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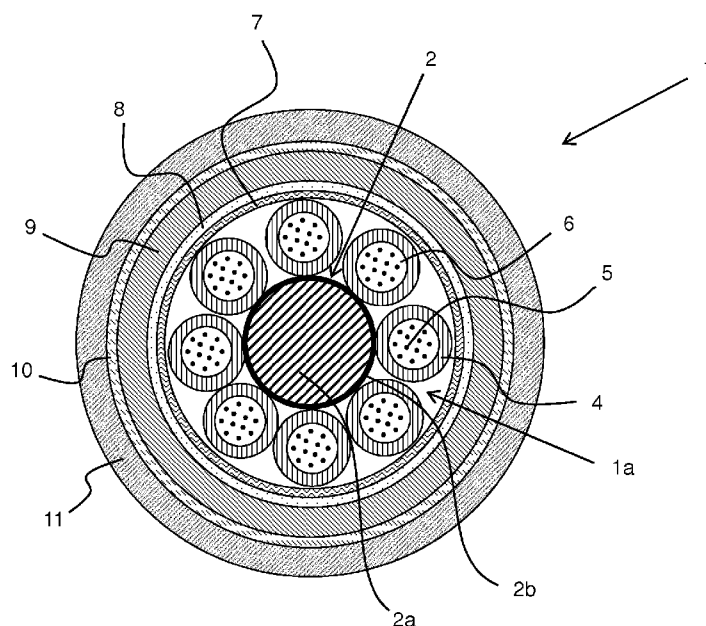


Fig. 1

(57) Abstract: Disclosed is a fire resistant fibre optic cable with high fibre count comprising: a core comprising: a central strength member, and a plurality of buffer tubes arranged around said central strength member, each buffer tube containing a plurality of optical fibres; a mica layer arranged around the core; a glass yarn layer surrounding and in direct contact with the mica layer; an inner sheath surrounding and in direct contact with the glass yarn layer; a metal armour surrounding the inner sheath; and an outer sheath surrounding and in direct contact with the metal armour, wherein the central strength member comprises a hydroxide-containing flame retardant polymeric material, and wherein the buffer tubes contain a water-blocking filling material comprising a silicone gel, wherein said silicone gel has a drop point of at least 200 °C.

EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
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FIRE RESISTANT FIBRE OPTIC CABLE WITH HIGH FIBRE COUNT

BACKGROUND

The present disclosure relates to the field of optical cables suitable
5 for operating during a fire and thereafter. In particular, the present
disclosure relates to a fire resistant fibre optic cable having a high fibre
count.

STATE OF THE ART

10 In certain applications, optical cables should have be able to
withstand fire without significantly decreasing of their transmission
performance. For instance, cables used in fire alarm systems and/or
local video surveillance should be able to continue to transmit
data/signals in the presence of fire.

15 GB 2 138 168 discloses a fire resistant fibre cable comprising an
optical fibre. The cable can comprise an inner core of fibre reinforced
plastics, around which the optical fibres are placed. Around each of the
optical fibres there is provided a jacket of organic material, and the
spaces between the fibre and the jacket are filled up with silicone
20 grease. Around each jacket of organic material there is wound a layer of
mica tape, preferably arranged on a glass carrier. Around one or a
group of organic jackets with fire retardant covers there is provided a
layer of glass tape. Outside the glass tape there is provided a filler
jacket having good fire retardant properties. Outside said filler jacket
25 there may be an armour, braiding, covering or wiring of glass, steel or
other fire-proof material.

US 2015/0131952 discloses a fire resistant optical communication
cable. The cable comprises a plurality of core elements including
bundles of optical fibers located within tubes arranged around a central
30 strength member formed from glass-reinforced plastic. A layer located

outside of and surrounding the elements of core may be a fire retardant tape such as mica tape. An armor layer may be located outside of the fire retardant layer. A plurality of particles of an intumescent material is embedded within the material of cable jacket.

- 5 FIREFLIX catalogue of Caledonian Cables Ltd (2016, page 30) discloses, *inter alia*, a fire resistant armoured fibre optic cable comprising a central loose tube containing 2-24 fibres, filled with water-blocking gel, said tube being wrapped with a fire blocking mica glass tape. Fibre glass is wound around the tube to provide physical
10 protection and tensile strength, with added fire protection. The cable can be jacketed with a thermoplastic LSZH (low smoke zero halogen) inner sheath. Around said inner sheath, a corrugated steel tape armour and an outer LSZH sheath are provided.

