APPLIANCE THEFT CONTROL ALARM SYSTEM

Filed March 20, 1968
An alarm system particularly suitable for indicating when an electrical appliance is disconnected from its grounded electrical power source, the alarm system comprising first circuit means adapted to be connected in parallel with such a source to the grounded side of such an appliance so that, when the appliance is disconnected from its source, the first circuit means will be disconnected from ground. The alarm system further comprises first means for bringing the relay, adapted to be connected between the first circuit means and an electrical power source, output means arranged to alert personnel, normally non-conducting electronic switch means arranged to control the flow of current through the output means, the switch means comprising a control electrode, and second circuit means for connecting the control electrode to the junction between the capacitance coupling means and the first circuit means so that, when the first circuit means is disconnected from ground, the voltage coupled through the capacitance means is applied to the control electrode to render the switch means conductive, thereby to energize the output means. Preferably, the second circuit means comprises resistance means connected between the control electrode and the capacitance coupling means, a unidirectional conductive device connected between ground and the junction of the resistance means and control electrode, and second capacitance means being chargeable to a voltage level sufficient to render the switch means conductive. Also, preferably, the output means is a relay, solenoid or the like arranged to be energized by current flow from a direct current power source and the switch means is of the type comprising an anode electrode connected to the output means and a cathode electrode connected to ground, the junctions between the anode and cathode being biased such that, when the switch means is rendered conductive by a positive voltage applied to the control electrode, the switch means will remain conductive as long as a positive voltage is applied to the anode, thereby to maintain the output means energized.

This invention relates to means for providing an alarm when an electrical appliance, such as a television receiver, is disconnected from its power source and more particularly for indicating an alarm when such an appliance has been disconnected from its conventional electrical power source and the appliance being monitored is connected to the grounded side of the appliance. It will be perceived that the system of this invention is ideally suited for use in the prevention of theft of appliances. The system is not limited, however, to the prevention or indication of a theft, but may be used to sound an alarm when any conductor is, for any reason, disconnected from its proper source.

It is well known to use relays to warn when appliances have been disconnected from electrical outlets. Such relays normally comprise switches arranged to energize an auxiliary alarm circuit, spring means for urging the switches to their normally-closed position and an armature connected to the switches and arranged so that, when the relay is energized, the switches are held open in opposition to the urging of the spring means. Thus, if the relay is energized through the same power circuit as an appliance and the appliance is disconnected, the auxiliary alarm circuit is energized. Relay systems of this type are bulky, expensive, difficult to maintain and inefficient because they consume significant quantities of electrical power. Hundreds of such relays installed in alarm systems for large hotels and motels would consume thousands of watts of power continually and develop a corresponding amount of heat. Further, the inductance or inductive reactance of such a large number of relays would tend to decrease the power factor of the electrical load and, when combined with other inductances, could decrease the power factor to the point where the motel or hotel would be charged a higher rate for its electrical power.

Relay contacts corrode with age and the laminations about which their coils are wrapped may become noisy and chatty. Salt atmosphere, such as may be encountered in a hotel or motel along the coast, can speed the corrosion of relay contacts. The maintenance of systems comprising a large number of relays is a headache to some business operations because maintenance personnel are difficult to find. The replacement of a relay usually requires the changing of one or more mounting screws and unsoldering and soldering at least four wires and perhaps more.

It is a primary object of my invention, therefore, to provide an alarm comprising means for sensing when a conductor is disconnected from ground, which sensing means does not utilize significant amounts of electrical power. My preferred sensing means comprises a normally non-conducting electronic switch having a control electrode, first circuit means connected to the grounded side of the appliance, coupling means adapted to be connected between an electrical power source and the first circuit means and through the first circuit means to ground and second circuit means connected between the control electrode and the junction between the coupling means and the first circuit means so that, when the first circuit means is disconnected from ground, the voltage coupled through the coupling means is applied to the control electrode to render the switch means conductive. I have connected the switch means in series with an output means and a power source so that, when the switch means is conducting, the output means will be energized. The output means may take any number of forms. I prefer to use a relay as the output means, the relay being arranged to energize an audio-alarm and a visual indicating means.

