Feb. 8, 1966 J. E. LINDBERG 3,234,537

FIRE DETECTION SYSTEM

Filed May 5, 1964 2 Sheets-Sheet 1

Fig. 1.

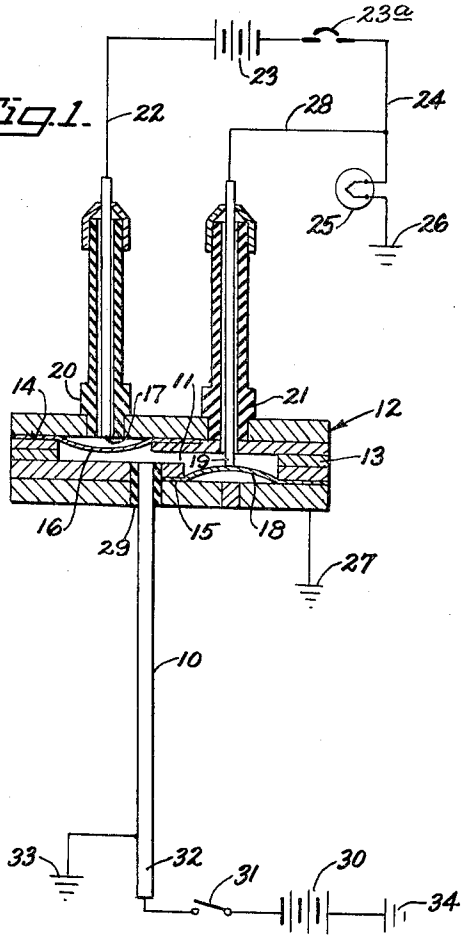


Fig. 2.

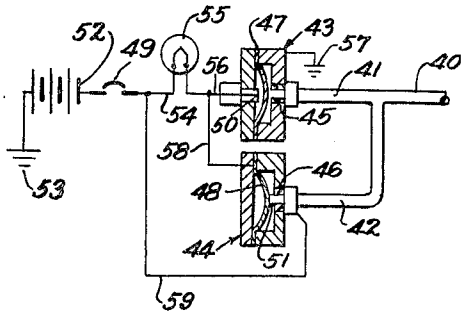
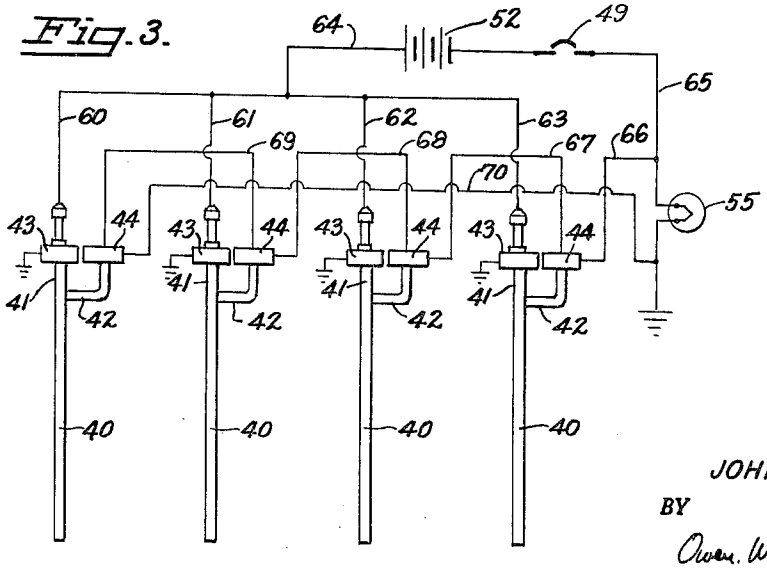


Fig. 3.



