United States Patent

[11] 3,621,203

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[32] Priority **June 26, 1970**
[33] **Netherlands**
[31] **7009422**

[54] **ELECTRIC RESISTANCE HEATING CABLE**
6 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **219/528,** 174/68, 219/544, 219/549, 338/139, 338/214
[51] **Int. Cl.** **H05b 3/34,** H05b 3/54
[50] **Field of Search** 219/528, 549, 542, 544; 338/214, 139–143; 174/68–69

[56] **References Cited**

UNITED STATES PATENTS

Re.26,522	2/1969	Fessenden	219/528
1,948,354	2/1934	Lodge	338/139 X
2,965,978	12/1958	Modrey	174/69
3,454,747	7/1969	Hart	219/549

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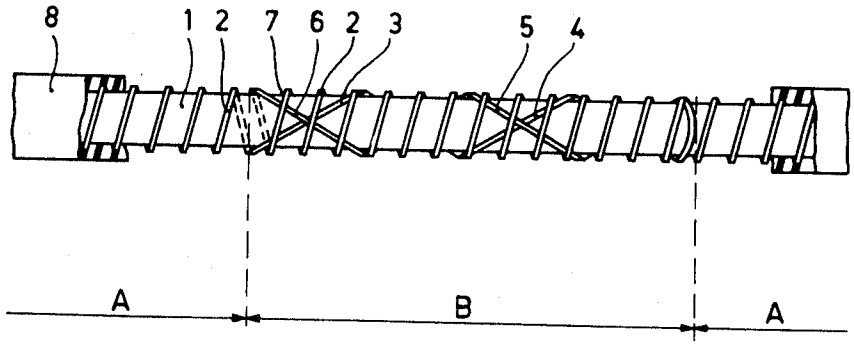
ABSTRACT: A resistance heating cable having relatively high and low temperature sectors during operation. The cable has a flexible core, a resistance wire wound thereon and an outer covering. The resistance wire is wound with a number of layers in the low temperature sectors one across the other, which layers establish mutual electrical contact with each other. The high temperature sectors have at least two layers of windings.