- FIREFLIX catalogue of Caledonian Cables Ltd (2016, page 35)
15 discloses, *inter alia*, a fire resistant armoured fibre optic cable comprising from 5 to 36 fibre containing tubes, stranded around a central strength member. The central strength member can be made of glass fibre reinforced plastics. Each tube contains from 4 to 12 fibres and is filled with a water-blocking gel. The tubes are individually wound
20 with fire blocking mica glass tape. The jelly filled tube is water-blocked by using swellable tape and thread. The cable is jacketed with an inner sheath in thermoplastic material LSZH, around which a corrugated steel tape armour and an outer LSZH sheath are provided.

25 **SUMMARY**

The Applicant has faced the problem of providing a fibre optic cable with high fibre count capable of maintaining its performance not only during fire but also for a predetermined period of time after the fire is extinguished.

Optical fibres have a coefficient of thermal expansion lower than that of the polymeric buffer tubes housing them. During the cooling after fire, the buffer tube shrinkage can mechanically stress the optical fibres up to breakage. As a result, the cable functionality, which was maintained during fire, may be impaired and the signal attenuated or even interrupted.

The Applicant experienced that damages to the optical fibre after fire was reduced by providing a silicone gel as water-blocking material inside the buffer tubes, said silicone gel having a drop point higher than 200 °C.

Silicone is generally a very stable polymer, a great deal of this stability deriving from reversible hydrolysis reactions occurring under heating such that the polymer essentially heals itself. Applicant observed that a silicone gel surrounding the optical fibres during and after fire could provide some protection against mechanical stress.

Aiming at a further reduction of optical fibre breakage after fire, the Applicant found that a hydroxide-containing flame retardant material in radially inner position with respect to the arrangement of buffer tubes which contain the optical fibres enabled a further reduction or even avoidance of said optical fibre breakage.

Hydroxides like magnesium hydroxide and aluminium hydroxide are used as flame retardant fillers because of their capability of releasing water during fire. Without wishing being bound to any theory, the Applicant conjectured that the hydroxide contained in a flame retardant material in radial inner position with respect to the buffer tubes, though not directly reached by the flame, was anyway subjected to a temperature triggering the release of an amount of water suitable for lowering the heat the buffer tubes. Accordingly, the buffer tube polymeric material underwent a lower thermal expansion which the

silicone gel water-blocking material was able to fully compensate during cooling after fire with limited stress to the optical fibre.

In addition, the presence of hydroxide-containing flame retardant material in radial inner position with respect to the buffer tubes allows
5 using a single fire barrier surrounding all of the buffer tubes together, rather than other arrangements such as a fire barrier around each single tube, enabling a saving of material for the fire barrier and a manufacturing process simplification.

Therefore, according to a first aspect, the present disclosure provides
10 a fire resistant fibre optic cable comprising:

a core comprising:

a central strength member, and

a plurality of buffer tubes arranged around the central strength member, each buffer tube containing a plurality of optical fibres;

15 a mica layer arranged around the core;

a glass yarn layer surrounding and in direct contact with the mica layer;

an inner sheath surrounding and in direct contact with the glass yarn layer;

20 a metal armour surrounding the inner sheath; and

an outer sheath surrounding and in direct contact with the metal armour,

wherein the central strength member comprises a hydroxide-containing flame retardant polymeric material, and

25 wherein the buffer tubes contain a water-blocking filling material comprising a silicone gel, wherein said silicone gel has a drop point of at least 200 °C.

In an embodiment, the fibre optic cable of the present disclosure comprises at least twenty-four (24) optical fibres. The fibre optic cable
30 can contain up to 144 optical fibres.

The number of buffer tubes in a cable and the number of optical fibres contained in each buffer tube may vary according to cable specification or customer request. For example, each buffer tube may contain from 5 to 12 optical fibres.

5 In some embodiments, the central strength member comprises a body of reinforced dielectric material. In an alternative embodiment, the central strength member comprises a body of metallic material, such as steel.

10 In an embodiment, the hydroxide-containing flame retardant polymeric material is embedded in the reinforced dielectric material of the central strength member. In another embodiment, the hydroxide-containing flame retardant polymeric material of the central strength member is in the form of a layer applied on the outer surface of the body of the central strength member.

