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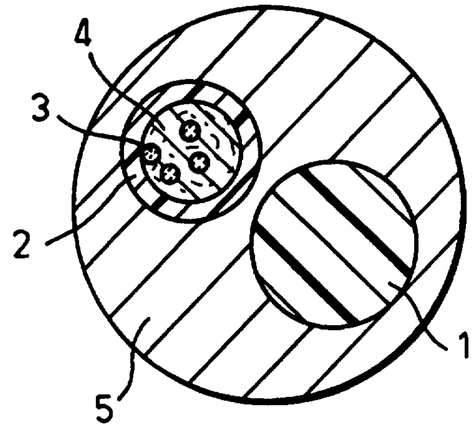
(54) Title: OPTICAL FIBRE CABLE

(57) Abstract

An optical cable comprises a strength member (1) extending along the cable, an extruded plastics sheath (5, 5') that envelops the strength member and contains at least one tubular passage (2, 2') in which is loosely housed at least one optical fibre (3), the strength member (1) and the sheath (5, 5') being non-concentric. The cable may be terminated by: (i) cutting the sheath (5, 5') circumferentially with a single cut which cuts or scores any tube located in the sheath that defines the or each tubular passage (2); (ii) breaking or kinking the strength member (1) by bending; and (iii) removing the sheath (5, 5') to expose the or each optical fibre(s) (3). The cable is relatively inexpensive to manufacture and can be terminated in a relatively simple manner at a customer entry enclosure.



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OPTICAL FIBRE CABLE

This invention relates to optical fibre cables, and especially to cables that have relatively low fibre counts.

Such cables are widely employed by telecoms utilities for routing optical fibres to individual buildings or groups of buildings, and may be directly buried in the ground, buried inside ducting in the ground, and/or suspended between towers or posts.

The present invention provides an optical cable which comprises a strength member extending along the cable, an extruded plastics sheath that envelops the strength member and contains at least one tubular passage in which is loosely housed at least one optical fibre, the strength member and the sheath being non-concentric.

Although it is possible for the cable to include more than one tubular passage, for example two or even three passages, it is preferred for the cable to include only a single passage. Such a cable is relatively inexpensive to manufacture and can be terminated in a relatively simple manner at a customer entry enclosure.

The strength member and the or each tubular passage are preferably arranged substantially symmetrically about the centre of the sheath. For example, where only a single tubular passage is present it may be arranged on the opposite side of the cable axis to the strength member while if two passages are present they may, together with the strength member, be located at the vertices of an equilateral triangle. The tubular passage(s) and the strength member will not normally, however, be exactly symmetrically arranged about the axis due to the differing sizes and/or properties thereof. The strength member and the passage(s) may extend along the cable parallel to the axis thereof, although it is preferred for them to be laid up helically, either in the form of a continuous helix in which the lay has only a single direction, or in which the lay of the helix alters along the length of the cable (so called "SZ stranding"). In fact, when the strength member and the tubular passage are laid up, the strength member tends to be substantially straight due to its greater stiffness, so that the passage and the sheath tend to extend helically around the strength member. Laying the passageway(s) helically has the advantage of improved low temperature performance of the cable as compared with a straight lay. When a cable with the strength member and passageway parallel, is coiled and subjected to low temperatures, the radius of the passageway can be caused to decrease due to the assymmetric geometry of the cable, with the result that the excess fibre length in the passageway can increase significantly and cause attenuation of the signal due to microbending of the fibres. To avoid this effect the cable can have the tube oscillated or helically stranded over the strength member, the helical pitch of this oscillation being just sufficient to prevent the tube laying substantially on the inside of the strength member when the cable is coiled. The amount of oscillation will usually be at least 270 degrees and preferably several rotations in both directions.

The strength member should be capable of withstanding not only tensile forces but also, at least to some extent, compressive forces, and so for example yarns that are not resin bonded should not be employed alone. The strength member should be capable of withstanding contraction of the sheath during processing, for example as it cools after extrusion, and/or if the sheath material crystallises, and any contraction of the sheath during service due to changes in temperature. Preferred materials for forming the strength member include glass reinforced plastics and metals, e.g. steel.

The sheath may be formed from any appropriate plastics material, for example from polyvinyl chloride, low, medium or high density polyethylene, polyurethane, polypropylene, polyamides, polyesters or combinations thereof. For example, a dual-wall sheath may be employed which may comprise a polyethylene inner layer that occupies most of the volume and has a nylon 12 outer layer to give the sheath improved properties such as termite resistance. If necessary or desirable, the materials may include one or more additives e.g. fillers, crosslinking agents, antioxidants, ultraviolet stablizers, flame retardants, pigments, fungicides and the like.

