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THERMOSENSITIVE PROTECTIVE SYSTEM FOR ELECTRICALLY HEATED FABRICS

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Fig. 1.

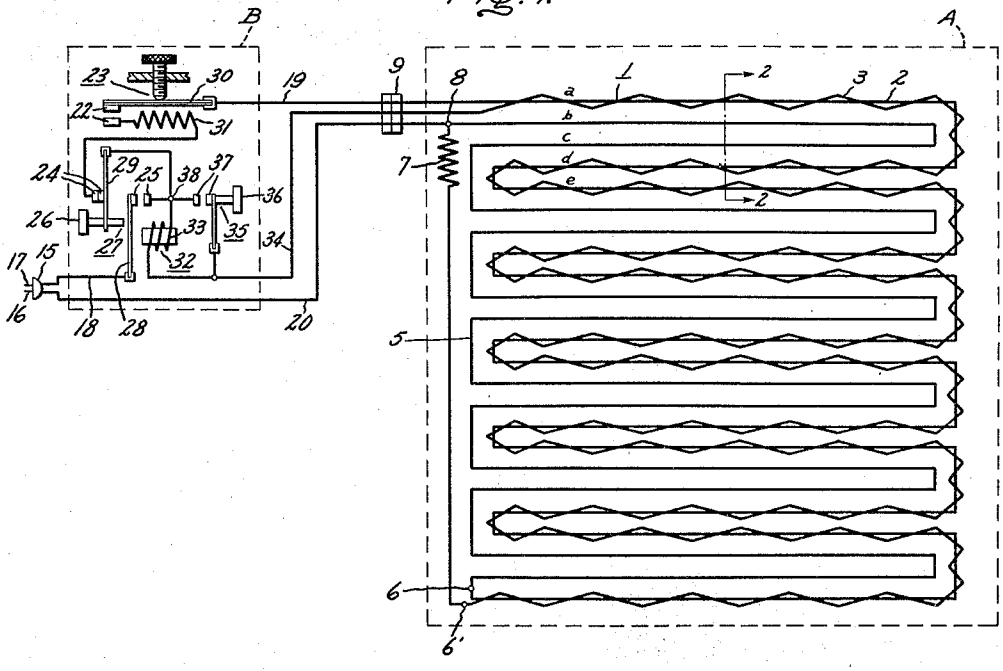
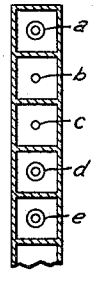



Fig. 2.




Inventors:
George C. Crowley,
Robert G. Holmes,
Robert A. Wise,
by Laurence R. Kempton
Their Attorney.

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# THERMOSENSITIVE PROTECTIVE SYSTEM FOR ELECTRICALLY HEATED FABRICS

George C. Crowley, Robert G. Holmes, and Robert A. Wise, Asheboro, N.C., assignors to General Electric Company, a corporation of New York

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6 Claims. (Cl. 219—20)

This invention relates to a thermosensitive protective system for electrically heated fabrics, and more particularly to the disposition of the thermosensitive cable within such fabrics and the associated control system.

The system embodying this invention may be used to excellent advantage in association with the thermosensitive systems disclosed and claimed in the patent of Spooner et al., No. 2,581,212, for an "Electrically Heated Fabric," which is assigned to the same assignee as the present invention. The patent of Spooner et al reveals a thermosensitive twin wire cable arranged inside of an electrically heated fabric in a series of convolutions or other patterns in such a manner as to distribute the cable throughout the fabric to be heated. The twin wire cable consists of a heater wire and a signal wire with an interposed thermosensitive layer therebetween. Overheat protection is achieved because the resistance of the thermosensitive layer varies sharply as the temperature rises above a safe value. By means of the present invention, we are able to provide essentially the same degree of overheat protection as has been previously provided for, but at a much reduced cost.

An object of this invention is to provide for use with an electrically heated fabric an improved disposition of thermosensitive cable within the fabric to obtain such a fabric at a lower cost without sacrificing any significant amount of overheat protection.

A further object of this invention is to provide a simplified control system which will automatically disconnect the entire system from the line upon occurrence of an overtemperature condition.

According to one form of this invention when used in an improved electrically heated fabric, thermosensitive twin wire cable is disposed within alternate pairs of parallel channels of the fabric with heater wire disposed within alternate pairs of parallel channels therebetween. The overheat protection afforded by the thermosensitive twin wire cable is thus effectively provided over the entire surface of the fabric with only half of the channels containing thermosensitive cable and the other half containing heater wire alone.

