

March 6, 1956

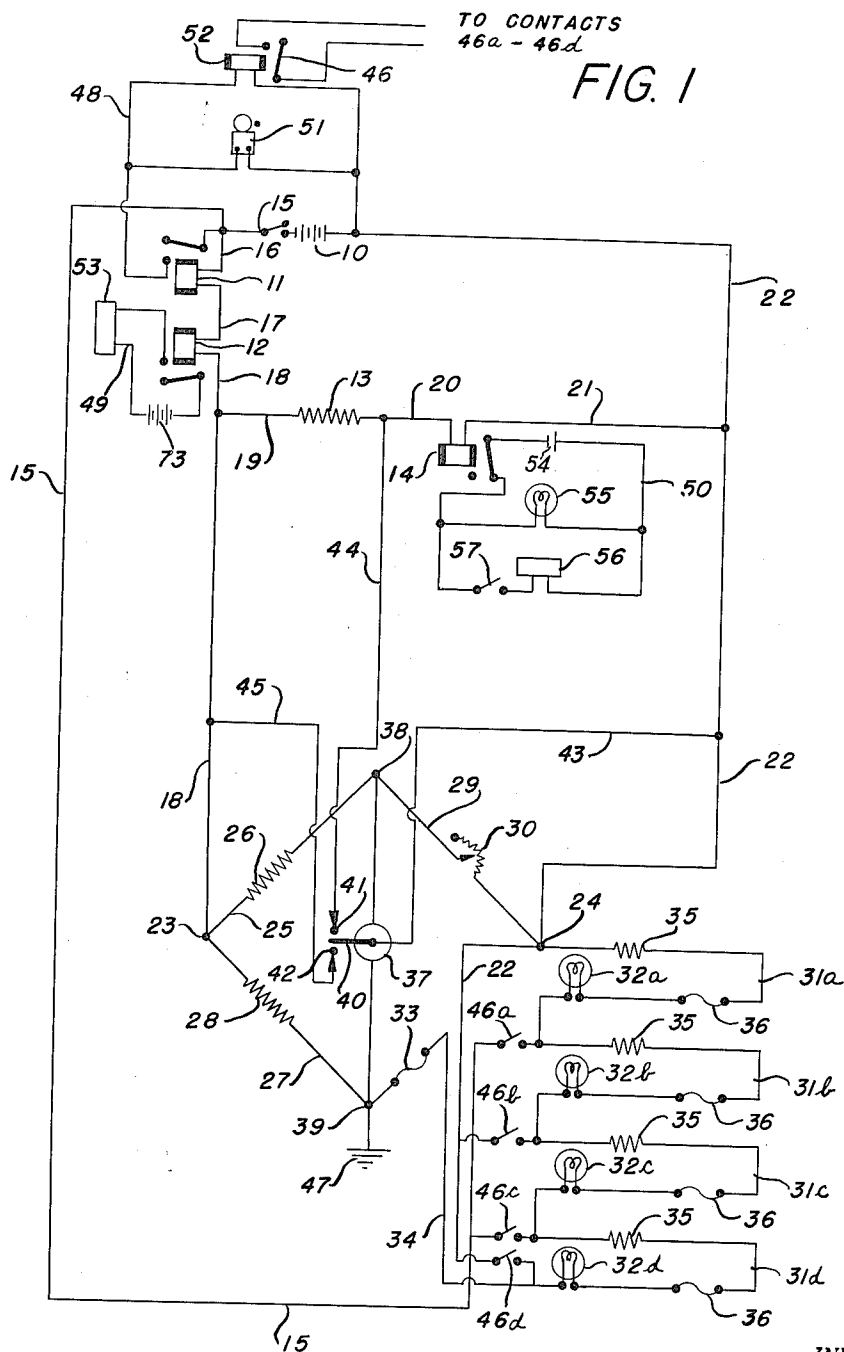
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2,737,642

