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(54) Flexible middle voltage (3.6/6 kV - 6/10 kV - 8.7/15 kV - 12/20 kV) electric cable resistant against fire, mechanical impacts and water jets, according to the Standard BS 7846:2009 CAT. F60

(57) An improved middle voltage electric cable, characterized in that said electric cable comprises a first layer made of an extruded elastomeric ceramics silicone material, and an optional outer layer made of a like material, thereby providing a thermally protective barrier for the innermost layers of said cable comprising copper conductors, a semiconductor material and an insulating material, preferably a HF-HEPR material.

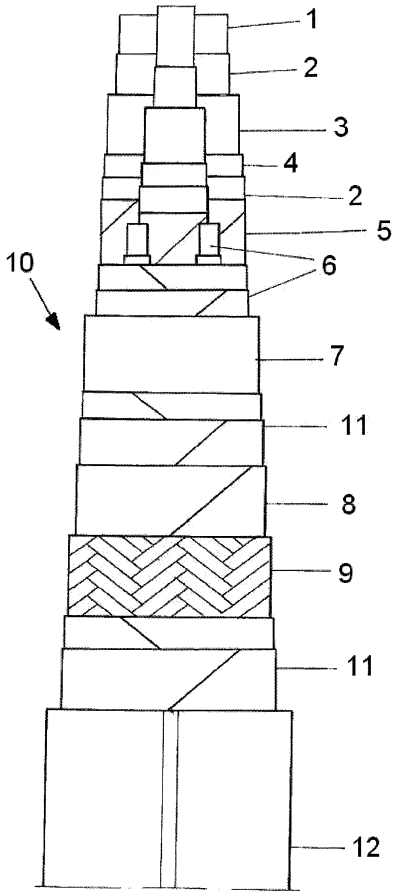

FIG. 1

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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a middle voltage fire resistant electric cable, simultaneously solving the following inevitable problems typical of a fire event:

1) A direct Fire or Flame Resistance for a minimum time of 60 minutes

[0002] The cable, being mechanically stressed by folding it to a "U" shape according to the standard, is exposed, at the bent portion thereof, to a burner direct flame at a temperature greater than 830°C for a minimum period of 60 minutes (Cat. F 60).

[0003] These high flame temperatures are herein provided since, in case of a true fire, said temperatures would be quickly reached in the involved environments.

[0004] Applicant's middle voltage cable, accordingly, solves, even for high voltage levels of 12 / 20 KV, which are at present conventionally used due to continuously increasing installed power requirements, a first main problem, that is to resist against a direct fire or flame to provide people with a sufficient time period for evacuating the fire affected regions.

[0005] In this connection it is also known that middle voltage electric cables power supply other types of already installed cables, i.e. for low voltage power, control and measurement applications.

[0006] Thus, to protect the above cables in a fire event would correspond to protect the overall electric system, included the anti-fire apparatus installed in the fire environment.

[0007] Prior middle voltage cables, on the other end, cannot resist against fire for the following reasons: the cable insulating material must have very good dielectric characteristics, because of the high involved voltage levels.

[0008] Cable makers have been urged, since a long time, to use XLPE (Cross-linked Polyethylene) or HEPR (High Modulus Ethylene Propylene) insulating materials.

[0009] The above high insulating materials, however, "degenerate" as a 300°C temperature is reached, thereby loosing their dielectric characteristics, and generating an abrupt short-circuit while simultaneously destructing a proper electric operation of the overall system.

[0010] On the contrary, the inventive electric cable has the main characteristic of protecting the mentioned XLPE or HEPR insulating materials from "degenerating".

[0011] This has been achieved by over-extruding a further thin thickness insulating elastomeric layer 4 based on a halogen-free ceramizing silicone material having good easy stripping characteristics and such a low thermal conductivity [W/(mK)] as to provide a "thermal barrier" allowing said XLPE and HEPR materials to continuously operate at temperatures lower than 250°C, without originating chemical-physical degenerating phenomena, within the required time range and well beyond.

[0012] In cooperation with the above mentioned further thin thickness insulating elastomeric layer, a second semiconductor material layer 2 is further co-extruded, indispensable in middle voltage cables due to its well known electric function.

[0013] To further assure that the insulating XLPE and HEPR materials are held within temperature limits not originating the above mentioned degenerating phenomena, the general inventive construction has been implemented accordingly, by replacing the inner sheath 7, usually constituted by a conventional halogen free elastomeric material, not susceptible to propagate fire, with a premium quality elastomeric material for the layer 4, and by increasing the number of very low thermal conductivity glass yarn material strips 6.

