March 4, 1952 D. R. SQUIER 2,587,916

HEAT DETECTING CABLE

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Fig. 1

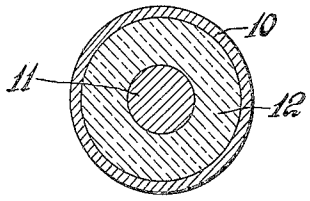


Fig. 2

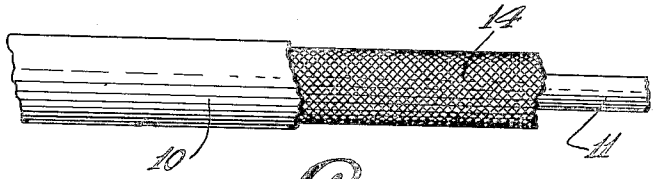


Fig. 3

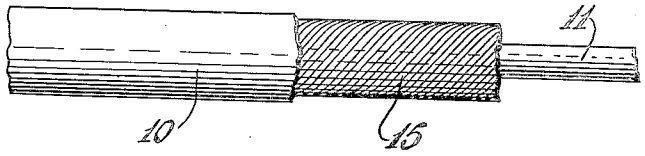


Fig. 4

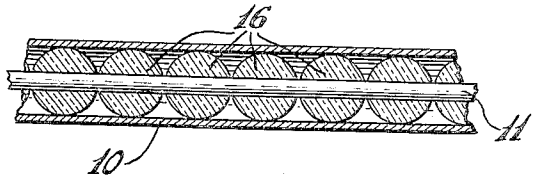
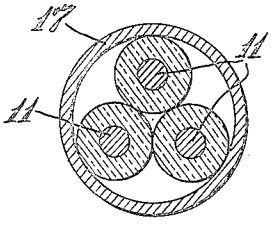


Fig. 5



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HEAT DETECTING CABLE

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8 Claims. (Cl. 201—63)

1

The present invention relates to electrical resistance elements having a negative temperature coefficient, and, more particularly, relates to improved heat detecting cables of the type illustrated in United States Patent No. 2,413,125.

Heat detecting cables of the foregoing type generally comprise a pair of electrically conductive elements adjacently disposed along the length of the cable and a material or composition separating the elements which is non-conductive at normal temperatures and is rendered conductive at abnormal temperatures to permit current to flow between the elements. Such cables are adapted to be utilized for detecting heat caused, for example, by flame or fire or other conditions which produce abnormally high temperatures, whereby, upon the flow of current, an alarm, indicator, fire extinguishing system or other apparatus is operated. The materials or compositions utilized in such cables have the general characteristics of thermistors, that is, the resistance thereof varies appreciably with changes in temperature.

It has been found that heat or flame detecting cables of this type heretofore utilized were not adapted for repeated use, primarily because the material or composition used therein decomposed or was altered upon being subjected to the heat of a flame, whereby the material or composition did not return to its initial non-conductive condition at normal temperatures or its temperature coefficient or resistivity was materially altered. Consequently, the cable, after once being heated to a high temperature, became unreliable for further use and had to be replaced. Such replacement required installing practically an entire detecting system.

Accordingly, an object of the present invention is to provide an improved heat or flame detecting cable which is not subject to the foregoing difficulties and disadvantages and which can be economically manufactured.

Another object is to provide a cable of the foregoing type which can withstand flame and/or temperatures in the neighborhood of about 2000° F. and is adapted for repeated use.

A further object is to provide such a cable which responds quickly at a predetermined temperature, which will not give false alarm indications, and which quickly returns to its non-conductive condition without substantial variation in its temperature coefficient when again subjected to normal temperatures.

Other and further objects of the invention will be obvious upon an understanding of the illustrative embodiment about to be described, or will be indicated in the appended claims, and various advantages not referred to herein will occur to one skilled in the art upon employment of the invention in practice.

2

In accordance with the invention, it has been found that the foregoing objects may be accomplished by providing a heat or flame detecting cable of the aforementioned type wherein the conductive elements are separated by a glass composition containing barium oxide and/or boron oxide, characterized in that it can withstand temperatures in the neighborhood of about 2000° F., is non-conductive at normal temperatures and is rendered conductive at abnormal temperatures. These characteristics of the glass composition may be improved by incorporating therein one or more suitable materials providing the composition with a desired negative temperature coefficient or resistivity and/or conditioning the composition to withstand the temperatures to which it may be subjected.

In a preferred embodiment about to be described, the conductive elements are separated by fiber glass of a suitable composition which may be in the form of a covering surrounding at least one of the elements and having distributed therein, for example by impregnation, a finely divided material which aids the fiber glass in withstanding heat or flame. If desired, the covering may be a fiber glass fabric suitably applied to the conductor element.

