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(54) Sensor cables and installations incorporating them.

(57) A heat-detector cable comprises first and second digital heat-detector elements assembled in close proximity, each comprising a pair of conductors biassed towards each other but normally prevented from contacting by a coating of a fusible insulating material on at least one of them, the response characteristics of the said first and second elements on exposure to hazardous temperatures differing such that the first said element responds sooner than the second. Preferably the fusible materials have substantially different softening temperatures, that in the first element having the lower softening temperature. Fire or overtemperature conditions can be distinguished from faults by the difference in response times.

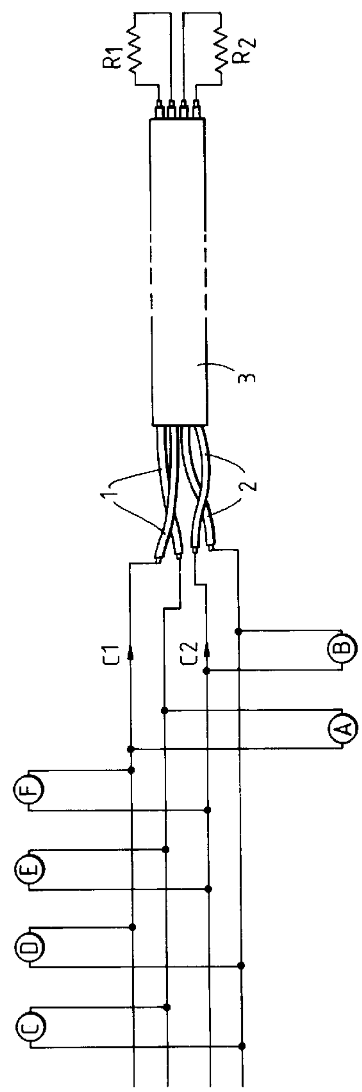

Fig.1.

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This invention relates to sensor cables for the detection of fires or other hazardous temperature-rise conditions (hereinafter for brevity called "heat sensor cables") and to installations in which they are used.

Beat sensor cables at present on the market are of two kinds:

The first kind, sometimes called an "analogue" sensor cable, has two or more conductors which are spaced apart from one another by a "sensitive" material whose resistivity (or some other appropriate property, but that has no particular relevance to the present invention) changes rapidly with temperature in the range of interest (typically all or part of the range from about 80°C to 250°C or in some cases higher). Detection circuitry continuously (or at very frequent intervals) monitors the resistance from one conductor to the other and compares it with a stored threshold value, giving an alarm if the monitored value exceeds the threshold.

The second kind, sometimes called a "digital" sensor cable, also has two conductors but in this case they are resilient ones biassed together but normally prevented from contacting one another by a coating of a fusible material; in this case an alarm is given if any measurable conductance from conductor to conductor is detected, since this indicates that the fusible coating has been melted (our prior UK Patent No.1461769 relates, but modern materials have raised the melting temperature limit for the fusible materials well over 200°C).

Each type has advantages and disadvantages. Analogue heat sensor cables are dependent not only on the uniformity and stability of the sensitive material but also on the stability of the detector circuitry and its power supply to provide the correct reference value; and since the resistance measured varies with the length that is hot, as well as its temperature, there is sometimes a risk of a high overall ambient temperature (due, for instance, to heatwave conditions or a stuck thermostat) producing an alarm because it has the same overall resistance from conductor to conductor as if a small flame were applied to one place on it while most of its length remained cold. Digital heat sensor cables avoid these difficulties.

On the other hand, digital heat sensors as hitherto known are unable to distinguish between the short-circuiting of the conductors that results from a temperature rise to be detected and short-circuiting of the conductors arising from some mechanical accident, while analogue sensors can discriminate by setting an upper threshold that can be reached only by a fault, and giving an alarm only if the monitored value remains between the two thresholds for a predetermined length of time (of the order of magnitude of a second).

False alarm signals are highly undesirable, particularly if the detector system automatically operates sprinklers, risking water-damage when there was no fire.

The present invention provides a digital heat-detector cable in which the risk of false alarms due to faults is greatly reduced.

The heat-detector cable in accordance with the invention comprises first and second digital heat-detector elements assembled in close proximity, each comprising a pair of conductors biassed towards each other but normally prevented from contacting by a coating of a fusible insulating material on at least one of them, the response characteristics of the said first and second elements on exposure to hazardous temperatures differing such that on exposure to temperatures sufficient to cause both elements to respond the first said element responds sooner than the second.

