

Oct. 23, 1962

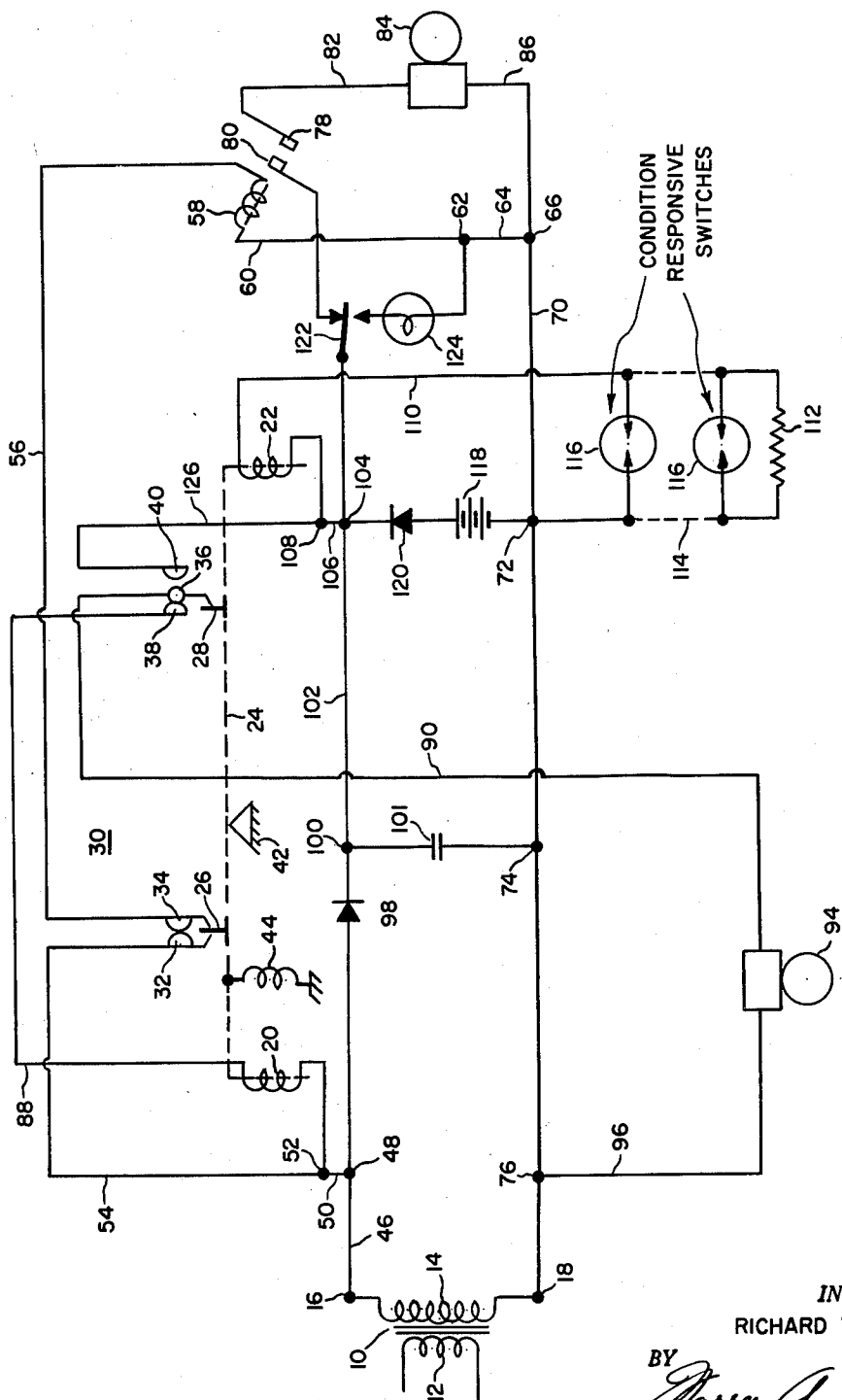
R. W. BROWN

3,060,416

SUPERVISED SIGNAL SYSTEM

Filed March 18, 1960

2 Sheets-Sheet 1



INVENTOR.

RICHARD W. BROWN

BY

BY
Tarron A. Sturm

ATTORNEY

Oct. 23, 1962

R. W. BROWN
SUPERVISED SIGNAL SYSTEM

3,060,416

Filed March 18, 1960

2 Sheets-Sheet 2

FIG. 3

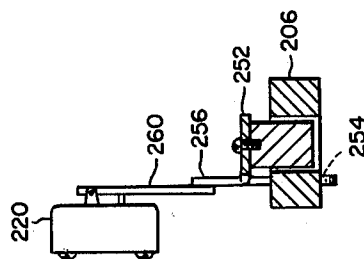
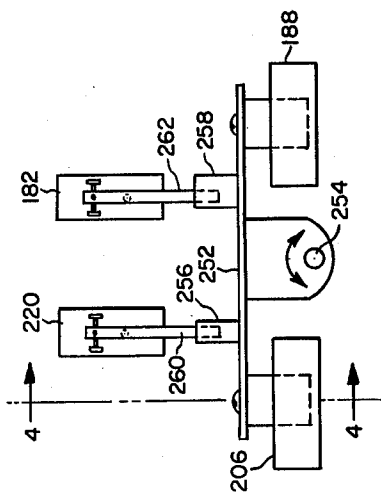