15 In an embodiment, the hydroxide-containing flame retardant polymeric material of the central strength member has a limiting oxygen index (LOI) $\leq 35\%$.

20 In an embodiment, the hydroxide-containing flame retardant polymeric material of the central strength member is a low smoke zero halogen material (LS0H or LSZH), a.k.a. halogen-free flame retardant material (HFFR). Flame retardant LS0H materials do not release toxic fumes.

25 In the present description and claims, as "hydroxide-containing flame retardant polymeric material" it is meant a polymeric material containing an inorganic flame-retardant filler selected from: metal hydroxides, hydrated metal oxides, metal salts having at least one hydroxyl group, and hydrated metal salts, said filler being capable of releasing water when heated.

30 In an embodiment, the hydroxide-containing flame retardant polymeric material of the central strength member comprises a flame-

retardant filler selected from aluminium or magnesium hydroxide, aluminium or magnesium hydrated oxide, aluminium or magnesium salt having at least one hydroxyl group or aluminium or magnesium hydrated salt.

5 In an embodiment, the hydroxide-containing flame retardant polymeric material of the central strength member comprises magnesium hydroxide, alumina trihydrate or hydrated magnesium carbonate. In another embodiment, the hydroxide-containing flame retardant polymeric material of the central strength member comprises
10 magnesium hydroxide.

Magnesium hydroxide is characterized by a decomposition temperature of about 340 °C and thus allows high extrusion temperatures to be used. The magnesium hydroxide of the present disclosure can be of synthetic or natural origin, the latter being,
15 obtained by grinding minerals based on magnesium hydroxide, such as brucite or the like, as described, for example, in WO2007/049090.

The flame-retardant filler can be used in the form of particles which are untreated or surface-treated with saturated or unsaturated fatty acids containing from 8 to 24 carbon atoms, or metal salts thereof, such
20 as, for example: oleic acid, palmitic acid, stearic acid, isostearic acid, lauric acid; magnesium or zinc stearate or oleate; and the like. In order to increase the compatibility with the polymer material, the flame-retardant filler can likewise be surface-treated with suitable coupling agents, for example short chain organic silanes or titanates such as
25 vinyltriethoxysilane, vinyltriacetylsilane, tetraisopropyl titanate, tetra-n-butyl titanate and the like.

In an embodiment, the hydroxide-containing LS0H flame retardant polymeric material of the central strength member comprises a polymer selected from: polyethylene; copolymers of ethylene with at least one α -olefin containing from 3 to 12 carbon atoms, and optionally with at least
30

one diene containing from 4 to 20 carbon atoms; polypropylene; thermoplastic copolymers of propylene with ethylene and/or at least one α -olefin containing from 4 to 12 carbon atoms; copolymers of ethylene with at least one ester selected from alkyl acrylates, alkyl methacrylates and vinyl carboxylates, wherein the alkyl and the carboxylic groups comprised therein are linear or branched, and wherein the linear or branched alkyl group may contain from 1 to 8, preferably from 1 to 4, carbon atoms, while the linear or branched carboxylic group may contain from 2 to 8, preferably from 2 to 5, carbon atoms; and mixtures thereof.

With " α -olefin" it is generally meant an olefin of formula $\text{CH}_2=\text{CH-R}$, wherein R is a linear or branched alkyl having from 1 to 10 carbon atoms. The α -olefin can be selected, for example, from propylene, 1-butene, 1-pentene, 4-methyl-1-pentene, 1-hexene, 1-octene, 1-dodecene and the like. Among them, propylene, 1-butene, 1-hexene and 1-octene are particularly preferred.

Examples of polymer that may be used in the flame retardant LS0H polymeric material for the central strength member of the present disclosure are: high-density polyethylene (HDPE) ($d=0.940\text{-}0.970\text{ g/cm}^3$), medium-density polyethylene (MDPE) ($d=0.926\text{-}0.940\text{ g/cm}^3$), low-density polyethylene (LDPE) ($d=0.910\text{-}0.926\text{ g/cm}^3$); linear low-density polyethylene (LLDPE) and very-low-density polyethylene (VLDPE) ($d=0.860\text{-}0.910\text{ g/cm}^3$); polypropylene (PP); thermoplastic copolymers of propylene with ethylene; ethylene/vinyl acetate (EVA) copolymers; ethylene/ethyl acrylate (EEA) copolymers, ethylene/butyl acrylate (EBA) copolymers; ethylene/ α -olefin rubbers, in particular ethylene/propylene rubbers (EPR), ethylene/propylene/diene rubbers (EPDM); and mixtures thereof.

