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[54] THERMAL CHANGE DETECTOR OF THE LINEAR THERMOPILE TYPE

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[51] **Int. Cl.**.....**G01k 7/02**, H01v 1/32

[58] **Field of Search** 340/228, 227; 136/208, 211, 136/212, 223, 224, 227, 216

[56] **References Cited**

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[57] **ABSTRACT**

An improved thermal change detector of the linear thermopile type is disclosed. A transient temperature differential between adjacent thermopile junctions is obtained by shaping each link in the linear thermopile asymmetrically and joining them so that the thermal capacity of the "hot" junctions is smaller than that of the "cool" junctions. When a rapid rise occurs in the temperature of the environment, as for example when a fire breaks out, the "hot" junctions, having less thermal capacity, heat up more quickly than the "cool" junctions. This produces an electric potential across the thermopile which may be used to trigger alarm circuitry.

10 Claims, 2 Drawing Figures

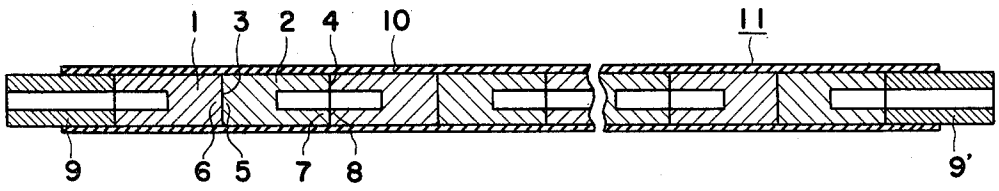


FIG. 1.

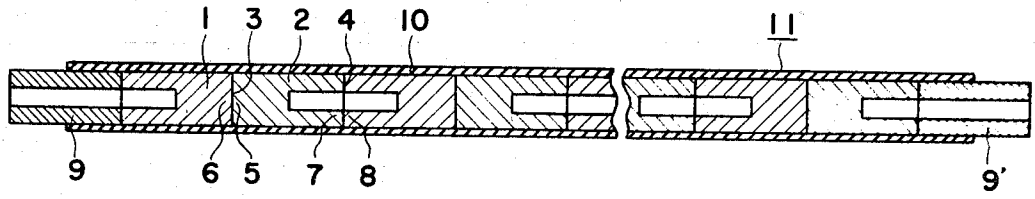
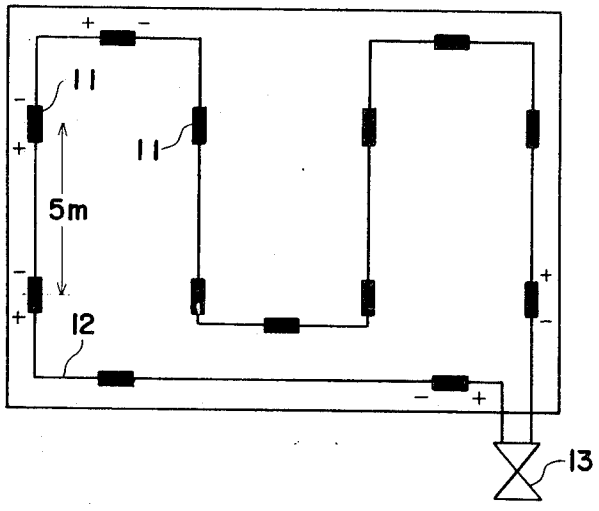


FIG. 2.



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THERMAL CHANGE DETECTOR OF THE LINEAR THERMOPILE TYPE

The present invention relates to an improved linear thermopile-type thermal change detector of pleasing appearance, which is triggered instantly by a relatively rapid change in room temperature and which is reliable in operation.

BACKGROUND OF THE INVENTION

There are presently several varieties of commercially available thermal change detecting systems. A first kind, known as the pneumatic type, comprises a relatively thin and inconspicuous copper pipe containing a metal diaphragm. The pipe is open on one side of the diaphragm to room pressure and on the other side, through a breather valve, to a relatively constant temperature reservoir. Increased room air pressure resulting from a fire or other cause of thermal change causes bowing of the diaphragm, bowing which is accentuated by the back pressure relief provided by the breather valve. Appropriate alarm circuitry is triggered by a predetermined amount of diaphragm movement.