In accordance with another aspect of my invention, the heater wire for a bedcover is distributed over the entire heated area, while a signal wire, separated from the heater by a thermosensitive layer, is coextensive with only a portion of the length of the heater wire. The signal circuit, including the signal wire, a voltage dropping resistor, and a voltage sensitive relay is electrically connected in parallel with the heater wire. Conduction through the thermosensitive wire, upon an over-temperature condition, decreases the voltage at the relay to below a drop-out value to de-energize the entire circuit.

The features of this invention which are believed to be novel are pointed out with particularity in the appended claims. The invention itself, however, both as to organization and mode of operation, together with further objects and advantages thereof, may be best understood by reference to the following description to



be taken in conjunction with the accompanying drawing.

Fig. 1 is a schematic diagram of an improved thermosensitive cable system embodying this invention.

Fig. 2 is an enlarged cross sectional view taken substantially along line 2—2 of Fig. 1.

Referring to Fig. 1 of the drawing, the dotted rectangle A indicates the outline of an electrically heated fabric such as a blanket, with a control element having a thermosensitive twin wire cable 1 consisting of a first heater wire 2, a signal wire 3, and a thermosensitive layer interposed therebetween. This thermosensitive layer is not illustrated, since the details thereof form no part of this invention; it may, for example, be of the type shown in Patent 2,581,212—Spooner et al. The thermosensitive heating cable 1 typically is disposed in the configuration of parallel runs as shown in the drawing. A second heater wire 5, approximately equivalent in length to the twin wire cable 1 is connected to heater wire 2 at terminal 6 and extends therefrom in the configuration of parallel runs which are interposed at intervals between the parallel runs of twin wire cable 1. Assuming that the electrically heated fabric is of a construction similar to the electrically heated blanket structure described in Patent No. 2,203,918, issued June 11, 1940 to I. O. Moberg, with a plurality of parallel heater wire channels or pockets, half of the heater wire channels or pockets may now contain twin wire cable, and the remaining half of the channels or pockets may contain only heater wire. Cable segment *"a"* may be disposed in a first channel, heater wire segments *"b"* and *"c"* may be disposed in second and third channels, and cable segments *"d"* and *"e"* may be disposed in fourth and fifth channels, and so on, as indicated in Fig. 2 of the drawing. Thermosensitive twin wire cable is thus disposed within alternate pairs of channels of the fabric, with heater wire 5 disposed within alternate pairs of channels therebetween.

While the disposition of the thermosensitive cable 1 and heater wire 5 has been illustrated and described as parallel runs distributed within alternate pairs of channels, it will occur to those skilled in the art that other arrangements can be made without departing from the invention. In its broader aspects, heating wire is distributed throughout the area to be heated, while a signal wire separated from the heater by a thermosensitive layer is coextensive with only a portion of the length of the heater. However, the signal wire is also distributed over the entire heated area.

Discussing now the circuit of the control element within the fabric, as shown in Fig. 1, one end of the heater wire for the twin wire cable is connected to the control circuit, shown in dotted rectangle B, through connector 9. From the other end of the twin wire cable 1, heater wire 5 is connected in series with heater wire 2 at terminal 6. A parallel electrical circuit includes signal wire 3 connected through terminal 6' to a voltage dropping resistor 7. The heater circuit and the electrically parallel signal circuit may be provided with a common terminal connection at 8 which may be located in the blanket, control, or anywhere along the connecting cord.

Referring to the control circuit shown in dotted rectangle B of Fig. 1, electrical power is supplied through a plug 15 having terminal prongs 16 and 17 for connection, for example, to a conventional 115 volt, 60 cycle alternating current domestic circuit. Power is supplied to series heater wires 2 and 5 from the plug 15 through conductors 18, 19, 20, and connector 9. To control the starting of the operation of the circuit, an "on" switch 27 is provided. This line switch includes contacts 25 in the circuit of conductor 18. In conductor 19 are contacts 24 of "on" switch 27 and contacts 22 of

a thermostatic cycling switch 23. The supply of power to the heater wires 2 and 5 is controlled by cycling switch 23, which is shown diagrammatically as comprising a bimetallic thermostat 30, a heater 31 for thermostat 30, and the contacts 22. One of the contacts 22 is carried by the free end of the thermostat 30 and the other contact is connected to heater 31.

The construction and operation of cycling switches of this type are now well known. Thermostat 30 operates alternately to open and close a heater circuit responsive to heat supplied to it by heater 31 and by the surrounding atmosphere. At a lower temperature when the control is calling for heat, contacts 22 are closed by the flexing of thermostat 30 downward. When heated to a certain extent by heating coil 31, thermostat 30 flexes upward to separate contacts 22 to open the heating circuit on both the heater wires 2 and 5 and thermostat heater 31. A cycling switch of this type is disclosed in the patent to Kearsley, No. 2,195,958, issued April 2, 1940.