Preferably the different characteristics are obtained by use of fusible materials with substantially different softening temperatures, that in the first element having the lower softening temperature. Alternatively (but less desirably) the second element right have a thicker fusible coating (requiring more time to absorb the latent heat needed for melting) or a higher metallic cross-section (slowing response by increasing thermal capacity).

Subject to control of tension, the two elements could be helically twisted together, but we prefer to lay them parallel and secure with a sheath braid or binder.

Preferably each detector element comprises two steel wires each having a tensile strength in the range 1250-1650MN/m^2, helically laid up together with a lay length in the range 20-60mm without any substantial torsional deformation of either the wires, at least one of the two wires having a coating of an appropriate fusible insulating material.

Suitable fusible insulating materials include:

material	melting temperature
low density polyethylene	150°C
50% ethylene-vinyl acetate copolymer (50% vinyl acetate content), 50% clay	85°C
intermediate density polyethylene	110°C
high density polyethylene	135°C
polypropylene	190°C
ethylene/tetrafluoroethylene copolymer	236°C
fluorinated ethylene/propylene copolymer	236°C

The installation in accordance with the invention comprises the digital heat-detector cable defined, first monitor means for detecting conductance between the conductors of the first said element, second monitor means for detecting conductance between the conductors of the second said element, and discriminating means generating an "alarm" signal if the detection of conductance by the first monitor means is followed after the passage of a first preset time interval but before the passage of a second preset time interval and a "fault" signal if the detection of conductance by the first monitor means is followed by the detection of conductance by the second monitor means within the said first preset time interval or if it is not followed by the detection of conductance by the second monitor means by the end of the said second preset time interval.

Preferably a "fault" signal is generated also if the second monitor means detects conductance without (or prior to) the first doing so; if desired, further monitoring means may be provided for detecting the occurrence of conductance between conductors not belonging to the same heat detector element and for generating a "fault" signal if such conductance is detected.

Preferably the installation includes terminating resistors connected across the conductors of each element at the end of the sensor cable remote fron the monitors, so that the monitors will normally detect a finite conductance (the "quiescent conductance") and can detect and indicate a fault (an open-circuit fault) if the conductance falls to zero.

The invention will be further described, by way of example, with reference to the accompanying drawings in which Figure 1 is a diagram of a cable and installation in accordance with the invention and Figure 2 is a diagramatic logic algorithm for the system.

The cable shown in Figure 1 comprises two digital heat-detector elements each comprising a pair of wires, 1,1 and 2,2 respectively; the two elements are laid parallel to one another and secured together by a sheath 3 made of fluorinated ethylene-propylene copolymer, 0.5mm thick. The wires 1,1,2,2 are each of tinned steel with a diameter of 0.885mm and a tensile strength of 1400MN/m^2 coated with fusible polymeric insulating material to a wall thickness of 0.3 mm radial. The two wires of each separate element are laid up together with a lay length of 30mm, a tension of 20N/m^2 and without torsional deformation of the wires. The wires 1,1 of the first element have a coating of low density polyethylene with a melting 105°C and wires 2,2 of the second element a coating of polypropylene having a melting temperature of 190°C. The result of using this combination of materials is that the response time of the second element in a fire will be slower than that of the first by at least 0.4 seconds (even if rapidly engulfed by a hot flame) but not more than 25 seconds unless the fire is both small and slowly developing.

The first and second elements are terminated at one end of the cable by resistors R_1 and R_2 respectively, and a set of monitors is connected to the other end as shown. Monitor A continuously monitors the conductance between the two conductors 1,1 of the first detector and produces an output to a logic device (not shown) equal to 0 if the conductance monitored is zero, Q if it is equal to the conductance of resistor R_1 and 1 if the conductance has a higher value. Similarly Monitor B provides an output to the logic which is 0 if the conductance between the conductors 2,2 of the second element is zero, Q if it is equal to the conductance of resistor R_2 and 1 if it has a higher value; optionally further monitors C_1 to C_4 may monitor conductivity between the other combinations of wires in the complete cable, producing inputs to the logic device with the value 0 if the conductance monitored is zero (as it normally is) and 1 if it has any other value.

As represented by Figure 2, the logic device initially sets all flags to "off" and all timers to reset (stopped). In the absence of either alarm or fault conditions, it then scans monitors A to F in order, finding an output Q from monitors A and B and an output 0 from each of monitors D to F, and then repeats.

