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(54) Heating cable

(57) The invention describes a heating cable. The heating cable comprises one or more strands assembled into the heating cable by means of twisting or cabling. At least one of the strands comprises at least one combined yarn. The combined yarn comprises a non-conductive polymer core around which at least one metal tape is wrapped. The metal tape is, when the heating cable is in use, generating heat via the Joule effect.

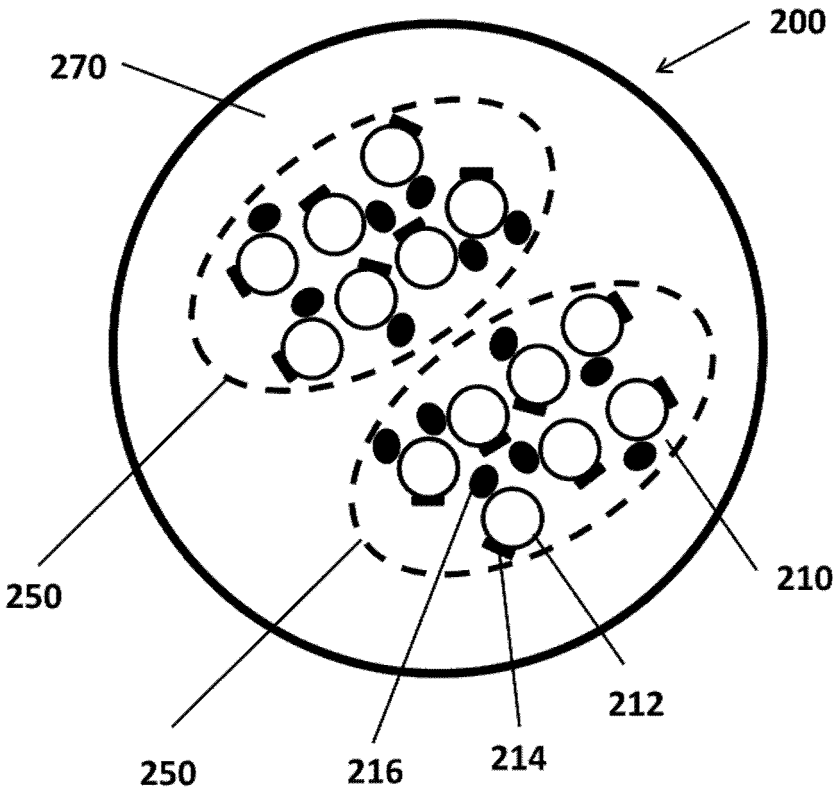

Fig. 2

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Description

Technical Field

[0001] The invention relates to heating cables wherein heat is generated via the Joule effect in metal filaments of the heating cable. The invention further relates to a car seat heating element. The invention also relates to uses of the heating cables.

Background Art

[0002] The use is known of heating cables in which metal filaments are twisted and/or cabled together and that operate according to the Joule effect. An example is in car seat heating elements.
The use of cables consisting of twisted copper multifilaments is well known in heating applications.
Other heating cables are disclosed in DE4312622, in which stainless steel multifilament, which can be twisted to form a cable, is used as electrical conductor to generate heat when the heating cable is in use. EP1705957 discloses a heating cable that has outer conductive strands which are wound around an inner strand that is also electrically conductive. The specific conductivity of the inner strand is smaller than the specific conductivity of the outer strands. The inner strand is made of a material having high tensile strength and/or high alternating bending strength than a material from which the outer strands are made.
[0003] Heating cables in car seat heating elements - but also in a number of other applications - are subject to repeated bending and/or flexing loading. It is a problem that today's heating cables - e.g. heating cables with copper or copper alloys as metal filament conductor - are not withstanding sufficiently such loading, especially for use in zones of the car seat where such loading is most intensive.