My preferred first circuit means includes a pair of separable contacts disposed in a conventional polarized receptacle, one of the contacts being connected to a wire which extends through the conventional power cord for an appliance to be connected internally of the appliance to the grounded side of its power source. Thus, if the power cord is cut or if the plug is removed from the receptacle, the first circuit means will be disconnected from ground and the voltage coupled through the coupling means will be available to be applied to the control electrode of the switch means.

It is another object of my invention to provide such an alarm system which will not utilize significant amounts of electrical power unless and until an appliance is being monitored is disconnected from its electrical power source. Another object of my invention is to provide an alarm system comprising an electronic switch for energizing an output means, the electronic switch being arranged so that once it is rendered conductive by the application of an input signal, it will remain conductive to maintain the output means energized.

Still another object of my invention is to provide an ultra-low-power consuming theft alarm system comprising a minimum number of parts and arranged to give years of...
maintenance-free service. I have built and used my system to keep the television sets in thirty motel rooms under surveillance and the system requires less than two and one-half watts of electrical power. Most of this power is required for a semiconductor-type direct current power supply which I prefer to use, and I believe that such a power supply is a sufficient direct current power source for use with an alarm system arranged to provide surveillance for a thousand or more different television sets or other such appliances.

Still a further object of my invention is to provide such a system which will continue to provide an alarm when a power plug has been removed from an electrical outlet and a jumper plug has been installed in its place. My system is so sensitive that it will provide an alarm when an appliance being monitored is disconnected for a fraction of a second, but will not, for reasons to be discussed hereinafter, give a false alarm because of power line or other electrical transient voltages.

Other objects and features of my invention will become apparent as this description progresses.

To the accomplishment of the above and related objects, my invention may be embodied in the form illustrated in the accompanying drawing, attention being called to the fact, however, that the drawing is illustrative only, and that change may be made in the specific construction illustrated and described, so long as the scope of the appended claims is not violated.

The sole drawing accompanying this specification is a schematic diagram of a preferred embodiment of my system.

Referring to the drawing, it will be seen that I have illustrated a television receiver, indicated generally by the reference numeral 14, a three-conductor power cord 15, a polarized electric power plug 16 on one end of the power cord and a polarized power source receptacle 17 into which the plug 16 is inserted. Two of the conductors of the power cord 15 are connected to the television receiver 14 as indicated at 15′, 15″. The third wire, indicated by the reference numeral 34, of the power cord 15 is connected to the ground wire 30 of the power cord as indicated at 33. The said ground wire is connected through the plug 16 to a contact member 25 in the receptacle 17, the contact member 25 being connected to ground. The wire 34 is connected through the plug 16 to a contact member 25 in the receptacle 17.

It will be understood that the three wires of the power cord 15 are connected to male contact members in the plug 16 and that the receptacle 17 includes three female contact members for receiving, respectively, the contact members carried by each plug 16. Thus, the reference numeral 25 represents a male contact member and a female contact member for separately connecting the wire 34 to the wire indicated by the reference numeral 32.

The connection indicated at 33 is preferably made within the housing of the television receiver 14 and may, if desired, be made directly to the connection indicated by the reference numeral 15″.

With the above-described arrangement, the wire 32 will be disconnected from ground if the power cord 15 is cut or severed to break either the ground wire 30 or the wire 34, or if the plug 16 is pulled away from the receptacle 17.

I have illustrated contact members 24′, each of which is connected to the end of a wire 32′. It will be understood that these contact members 24′ are provided so that other appliances, such as other television receivers, can be monitored. For example, a receptacle 17 having a contact member 24′ can be placed in each of rooms in a motel for use with television receivers equipped with power cords similar to the power cord 15.

My illustrated alarm system is arranged to provide surveillance of four different electrical appliances. It will be understood, however, that any number of appliances can be monitored merely by expanding my basic system. I have found that it is more convenient to arrange my system to provide surveillance for groups of appliances and to provide an alarm indicating in which group an appliance has been tampered with as well as the particular appliance. This arrangement will be discussed more fully hereinafter.

