(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 802 701 A2

(12) # EUROPEAN PATENT APPLICATION

(43) Date of publication:
22.10.1997 Bulletin 1997/43

(51) Int. Cl.^{6}: **H05B 3/56**

(21) Application number: **96303335.2**

(22) Date of filing: **13.05.1996**

(84) Designated Contracting States:
DE FR GB IT NL

(30) Priority: **19.04.1996 CA 2174615**

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(54) **Variable power limiting heat tracing cable**

(57) A heating cable includes a pair of elongated electrode wires, each of which is coated with a first layer of insulating material. The first layer of insulating material is at least partially stripped off selected ones of the wires at spaced, alternating locations. A resistive heater wire, together with a yarn of fibrous insulating material, is spirally wound around the electrode wires whereby the heater wire is brought into electrical contact with selected ones of the electrode wires at the alternating locations, to electrically connect the alternating locations with the resistive heater wire. A second layer of an insulating material is provided over the resistive heater wire and insulating material, forming an outer surface for the cable.

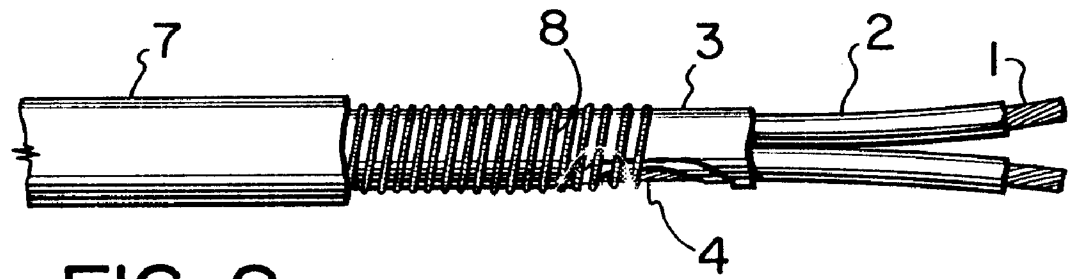

FIG. 2

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Description

The present invention relates to the field of electrical heating cable. In particular, the present invention provides an improved parallel zone heating cable with enhanced flexibility and shortened zone length.

DESCRIPTION OF THE PRIOR ART

Parallel zone heating cables are known **per se** and are in common usage in the heat tracing industry. In a typical construction of a parallel zone cable, two or three insulated bus wires (also called electrode wires) are provided. They may be solid or stranded, and are typically insulated with PCV, FEP, TPR or any other known and temperature rated conventional insulation. The insulated bus wires are jacketed with a further layer of insulating material, which is provided to maintain the bus wires in a parallel, untwisted configuration, as is necessary for further processing. The resulting jacketed bus wire construction is referred to as a core. The insulation over short, one to two inch sections of bus wire is then skinned off, at alternating sites from one bus wire to the next along the length of the core, to expose the metal bus wire. A heater wire of known resistance, (measured in ohms/linear foot) is then spirally wound around the core, making electric contact at the alternating exposed sites, with the bus wire. A layer of fibreglass may then be wound over the heater wire, to secure and cushion the heater wire, and the entire construction is then jacketed with an electrically insulating layer.

The cable described above has been in common use for a number of years and under most conditions will function quite well. However, the heater wire that has traditionally been utilized has been a monofilament wire, and under conditions of rough handling or rapid heat cycling, it tends to break, causing a zone (being the distance between two alternative sites on the core where the insulation has been skinned away) to lose electrical continuity and its heating ability. A small number of zone failures is not considered fatal to a cable, since a zone will be heated by the preceding and following functioning zones, but a larger number of zone failures will necessitate removal of the affected cable.

It has also been observed in parallel zone cables of the sort described above, that due to the thermal shock to the heating wire during the application of an extruded outer jacket, the installation of cable in curved configurations, and rapid duty heat cycling, there is a tendency for the heater wire to form a V-shaped groove along the inner curve of a cable, between the bus wires. This is referred to as chevroning, and may result in heater wire kinking and breakage.