The tubular passage may, in one form of cable according to the invention, be defined by a hollow tube that is enveloped by the sheath. In this form of cable the hollow tube may be formed about the fibre or fibres and laid up with the strength member before the sheath is extruded over the combination. However, in an alternative form of cable, it is possible to dispense with the tube, and to form the hollow tubular passage directly in the sheath as it is extruded. This form of cable may, for example, be manufactured by extruding the sheath about the strength member and a delivery tube through which the optical fibre is passed, the delivery tube in effect forming part of the extrusion head for the sheath.

The cable according to the invention may be terminated in a relatively simple manner at a subscriber entry enclosure, joint enclosure or other location. The cable is preferably terminated by:

(i) cutting the sheath circumferentially with a single cut which cuts or scores any tube located in the sheath that defines the or each tubular passage;
(ii) breaking or kinking the strength member by bending ; and
(iii) removing the sheath to expose the or each optical fibre.

Thus it is possible to dispense with separate operations such as the steps of cutting individual tubes holding the optical fibres that are required with conventional optical cables. When terminating the cable, the strength member can be terminated by clamping the sheath of the cable at the enclosure, and spare fibre may be stored within the enclosure as an organized coil but without the protective loose tube as in normal practice, or the spare fibre may be stored outside the enclosure as a coil of the cable. The cable will normally include one or more stripping threads or rip-cords in order to enable the sheath and any tube to be removed. For example, one thread may be located along the strength member and another thread may be located between a tube containing the fibres and the sheath.

Some degree of adhesion between the strength member and the sheath is desirable for stable long-term performance of the cable, in order to prevent retraction of the sheath from pulling the sheath, tube (if present) and fibres back along the strength member and causing microbending losses due to the increase in excess length of the fibre over the length of the sheath. An interference fit is usually obtained by defining the process conditions so that the sheath contracts tightly over the strength member, a degree of mechanical locking may facilitate this by using a roughened surface on the strength member.

Also, it is possible for the sheath to adhere to the tube since the sheath is not separated from the tube in the termination method according to the invention. However, if conventional termination methods are used in which the sheath is separated from the tube and a spare length of fibre is stored within the tube at the enclosure, then adhesion between the tube and sheath is preferably reduced by appropriate choice of materials or by the use of agents to reduce the adhesion.

Two forms of optical cable according to the invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a schematic cross-section through one form of cable according to the invention that employs a loose tube in which the fibres are located; and

Figure 2 is a schematic cross-section through another form of cable that does not employ a separate loose tube.

Referring to the accompanying drawings, figure 1 shows one form of cable according to the invention. In this form of cable a glass reinforced plastics strength member 1 and a hollow plastics tube 2 are laid up with alternating directions of lay to produce a SZ stranded configuration in which the strength member is substantially straight and the plastics tube revolves about the strength member in alternating directions.

The tube 2 contains four optical fibres 3 that are loosely housed in the tube so that the length of the fibres in the tube exceeds the length of the tube by a small amount, e.g. up to 0.1% of the length of the tube, (often called the "strain margin") in order to allow the cable to stretch when subjected to tensile forces without exerting any stress on the fibres. In addition, the tube 2 may contain a water resistant gel 4 in order to prevent migration of moisture along the cable and also, if necessary, to dampen any motion of the fibres 3 within the tube if the cable is subjected to vibration. The tube 2 may be formed by methods known per se, for example by extruding plastics material to form a tube around an optical fibre delivery tube through which the optical fibre or fibres are passed. One method of forming such a tube is described in GB application No. 2,186,520A. If necessary, a gel delivery tube may be located within the fibre delivery tube to fill the plastics tube so formed with a gel downstream of the point at which the fibre delivery tube ends. The tube may be stretched slightly as it is wound onto a drum so that when it is later allowed to relax, contraction of the tube will cause the optical fibres to be loosely housed therein.

When the tube 3 and the strength member 1 are laid up, a sheath 5 is extruded onto the laid up tube and strength member so that no voids exist between the tube and strength member or between either of the tube and strength member and the sheath. In addition, the cable is formed so that the tube 2 and the sheath do no adhere to one another to any significant extent. This may be achieved by appropriate choice of materials, for example by forming one of the components from a polyester such as polybutylene terephthalate, and the other from polyethylene, or by coating the tube with a material that will prevent bonding of the sheath to it. The sheath 5 may have a substantially circular cross-section as shown in the drawing although it may instead have a flattened, e.g. elliptical, cross-section.