SUPERVISED FIRE DETECTION AND ALARM SYSTEM

Filed Jan. 7, 1954

2 Sheets-Sheet 1



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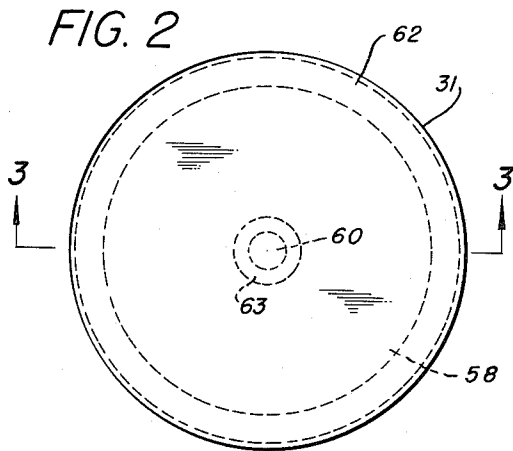
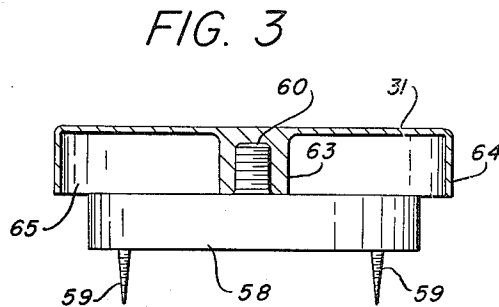
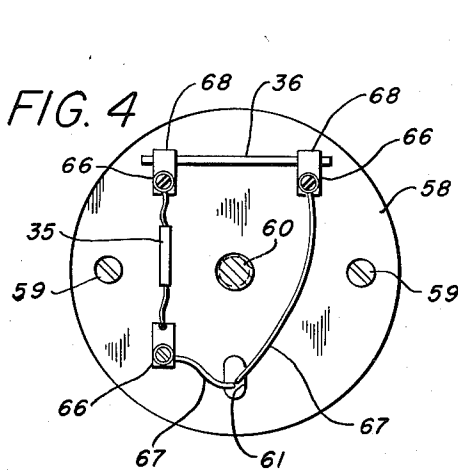
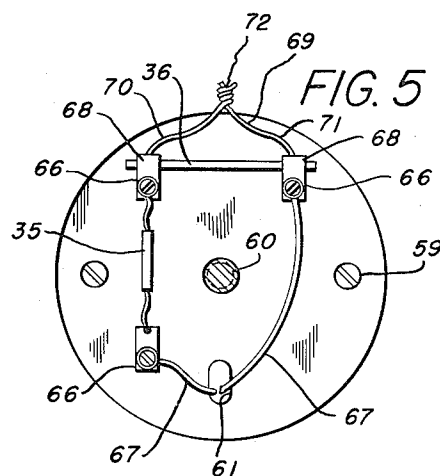
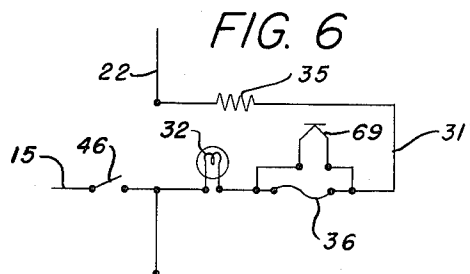
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SUPERVISED FIRE DETECTION AND ALARM SYSTEM

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2 Sheets-Sheet 2



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SUPERVISED FIRE DETECTION AND ALARM SYSTEM

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Application January 7, 1954, Serial No. 402,745

10 Claims. (Cl. 340—227)

This invention relates in general to an electrically energized system for sensing abnormal conditions of temperature resulting from fire, and automatically denoting said condition by an appropriate signal or alarm. More particularly, this invention pertains to such a system which is additionally provided with means for sensing and signaling the existence of operative defects or disturbances in the system, so that the operative condition of the system for fire detection is automatically supervised.