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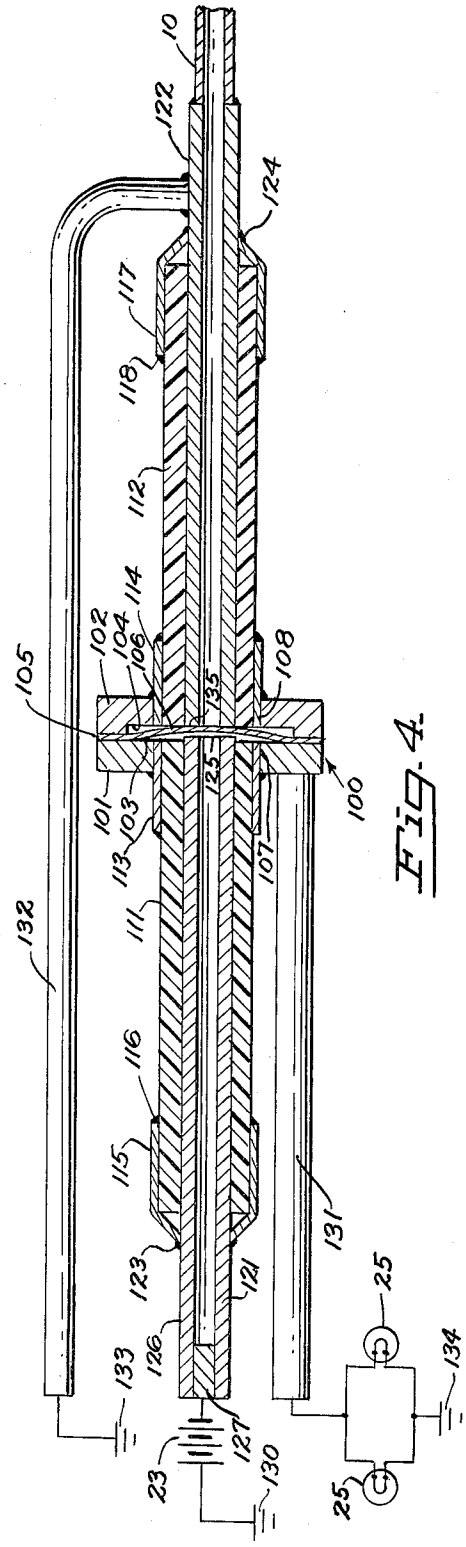


Fig. 4.

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FIRE DETECTION SYSTEM

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11 Claims. (Cl. 340—229)

This invention relates to improvements in fire detection systems. This application is a continuation-in-part of application Serial Number 252,730, filed January 21, 1963, now abandoned.

Fire detection systems have long been prone to give false alarms. When the system is installed on an airplane, the consequences of a false alarm are very grave, because the pilot must immediately take drastic remedial action, including the jettisoning of fuel and the search at once for a suitable place to land. Every false warning is very expensive to an airline, and some false warnings result in crashes.

The present invention provides a fire detection system in which the probability of the occurrence of a false warning is unusually low. In fact, it is nearly impossible to obtain a false warning from the fire detection system of this invention.

A preferred form of the invention entails the use of a fire detection or temperature-sensitive sensor in connection with two sensor-actuated switches, one of which is normally open and one of which is normally closed. A power source and a warning device are connected in series with the normally open switch, and the normally closed circuit is connected in parallel with the warning means. In true operation, the sensor simultaneously closes the normally open switch and opens the normally closed switch, so that the power source actuates the warning signal. However, when there is no true actuation, any short circuit around the normally open switch that would ordinarily cause a false-warning type of actuation of the warning device is nullified by the parallel connection, which provides a dead short through the normally closed switch around the signal device, and thereby prevents the actuation of the signal device.

Addition advantages and features of the invention will appear from the following description of a preferred form thereof.

In the drawings:

FIG. 1 is a circuit diagram of a fire detection system embodying the principles of the invention, with an actuator shown in elevation and in section, the vertical thicknesses of the members being greatly exaggerated.

FIG. 2 is a circuit diagram of a modified form of system embodying the principles of the invention, showing also a modified actuator, in elevation and in section, thicknesses again being greatly exaggerated.