In order to provide overheat protection for the fabric, relay 32, of which contacts 25 of "on" switch 27 are a part, has its winding 33 connected by conductor 34 through connector 9 in series with the signal circuit comprising signal wire 3, series voltage dropping resistor 7, and conductor 20. Relay winding 33 and resistor 7 typically are high impedance elements, having values such as 80,000 ohms and 20,000 ohms, respectively. Furthermore, the relative impedance values of the relay winding and the voltage dropping resistor 7 are selected so that the voltage normally appearing across the relay winding substantially exceeds the voltage drop across heater section 2.

Contacts 25 of "on" switch 27 are normally open. One of the contacts 25 is connected to terminal 38, to which conductor 19 with cycling switch 23 and conductor 34 with relay winding 33 are also connected. The other of contacts 25 is supported by relay armature 28 and connected to prong 17 of plug 15 through conductor 18. Contacts 24 of "on" switch 27 are normally closed. Movable contact carrying arm 29 supports the one of contacts 24 closest to terminal 38. Button actuator 26 is secured to arm 29 and disposed in a suitable position to manually move armature 28 to the right to close contacts 25 and open contacts 24.

To provide for discontinuing operation of the circuit, "off" switch 35 is connected to shunt relay winding 33. Normally open contacts 37 of the "off" switch may be closed by a push button actuator 36 secured to an arm supporting one of the contacts.

In operation, assuming plug 15 has been connected to a source of alternating current, the user manually presses button actuator 26 which closes contacts 25 of the "on" switch, causing current to flow into the signal circuit. As button actuator 26 is moved to the right, the normally closed contacts 24 are simultaneously opened in the heater circuit. Thus, the operator cannot bypass the control system and cause continuous operation of the heater circuit by "jamming" the "on" button. Current flow through relay winding 33 then retains contacts 25 in the closed position through the attraction of relay armature 28. When the user releases button actuator 26, contact carrying arm 29 returns to its normal position, closing contacts 24. Current then flows through the cycling switch contacts 22 and into heater wires 2 and 5. When the temperature of the thermosensitive layer interposed between heater wire 2 and signal wire 3 reaches an overheat value, the impedance of the layer decreases, and the layer becomes more conductive than insulative. This results in a substantial decrease in voltage across the relay winding 33, because the added current flowing through voltage dropping resistor 7 and thermosensitive layer material causes an increased voltage drop across the voltage dropping resistor 7. This decrease in voltage applied to the relay winding causes the release of armature 28, which opens contacts 25 and de-energizes the control circuit and



both heater wires. As previously explained, the entire heater circuit is electrically in parallel with the signal circuit. However, the signal wire is coextensive with only section 2 of the complete heater. It is to be noted, therefore, that upon appreciable conduction through the thermosensitive layer, the voltage drop across heater section 2 limits the voltage which can appear across the relay winding. If, for example, heater sections 2 and 5 have substantially the same electrical resistance, the voltage drop through heater section 2 will be approximately one-half line voltage, disregarding the small resistance drop in the control assembly B. Therefore, if the thermosensitive layer becomes conductive adjacent terminal 6, no more than one-half line voltage can appear across the terminals of relay coil 33. Under these circumstances, the relay is so constructed that the armature 24 will be released and line switch 25 opened, thereby to de-energize the entire circuit. If the thermosensitive layer becomes conductive at any other point along its length, even less than half-line voltage may appear at the relay coil terminals. Therefore, whenever appreciable conduction occurs through the thermosensitive layer, the relay line switch opens to de-energize the circuit. To again energize the heater and control system, the operator must depress the "on" actuator.

For manually de-energizing the control circuit and the heater wires, actuator 36 is moved to the left to close normally open contacts 34 of "off" switch 35, thereby shunting out relay winding 33 and causing the release of relay armature 28 to open contacts 25.

Our thermosensitive cable system is relatively simple in structure, reliable in operation and capable of being manufactured at low cost. With thermosensitive twin wire cable spread at intervals over the entire surface of the electrically heated fabric, only approximately half as much twin wire is required with no appreciable sacrifice in overheat protection. An important advantage of our thermosensitive cable system resides in its simplicity and the resultant economy derived from the reduction in the length of thermosensitive cable used in an electrically heated fabric. Furthermore, the electrical control system is simplified in that a simple voltage sensitive relay can be used to open a line switch upon any overtemperature condition.