The wires 32 and 34 and the contact members connecting these wires, which contact members are indicated by the reference numeral 24, comprise the above-mentioned first circuit means which is disconnected from ground when the plug 16 is removed from the receptacle 17 or when the wire 34 is unexpectedly severed.

I prefer to mount the components of my system on a panel 19 which is metal and, therefore, electrically conductive. It will be understood, however, that this feature is not critical, but is merely a matter of convenience.

I have illustrated another three-conductor power cord 19′, one end of which is connected to another conventional polarized plug 20 which is adapted to be plugged into another conventional polarized receptacle 20′. Two of the female contact members 36, 37 in the receptacle 20′ are connected to ground as illustrated.

The panel 19 is maintained at ground potential by the wire 38 of the power cord 19′, the wire 38 being connected between the panel 19 as indicated at 35 and the male contact member in the plug 20 which is received in the female contact member 36. The other ground terminal 37 is connected through the power cord 19′ to the following ground terminals 49, 43, 55 and 41. The power cord 19′ includes the conventional high-voltage conductor wire 28 which is connected through a switch 21 to the illustrated terminal 48.

The power sources represented by the receptacles 17 and 20′ are preferably conventionally alternating current power sources. Thus, an alternating current potential is coupled from the terminal 48′ through the illustrated wire 26 to the illustrated terminal 48′. A capacitor 1 is connected between one of the terminals 48′ and the end of the wire 32 at the illustrated terminal 31. Thus, the alternating current voltage at the terminal 48′ is coupled through the capacitor 1, terminal 31, wire 32, wire 34 and the wire 30 to ground. In a similar manner, a capacitor 1′ is connected between each of the other terminals 48′ and one of the wires 32′ to provide an alternating current voltage at each of the illustrated contact members 24′.

I prefer to connect a neon lamp 2 between each junction 31, i.e., the junction between each capacitor 1 and wire 34, and ground. In the illustrative system, the neon lamps 2, 2′ are connected between the terminals 31, 31′ and the ground terminal 41. These lamps 2, 2′ will not be energized as long as the wires 32, 32′ to which they are respectively connected are connected to ground. The lamp 2 will not be energized, for example, as long as the plug 16 is in the receptacle 17 and the wires 30, 34 have not been cut or disconnected at the point 33.

If, for some reason, the plug 16 is removed from the receptacle or, if one of the wires 30, 34 is cut, the alternating current voltage coupled through the capacitor 1 to the terminal 31 will be ungrounded and, therefore, the lamp 2 will be energized. This lamp 2 will then serve as a visual indication that the television receiver 14 has been disconnected from its power source.

The ungrounded alternating current voltage at the terminal 31 is also available, with proper electronic equipment, to trigger an electronic switching means such as the illustrated silicon controlled rectifier 6. Thus, I have connected each terminal 31, 31′ to a terminal indicated at 39 through an isolation resistor 3, 3′. These isolation resistors 3, 3′ serve to reduce the potential of the alternating current voltage at the terminals 39 to a value which is suitable for use in triggering a silicon controlled rectifier. The terminal 39 is connected to a positive voltage only to the gate electrode, I have connected a diode 4 between the terminal 39 and the ground terminal.
In order to apply the proper voltage level to the gate electrode, I have connected a capacitor 5 in parallel with the diode 4. The charging requirement of this capacitor is sufficient, so that the potential across it will not change during the loading transients or other voltage disturbances from triggering the silicon controlled rectifier 6 to give a false alarm, but small enough to permit the silicon controlled rectifier 6 to be triggered by the disconnection of the television receiver 14, or any other appliance being monitored, from its power source, even if it is only disconnected for a fraction of a second.

Each resistor 3, 3' and the diode 4 and capacitor 5 comprise the above-referred to second circuit means for connecting the control electrode of the silicon controlled rectifier to the junction between the capacitor 1 and the above-referred to first circuit means.

The silicon controlled rectifier 6 may be used to energize or, more specifically, to control the energization of any suitable output means such as an alarm bell or buzzer, a warning light or any other suitable means for alerting personnel.