FIG. 4

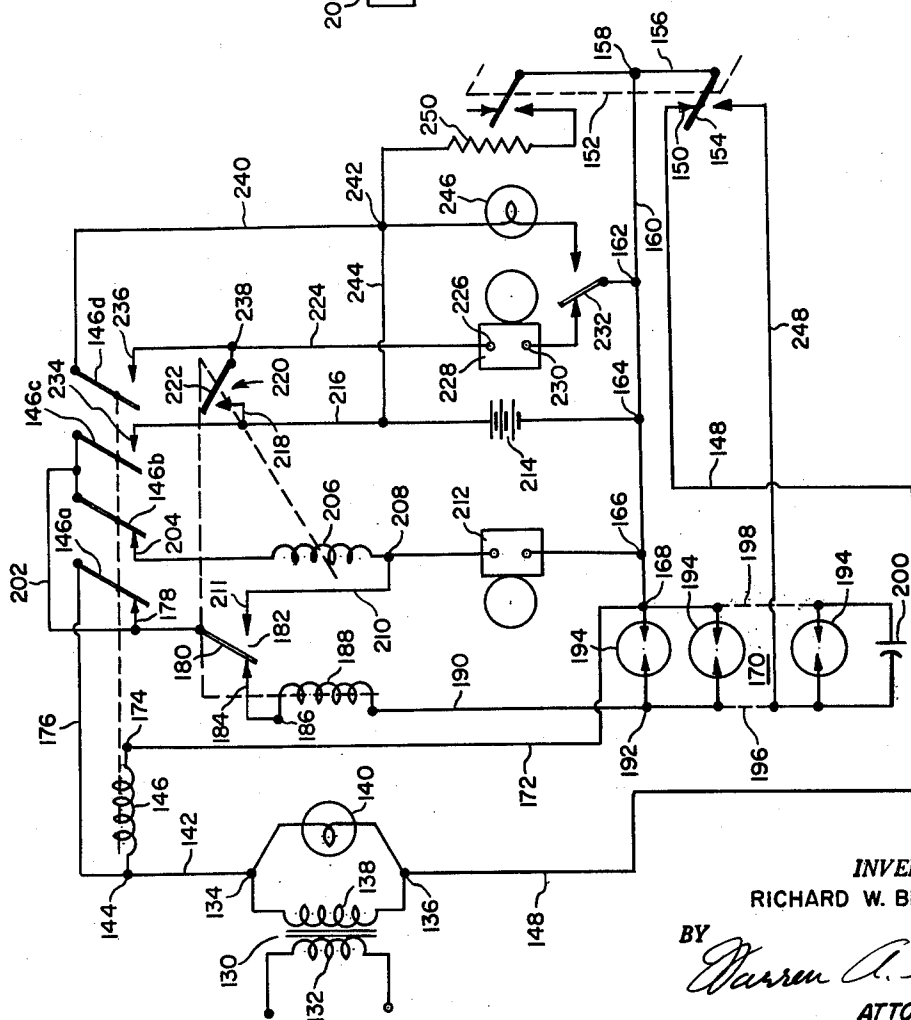


FIG. 2

INVENTOR.
RICHARD W. BROWN
BY *Warren A. Starn*
ATTORNEY

1

3,060,416

SUPERVISED SIGNAL SYSTEM

Richard W. Brown, St. Louis Park, Minn., assignor to Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., a corporation of Delaware
Filed Mar. 18, 1960, Ser. No. 15,958
3 Claims. (Cl. 340-213)

This invention relates generally to electrical signaling systems and more specifically to electrical alarm circuits which are responsive to the occurrence of a dangerous condition to advise supervisory personnel of this condition. Apparatus of this general type may be used in fire, burglar, or any other application where it is desired to notify personnel in time for them to take precautionary measures.

In applications where human life is at stake, it is an absolute requirement that the signaling system employed be highly reliable. Because of this reliability requirement, the systems disclosed in the prior art tend to be quite complex and expensive thereby pricing the system out of reach of the average homeowner. The circuit embodiments disclosed in the present application are relatively simple in form and quite inexpensive. Notwithstanding these advantages, no sacrifice is made in the reliability requirements deemed to be so necessary.

The alarm systems of my invention are arranged to provide an audible and/or visual alarm upon the occurrence of a dangerous condition to which it is responsive. As mentioned above, this may, for example, be an over-temperature produced by a fire, or any other occurrence where it is desirable to notify supervisory personnel such that appropriate action may be taken.

Additionally, provision is made in my alarm systems to give an indication, either audible or visual, to supervisory personnel in the event that a fault such as a short circuit or open circuit has occurred somewhere in the circuit. Furthermore, there is provided in my systems a self-contained auxiliary source of power which becomes operative to maintain the system in a standby condition in the event of a power failure, and to cause the alarm to sound in the event that the dangerous condition arises during the interval that the power has failed.

Included in my signaling system is a differential relay having switch means associated therewith. When the circuit is in its standby condition, the switch means are in a first position in which both the alarm and the fault indicator are inoperative. Upon the occurrence of the dangerous condition, the balanced condition of this relay is disturbed so as to cause the switch means associated therewith to be moved to a second or alarm position thereby allowing current to flow through said alarm causing it to operate. Furthermore, the circuits are designed such that a fault occurring in the system is effective to cause an unbalance of the relay such that its associated switch means is moved to still a third position in which the fault alarm is energized.

