Dec. 14, 1954

J. MORRIS, JR

2,697,215

TEMPERATURE CHANGE AND FIRE ALARM APPARATUS

Filed Dec. 1, 1951

2 Sheets-Sheet 1

FIG. 1.

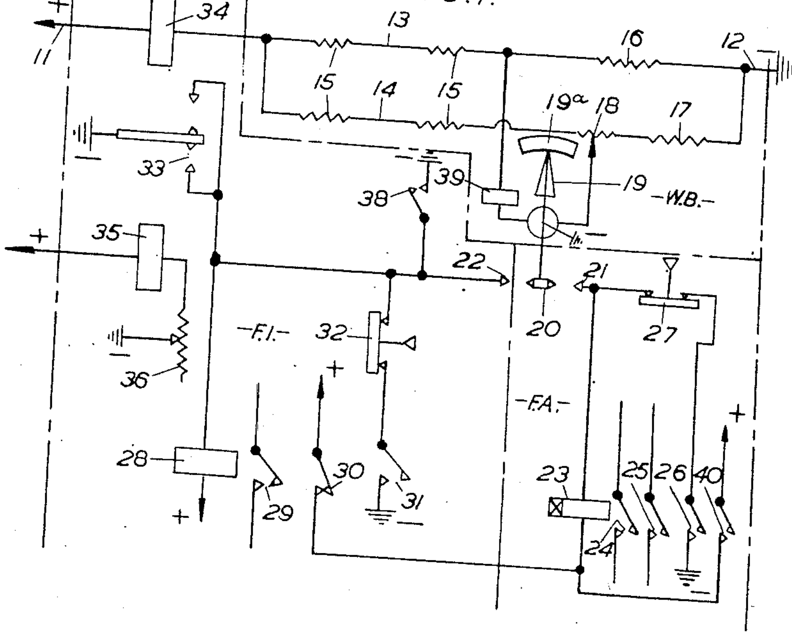


FIG. 2.

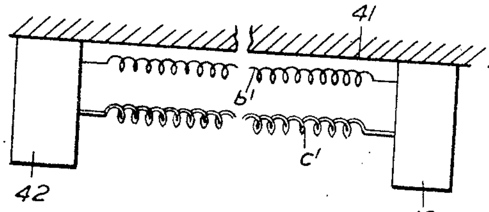


FIG. 3.

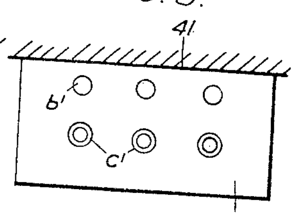


FIG. 4.

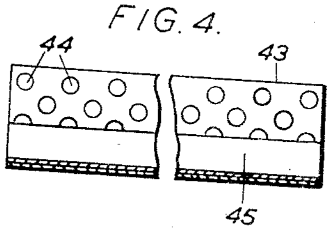
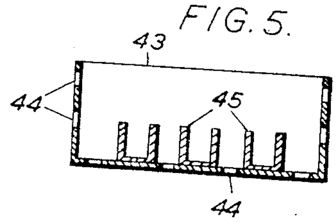


FIG. 5.



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2 Sheets-Sheet 2

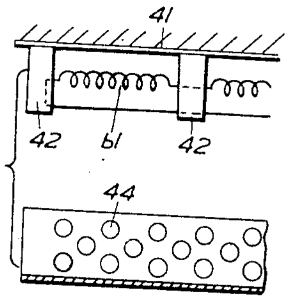


FIG. 6.

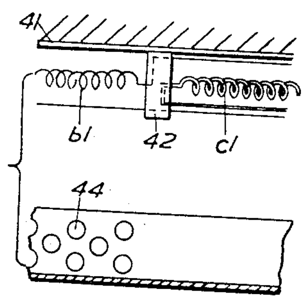


FIG. 7.

FIG. 8.

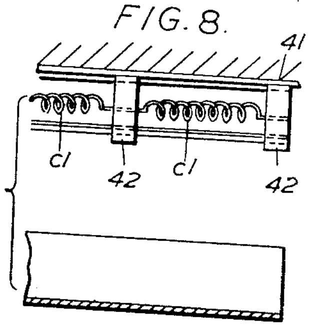


FIG. 9.