In the field of fire detection systems, particularly those systems adapted for use in residential structures, the paramount objective is the saving of life and the reduction of property loss. In large commercial or industrial structures, the use of fire detection systems is generally supplemented by continuous surveillance of the premises by personnel employed for that purpose. Thus, in such fire detection installations, a failure of the system does not necessarily leave the premises completely unprotected, against the hazard of fire. It may also be noted that commercial and industrial fire detection systems are subject to periodic inspection and test by qualified maintenance personnel as well as by governmental authorities in order to prevent and preclude functional failures.

In contrast to the foregoing, the residential fire detection system, as in a home or apartment, is usually the sole means for continual fire surveillance and is therefore relied upon entirely and exclusively for automatic protection of life and property. Such domestic systems are generally not under the control of qualified personnel, nor are they routinely inspected and checked. Inoperativeness of the fire detection system may remain unobserved and undetected and thus defeat the entire purpose of the system upon which reliance has been placed.

It is a primary object of my invention to provide an automatic fire detection and alarm system which is self-supervised to detect and indicate conditions of inoperativeness in the system.

Another object of my invention is to provide a system of the character described in which the number of circuit elements utilized is held to substantially a minimum, thus reducing the possibility of failure.

Still another object of my invention is to provide a system of the character described wherein means are provided for indicating the location of the specific area in which the fire is detected.

A further object of my invention is to provide a system of the character described which is sensitive to the rate of rise of temperature as well as to critical ambient temperature.

Other objects and advantages of my invention will be apparent during the course of the following description.

In the accompanying drawings forming a part of this specification and in which like numerals are employed to designate like parts throughout the same,

Fig. 1 is a wiring diagram of a supervised fire detection system embodying the features of my invention.

Fig. 2 is a plan view of the exterior of a thermal unit which may be utilized in my fire detection system.

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Fig. 3 is a cross-sectional view taken on line 3—3 of Fig. 2, with the circuit elements not shown.

Fig. 4 is a plan view of the thermal unit with the cover removed and showing the circuit elements therein.

Fig. 5 is a view similar to Fig. 4 showing a modified form of thermal unit.

Fig. 6 is a fragmentary wiring diagram of the modified form of thermal unit shown in Fig. 5.

Referring more particularly to Fig. 1 of the drawings, I have shown a fire detection system which includes a source of power supply 10 which is preferably independent of the general power supply of the structure to be protected, and can conveniently be a dry cell battery of low voltage, for example, 9 volts. The system may, for convenience, be considered as consisting of a power circuit, a detection and control circuit, and the subsidiary signal or alarm circuits, all of which are fully described hereinafter.

The power circuit is connected in series with the battery 10 and includes an internal signal relay 11, an external signal relay 12, a resistor 13, and a voltage relay 14. The resistor 13 is included in the circuit to reduce the current value of the power circuit to a point where it is incapable of actuating the relays 11 and 12, while at the same time permitting sufficient current flow to energize relay 14. It will be understood that in selecting the resistor value to be used consideration must be given to the electrical characteristics of the other power circuit elements so as to obtain the functional condition above mentioned. Such selection is well within the skill of the art. In the illustrative example of Fig. 1, the resistor may have a value of 3600 ohms in relation to relays 11 and 12 of 200 ohms each, and relay 14 of 5500 ohms.

For clarity of description, the conductors in the power circuit will be identified as follows: 15 is the bus line from the negative terminal of the battery 10; 16 is the conductor connecting one side of relay 11 to negative line 15; 17 is the lead connecting relays 11 and 12; 18 is a lead connected to the positive side of relay 12; 19 is a branch lead connecting resistor 13 to conductor 18; conductor 20 connects resistor 13 and relay 14; and 21 is a branch lead connecting relay 14 to bus line 22 which is connected to the positive side of battery 10.

The detection and control circuit is connected across the power supply 10, in series with the relays 11 and 12 and in parallel with the resistor 13 and relay 14.

The circuit comprises a Wheatstone bridge connected at 23 to lead 18 and connected at 24 to positive bus line 22. An arm 25 includes resistor element 26, and another arm 27 of the bridge includes resistor element 28. A third arm 29 includes a variable resistance or rheostat 30. The fourth arm of the bridge includes one or more thermal units 31 (as shown in Figs. 2—4) connected in series with each other and with signal units 32, which are here shown as lamps.