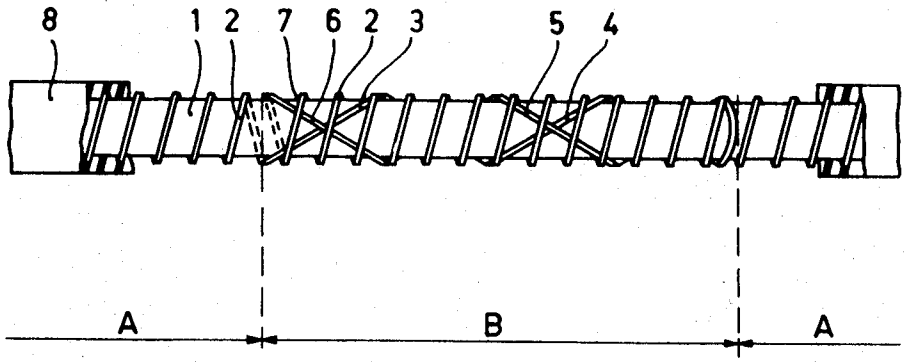


FIG. 1

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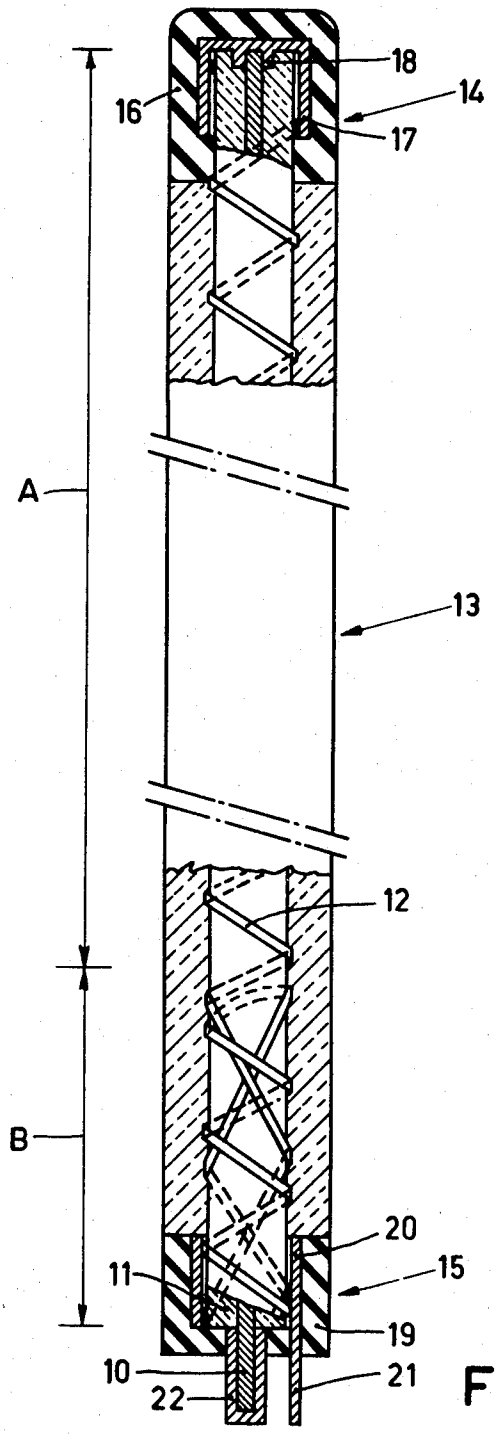

Fig. 2

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ELECTRIC RESISTANCE HEATING CABLE

The invention relates to an electric resistance heating cable comprising a flexible core of electrically insulating material, a heating wire wound helically around this core and extending throughout the length of the cable and a covering of electrically insulating material. The cable is divided into at least two groups of alternating sectors extending along the cable. The different sectors produce different temperatures during use of the cable.

A cable of this kind is known from German Pat. No. 820,943. In this cable the heating wire in the sectors which have the low temperature during use is wound at a greater pitch than in the sectors which have a higher temperature during use.

It has been found in practice that such a construction is not conducive to the manufacture of a cable having sectors of very great temperature differences (several hundred degrees of Celsius). The temperature of the heating wire itself exhibits little differences in the different sectors.

A further construction of such a cable is described in U.S. Pat. No. 26,522.

In the electric resistance heating cable disclosed in this patent sectors whose temperature does not increase or only increase to a relatively low value during use are obtained by short-circuiting a number of windings of the heating wire at different distances along the cable by means of a conducting strip. The strip is provided between the core and the windings of the heating wire.

When such a cable is kinked or is repeatedly bent there is the risk that the ends of the strips will slide out from the windings of the resistance wire and be bent, thereby damaging the insulating outer covering and causing a short circuit between the cable and other metal parts which are in the vicinity of the cable during use. In addition, local variations in the resistance of the cable occur.

In the proposed construction it is not quite clear how sectors having a relatively low temperature and small dimensions are ts be obtained.

An object of the present invention is to provide a construction for an electric resistance heating cable which avoids the drawbacks of the known constructions.

According to the invention, an electric resistance heating cable which satisfies the above is characterized in that an odd number of helically wound layers of heating wire are provided in the sectors of the cable which produce a relatively low temperature during use. These are in electrical contact with one another and alternate layers are wound in the same direction as that in which the heating wire is wound in the sectors having a higher temperature during use and are wound in the opposite direction, is located one across the other on the core. The number of layers provided one across the other exceed the numbers of layers in the high temperature sectors by at least two.

In this connection a heating wire is understood to mean a wire of arbitrary shape and optionally a composite structure.

By using the construction according to the invention, sectors which extend in the longitudinal direction of the cable may be obtained in a simple manner without using other materials than that for the heating wire itself, which sectors have mutually different resistances per unit length and consequently a mutually different heat development during use.

The occurrence of a temperature difference results exclusively from the special construction of the cable according to the invention.

In one suitable embodiment three layers of heating wires are arranged one across the other in the low temperature sectors of the cable, while the heating wire is wound in a single layer in the higher temperature sectors.