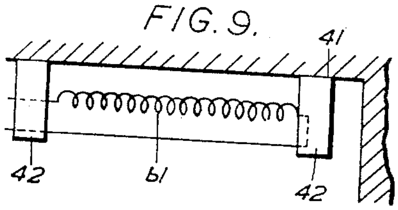
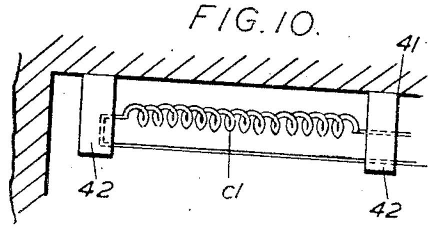


FIG. 10.



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2,697,215

Patented Dec. 14, 1954

2,697,215

TEMPERATURE CHANGE AND FIRE ALARM APPARATUS

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Application December 1, 1951, Serial No. 259,345

Claims priority, application Great Britain December 4, 1950

2 Claims. (Cl. 340—227)

This invention relates to fire alarm systems and to systems which are like fire alarm systems in that they respond to an excessive change in temperature.

Among the objects of the invention is that of providing in a fire alarm or like system for the giving of an indication or other appropriate response upon the occurrence of some abnormal condition other than a fire or the like. Such other condition might be a defect or failure in the system or in the electric supply thereto. Again it might be an excessive change in temperature in the opposite sense from that which operates the fire or like alarm. Yet again the other abnormal condition might, in a case where the change which operates the fire or like alarm must be rapid as well as excessive, be an excessive but not rapid rise in temperature. In any one or more of these conditions it may be desirable to give an indication or perhaps to prevent the fire alarm from operating when it otherwise would do so.

The invention makes use of electrical elements sensitive to temperature, in that their ohmic resistance or impedance or some other electrical characteristic varies with temperature; and such are referred to hereinafter as detection elements. These detection elements are used in pairs in a parallel circuit arrangement, the two elements of a pair being differently responsive to temperature; that is to say either the temperature co-efficients differ, so that any sufficient change of temperature in the appropriate sense will operate the alarm, even though the change occur but slowly, or there is a difference in the rates at which two elements of same coefficient respond to a certain instantaneous change of temperature, so that a change of temperature will operate the alarm only if it is both excessive and rapid. As illustrative of the way in which two otherwise similar elements may be made to differ in their rates of response may be mentioned the wrapping of one but not the other with heat-insulating material, or the giving to one of a differently heat-absorbent surface finish.

The invention can be used in a great variety of situations where temperature changes are material. Thus although the obvious use of a fire alarm system is in the detection of a fire within a space, a system in accordance with the present invention may be used to detect the over-heating of parts of machinery. Thus it may be material to have warning of the fact that bearings or rotating parts are running hot. Again, in a coal mine conveyor belt system it may be possible to detect the occurrence of some untoward event, such as a fall of rock on to a coneyor belt sufficient to retard or stop the belt and so cause over-heating of a rotating driving roller due to friction between the roller and the retarded or stationary belt. Yet again, the propeller shaft of a ship is a sensitive piece of machinery wherein an abnormal heating is indicative of undesirable conditions. On the other hand, in some chemical processes where the maintenance of a certain temperature is important, it may be that the abnormal change of temperature to be detected is a fall instead of a rise. In all these and many other circumstances the present invention may find application.

The following description relates to the accompanying drawings, which show by way of example only and not by way of limitation one embodiment of the invention.

In the drawings:

Figure 1 is a circuit diagram of a fire alarm system in accordance with the invention;

Fig. 2 is a broken front elevation of a mounting construction for the detection elements of the Wheatstone bridge;

Fig. 3 is an end elevation of the same;

Fig. 4 is a broken sectional elevation of a cover for the parts shown in Fig. 2;

Fig. 5 is a transverse section of the cover shown in Fig. 4;

Figures 6, 7 and 8 are partial front elevations showing further methods of constructions and mounting parts of a Wheatstone bridge for use in indicating a rate of temperature rise in the ambient air each having a sectional elevation of the appropriate cover used below it;

Figure 9 is a front elevation of part of a Wheatstone bridge where a comparision of temperatures at different places is obtained, and

Figure 10 is a similar view of a complementary part at the other place.

Referring to Figure 1 of the accompanying drawings, it will be seen that the electrical system is divided into three principal parts by dotted lines and these three principal parts of the equipment are a Wheatstone bridge designated generally WB, a fire alarm circuit designated generally FA and a fault indicator circuit designated generally FI.