It is accordingly an object of the present invention to provide an improved means for giving an alarm at a central location upon the actuation of distributed detector means, and also to provide means whereby a break or short circuit fault in the system may be signalled.

It is another object of my invention to provide an alarm system which is both reliable and inexpensive.

Still another object of my invention is to provide an alarm system which remains operative even when a failure of the main source of power has occurred.

Still other objects of the present invention will be hereinafter pointed out in the accompanying specification and claims and shown in the drawings which by way of illus-

2

tration show one and a preferred embodiment of the invention.

In the drawing:

FIGURE 1 is a diagram illustrating an electric alarm circuit in accordance with my invention;

FIGURE 2 is a circuit diagram illustrating a modification of the system shown in FIGURE 1, FIGURE 2 being the preferred embodiment of the invention; and

FIGURE 3 illustrates a plan view of switch means suitable for use in the embodiment of FIGURE 2.

FIGURE 4 is a detail showing of the mounting structure for a switch which I utilize in a preferred embodiment of my invention.

Referring now to the schematic diagram of FIGURE 1, there is shown transformer 10 having a primary winding 12 and a secondary winding 14. Primary winding 12 is adapted to be connected to a convenient source of alternating current potential, such as a 120 volt 60 cycle source. Transformer 10 is effective to step down this voltage to a value suitable for use with the alarm. For example, the voltage appearing across terminals 16 and 18 of the secondary winding 14 may be approximately 15 volts.

As shown in FIGURE 1, the differential relay is comprised of a pair of coils 20 and 22 having a common armature which is indicated schematically by a dash line 24. Armature 24 is shown as having a pair of projections 26 and 28 cooperating with switch means indicated generally by the numeral 30. The projection 26 on armature 24 is arranged to operate the contacts 32 and 34 of switch means 30. Likewise, a projection 28 of armature 24 is arranged to operate a contact 36, which when moved, makes contact with either contact 38 or contact 40. Armature 24 is shown as being rotatably mounted with respect to a pivot or fulcrum 42. A spring member 44 is connected to the armature 24 so as to offer a predetermined force tending to rotate said armature in the counter-clockwise direction. It should be understood that the switch means and the relay armature are represented schematically and that several arrangements are available for performing the desired function.

When the signaling circuit of this invention is in its standby condition, i.e., the condition which exists when the system is free from faults and no dangerous condition is present, the projections 26 and 28 as well as the switch means 30 are in the position illustrated. When the circuit is in this condition, a conducting path may be traced from the transformer secondary winding terminal 16 through a conductor 46, a junction 48, a conductor 50, a junction 52, a conductor 54 and through the contact 32 to the contact 34. From contact 34 the path continues through a conductor 56, a fault indicator relay coil 58, a conductor 60, a junction 62 and a conductor 64 to the junction 66 on conductor 70. Conductor 70 is connected through the junctions 72, 74, and 76 to the other terminal 18 of the transformer secondary winding 14. The current which flows through this above mentioned path is effective to normally maintain the relay coil 58 in an energized condition such that the trouble alarm contacts 78 and 80 remain open. Contact 78 is connected through a conductor 82 to one terminal of a trouble alarm 84. The other terminal of the trouble alarm is connected through a conductor 86 to the junction 66 on the conductor 70.

Similarly, when the circuit is in its standby condition as shown, a circuit path may be traced from the terminal 16 through conductor 46, junction 48, and conductor 50 to the junction 52. From junction 52 the circuit may be continued to be traced through the relay coil 20, a conductor 88, through the contacts 36 and 38, and through a conductor 90 to a first terminal of an alarm means 94,

here represented as a bell. A conductor 96 completes the circuit of the alarm bell back to the junction 76 on conductor 70 which in turn is connected to a transformer secondary winding terminal 18.

The relay coil 22 received its energization by current flowing through the following path: from terminal 16, through conductor 46, junction 48, a diode 98, a junction 100, a conductor 102, a junction 104, a conductor 106, a junction 108, a conductor 110, a termination or "end of line" resistor 112, a conductor 114, and conductor 70 which is connected to the secondary winding terminal 18. A filter capacitor 101 is connected between junction 100 on conductor 46 and junction 74 on conductor 70 to provide smoothing of the rectified voltage appearing at junction 100. Connected directly between the conductors 110 and 114 in parallel with a termination resistor 112, are a plurality of detector means 116. Conductors 110 and 114 pass through the areas to be protected and one or more detector means 116 is provided for each separate area. Detectors 116 are illustrated as being of the normally open contact type with when exposed to a dangerous condition become closed.

In order to supply energy to the circuit in the event of a failure of the line voltage, a battery source 118 is connected in series with a diode rectifier 120 between the junction 104 on conductor 46 and the junction 72 on conductor 70. The potential appearing at junction 104 is normally applied through a single pole double throw switch 122 to the trouble alarm contact 80. When the switch is thrown from the position shown to its opposite position, a lamp 124 is inserted in the circuit between junctions 62 and 104. Finally, a conductor 126 is used to connect the switch means contact 40 to the junction 108.

Now that the circuit layout and various connections have been described in some detail, a description of the circuit operation will be presented.