Each thermal unit 31 is physically located in a specific detection area of the structure to be protected, and as many thermal units may be used as are necessary to provide adequate overall area protection. Fig. 1 illustrates four of such thermal units 31a, 31b, 31c and 31d connected in series with each other and with a fusible link 33 to establish the fourth arm 34 of the Wheatstone bridge.

Each thermal unit includes a resistor 35 connected in series with a fusible link 36 which, in turn, is in series with a lamp 32a, 32b, 32c or 32d which may be located at a point remote from the thermal unit proper.

A sensitive relay 37 of the galvanometer type is connected across the Wheatstone bridge at points 38 and 39 and will indicate, by means of a movable pointer or arm 40, the conditions of balance or unbalance existing in the circuit. The relay 37 has double contacts 41 and 42 which

are engageable by pointer 40 which acts as a moving contact or switch arm. I prefer to use a relay 37 having magnetic contacts for holding the pointer 40, with suitable reset means being provided. The miniature Sensitrol relay, Model 813, sold by Weston Electrical Instrument Corporation of Newark, New Jersey, is exemplary of a preferred form of relay 37 for use in this circuit.

The pointer 40 is connected to positive bus line 22 by means of a branch lead 43. The contact 41 is connected in parallel with relay 14 by means of lead 44. The contact 42 is connected to lead 18 by means of conductor 45 to provide a shunt circuit across resistor 13 and relay 14.

In addition to the series arrangement of the thermal units 31, an alternate parallel circuit is provided in which the units 31 are connected across positive bus line 22 and negative bus line 15; these parallel circuits each including a contact of a normally-open relay-actuated four pole switch gang 46, the contacts of which are designated 46a, 46b, 46c and 46d.

The foregoing describes the elements of the detection and control circuit. In addition, I consider it desirable to ground the Wheatstone bridge as indicated at 47, for a purpose to be described hereinafter.

The signal or alarm circuits can be designated as an internal alarm circuit 48, an external alarm circuit 49 and a trouble alarm circuit 50.

By further reference to Fig. 1, it will be noted that alarm circuit 48 includes a signal element or bell 51 connected in parallel with a locator relay 52. This circuit is normally open and is energized by battery 10 in response to actuation of relay 11 in the power circuit. It will be understood that relay 52, when energized, serves to close the normally-open switch gang 46 consisting of contacts or switches 46a, 46b, 46c and 46d.

The external alarm circuit includes any form of signal or indicator element which may be physically remote from the structure to be protected. For purpose of illustration I have shown this element to be a siren 53. This circuit is normally open and is energized by battery 73 in response to actuation of relay 12 in the power circuit.

The trouble signal circuit 50 is provided with an independent power supply 54 which may be a mercury cell or the like. It includes a visual signal element 55, which may be a lamp, and an audible signal element 56, such as a buzzer, connected in parallel across the power supply 54. A manually operable normally closed switch 57 is in series with buzzer 56. The trouble signal circuit is normally-closed, but is opened in response to actuation of relay 14 in the power circuit.

The alarm operation of the above described system is based upon the creation of a condition of unbalance in the Wheatstone bridge circuit. Therefore, when the system is in normal operation, the Wheatstone bridge is in balance. For example, resistors 26 and 28 may be fixed at 5600 ohms, resistors 35 may be 10 ohms each and variable resistor 30 may have a range of 0-500 ohms. When the system is installed, resistor 30 is adjusted to create a condition of balance in the Wheatstone bridge so that no current will flow through relay 37 and pointer 40 will therefore lie intermediate the relay contacts 41-42.