Electrically, such a cable comprises a plurality of sectors having a comparatively high resistance and a plurality of sectors having a comparatively low resistance. The latter sectors are produced by winding the heating wire in such a manner that a plurality of partial resistors is produced each of which convey only a part of the current which is passed through the heating wire in the other sectors. The plurality of partial resistors present in a given sector determines the temperature which is reached during use in said sector, as a function of the load.

The heating wire may be wound at the same or a different pitch in the different sectors and in the layers located one on top of the other.

It is also possible to vary the pitch within a sector during winding so that a certain temperature profile is obtained within a sector.

In a suitable embodiment in which three layers of heating wire are located one on top of the other in the low temperature sectors, the first two layers located on the core are wound at a greater pitch than is the third layer. When using this construction a greater temperature difference is produced between the different sectors than in a construction in which the first two layers located on the core are wound at a pitch which is equal to that of the third layer. Winding of the third layer at a small pitch produces a satisfactorily electrical contact between the different layers and facilitates the application of contacts which are reliable in operation. The desired temperature difference may of course alternatively be obtained by winding a number of layers, greater than three, one across the other at the same small pitch. However, the preferred embodiment provides a considerable economy in material as compared with such a construction.

The core of the cable may consist of any electrically insulating organic or inorganic material which is resistant to the temperatures prevailing during use of the cable. The core may have a single or composite structure and may comprise, for example, polyvinylchloride, silicon rubber, nylon, glass fiber, asbestos fiber, polytetrafluoroethylene and polyfluoroethylene propylene.

A central conductor may be provided within the core. This conductor extends throughout the length of the core and may be used for connector purposes when it is difficult to hoop the cable or to establish contact in a different manner.

The heating wire may in principle comprise any electrically conducting material. However, a material having a high positive temperature coefficient of the specific resistance is preferably used (0.002 or more per °C.) for example, nickel, copper. In fact, as a result thereof the temperature difference in a given construction is increased and in case of a prescribed temperature difference less material may suffice than when using materials having a low temperature coefficient.

Depending on the temperatures occurring during use the outer covering may consist of organic or inorganic materials, which are known for this purpose. In principle the same materials may be used as those which are suitable for the core.

The cable may be produced by passing the core, which will generally have a circular cross section, continuously in one direction through a winding device and to cause this device to perform a forward and backward movement along the core when single layers are to be wound one on top of the other. According to a further method a fixed winding point is used and the core is moved forward and backward when single layers are to be wound one on top of the other. The core wound with the resistance wire is subsequently provided with an outer covering, for example, by winding and/or pleating it with glass or asbestos fibers or rayon or cotton, or by passing it through an extrusion device by which the cable is provided with a synthetic resin covering.

The outer covering may optionally consist of a plurality of apertures bodies of ceramic material.

Since it is desirable to be able to recognize the different heating sectors when the cable is not in use, for example, when mounting it in apparatus or when providing connecting pieces, it is recommended that the outer covering be approximately marked or labeled In the covered cable the relative low temperature sectors can be found back by magnetic or electric means because of the presence of a greater quantity of metallic material. A marking device may be coupled to a device suitable for this purpose.

Cables according to the invention may be used in apparatus in which heat must be generated locally while the intermediate parts of the apparatus and the connecting points must not increase or increase only to a slight extent in temperature.

Cables according to the invention may be used, for example, in heaters for hair curlers in principle consisting of a plurality of hollow cylinders or "fingers" to be heated which project from a bottom plate onto which the hair curlers can be slid. The sectors of the cable which reach a high temperature during use are accommodated in the fingers while the parts which remain comparatively cold are provided in the bottom plate.

Cables according to the invention may also be used in defrosters for refrigerators.

In order that the invention may be readily carried into effect, embodiments thereof will now be described in detail by way of example.

In this respect reference is made to the accompanying drawing in which FIGS. 1 and 2 show sn an sectors scale cable sections according to the invention.