OPERATION

As mentioned earlier, the purpose of the signaling system of FIGURE 1 is to sound an alarm whenever a condition arises to which one or more of the detector means 116 is responsive and to operate a fault indicator in the event that one or more of the circuit connections becomes either opened or shorted. When initially placed in operation, the circuit is balanced by varying the magnitude of the termination resistor 112, such that the magnetic force produced as a result of current flowing through relay coil 22 is exactly counteracted by the force of spring member 44 and the magnetic force produced by current flowing through relay coil 20. When these forces are balanced, the projections 26 and 28 on the armature 24 are in the position shown such that the switch means is in its normal first or standby position, as illustrated.

If the current flowing through the relay coil 20 decreases or the current flowing through the relay coil 22 increases from that which exists when the system is in balance, the armature member 24 will rotate clockwise about fulcrum 42 such that the projection 26 pushes against the appendage on contact 34 thereby opening contacts 32 and 34. At the same time the projection 28 pushes against the appendage on the contact arm 36 thereby interrupting the connection between contacts 36 and 38 and establishing continuity between contacts 36 and 40. When the switch means are in this last mentioned position, the circuit is said to be in its second or alarm position.

Either an increase in the current flowing through coil 20 or a decrease in the current flowing through coil 22 causes the armature member to rotate counter-clockwise about the fulcrum 42 such that the projection 26 on armature 24 pushes against the appendage on contact 32 causing the connection between contacts 32 and 34 to open. When the switch contacts 32 and 34 are open and the contacts 36 and 38 are closed, the switch means 30 is in its third or fault position.

When the circuit is in its standby condition, a current flows from the secondary winding terminal 16 through conductors 46 and 50, 54, and 56 to the fault indicator relay coil 58 and from there through the conductors 60, 64, and 70 to terminal 18 of secondary winding 14. The current flowing through the fault indicator relay winding 58 produces a magnetic force tending to hold the contacts 78 and 80, thereby opening the circuit to the fault indicator 84.

The current which flows through the relay coil winding 20 when the circuit is in its standby position also flows through the alarm 94 by way of conductor 38, contacts 36 and 38, and conductors 90 and 96. The alarm 94 is designed to have a relatively high impedance to alternating current compared to its resistance to direct current so that the alternating current flowing through the alarm at this time is insufficient to cause it to operate. If when the circuit is in its standby condition a dangerous condition arises to which the detector means 116 is responsive, the normally open contact of the detector means 116 closes thereby shorting out the termination resistor 112. With resistor 112 shorted out of the circuit, there is an increase in the current flowing from junction 100 through conductor 102, conductor 106, and relay coil 22. This increase in current flowing through the relay coil 22 has two effects. First of all, the armature 24 of the differential relay moves in a clockwise direction causing the projection 26 to push against the appendages on contacts 34 and 36 such that the continuity between contacts 32 and 34 is interrupted. Secondly, the movement of projection 28 breaks the circuit between contacts 36 and 38 and completes the circuit between the contacts 36 and 40. With contacts 32 and 34 open, current is precluded from flowing through conductors 50, 54, and 56 so that the fault indicator relay coil 58 becomes deenergized. This results in a closure of the contacts 78 and 80 thereby connecting the fault indicator 84 directly across the output of the half wave rectifier, i.e. between junctions 104 and 72, so as to render the fault indicator operative. Since the contact 40 is connected through conductors 126 and 106 to the direct current side of the half-wave rectifier, a direct current flows through conductors 102, 106, 126, and conductor 90 to the main alarm. Since, as mentioned previously, the direct current resistance of the alarm 94 is low, the direct current which flows through the alarm when contact 36 closes against contact 40 is effective to cause it to sound.

It can be seen then that if a condition arises which causes the normally open contacts of the detector means to close, both the fault indicator 84 and the alarm 94 are rendered operative. The fault indicator 84 is generally located at the control panel of a central station. If the noise it produces should become objectionable to personnel located at the central station, it is possible to silence the fault alarm by throwing switch 122 from the position shown, such that the fault indicator lamp 124 is connected into the circuit.

If when the signaling system of this invention is in its standby position and either the alarm 94 becomes shorted or either of lines 114 or 110 are interrupted, the magnetic force produced by coil 20 will exceed that produced by the coil 22 causing the armature member 24 of the differential relay to move counter-clockwise. As mentioned previously, this is the fault position and the projection 26 moves against the appendage on contact 32 such that contacts 32 and 34 are open. The effect of this is to interrupt the current flow through conductors 50, 54, and 56 to the fault indicator relay coil 58. Contacts 78 and 80 therefore close which, in turn, causes the fault indicator 84 to operate. Again the fault indicator may be silenced by throwing switch 122 from the position shown to its opposite position such that the fault indicator lamp becomes lighted. After the fault is corrected, contacts 78 and 80 will again become open and when switch 122 is

returned to its normal position the fault indicator 84 will not operate.

Again, if the signaling system is in its standby condition and the alarm circuit opens, say conductor 90 or 96 is interrupted, no current will flow through the relay coil 20 so that the armature 24 is now moved in a clockwise direction by the action of the magnetic force produced by coil 22. The projection 26 on armature 24 again pushes against the appendage on contact 34 causing contacts 32 and 34 to open. The projection 28 pushes against the appendage on contact 36 thereby interrupting the continuity between contacts 36 and 38 and establishing a circuit between contacts 36 and 40. Since it has been assumed that the alarm circuit is open, the direct current which would normally flow through the contacts 36 and 40 cannot do so and hence, the alarm 94 remains silent. However, since the continuity between contacts 32 and 34 is broken the fault indicator relay coil is deenergized thereby allowing contacts 78 and 80 to close. As a result, supervisory personnel at the central location are advised that a fault exists in the system by an alarm given by the fault indicator 84.