Across the positive and negative mains leads **11** and **12** is connected the Wheatstone bridge WB. Of the four arms of this bridge the two adjacent arms **13** and **14** each contain one of a pair of detection elements **15**, that in the arm **13** being of a different temperature responsivity from that in the arm **14** as has been described. If, as shown, there are more than a single pair of detection elements **15**, then the several elements in each arm are arranged in series. The ratio arms **16** and **17** consist of fixed resistors, with a potentiometer adjustment **18** between the series arms **14** and **17**. A voltage sensitive indicator **19** is connected across the bridge in well known manner.

The pointer of indicator **19** moves over a dial **19A** which may be calibrated in degrees of temperature, so that a continuous visual indication is given of the temperature prevailing at the point under supervision. This pointer also carries contact **20** which occupies a central or neutral position so long as the bridge is balanced, but which when the bridge is sufficiently unbalanced swings into contact either with the contact **21** or with the contact **22** according to the sense of the unbalance. This contact **20** is connected to the negative side of the mains supply.

Upon closure of contacts **20, 21**, a circuit is completed from negative, over contacts **20, 21**, through winding **23** of a slow operating relay, over normally-closed contacts which will be further described in the fault indicator circuit FI, to positive; thus the relay **23** is energised, closing contacts **24** to give a fire alarm, closing contacts **25** to stop machinery or perform some similar operation, and closing contacts **26** to complete a holding circuit for itself so that it remains energised until manual operation of the normally closed push button **27**. All these operations follow from an unbalance in the Wheatstone bridge in the sense to close contacts **20, 21**, being the sense corresponding to a change in the resistances of elements **15** which would result from an excessive heating thereof such as due to fire.

It is desired however that an indication should be given, but of a different kind, should some fault occur in the system, as for example, should there be a failure in the power supply through the Wheatstone bridge, or should some fault occur in any of the arms thereof in the nature of an open-circuit i. e. tending to increase the resistance of the faulty part, or in the nature of a short-circuit i. e. tending to decrease the resistance. For this purpose there is provided the fault indicator circuit FI. This circuit includes a relay **28** which when energised closes contacts **29** to give an alarm, opens contacts **30** to disable the fire alarm relay **23**, and closes contacts **31** in a holding circuit for itself over push button **32**. There are three separate circuits shown for the energisation of fault relay **28**. The first closure is that over contacts **20, 22**, already described, this happening upon an unbalance of the Wheatstone bridge in the opposite sense from that which is to be expected upon a fire or like. The second closure is provided by the contact set 33 which consists of a moving contact balanced between two fixed contacts. The control of this set is effected by means of a pair of solenoids 34, 35, arranged in opposition on either side thereof and balanced by potentiometer 36. The one solenoid 34 is arranged in series with the bridge and will be affected by any change in the current therein; the other solenoid 35 is independent of the bridge. The third closure is that over contacts 38 of relay 39 arranged in series with the indicator 19 across the Wheatstone bridge. These latter two means of closure may be alternative to each other or both may be incorporated in the one system as has been shown.

In describing the operation of this circuit arrangement reference must be made to the respective current and resistance values, but any numerical values that may hereinafter be given are so given solely for the purpose of theoretical explanation and do not necessarily represent the actual values that would obtain in a system embodying the invention.

The total current through the Wheatstone bridge, i. e. that through the solenoid 34, may be of the order of 50 milli-amperes splitting, when the bridge is balanced, into two parts each of 25 milli-amperes through each of the two parallel branches of the bridge. The resistance of said solenoid 34 is small, say 1 ohm, as compared with that of the bridge as a whole which, with each of the arms at 150 ohms would have an equivalent resistance of 150 ohms. The order of current through the indicator 19 necessary to engage contacts 20 and 21 would be measured in micro-amperes, and would correspond to a change in the relative resistance of arms 13 and 14 of ½ ohm. On the other hand the current to engage contacts 20 and 22, though also in micro-amperes, would correspond to a change (in the opposite sense of course) of relative resistance at 13, 14 of 2½ ohms. In the cases of relay 39 and solenoid 34, the effective currents here would be measured in milli-amperes, corresponding in the case of solenoid 34 to a change of total bridge resistance of say 30 ohms.

With these values in mind the operation of the system becomes clear. Should there occur the untoward condition which has been envisaged as fire, then there will be a small increase in the resistance of one of the elements 15 relative to the other of the pair, an increase of perhaps ½ ohm in say arm 13. This will close contacts 20, 21, so that after the pre-determined delay time the relay 23 operates, giving the fire alarm and locking over contacts 26. Previous to this the movement of pointer 19 over scale 19*a* will have given visual indication of an undesirable rise in temperature.

