

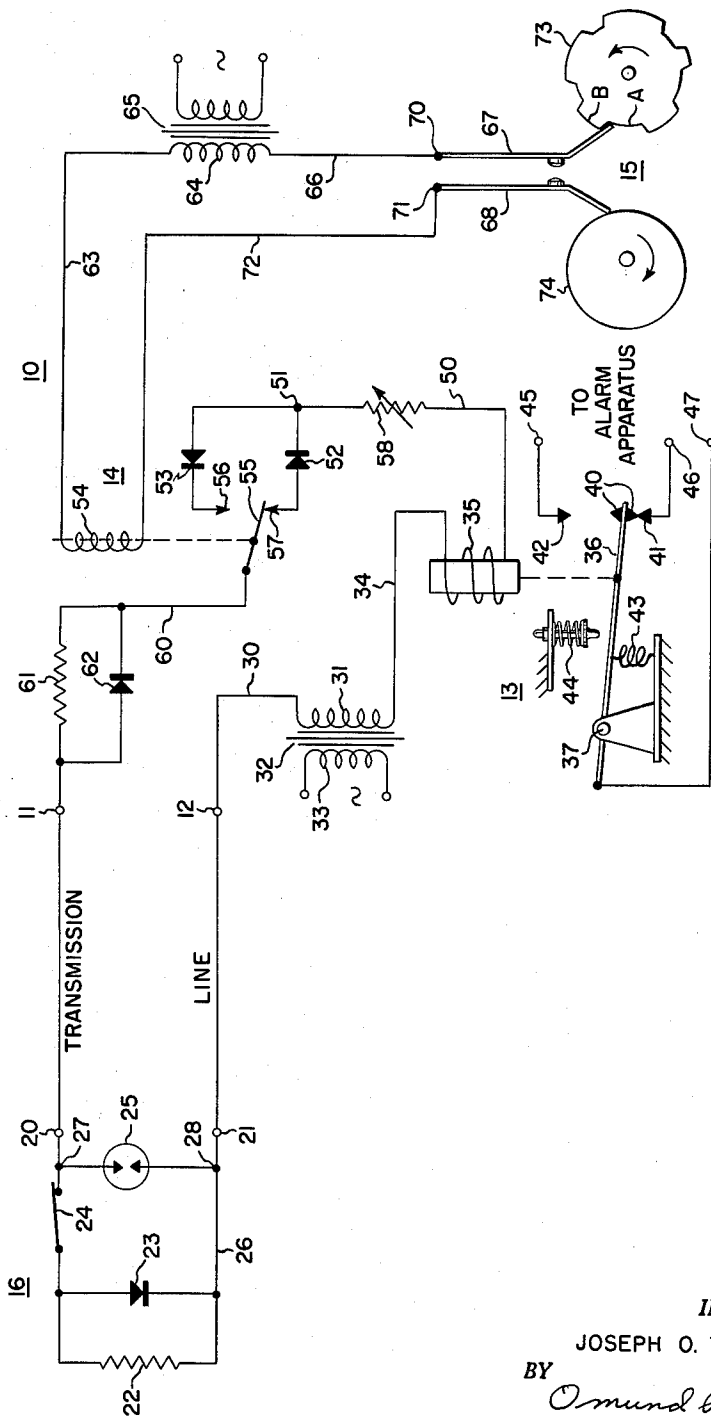
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SUPERVISORY SYSTEM

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SUPERVISORY SYSTEM

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This invention relates generally to the field of self-supervised electrical apparatus and is more particularly related to a method and means for providing a self-supervisory function in a manner which is substantially tamper proof.

In prior systems wherein the remote location is included in an electrical circuit embodied in an electrical apparatus, it has been determined that a desirable feature is that of providing a self-supervisory function so that unauthorized interference with the electrical connecting circuit causes an indication. This self-supervisory feature has been used, for example, in alarm systems wherein it must be known at all times whether or not this system is capable of operation. Particularly with regard to security alarm systems, it is necessary to provide a self-supervising function that is tamper proof so that various types of sensing devices connected to an electrical circuit in a remote location will provide signals to sound an alarm when the particular condition occurs to which they are responsive. One common practice in this general field has been to utilize a circulating current through the entire system and to provide equipment responsive to the absence of this circulating current to provide an indication that the continuity of the electrical circuitry has been altered either by failure or by design.