Should the source of line voltage fail while the signaling system is in its standby position, means are provided to energize the fault indicator. Also, if a dangerous condition should arise during the interval that the main source of power is off, this same means which is used to energize the fault indicator is also used to supply energy to the alarm 94 thereby allowing it to sound. As shown in FIGURE 1, there is included in the circuit between junction 72 on conductor 70 and the junction 104, a series arrangement of a battery 118 and a rectifier 120. The battery potential is chosen such that when the main source of power is on, the voltage appearing at junction 104 is sufficient to back-bias diode 120 so that only a very small leakage current is drained from the battery 118. For example, the voltage normally appearing at terminal 104 may be 12 volts whereas the potential of the battery source may be in the neighborhood of 10 volts. Now, if the power should fail, the back-biasing potential normally appearing at junction 104 disappears and a substantial current now flows from the battery source 118, through the diode 120, through conductor 106, through the relay coil 22, through conductor 110, termination resistor 112 and conductor 114. Because of the power failure, however, no current flows through the relay coil 20, the conductor 88, the conductor 90 or the alarm 94. The spring member 44 however, provides a sufficient force to balance out that produced by the current flowing from the battery through the relay coil 22 so that the armature 24 stays in its standby position. Also, because of the power failure, no current flows through conductors 50, 54, 56, and the fault indicator relay 58. Contact 78 therefore closes against contact 80 to establish a path for the flow of current from the battery 118 through the diode 120 and switch 122, and through conductor 82 to the fault indicator 84. The personnel located at the central station are thereby advised that a fault has occurred and they may then check to determine the origin of this fault.

In the event that a dangerous condition should arise during the interval that the power has failed, a normally open contact of one of the detector means 116 closes, thereby shorting out the termination resistor 112. Since resistor 112 is shorted out, there is a substantial increase in the current flowing from the battery source 118 through the diode 120 and the relay coil 22. This increase in current flow is effective to increase the magnetic force of coil 22 so as to overcome the counteracting force exerted by the spring member 44. The armature 24 of the differential relay therefore rotates in a clockwise direction about the fulcrum 42 such that the projection 28 on armature 24 pushes against the appendage on contact 36 and moves the contact 36 against contact 40. A current path is thereby established from battery source 118

through the diode 120, through conductors 106, 126, and 90 to an alarm 94. Because the direct current resistance of alarm 94 is low, sufficient current is capable of flowing through it to allow it to sound.

Thus it can be seen that the circuit of FIGURE 1 is effective to give an alarm indicating the presence of a dangerous condition to which detectors 116 are responsive, and to provide an indication to supervisory personnel in the event that a fault occurs in the system.

FIGURE 2 CIRCUIT

FIGURE 2 illustrates schematically a preferred embodiment of the present invention. Since diodes and capacitors are the weakest link in this system and are most subject to failure, the signaling circuit of FIGURE 1 has been modified to eliminate these components. As in the embodiment of FIGURE 1, the alarm system of FIGURE 2 normally receives its power from an alternating current line source through a suitable step-down transformer 130. The voltage applied to the primary winding 132 may, for example, be 120 volts whereas the voltage appearing across secondary winding may be approximately 12 volts. Connected directly between the output terminals 134 and 136 of the transformer secondary winding 138 is an indicator lamp 140 which, when lighted, indicates to supervisory personnel that the line power is on. A conductor 142 connects the secondary winding terminal 134 to a first terminal 144 of a power failure relay coil 146. Secondary winding terminal 136 is connected through a conductor 148, a contact 150 of a double pole double throw system test switch 152, a switch arm 154, and a conductor 156 to a junction 158. A conductor 160 is used to connect the junction 158 to the junctions 162, 164, and 166 and to a first terminal 168 of the detector circuit which is indicated generally by the numeral 170. A conductor 172 is used to connect terminal 168 to the other terminal 174 of the power failure relay 146. By tracing through the above path, it can be seen that when the switch arm 154 of the system test switch 152 is in contact with contact 150, the power failure relay 146 is connected directly across the secondary winding 138 of transformer 130.

Power failure relay coil 146 controls the operation of the switch arms 146a, 146b, 146c, and 146d. A conductor 176 connects the junction 144 to the switch arm 146a such that when the relay coil 146 is energized, a current path may be traced from the secondary winding terminal 134 through conductor 142, junction 144, conductor 176 and switch arm 146a to the contact 178 which is arranged to cooperate with switch arm 146a. From contact 178 the path may be continued to be traced through a switch arm 180 of a single pole double throw switch 182 and the contact 184 to a first terminal 186 of a relay coil 188. The current which flows through relay coil 188 continues to flow through conductor 190 to a second terminal 192 of the detector circuit 170.

Detector circuit 170, in the preferred form of this invention, may be comprised of a plurality of normally open contacts 194, which close upon the occurrence of a condition to which they are responsive, connected in parallel between a pair of lines 196 and 198 which are strung through the areas to be protected. For example, when used in a building, the lines 196 and 198 may pass through each room in the building and there may be one or more detectors 194 located in each room. A capacitor 200 is used to terminate the lines 196 and 198. The current which energizes the relay coil 188 therefore normally flows through capacitor 200 and the conductor 198 to terminal 168. From terminal 168 this current flows through conductors 160 and 156, switch arm 154 and conductor 148 back to the secondary winding terminal 136.

