July 10, 1962 A. T. ABROMAITIS 3,044,050

FIRE DETECTION SYSTEM

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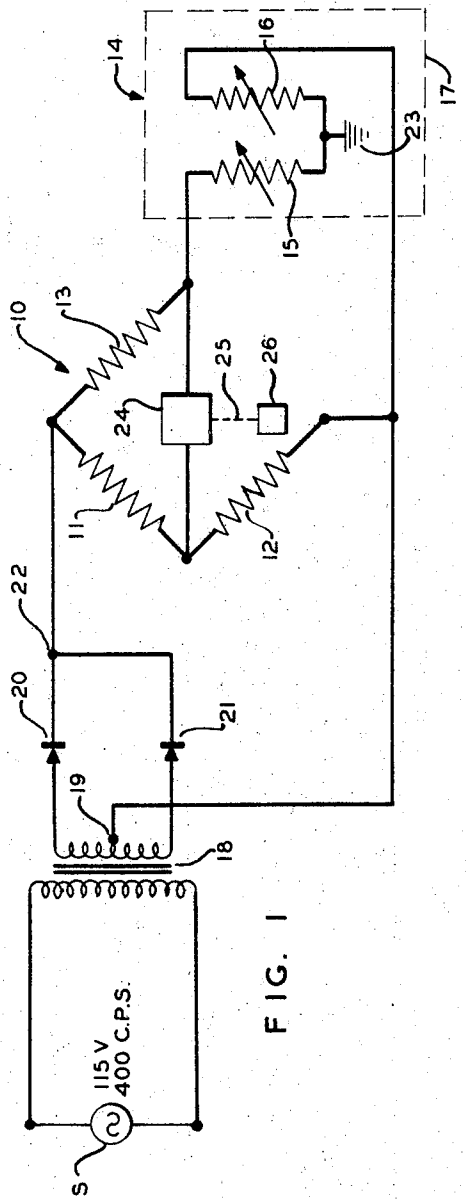


FIG. 1

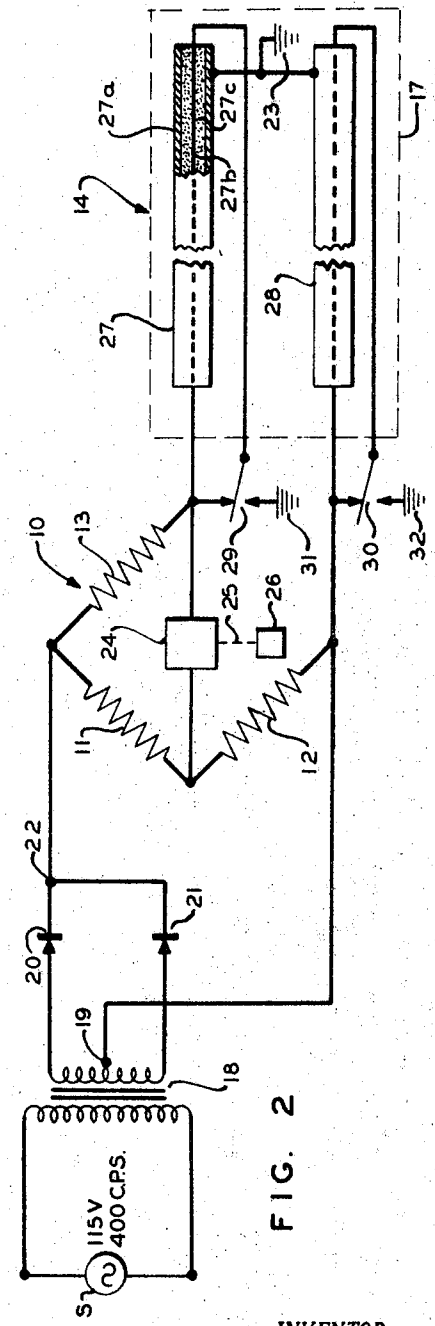


FIG. 2

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FIRE DETECTION SYSTEM

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This invention relates to fire detection systems of the type using temperature-responsive resistance-variable sensing devices, and more particularly it relates to an improved form of such system wherein two of such sensing devices are used in a novel manner in the space being monitored to provide greater reliability in the operation of the system.