2) Mechanical shocks directly applied on the cable and not on its supporting structure

[0014] This requirement of the standard BS 7846:2009 has been set to verify that the cable overall construction is so strong as to resist against possible mechanical impacts or shocks in general, due to a predictable progressive yielding of the supporting or bearing construction, in a fire event.

[0015] The inventive cable fully meets this standard requirement and has moreover a very high resistance against water jets, thereby providing a highly water impermeable electric cable.

[0016] In a fire event, a quick fireman intervention would be obviously required.

[0017] Moreover, if available, it would also be necessary to use indoor personnel for performing emergency operations.

[0018] The most common means, and, in actual practice, the most efficient one, are the water jets ejected from fire hydrants.

[0019] If conventional middle voltage cables are not in a proper operating condition, then any other parts of the overall electric systems would not be operative, with a consequent disabling of the electric cable power supplied anti-fire apparatus themselves.

[0020] To the above it should be further added that also the emergency lights, which, notwithstanding a dense fume generated in a fire event, represent anyhow an important auxiliary means of quickly detecting escaping ways to reduce to a minimum the time in which people is restricted in toxic fumes, will also be disabled.

[0021] If, on the other hand, said prior middle voltage cables are yet either fully or partially operating, it is anyhow necessary to switch off their power supply for preventing fire hydrant handling operators from being struck by electric discharges.

[0022] Thus, intervention and evacuating conditions would be identical to the above disclosed ones.

[0023] Tragic accidents frequently demonstrate that, in high risk environments/structures, or in people crowd-

ed places, a simple qualification as "fire resistant cables" cannot be further considered as sufficient.

[0024] Expensive safety apparatus and, accordingly, power cables supplying them, must be adapted to continuously operate up to a complete extinguishing of the fire, while allowing persons affected by toxic fumes and gases, which are a primary cause of death, to quickly evacuate the fire regions.

[0025] The present invention just solves the above problem.

[0026] The copper strips 8, of a set suitable thickness, have a double function.

[0027] In the absence of a fire, said strips provide the inventive middle voltage cable with electromagnetic compatibility (EMC) features.

[0028] In the presence of a fire and high temperatures, the strips 8 weld to one another, thereby providing a copper continuous tube, which cannot be penetrated even by strong water jets so that, as demonstrated by practical tests, the inventive cable becomes a fully impermeable one.

[0029] This can be also demonstrated by immersing the inventive cable into water for an indefinite time, from which test it appears that, after burning, the cable is still able of providing a power of several thousands of volts.

[0030] No prior middle voltage cable has shown like operating characteristics.

[0031] In particular, the above disclosed functional and constructional features of the inventive cable have been achieved according to the cable construction claimed in claim 1 and dependent claims.

[0032] With reference to figure 1 of the accompanying drawings, the inventive cable comprises:

At 1 the flexible conductors or wires made of an annealed and tinned copper material IEC 60228 - Class 2.

At 2 a first and second semiconductor extruded layers.

At 3 an insulating XLPE or HEPR IEC 60092-354 material.

[0033] Moreover, the inventive cable further comprises the following elements:

[0034] An additional silicone insulating layer 4 with a thermal barrier function.

[0035] Electrical screens or shields 5 for shielding the individual cable phases, contacting one another and made of copper yarn strips or braids.

[0036] Circular filling glass yarn strips 6 and 11 spoon finer material with a further thermal barrier function.

[0037] A silicone based inner sheath 7, operating as yet another thermal barrier.

[0038] Copper self-welding strips 8, which can weld to one another as they are subjected to high temperatures, so to provide the inventive cable with water sealing properties.

[0039] A tinned copper thread reinforcement braid 9, which is usually coupled to the earth or ground and which may be made of galvanized steel or phosphorous bronze wires, and an outer sheath 12 which may be made of an elastomeric or thermoplastic material.

[0040] In other words, the inventive middle voltage electric cable 10 is characterized in that it comprises a plurality of copper wires or conductors 1 which are coated by a covering sheath 2 made of semi-conductor materials.

[0041] Said sheath 2 is in turn covered by an insulating layer 3, preferably made of an elastomeric material comprising an (HF HEPR) insulating compound.

[0042] The latter will start to degenerate so as to lose its chemical-physical features and electric insulating capability as a temperature threshold of 300°C is exceeded.

[0043] For this reason, the HF HEPR insulating material sheath 3 is coated by an extruded silicone and ceramizing elastomeric layer 4.