FIG. 3 is a circuit diagram showing how several of the sensor-responder combinations of FIG. 2 can be placed in the same circuit with a single power source and a single warning device.

FIG. 4 is a circuit diagram of another modified form of the invention, another form of actuator being shown in elevation and in section, thicknesses again being greatly exaggerated.

The device shown in FIG. 1 includes a suitable temperature-detecting sensor **10**; for the purposes of this explanation, the sensor **10** may be considered as one like that described and claimed in my patent application Serial No. 102,622 filed April 10, 1961, now abandoned, namely, a tube closed at one end and containing some metallic hydride and also a noble gas. This device responds to temperature increases by an increase in internal pressure. When the temperature reaches a predetermined warning level, the pressure within the sensor **10** and within a chamber **11** with which the interior of the sensor **10** communicates, reaches a predetermined level which is used to actuate one or more pressure switches.

Here, the sensor **10** is shown connected to a responder **12** having a body **13** and a pair of metal diaphragms **14** and **15**. The diaphragm **14** has as its active portion a spherical segment or blister **16** which is actuated at the critical pressure in the chamber **11** to move upwardly toward a flattened position against an electrode **17**. The diaphragm **15** has a similar blister **18** which is actuated downwardly toward a flat position at the same critical internal pressure, to move it away from an electrode **19** with which it is normally in contact. The diaphragm blister **16** and electrode **17** operate as a normally open switch, while the diaphragm blister **18** and electrode **19** form a normally closed switch. If the responder body **13** is metal, the electrodes **17** and **19** are insulated from the body **13** by suitable insulating means such as ceramic tubes **20** and **21**.

The electrode **17** is connected by a wire **22** to a battery **23**, and the battery **23** is connected (preferably through a circuit breaker **23***a*) by a wire **24** to a suitable warning device, such as a signal lamp **25**, although a bell or any other type of warning device may be used. The lamp **25** may be connected to a ground **26**, and the body **13** is connected to a ground **27**, so that the lamp **25**, battery **23**, and normally open switch **16**, **17** are in series. The electrode **19** is connected in parallel with the lamp **25** by a lead **28** which is located as close to the lamp **25** as possible, and by the grounds **26** and **27**. The sensor **10** is insulated from the responder body **13** by a suitable insulator fitting **29**. This enables the use of a separate electrical circuit comprising a second battery **30**, a switch **31**, a portion **32** of the sensor **10** itself, and two ground points **33** and **34** to heat the sensor portion **32** electrically in order to cause a test actuation of the device.

The system of FIG. 1 operates as follows: when the internal pressure in the sensor **10** and chamber **11** reaches its predetermined critical point, either due to the use of the test circuit **30**, **31**, **32**, **33**, **34**, or by actual fire conditions, that pressure moves the two diaphragm blisters **16** and **18** simultaneously, the diaphragm **16** moving upwardly to touch the electrode **17** and thereby close its normally open circuit, the diaphragm **18** moving downwardly away from the electrode **19** thereby to open its normally closed circuit. As a result, the circuit comprising the diaphragm **16**, the electrode **17**, lead **22**, the battery **23**, lead **24**, the warning device **25** and the two grounds **26** and **27** are in series and the warning device is actuated; i.e., the lamp **25** will light.

Only the reading of the critical pressure will move these diaphragm blisters **16** and **18**; so no false warning can come from that source. If, when the sensor pressure is below the critical level, the battery **23** should get grounded into any other part of the circuit or anywhere on the lead **22** or elsewhere, the lamp **25** will not be operated because the normally closed switch **18**, **19** is closed and simply shorts out the battery **23** around the lamp **25**. The circuit breaker **23***a* or a suitable load (see FIG. 4), prevents this shorting from draining the battery **23** or damaging the wiring.

