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CURIE POINT FIRE DETECTOR CABLE

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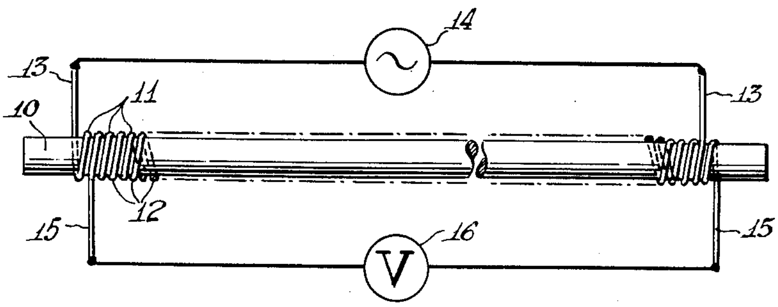

Fig-1

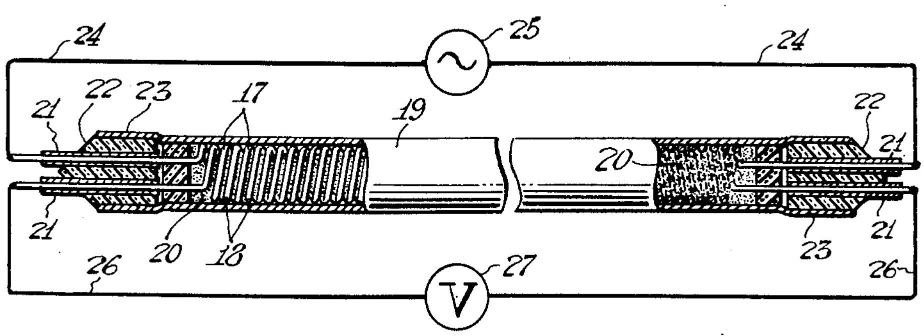

Fig-2

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CURIE POINT FIRE DETECTOR CABLE

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2 Claims. (Cl. 340—227)

This invention relates to a novel fire detector cable of an electromagnetic type dependent for its operation on the use of a ferromagnetic alloy in the magnetic flux circuit having a permeability which changes sharply with temperature.

It is well known that certain ferromagnetic alloys of high magnetic permeability undergo a nearly complete loss of permeability at critical temperatures known as their Curie points. My invention involves the use of this principle in novel forms of temperature-responsive transformers having distributed solenoidal-type windings in cable form. These cables may be provided in any suitable length. Short lengths of such cables are referred to as probe elements.

Objects of my invention are to provide new forms of fire detector cables having therein a temperature-variable electromagnetic induction means.

Another object is to provide novel transformers having distributed windings in cable form with associated temperature-responsive means for altering the transformer coupling.

Another object is to provide an elongated transformer of cable form having distributed windings and an associated magnetic sheath or core forming at least partially the magnetic coupling circuit and made of an alloy having a sharply-reduced permeability at a selected operate temperature for the cable.

Still further objects are to provide temperature-responsive cables of a novel construction which can be built economically to detect any selected temperature within a wide range.

These and other objects and features of my invention will be apparent from the following description and the appended claims.

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

Figure 1 is a plan view of one embodiment of my invention comprising primary and secondary solenoidal coils wound on a core of permeable ferromagnetic material; and

Figure 2 in a plan view with parts broken away of a second embodiment of my invention comprising primary and secondary solenoidal coils encased by a metal sheath of permeable ferromagnetic material.

The embodiment of my invention shown in Figure 1 comprises a central elongated core **10** of a suitable ferromagnetic metal having the desired Curie point. This metal core is covered with a thin layer of a suitable insulating material capable of withstanding flame temperatures such as aluminum oxide. Wound onto this core throughout its length is a pair of interleaved solenoidal coils **11** and **12** of a wire also covered with a film of heat-resistant insulation such as aluminum oxide, a suitable wire size being for example one permitting about 40 turns to the inch. These coils may be encased by any suitable heat-resistant protective sheath not shown. The coil **11** is connected by leads **13** to a source of alternating current designated **14**, and the coil **12** is connected by

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leads **15** to a receiving instrument such as a voltmeter **16**. Alternatively, the receiving instrument may be a ratiometer having one winding energized by the coil **12** and another winding energized by the source **14** according to standard practice so that the indications of the meter will be independent of fluctuations in the voltage supply.