[0044] One of the most important features of the inventive cable 10 is the use of an extruded ceramizing silicone elastomeric layer 4, providing a very efficient thermal barrier, while allowing the HF HEPR insulating material of the coating layer 3 not to exceed the temperature threshold of 250°C.

[0045] Thus, as stated, said HF HEPR layer 3 will not degenerate, thereby preserving its chemical-physical properties and electrically insulating capability, the degeneration of which, as stated, would occur if the layer 3 would exceed a temperature threshold of 300°C.

[0046] The cable is further provided with a screen or shield 5 constituted by a copper strip.

[0047] Said screen or shield 5 is wound as a strip proper on the single cable phases.

[0048] Alternatively, for forming the above mentioned screen or shield 5, it is also possible to use a tinned copper yarn or wire braids.

[0049] In this connection it should be pointed out that the screens or shields 5 are so coupled to one another as to assure their connection to the ground or earth.

[0050] The cable 10 according to the present invention further comprises a thermally insulating layer including a plurality of glass fiber strips 6 covering in turn the copper inner sheath 5 or shield.

[0051] The inventive cable also comprises a sheath 7 made of an extruded ceramizing silicone elastomeric material providing both an electrical insulation and a thermal insulation.

[0052] The middle voltage electric cable 10 according to the invention further comprises a copper strip 8 providing the cable with water sealing or impermeable properties.

[0053] The mentioned copper strip 8, as it is exposed to fire, is welded to itself thereby providing a tubular element adapted to protect the cable against water jets and sprays.

[0054] The inventive cable 10 further comprises a braid 9 made of tinned copper wires or yarns and galvanized steel or bronze-phosphorous wires operating as a me-

chanical reinforcing arrangement, which is coupled to the ground so to provide maximum safety against possible electrocution phenomena.

[0055] The inventive cable further comprises yet another glass yarn strip 11 operating to further increase the cable fire thermal resistance, as said cable is exposed to very high temperatures.

[0056] The cable 10 also comprises an outer sheath 12 made of an elastomeric or thermoplastic material.

[0057] As it should be easily apparent, the very high fire and water resistance properties of the inventive middle voltage cable 10 are given thereto, in particular, by one or more extruded ceramizing silicone elastomeric layers 4 and 7 and by glass yarn strips 6 and 11 which may be included either as a single strip or as multiple strips.

[0058] The above disclosed elements provide the inner layers of the inventive cable with a very high fire and water resistance, much greater than that of prior middle voltage electric cables, which, as above disclosed, have a very poor fire resistance and cannot resist to water jets since they would be subjected to abrupt shorts.

[0059] The improved middle voltage electric cable according to the invention has been thereinabove disclosed only by way of an illustrative but not limitative example.

[0060] Thus, it is susceptible to several modifications and variations, all of which will come within the scope of the invention.

Claims

1. An improved middle voltage electric cable, **characterized in that** said electric cable comprises a first layer made of an extruded elastomeric ceramics silicone material, and an optional outer layer made of a like material, thereby providing a thermally protective barrier for the innermost layers of said cable comprising copper conductors, a semiconductor material and an insulating material, preferably a HF-HEPR material.

2. An improved middle voltage electric cable, according to claim 1, **characterized in that** said cable comprises a plurality of fiberglass strips wound on said innermost layers forming said electric cable.

3. An improved insulated cable, according to claim 1, **characterized in that** said cable comprises a plurality of copper conductors or wires (1), coated by a semiconductive material layer (2) and an insulating material (3), preferably comprising HF-HEPR, said materials being in turn coated by an extruded elastomeric ceramics silicone material.

4. An improved middle voltage electric cable, according to claim 1, **characterized in that** said cable comprises a copper strip and a braid including a plurality of tinned copper wires (5) coating the cable innermost layers so as to provide a plate-like screen for screening individual phases of said cable.

5. An improved middle voltage electric cable, according to claim 1, **characterized in that** said screens are coupled to one another thereby providing a safe ground connection.

6. An improved middle voltage electric cable, according to claim 1, **characterized in that** said cable comprises a plurality of glass fiber strips wound on the cable innermost layers (1, 2, 3, 4 and 5).

7. An improved middle voltage electric cable, according to one or more of the preceding claims, **characterized in that** said cable comprises an elastomeric material inner sheath (7).

8. An improved middle voltage electric cable, according to claims 1 and 7, **characterized in that** said cable (10) comprises an inner sheath made of a ceramics silicone material.

9. An improved middle voltage electric cable, according to claim 1, **characterized in that** said cable comprises a copper strip (8) having waterproofing properties for allowing said cable to resist against fire, said copper strip (8) being welded in said cable thereby forming a tubular element providing said cable (10) with safe waterproofing properties.