In the switchable embodiment, the anode and cathode electrodes, i.e., the input and output electrodes, of the silicon controlled rectifier 6 are connected in series with the coil of a relay 7 so that, when the silicon controlled rectifier is triggered to its conductive state, current can flow through the coil to actuate the armature of the relay. The armature of the relay 7 is connected by a linkage 7' to a pair of switches 46, 47. The switch 46 is arranged so that, when the relay 7 is energized, a neon lamp 8 is energized by current flow from the terminal 48 through wire 56 and the lamp to the ground terminal 41. The lamp 8, when energized, will alert personnel to the fact that one of the wires 32, 32' has been disconnected, at least, momentarily, from ground. That is, the lamp 8 will provide a visual indication that one of the illustrated group of monitoring circuits, i.e., one of the wires 32, 32', has been disconnected from ground.

I prefer to use a latching-type silicon controlled rectifier, i.e., a rectifier which will remain conductive once a proper triggering voltage is applied to the gate electrode and as long as there is a proper voltage applied to its anode electrode. Such silicon controlled rectifiers are well known and commercially available and need not be discussed, in detail, in this description.

I also prefer to use a direct current power source, i.e., a power source of direct current voltage, which is connected to the illustrated relay 7 through one of the wires 32, 32', and the associated capacitor 1, 1', which is energized by the direct current power source 13. The direct current power source 13 is arranged to convert the alternating current voltage between the terminal 48 and the ground terminal 49 to a direct current voltage. It will be understood, however, that this is merely a matter of convenience and that, for instance, a battery may be arranged to provide current for energizing the relay 7.

In the illustrated embodiment of this invention, the direct current power source 13 is arranged to convert the alternating current voltage between the terminal 48 and the ground terminal 49 to a direct current voltage. It will be understood, however, that this is merely a matter of convenience and that, for instance, a battery may be arranged to provide current for energizing the relay 7.

Further, I prefer to provide an audio alarm, such as the illustrated buzzer 12, which is connected in series with the switch 47 between the terminal 48 and the ground terminal 49. The buzzer 12 will remain energized in the same manner that the lamp 8 will remain energized.

I have arranged my system so that, when one of the wires 32, 32' is disconnected from ground, the lamp 8 and buzzer 12 will remain energized even after the wire is reconnected to ground. Thus, if a thief pulls the plug 16 from the receptacle 17 and inserts another plug into the receptacle 17 to connect the contact member 24 to the contact member 25, the lamp 8 and buzzer 12 will remain energized to indicate that the television receiver 14 has been tampered with. Further, the lamp 8 will remain energized even though the lamp 2 is deenergized when the wire 32 is reconnected to ground. If the personnel responsible for monitoring the alarm system happen to miss seeing the particular lamp 2, the particular lamp 8, which is energized because one of the wires 32, 32' is disconnected from ground and then subsequently reconnected, they will at least be aware that one of four television receivers has just been tampered with. In the motel environment discussed previously, the continued energization of the lamp 8 and buzzer 12 will indicate to the necessary personnel that they must watch only the four rooms having the receptacles containing the contact members 24, 24' and will not have to watch dozens or hundreds of other rooms to see which television receiver has been tampered with.

I have illustrated a terminal 9 which may be connected to other groups of capacitors corresponding to relays 7 and 51. Terminal 10 may be connected to other groups of relays corresponding to relay 7 and terminal 11 which may be connected to other switches corresponding to switch 47. When my alarm system is used, for instance, to provide surveillance of television receivers in a multitude of motel rooms, each group of wires 32, 32' and their associated capacitors 1, 1' is preferably used with a single silicon controlled rectifier and relay 7 combination. Therefore, there will be one silicon controlled rectifier 6 and relay 7 associated with each group of rooms under surveillance. It may be desirable, however, for some motel or hotel operations, to use only one silicon controlled rectifier 6 and relay 7 for monitoring the power connection to every television receiver or, for that matter, every appliance in the hotel or motel. In such a case, if a thief happens to pull a plug 16 and then inserts another plug to connect the contact members 24 and 25 of a receptacle, it will be necessary, or at least advisable, to watch every room in the motel or hotel.