Current will flow through the power circuit to energize relay 14 and thus keep trouble alarm circuit 50 open. However, as heretofore explained, the current value in the power circuit is insufficient to actuate relays 11 and 12. A supervisory current will also flow through the detection circuit containing thermal units 31 and lamps 32 in series, thus causing all the lamps 32a, 32b, 32c and 32d to be supervised. The detector circuit is thereby constantly supervised during normal operation, and visual indication of such supervision is given by the lamps 32. In the absence of the alternate parallel thermal unit circuit, previously described, any failure of the circuit elements 11, 12 or of any elements of the arm 34 of the Wheatstone bridge would cause the lamps to be extinguished

and thus indicate such failure. However, it is desired, not only that the system indicate failure, but also that it indicate, whenever possible, the physical location of such failure as well as to some extent, the character of the failure or difficulty. This attribute of the system is best described by the following the operation of the system under the various conditions to which it may be subjected.

Should any of the thermal units 31 become short-circuited, the arm 34 of the Wheatstone bridge will have a decreased value of resistance which will unbalance the bridge circuit and cause deflection of the pointer 40 of relay 37 so as to engage magnetic contact 41. The shunt circuit between lead 20 and positive bus line 22, which is established by leads 43 and 44, is thereby closed to effectively short-circuit the voltage relay 14 and cause the trouble alarm circuit 50 to be closed. The lamp 55 and buzzer 56 will be energized by cell 54 and give both visual and audible indication of the existence of trouble in the system. The switch 57 may be opened to still the buzzer, but the lamp 55 will remain lit until the short circuit is remedied. After the short circuit is remedied, the pointer 40 is reset to open the shunt circuit, and the relay 14 then is actuated to open trouble alarm circuit 50 to restore the system to normal operation.

If the wiring or circuit elements of the arm 34 are in contact with a foreign electrical ground, the Wheatstone bridge will react in the same manner as described for a short circuit, to actuate a trouble alarm in circuit 50.

Another condition which may occur is that resulting from complete failure of the power supply 10. Under such circumstances, the voltage relay 14 is deenergized and circuit 50 is thereby closed to indicate the existence of trouble in the manner heretofore described. The same result would occur if there is any failure of the power circuit as a result of a break in the conductors or in the circuit elements 11, 12, 13 or 14. It will be noted that under these trouble conditions, which result from power failure, there is no actuation of relay 37 in the Wheatstone bridge circuit. Thus an inspection of the position of the pointer 40 will show that the trouble condition does not exist in the detector circuit, but elsewhere in the system. If the power supply interruption is of a temporary nature, the trouble alarm circuit 50 will be automatically opened by relay 14 as soon the power supply is reestablished.

Another condition which may occur is gradual weakening of the power supply 10. The system will react to this condition in the same manner as it does to power failure, as it is in a sense a form of failure or deterioration. When the voltage of the battery 10 drops to a predetermined value, say from nine volts to approximately six volts, or about 60% of full strength, there will be insufficient current flow in the power circuit to keep relay 14 actuated. Therefore the trouble alarm circuit 50 will again be completed to give indication of a trouble condition. It is to be noted that even under this condition, the system is capable of detecting fire and establishing the alarm circuits 48 and 49. The relay 14 may be selected to have any suitable energization characteristic, say, as low as 25% of the power supply rating, this being somewhat a matter of choice.

The foregoing serves to illustrate the manner in which the system is supervised so that any trouble condition is immediately announced without the necessity of any periodic test or inspection of the system. The detector system can thus be relied upon to perform its primary function of fire detection.

If an uncontrolled fire condition occurs in any supervised area, there will be an abnormal increase in temperature which will cause a fusible link 36 to melt when a predetermined temperature is reached. If, for example, the fusible link 36 in thermal unit 31c should melt, then the Wheatstone bridge would be unbalanced due to the infinite resistance introduced into the arm 34 of the bridge. The pointer 40 of relay 37 would then be deflected to

magnetic contact 42 to close the circuit 43—45 across positive bus line 22 and negative line 18. The elements 13 and 14 are thus short circuited to permit actuation of relays 11 and 12, as well as to cause the closing of trouble alarm circuit 50.

The actuation of relay 12 closes the external alarm circuit 49 to energize siren 53. The actuation of relay 11 closes the internal alarm circuit 48 to energize bell 51 and locator relay 52.

