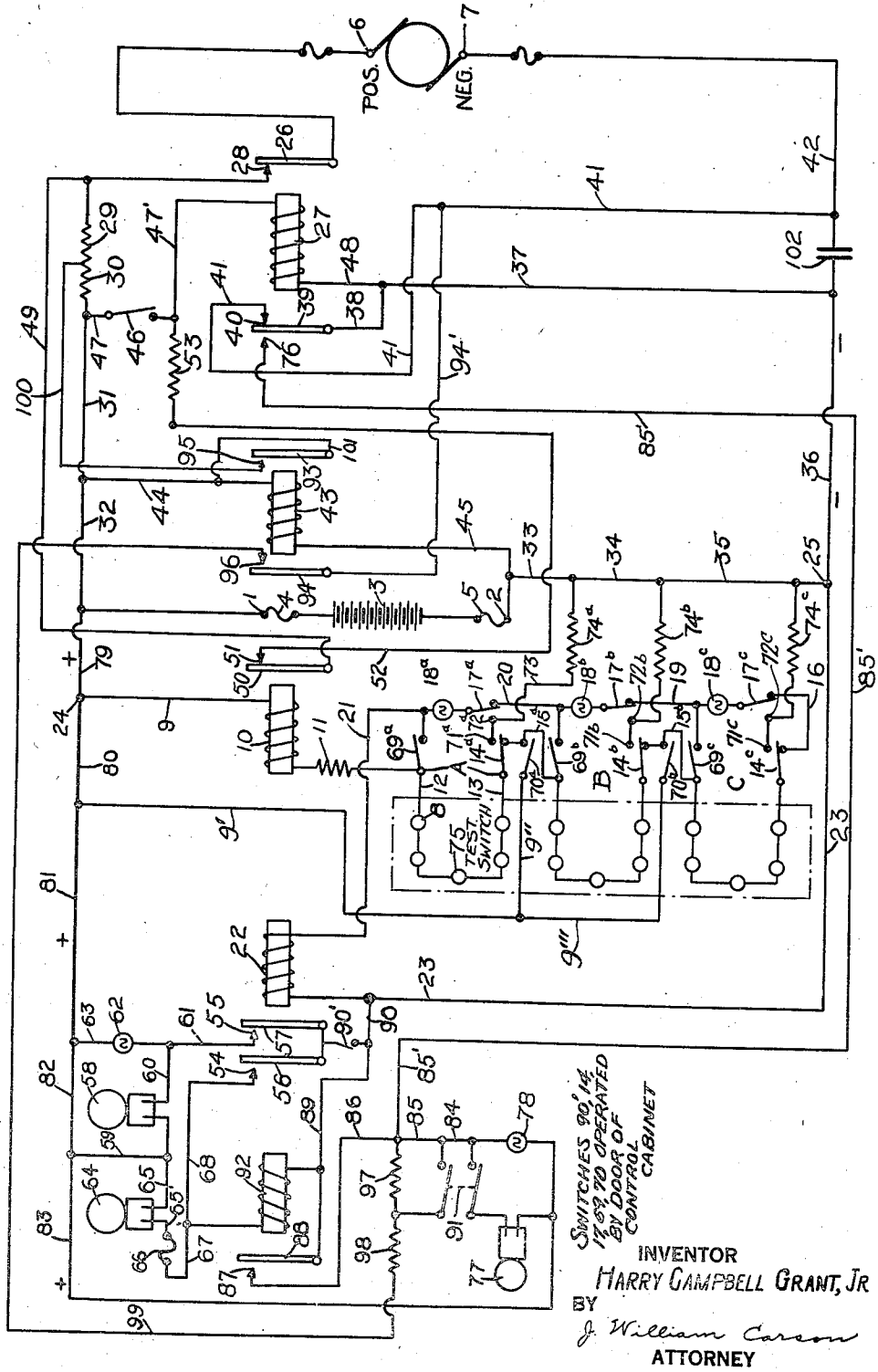
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SUPERVISED ELECTRIC SYSTEM

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SUPERVISED ELECTRIC SYSTEM

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This invention relates to alarm systems, for fire, for burglary, and so forth, of the type in which a plurality of external circuits, each containing one or more normally closed circuit opening devices, are connected in series with a no-load relay and a source of electric potential, whereby the opening of the circuit at any point, due to a fire condition or burglary, is indicated at a central alarm station.