In an embodiment, the silicone gel as water-blocking material is a polyorganosiloxane, for example dimethylsiloxane, dimethyl-methylphenyl siloxane, methyl-phenylsiloxane.

In an embodiment, the silicone gel as water-blocking material has a
5 drop point ≥ 250 °C.

In an embodiment, the mica layer comprises one or two mica tapes. The mica tape/s is/are wound around the core comprising the central strength member and the buffer tubes. When two mica tapes are present, they can be wound in the same direction.

10 The metal armour of the cable of the disclosure can be made of any material suitable for providing the cable core with protection against external stress, in particular against compressive forces and to make the cable rodent-proof. In an embodiment, the armour is made of steel which can be in form of a corrugated tape or of a longitudinally sealed
15 tube, optionally applied around the cable core by a draw down technique.

In an embodiment, a water swellable tape is interposed between the inner sheath and the metal armour.

In an embodiment, the inner sheath and/or the outer sheath are
20 made of a flame retardant LS0H polymeric material. In an embodiment this material has a limiting oxygen index (LOI) $\geq 30\%$, for example $\geq 40\%$. In an embodiment, the flame retardant LS0H polymer-based material of the inner sheath and/or of the outer sheath can have a LOI $\leq 70\%$, for example preferably $\leq 60\%$.

25 In an embodiment, the inner sheath and the outer sheath are made of the same LS0H flame-retardant polymeric material.

In another embodiment the LS0H flame-retardant polymeric material of the inner sheath has a LOI higher than that of the outer sheath material.

The polymer material of the inner and the outer sheath can be selected from the list already given in connection with the hydroxide-containing flame retardant material of the central strength member. The same applies for the inorganic-flame retardant filler contained therein.

5 In further embodiment, the buffer tubes are made of a polymer base mixed with inorganic-flame retardant filler/s, too.

In an embodiment, the amount of the flame-retardant filler in any flame retardant LSOH polymeric material for the cable of the present disclosure is lower than 500 phr, preferably from 130 phr to 300 phr.

10 Within the present description and the claims, the term “phr” (acronym of “parts per hundred of rubbers”) is used to indicate parts by weight per 100 parts by weight of the polymer base material.

For the purpose of the present description and of the appended claims, except where otherwise indicated, all numbers expressing
15 amounts, quantities, percentages and so forth, are to be understood as being modified in all instances by the term “about”. Also, all ranges include any combination of the maximum and minimum points disclosed and include any intermediate ranges therein, which may or may not be specifically enumerated herein.

20 For the purpose of the present description and claims, an optical fibre comprises a core surrounded by a cladding, said core and cladding being preferably made of glass, and one or two protecting coatings based, for example, on acrylate material.

For the purpose of the present description and claims, as “limiting
25 oxygen index” (LOI) it is meant the minimum concentration of oxygen, expressed as a percentage, that will support combustion of a polymer. Higher values of LOI indicate greater fire retardancy. LOI values are determined by standards, such as ASTM D2863-12 (2012).

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5 determined by standards, such as ASTM D2863-12 (2012).

For the purpose of the present description and appended claims, drop point is a numerical value assigned to a grease composition representing the temperature at which the first drop of material falls from a test cup. Drop point can be measured under the conditions set
10 forth in ASTM D566-02 (2002).

BRIEF DESCRIPTION OF THE FIGURES

The present disclosure will become fully clear after reading the following detailed description, given by way of example and not of
15 limitation, with reference to the attached Figure 1 which is a cross-section of a fire resistant fibre optic cable according an embodiment of the present disclosure.

DETAILED DESCRIPTION

20 In Figure 1, the fibre optic cable is indicated by reference number 1.

Cable 1 comprises a core 1a. The core 1a, in turn, comprises a central strength member 2 and a plurality of buffer tubes 4, each comprising a plurality of optical fibres 5.

The central strength member 2 is an elongated member and it can
25 have a circular or substantially circular cross-section. In the present embodiment, the central strength member comprises a body 2a of reinforced dielectric material, for example glass reinforced plastic (GRP), fibre reinforced plastic (FRP) or any other similar material.