SUMMARY OF THE INVENTION

The object of the present invention, in view of the foregoing, is to provide a parallel zone electrical heating cable that is very flexible, and able to withstand rough handling and rapid heat cycling, with minimum zone failure. A further object of the present invention is to provide such a heating cable with a short zone length, since it is desired to have a short zone length, as this will minimise the impact of zone failure.

The objects of the present invention are substantially met, and the defects of the prior art overcome, by utilizing a different form of heating element, one that is less susceptible to kinking or breaking. To this end, the applicant has designed a heating element in the form of an elongated resistor core. A length of fibreglass or other insulating yarn having good flexibility is provided, and a thin resistive wire is helically wound around same, fairly tightly. The resulting elongated resistor core will exhibit a fairly high resistance measured in ohms/linear foot, since it utilizes a much greater length of heater wire, wrapped helically around the fibreglass yearn, that the final length of resistor core, which will be about equal to the length of fibreglass yarn utilized in the core. Moreover, the elongated resistor core, even though tightly wrapped, will exhibit much more pronounced limpness than a monofilament heating wire of necessarily thicker gauge. This limpness serves to eliminate breakage due to kinking of the heater wire, and also to eliminate chevroning.

Furthermore, the innovative design of the elongated resistor core may be more rapidly cycled, without damage, than previous designs. As the heater wire expands and contracts against the fibreglass yarn core, the yarn core absorbs and cushions the contraction of the heater wire. In a conventional design, the heater wire's contraction is substantially uncushioned, resulting in both breakage of the wire, and stretching of the wire. Stretching of the wire causes both chevroning, and looseness resulting in poor electrical contact with the electrode wires.

In order to assure constant electrical contact between the elongated heater core and the electrode wires at the stripped portions of same, and to provide additional impact cushioning, a fibreglass (or other insulating yarn) layer is braided over the resistor core after it is wound around the electrode wires. A final insulating layer is then applied.

In a broad aspect, the present invention relates to a heating cable, including: (a) a pair of elongated electrode wires, each of said wires being coated with a first layer of insulating material, said first layer of insulating material being at least partially stripped off selected ones of said wires at spaced, alternating locations; (b) a resistive heater wire which together with a yarn of fibrous insulating material is spirally wound around said electrode wires whereby said heater wire is brought into electrical contact with said selected ones of said electrode wires at said alternating locations, to electrically connect said alternating locations with said resistive heater wire; (c) a second layer of an insulating material over said resistive heater wire and insulating material forming an outer surface for said cable.

BRIEF DESCRIPTION OF THE DRAWINGS

In drawings that illustrate the present invention by way of example:

Figure 1 is a perspective view partially cut away of a parallel zone heating cable typical of the prior art;
Figure 2 is a perspective view partially cut away of a heating cable of a first embodiment of the present invention;
Figure 2A is a detail view of the end of a heater wire construction of the cable of Figure 2;
Figure 3 is a schematic of the manufacturing method for manufacturing the prior art cable of Figure 1;
Figure 4 is a schematic of the manufacturing method for manufacturing the cable of the present invention; and
Figure 5 is a perspective view, partially cut away, of a second embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to Figures 1 and 3, it will be seen that prior art parallel zone heating cables provide a pair of bus wires 1, coated with insulation 2. The pair of insulated bus wires is then coated, while in a parallel state, with an insulator coat 3. At alternating locations 4, typically 12-36 inches apart, the insulating coats 2 and 3 are stripped off of the bus wire, then the metal of the other bus wire, and so on. A heater wire 5 is then wound around the alternately stripped core to make electrical contact with the bus wires 1, to create heating circuits between the bus wires, corresponding to the distance between stripped locations on the bus wires. A fibreglass layer 6, which may be a woven braid or helically applied yarn, may then served over the heater wire. A final layer of insulation 7 is then extruded over the fibreglass layer, yielding a finished product.

The present invention, on the other hand, as can be understood from Figures 2, 2A, 4 and 5, provides a different construction to achieve an end result that shares many basic characteristics of known parallel zone heating cables, but is an improvement over same.