A conductor 202 connects the switch contact 178 to the power failure relay switch arms 146b and 146c. When the line power is on and the power failure relay coil 146 is energized, a second circuit path may be

traced from secondary winding terminal 134 through conductors 142 and 176, through the switch contact 178 and conductor 202 to the switch arm 146b. From switch arm 146b a current may flow through contact 204 associated with arm 146b and through the relay coil 206 to a junction 208. A conductor 210 joins junction 208 to a normally open contact 211 of the single pole double throw switch 182. Also, connected between the junction 208 and the junction 166 on conductor 160 is an alternating current/direct current operated alarm means 212.

An auxiliary source of power, here shown as a battery 214, is connected by means of a conductor 216 to the normally open contact 218 of a single pole single throw switch 220. The switch arm 222 of this switch is connected by means of a conductor 224 to a first terminal 226 of a direct current operated fault indicator means 228. The other terminal 230 of fault indicator means 228 is normally connected through a single pole double throw switch to the junction 162 on conductor 160. As a result, when switch 220 is closed, current flows from the positive terminal of battery 214 through conductor 216 and switch 220 and conductor 224 to the fault indicator means 228. This current is returned to the negative terminal of battery 214 by way of switch arm 232 and conductor 160. Conductor 216 also connects the positive terminal of the battery 214 to a normally open contact 234 which is associated with the power failure relay switch arm 146c. A contact 236 associated with the power failure relay switch arm 146d is connected to conductor 224 at a junction 238. Arm 146d is connected by means of a conductor 240 to a junction 242 which, in turn, is connected by means of a conductor 244 to the positive terminal of battery 214. A fault indicator lamp 246 is arranged to be connected directly across the battery source 214 when the fault indicator silencing switch 232 is manually switched to its opposite position.

Manual operation of the double pole double throw system test switch 152 is effective to short out the detector circuit 170 by way of conductors 248, 156, and 160. Also, operation of switch 152 from the position shown to its opposite position is effective to connect a resistance 250 directly in parallel with the battery source 214.

The position of the switch arms 180 and 222 of switch means 182 and 220 is controlled by the joint action of the magnetic forces produced by the relay coils 188 and 206. When the amount of current flowing through relay coil 188 is equal to that flowing through the relay coil 206, the switch arm 180 is positioned against contact 184 and the switch arm 222 is out of contact with the contact 218. If the current flowing through the relay coil 188 exceeds that flowing through relay coil 206, the switch arm 180 is moved against contact 210 and also, the switch arm 222 is moved against contact 218. Finally, if the current flowing through relay coil 206 exceeds that flowing through relay coil 188 only switch 220 is operated.

Referring momentarily to FIGURE 3, which illustrates one method of obtaining the above described switching function, there is shown a plan view of the relay coils 188 and 206 which are arranged to operate a switch actuator member 252. Switch actuator member 252 is rotatably mounted with respect to a pivot point 254 such that when the magnetic force produced by current flowing through coil 206 exceeds the magnetic force resulting from the flow of current through coil 188, the actuator 204 moves in the counter-clockwise direction. Similarly, when a magnetic force produced by relay coil 188 exceeds that produced by relay coil 206, switch actuator 204 is caused to rotate in the clockwise direction.

Attached to or formed integral with an actuator member 204 are a pair of projections 256 and 258. Projection 256 is of substantially smaller width than projection 258. Switch means 182 and 220 may both be snap-acting switches, switch 182 being of the single pole double throw type and switch 220 being of the single throw type.

When the switch actuator 252 is in its standby position, i.e., the position shown in FIGURE 3, the switch means 182 and 220 are in the condition illustrated in FIGURE 2. However, when the actuator member 252 is made to move in its counter-clockwise direction the arm 260 is disengaged from the projection 256 and allowed to trip up so as to cause switch arm 222 to close against switch contact 218. Because projection 258 is substantially wider than projection 256, the counter-clockwise rotation of the actuator member 252 does not allow the arm 262 on snap switch 182 to be released from its engagement underneath projection 258. The switch arm 180 of switch 182 therefore remains in contact with contact 184. A clockwise rotation of the actuator member 252, however, causes both the arms 260 and 262 to be disengaged from the projections 256 and 258, such that switch arm 222 of switch 220 closes against its associated contacts 218 and also continuity is established between switch arm 180 of switch 182 and its associated contact 210. Once the arms 260 and 262 are disengaged from the projections 256 and 258 they remain so until they are manually reset. The interaction of the projections on actuator 204 with the snap-acting switches may best be seen in FIGURE 4 which is a sectional view taken along the line 4—4 in FIGURE 3.