It has been found that glass compositions of the borosilicate type and of the barium type are suitable in practicing the present invention. Such compositions have relatively high softening point temperatures and have good thermal endurance, that is, they can withstand sudden changes in temperature without material variation in physical or chemical characteristics. Also, repeated changes in temperature from normal temperature to flame temperature and return to normal temperature, do not materially alter the temperature coefficient or resistivity of such compositions, thereby facilitating repeated use thereof in heat or flame detecting cable.

Such glass compositions may include between about 2 and 8% aluminum oxide, between 10 and 48% barium oxide, and/or between 10 and 12% boron oxide, the percentages given being by weight. Barium oxide makes the glass stable and heat resistant; boron oxide increases toughness and thermal endurance; and aluminum oxide raises the softening point temperature and makes melting more difficult. If desired, zinc oxides in quantities up to 14% by weight may be added to further enhance thermal endurance and to raise the softening point temperature.

In addition to the foregoing materials, these glass compositions may contain oxides of metals which give the compositions a low conductivity at normal temperatures and slightly above normal temperatures or in some cases up to temperatures just below high heat or flame temperatures, and which apparently further the ionization of the compositions to provide for sudden increases in conductivity thereof upon being subjected to flame or high heat, of which an indication is desired. One or more of the following oxides may be utilized for this purpose: beryllium oxide, cadmium oxide, calcium oxide, cerium oxide, chromium oxide, cobalt oxide, copper oxide, iron oxide, lead oxide, magnesium oxide, manganese oxide, nickel oxide, strontium oxide, tin oxide, titanium oxide, and tungsten oxide. Barium oxide also produces the foregoing effect. Calcium oxide is particularly effective for this purpose. Large percentages of lead oxide preferably should be avoided because of the tendency to lower the softening point temperature thereof.

The glass compositions may be in the form of a solid mass or in the form of fibers. Where fiber glass is utilized, the fibers may be in bulk, spun threads or tape or fabric woven or braided therefrom, or may be formed into objects such as beads or the like.

It has been found that it is suitable to utilize fiber glass which has been leached, for example, by treating the same in a 15% hydrochloric acid solution at about 150° F. It is believed that this treatment removes lead oxide and the like in the glass composition and provides an ultimate composition which has a higher softening point temperature and is thereby adapted to withstand temperatures approaching 2000° F.

The use of fiber glass is preferred because of its flexibility, which enables cables containing such glass composition to be bent into most any desired shape and form.

Fiber glass also has an additional advantage in that it may have distributed therein finely divided material which enhances the ability of the composition to withstand high temperature without adversely affecting the temperature coefficient thereof and its thermal endurance. Such materials may be compounds or complexes of the refractory or high heat resisting type which contain aluminum, calcium, chromium, magnesium, silicon, titanium or zirconium as elements thereof, for example, such compounds may be aluminum oxide, aluminum silicate, calcium oxide, chromite, magnesium oxide, magnesium silicate, silicon carbide, silicon oxide, titanium oxide, zirconium oxide and zirconium carbide. Silicon dioxide, in colloidal form, has been found to be particularly effective for this purpose.

These materials may be used separately or in mixtures of two or more, and need not necessarily be in substantially pure form, it being contemplated that high heat withstanding carbonates may be utilized without materially affecting the refractory properties of such materials or mixtures. For example, various commercially available mixtures sold as refractory type cements may be used to good advantage.

Graphite of the refractory type may also be utilized, but, due to its relatively high electrical conductivity, its use in small amounts or in mixtures comprising a major proportion of less conductive refractory materials is recommended.

The foregoing additive materials may be utilized to good advantage in fiber glass composition by distributing incorporating or impregnating

the same in the composition in amounts up to about 50% by weight.

Where such additive materials are utilized, the composition of the glass fibers is not as critical, because the high heat resisting material cooperates with the glass fibers, whereby the overall composition or mixture can withstand high heat or flame without adverse affect on the temperature coefficient thereof. In some cases it was found that a composition of fiber glass and, for example, silicon dioxide, when subjected to temperatures approaching 2000° F., tends to sinter and results in a composition which thereafter may be repeatedly and alternately subjected to temperatures varying between about —70° F. and about 2000° F. without any material change in the temperature coefficient of resistivity of this material, thereby enabling the same to be advantageously utilized in practicing the present invention.

In the drawing:

Figure 1 is an enlarged sectional view of a cable in accordance with the invention.

Figure 2 is an enlarged fragmentary elevational view of a cable of modified construction.

Figure 3 is a view similar to Figure 2, illustrating another modification of the invention.

Figure 4 is an enlarged longitudinal sectional view, of still another form of cable construction.