The body 2a is covered by a coating 2b made of hydroxide-
30 containing flame retardant LSOH polymeric material. The material of the

coating 2b contains magnesium hydroxide in an amount of about 130 phr. This material can have a LOI of 28%.

A number of buffer tubes 4 are arranged radially outer with respect to the central strength member 2. In an embodiment, the buffer tubes 4
5 are stranded around the central strength member 2 in S-Z configuration.

In the embodiment of Figure 1, eight buffer tubes 4 are provided around the central strength member 2. However, there could be more or less tubes in other embodiments.

The buffer tubes 4 can be made of any suitable polymeric material,
10 for example polybutylene terephthalate (PBT). In an embodiment, the buffer tubes can be made of a hydroxide-containing flame retardant LSOH polymeric material.

Each buffer tube 4 contains a plurality of optical fibres. In an embodiment, each buffer tube 4 contains 12 optical fibres.

15 Each buffer tube 4 may contain water-blocking filling material 6 comprising a silicone gel with a drop point of at least 200°C.

For example, materials suitable as water-blocking filling for the cable of the present disclosure are polyorganosiloxane marketed as Rhodorsil® by Rhodia Siliconi Italia S.p.A., Italy.

20 It should be remarked that each single buffer tube 4 is not individually protected by fire resistant materials, for example mica tapes.

The core (1a) comprising buffer tubes 4 and central strength member 2 is wrapped by a mica layer 7.

In an embodiment, the mica layer 7 comprises two mica tapes. Mica,
25 for example in form of flakes, may be bonded to a backing layer using a binding agent, such as silicone resin or elastomer, acrylic resin and/or epoxy resin. The backing layer may be formed of a supporting fabric, such as woven glass and/or glass cloth.

In an embodiment, each mica tape is wound with an overlapping.
30 The overlapping can be higher than 40 % and preferably of 50%.

In radial external position and in direct contact with the mica layer 7 a layer of glass yarns 8 is provided.

The layer of glass yarns 8 and the mica layer 7 act as fire barrier. The fire barrier layer has mainly the function of avoiding direct contact
5 of the inner core with the flames which surround the cable in case of fire.

In radial external position and in direct contact with the layer of glass yarns 8 an inner sheath 9 is provided. The inner sheath 9 can be extruded directly on the layer of glass yarns 8.

10 The inner sheath 9 can have a thickness between 1 and 3 mm. In one embodiment such thickness is of 1.5 mm.

The inner sheath 9 is made of a flame retardant LSOH polymer material. The material of the inner sheath 9 contains magnesium hydroxide in an amount of about 200 phr. This material can have a LOI
15 of 37%.

In radially outer position with respect to the inner sheath 9 a metal armour 10 is provided. In the present embodiment, armour 10 is made of corrugated metal tape 10 made, at least partially, of steel, for example.

20 Armour 10 can have a thickness of 0.15 mm.

In one embodiment the metal armour has at least one surface coated with a polymer layer. In another embodiment the metal armour 10 has both the surfaces coated with a polymer layer.

In a radially outer position to and in direct contact with the metal
25 armour 10, an outer sheath 11 is provided. The outer sheath 11 can be extruded directly on the armour 10.

The outer sheath 11 can have a minimum thickness between 1 and 3 mm. In one embodiment such thickness is of 1.4 mm.

Outer sheath 11 is made of a flame retardant LSOH polymeric
30 material. The material of the inner sheath 11 contains magnesium

hydroxide in an amount of about 200 phr. This material can have a LOI of 37%.

EXAMPLE

The Applicant has conducted fire-resistance tests on different cables.

5 All of the tested cables have a structure analogous to that of cable 1 of Figure 1 and contained 72 fibres in 6 buffer tubes, 12 fibres each. The buffer tubes of Cable 1 (comparative) were filled with a severely hydrotreated and hydrocracked base mineral oil having a drop point lower than 200°C (about 180°C), while the buffer tubes of Cable 2
10 (according to the present disclosure) were filled with a polydimethylsiloxane gel having a drop point greater than 250°C.

Cable 1 (comparative) had a central strength member made of GRP and no hydroxy-containing flame retardant polymeric material, while Cable 2 (according to the present disclosure) had a central strength
15 member made of GRP covered by a coating made of hydroxy-containing flame retardant LS0H polymeric material having a LOI of 28%.