Next, suppose that either the arm 13 is open-circuited or an element in arm 14 is short-circuited, then the contacts 20, 21 will again be closed, but at the same time relay 39 will operate and/or contacts 33 will close, in either case causing an immediate operation of relay 28 in the fault indicator circuit. At this time the relay 23 will not yet have operated, and will now be disabled from so doing by the opening of contacts 30.

A fault in the nature of a short on arm 13 or in the nature of a break in 14 will engage contacts 20, 22, and/or operate relay 39, and/or close contacts 33.

Finally, a break in the supply across mains leads 11, 12 will close contacts 33 by means of solenoid 35.

If a fire occurs so that the fire alarm operates then if this is followed by the occurrence of a fault it is desirable that the fire-alarm should not be thereby disabled but should continue in operation. To this end the alternative circuit over contacts 40 is provided so that once the fire-alarm has operated it will be maintained.

The interrelation between the three alarm systems WB, FA and FI is evident from the above explanation of operation. Both the fire alarm and the fault indicator systems respond to unbalance of the relative resistance in the legs of the bridge, the direction of operation of indicator 19 depending upon the polarity of the current flowing through the bridge. The fire alarm circuit is initially under the control of the fault indicator circuit so that a current in the bridge of the proper sense to close the fire alarm circuit must be below a certain value to energize the slow acting relay 23. Above that value it will energize relay 39 and close the circuit of relay 28 and open contacts 30, thus preventing the closing of the circuit of relay 23. As pointed out relay 28 may also be energized by the closing of contacts 20, 22 and by the closing of contacts 33. However energized, relay 28 operates to disable the fire alarm circuit, provided relay 23 has not become energized and closed its holding circuit before the energization of relay 28.

In Figs. 2, 3, 4, and 5, an arrangement of two sets of three detectors *b1* and *c1* is shown in which they are mounted under a ceiling 41, and carried by supports 42.

The detectors *b1* may be considered as the more sensitive detectors and the detectors *c1* as the less sensitive detectors. The two sets of detectors are enclosed by a cover 43 provided with holes 44 to afford access for the air to the interior and the bottom of the cover has on it imperforate channels 45 to receive the less sensitive detectors *c1* and to protect them still further from the heat.

In Figs. 6, 7 and 8 an arrangement is shown wherein detectors *b1* and *c1* are in separate supports 42 below the ceiling 41, either side by side as in Figs. 6 and 8 or end to end as in Fig. 7, the supports 42 having secured to their lower ends a cover 43 having holes 44 below the more sensitive detectors *b1* and having no holes under the less sensitive detectors *c1*, whereby they are protected.

In Figs. 9 and 10 an arrangement is shown wherein the more sensitive detector *b1* is shown in its position and the less sensitive *c1* is shown as completely removed from it and is protected, not by a cover as in the previous arrangements described, but by being removed to any desired distance.

It is to be understood that the invention is not restricted to the arrangements shown as these are used only for illustration and other arrangements and constructions may be used, modified or altered as requirements demand.

I claim:

1. An electrically operated alarm system comprising an electric circuit including two parallel branches, a resistance in each branch, the two resistances being differentially responsive to ambient temperature conditions, a bridge connection across the branches including a voltage sensitive indicator having a movable electrical contact and a relay in series with the indicator including a normally open contact, the indicator being operatively responsive to a lesser current than the relay, a fire alarm circuit and a defect alarm circuit each including a normally open contact, a relay solenoid in control of each normally open contact, the solenoid in control of the said contact in the fire alarm circuit being relatively slow operating, and a normally open circuit for each alarm circuit relay solenoid, each normally open circuit including a fixed contact, the two fixed contacts being alternatively engageable by the movable contact of the indicator, the fixed contact in the circuit for the solenoid in control of the contact in the defect alarm circuit being connected in parallel with the normally open contact of the relay in the bridge connection and a normally closed contact in the circuit for the relay solenoid in control of the contact in the fire alarm circuit operatively related to the solenoid in control of the contact in the defect alarm circuit.

2. An electrically operated alarm system as claimed in claim 1 in which the circuit for the relay solenoid in control of the contact in the defect alarm circuit includes another movable contact in parallel with the contact of the relay in the bridge connection, together with a solenoid responsive to current changes in the electric circuit and arranged in control of the said other movable contact.

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