FIGURE 2 OPERATION

When the line power is applied to the primary winding 132 of the step-down transformer 130, the power indicator lamp 140 is illuminated and the power failure relay 146 becomes energized. Switch arm 146a therefore closes against its associated contact 168 and switch arm 146b closes against its contact 204. Arms 146c and 146d assume an open position, i.e. out of contact with contact 234 and 236, respectively. Alternating current therefore flows from the secondary winding terminal 134 through conductors 142 and 176, through the switch arms 146a and 180 through relay coil 188, through conductors 190 and 196 and the termination capacitor 200, through conductors 198, 160, 156, and 148 back to the secondary winding terminal 136. The magnetic force produced by the current flowing through relay coil 188 is normally balanced by the current which flows through the relay coil 206. The energizing current for relay coil 206 normally flows from the secondary winding terminal 134, through conductors 142 and 176, through the switch arm 146a and conductor 202, through the switch arm 146b and its associated contact 204. The current which flows through relay coil 206 continues to flow through the alarm means 212 and back to the secondary winding terminal 136 by way of conductors 160, 156, and 148. The impedance of the termination capacitor 200 is designed to be approximately equal in magnitude to the impedance of the alarm means 212, such that the currents normally flowing through the relay coils 188 and 206 are equal. Also, the impedance of the relay coil 206 is of such a value that when added to the impedance of the alarm means 212, is sufficiently high to limit the current flowing through alarm means 212 to a value which is insufficient to cause the alarm to operate.

If a dangerous condition should arise when the circuit is in its normal or standby condition so as to cause one of the normally open detector means 194 to close, the termination impedance 200 is effectively shorted out by the responsive detector such that there is a substantial increase in the current flowing through the relay coil 188 connected in series therewith. As a result, the switch actuator member 252 is caused to rotate in a clockwise direction, as previously explained, thereby releasing both of the arms 260 and 262. With arm 260 released, switch 220 is closed thereby allowing current to flow from the direct current source 214, through conductor 216, through switch arm 222 and conductor 224, to the direct current fault indicator 228. The return path for this current is through the switch arm 232 of the alarm silencing switch and conductor 160 back to the negative terminal of source

214. This current flowing through the fault indicator renders it operative. At the same time, the disengagement of the arm 262 causes switch arm 180 to move from its position in contact with contact 184 to a new position in contact with contact 211 which is effective to short out the relay coil 206. The shorting out of this coil reduces the impedance in series with the alarm means to a sufficiently low value to allow the alarm means to become operative. The alarm means remains operative until the dangerous condition subsides, at which time the switch means 182 and 220 are manually reset to their normal or standby position by again engaging the arms 262 and 260 beneath the projections 258 and 256, respectively.

If when the switch means is in its standby position there should occur a fault, such as either lines 196 or 198 breaking or the alarm means 212 being shorted out, the magnetic force produced by the relay coil 206 will exceed that produced by the relay coil 188 causing the switch actuator member 252 to rotate in the counter-clockwise direction. Counter-clockwise rotation of the switch actuator is effective to cause only arm 260 to be released from its engagement with projection 256 thereby allowing only switch 220 to close. As before, the closure of this switch allows a direct current to flow from the battery source 214 to the direct current fault indicator. If the fault which caused the counter-clockwise rotation of the actuator is of the intermittent type, that is, of the type in which the trouble corrects itself, fault alarm 228 remains operative until the switch means is manually reset. The tripping of the switch 220, however, does not lock out the system and, for this reason, the system is still capable of indicating the occurrence of a dangerous condition even when the circuit is indicating a previous intermittent fault.

If the power should fail when the switch means is in its standby condition, the power failure relay 146 becomes de-energized and hence, the contacts 178 and 204 which were previously closed now open. Similarly, contacts 234 and 236 which heretofore were open, now close. With switch arm 146d now closed against contact 236, a current is again able to flow from the battery source 214 through conductors 244, 240, and 224 to the fault indicator 228. The fault indicator therefore is rendered operative until the power is restored or until someone throws the silencing switch arm 232 to its opposite position so as to substitute the trouble lamp 246 for the audible fault indicator signal. The switch actuator member 252, however, is not altered in position and no current flows through either of the relay coils 188 or 206. The opening of the contacts 204, which occurs when a power failure exists, precludes the current from flowing through the relay coil 206. Current would flow from battery source 214 through the now closed switch arm 146c, the conductor 202, the switch arm 180, and the relay coil 188 were it not for the capacitive termination impedance 200 connected in series therewith which prohibits the flow of direct current. Battery drain is therefore held to a minimum during power failure because current from the battery source is not used to supervise the system.

If a dangerous condition should arise during the interval in which the power is off, one of the detector means responds to this condition and is effective to short out capacitor 200. A direct current is now able to flow from battery source 214 through conductor 216, switch arm 146c, conductor 202, switch arm 180, relay coil 188, conductors 190 and 196, through the particular detector 194 which has its contacts closed, through line 198 and conductor 160 back to the negative terminal of source 214. As before, a current flowing through relay coil 188 is effective to produce a clockwise rotation of a switch actuator member 252. This clockwise rotation releases arm 262 and establishes a current path from the positive terminal of battery source 214 through conductor 216, switch arm 146c, conductor 202, switch arm 180, conductor 210, to the alarm means 212. Alarm means 212 is rendered operative and supervisory personnel are advised that a

dangerous condition exists somewhere in the building being protected. Because switch 182 trips up immediately when one of the connector means 194 shorts out, the termination impedance 200, battery drain is reduced since no power is dissipated in coil 188. The battery 214 need only supply current to the alarms.