According to the present invention, a similar core of parallel, untwisted and insulated 2 bus wires 1 is coated with an insulating jacket 3, and stripped at alternating locations 4. A comparison of Figures 3 and 4, however, indicates that at this point, the present invention diverges from the prior art. Whereas in the Figure 3 prior art method of manufacture a heater wire 5 (see Figure 1) is then wound directly over the bus wire core, in the method of the present invention, a heater wire 9 (see Figure 2A) is wound over a fibreglass or other insulating core 10, and then the heater wire/fibreglass combination 9/10 is wound over the bus wire core. Depending on the desired use of the product, a fibreglass layer 11 may be braided over the heater wire/fibreglass combination, as shown in Figure 5. Use of a braided layer 11 provides an added measure of assurance of good electrical contact between the heater wire and the electrode wire. It will be understood that the heater wire 9 utilized in the present invention may be of very much smaller diameter than that of the prior art. This feature, combined with the cushioning effect of the fibreglass core 10 provides a heating element combination that is very flexible and supple. Moreover, it has been observed that such a combination, because of the cushioning effect of fibreglass core 10, is capable of withstanding mechanical impacts associated with an individual installation environment and rapid heat and cooling cycles without breakage, unlike the heater wire of the prior art, that is wound directly onto the fairly unyielding bus wire core. Furthermore, because a greater length of heater wire 9 is utilized, helically wrapped around a fibreglass core 10, equivalent heating characteristics with much shorter zone lengths are possible.

In a typical cable, according to the present invention, the following materials are used:

bus wire 1: stranded copper, AWG 18-10
insulating material 2: PVC or similar
insulating material 3: PVC or similar
resistor core 10: fibreglass, stranded yarn
heater wire 9: 70% Ni, 30% Fe, AWG 30-48
(up to 99% Ni wires with similar PTC turn-down phenomena are suitable)
insulating jacket 7: PVC or similar
braid 11: fibreglass yarn

This construction results in a cable having technical specifications that meet or exceed industry standards, with short zones and good impact resistance, as well as superior ability to withstand rapid heating cycling without breaking down.

It will be understood that the foregoing table is by no means exhaustive. Bus wire 1 may be any desired, single or multi strand wire, as will be obvious to one skilled in the art. Insulating layers 2, 3, 7 may be FEP, PTFE, PFA, TPR, PVC, fibreglass, ceramic fibre, or any other suitable insulation.

Heater wire 9 may be AWG 30 to AWG 48, and insulating core 10, as well as being fibreglass, may be polypropylene, polyester, ceramic fibres, or other suitable temperature rated material. The selection of heater wire 9 will depend on the desired characteristics and the intended use of the cable. Preferably, a heater wire exhibiting positive temperature coefficient of resistance (PTC) is used, and in this regard, a minimum 60% nickel wire is desirable. The balance may be chrome, copper, or iron, or a combination thereof. Preferably, 70% nickel to 99% nickel, remainder iron, alloy is utilized.

It is to be understood that the examples described above are not meant to limit the scope of the present invention. It is expected that numerous variants will be obvious to the person skilled in the heat tracing field art, without any departure from the spirit of the present invention. The appended claims, properly construed, form the only limitation upon the scope of the present invention.

Claims

1. A heating cable, including:

    (a) a pair of elongated electrode wires, each of said wires being coated with a first layer of insulating material, said first layer of insulting material being at least partially stripped off selected ones of said wires at spaced, alternating locations;

    (b) a resistive heater wire which together with a yarn of fibrous insulating material is spirally wound around said electrode wires whereby said heater wire is brought into electrical contact with said selected ones of said electrode wires at said alternating locations, to electrically connect said alternating locations with said resistive heater wire;

    (c) a second layer of an insulating material over said resistive heater wire and insulating material forming an outer surface for said cable.

2. A heating cable as described in Claim 1, wherein said resistive heater wire is wound helically around said yarn of fibrous insulating material to form an elongated resistor core, said resistor core being spirally wound around said selected ones of said electrode wires.