Ferromagnetic alloys can be made to have Curie points at any temperature within a wide temperature range. For example, four different commerical alloys having Curie points at intervals of about 100° C. are as follows:

Alloy	Constituents, Percent	Curie Point, ° C.	Maximum Permeability
78 Permalloy	78.5 Ni 21.2 Fe .3 Mn	200	100,000
1040 Alloy	3 Mo 14 Cu 72 Ni 11 Fe	290	100,000
Supermalloy	5 Mo 79 Ni 15.7 Fe .3 Mn	400	1,000,000
Hipernik	50 Ni 50 Fe	500	70,000

When the center wire **10** is made, for example, of Supermalloy, its high permeability at temperatures below its Curie-point temperature of 400° C. will cause maximum induction in the secondary coil **12** because the flux circuit around the turns of the primary coil **11** will pass through the adjacent core portions and around the coil turns through the shortest possible air paths because of the core being in close proximity to the coil. A maximum voltage is therefore induced into the secondary coil **12** which will be indicated by the meter **16**. Should the whole length of the cable be heated to the Curie point, the entire flux path around each turn will in effect become approximately an air path. As a result, the induction is reduced so that the meter reads a minimum voltage. When only a portion of the cable is heated, the voltage will fall from its maximum value by a percentage of the difference between its maximum and minimum values according to the percentage length of the cable so heated. This is because the energy transferred from the primary to the secondary coil is reduced at that heated portion due to the higher reluctance of the flux paths around the coil turns being heated to the Curie point of the metal. When the cable is operated from a stabilized voltage source, the voltage changes responsive to the heating to the Curie point of a portion of the cable as small as 5% of its length can be accurately detected to operate an alarm or suitable control apparatus.

The embodiment of my invention shown in Figure 2 comprises a pair of interleaved solenoidal primary and secondary coils **17** and **18** wound of a wire covered with heat-resistant insulation as aforestated. These coils are encased in a sheath **19** of a ferromagnetic alloy having the desired Curie point. The coils are preferably mounted in close contact with the internal wall of the sheath with only a thin layer of electrical insulation, such as of aluminum oxide, provided on the inside wall to insulate the coils from the sheath. In this way maximum inductive coupling is obtained between the coils for achieving a cable of maximum sensitivity. The space within the coils throughout the length of the cable is filled with a suitable refractory insulating material **20** such, for example, as compressed aluminum oxide powder. The ends of the sheath may be hermetically sealed by fuzing sleeves **21** of suitable metal onto the wires and fuzing a bead **22** of suitable glass between these sleeves and the overlapping end portion **23** of the sheath.

The primary coil **17** is connected by leads **24** to a voltage source **25** and the secondary coil **18** is connected by leads **26** to a voltmeter **27**. The same kind of flux circuit is obtained around the turns of the primary and secondary coils in this embodiment as in my previous embodiment, the only difference being that the high permeable metal portion of each flux path is on the outer side of the coils instead of on the inner side thereof. Consequently, as in the previous embodiment, the heating of any portion of the cable to the Curie point of the sheath material will result in a proportional decrease in the output voltage. Importantly, because the voltage decrease is due to the permeability change in the outer sheath material and this sheath material is directly exposed to the flame being detected, the response of the cable is at a maximum rate.

The embodiments of my invention herein particularly shown and described are intended to be illustrative and not limitative of my invention since the same are 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 temperature-responsive device of cable-like form comprising a pair of coaxial solenoidal primary and secondary coils distributed along one another in close inductive coupling throughout their full lengths, an elongate member of ferromagnetic material in close proximity to said coils along the lengths thereof, each incremental length of said ferromagnetic member forming part of the magnetic circuit for the magnetic flux linking the adjacent turns of said coils when said primary coil is energized, said ferromagnetic member being of a material having a temperature-responsive permeability which is reduced sharply at a predetermined temperature, means for supplying an alternating current to said primary coil to cause a voltage to be induced in said secondary coil, said induced voltage being decreased in proportion to the length of said ferromagnetic member heated to said predetermined temperature, and means for measuring the voltage induced in said secondary coil.

2. The temperature-responsive device set forth in claim 1 wherein the turns of said primary and said secondary coils are interleaved with each other.

References Cited in the file of this patent

UNITED STATES PATENTS

2,431,352	Theillaumas	Nov. 25, 1947
2,540,527	Ingels	Feb. 6, 1951
2,719,197	Hall et al.	Sept. 27, 1955

FOREIGN PATENTS

623,707	Great Britain	May 20, 1949