Upon actuation of relay 52, the switch gang 46 closes to establish the parallel circuits through contacts or switches 46a, 46b, 46c and 46d, thereby energizing lamps 32a, 32b and 32d, even though the series circuit through the lamps has been opened by the melting of the fusible linke 36 in thermal unit 31c. However, lamp 32c will not light due to the breaking of the circuit in thermal unit 32c.

It will be apparent that when the system senses a fire condition, all the alarm circuits, including independently powered alarm circuit 50, are energized. This condition can therefore be readily distinguished from the trouble conditions heretofore described wherein only the circuit 50 was energized. By using the separate alarm circuits to distinguish between fire conditions and trouble conditions, false fire alarms are minimized thereby not exposing the occupants of the premises to the confusion and fear which would otherwise result. It will also be noted that the alarm circuit 50 will remain operative, even if the fire disrupts the power supply to the circuits 48 and 49.

As above described, the lamp 32c relating to thermal unit 31c, will not be lit, whereas the other lamps will remain lit. Thus there is a visual indication of the location of the fire area which serves to direct control efforts to the danger area without the necessity of time-consuming search.

If there is any break in the wiring or elements of the thermal units 31, the detector system would react in the same manner as it does to a fire condition.

It will be understood that all the components of the detector system, with the exception of the thermal units 31 and the external alarm 53, may be physically grouped in a centrally-located control box or the like. The lamps 32 may be associated with suitable indicia of area location. By having the lamps 32 lit during alarm, a sufficient degree of illumination is provided at the control box to enable its location to be readily determined in the dark. Under fire conditions, those lamps 32 which remain lit serve to illuminate the indicia of area location so that the area of the fire (designated by the extinguished lamp) can be quickly noted. Secondly, the lamps 32 will provide some degree of illumination in the event of failure of the main power supply serving the premises.

The fusible link 33 serves to sense any fire condition in the vicinity of the control box and will cause the detector system to sound all alarms in the manner above-described, when it breaks the circuit in arm 34 of the Wheatstone bridge.

After the condition causing the fire alarm has been remedied, the detector system can be restored to normal operating condition by resetting of the relay 37. It will be noted that under fire alarm conditions, the circuit 43—40—42—45 short circuits the Wheatstone bridge and thereby protects the sensitive relay 37 against current overload.

In Figs. 2, 3 and 4, I have shown the structural details of a preferred form of thermal unit 31 for use in the detector system. In Fig. 3 the electrical elements are not shown, so as to permit clarity of illustration.

The thermal unit 31 includes a base 58 adapted to be secured to a mounting surface, such as a wall or ceiling, by means of suitable fasteners 59. The base 58 is preferably molded of a rigid synthetic resin and has integrally formed thereon a centrally projecting stud 60. An opening 61 is provided for the connecting wires.

A circular cover 62, also preferably of molded synthetic resin, is provided with a central embossment 63 for threaded engagement with the stud 60. The cover 62 has an annular flange 64 having a greater diameter than the base 58, thereby providing an unobstructed annular space 65 for circulation of air through the unit. This arrangement permits ready removal of the cover 62 for inspection of the unit, while at the same time providing a ventilating area which is not subject to clogging.

Secured to terminal posts 66 on the base 58 are the resistor element 35 and the fusible link 36, electrically connected in series with each other and with other elements of the circuit by means of conductors 67. There are no movable contacts associated with the link 36, as is the customary practice, as it is my desire to keep the detector system as free as possible from movable contacts which often provide points of failure due to in-operativeness or fouling of the contacts. The link 36 is clamped against the surface of base 58 by knurled lugs 68 and is exposed to the ambient temperature of the air. The circuit-breaking function of the link 36 is thereby effected directly, without reliance upon any associate contact mechanism.

When the thermal unit is mounted on a vertical surface, such as a wall, it is mounted with the link 36 in the uppermost position, so that it will be closest to the uppermost layers of air near the ceiling and thereby more quickly respond to conditions of overheating.

