PATENT SPECIFICATION (11) 1 588 784

1 588 784

(21) Application No. 3866/78 (22) Filed 31 Jan. 1978 (19)

(23) Complete Specification filed 31 May 1978

(44) Complete Specification published 29 April 1981

(51) INT. CL.³ H02H 5/04

(52) Index at acceptance
H2K 234 252 452 544 761 765 766 76Y CB

(72) Inventor GRAHAM MALCOLM C OLE

(54) HEATING CIRCUITS

(71) We, DREAMLAND ELECTRICAL APPLIANCES LIMITED, a British company, of Shipyard Estate, Hythe, Southampton, Hampshire SO4 6YE, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:–

This invention relates to heating circuits.

According to the invention there is provided a heating circuit comprising a cable that comprises a first conductor to effect heating, a second conductor and means that separate said two conductors and which will melt in the event of overheating to allow contact between the two conductors. the second conductor being interrupted at a position along its length to define two portions and each such portion being directly connected to the end of the first conductor nearer the other such portion, and two-terminal circuit interruption means connected in series with the first conductor such that current supplied to the first conductor also flows through the circuit interruption means, the circuit interruption means being responsive to current flowing therethrough increasing as a result of contact between the two conductors to become open circuit to stop current flowing through the first conductor.

In a circuit in accordance with the invention, by virtue solely of the separation of the second conductor into two portions and the connection of such portions to the ends of the first, heating conductor as set forth above, there will be a large increase in the current through the circuit interruption means in the event of contact between the two conductors, regardless of where along the length of the cable the position of contact is located. Thus, with only a two conductor cable and a simple two-terminal circuit interruption means (e.g. a fuse), and without the use of additional circuit components to amplify the effect of a fault, good protection against overheating is provided.

In a preferred embodiment of the invention described hereinbelow the cable is a dual-coaxial heating cable and the means separating the two conductors comprises a plastics material such as polyethylene or polyvinyl chloride (PVC), and the circuit interruption means is a fuse. The second conductor is interrupted halfway along the length of the cable whereby in the event of a fault the current through the fuse will increase to anywhere between twice its normal value and a substantially unbounded value, depending on the location of the fault, to ensure that the fuse is blown.

Heating circuits in accordance with the invention are applicable to the heating of a variety of objects or media. They may be used, for example, in pipe heating, soil warming, industrial process heating or in space heating, for instance in ceiling heating or underfloor heating. The invention is, however, expecially suited to the heating of electric blankets, which term is to be deemed to encompass not only electrically heated overblankets but also electrically heated underblankets, and electrically heated pads.

The invention will now be further described, by way of example, with reference to the accompanying drawing, the sole figure of which is a circuit diagram of a heating circuit embodying the invention for an electric blanket or pad.

The illustrated heating circuit comprises a cable 1 which is incorporated in an electric blanket or pad (not shown) in a manner known in the art. The cable 1 comprises a heating conductor 2 and a sensor conductor 3 separated by a material 4 shown in the drawing by cross-hatching. The heating conductor 2 is of resistance wire and is therefore represented as a resistor. The sensor conductor 3 is preferably a low resistance conductor, for instance of copper. The cable 1 is preferably so constructed that the conductors 2 and 3 are coaxial: the heating conductor is the inner one of the conductors and is wound on an electrically insulative core, the material 4 surrounds the conductor 2, the sensor conductor 3 is wrapped or wound around the material 4, and an outer sheath covers the sensor conductor 3. The material 4 is of such a nature that in the event of overheating of the cable

1 it will melt causing the outer sensor conductor 3 to collapse onto the inner heating conductor 2 so that the two conductors come into contact, that is say are short-circuited together. The material 4 is preferably a plastics material, for instance polyethylene or polyvinyl chloride (PVC), which has a melting temperature of about 160°C, or more precisely about 150 to 170°C, which is too low to support combustion of the electric blanket or pad.

The sensor conductor 3 is interrupted substantially half-way along the cable 1, at a position 5, to define two sensor conductor portions 3′, 3″. (Alternatively, the cable 1 could be constituted by two like cable portions of which the heating conductors are joined end-to-end to form a structure exactly the same as that just described.)

The ends of the sensor conductor portion 3′ are connected together and are directly connected via a conductor 6 (i.e. not via a circuit component or a part thereof) to the end of the heating conductor 2 nearer the portion 3″. The ends of the sensor conductor portion 3″ are connected together and directly connected via a conductor 7 to the end of the heating conductor 2 nearer the portion 3′.

The heating conductor 2 is connected in series with a quick-blow cartridge fuse 8 between a pair of input terminals 9, 10 for connection to the live (L) and neutral (N) conductors of an AC power supply (not shown), the fuse 8 being adjacent the live terminal 9.

The above-described circuit operates in the following manner. When the terminals 9, 10 are connected to the power supply, current flows through the heating conductor 2 and warms the blanket or pad. In the absence of an overheat condition the material 4 acts as an insulator separating the conductors 2 and 3. Consequently, the heating current flowing through the heating conductor 2 adopts a value I_N determined substantially by the total resistance of the heating conductor 2.