This variety of thermal change detector, however, has several drawbacks. The metal diaphragm can become distorted with age, and the sensitivity of the device may be seriously affected by changes in the reservoir temperature. Therefore, while the pneumatic type detector may be relatively inoffensive to the appearance of the protected room, it has significant functional deficiencies.

A second variety of thermal change detection system utilizes thermally generated electric voltages for its operation. These devices rely on the physical phenomenon known as the Seebeck effect: that an electric potential is developed between two junctions of many dissimilar metals or metal alloys if the temperatures of those junctions are caused to differ. The simplest arrangement of this type, where a strip of one metal, commonly iron, is joined at each end to a strip of a second metal, commonly the alloy constantan, is called a thermocouple. The voltages produced across such a thermocouple are on the order of a few millivolts.

When a number of thermocouples are arranged in series with alternating hot and cold junctions, the resulting array is called a thermopile. The voltage generated in a thermopile for a given temperature differential will be an appropriate multiple of the thermocouple voltage produced by the same differential.

One form of thermopile-type thermal change detector in use comprises a succession of interconnected wire pieces or links, alternately iron and constantan, having every other junction covered with an insulating material such as vinyl chloride. If such a thermopile is mounted on a ceiling, in case of fire or other cause of thermal change the uninsulated junctions will be heated to a temperature above that of the insulated junctions, producing a voltage across the thermopile which can be used to trigger appropriate alarm circuitry.

There are, however, at least two deficiencies in this form of detection apparatus. First, in an age where interior design is considered important, the appearance presented by this uneven contour mounted on the ceiling is undesirable. Second, because of the uneven surface of the complete thermopile, some portions thereof may touch the ceiling while other portions may not. This will cause the thermal capacities of the junctions to be nonuniform and will thereby change the operating characteristics of the device.

SUMMARY OF THE INVENTION

The present invention concerns an improved form of thermopile-type thermal change detector which has a neat, inconspicuous appearance and provides accurate, reliable fire detection. The invention comprises a plurality of serially connected thermopiles, each constructed according to an improved, novel design. The "hot" junctions in each of the thermopiles are composed of tubular sections of the two metals or metal alloys used, and the "cool" junctions are composed of solid sections of the same. The complete thermopiles are wrapped in a protective, decorative coating and are connected in series with each other and with suitable alarm circuitry.

DESCRIPTION OF THE FIGURES

FIG. 1 is a sectional view of a thermopile constructed according to the teachings of the present invention.

FIG. 2 is a diagram illustrating one possible ceiling arrangement of thermopiles of the present invention.

DETAILED DESCRIPTION

Referring now to those Figures, the linear thermopile shown in FIG. 1 is built around a number of iron links 1 and an equal number of constantan links 2 arranged in alternating sequence. Each of links 1 and 2 is cylindrical in shape, roughly 20 millimeters in length and 1.6 millimeters in outer diameter. One-half of each link is solid, but the other half is tubular, with an axial cylindrical opening therein roughly 1.2 millimeters in diameter and 10 millimeters deep. The solid ends of the iron and constantan links (6 and 5 respectively) are welded together to form what will be the "cool" junctions 3 and the tubular ends (8 and 7 respectively) are likewise connected to form what will be the "hot" junctions 4.

At each extremity of the linear thermopile thus formed, the open ends of the links are welded to electrical terminals such as copper connectors 9 and 9'. These in turn are attached as shown in FIG. 2 to vinyl-coated wire 12 which interconnects each thermopile with the remainder of the circuit. The assembly is then, finally, covered with a vinyl coating 10 forming a complete linear package 11 approximately 2 millimeters in diameter and, if 10 links each of iron and constantan are used, one-half meter in length.