Figure 5 is an enlarged sectional view of a cable in accordance with the invention which comprises a multiplicity of conductors.

Referring to the drawing in detail and particularly to Figure 1 thereof, there is shown a cable comprising an outer electrically conductive element, such as a metallic tube or sheath 10, an inner electrically conductive element, such as a metallic wire 11 substantially centrally disposed in the tube 10, and a glass composition 12, in accordance with the invention, surrounding the wire 11 and separating the same from the tube. The glass composition 12 may be a solid mass or may be composed of glass fibers with or without additive high heat resisting or refractory material.

While the tube, wire and glass filler may have any desired cross-sectional dimensions, a practical embodiment of the invention comprises a tube having an outer diameter of about fifty thousandths of an inch and a wall thickness of about five thousandths of an inch, and a wire having a diameter of about six thousandths of an inch, whereby the glass composition separates the tube and wire at least about seventeen thousandths of an inch.

In Figure 2, the glass composition separating the conductive elements 10 and 11 is shown as being in the form of a fabric covering 14 provided by weaving or braiding on the wire strands or threads spun from glass fibers. Additive materials may be incorporated in the covering by impregnating the covering or the thread from which the covering is formed with such materials in powder, paste or slurry form, or by distributing such materials in the fibers in powder form prior to forming the fibers into threads or strands.

In Figure 3, the covering is shown as being in the form of a fiber glass thread or tape 15 spirally wound on the wire 11.

In Figure 4, the glass composition separating the conductive elements 10 and 11 is shown as being in the form of spherical beads 16 having central apertures through which the wire 11 extends. It will be understood that these beads may have any other suitable shape. These beads

may be in the form of a mass of solid glass or may be formed, for example by molding the same from glass fibers having additive heat resisting material and a binder distributed therein.

In Figure 5, a multiple conductor type cable is illustrated wherein two or more, for example three, wires 11 are housed in a tubular sheath 17 which need not be utilized as a conductive element. The wires each may have a covering thereon in the form of a solid mass, a molded fiber glass mass, fiber glass threads or fabric (Figures 2 and 3) or beads as described in connection with Figure 4. If desired, wires having a covering thereon composed of fiber glass thread or fabric may be twisted or braided together.

From the foregoing description, it will be seen that the present invention provides an improved heat or flame detecting cable adapted to withstand high temperature repeatedly without chemical or physical deterioration or breakdown of resistivity. The cable and component parts thereof are simple and economical in construction and can readily withstand such rough usuage to which they may be subjected.

As various changes may be made in the form, construction and arrangement of the parts herein, without departing from the spirit and scope of the invention and without sacrificing any of its advantages, it is to be understood that all matter herein is to be interpreted as illustrative and not in any limiting sense.

I claim:

1. A heat or flame detecting cable of indefinite continuous length responsive to abnormal temperature conditions at any location adjacently along its length, comprising a pair of electrically conductive elements adjacently disposed along the length of the cable, and a fiber glass composition separating said elements from each other, said glass composition containing an oxide selected from the group consisting of barium oxide and boron oxide and being characterized in that it can withstand temperatures in the neighborhood of about 2000° F. and that it is non-conductive at normal temperatures and is rendered conductive at abnormal temperatures.

2. A heat or flame detecting cable according to claim 1, wherein said fiber glass has distributed therein a finely divided refractory material to improve its heat withstanding characteristics.

3. A heat or flame detecting cable according to claim 1, wherein said fiber glass has distributed therein at least one finely divided refractory material selected from the group consisting of aluminum oxide, aluminum silicate, calcium oxide, chromite, graphite, magnesium oxide, magnesium silicate, silicon carbide, silicon oxide, titanium oxide, zirconium carbide and zirconium oxide.

4. A heat or flame detecting cable of indefinite continuous length responsive to abnormal temperature conditions at any location adjacently along its length comprising a pair of electrically conductive elements adjacently disposed along the length of the cable, and a continuous fiber glass covering applied on and surrounding at least one of said elements and separating said elements from each other throughout the length of the cable, said glass containing an oxide selected from the group consisting of barium oxide and boron oxide and being adapted to withstand temperatures in the neighborhood of about 2000° F. and being non-conductive at normal temperatures and is rendered conductive at abnormal temperatures.

5. A heat or flame detecting cable according to claim 4, wherein said covering is in the form of a fabric.

6. A heat or flame detecting cable according to claim 4, wherein said covering is a fiber glass fabric impregnated with colloidal silicon dioxide.

7. A heat or flame detecting cable according to claim 4, wherein said covering is composed of fiber glass yarn.

8. A heat or flame detecting cable according to claim 4, wherein said covering is impregnated with finely divided refractory material.

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