The present fire detection system uses typically sensing devices of cable form such as are described and claimed in the Kelly et al. Patent No. 2,740,874, issued April 3, 1956. Such fire detector cables have a center wire and a spaced metallic sheath with an intervening semiconductive material which has a negative temperature coefficient of resistance. The fire detection system will provide an alarm when any portion of such cable is overheated. The advantage of using a sensing device of cable form is that the cable can be disposed throughout the whole area to be monitored for fire. This form of fire detection system is now commonly used on aircraft for detecting engine oil fires. In this application the system must perform with utmost reliability not only in giving a positive alarm when fire occurs but also in having maximum freedom from false alarm, notwithstanding that the conditions of use are very severe.

It has been found from experience that usually when failure or false alarms occur it is because of an open or short-circuit condition in the sensing cables or associated circuitry arising from the heavy vibration and varying weather and temperature conditions to which the cables are exposed. The present invention is designed to reduce to a minimum this source of failure of the system by using two fire detector cables in side-by-side relationship throughout the area being monitored for fire but with the cables connected serially to form a single unitary sensing device. More particularly, the invention is in using two of such parallel disposed, electrically serially connected cables as a single arm of a Wheatstone bridge which has a receiving device diagonally connected thereto with the bridge adjusted to provide an alarm or other indication when the bridge is in a balanced or null condition.

An object of the invention is therefore to provide an improved fire detection system which has the utmost in reliability adapted to meet the high standards required of fire detection systems for aircraft.

A further object is to provide such improved system which can be easily checked for operability both as to short- and open-circuits in the sensing devices and associated circuits.

A still further object is to provide a fire detection system of improved reliability having a minimum complication over the prior forms of fire detection systems using single fire detector cables.

Still further objects and features of the invention will be apparent from the following description and the appended claims.

In the description of the invention reference is had to the accompanying drawings, of which:

FIGURE 1 is a purely schematic circuit diagram of electrical system embodying the invention; and

FIGURE 2 is a schematic circuit diagram of the present fire detection system, showing the cables in diagrammatic form with respective test circuits therefor according to the invention.

The circuit shown in FIGURE 1 comprises an electrical

bridge **10** having one branch with fixed impedance arms **11** and **12** and a second branch with one fixed impedance arm **13** and a variable resistance arm **14** constituting the sensing means of the fire detection system. In accordance with the invention the arm **14** comprises two temperature-responsive, serially connected, resistance type sensing devices designated in the circuit simply as variable resistors **15** and **16**. These temperature sensitive resistors are located along each other in an area to be monitored represented by the dash-dot enclosure **17**. The arm **12** opposite that of the sensing means is a resistor which determines the state of balance of the bridge when the sensing means is at a predetermined operate temperature. The arms **11** and **13** are preferably resistors as shown but could be reactive impedances if an A.C. source of potential were employed. Preferably, the present bridge is operated from a D.C. supply derived from the 115 volt, 400 c.p.s. source S as typically provided on aircraft. This source is connected through a transformer **18** having a secondary winding with a center tap **19** forming one terminal of the D.C. supply to the bridge, the secondary winding being connected through respective half wave rectifiers **20** and **21** to a junction **22** forming the other terminal of the D.C. supply. Such D.C. supply may be ungrounded to permit an intermediate point **23** of the sensing means to be grounded for reasons which will be apparent. Connected diagonally of the bridge from the junction point between the arms of one branch to the junction point between the arms of the other branch is a receiving device **24** controlling through a line **25** an alarm or other indicating device **26**, as diagrammatically shown. The receiving device may compise simply a sensitive relay or it may include also a magnetic or transistor amplifier permitting the use of a less sensitive and more rugged relay. The receiving device may be set to operate when the bridge is in a predetermined state of unbalance, but preferably in order to reduce sensitivity of the system to variations in the voltage supply the bridge is adjusted so that it will be substantially balanced at the operate temperature. The receiving device is therefore one which will provide an alarm or other indication when the control current in the diagonal arm of the bridge is at a predetermined minimum value.