In my invention I have provided a method and apparatus for utilization in an electrical circuit of the type above described to allow operation that increases the difficulty of an attempt to defeat, or otherwise tamper with the electrical circuitry utilized in this apparatus.

It is therefore an object of my invention to provide apparatus for inclusion in an electrical circuit interconnecting a central location with a remote location so that a tamper proof self-supervisory operation may be obtained.

This and other objects of my invention will be apparent from further consideration of the specification, claims and drawing in which the single FIGURE is a schematic drawing of a security alarm system utilizing the principles of my invention for self-supervisory operation.

Referring now generally to the figure, there is shown an electrical apparatus 10 to the right of a pair of terminals 11 and 12 which may be located at a central security station and which includes current responsive alarm means here shown as a three-position alarm relay 13; and current reversing means including relay 14, and a random switching arrangement 15 comprising cams and contacts. A remote station 16 has a pair of terminals 20 and 21 connected by a pair of transmission lines to the terminals 11 and 12. The remote station 16 further includes asymmetric conductor means which offers different resistances to steady currents flowing in opposite directions, here shown as a terminating resistance 22 which is shunted by a rectifying diode 23; a normally closed condition operated switch 24 and a normally open condition responsive switch 25. The entire apparatus may operate as a fire or burglar alarm system including a central station 10 connected to a remotely located sensor station 16 through the pair of transmission lines.

Referring now in more detail to the central station 10, the terminal 12 is connected by a conductor 30 to one terminal of a secondary winding 31 of a power transformer 32, the primary winding 33 of which is ener-

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gized by a suitable source of alternating current. The other terminal of winding 31 is connected by a conductor 34 to a winding 35 of a three-positioned relay 13. Relay 13 has a moveable arm 36 which is pivoted about a point 37 and which carries contacts 40. The movable arm 36 operates between a de-energized position in which the contact 40 makes electrical connection with a stationary contact 41, a second position where the moveable contact 40 makes no contact and to an upper energized position where the moveable contact 40 makes electrical connection with a stationary contact 42. A first spring 43 returns the moveable arm 36 to the de-energized position, as shown, in which position contact 40 makes with contact 41. A first degree of energization of the relay causes the moveable arm to operate against the spring 43 until it reaches second spring 44, this being the mid position in which moveable contacts 40 complete no circuit. Further energization of the winding 35 causes the arm 36 to overcome both springs 43 and 44 such that the arm moves to its upper position where contacts 40 make with contact 42. Contacts 42, 40 and 41 are connected, respectively, to output terminals 45, 46 and 47, which are intended to be connected to suitable alarm apparatus, not shown.

The central circuit 10 has a conductor 50 connected from the lower terminal of the relay winding 35 through a variable resistor 58 to a junction 51. Connected to junction 51 is a pair of diodes 52 and 53, the cathode of one and the anode of the other being connected to junction 51. The relay 14 comprises a winding 54, which operates a SPDT switch including a moveable contact arm 55 and stationary contacts 56 and 57. Contacts 56 and 57 are connected respectively to the opposite electrodes of the rectifying diodes 53 and 52. The moveable contact 55 is connected by a conductor 60 and through another asymmetric conductor means to the terminal 11. The asymmetric conductor means as here shown comprises a rectifying diode 62 connected in parallel with a resistor 61 with the direction of easy current flow of diode 62 being towards the contact 55.

The upper terminal of relay winding 54 is connected by a conductor 63 to a secondary winding 64 of a power transformer 65, the primary of which is energized by a source of A.C. current, which may be the same as energized winding 33. The opposite terminal of the winding 64 is connected by a conductor 66 to a contact 67 of a pair of mating contacts 67 and 68. The contacts 67 and 68 pivot about points 70 and 71 respectively, and are normally biased apart by means not shown. Contact 68 is connected by a conductor 72 to the lower terminal of the relay winding 54 thus completing the circuit.

The random switching device 15, in addition to including contacts 67 and 68, also includes a slow-moving cam 73 which slowly rotates and changes the position of contact point 67. Also included is a second cam 74 which is eccentrically mounted to oscillate the contact point 68 into and out of contact with 67. The position of slow-moving cam 73 causes the "on" time of the contacts 67 and 68 to be varied in a completely random fashion since the periphery of cam 73 is made up of completely random width notches or valleys. Whenever the cam 74 causes the contact 68 to make with the contact 67, a circuit is closed which energizes relay 54 to operate contact 55 from its deenergized position in which it is in contact with stationary contact 57 and into contact with the upper stationary contact 56. It will be apparent that the switching of contact arm 55 will be in a random time as determined by the position of the cams 74 and 73.