To deal first with the simpler situations, if an output of 0 instead of Q is found at Monitor A or Monitor B, "Fault 1" or "Fault 2" respectively is indicated, representing an open-circuit fault in the first or the second element respectively. If desired, the installation can on occurence of a fault of this kind be switched (automatically or manually) to a conventional mode of operation using the element that remains serviceable, so that protection is maintained, though with an increased risk of false alarms, until repair can be effected.

If an output of 1 instead of 0 is found at any one of monitors C to F, "Fault 3" is indicated, signifying a short circuit fault between conductors not in the same element.

If an output of 1 instead of Q is found at Monitor A, this may be due to a fire or other overtemperature condition calling for an alarm signal, or it may be due to a short-circuit fault in the element. To discriminate between these possibilities, the logic device starts its timer and sets flag T1 to indicate the start of the preset time periods; after expiry of a first preset period (0.4 seconds in this particular case), flag T2 is set and at the end of a second preset time period, of 25 seconds in the particular case, flag T3 is set.

If an output of 1 instead of Q is found at Monitor B, at any time, the logic first determines whether the T1 flag is set and if so whether flag T2 is set. If the T1 flag is not set, then the logic indicates "fault 5", signifying that the conductors 2,2 have gone to short circuit before the conductors 1,1 have done so (or without their doing so at all). If the T1 flag is set but the T2 flag is not, the logic indicates "fault 6", signifying that the conductors 2,2 have gone to short circuit within 0.45 of conductors 1,1 doing so, thus implying mechanical damage to the cable rather than a fire condition. If flags T1 and T2 are both set, the logic sets flag B1 and continues to scan. On completion of the scanning sequence, the logic scans the T3 timer end flag; if it is not set, scanning continues, but if it is, indicating that the second element has been short-circuited between 0.4 and 25 seconds after the first, the B1 flag is interrogated; if it is set, then the second element has become short-circuited beween 0.4 and 25 seconds after the first, and since this is almost certainly due to a fire/ overtemperature condition a "FIRE ALARM " is indicated; if it is not, the first element has been short-circuited for 25 seconds without the second becoming short-circuited, and so a Fault 4 is indicated, signifying a short-circuit fault in the first element. When "Fault 4" is indicated, preferably the installation is switched to an emergency mode in which the second element only is used in a conventional manner. In the event of an alarm arising in this mode, it may be considered appropriate to evacuate personnel and to inspect for fire (and for causes for false alarm) but not to actuate sprinklers automatically.

Claims

1. A heat-detector cable comprising first and second digital heat-detector elements assembled in close proximity, each comprising a pair of conductors biassed towards each other but normally prevented from contacting by a coating of a fusible insulating material on at least one of them, the response characteristics of the said first and second elements on exposure to hazardous temperatures differing such that on exposure to temperatures sufficient to cause both elements to respond the first said element responds sooner than the first.

2. A heat-detector cable in accordance with Claim 1 in which the fusible materials have substantially different softening temperatures, that in the first element having the lower softening temperature.

3. A heat-detector cable in accordance with Claim 1 or Claim 2 in which each detector element comprises

two steel wires each having a tensile strength in the range 1250-1650 MN/m^2, helically laid up together without any substantial torsional deformation of ether of the wires, at least one of the two wires having a coating of an appropriate fusible insulating material.

4. A heat-detector cable as claimed in any one of claims 1-3 in which the said fusible insulating materials are selected from low density polyethylene, 50% ethylene vinyl acetate copolymer/50%, clay, intermediate density polyethylene, high density polyethylene, polypropylene, ethylene/ tetrafluoroethylene copolymer or fluorinated ethylene/ propylene copolymer.

5. A heat-detector cable as claimed in any one of the preceding claims in which the two said elements are laid parallel to one another and secured together by a braid or binder.