The inner and outer sheath of Cable 1 and Cable 2 were made of the same flame retardant LS0H polymer-based material containing
20 magnesium hydroxide and having a LOI of about 37%.

Two standards were used for testing the above mentioned cables: IEC 60331-25 (1999) and EN 50200 (2106).

Cable 1 (comparative) failed both the fire resistance tests performed on this cable. Regarding test IEC 60331-25, after 90 minutes at 750°C,
25 a 2.54 dB signal attenuation was detected. After a cooling of 4 minutes, a 5.58 dB signal attenuation was observed and cracks of the optical fibres were detected. Regarding test EN 50200, after 90 minutes at 830°C, a 1.24 dB signal attenuation was detected. As this standard does not prescribe a cooling period monitoring of the signal attenuation
30 was continued after the flame was removed. A 5.54 dB signal

attenuation was observed after 2 minutes of monitoring since the flame removal, and the fibres were found to be broken.

Cable 2 according to the present disclosure passed both the above mentioned tests. Regarding test IEC 60331-25, after 90 minutes at
5 750°C , a 1.34 dB signal attenuation was detected. After a cooling of 15 minutes, a 1.51 dB signal attenuation was detected, and the optical fibres were found to be fully functioning (not broken, no disconnection of signal). Regarding test EN 50200, after 120 minutes at 830°C, a 1.54
10 dB signal attenuation was detected. As this standard does not prescribe a cooling period, monitoring of the signal attenuation was continued after the flame was removed. The optical fibres were found to be fully functioning (not broken, no disconnection of signal).

In addition, Cable 2 according to the present disclosure was tested according to IEC 60332-3-24 (2000) and gave a flame propagation in
15 vertical position of 770 mm (the maximum propagation according to the standard is 2,500 mm). Also Cable 2 was tested according to IEC 61034-2 (2005) relating to the density of the smoke generated by the cable while burning and gave a light transmission of 80.52% (the light transmission according to the standard has to be of at least 60%).

20

CLAIMS

1. A fire resistant fibre optic cable (1) comprising:
a core (1a) comprising:
 - 5 a central strength member (2), and
 - a plurality of buffer tubes (4) arranged around said central strength member (2), each buffer tube (4) containing a plurality of optical fibres (5);a mica layer (7) arranged around the core (1a);
 - 10 a glass yarn layer (8) surrounding and in direct contact with the mica layer (7);
 - an inner sheath (9) surrounding and in direct contact with the glass yarn layer (8);
 - a metal armour (10) surrounding the inner sheath (9); and
 - 15 an outer sheath (11) surrounding and in direct contact with the metal armour (10),wherein the central strength member (2) comprises a hydroxide-containing flame retardant polymeric material, and
wherein the buffer tubes (4) contain a water-blocking filling
 - 20 material (6) comprising a silicone gel, wherein said silicone gel has a drop point of at least 200 °C.
2. The fibre optic cable (1) of claim 1 comprising at least 24 optical fibres (5).
3. The fibre optic cable (1) of claim 1 wherein the central strength
 - 25 member (2) comprises a body (2a) and hydroxide-containing flame retardant polymeric material is in form of a layer (2b) on the outer surface of the body (2a).
4. The fibre optic cable (1) of claim 1 wherein the hydroxide-containing flame retardant polymeric material of the central
 - 30 strength member (2) is a LS0H material.

5. The fibre optic cable (1) of claim 1 wherein the hydroxide-containing flame retardant polymeric material of the central strength member (2) has a limiting oxygen index, LOI, $\leq 35\%$.
6. The fibre optic cable (1) of claim 1 wherein the silicone gel has a drop point of $\geq 250^\circ\text{C}$.
7. The fibre optic cable (1) of claim 1 wherein a water swellable table is interposed between the inner sheath (9) and the metal armour (10).
8. The fibre optic cable (1) of claim 1 wherein the inner sheath (9) and/or the outer sheath (11) are made of a flame retardant LS0H polymer-based material.
9. The fibre optic cable (1) of claim 8 wherein the flame retardant LS0H polymer-based material has a limiting oxygen index (LOI) $\geq 30\%$.
10. The fibre optic cable (1) of claim 8 wherein the flame retardant LS0H polymer-based material has a limiting oxygen index (LOI) $\leq 70\%$.
11. The fibre optic cable (1) of claim 8 wherein the inner sheath (9) and the outer sheath (11) are made of the same LS0H flame-retardant polymer-based material.
12. The fibre optic cable (1) of claim 8 wherein the LS0H flame-retardant polymer-based of the inner sheath (9) has a LOI higher than that of the outer sheath material (11).