Suppose now that, for example due to a ruck in the blanket or pad or a twist in the cable 1, the cable becomes overheated at a position along its length. The material 4 then melts and the conductors 2, 3 come into contact with one another. If the overheat is located at the left hand (or right hand) end of the cable 1 as viewed in the drawing, the sensor conductor portion 3′ (or 3″) contacts the conductor 2. This produces a virtual short-circuit across the input terminals 9, 10 whereby the current demanded from the supply is substantially unbounded and the fuse 8 immediately blows to stop current flowing through the heating conductor 2. If the location of the overheat is spaced inwardly of the ends of the cable 1 the same thing happens, but the current is limited by that portion of resistance of the heating conductor 2 between the nearer end of the cable and the location of the overheat. The current in the event of an overheat is at a minimum value if the overheat is disposed half-way along the cable 1, the minimum value being equal to twice the normal heating current I_N in view of the fact that only half of the total resistance of the heating conductor 2 is in circuit.

Thus, regardless of the location of the overheat, there will be a large increase in the current through the fuse 8 and, provided the overheat is not located at or very close to the mid-point of the cable, the increase will be sufficient to cause the fuse to blow virtually immediately (that is to say within less than about one second) contact between the conductors 2 and 3 occurs. In the event that the overheat is disposed at or very close to the mid-point of the cable 1, the consequent doubling of the current might not in practice be sufficient to lead to the fuse 8 blowing immediately. However, it should be borne in mind that the short-circuit between the conductors 2, 3 is due to an external abuse condition which has caused the material 4 to heat up to around 160°C. The quadrupling in power dissipation in the portion of the cable 1 still carrying current after a fault at the mid-point of the cable causes severe overheating of that portion of the cable whereby the overheating of the cable already present due to the fault condition is greatly exacerbated. Thus, further contact between the conductor 2 and the conductor portion 3′ or 3″ soon occurs at a position or positions away from the mid-point of the cable 1, whereby the fuse 8 blows. In practice, if an overheat occurs resulting in contact between the conductors 2 and 3 at the mid-point of the cable 1, the fuse 8 will be blown within a few minutes of the contact occurring due to the thermal run-away effect just described.

As well as providing protection against localised overheating of the cable 1 due to an external abuse condition such as might be caused, for example, by a ruck in the blanket or pad or a twist in the cable, the above-described heating circuit also provides protection against localised overheating of the cable that might occur as a result of a break in the conductor 2. A break in the conductor 2 leads to arcing across the break. The arc heats and melts the material 4 and causes the conductors 2 and 3 to come into contact whereby, as described above, the fuse 8 blows either virtually immediately or, if the arc is at the mid-point of the cable 1, after a few minutes or so due to the above-described thermal run-away effect. In fact, breaks in electric blanket or pad heating conductors tend to occur near the ends of the cable in the region of the cable termination area, so that in virtually all cases the increase

in current due to the consequences of arcing in the event of a break will be of a sufficiently high magnitude to cause the fuse 8 to blow substantially immediately.

The circuit described above could be modified by not connecting together the ends of the sensor conductor portions 3′ and 3″. However, connection together of the ends of the portions 3′, 3″ is preferred, since in this event the circuit will continue to function satisfactorily in the event of a single break in either of the portions 3′, 3″.

WHAT WE CLAIM IS:—

1. A heating circuit comprising a cable that comprises a first conductor to effect heating, a second conductor and means that separates said two conductors and which will melt in the event of overheating to allow contact between the two conductors, the second conductor being interrupted at a position along its length to define two portions and each such portion being directly connected to the end of the first conductor nearer the other such portion, and two-terminal circuit interruption means connected in series with the first conductor such that current supplied to the first conductor also flows through the circuit interruption means, the circuit interruption means being responsive to current flowing therethrough increasing as a result of contact between the two conductors to become open circuit to stop current flowing through the first conductor.

2. A heating circuit according to claim 1, wherein the separating means is disposed around the first conductor and the second conductor is disposed around the separating means coaxially of the first conductor.

3. A heating circuit according to claim 1 or claim 2, wherein the two-terminal circuit interruption means is a fuse.

4. A heating circuit according to claim 1, claim 2 or claim 3, wherein the means separating the two conductors comprises a plastics material.

5. A heating circuit according to claim 4, wherein the plastics material is polyethylene.

6. A heating circuit according to claim 4, wherein the plastics material is polyvinyl chloride.

7. A heating circuit according to any one of the preceding claims, wherein said position of interruption of the second conductor is half-way along the length of the cable.

8. A heating circuit according to any one of the preceding claims, wherein the ends of each second conductor portion are connected together.

9. A heating circuit substantially as herein described with reference to the accompanying drawing.

10. An electric blanket incorporating a heating circuit according to any one of claims 1 to 9.

11. An electric pad incorporating a heating circuit according to any one of claims 1 to 9.

For the Applicants,
D YOUNG & CO.,
Chartered Patent Agents,
9 & 10 Staple Inn,
London WC1V 7RD.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1981.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained.

1588784 COMPLETE SPECIFICATION
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*