Previous systems of the type described have been objectionable because of the need for an alarm relay for each of the several external circuits. Such a system, for instance, is shown in Letters Patent of the United States No. 916,280, granted March 23, 1909. Another objection to previous systems has been incomplete supervision against various kinds of trouble which may be encountered under conditions of actual service.

It is therefore the primary object of the present invention to provide a fire alarm system of the type referred to which will meet the public demand for a simple and efficient system, and which at the same time is fully supervised against any troubles which may develop.

The present invention is generally similar to that shown and described in my copending application of the United States, Serial No. 572,783, filed October 23, 1931; but differs therefrom in the provision of simpler means for locating the external circuit or circuits from which a fire signal has been relayed to the central fire alarm station, it being unnecessary to search for the circuit in alarm by operation of various switches as provided for in my earlier application.

It is therefore another object of the present invention to provide a closed circuit fire alarm system in which simpler means is provided to locate the external circuit or circuits from which a fire signal has been relayed to the central fire alarm station, without having troublesome and inexpensive contact relays for each of the external circuits and without any searching operation being necessary.

It is also an object of this invention to provide a system which can be electrically energized either by a main source of electrical potential, or by a secondary source of electrical potential normally under charge from the main source, the system likewise being capable of energization simultaneously by both of the sources of potential.

It is also an object of this invention to indicate failure of the main source of electrical energy.

It is a further object to indicate failure of the secondary source of electrical energy.

It is a still further object to completely supervise the external circuits against grounds and to provide means to remove the grounds so as to avoid dangerous conditions which would otherwise occur.

A still further object is to provide means to detect short-circuits occurring in any one of the external circuits.

Further objects, not specifically enumerated above, will be apparent as the invention is described in greater detail in connection with the accompanying drawing, in which the single figure is a diagrammatical representation of an alarm system constructed and arranged in accordance with the invention.

In the system shown the reference numerals 1 and 2 represent the positive and negative terminals of a secondary source of electrical potential in the form of a battery 3, which is protected by fuses 4 and 5 and which is normally under charge, in a manner hereinafter to be described, from a main source of electrical energy, the positive and negative terminals of which are shown at 6 and 7.

At A there are shown the terminals of a so-called "external" circuit containing normally closed circuit opening thermostats 8. B and C indicate the terminals of additional external circuits, all of which are connected in series in the following manner; current flowing from the positive line through the wire 9, the ground detector relay 10, the resistance 11, one side, 12, of the external circuit A, the other side, 13, of the external circuit A, switch 14^a, wire 15^a, through the external circuit B, switch 14^b, wire 15^b, through the external circuit C, switch 14^c, wire 16, switch 17^c, circuit lamp 18^c, wire 19, switch 17^b, circuit lamp 18^b, wire 20, switch 17^a, circuit lamp 18^a, wire 21, the fire alarm relay 22 and the wire 23 to the negative line. The electrical characteristics of the various elements in the series circuit are so chosen that the current normally flowing in the circuit is of a value insufficient to illuminate the circuit lamps, the current however being of a sufficient value to energize the fire alarm relay 22 and serving as a supervisory current for the various elements in said series circuit, the relay 22 being a circuit supervising relay as well as a fire alarm relay.

The circuit just described and the battery 3 are connected in parallel with the main supply terminals 6 and 7, the latter normally supplying the energizing current for said circuit and the charging current for the battery, the positive and negative junction points being at 24 and 25.

The path of the charging current for the bat-

tery is from the main supply terminal 6 through the armature 26 of the main supply supervising relay 27, the contact 28, the charging resistances 29 and 30, the wires 31 and 32, through the battery, the wires 33, 34, 35, 36, 37, and 38, the armature 39, the contact 40, and the wires 41 and 42 to the main supply terminal 7.