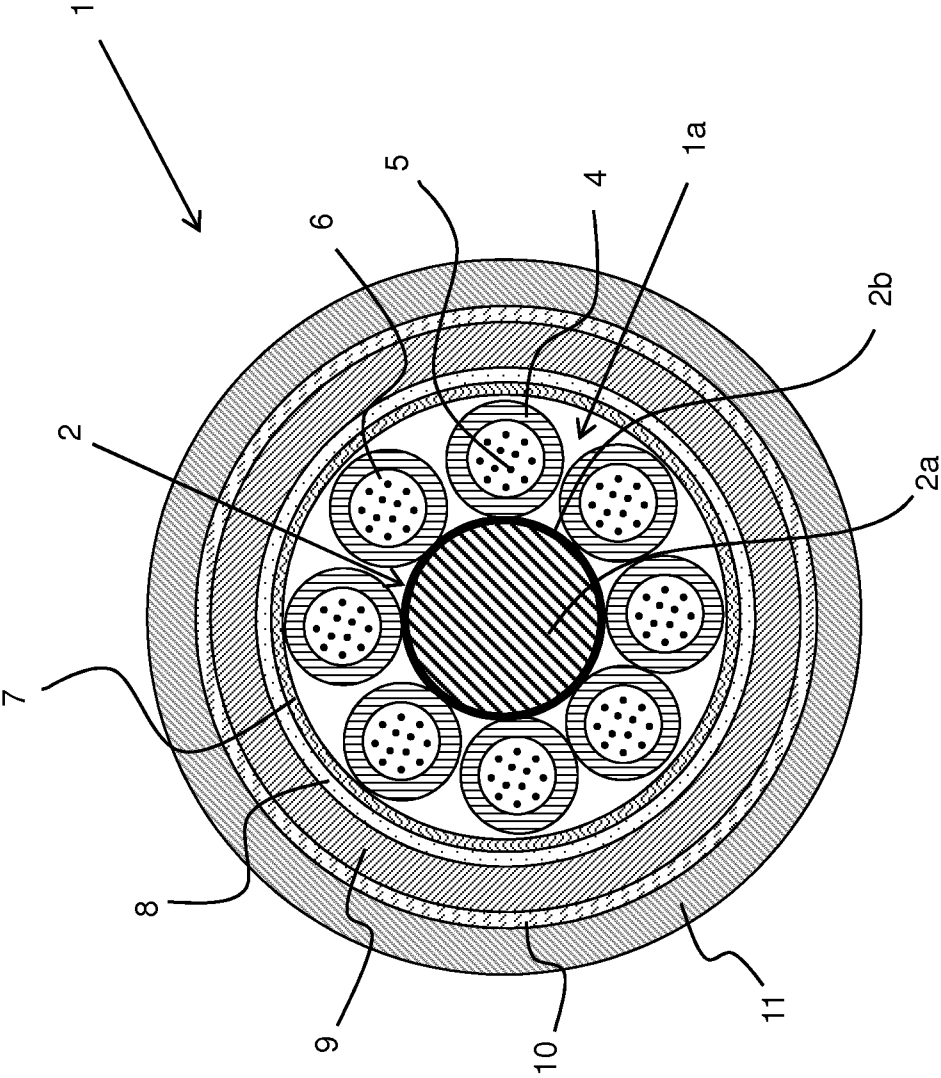


Fig. 1

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/075455A. CLASSIFICATION OF SUBJECT MATTER
INV. G02B6/44 H01B7/295
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G02B H01B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Caledonian Technology Ltd: "Fire resistant Multi Loose Tube Fiber Optic cables", 12 January 2017 (2017-01-12), XP002781692, Retrieved from the Internet: URL:https://web.archive.org/web/20170112105032/http://caledonian-cables.com/product/Fire-Resisting-Cable/Multi-Loose-Tube.html [retrieved on 2018-06-06] cable "steel wire braid" ----- -/-	1-12



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

6 June 2018

Date of mailing of the international search report

15/06/2018

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
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Authorized officer

Dregely, Daniel

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/075455

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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