The system of FIG. 2 is substantially the same in principle as that of FIG. 1. Here, a sensor **40** is provided with two terminal branches **41** and **42** leading to separate and completely isolated responders **43**, **44** which may be made from insulating material or may instead be insulated by insulators **45**, **46** from the sensor branches **41**, **42**. The responders **43**, **44** have respective conductive diaphragms **47**, **48**. Normally, that is, at all internal sensor pressures below the critical actuation level, the diaphragm **47** is spaced away from its associated electrode **50**, but at the critical pressure, the diaphragm **47** is closed

against the electrode 50. Normally, the diaphragm 48 is closed against its electrode 51, but at the critical pressure, the diaphragm 48 is moved away from the electrode 51.

A battery 52 is connected at one side to a ground 53 and at its other side it is connected (through a circuit breaker 49) by a lead 54 to a warning device 55, which, in turn, is connected by a lead 56 to the electrode 50. The diaphragm 47 is grounded at a ground 57. A parallel circuit for the normally closed switch 48, 51 is provided by a lead 58 to the diaphragm 48 and a lead 59 to the electrode 51. Operation is about the same as for the system of FIG. 1, and in the same way false warnings are avoided by the normally closed switch 48, 51 in parallel with the lamp 55.

FIG. 3 shows a plurality of devices like that of FIG. 2 with the electrodes 50 of the normally open switches in the responders 43 being connected in parallel with each other by wires 60, 61, 62, 63 and by the wires 64 and 65 in series with the battery 52 and the warning device 55, while the electrodes 51 of the normally closed switches are connected in series with each other by wires 66, 67, 68, and 69 and in parallel with the lamp 55 (by the line 70), to provided the saving or false-warning-prevention circuit.

FIG. 4 shows a system basically like that of FIG. 1, but with some significant differences. Here, the sensor 10 is connected to a novel responder unit 100 having two body members 101 and 102, both preferably of metal. The inner surface 103 of the body member 101 is preferably flat, while the facing inner surface of the body member 102 is preferably provided with a shallow recess 104. A metal diaphragm 105 is hermetically brazed between the two body members 101 and 102 and has a blister 106, which is shown in its unstressed position. The body members 101 and 102 have respective central openings 107 and 108.

Two ceramic tubes 111 and 112 are provided, both in order to provide insulators, and the tube 111 is brazed to the body member 101 in the opening 107, by means of a brazing tube 113, while the tube 112 is brazed to the body member 102 in the opening 108 by means of a brazing tube 114. An end closure member 115 is brazed to the outboard end of the ceramic tube 111 by a braze 116, and an end closure member 117 is brazed to the outboard end of the ceramic tube 112 by a braze 118. The end closure members 115 and 117 are tubular and are brazed respectively to tubular electrode members 121 and 122 by brazes 123 and 124. The electrode 121 need not be tubular, especially at its electrode end 125 where it projects very, very slightly beyond the flat surface 103; that part may be solid. If the electrode 121 is tubular, its outer end 126 is sealed, as by a brazed wire 127. The tubular electrode 122 is brazed to the sensor 10 and its interior passage 188 provides the communication between the sensor 10 and the responder chamber.

The outer end 126 of the electrode 121 provides a terminal or contact member, and this contact 126 is the one that is connected to the battery 23, the other side of the battery being grounded, if desired, by a suitable ground 130. If desired, a return line, closed system may be used instead.

A second contact 131 is brazed to the body member 101, while a third contact 132 may be brazed to the electrode 122. The contact or terminal 132 is grounded by a ground 133. The contact or terminal 131 is connected to the signal lamps 25, the other side of which is either directly connected to the battery 23 or is grounded at 134 to produce the same net effect.

The diaphragm blister 106 has two positions: a rest unstressed position where it rests on an end 135 of the grounded electrode 132, and an actuated position when an increased pressure in the sensor 10 pushes it against the power electrode 126. The lamps 25 are lighted only when the blister 106 engages the power electrode 126. When the blister 106 engages the grounded electrode 132, the power circuit is open, and even if there should be a short circuit from it to the battery 23, the grounded electrode 132 would prevent actuation of the lamps 25. The sensor 10 may include a heater test circuit like that shown in FIG. 1.