The silicon controlled rectifier 6 as used in my system is a normally non-conducting electronic switch. The relay 7 remains deenergized until the switch 6 is rendered conductive. Thus, the only significant power requirement of my system is to keep the direct current power source 13 energized. I have found that a conventional semiconductor power supply, which is well known in the electrical and electronic arts and which need not be discussed, in detail, in this description, will provide sufficient power to operate large numbers of relays 7, but will only draw 2½ watts of power when such relays are deenergized. This 2½ watts is required to keep the power supply 12 in a state in which, if required, it can provide enough power to operate the relays.

My illustrated system may be reset after a wire 32, 32' has been disconnected and subsequently reconnected to ground by opening the switch 21 which deenergizes the power supply 13 to permit the switches 46 and 47 to open and then reclosing the switch 21. Further, it will be apparent that a switch (not shown) may be used manually to disconnect the buzzer 12 from its power source. That is, it is anticipated that, once the necessary personnel has been alerted, the personnel may desire to disconnect the buzzer 12 and so rely on the lamp 8.

I prefer to connect a resistor 60 between the terminal 42 and the coil of the relay 7 and a capacitor 62 between ground and the junction between the relay coil and the resistor 60. The network comprising the resistor 60 and capacitor 62 acts as an inductive filter to prevent the kicks of some relays 7 from momentarily disturbing other silicon controlled rectifiers 6 on the panel 19. That is, the resistor 60 and capacitor 62 serve to isolate the illustrated relay 7 from power source 13 transients caused by the
energization of other relays which are connected to the power source.

In the alarm system which I have constructed and tested, the following characteristics were selected for the components:

Capacitor 1—0.01 μF, 1000 volts
Capacitor 2—0.5 μF, 200 volts, D.C.
Resistor 3—1 megohm, ½ watt
Resistor 4—100 ohm, 1 watt
Capacitor 5—16 μF, 100 volts, D.C.

What is claimed is:
1. An alarm system for indicating when an electrical appliance is disused, one side of its grounded electrical power source, said alarm system comprising first circuit means adapted to be connected in parallel with such a source to the grounded side of such an appliance so that, when such an appliance is disconnected from its source, said first circuit means will be disconnected from ground, capacitance means connected between said first circuit means and the high side of an alternating current electrical power source, said first circuit means being substantially purely conductive between its junction with said capacitance means and ground, output means arranged to alert personnel, normally non-conducting electronic switch means arranged to control the current through said output means, said control switch means including a control electrode, and second circuit means for connecting said control electrode to the junction between said capacitance means and said first circuit means so that, when said first circuit means is disconnected from ground, the alternating current voltage coupled through said control switch means is applied to said control electrode to render said switch means conductive, thereby to energize said output means.

2. An alarm system as in claim 1 wherein said second circuit means comprises normally non-conducting resistance means connected between said control electrode and the junction between said capacitance means and said first circuit means, said control switch means being charged to a voltage level sufficient to render said switch means conductive when said first circuit means is disconnected from ground to cause current to flow through said resistance means.

3. In combination, first means for connecting an electrically-operated appliance to an alternating current electrical power source, one side of which is grounded, said first means including conductor means arranged to connect one side of such an appliance to the high side of such an alternating current electrical power source, first circuit means connected to said conductor means at a point adjacent its connection to such an appliance, whereby said first circuit means is connected to ground, capacitance means connected between said first circuit means and the high side of such an alternating current power source, said first circuit means being substantially purely conductive between its junction with said capacitance means and ground, output means arranged, when energized by current flow therethrough, to alert personnel, normally non-conducting electronic switch means arranged to control the flow of current through said output means, said switch means including a control electrode, and normally non-conducting second circuit means for connecting said control electrode to the junction between said capacitance means and said first circuit means so that, when said first circuit means is disconnected from ground, the alternating current voltage coupled through said capacitance means is applied through said second circuit means to said control electrode to render said switch means conductive, thereby to energize said output means.