In addition, a stripping thread (not shown) is provided between the tube and the sheath and also between the strength member and the sheath.

In order to terminate the cable, a single circumferential cut is made around the cable at an appropriate point and in so doing nicking the tube 2. Before or after the circumferential cut is made, the sheath is removed from the strength member, and the tube 2 by means of the stripping threads, and the tube 2 is then slid off the fibres. In addition, the strength member 1 is manually broken at a predetermined distance from the end of the sheath 5. The cable is now ready to be clamped at the joint or subscriber termination enclosure and the optical fibres jointed.

Figure 2 shows an alternative form of cable according to the invention. This form of cable is as described with reference to figure 1 with the exception that a tubular passage 2' for the fibres is formed directly in the sheath 5 as it is extruded. This form of cable is terminated in exactly the same manner as the cable shown in figure 1 with the exception that there is no tube 2 that needs to be nicked when the sheath is circumferentially cut.

<u>Claims</u>:

1. An optical cable which comprises a strength member extending along the cable, an extruded plastics sheath that envelops the strength member and contains at least one tubular passage in which is loosely housed at least one optical fibre, the strength member and the sheath being non-concentric.

2. A cable as claimed in claim 1, wherein the sheath contains only a single tubular passage.

3. A cable as claimed in claim 1 or claim 2, wherein the strength member and the or each tubular passage are arranged substantially symmetrically about the centre of the sheath.

4. A cable as claimed in any one of claims 1 to 3, wherein the strength member and the or each tubular passage are laid up helically.

5. A cable as claimed in claim 4, wherein the direction of lay of the strength member and the or each passage alters along the length of the cable.

6. A cable as claimed in any one of claims 1 to 5, wherein the or each tubular passage contains a gel.

7. A cable as claimed in any one of claims 1 to 6, wherein the strength member has sufficient strength against compressive forces to withstand contraction of the sheath during processing and due to thermal contraction.

8. A cable as claimed in any one of claims 1 to 7, wherein the strength member is formed from glass reinforced plastics or a metal.

9. A cable a claimed in any one of claims 1 to 8, wherein the or each tubular passage is defined by a hollow tube that is enveloped by the sheath.

10. A cable as claimed in any one of claims 1 to 9, which includes one or more stripping threads to enable removal of the sheath.

11. A method of terminating an optical cable comprising a strength member extending along the cable, an extruded plastics sheath that envelops the strength member and contains at least one tubular passage in which is loosely housed at least one optical fibre, the strength member being non-concentric, which method comprises the steps of:

(i) cutting the sheath circumferentially with a single cut which cuts or scores any tube located in the sheath that defines the or each tubular passage;

(ii) breaking or kinking the strength member by bending; and

(iii) removing the sheath to expose the or each optical fibre.

Fig.1.

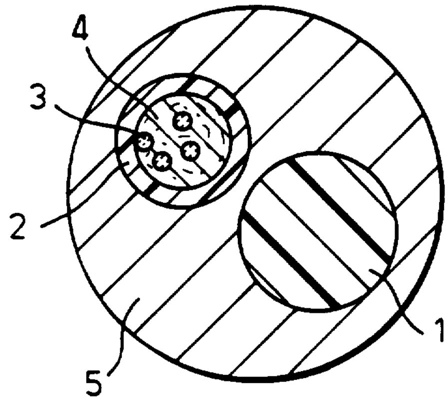
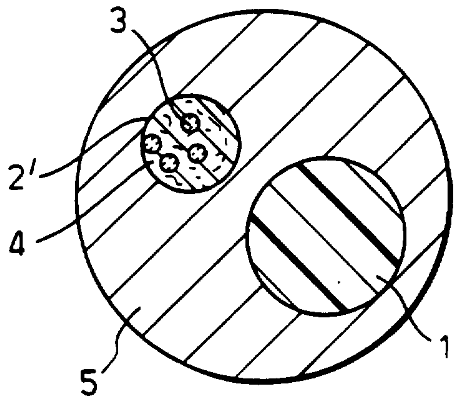


Fig.2.



INTERNATIONAL SEARCH REPORT

International Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G02B6/44

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)
IPC 6 G02B

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 practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP,A,0 240 165 (FUJIKURA LTD ;NIPPON TELEGRAPH & TELEPHONE (JP)) 7 October 1987 see claims; figures	1,2,6-9
A	GB,A,2 186 520 (AUSTRAL STANDARD CABLES PTY LT) 19 August 1987 cited in the application see claims; figures	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-0240165	07-10-87	JP-C- 1753470	23-04-93
		JP-B- 4042649	14-07-92
		JP-A- 62209405	14-09-87
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