Disclosure of Invention

[0004] It is the objective of the invention to provide heating cables that have a high ability to be bent and that are maintaining their functional (heat generation) properties during a long lifetime, especially in situations where repeated bending or flexing load occurs. It is a specific objective to provide heating cables that have a high level of flex fatigue resistance and a high level of corrosion resistance. It is a further objective to provide a heating cable in which the occurrence of hot spots is minimized. It is a further objective to provide a heating cable that can be easily connected to energy supplying means.
[0005] It is a further objective to provide heating elements, e.g. car seat heating elements comprising improved heating cables.
[0006] According to a first aspect of the invention a heating cable is provided. The heating cable comprises one or more strands assembled into the heating cable by means of twisting or cabling. With strand is meant a combination of individual elongated elements (e.g. yarns or monofilaments) running elongated together, that are combined into a same twisted or cabled unit in the heating cable. The heating cable can comprise one strand. Preferably it comprises at least 2 strands, more preferably at least 3 strands, even more preferably at least 5 strands, even more preferably at least 7 strands. Preferably the heating cable comprises less than 14 strands.
At least one of the strands comprises at least one combined yarn as an individual elongated element. The combined yarn comprises a non-conductive polymer core around which at least one metal tape is wrapped. With metal tape is meant a metal monofilament that is having a cross section that is thin compared to its width.
Preferably, at least one of the strands has at least two combined yarns, more preferably at least three combined yarns, more preferably at least five combined yarns, more preferably at least seven combined yarns, that each have a non-conductive polymer core around which at least one metal tape is wrapped.
The metal tape generates, when the heating cable is in use, heat via the Joule effect.
Preferably, the heating cable comprises at least ten combined yarns, that each have a non-conductive polymer core around which at least one metal tape is wrapped.
[0007] The combination of structural features of the heating cable of the invention results in a heating cable that is easy to bend and which has a long lifetime maintaining its functional properties. Such heating cables have a high level of resistance against flex fatigue and the occurrence of hot spots is prevented. With hot spots is meant that along the length of the heating cable, when in use, locally the heating cable has a higher temperature than in other places. Such hot spots are negative in that when using the heating cable in e.g. a car seat, locally excessive temperatures can be reached. In heating cables according to the invention hot spots are avoided by reducing and/or preventing breakage of the electrical conductors in the heating cable.
In at least some of the embodiments hot spots are further synergistically avoided by preventing electrical contact of broken conductors with other - parallel - conductors in the heating cable.
A number of embodiments have excellent corrosion resistance.
It is a specific benefit that the invention allows to make heating cables with excellent properties and with copper as electrical conductor. The invention provides a heating cables with pronounced benefits over twisted copper filament heating cables.
[0008] The heating cable of the invention has the further benefit that it can be more easily connected via mechanical crimping, e.g. to a bus bar or to a power supply. The use of metal tapes as electrical conductors in the heating cable and the use of the non-conductive polymeric core which is easily compressed when crimping, result in it that the mechanical crimping more easily re-

sults in good electrical contact, with low contact resistance. Even when the combined yarn comprises an electrically insulating wrap of fibers, filament, tape or yarn; wrapped around the non-conductive polymer core wrapped with the at least one metal tape; mechanical crimping still results in good results, as the insulation wrap can be pushed open and/or away when crimping enabling good electrical contact between and with conductors. Best results are obtained when the insulating wrap is a tape. Obviously when the heating cable of the invention comprises a polymer sheath (e.g. an extruded polymer sheath) such sheath is best removed before mechanical crimping, which can be done easily, after which the benefits in mechanical crimping are obtained.

[0009] It is a further benefit of at least some of the heating cables of the invention that they can be more easily processed into heating elements, e.g. in car seat heating elements, in apparel heating elements... Such improved processing is related to the combination of the size of the heating cable and its easy and good flexing and bending capabilities.

[0010] In a preferred embodiment, one or more metal tapes are wound in the same direction (S- or Z-direction) around the non-conductive polymer core. More preferably, only one metal tape is wrapped around the non-conductive polymer core. Such heating cables are particularly beneficial as they can be made and processed more easily.

[0011] Preferably, the wrapping of the metal tape or metal tapes is performed such that at least 80%, more preferably at least 90%, even more preferably at least 95%, of the surface of the non-conductive polymer core is covered by metal tape. It is a benefit of such a cable that it can be more easily processed, thanks to the smooth surface of the combined yarn.

[0012] In a preferred embodiment, the heating cable comprises one strand comprising combined yarns that comprise a non-conductive core around which at least one metal tape is wrapped. The metal tape is when the heating cable is in use, generating heat via the Joule effect. Preferably, such a heating yarn comprises in that strand at least 5 - more preferably at least 10, even more preferably at least 20 - combined yarns that comprise a non-conductive core around which at least one metal tape is wrapped.