In Figs. 5 and 6, I have shown a modified form 31' of the thermal unit which is more sensitive to the rate of rise of temperature than is the first-described detection system. This modified system will detect and indicate a rapid rise in temperature under conditions where the fusible link 36 will respond only after a time lag.

The modification provides for the addition of a thermocouple element 69 to the circuit elements of the thermal unit 31. The thermocouple cold leads 70—71 are electrically connected in parallel across the fusible link 36. The hot junction 72 is exposed to the air exteriorly of the unit 31. During normal operation, the thermocouple will not disturb the electrical balance of the system, as it is short-circuited by the link 36. In response to a sudden rise in temperature, for example, a rate of rise of 25° F. per minute, the thermocouple will generate an electrical current of sufficient value to melt link 36. The thermocouple then becomes a series element of the circuit and must have a characteristic resistance of sufficient value to unbalance the Wheatstone bridge as well as to dim or extinguish the lamp 32. In a system having the electrical characteristics heretofore mentioned, a thermocouple having a resistance value of more than double the resistance of resistor 35 will effect the desired result.

It will be understood that the modified system will respond to a gradual rise in temperature to a predetermined value by melting of the fusible link, apart from any generated EMF by the thermocouple.

Except as above noted, the operation of the modified detection system is in all respects the same as the form shown in Fig. 1.

It is to be understood that the forms of my invention, herewith shown and described, are to be taken as preferred examples of the same, and that various changes in the shape, size and arrangement of parts may be resorted to, without departing from the spirit of my invention, or the scope of the subjoined claims.

Having thus described my invention, I claim:

1. In a fire detection system of the character described, the combination of an electrical power supply, a normally open alarm circuit, an alarm circuit-closing element electrically connected in series with said power supply and responsive to a predetermined energization value to effect closing of said alarm circuit, a fixed resistance connected in series with said element, said resistance depressing

current flow through said element to a value below said predetermined energization value, a normally open shunt circuit connected in parallel with said resistance, a closed thermo-responsive detection circuit connected to said power supply, and a switch element in said shunt circuit, said switch element being actuated in response to interruption of said thermo-responsive detection circuit, whereby to close said shunt circuit and thereby effect actuation of said alarm circuit closing element.

2. In a fire detection system of the character described, the combination of an electrical power supply, a normally open alarm circuit, an alarm circuit-closing element electrically connected in series with said power supply and responsive to a predetermined energization value to effect closing of said alarm circuit, a fixed resistance and a relay connected in series with said element, said resistance depressing current flow through said element to a value below said predetermined energization value, a normally closed independently energized signal circuit, switch means responsive to actuation of said relay to open said signal circuit, a normally open shunt circuit connected across said resistance and relay, a closed thermo-sensitive detection circuit connected to said power supply, and a switch element in said shunt circuit, said switch element being actuated in response to opening of said thermo-sensitive detection circuit whereby to close said shunt circuit to effect actuation of said alarm circuit-closing element and deenergization of said relay to establish both said alarm circuit and said signal circuit.

3. In a fire detection system of the character described, the combination of an electrical power supply, a normally open alarm circuit, an alarm circuit-closing element electrically connected in series with said power supply and responsive to a predetermined energization value to effect closing of said alarm circuit, a fixed resistance and a relay connected in series with said element, said resistance depressing current flow through said element to a value below said predetermined energization value, a normally closed independently energized signal circuit, switch means responsive to actuation of said relay to open said signal circuit, a normally open shunt circuit connected across said resistance and relay, a closed thermo-sensitive detection circuit connected to said power supply, and a switch element in said shunt circuit, said signal circuit being closed by said switch means in response to deterioration of said power supply, and said switch element being actuated in response to opening of said thermo-sensitive detection circuit whereby to close said shunt circuit to effect actuation of said alarm circuit-closing element and deenergization of said relay to establish both said alarm circuit and said signal circuit.