One possible ceiling arrangement of 13 such thermopiles 11 is shown in FIG. 2, for even coverage of a room approximately 10 by 15 meters. The linear thermopiles 11 are spaced about 5 meters apart in the room ceiling and are connected in series with each other and with a relay 13 by wire 12. While the pattern shown provides substantially even coverage of the whole room, it is not the only possible arrangement; the invention may be practiced in any desired pattern using any desired number of linear thermopiles 11.

In operation as a fire detector, a fire causes the temperature of the environment surrounding each thermopile 11 to rise quickly. Because those portions of the iron and constantan links adjacent to the "hot" junction 4 are hollow, that junction will have a smaller thermal capacity than "cool" junction 3. Therefore, while in the steady state both junctions will rise to the same temperature, the "hot" junction 4 will experience a transient temperature differential over the "cool" junction 3 in the early moments of a fire, producing a voltage proportional to the rate of rise of the room temperature.

Stated differently, although the two junctions have the same surface area, there is more mass present at junction 3 than at junction 4. Therefore, junction 3 will experience a lower rate of temperature rise than junction 4 for the same rate of heat transfer from the environment. This produces an output voltage which is used to trigger alarm circuitry.

The thermopiles 11 must be connected, as shown in FIG. 2, with all their polarities oriented similarly. Relay 13 is adjusted to react when a certain total voltage appears.

Each thermopile built as described has the shape of a cylinder only a very few millimeters in diameter including a cover which can be chosen at least in part for appearance. It will not, therefore, be a visual intrusion on the decor of the room being protected. Because both sets of junctions are wrapped with the same amount of protective material, the linear thermopile 11 does not have an uneven outer surface, and this also improves its appearance.

It should be added that the number, size, shape and composition of the thermopile links may be varied widely. As was suggested above, iron and constantan are commonly used materials, but many combinations of metals and metal alloys may be used. The only requirement is that the characteristics

of the metals be such that when the detector is subjected to a thermal change, a nonzero net voltage appears across the thermopile. Furthermore, the sizes given are illustrative only, and it is clear that the links need not be cylindrical. Other modifications will likewise be apparent to those skilled in the art which do not depart from the spirit and scope of the present invention.

What is claimed is:

1. A thermal change detector comprising

a plurality of first links of a material chosen from the group consisting of metals and metal alloys,

an equal number of second links of a different material chosen from said group,

the first and second links being of equal dimensions and having equal portions of material removed from one end thereof to provide the one end with a smaller thermal capacity than the other end,

the first and second links being arranged in alternate sequence with the smaller thermal capacity ends joined together, means for completing an electrical circuit connecting the first and last link in the sequence,

the materials of the first and second links being chosen so that when the detector is subjected to a thermal change a net voltage other than zero appears across the links.

2. A thermal change detector as described in claim 1 wherein the linear arrangement of the links is covered by a protective coating.

3. A thermal change detector as claimed in claim 1 wherein the links are linearly arranged in alternating sequence.

4. A thermal change detector as claimed in claim 1 wherein the links are shaped to have one solid end and one tubular end.

5. A thermal change detector as claimed in claim 1 wherein the first links are made of iron and the second links of constantan.

6. A thermal change detection system comprising a plurality of spaced thermopiles wherein each of the thermopiles comprises

a number of first links of a material chosen from the group consisting of metals and metal alloys,

the same number of second links of a different material chosen from the same group,

the first and second links being of equal dimensions and having equal portions of material removed from one end thereof to provide the one end with a smaller thermal capacity than the other end,

the first and second links being linearly arranged in alternating sequence with the smaller thermal capacity ends joined, the materials of the first and second links being chosen so that when the thermopile is subjected to a thermal change a net nonzero voltage appears across the thermopile,

the spaced thermopiles being interconnected in series by circuit-completing means.

7. A thermal change detection system as described in claim 6 wherein the circuit-completing means includes alarm means.

8. A thermal change detection system as described in claim 6 wherein each thermopile is covered by a protective coating.

9. A thermal change detection system as described in claim 6 wherein the one end of each link having a smaller thermal capacity is tubular and the other end of each link having a larger thermal capacity is solid.

10. A thermal change detection system as described in claim 9 wherein the circuit-completing means includes alarm means.

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