10. An improved middle voltage electric cable, according to claim 1, **characterized in that** said cable comprises a cable braid made of a plurality of tinned copper, galvanized steel or phosphorous bronze wires operating as a cable reinforcing arrangement (9) to be coupled to ground thereby protecting said cable against possible electrocution phenomena.

11. An improved middle voltage electric cable, according to claim 1, **characterized in that** said cable comprises one or more cable strips made of glass yarns (6 and 11) providing said cable with an improved thermal resistance against high temperature flames.

12. An improved electric cable, according to claim 1, **characterized in that** said cable comprises an outer sheath (12) made of an elastomeric or thermoplastic material coating said cable (10) thereby providing said cable with high electrical insulating properties in a regular use condition.

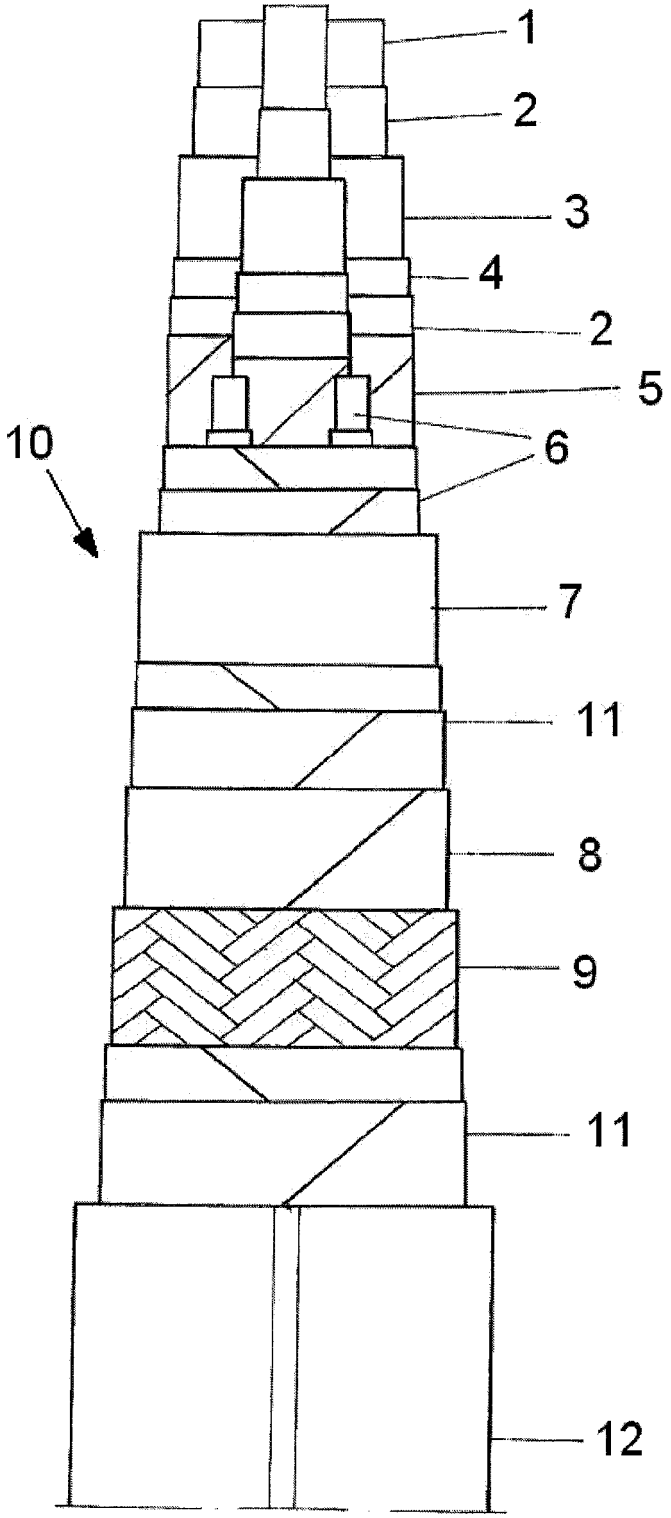

FIG. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 11 16 6844

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 4 150 249 A (PEDERSEN NARVE S) 17 April 1979 (1979-04-17) * column 2, line 40 - line 54; figure 4 * * column 3, line 62 - column 4, line 22; claims 1-8 *	1-12	INV. H01B3/28 H01B3/46
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TECHNICAL FIELDS SEARCHED (IPC)

H01B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	15 December 2011	Marsitzky, Dirk

CATEGORY OF CITED DOCUMENTS

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