4. The combination of claim 3 wherein said second circuit means comprises unidirectional conductive means connected between said control electrode and ground to establish the polarity of the voltage applied to said control electrode and wherein the cathode of said unidirectional conductive means is connected to said control electrode, and wherein said second circuit means further comprises normally non-conducting resistance means connected between said control electrode and the junction between said first circuit means and said capacitance means and second capacitance means connected between said control electrode and ground, whereby, when said first circuit means is disconnected from ground, current flows through said resistance means and said second capacitance means charged by such current flow with a positive voltage with respect to ground and sufficient to render said switch means conductive.

5. Means for providing an alarm when a grounded conductor is disconnected from ground, said means comprising capacitive alternating current coupling means connected between the high side of an alternating current electrical power source and such a conductor, the low side of said power source being connected to ground, output means, switch means arranged to control the flow of current through said output means, said switch means comprising an input electrode, an output electrode and a control electrode being responsive to a predetermined electrical potential and effective, when such a potential is applied thereto, to render said switch means conductive between said input and output electrodes, thereby to energize said output means, and normally non-conducting circuit means connected between said control electrode and the junction between said capacitive coupling means and such a conductor, said circuit means being effective, when such a conductor and said junction is disconnected from ground, to apply such a predetermined potential to said control electrode.

6. In combination, a power cord for connecting an electrically-operated appliance to an alternating current electrical power source, one side of which is grounded, said power cord including a first conductor wire arranged to connect one side of such an appliance to the high side of said an electrical power source and a second conductor wire connected to said first conductor wire at a point adjacent its connection to such an appliance, whereby said second conductor wire is connected to ground, a first alternating current capacitor connected between said second conductor wire and the high side of said power source, electrically-operated means for alerting personnel, a relay arranged, when energized by this coil, to energize said personnel alerting means, a normally non-conducting electronic switch having an anode, cathode and control electrode, said electronic switch being connected between a first side of said coil and ground, the second side of said coil being connected to a second direct current power source so that, when said electronic switch is rendered conductive, current can flow through said coil, a normally non-conducting resistor connected between said control electrode and the junction between said first capacitor and said second conductor wire, a diode connected between ground and the junction between said first resistor and said control electrode, a second capacitor connected between the last said junction and ground, said second capacitor being chargeable to a voltage level sufficient to render said electronic switch conductive, whereby, when said second conductor wire is disconnected from ground, the alternating current voltage supplied by such a first power source, coupled through said first capacitor is rectified and applied to said control electrode to render said electronic switch conductive, thereby to energize said relay.

7. An alarm system including a first alternating current capacitor connected between the high voltage wire of a wire grounded inside of an appliance, a silicon controlled rectifier, a normally non-conducting first resistor coupled between the grounded ter-
9. An alarm system for protecting a plurality of appliances against theft, including a plurality of first alternating current capacitors, each first capacitor having one terminal coupled to the high voltage wire of a commercial alternating current power source connected to said appliances and its other terminal coupled to a wire grounded inside one of said appliances, a normally non-conducting resistor associated with each first capacitor, the grounded terminal of each capacitor being connected to one side of its associated said resistor, a silicon controlled rectifier, the other side of each said resistor being connected to the gate of said rectifier, an output means, second resister, and a direct current power source, said rectifier having its anode coupled in series with said output means and said second resistor to the positive side of said direct current power source, and a second capacitor coupling said gate to ground for transient protection, the cathode of said silicon controlled rectifier also being coupled to ground.

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340—256
UNIVERS STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,537,095 Dated October 27, 1970

Inventor(s) Van B. Cones

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 16, -- corrode -- is misspelled; same column, line 65, "energy" should be -- energize --.
Column 3, line 69, -- several different -- should be inserted after "of".
Column 4, line 35, "terminal" should be -- terminals --.
Column 5, line 21, "ber" should be -- zer --.
Column 6, line 29, after "motel" insert -- or hotel --.
Column 9, line 4, "resistors" should be -- resistor --; same column, line 14, -- appliances -- is misspelled; same column, line 16, "appliances" should be -- appliance --.

Signed and sealed this 9th day of March 1971.

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM L. SCHUYLER, JR.
Commissioner of Patents