At 43 is shown the battery supervising relay which is connected to the positive terminal of the battery by wires 32 and 44, and to the negative terminal of the battery by the wire 45.

When a system in accordance with the present invention has been installed and is to be made ready for use, the reset switch 46 is closed, whereupon current flows from the positive terminal of the battery through the wires 32, 31, and 47, the reset switch 46, the wire 47', the main supply supervising relay 27, and the wires 48, 37, 36, 35, 34, and 33 to the negative terminal of the battery. This results in energization of the main supply supervising relay 27, causing closing of the contacts 28 and 40. Upon intentional reopening of the reset switch 46, which is therefore preferably of the push-button type, the main supply supervising relay 27 will be found to be connected across the main supply terminals 6 and 7 through the armature 26, the contact 28, the wire 49, the armature 50 of the ground detector relay 10, the contact 51, the wire 52, the resistance 53, the wires 47', 48, and 38, the armature 39, the contact 40, and the wires 41 and 42, thus holding the relay 27 energized.

By reason of the herein-referred to flow of current through the external circuits from the junction point 24 to the junction point 25, the fire alarm relay 22 is normally energized, but as soon as a fire occurs in a space protected by an external circuit, as for example in the space indicated by the thermostat 8 on the external circuit A, the circuit between the junction points 24 and 25 is broken by the opening of the thermostat, whereby the fire alarm relay 22 is deenergized. This results in the closing of the contacts 54 and 55 by the armatures 56 and 57, whereupon fire alarm signals are rendered in the following manner. The reference numeral 58 represents the fire alarm gong which is normally located at the central fire alarm station. This gong is sounded by reason of current flowing from the positive line through the wires 59, 60, and 61, the contact 55, the armature 57, switch 90', wire 90, and the wire 23 to the negative line. At the same time the fire alarm lamp 62, normally located at the central fire alarm station, is illuminated by current flowing from the positive line through the wires 63 and 61, the contact 55, the armature 57, and the wire 23 to the negative line.

In certain types of installations, for example on board ships, it is advisable to signal the presence of fire to the engine room or some other location than the central fire alarm station, which is normally in the wheelhouse or chart room of the ship. For this purpose there is provided a second fire alarm gong 64, which becomes energized by current flowing from the positive line through the wires 59 and 65, the fuse 66, the wires 67 and 68, the contact 54, the armature 56, and the wire 23 to the negative line.

As soon as the presence of fire is made known by any one or more of the means provided, the fire-watch attendant immediately proceeds to the central fire alarm station, at which point he will find on the operating panel the already referred to switches 14a, 14b, 14c, 17a, 17b, and 17c, all of which are two-position switches. He will also find the normally open switches 69a, 69b, 69c, 70a, and 70b. All that it is necessary for the fire-watch attendant to do is to throw all of the two-position switches from their one position to the other and to close all of the herein-mentioned normally open switches.

If no fire has occurred in any of the spaces protected by the external circuit A, so that no thermostat has operated on this circuit, no indication will be given by the circuit lamp 18a, as both sides of the circuit lamp will be found to be connected to the positive line; the one side through the wire 9, the ground detector relay 10, the resistance 11, and the switch 69a; and the other side through the wire 9, the ground detector relay 10, the resistance 11, the external circuit A, the switch 14a, the contacts 71a and 72a, and the switch 17a. If, however, fire has occurred in one of the spaces protected by the external circuit A, so that one of the thermostats 8 on the external circuit A has operated to open the circuit, the last referred to connection of the one side of the circuit lamp 18a to the positive line through the external circuit A itself would not be completed, because of the open circuit caused by the operated thermostat 8. The circuit lamp 18a is then illuminated by reason of the first mentioned connection of the lamp to the positive line and by reason of its connection to the negative line through the switch 17a, the contact 72a, the wire 73, the resistance 74a, and the wires 34, 35 and 36, thus indicating that a thermostat has been operated on the external circuit A. The resistance 74a is a current consuming resistance which has its principal use when both sides of the circuit lamp 18a are connected to positive in the manner already described.