A pair of transmission lines connect the output terminals 11 and 12 of the central station 10 to the output terminals 20 and 21 of the remote station 16. A circuit

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may be traced in the remote station from the terminal 21 through a conductor 26, a terminating resistor 22, and through a normally closed switch 24 to the terminal 20. Connected in parallel with the resistor 22 is a diode 23 which is identical with the diode 62 in the central station. The direction of easy current flow is towards terminal 21. The value of resistance 22 is identical with the value of resistance 61 for reasons which will become apparent below. The switch 24 is representative of one of a number of normally closed series connected detecting elements normally used in a security alarm system. Connected across the remote line is a normally open condition responsive detecting element 25. The element 25 is shunted across the line and is connected at a junction 28 on conductor 26 and to a junction 27 between the terminal 20 and the switch 24. It will be recognized that any number of units similar to 25 may be placed in parallel with it.

Considering briefly the normal operation of security alarm systems in general, an alarm relay is connected in a circuit which contains current limiting impedances and normally closed condition responsive detecting elements in series with the line and normally open condition responsive detecting elements connected in shunt with the line. Under normal operating conditions the value of the current flowing in the series loop is such that the alarm relay is in a position so that it will not be indicating an alarm or trouble condition, and that therefore for proper operation it is generally desirable to have a substantially constant current flowing in the series loop being supervised.

Turning now to the operation of the figure in more detail, it will be noted that in the above described series circuit when the upper terminal of winding 31 is positive a current path may be traced from the upper terminal of secondary winding 31 through conductor 30, junction 12, the transmission line to junction 21 of the remote unit, through resistor 22, switch 24, remote terminal 20 and through the other side of the transmission line to terminal 11, then through diode 62, conductor 60, contacts 55 and 57, rectifier 52, current adjusting resistor 58, and conductor 50, through winding 35 of the relay 13 and back through conductor 34 to winding 31. It will be noted that during this half cycle of operation current flows through the resistance 22 in the remote unit 16 but bypasses the equal resistance 61 in the central unit 10 by flowing through the parallel diode 62. On the second half cycle of the alternating current supply at winding 31, that is, when the lower terminal is instantaneously positive, no current flows in this circuit because of rectifying diode 52. Thus it is apparent that half cycle direct current pulses are flowing in the circuit. Under normal operating conditions the resistor 58 is adjusted so that sufficient current is flowing in the circuit so that the relay winding 35 is sufficiently energized to move the relay arm 36 away from contact 41 and to its center position where the arm comes in contact with the second spring 44. Under these conditions contact 40 makes no connection with either contacts 41 or 42 and the alarm apparatus which is connected to contacts 45, 46 and 47 is not actuated. This alarm apparatus, not shown, may be any conventional type such as bells, lights or other suitable equipment.

As the eccentric cam 74 revolves, the contact 68 is brought into electrical connection with the contact 67. During this interval of time, a current path may be traced from one terminal of the secondary 64 of transformer 65 through conductor 66, contacts 67 and 68, through conductor 72, relay winding 54, back through conductor 63 to the secondary winding 64.

The energization of relay 54 causes contact 55 to move up and make physical and electrical connection with stationary contact 56. A new circuit path may now be traced in the series circuit of the alarm system. During the half cycle of A.C. energization when the lower ter-

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minal of winding 31 is positive, a current path may be traced through conductor 34, winding 35 of relay 13, conductor 50, resistor 58, rectifier 53, contacts 56 and 55, conductor 60, resistor 61, to terminal 11 and through the upper transmission line to terminal 20, through the switch 24, diode 23, conductor 26, terminal 21, through the lower transmission line to terminal 12, and through conductor 30 to the upper terminal of winding 31. It will be noted that under this condition of operation current is flowing through resistor 61 and is being bypassed around resistor 22 by diode 23. Since the diodes 23 and 62 are symmetrical and since the resistances 61 and 22 are chosen to be identical, the current flowing in each of the two circuits is equal but opposite in direction. The current through winding 35 of relay 30, therefore, is the same no matter whether the contact 55 of relay 14 is in its upper or lower position and the three-position relay 13 will remain in its center position as long as normal conditions of operation are encountered.