6. A heat-detector cable substantially as described with reference to the drawing.

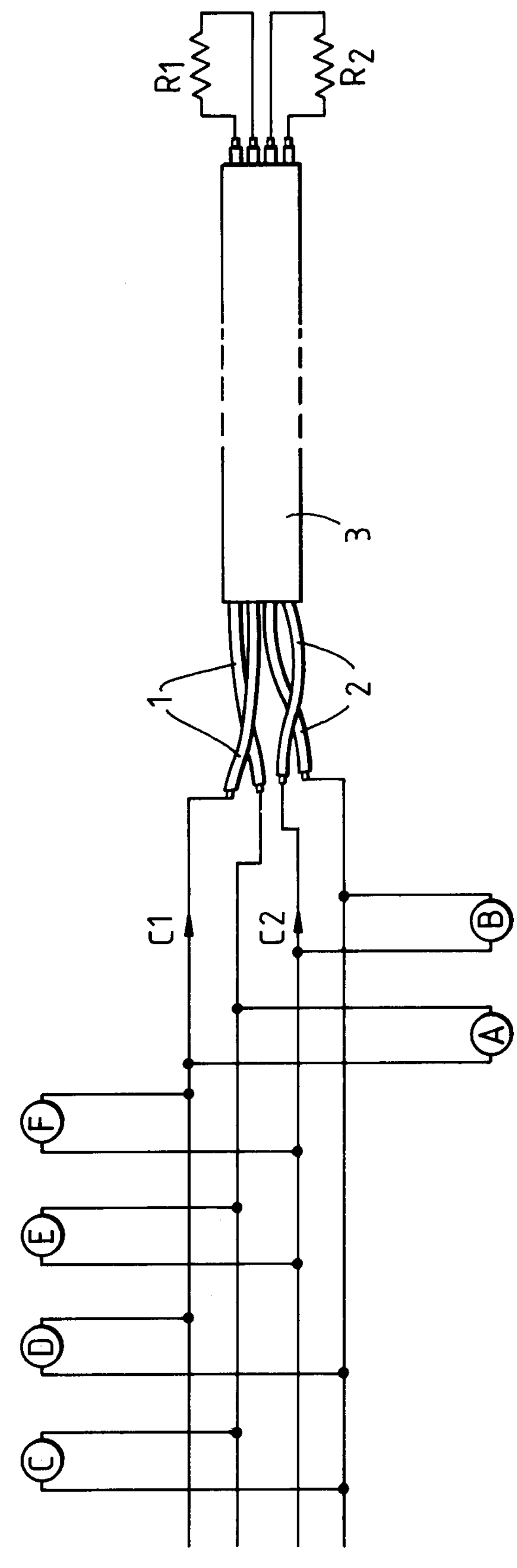
7. A heat-detector or cable installation comprising a digital heat-detector cable as claimed in any one of the preceding claims, first monitor means for detecting conductance between the conductors of the first said element, second monitor means for detecting conductance between the conductors of the second said element, and discriminating means generating an "alarm" signal if the detection of conductance by the first monitor means is followed after the passage of a first preset time interval but before the passage of a second preset time interval and a "fault" signal if the detection of conductance by the first monitor means is followed by the detection of conductance by the second monitor means within the said first preset time interval or if it is not followed by the detection of conductance by the second monitor means by the end of the said second preset time interval.

8. An installation as claimed in Claim 7 including additional means for generating a "fault" signal if the second monitor means detects conductance without (or prior to) the first doing so.

9. An installation as claimed in Claim 7 or Claim 8 including further monitoring means for detecting the occurrence of conductance between conductors not belonging to the same heat detector element and for generating a "fault" signal if such conductance is detected.

10. An installation as claimed in any one of claims 7-9 in which each said element is terminated by a resistor to enable monitoring for open-circuit faults.

Fig.1.