These various forms of the invention each have their own uses and are illustrative of the principles of the invention, though not exhaustive thereof.

To those skilled in the art to which this invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the spirit and scope of the invention. The disclosures and the description herein are purely illustrative and are not intended to be in any sense limiting.

I claim:

1. A temperature detection system including in combination:
- a source of electrical power,
- an electrically actuated signal device in series with said source,
- low-resistance shunt means around said signal device to prevent actuation thereof when the power is on,
- normally closed freely openable and reclosable switch means in said shunt means for opening said shunt means,
- a temperature detector connected to said switch means for causing it to open said shunt means at any time a predetermined critical temperature is attained by said detector, said shunt means being closed again when said detector temperature drops below the critical value, and a second normally open switch means in series with said power source and said signal device, connected to said temperature detector for actuation thereby, being closed thereby at said predetermined critical temperature, both closure of said second switch means and opening of said shunt means being required for actuation of said signal device.

2. A fire detection system, including in combination:
- heat-detection sensor means for increasing pressure with temperature,
- first and second pressure-responsive switch means actuated at the same critical temperature and both connected to said sensor means for pressure response,
- said first pressure responsive switch being normally open,
- said second pressure responsive switch being normally closed,
- an electrically actuated warning device in parallel with said second pressure responsive switch, and
- a source of electrical potential, connected in series with said first pressure responsive switch and said warning device.

3. The system of claim 2 having a second source of electrical potential for heating said sensor means to the critical temperature, and switch means for actuating said second source at will to test the operability of the system.

4. The system of claim 2 wherein said first and second pressure responsive means comprise two electrically-conductive diaphragms in the same electrically-conductive housing, and electrodes insulated from said housing.

5. The system of claim 4 wherein said housing is grounded and so is said warning device.

6. The system of claim 2 wherein said first and second pressure responsive means comprise first and second electrodes facing each other in a housing and a single electrically-conductive diaphragm between them, normally resting against said second electrode and cooperating with it to form said second switch, said diaphragm being movable away from said second electrode, to open said second switch, and against said first electrode, with which it provides said first switch, to close said first switch.

7. The system of claim 6 wherein said second electrode is grounded and so is said warning device.

8. The system of claim 2 wherein said first and second pressure responsive means are in separate isolated hous-

ings and said sensor is branched to communicate with both of them.

9. A fire detection system, including in combination:

a plurality of heat-detection sensor means for increasing pressure with temperature,

a corresponding plurality of first and second pressure responsive switch means isolated electrically from each other and actuated at the same critical temperature, one of each being connected to each said sensor means for pressure response, each said first pressure responsive switch being normally open, each said second pressure responsive switch being normally closed,

a single electrically actuated warning device, and

a single source of electrical potential,

all said first switches being connected in parallel with each other and in series with said source and said warning device,

all said second switches being connected in series and in parallel with said warning device.

10. A device for use in temperature detection with a sensor in which a temperature increase leads to a pressure increase, comprising,

a housing comprising facing first and second body members, each having a central opening, said second body member having a recess,

a diaphragm sealed between said first and second body members and having a blister normally in said recess,

first and second insulating tubes sealed in the respective central openings of the first and second body members respectively, and

first and second electrodes sealed to an outer portion of said insulating tubes,

said second electrode being tubular for connecting the interior of said sensor to said diaphragm, an end of said second electrode extending into said recess and said blister normally resting against it,

said first electrode extending beyond said first housing member for contact with said diaphragm when sensor pressure flexes said blister thereagainst.

11. The device of claim **10** having means for grounding said second electrode and having said first electrode providing first contact means and having second contact means electrically connected to said housing.

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NEIL C. READ, *Primary Examiner.*