Similar indications are given in connection with the external circuits B and C, the corresponding switches, lamps and current consuming resistances being indicated by similar reference numerals.

If no fire has occurred in any of the spaces protected by the external circuit B, so that no thermostat has operated on this circuit, no indication will be given by the circuit lamp 18b, as both sides of the circuit lamp will be found to be connected to the positive line; the one side through the wire 9', the wire 9'', the switch 70a, the wire 15a and the switch 69b; and the other side through the wire 9', the wire 9'', the switch 70a, the wire 15a, the external circuit B, the switch 14b, the contacts 71b and 72b and the switch 17b. If, however, fire has occurred in one of the spaces protected by the external circuit B, so that one of the thermostats 8 on the external circuit B has operated to open the circuit, the last referred to connection of the one side to the circuit lamp 18b to the positive line through the external circuit B itself would not be completed, because of the open circuit caused by the operated thermostat 8. The circuit lamp 18b is then illuminated by reason of the first mentioned connection of the lamp to the positive line and by reason of its connection to the negative line through the switch 17b, the contact 72b, the resistance 74b, and the wires 35 and 36, thus indicating that a thermostat has been operated on the external circuit B. The resistance 74b is a current consuming resistance which has its principal use when both sides of the circuit lamp 18b are connected to positive in the manner already described.

If no fire has occurred in any of the spaces protected by the external circuit C, so that no thermostat has operated on this circuit, no indication will be given by the circuit lamp 18c, as both sides of the circuit lamp will be found to be connected to the positive line; the one side through the wire 9', the wire 9''', the switch 70b, the wire 15b and the switch 69c; and the other side through the wire 9', the wire 9''', the switch 70b, the wire 15b, the external circuit C, the switch 14c, the contacts 71c and 72c, and the switch 17c. If, however, fire has occurred in one of the spaces protected by the external circuit C, so that one of the thermostats 8 on the external circuit C has operated to open the circuit, the last referred to connection of one side of the circuit lamp 18c to the positive line through the external circuit C itself would not be completed, because of the open circuit caused by the operated thermostat 8. The circuit lamp 18c is then illuminated by reason of the first mentioned connection of the lamp to the positive line and by reason of its connection to the negative line through the switch 17c, the contact 72c, the resistance 74c, and the wire 36, thus indicating that a thermostat has been operated on the external circuit C. The resistance 74c is a current consuming resistance which has its principal use when both sides of the circuit lamp 18c are connected to positive in the manner already described.

It should be noted that as a practical matter, since all of the above referred to switches on the control panel at the central station are to be operated at the same time, the switches might well be arranged to be operated simultaneously by any suitable mechanism. In fact, as it is customary to locate the central station apparatus in a central cabinet, it can be easily arranged to have all of the switches operated automatically upon the opening of the control cabinet door.

It will, of course, be understood that the occurrence of a wire break in any of the external circuits will turn in fire alarm signals, but the existence of a wire break will not become apparent until after an unsuccessful search for the presence of fire on the circuit indicated, the same condition holding whenever a circuit lamp burns out, or whenever any other element in the supervised alarm circuit fails.

Testing of any one of the external circuits can be accomplished by opening the test switches provided in the various circuits. For the external circuit A the test switch is shown at 75. Although the test switches can be employed to test simply the operability of the central station fire alarm apparatus, the primary object of the test switches is to locate short-ciruits of the external circuit leads which would prevent operation of the central station fire alarm apparatus by thermostats more remote from the central station than the existing short-circuit. Accordingly a test switch is placed at the most remote point of each of the external circuits; and failure of the central station fire alarm apparatus to function upon opening of a test switch is an indication of a short-circuit in the particular external circuit tested. It should be noted that short-circuits of the external circuit leads can not be detected automatically but only by manual test, as the external circuits have no current limiting resistances and therefore a short-circuit has the same resistance as the normal line circuit.