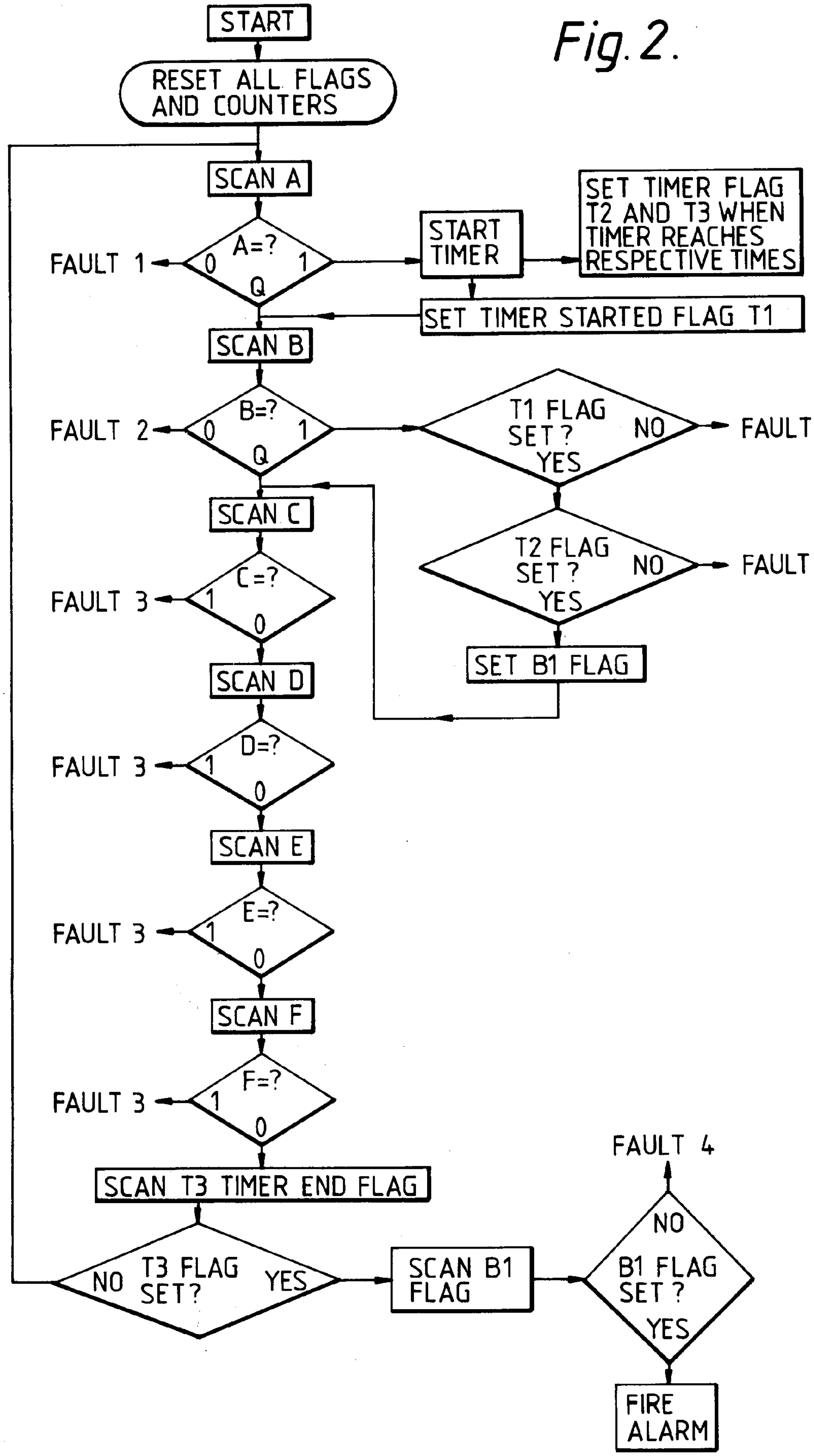

START
RESET ALL FLAGS AND COUNTERS
SCAN A
A=?
0
1
Q
FAULT 1
START TIMER
SET TIMER FLAG T2 AND T3 WHEN TIMER REACHES RESPECTIVE TIMES
SET TIMER STARTED FLAG T1
SCAN B
B=?
0
1
Q
FAULT 2
T1 FLAG SET ?
NO
YES
FAULT 5
T2 FLAG SET ?
NO
YES
FAULT 6
SET B1 FLAG
SCAN C
C=?
1
0
FAULT 3
SCAN D
D=?
1
0
FAULT 3
SCAN E
E=?
1
0
FAULT 3
SCAN F
F=?
1
0
FAULT 3
SCAN T3 TIMER END FLAG
T3 FLAG SET?
NO
YES
SCAN B1 FLAG
B1 FLAG SET ?
NO
YES
FAULT 4
FIRE ALARM

Fig. 2.

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EUROPEAN SEARCH REPORT

Application Number
EP 92 30 7781

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	DE-A-2 805 249 (DAVIES) * page 14, line 13 - page 16, line 25; figures 5-7 * & US-A-4 157 526	1,2,10	G08B17/06
Y	US-A-4 316 179 (BLISS ET AL) * column 2, line 24 - column 3, line 45; figures 2,3 *	1,2,10	
Y,D	GB-A-1 461 769 (BICC) * page 1, line 27 - line 38 *	3,4	
Y	GB-A-1 461 770 (BICC) * page 2 *	3,4	
A	GB-A-2 186 699 (PJO INDUSTRIAL) * abstract; figure 1 *		

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

G08B
G01K
H01B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	24 NOVEMBER 1992	J. Breusing

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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