The circuit shown in FIGURE 2 differs from that in FIGURE 1 only in that the sensing means **14** of the bridge is shown in more detail as comprising respective fire detector cables **27** and **28** of the resistance type described in the Kelly et al. Patent No. 2,740,874 beforementioned. For example, cable **27** has a flexible metallic sheath **27*a***, a center wire **27*b*** running the length thereof and an intervening semi-conductive material **27*c*** such as of a manganese oxide. Such cables have a negative temperature coefficient of resistance causing them to have a high resistance between the center wire and sheath at low temperatures and a sharply decreasing resistance as any portion of the cable is heated to a predetermined elevated temperature, the resistance being typically 100 ohms or less when the heating is to an overheat or flame temperature. The cables are mounted along-side each other in the space **17** being monitored. In applications for detecting engine oil fires on aircraft, the cables are mounted on the fire wall behind the engines with ground connection of the sheaths to the airplane structure as indicated at **23**. To facilitate testing, the cables **27** and **28** have center wire terminals at each end, which are normally interconnected through respective single-pole double-throw test switches **29** and **30**. One end terminal of each cable has a permanent connection to the bridge so that the conductive path of the sensing arm **14** is from center wire to grounded sheath of one cable and from grounded sheath to center wire of the other cable. The permanently connected end terminal of each cable is connected also to a

contact of the respective test switch, the pole member of the test switch is connected to the other or far end terminal of the respective cable and the other contact of the test switch is grounded, the grounds for the switches **29** and **30** being respectively at **31** and **32**. Thus, when either test switch is operated it breaks connection of the far end terminal from the end terminal connected directly to the bridge, and connects the far end terminal to ground.

If a short circuit develops in the single cable systems as heretofore used, the receiving device is operated to give a false alarm. It is especially important in aircraft fire detection systems to avoid ever giving any false alarm. In the present dual cable system a short-circuit in either cable will not give a false alarm and will not even render the system inoperable but has only the effect of reducing slightly the operate temperature at which an alarm is given, the amount by which the operate temperature is so reduced being typically about 40° F. for the type of cable herein particularly considered. The advantage of the present invention resides in the probability that both cables will not likely develop a short-circuit at the same time, that such fault in either cable will not give rise to a false alarm and that such fault in either cable can be easily detected by the test means described.

Because of the dual connection made to each cable an open circuit in either cable, such as a break in the center wire or even the whole cable, or a break in the circuit connection at either end of the cable, will not give any false alarm or affect the operation of the system. However, once any such open circuit has developed at one point in either cable the system would be seriously impaired were such open circuit to develop at still another point. It is therefore important to be able to detect also by the present test means whenever any open circuit condition has developed.

The test means has the following operation: normal operation is indicated when upon pressing either test switch no alarm is given and upon pressing both test switches at the same time an alarm is given. A short-circuit condition is indicated in one cable or its circuitry when upon pressing the test switch of the other cable an alarm is given. An open circuit condition is indicated when upon pressing both test switches at the same time no alarm is given.

From the foregoing description it will be apparent that I have provided a fire detection system which will not likely ever produce a false alarm from the usual faults which may occur; and further, the occurrence of any such usual fault can be detected readily by a simple test operation. Moreover, the invention is carried out with a

minimum complication over the prior fire direction systems.

The embodiment of my invention herein particularly shown and described is intended to be illustrative and not limitative of the invention since the same is subject to changes and modifications without departure from the scope of my invention, which I endeavor to express according to the following claims.

I claim:

1. A fire detection system comprising a pair of fire detector cables each having a pair of spaced apart conductors separated by a temperature-responsive resistive material which is essentially an insulator at room temperature and a conductor at a predetermined elevated temperature indicative of fire, said cables having resistances which vary continuously as the temperature changes progressively from said room temperature to said predetermined elevated temperature, said cables being positioned alongside each other and exposed equally to overheat conditions in the space being monitored, an electrical bridge comprising two parallel-connected branches of which one branch comprises two fixed impedance arms serially connected and the other branch comprises a third fixed impedance arm serially connected with a fourth arm including said cables electrically serially connected via the center wire and sheath of one cable and the sheath and center wire of the other cable in the sequence here named, and a receiving device connected between said branches diagonally of said bridge for providing an indication when a source of voltage is applied across said branches and a portion of each of said cables is heated to said predetermined elevated temperature.

2. The fire detection system set forth in claim 1 including an underground source of D.C. potential connected across said branches, and a connection between the sheaths of said cables connected to ground.

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