It has already been mentioned that the external circuits are protected against the occurrence of grounds, and the relay 10 has already been referred to as the ground detector relay, which relay is normally not energized by the relatively small supervisory current which flows through the external circuits from the junction point 24 to the junction point 25, the voltage drop across the relay 10 and the resistance 11 being only a fraction of the total drop from the junction points 24 and 25 by reason of the far greater resistance of the fire alarm relay 22 in the same series circuit.

It is customary in ship installations to have the ship's electrical circuits ground clear but this condition rarely exists. At times the ship's negative may be grounded and shortly after this the ground may be changed from negative to positive. The relative position of the ground on a ship's generator and various points of the circuit in accordance with the present invention will cause different indications to be given at the central control station.

In order to clarify the discussions which follow, let it be assumed, by way of example, that a ship has a 220 volt supply and that the battery 3 of the present invention is a 40 volt battery.

If, therefore, any one of the wires of any of the external circuits becomes grounded, while at the same time the positive side of the main power supply is normally grounded, a much greater than normal voltage is applied across the ground detector relay 10 and the resistance 11, whereupon the ground detector relay is energized and the contact at 51 is opened. The opening of the contact 51 directly interrupts the already described energizing circuit of the main supply supervising relay 27, whereupon the latter is de-energized, opening the contact at 40, and closing the contact at 76. This action results in the sounding of the trouble gong 77 and the illumination of the trouble lamp 78, by reason of current flowing from the positive terminal of the battery through the wires 79, 80, 81, 82, and 83, then in parallel through the trouble gong 77 and the trouble lamp 78, then through the wires 84 and 85', the contact 76, the armature 39, and the wires 38, 37, 36, 35, 34, and 33 to the negative terminal of the battery. The sounding of the trouble gong 77 can be stopped by opening the normally closed switch 91, but the trouble lamp will remain illuminated until the trouble has been repaired.

If, on the other hand, any one of the wires of one of the external circuits should become grounded, while at the same time the negative side of the main power supply is normally grounded, the fire alarm relay 22 will be short-circuited, whereby the full normal voltage between the junction points 24 and 25 will be applied across the ground detector relay 10 and the resistance 11, whereby the ground detector relay is energized and the main supply supervising relay 27 is de-energized in the manner already described in connection with the occurrence of a ground when the positive side of the main power supply is normally grounded. The already mentioned short-circuiting of the fire alarm relay 22 results in its momentary de-energization, but this relay will again be energized and the ground detector relay 10 will be de-energized when the ground is removed in the manner about to be explained.

Although it is one of the purposes of the main supply supervising relay 27 to indicate the failure of the main supply, whereby the relay would be de-energized and the trouble signals given in the manner already explained, the most important function of the relay 27 is to break the circuit between the fire alarm system and the

main supply on both sides, thus removing the ground and allowing the battery to re-energize the fire alarm relay 22, so that dangerous currents often flowing for ground conditions will be interrupted. For this reason the relay 27 is not arranged to pick up on the main supply voltage directly, but, if de-energized, is required to be reset manually by the reset switch 46, as otherwise, upon de-energization of the relay 27 due to a ground with consequent breaking of the ground circuit, the relay 27 would be re-energized and thus bring back the ground, with the result that the relay would buzz rapidly and burn off either of the contacts 28 or 40, depending on the relative location of the grounded points.

The relay 27 has also a third function, which is best mentioned at this time, in that the breaking of the circuit between the fire alarm system and the main supply upon failure of the main supply prevents the battery from discharging back into the main supply lines, the battery now serving as the main and only source of energy.

In view of the fact that the auxiliary fire alarm gong 64 is normally located at some distance from the central fire alarm station, defects can easily occur in the external leads to the auxiliary fire alarm gong, and this gong is accordingly supervised by means of the auxiliary gong supervising relay 92, current flowing from the positive line through the wire 59, the external gong lead 65, the auxiliary fire alarm gong 64, the fuse 66, the wire 67, the auxiliary gong supervising relay 92, and the wires 89, 90, and 23 to the negative line.

