectively connect one at a time either of the branches in the supervisory circuit to selectively and operably disconnect the detection means from the control whereby actuation of the detection means does not actuate the output means.

6. The switching device of claim 5 wherein said first branch circuit includes a normally open switch connected in parallel with an impedance and in series parallel with a steering diode and an impedance and the second branch circuit includes a diode in series with an impedance, said diodes being oppositely polarized, and said security switch means includes a normally open switch connected in parallel with said parallel branches.

7. The controlled device of claim 5 wherein said supervisory circuit includes an amplifying means having an input circuit connected to the controlled device and an output circuit including switching means connected to actuate an alarm means and to a power connection means for the supervisory circuit, said amplifying means establishing an output in the standby condition to maintain said switching means to deactivate the alarm and establish the power connection.

8. The switching device of claim 5 wherein said first branch circuit includes a normally closed switch connected in parallel with an impedance and in series parallel with a steering diode and an impedance and the second branch circuit includes a diode in series with an impedance, said diodes being oppositely polarized.

9. The controlled device of claim 8 wherein a timing reset means is connected to be actuated by the switching means and operable after a selected time period to establish a separate power connection to the supervisory circuit.

10. The controlled device of claim 8 wherein the amplifying means includes a differential amplifier having a pair of input means, one of which is connected to a fixed biased signal source and the other of which is connected to the actuated unit and an output amplifier having an input means connected to the differential amplifier output and an output means, said switching means including operating relays having contacts connected to control the alarm means and the power connection means, and a timing relay means connected in parallel with the alarm means and having contacts connected to bypass the power connection contacts of the switching means.

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