[0013] In a preferred embodiment, the heating cable comprises more than one strand that, preferable each, comprise at least one combined yarn that comprises a non-conductive core around which at least one metal tape is wrapped. The metal tape is when the heating cable is in use, generating heat via the Joule effect.

[0014] In a preferred embodiment, the metal tape or the metal tapes have an additional metal layer providing the metal tape with increased corrosion resistance compared to the metal of the metal tape, the metal layer can e.g. comprise zinc, nickel, tin or silver.

Examples of such embodiments with a corrosion resistant additional metal layer are: nickel coating layer on copper tape; steel tape with a zinc or nickel coating layer.

[0015] It is possible to provide the metal tape, e.g. a copper or copper alloy metal tape, with a polymer lacquer or coating layer, e.g. for improved corrosion resistance. A polyurethane lacquer or a polyamide coating can e.g. be provided, e.g. on a copper or copper alloy metal tape.

[0016] It is however also possible that the metal tape is devoid of a polymer lacquer or polymer coating, meaning that the metal tape has a metal surface layer.

[0017] In a preferred embodiment, the combined yarn has a second metal tape wrapped around the polymer core in the opposite direction of the wrapping of the metal tape. Such embodiments allow to obtain a higher covering of the polymer core and a lower electrical resistance of the heating cable.

[0018] In a preferred embodiment of heating cables according to the first aspect of the invention, the combined yarn comprises an electrically insulating wrap of fiber, filament, tape or yarn; wrapped around said non-conductive polymer core already wrapped with the at least one metal tape. The electrically insulating wrap can be wrapped in the same or in the opposite direction of the wrapping of the at least one metal tape. Preferably, the electrically insulating wrap of fiber, filament, tape or yarn covers at least 90%, preferably 95%, more preferably 99% of the surface of the metal tape that is wrapped around the non-conductive polymer core. Most preferably, the electrically insulating wrap of fiber, filament, tape or yarn covers substantially the total surface of the metal tape that is wrapped around the non-conductive polymer core.

[0019] In a preferred embodiment, the metal tape comprises or consists out of copper, a copper alloy, steel, stainless steel, copper cladded steel, steel cladded copper or steel cladded copper alloy as electrical conductor.

[0020] Preferably, the metal tape has a width between 0.05 and 2 mm and/or a thickness between 5 and 40 micrometer. A more preferred thickness range for the metal tape is 10 - 30 μm.

[0021] Preferably, the ratio of the width of the tape over the thickness of the tape is higher than 3, more preferably higher than 5, even more preferably higher than 8, even more preferably higher than 10. Such heating cables have an improved flex life and can be processed more easily. The latter benefit is due to the smoother surface of the heating cable.

[0022] Preferably the polymer core is a polymer monofilament or a polymer multifilament yarn or a polymer spun yarn. Preferably, the polymer core is not comprising elastomeric filaments nor elastomeric fibers.

[0023] Preferably, the heating cable comprises a polymer sheath, preferably an extruded polymer sheath.

[0024] A second aspect of the invention is the use of a heating cable of the first aspect of the invention in car seat heating, or in steering wheel heating, or in heating systems for apparel or in heating of tubes. For heating in tubes, the tube can be provided with one more heating cables inside the tube, in the wall of the tube or around

the outside of the tube.

[0025] A third aspect of the invention is a car seat heating element comprising a heating cable as in the first aspect of the invention. Preferably, the car seat heating element is comprising means for providing electrical current to the heating cable. Such means can e.g. be a mechanically crimped connection to means for providing electrical current to the heating cable.

[0026] Features of the different embodiments and examples can be combined while staying within the content of the invention.

Brief Description of Figures in the Drawings

[0027]

Figure 1 shows an example of a combined yarn that can be used in the invention.

Figure 2 shows an example of a heating cable according to the invention.

Mode(s) for Carrying Out the Invention

[0028] In order to make an example of a heating cable according to the invention, a copper wire of 80 μm diameter was flattened to a copper tape of 23 μm thickness and a width of 0.22 mm.

The so-formed copper tape is wrapped around a polyester multifilament (the non-conductive polymer core), e.g. of 200 dtex. The wrapping can e.g. be done in Z-direction, and can be done to an extent to cover substantially the full surface of the non-conductive core.

A polymer tape, e.g. of polyester, e.g. of flame retardant polyester, with a thickness of 12 μm and a width of 0.23 mm was wrapped in S-direction around the polyester multifilament wrapped with the copper tape, forming a combined yarn, thereby covering the full surface of the non-conductive core already wrapped with the metal tape. Alternatively, the electrically insulating wrap can be fibers, filament or yarn instead of a polymer tape. Figure 1 shows schematically such a combined yarn 10, with the polyester multifilament core 12, the copper tape 14 and the insulating polymer tape 16 (alternatively, the electrically insulating wrap can be fibers, filament or yarn instead of a polymer tape). Preferably, the metal tape 14 is covering at least 90%, more preferably at least 95% of the surface of the core 12. Preferably the polymer tape 16 (or the alternative insulating wrap) is covering substantially the full surface of the core 12 wrapped with the copper tape 14.

Both wrapping operations can be performed in a one-step operation. However, it is also possible to perform the wrapping in two steps, in a first wrapping operation, the metal tape 14 is wrapped around the non-conductive polymer core 12. In the second wrapping operation, the non-conductive polymer tape 16 (or alternative insulating wrap) is wrapped around the non-conductive polymer already wrapped with the conductive metal tape.

However, it is also possible to make the combined yarn without the wrapping with a non-conductive polymer tape or other non-conductive yarn.

Seven of such combined yarns are twisted together with 120 turns per meter twist is Z direction to form a twisted strand. Two of such strands are twisted together with 80 turns per meter in S direction. Such heating cable 200 is shown schematically in figure 2, showing the combined yarns 210 which are combined in two strands 250 of seven combined yarns 210 each. The combined yarn 210 has a non-conductive core 212 which is wrapped with a metal tape 214 (e.g. a copper tape or a stainless steel tape), combination which is wrapped by a non-conductive yarn, e.g. a non-conductive tape 216.

The so-formed heating cable is coated with a coating layer 270, e.g. a thermoplastic elastomer. Such coating can an extrusion coating.

The so-formed heating cable has an electrical resistance of 0.24 Ohm/meter. The heating cable has an excellent flexibility, meaning that it can be bent easily and to a small bending radius. It has shown to have excellent flex fatigue and it is maintaining its heat generation functionality during a long lifetime, even when subjected to mechanical loads, e.g. to repeated flexing and bending. It can also be easily connected via mechanical crimping, e.g. to a bus bar or to energy supplying means.

[0029] Another example of heating cable is made with the same combined yarns as in the first example, but wherein one strand of 14 combined yarns is twisted to form the heating cable, which can be coated, e.g. extrusion coated.

[0030] Comparative flex life tests have been performed comparing two heating cables with the same electrical conductivity per unit of length:

- a twisted copper cable as in the prior art having 14 copper filaments of 79 μm diameter each. The flex life was 200 cycles.
- a heating cable according to the invention, comprising 14 combined yarns twisted together, each combined yarn is a polyester multifilament wrapped with a copper tape of 35 μm by 0.15 mm. The flex life was over 10000 flexing cycles. Wrapping the combined yarn with a non-conductive yarn, tape or monofilament even resulted in even longer flex life.

Claims

1. Heating cable, comprising one or more strands assembled into the heating cable by means of twisting or cabling,
   wherein at least one of the one or more strands comprises at least one combined yarn,
   wherein said combined yarn comprises a non-conductive polymer core around which at least one metal tape is wrapped.

2. Heating cable as in claim 1, wherein more than one of said strands comprise at least one combined yarn that comprises a non-conductive core around which at least one metal tape is wrapped.

3. Heating cable as in any of the preceding claims , wherein said combined yarn comprises an electrically insulating wrap of fibers, filament, tape or yarn; wrapped around said non-conductive polymer core wrapped with the at least one metal tape.

4. Heating cable as in any of the preceding claims, wherein said at least one metal tape has an additional metal layer providing said metal tape with increased corrosion resistance compared to the metal of the metal tape, said metal layer can e.g. comprise zinc, nickel, tin or silver.

5. Heating cable as in any of the previous claims, wherein said metal tape comprises copper, a copper alloy, steel, stainless steel, copper cladded steel, steel cladded copper or steel cladded copper alloy.

6. Heating cable as in any of the previous claims, wherein said metal tape has a width between 0.05 and 2 mm and/or a thickness between 5 and 40 micrometer.

7. Heating cable as in any of the previous claims, wherein said non-conductive polymer core is a polymer monofilament, or a polymer multifilament yarn or, a polymer spun yarn.

8. Heating cable as in any of the preceding claims, wherein said combined yarn has a second metal tape wrapped around said polymer core in the opposite direction of the wrapping of said metal tape.

9. Heating cable as in any of the previous claims, wherein said heating cable comprises a polymer sheath, preferably an extruded polymer sheath.

10. Use of a heating cable as in any of the previous claims, in car seat heating, or in steering wheel heating, or in heating systems for apparel, or in heating of tubes.

11. Car seat heating element comprising a heating cable as in claims 1 to 9.

12. Car seat heating element as in claim 11, comprising means for providing electrical current to said heating cable.

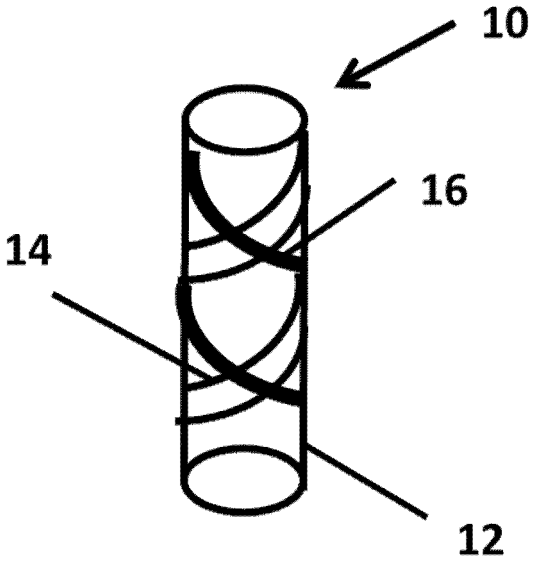

Fig. 1

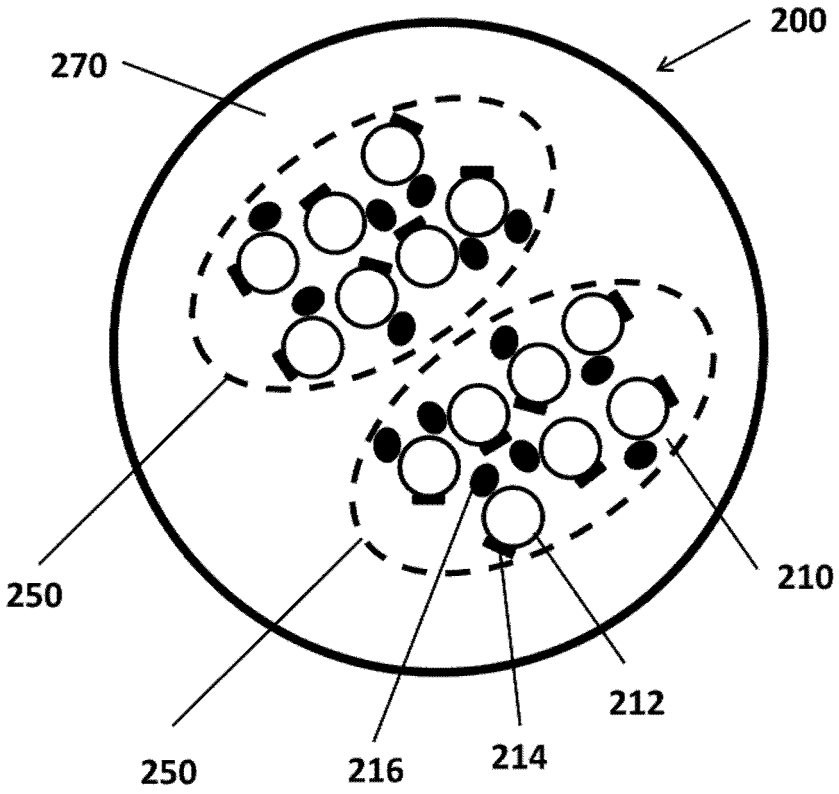

Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 13 16 5392

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H05B
D02G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	18 September 2013	Chelbosu, Liviu

CATEGORY OF CITED DOCUMENTS

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