If now the main supply is normally grounded on the negative side, and if a ground occurs in the external gong lead 65', the auxiliary gong supervising relay 92 will be short-circuited and consequently de-energized, whereby the armature 88 will close the contact 87, and the trouble gong and trouble lamp will be operated by reason of current flowing from the positive line through the trouble gong and trouble lamp in parallel, the wires 84, 85, and 86, the contact 87, the armature 88, and the wires 89, 90, and 23 to the negative line. At the same time the auxiliary gong 64 will sound due to the cutting out of the high resistance of the supervising relay 92. If, however, a ground occurs in the external gong lead 65, such ground will constitute a direct short-circuit across the battery 3 and one of the fuses 4 and 5 will blow out, whereupon the battery supervising relay 43 will be energized and will give the trouble signal in a manner hereinafter to be described.

If, instead of the main supply line being normally grounded on the negative side, it is normally grounded on the positive side, a ground in the external gong lead 65' will cause the auxiliary gong to sound by reason of the increased voltage to which it will be subjected. On the other hand, if the external gong lead 65 becomes grounded, the increased voltage on the entire system will cause the battery supervising relay 43 to be energized and the trouble signal given in a manner hereinafter to be described. At the same time the abnormally high charging current will cause one of the fuses 4 and 5 to blow, thus protecting the battery against excessive charge.

The external gong leads are not only protected against grounds in the manner already described, but likewise against direct short-circuits of the leads. Such a short-circuit is normally undetected, but as soon as a fire alarm signal is given, the short-circuit of the auxiliary gong leads constitutes a direct short-circuit of the battery, whereupon the fuse 66 or one of the battery fuses 4 and 5 will be blown out, and the battery supervising relay 43 will be energized and the trouble signal given in a manner now about to be described.

While the main supply supervising relay 27 is normally energized, the battery supervising relay 43, which is connected across the terminals of the battery 3, is not energized by the normal battery voltage, but is designed to energize upon a considerable increase in voltage across the relay winding.

It has already been explained that the external circuit between the junction points 24 and 25, and the battery 3, are connected in parallel across the main supply terminals 6 and 7, so that normally the main supply terminals provide the supervisory current flowing through the external circuit and the charging current flowing into the battery. When, however, a fire alarm or trouble alarm is given, the increased current required by the alarm gongs is greater than can be supplied by the main supply. The charging current normally flowing into the battery therefore reverses itself and the battery supplies the excess current required when alarm conditions arise.

If now the battery should fail for any reason, not only will the battery supervising relay 43 be energized and give the trouble signals, but a portion of the charging resistance 29—30 will be cut out of the main supply line, so that the main supply will be capable of supplying the increased current required when alarm conditions arise.

The battery supervising relay 43 is energized upon failure of the battery, both when the system is in its otherwise normal condition and when fire alarm or trouble alarm conditions exist. The manner in which the battery supervising relay is thus energized will be better understood if it is kept in mind that the voltage across the relay winding is normally the same as the voltage across the battery and across the external circuit between the junctions 24 and 25. In the system herein described, the resistance of the external circuit is considerably greater than the internal resistance of the battery, and is also somewhat greater than the value of the charging resistance 29—30. It also happens that in the system described the internal resistance of the battery is less than the value of the charging resistance 29—30. When, therefore, the battery fails for any reason with the substitution of practically infinite resistance in place of the normally small internal resistance of the battery, a considerably increased voltage drop will occur across the external circuit, due to the fact that removal of the battery charging current load will reduce the voltage drop across the charging resistance 29—30, and this increased voltage, occurring likewise across the winding of the relay 43, will cause the relay to pick up its armatures 93 and 94 and close the contacts at 95 and 96. The trouble signals will then be given by reason of current flowing from the positive line through the trouble gong and trouble lamp in parallel, the wire 84, one side of the switch 91, the resistance 98, the wire 99, the contact 96, the armature 94, and the wires 94' and 42 to the main supply terminal 7. Instead, however, of the connection from the main supply terminal 6 being through the charging resistance 29—30, the increased current which the main supply is called upon to supply when the fire or trouble gongs are sounded, requires that part of the charging resistance be by-passed, and it will