As the slowly rotating cam 73 moves from its present position as shown in the drawing in which the contact arm 67 is resting in valley A of the periphery of the cam to the raised portion B of the periphery of the cam, the contact arm 67 is moved towards contact arm 68. This has the effect of changing the length of time or proportion of a rotating cycle of cam 74 that contact 68 is in electrical connection with contact 6. It thus effects a change in the portion of the time during which relay 14 is energized. It will be noted that a cycle is determined by the time duration taken for one revolution of the cam 74 since the contacts 68 and 67 are closed and opened once during each revolution of cam 74. Since slow moving cam 73 is designed with completely random width elevated and depressed portions about its periphery, it becomes very difficult for anyone attempting to defeat the system to determine when the direction of current flow through the circuit energized by winding 31 will change from one direction to the other.

The random switching described above is activated by cam action. It is to be realized that this specific method of random switching is disclosed for illustrative purposes and is not intended as a limitation. The random switching may also be done electronically, for example. The electronic switch could be triggered by cosmic radiation triggering a Geiger tube or it could be randomly triggered by atmospheric static or the like. The current reversing means as described above comprises a pair of diodes 52 and 53 and switch contacts 55, 56 and 57. The current reversing means could also be a single diode together with a DPDT switch connected in a crossover connection such that the diode terminals are physically reversed in the current by the switch. The A.C. source may be replaced by a D.C. source which is connected into the DPDT crossover switch to provide reversing current.

The detecting elements located in the remote area are disclosed as being of two types. The normally open type of detection apparatus may, for example, comprise a thermostatic element that closes its contacts upon a predetermined rise in temperature to indicate a fire. The normally closed switch 24 may be in the form of a type of switch which upon the opening of a window or a door interrupts the series circuit. In the event the switch 25 is actuated and its contacts closed, resistance 22 and diode 23 are shunted out of the circuit and the current to relay 35 increases such that relay arm 36 is actuated to its upper position where contact 40 makes electrical connection with contact 42 to provide an alarm. If either of the transmission lines is opened or if the detecting element represented by switch 24 is opened, the current to winding 35 is reduced and the relay drops to its de-energized position where contact 40 makes electrical connection with contact 41 to energize an alarm through the terminals 46 and 47. By reason of the fact that if the transmission lines are tampered with the current in both directions will not be identical thereby operating the

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three-position relay 13 to sound an alarm and further in that the relay 54 is operated in an irregular sequence so that the transmission lines cannot easily be tapped, studied and rigged to give a false signal, it is believed that my invention may be considered to be tamper proof.

In general, while I have shown a specific embodiment of my invention, it is to be understood that this is for the purpose of illustration and that modifications of this invention will undoubtedly occur to those who are skilled in the art and that my invention is to be limited solely by the scope of the appended claims.

I claim:

1. Self-supervised electrical circuit apparatus comprising: a source of electrical current; current responsive means; remote circuit means comprising condition sensing switch means and first asymmetric conductor means; local circuit means comprising randomly operated current reversing means, second asymmetric conductor means, said current responsive means and said source; connection means connecting said remote circuit means and said local circuit means in series, said first and second asymmetric conductor means being connected in polarity opposition.

2. Self-supervised electrical alarm apparatus comprising: a source of electrical current; current balanced alarm means; remote station means comprising condition sensing switch means and first asymmetric conductor means; central station means comprising, second asymmetric conductor means, said current balanced alarm means and said source; connection means including randomly reversed current rectifying means connecting said remote circuit means and said local circuit means in series with said first and second asymmetric conductor means being connected in polarity opposition.

3. Self-supervised electrical alarm apparatus comprising: a source of electrical current; current responsive alarm means; first and second matched resistance elements; first and second matched diodes, said first and second diodes being connected, respectively, in parallel with said first and second resistance elements; remote station means comprising condition sensing switch means and said first resistance element and first diode; central station means comprising randomly operated current reversing means, and second resistance element and second diode, said current responsive means and said source; connection means connecting said remote circuit means and said local circuit means in series, said first and second diodes being connected in polarity opposition.