The cable has a glass fiber core 1. A heating wire 2 is wound on the core. In the sectors A, which are partially visible, the heating wire 2 is wound in a single layer, the resistance being 30 ohms per meter. The sectors A reach a temperature of approximately 400° C. during use at a load of 90 watts per meter. In the sectors B, one of which is visible in the Figure, the heating wire 2 is wound in three layers. In the first layer, which is directly located on the core 1, the heating wire 2 is wound at a pitch which is approximately 20 times greater than the pitch in the sectors A (wire parts denoted by the reference numerals 3 and 4 in the Figure) in the same direction (in the Figure to the right-hand side) as in the previous sector A. In the layer provided thereupon (wire parts denoted by the reference numerals 5 and 6) the heating wire is likewise wound at this greater pitch, but now in the opposite direction. In the third layer (starting from the wire part denoted by the reference numeral 7) the heating wire is again wound at the same pitch and in the same direction as in the previous sector A (in the Figure to the right-hand side). The temperature in sector B is approximately 50° C. during use. The length of the sectors B is equal to that of the sectors A. The electrically insulating covering 8 of the cable may be a glass-fiber pleat having an overall thickness of 0.5 mm.

The cable of FIG. 2 has a central conductor 10 provided with a glass-fiber envelope 11 as a core. A heating wire 12 is wound on this core. The heating wire is wound in a single layer 12 in the visible sector A of the cable. In the sector B of the heating wire is wound in three layers as described with reference to FIG. 1. Furthermore, the cable has an outer covering 13 and two end pieces 14 and 15. The end piece 14 serves to connect the heating wire 12 to the central conductor 10, being for example, a copper wire of low resistance. To this end the end piece 14 comprises an outer envelope 16 of electrically insulating material and a metal bush 17 which fits around the core including heating wire 12, which metal bush includes a metal cylinder 18 fitting around the central conductor. The end piece 15 acts as an electrical contact. It consists of a bush of electrically insulating material which is provided with a metal inner bush 20 supporting a contact pin 21. The end piece also supports a metal hollow pin 22 accommodating the part of the central conductor 10 protruding from the envelope.

Since the heating wire 12 is wound in different layers in the sector B, the temperature in this sector does not become very high. The covering 19 of the end piece may therefore consist of synthetic resin.

The advantage of this embodiment of the heating cable is that the electrical contact of the cable may be established on one side thereof.

What is claimed is:

1. An electric resistance heating cable comprising a flexible core of electrically insulating material, a heating wire helically wound on said core and extending the length of the cable, said cable being divided into groups of a first heating sector for producing relatively low temperatures during operation and a second heating sector for producing relatively high operating temperatures, said first sector having a plurality of layers of heating wire in electrical contact with each other wound about the core therethrough, said plurality of layers being an odd number of layers, alternate layers of said plurality being helically wound in the same direction as the heating wire wound about the core through said second sector, the layers intermediate said alternate layers being wound in the opposite direction, adjacent layers being located one across the other, said plurality of layers in the first sector exceeding the layers in the second sector by at least two layers, and a covering about said cable of electrically insulating material.

2. The electric resistance heating cable as claimed in claim 1, wherein said heating wire is of a material having a high positive temperature coefficient of the specific resistance.

3. The electric resistance heating cable as claimed in claim 1, wherein said odd number of layers of heating wire in said first heating sectors comprises three layers located one across the other and wherein the number of layers of heating wire in said second heating sectors is a single layer.

4. The electric resistance heating cable as claimed in claim 3, wherein the first two layers of heating wire in said first sector located on the core being wound at a greater pitch than is the third layer.

5. The electric resistance heating cable as claimed in claim 3, wherein said core is comprised of glass fibers and wherein said electrically insulating material of said cover is comprised of a glass-fiber pleat.

6. The electric resistance heating cable as claimed in claim 1, further comprising a central electric conductor within said core, said conductor being surrounded by an electrically insulating envelope and extending throughout the length of the cable.

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(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,621,203 Dated November 16, 1971

Inventor(s) LOUIS JOSEPH HENRI GEOMINY ET AL

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the Heading under Priority, a second application should be added -

--July 10, 1969
Netherlands
6910582--

In the Abstract - line 7, after "two" insert --less--

Column 1, line 21, before "26" insert --RE--

Column 2, line 71, after "labeled" insert --.--

Column 3, line 19, delete "sn an sectors" and insert

--on an enlarged--

Signed and Sealed this 27th day of June 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents