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(54) Heating cable

(57) The present invention relates to electrical cables - such as heating cables - having at least one insulated wire conductor (1) - such as a resistance wire terminated with 'cold' wire ends - and at least one earthing conductor (3) arranged within at least one common outer layer. The at least one earthing conductor (3) is arranged within or in contact with a semiconductive layer (4).

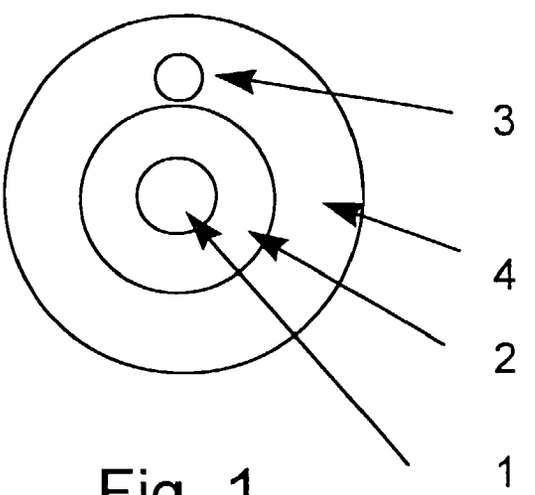

Fig. 1

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Description

[0001] The present invention relates to electrical cables and in particular to heating cables having at least one insulated wire conductor - such as a resistance wire terminated with 'cold' wire ends - and at least one earthing conductor arranged within at least one common outer layer.

[0002] EP 0 098 253 describes a heating cable having at least two conductors extending longitudinally of each other in spaced relation. Each of the conductors has an insulating coating which completely covers the respective conductors except for apertures in the conductors which are spaced longitudinally thereof. The apertures are arranged alternately in the conductors which are surrounded by a continuous layer of relatively low and substantially temperature-independent resistivity. The plastic layer is in contact with the conductors through the apertures and an electrically insulation outer layer covers the plastic layer completely.

[0003] EP 0 609 771 describes an electrical heating cable where a resistance wire is covered with heat resistive polymer insulation and outer mechanically resistive layers.

[0004] EP 0 312 204 relates to a heater conduit having a hollow tube comprising a conductive polymeric material that exhibits PTC behaviour, and two electrodes positioned in electrical contact with the tube, preferably in a helical configuration. There is preferably an electrically insulating core inside and an outer jacket around the conductive polymeric tube. The conduit can be heated by the passage of electrical current therethrough, and is preferably used to heat a fluid passing through the tube.

[0005] US 4,309,597 relates to a heating element for use in an electric blanket or the like including conductors spaced apart in a positive temperature coefficient (PTC) material which serves as a self-limiting heater. The conductors are separated by a spacer which prevents the conductors from engaging each other when the PTC material softens or melts during annealing thereof. A coating of material having a higher melting point than the PTC material is placed over the PTC material to maintain its shape during the annealing process.

[0006] There are a number of prior art solutions designed for specific applications, using various types of metal sheaths/screens and various outer sheath materials. Most solutions are time consuming and expensive.

[0007] A constant objective with heating cables is reduction of production cost and improvement of the product design. The main features of the invention are defined in the claims. The basic idea is to combine the metallic sheath/screen and outer sheath in one semiconductive layer.

[0008] The solution in connection with a heating cable comprising an insulated conductor and an earthing conductor arranged within an outer layer, is that the earthing conductor is arranged within or in contact with a semiconductive layer. The semiconductive material should have a conductivity/resistivity corresponding to that of conventional shields, i e with a volume resistivity <100 ohmcm at 20°C and <1000 ohncm at 90°C taken together with an earthing conductor having a conductivity corresponding to at least 1 mm^2 Cu.. The material need not have any particular PTC or NTC properties. Advantages are cost reduction, process simplification, design improvement (thinner) and handling improvement (lighter).

[0009] Above mentioned and other features and objects of the present invention will clearly appear from the following detailed description of embodiments of the invention taken in conjunction with Figures 1 to 13 which illustrate a number of innovative principles. All embodiments have at least one conventional wire conductor such as a resistance wire which is terminated with 'cold' leads i e copper wire installation ends. Each conductor is covered by a layer of insulation material.

[0010] Figures 1-7 illustrate crossections of single-conductor cables, - whereas Figures 8 to 13 illustrate crossections of two-conductor cables.

In Figure 1 is illustrated the crossection of a heating cable including a (resistance/copper) wire conductor 1 with an extruded layer of polymer insulation material 2, an earthing conductor 3 - such as a copper conductor - in parallel with or wound around the insulation layer 2 and an external extruded semiconductive layer 4 embedding the earthing conductor 3. The conductor 3 together with the layer 4 constitute a combined outer screen/layer having a minimum conductance in accordance with requirements which could be equivalent to at least one square millimeter of copper.

In Figure 2 is shown a heating cable having an insulated conductor 1,2 with a (full) layer of earthing conductors 5 - such as copper conductors - wound around the insulation layer 2 and an external extruded semiconductive layer 4 embedding the earthing conductors 5.

Figures 3 and 4 respectively illustrate the cables of Figures 1 and 2 and include an outer protective insulation layer 6.

In Figure 5 is illustrated a heating cable having an insulated conductor 1,2, a semiconductive layer 4 and an outer insulation layer 6 in which there is embedded an earthing conductor 3 - such as a copper conductor - wound around and in contact with the semiconductive layer 4.

In Figure 6 as compared to Figure 5, the single earthing conductor 3 is substituted with a number of conductors 5.

In Figure 7 is illustrated a heating cable having an insulated conductor 1,2 and an earthing conductor 10 - such as a copper conductor - with an extruded

semiconductive layer 11 in parallel with or wound around the insulated conductor 1,2. A closed or open metal screen 12 is arranged around the insulated conductor 1,2 and the earthing layer 11 in electrical contact with the earthing layer. The space within the screen 12 may or may not be filled with insulation material. There is provided an outer protective insulation layer 13.

In Figures 8 to 13 there are illustrated crossections of heating cables having two parallel or stranded insulated conductors 20 and 21. Figures 8 and 9 are similar to the embodiments of Figures 1 and 2 with an earthing conductor 22 (or an earthing conductor layer 23) and a semiconductive layer 24. In Figures 10 and 11 there is added an outer insulation layer 25 as in the embodiments shown in Figures 3 and 4. And in Figures 12 and 13 the earthing conductors 22 and 23 are in parallel with or stranded around the semiconductive layer 24 and embedded within the outer layer 25.

[0011] The above detailed description of embodiments of this invention must be taken as examples only and should not be considered as limitations on the scope of protection.

[0012] The semiconductive, polymer material (compound) may as base polymer material consist of:

- Polyethylene/PE and its copolymers produced with different reactor and catalyst technology, in thermoplastic or in cross-linked version.
- Polypropylene/PP produced with different reactor and catalyst technology, in thermoplastic or in cross-linked version.
- Plastisized PVC-compound, in thermoplastic or in cross-linked version.
- Thermoplastic Elastomer/TPE.

[0013] The insulation polymer material (compound) may as base polymer material consist of:

- Polyethylene/PE and its copolymers produced with different reactor and catalyst technology, in thermoplastic or in cross-linked version.
- Polypropylene/PP produced with different reactor and catalyst technology, in thermoplastic or in cross-linked version.
- Fluoropolymers as: PFA, FEP, ETFE, ECTFE or PVDF.
- Thermoplastic Polyesters as: PET, PBT or equivalent.
- Polyamides as: PA11 and PA12.

[0014] The outer, protective layer polymer material (compound) may as base polymer material consist of:

- Polyethylene/PE and its copolymers produced with different reactor and catalyst technology, in thermoplastic or in cross-linked version.
- Polypropylene/PP produced with different reactor and catalyst technology, in thermoplastic or in cross-linked version.
- Fluoropolymers as: PFA, FEP, ETFE, ECTFE or PVDF.
- Thermoplastic Polyesters as: PET, PBT or equivalent
- Polyamides as: PA11 and PA12.
- Plastisized PVC compound
- Thermoplastic Elastomer/TPE

[0015] The layers may consist of one single layer or two or more layers based on the same polymer, or a combination of the different polymers.

[0016] If two or more layers are used these may be applied both in an Extruder Tandem Process or by a common cross-head.

[0017] The compounds not being flame retardant may be made flame retardant by either halogenated or by so called halogen-free additives/systems.

[0018] Different colours may be achieved by adding necessary amount of colour masterbatch to the compound in the extruder process. There may be one single colour or different colours, as two or several stripes longitudinally.

Claims

1. Electrical cable - such as a heating cable - having at least one insulated wire conductor (1) - such as a resistance wire terminated with 'cold' wire ends - and at least one earthing conductor (3) arranged within at least one common outer layer,
characterized in that
the at least one earthing conductor (3) is arranged within or in contact with a semiconductive layer (4)

2. Cable according to claim 1,
characterized in that
the conductivity/resistivity of the semiconductive layer is typically <100 ohmcm at 20°C and <1000 ohmcm at 90°C taken together with an earthing conductor having a conductivity corresponding to at least 1 mm^2 Cu.

3. Cable according to claim 1 or 2,
characterized in that
it includes a wire conductor (1, Fig 1) with an extruded insulation of polymer insulation material (2), an earthing conductor (3) - such as a copper conductor - wound around or in parallel with the insulation layer and an external extruded semiconductive layer (4) embedding the earthing conductor.

4. Cable according to claim 1 or 2,
characterized in that
it includes a wire conductor (1, Fig 2) with an

extruded insulation of polymer insulation material (2), a full layer of earthing conductors (5) - such as copper conductors - wound around or in parallel with the insulation layer and an external extruded semiconductive layer (4) embedding the earthing conductor.

5. Cable according to claim 3 or 4,
characterized in that
it includes an outer protective insulation layer (6, Figs 3 and 4).

6. Cable according to claim 1 or 2,
characterized in that
it includes a wire conductor (1, Fig 5) with an extruded layer (2) of polymer insulation material, an extruded layer (4) of semiconductive material over the insulation layer (2), an earthing conductor (3) - such as a copper conductor - wound around or in parallel with and in contact with the semiconductive layer (4) and an outer protective insulation layer (6) embedding the earthing conductor (3).

7. Cable according to claim 1 or 2,
characterized in that
it includes a wire conductor (1,Fig 6) with an extruded layer (2) of polymer insulation material, an extruded layer (4) of semiconductive material over the insulation layer (2), a full layer of earthing conductors (5) - such as a copper conductor - wound around or in parallel with and in contact with the semiconductive layer (4) and an outer protective insulation layer (6) embedding the earthing conductor (5).

8. Cable according to claim 1 or 2,
characterized in that
it includes two wire conductors (20, Fig 8) each with an individual extruded layer of polymer insulation material (21), an earthing conductor (22) - such as a copper conductor - arranged in parallel with the insulated wire conductors (20,21) and an extruded semiconductive layer (24) covering all three conductors.

9. Cable according to claim 1 or 2,
characterized in that
it includes two wire conductors (20, Fig 9) each with an extruded layer of polymer insulation material (21), a full layer of earthing conductors (23) - such as copper conductors - arranged around or in parallel with the insulation layers (21) and an extruded semiconductive layer (24) covering the insulated conductors (20,21) and the earthing layer (23).

10. Cable according to claims 8 or 9,
characterized in that
the conductors - and earthing arrangement - have a stranded/parallel configuration.

11. Cable according to claim 8,9 or 10,
characterized in that
it includes an outer protective insulation layer (25, Figs 10 and 11).

12. Cable according to claim 1 or 2,
characterized in that
it includes two wire conductors (20, Fig 12) each with an extruded layer (21) of polymer insulation material, an extruded layer (24) of semiconductive material over the two insulated conductors (20,21), an earthing conductor (22) - such as a copper conductor - wound around or in parallel with and in contact with the semiconductive layer (24) and an outer protective insulation layer (25) embedding the earthing conductor (22).

13. Cable according to claim 1 or 2,
characterized in that
it includes two wire conductor (20, Fig 13) each with an extruded layer (21) of polymer insulation material, an extruded layer (24) of semiconductive material over the insulation layer (21), a full layer of earthing conductors (23) - such as copper conductors - wound around or in parallel with and in contact with the semiconductive layer (24) and an outer protective insulation layer (25) embedding the earthing conductor layer (23).

14. Cable according to claim 1 or 2,
characterized in that
it includes a wire conductor (1, Fig 7) with an extruded layer of polymer insulation material (2), an earthing conductor (10) - such as a copper conductor - with an extruded semiconductive layer (11) in parallel with or wound around the insulated conductor (1,2), a metal screen (12) encompassing the insulated conductor (1,2) and the earthing layer (11) in electrical contact with the earthing layer and an outer protective insulation layer.

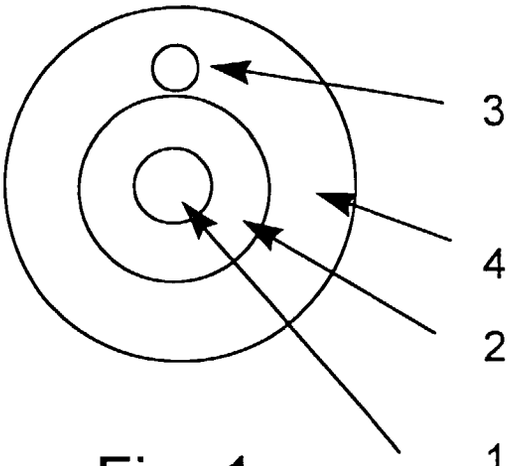

Fig. 1

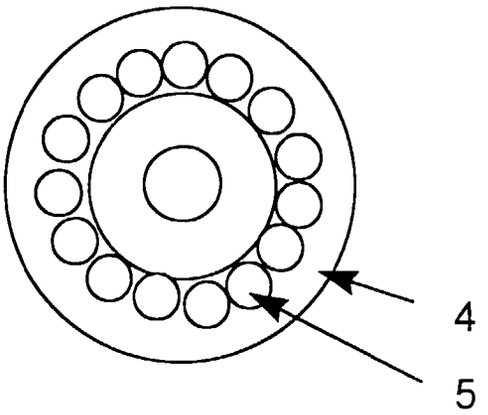

Fig. 2

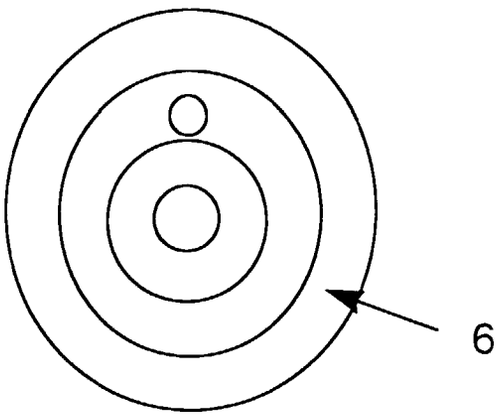

Fig. 3

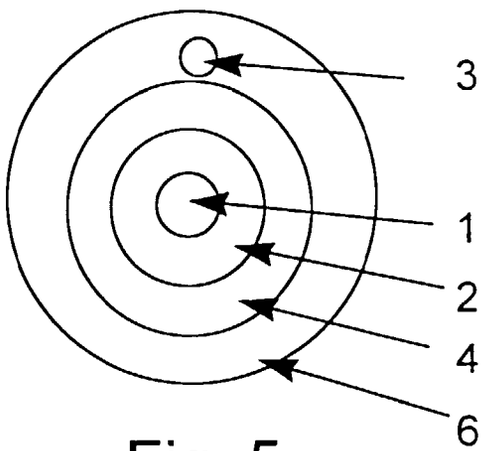

Fig. 5

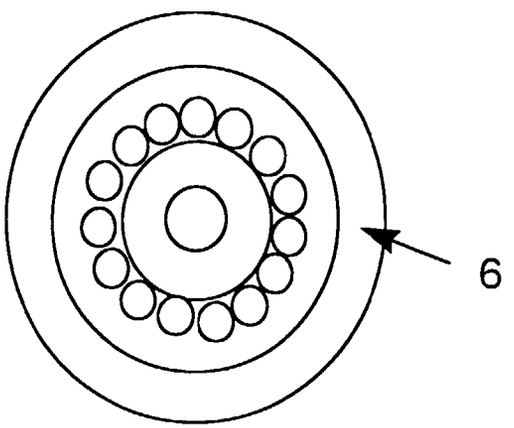

Fig. 4

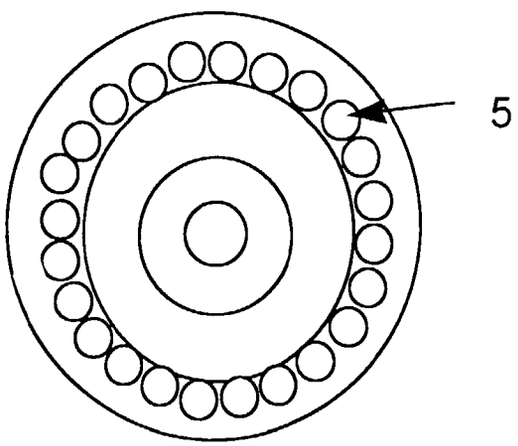

Fig. 6

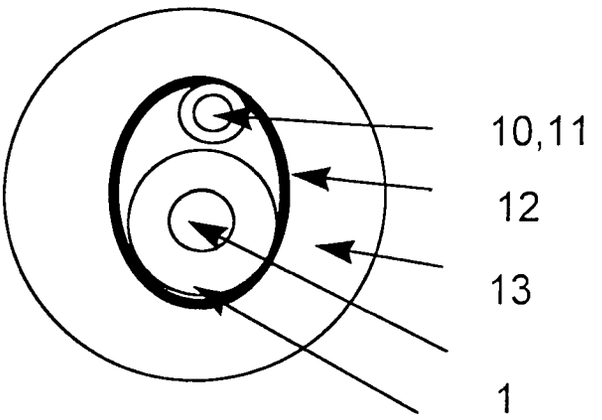

Fig. 7

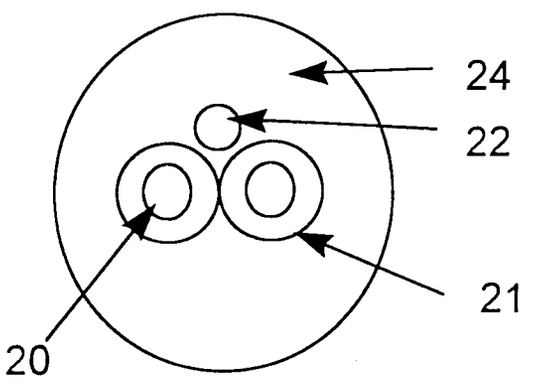

Fig.8

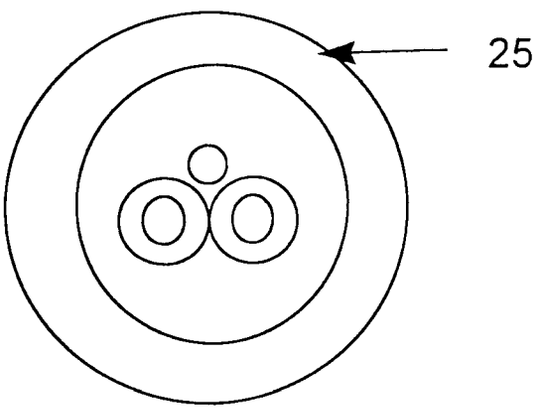

Fig. 10

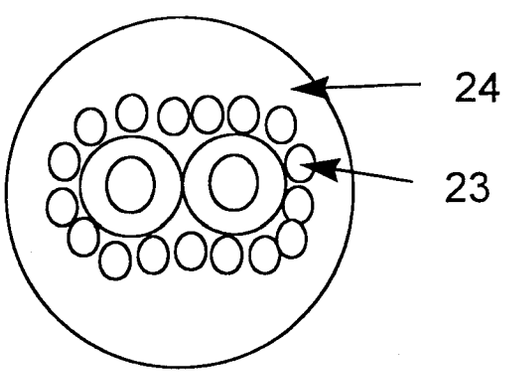

Fig. 9

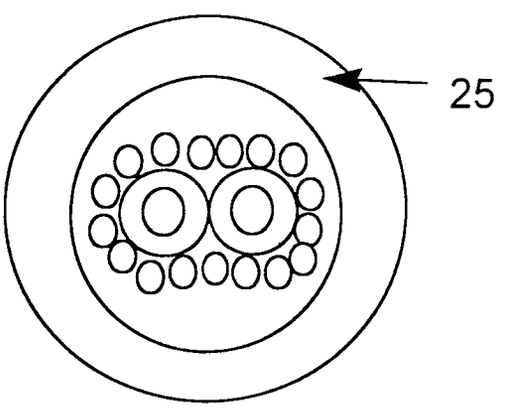

Fig.11

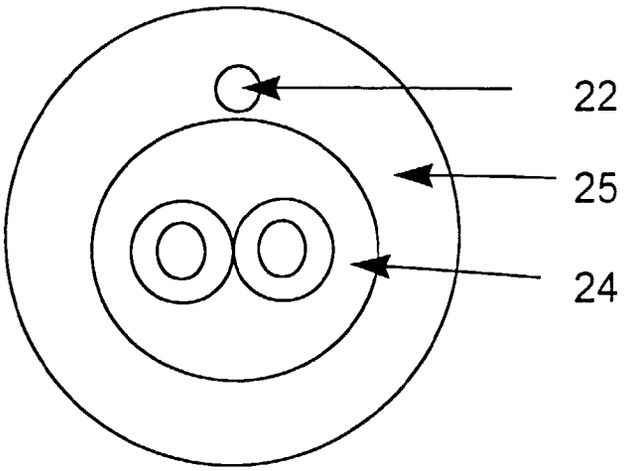

Fig. 12

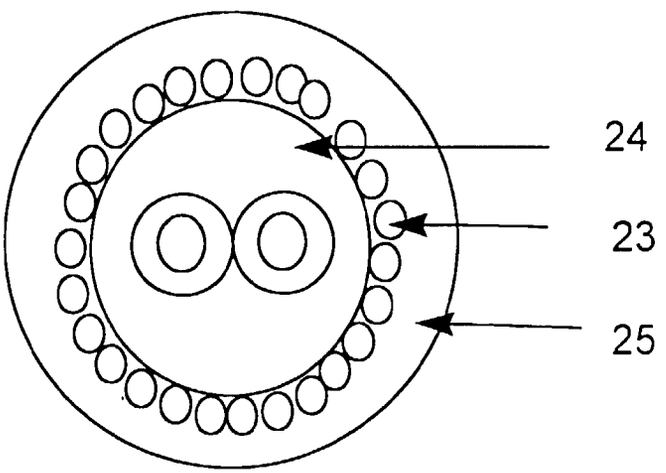

Fig. 13