4. In a self-supervised electrical circuit apparatus having current responsive means therein for indicating the event of an abnormal current and driven switching means adapted to randomly reverse the direction of current flow through a supervisory line, the combination comprising: a source of electrical current; current responsive alarm means; first and second asymmetric conductor means; randomly operated current reversing means; supervisory line circuit means connecting in series said first and second asymmetric conductor means, said current responsive alarm means and said current reversing means to said source such that under normal conditions a predetermined level of current flows to said current responsive alarm means in either direction of current flow in said circuit as determined by said current reversing means.

5. In a self-supervised electrical circuit apparatus having current responsive means therein for indicating the event of an abnormal current and driven switching means adapted to randomly reverse the direction of current flow through a supervisory line, the combination comprising: a source of electrical current; current responsive alarm means; first and second impedance matched asymmetric conductor means; randomly operated current reversing means; supervisory line circuit means connecting in series said first and second asymmetric conductor means, and said current responsive alarm means; current reversing

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means connecting said supervisory line means to said source such that under normal conditions a predetermined level of current flows to said current responsive alarm means in both directions of current flow in said circuit as determined by said current reversing means.

6. In a self-supervised constant impedance electrical circuit apparatus for detecting a condition, the combination comprising: a source of electrical current; current responsive alarm means; first and second impedance matched asymmetric conductor means; remote circuit means comprising condition sensing switch means and said first asymmetric conductor means; central station circuit means comprising randomly operated current reversing means, said second asymmetric conductor means, said current responsive alarm means, and said source; means connecting said remote circuit means and said central station circuit means in series with said first and second asymmetric conductor means being connected in polarity opposition to provide an equal impedance to current flow in either direction under normal conditions, whereby said current responsive alarm means receives equal current in both directions as controlled by said randomly operated current reversing means so that an alarm caused by a change in said current indicates the operation of said condition sensing switch means or the tampering with said apparatus.

7. In a self-supervised electrical circuit apparatus for detecting a condition, the combination comprising: a source of electrical current; current operated alarm means; first and second impedance matched asymmetric conductor means; remote circuit means comprising said first asymmetric conductor means; central station circuit means comprising randomly operated current reversing means, said second asymmetric conductor means, said current responsive alarm means, and said source; means connecting said remote circuit means and said central station circuit means in series with said first and second asymmetric conductor means being connected in polarity opposition to provide an equal impedance to current flow in either direction under normal conditions, whereby said current responsive alarm means receives equal current in both directions as controlled by said randomly operated current reversing means; and condition responsive switch means in said remote circuit means effective upon switching to change the impedance to current flow so that an alarm caused by a change in said current indicates the operation of said condition sensing switch means or the tampering with said apparatus.

8. In a self-supervised electrical alarm apparatus for detecting a condition, the combination comprising: a source of electrical current; current responsive alarm means; first and second resistance matched elements; first and second diodes, said first diode being connected in parallel with said first resistance element, said second diode being connected in parallel with said second resistance element; remote circuit means comprising condition sensing switch means, said first resistance element and said first diode; central station circuit means comprising randomly operated current reversing means, said second resistance element, said second diode, said current responsive alarm means, and said source; means connecting said remote circuit means and said central station circuit means in series to provide an equal impedance to current flow in either direction under normal conditions, said first and second diodes being connected in polarity opposition one to the other whereby said current responsive alarm means receives equal current in both directions as controlled by said randomly operated current reversing means so that an alarm caused by a change in said current indicates the operation of said condition sensing switch means or the tampering with said apparatus.

9. In a self-supervised electrical alarm apparatus having current responsive means therein for indicating the event of an abnormal current and cam driven switching means adapted to randomly reverse the direction of cur-

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rent flow through a supervisory line, the combination comprising: a source of alternating current; current responsive alarm means; first and second asymmetric conductor means; supervisory line circuit means connecting in series said first and second asymmetric conductor means, and said current responsive alarm means to said source; and rectifying means in said supervisory line means for providing unidirectional current flow therein; cam driven switch means associated with said rectifying means for reversing said unidirectional current flow, said switch

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means being operated in a random time cycle such that under normal conditions a predetermined level of current flows to said current responsive alarm means for both directions of current flow in said circuit as determined by said current reversing means and wherein the direction of current flow is reversed at random time periods thereby making difficult tapping and evaluation of said supervisory line.

No references cited.

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