In order to periodically check the condition of the battery source 214 and the system operation, the system test switch 152 is included in the alarm system of FIGURE 2. When switch 152 is manually thrown from the position shown to its opposite position, the continuity between conductors 148 and 160 is broken so that no current is able to flow through the power failure relay coil 146. Contacts 178 and 204 therefore open and contacts 234 and 236 close. When switch 152 is moved to its test position, the termination impedance 200 is also shorted out by way of conductors 248, 156, and 160. A current therefore flows from the battery 214 through the now closed contacts 234, the switch arm 146c, conductor 202, switch arm 180, the relay coil 188, through conductors 190, 196, 248, 156, and 160 back to the negative terminal of the battery 214. This current flowing through relay coil 188 is effective to cause a clockwise rotation of the switch actuator member 252. As mentioned previously, the clockwise rotation of the actuator member 252 causes the switches 182 and 220 to move from their normal position shown in FIGURE 2 to their alternate positions. If the battery is in proper working order, both the alarm means 212 and the fault indicator means 228 should be rendered operative at this time. As a precautionary measure, a predetermined impedance 250 is connected directly in parallel with the battery supply 214 when the system test switch 152 is moved to a test position. The current flowing through this impedance is an additional drain on the battery, over and above that required to energize the alarm means and the fault indicator means. Hence, if the battery is capable of supplying sufficient current to sound the two alarms even when this additional load is present, it is certain that there is sufficient life left in the battery to activate the alarm means and fault indicator means when the load is not in the circuit.

By way of example only, since the choice of component values and voltages are not critical, the following values and components may be used in constructing the preferred embodiment of FIGURE 2.

Transformer 130	120 v./12 v.
Relay 146	12 v.—2 N.O. and 2 N.C. contacts.
Lamp 140	12 v.
Lamp 246	6 v.
Fault indicator 228	6 v. D.C. Bell.
Alarm 212	6 v. D.C./12 v. A.C. Bell.
C200	125 microfarads.
R250	10 ohms.
Battery 214	6 v.
Coils 188, 206	600-800 turns—#25 A.W.G.
Switch 182	S.P.S.T. microswitch.
Switch 220	S.P.D.T. microswitch.

From the above description it will be apparent that I have produced a system and apparatus which possesses all of the features that are set forth as desirable; and while I have described and illustrated what appears to be the preferred form of the invention, I reserve the right to make all changes within the spirit of the invention and without being ambit of the prior art.

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

1. In a supervised condition detection and alarm apparatus, first alarm means for indicating the presence of an undesired condition, second alarm means for indicating the presence of circuit trouble, switch actuating means having a balanceable member normally held

in a center position and controlled by a first and a second winding to close a first switch when said member moves in a first direction and to close a second switch when said member moves in an opposite direction, said first switch being closed when an output of said first winding produces to dominating force on said member, said second switch being closed when an output of said second winding produces the dominating force on said member, an alternating current source of power, a plurality of abnormal condition detector means, said detector means being normally open and connected in parallel, an end impedance connected adjacent a farthestmost of said parallel detector means, said end impedance blocking D.C. current, a first resistance connected adjacent a closest of said detector means, circuit means including said first switch for connecting said second alarm to said source, circuit means including said second switch for connecting said first alarm to said source, first circuit means including a parallel circuit of said first resistance, said end resistance and said parallel detectors for connecting said second winding to said source, a second resistance connected in parallel with said first alarm means, circuit means comprising said second resistance for connecting said first winding to said source, a secondary direct current source of power, a power failure relay, means associated with said relay for disconnecting said alternating current source and connecting said direct current source to said first circuit whereby a replacement source is available when one of said detector means closes to energize said first alarm means however said end impedance prevents an undesired current drain on said D.C. source.

2. In a supervised condition detection signal system, a pair of circuits, a plurality of normally open condition responsive detector switches connected in parallel between said circuits, said detectors closing upon the presence of an undesired condition, impedance means connected in parallel and adjacent a farthestmost of said detectors, said impedance means having a high resistance to unidirectional current and a low resistance to A.C. current, a first alarm circuit, a source of A.C. power, circuit means including said pair of circuits for connecting said source to said alarm whereby upon the pres-

ence of a closed detector said alarm is energized, a supervisory alarm, circuit means including said pair of circuits and said impedance means for providing a supervision current path connected to energize said supervisory alarm when said path supervision current changes, a power failure relay to be deenergized upon said source failing, a secondary source of power having a unidirectional current, means including said relay for connecting said secondary source in said first alarm circuit to maintain said first alarm circuit active to respond to the presence of a closed detector, said impedance means preventing said supervisory current from flowing in said pair of circuits to lessen the current drain on said secondary source.

3. In a supervised condition detection and alarm apparatus, an abnormal condition detection circuit comprising a plurality of normally open detector means connected in parallel, an end impedance means having a high resistance to unidirectional current flow and a low resistance to alternating current flow, said impedance means being connected at an end of said detection circuit in parallel with said detector means, an alarm circuit, an alternating current source, means including said detection circuit for connecting said source to said alarm circuit whereby said alarm circuit is energized when one of said detector means closes, a reserve unidirectional current power source, a normal supervision circuit using said alternating source of power to supervise the flow of an alternating current through said end impedance, and means to replace said alternating source of power with said reserve source whereby said end impedance prevents the use of said reserve source for said supervision circuit so said reserve source is available for said alarm.

References Cited in the file of this patent

UNITED STATES PATENTS

1,537,211	Wooton	May 12, 1925
2,074,262	Grant	Mar. 16, 1937
2,728,904	Shafer	Dec. 27, 1955
2,832,946	Beck	Apr. 29, 1958
2,891,240	Rohulich	June 16, 1959
2,919,438	Deziel	Dec. 29, 1959