3. A heating cable as described in Claim 2, wherein said core of insulating material around which said heater wire is wound is selected from the group including fibreglass, polypropylene, polyester, ceramic fibre and other insulating fibres.

4. A heating cable as described in any one of Claims 1 to 3, wherein said heater wire is wire exhibiting positive temperature coefficient of resistance.

5. A heating cable as described in Claim 4, wherein said heater wire is an alloy containing at least 60% nickel, and the remainder chromium, copper, iron, or a combination thereof.

6. A heating cable as described in Claim 5, wherein said heater wire contains from 70% to 99% nickel, and the remainder iron or similar metals.

7. A heating cable as described in any one of Claims 1 to 6, wherein said alternating locations of said selected ones of said electrode wires where said first layer of insulation is stripped away are from 0.45m to 1.83m (18 to 72 inches) apart.

8. A heating cable as claimed in any one of Claims 1 to 7, further including a layer made of a yarn of fibrous insulating material applied over said layer (b) of resistive heater wire together with a yarn of fibrous heating material.

9. A heating cable as claimed in Claim 8, wherein said layer made of a yarn of fibrous insulating material is made from fibreglass, polyester or similar yarn, braided snugly over said layer of resistive heater wire together with a yarn of fibrous insulating material.

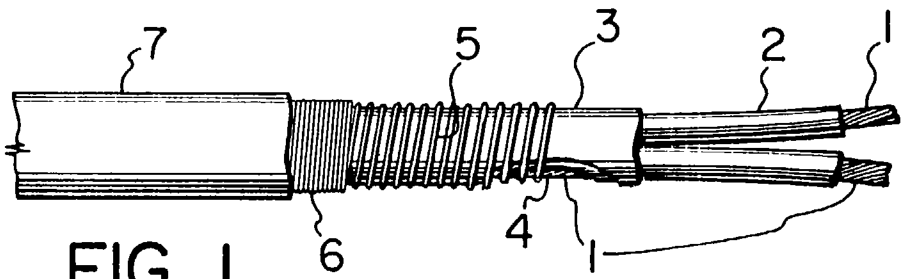

FIG. 1
PRIOR ART

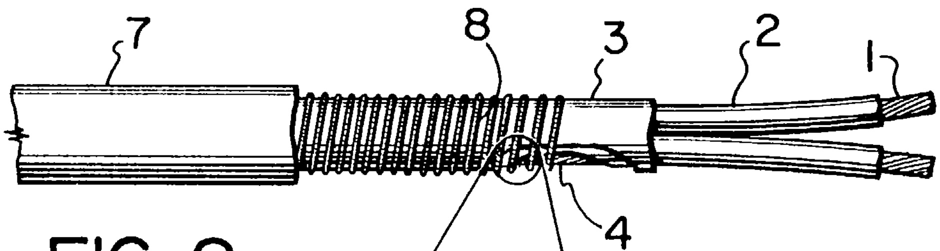

FIG. 2

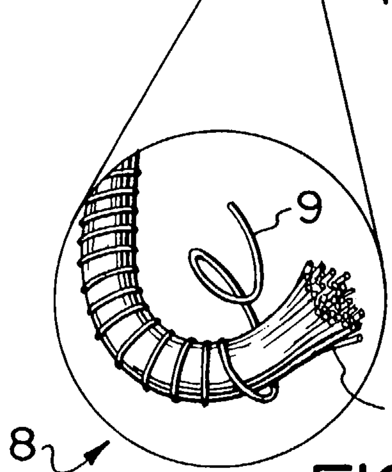

FIG. 2A

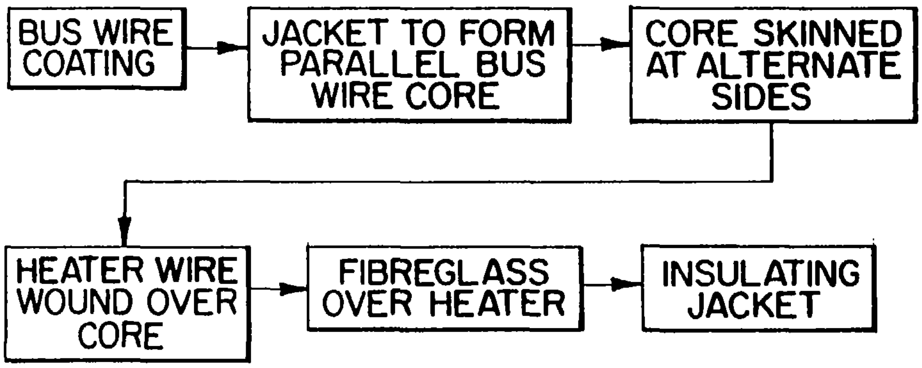

FIG. 3 PRIOR ART

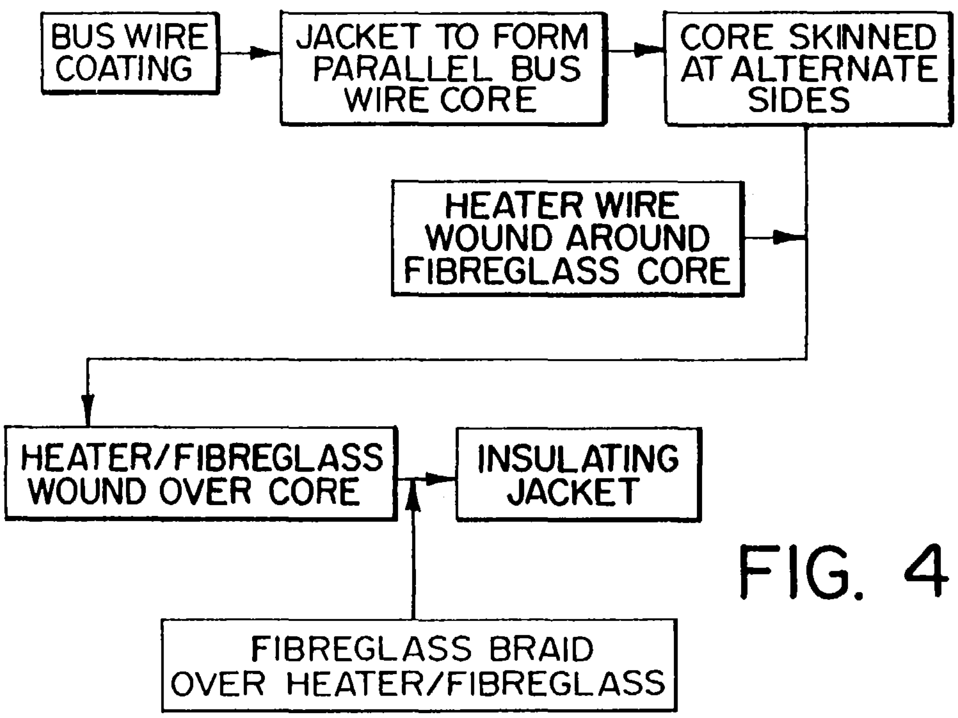

FIG. 4

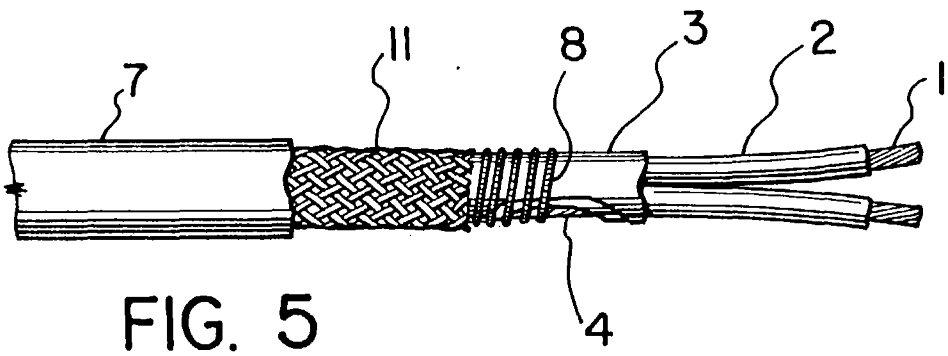

FIG. 5