While we have herein shown and described a typical embodiment of our invention, it will be understood that the invention is not limited to the precise details described or to the exact procedure set forth.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. In an electrically heated bedcover, a heater wire distributed over the area of said cover, a signal wire coextensive with a portion substantially less than the total length of said heater wire, a resistor in series with said signal wire, a layer of thermosensitive material between said heater and signal wires which is an insulator at normal operating temperatures and a conductor at a higher temperature, a heater circuit including said heater wire, a relay having a relay coil and a line switch operated thereby, said relay coil being constructed to open said line switch when the voltage across said coil decreases to a drop-out level substantially below normal operating voltage, a signal circuit including said relay coil with said series signal wire and resistor connected electrically in parallel with said heater wire, whereby the voltage across said relay coil decreases below drop-out level whenever a conductive path is established through said layer.

2. An automatically controlled and electrically heated bedcover comprising an electrical heating wire distributed over the area of the cover, a signal wire coextensive with said heater wire from one end thereof to the midpoint of said heater wire, said heater and signal wires being separated by a layer of flexible material which at normal operating temperatures is essentially an insulator and which becomes conductive at a higher temperature, a heater circuit including said heater wire, a relay having an op-

erating coil and a line switch held in a closed position when said relay is energized at more than one-half line voltage, and a signal circuit including said signal wire and said relay operating coil, a series resistor in said signal circuit to establish a voltage exceeding one-half line voltage across said relay operating coil under normal conditions, said heater and signal circuits being connected electrically in parallel whereby a conductive path through any point along said conductive layer upon an overheat condition reduces the voltage across said relay to less than that required to hold said line switch in a closed position.

3. An electrically heated fabric and control therefor comprising a plurality of channels within said fabric, a thermosensitive cable disposed within alternate pairs of said channels, said thermosensitive cable including a first heater wire and a signal wire with an interposed layer of thermosensitive material therebetween, said layer becoming electrically conductive upon an overtemperature condition, a second heater wire approximately equivalent in length to said cable and disposed in alternate pairs of channels between the channels containing said cable, a heater circuit including both of said heater wires in electrical series, a signal circuit including said signal wire in electrical parallel with said heater circuit, and voltage sensitive means in said signal circuit to open the heater circuit upon conduction through said layer.

4. In an electrically heated bedcover, a heater wire distributed over the area of said bedcover, a signal wire co-extensive with a portion less than the total length of said heater wire, a resistor connecting said signal wire to said heater wire whereby the voltage drop across said resistor causes said signal wire to operate at a fraction of the heater wire voltage during normal operation of the blanket, a layer of thermosensitive material between said heater and signal wires which is an insulator at normal operation temperatures and a conductor at higher temperatures, a heater circuit including said heater wire, a relay having a relay coil and a line switch operated thereby, said relay coil being constructed to open said line switch when the voltage across said coil decreases to a drop out level substantially below normal operating voltage, one end of said relay coil being at substantially line voltage during normal operation of the blanket, the other end of said relay coil being connected to said signal wire whereby sufficient current normally flows through said coil to maintain said line switch closed, but



whenever a conductive path is established through said layer, the voltage applied to said signal wire and the other end of said relay coil increases thus causing the voltage across said relay coil to decrease below drop-out level to thereby open said line switch.

5. An electrically heated fabric and control therefor comprising: a plurality of channels within said fabric, a thermosensitive cable disposed within a plurality of adjacent pairs of said channels, said thermosensitive cable including a first heater wire and a signal wire with an interposed layer of thermosensitive material therebetween said layer becoming electrically conductive upon an overtemperature condition, a second heater wire disposed within a plurality of other adjacent pairs of said channels, a heater circuit including both of said heater wires in electrical series, a signal circuit including said signal wire in electrical parallel with said heater wire, and voltage sensitive means in said signal circuit to open said heater circuit upon conduction through said layer.

6. In an electrically heated warming device, electrical heating and control means comprising: a thermosensitive heating cable distributed over the area of the device, said cable including a first heater wire and a signal wire separated by a layer of thermosensitive material changing in resistance upon an overtemperature condition, a second heater wire in electrical series with said first heater wire and also distributed over the area of the device, a line switch, a heater circuit including said first and second heater wires and said line switch, a voltage sensitive relay coil for operating said line switch, and a control circuit including said relay coil and said signal wire to apply normal voltage to said relay coil to maintain said line switch closed at normal operating temperature and to change the voltage applied to said relay coil upon change in resistance of said thermosensitive material upon an overtemperature condition, thereby to open said line switch.

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