4. In a fire detection system of the character described, the combination of an electrical power supply, a normally open alarm circuit, a locator relay connected in said alarm circuit, an alarm circuit-closing element connected in series with said power supply and responsive to a predetermined energization value to effect closing of said alarm circuit, a fixed resistance connected in series with said element, said resistance depressing current flow through said element to a value below said predetermined energization value, a normally open shunt circuit connected across said resistance, a closed thermo-sensitive detection circuit connected to said power supply, said thermo-sensitive circuit including a plurality of thermal units each connected in series with the other, each of said thermal units including a thermo-responsive circuit-opening element and a lamp connected in series, normally open switch means responsive to energization of said locator relay to connect each of said thermal units in parallel across said power supply, and a switch element in said shunt circuit, said switch element being actuated in response to opening of said thermo-sensitive detection circuit whereby to close said shunt circuit and thereby effect energization of said alarm circuit and actuation of said locator relay to establish said parallel circuit for

each of said thermal units in which no circuit opening has occurred.

5. In a fire detection system of the character described, the combination of an electrical power supply, a normally open alarm circuit, a locator relay connected in said alarm circuit, an alarm circuit-closing element connected in series with said power supply and responsive to a predetermined energization value to effect closing of said alarm circuit, a fixed resistance and a voltage relay connected in series with said element, said resistance depressing current flow through said element to a value below said predetermined energization value, a normally closed independently energized signal circuit, switch means responsive to actuation of said voltage relay to open said signal circuit, a normally-open first shunt circuit connected across said resistance and said voltage relay, a normally-open second shunt circuit connected across said voltage relay, a normally-balanced Wheatstone bridge connected in closed circuit with said power supply, one arm of said Wheatstone bridge defining a thermo-sensitive detection circuit, said thermo-sensitive detection circuit including a plurality of thermal units each connected in series with the other, each of said thermal units including a resistor, a lamp and a thermo-responsive circuit opening element connected in series, normally-open switch means responsive to energization of said locator relay to connect each of said thermal units in parallel across said power supply, a directional relay connected across said Wheatstone bridge and energizable in response to a condition of unbalance in said bridge, and switch means responsive to energization of said directional relay by one direction of current flow to close said first shunt circuit to effect actuation of said alarm circuit and said signal circuit and responsive to energization of said directional relay by countercurrent flow to close said second shunt circuit to effect only actuation of said signal circuit.

6. A combination as defined in claim 5, wherein a significant increase in the resistance of said one arm of said Wheatstone bridge causes current flow through said directional relay in said one direction, and a significant decrease in the resistance of said one arm of said Wheatstone bridge causes current flow in said counter-direction.

7. A combination as defined in claim 5, wherein said voltage relay is actuated by an energization value below said predetermined energization value but not below 25% to 60% of the power supply rating.

8. In a fire detection system of the character described, the combination of an electrical power supply, a normally open alarm circuit, a locator relay connected in said alarm circuit, an alarm circuit-closing element connected in series with said power supply and responsive to a predetermined energization value to effect closing of said alarm circuit, a resistor connected in series with said element, said resistor depressing current flow through said element to a value below said predetermined energization value, a normally-open shunt circuit connected across said resistor, a closed thermo-sensitive detection circuit connected to said power supply, said thermo-sensitive circuit including a plurality of thermal units each connected in series with the other, each of said thermal units including a thermo-responsive circuit opening element and electrical energy generating means electrically connected to said thermo-responsive circuit opening element, said generating means being responsive to a predetermined rate of temperature rise to impress a thermal overload on said thermo-responsive circuit opening element, normally open switch means responsive to energization of said locator relay to connect each of said thermal units in parallel across said power supply, and a switch element in said shunt circuit, said switch element being actuated in response to opening of one of said thermo-responsive circuit opening elements to

close said shunt circuit and thereby effect energization of said alarm circuit.

9. A combination as defined in claim 8, wherein said electrically energy generating means comprise a thermocouple having its cold junction established in parallel 5 with said thermo-responsive circuit opening element.

10. A combination as defined in claim 8, wherein said thermo-responsive circuit opening element is a fusible element.

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