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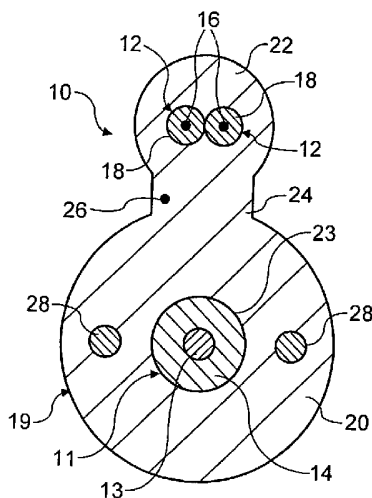


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(54) Title: OPTICAL FIBRE DROP CABLES



(57) Abstract: An optical fibre drop cable (10) for suspension installation comprises sheathing having a first portion (20) containing a strengthening arrangement (28) for supporting the cable in a said suspension installation and a second portion (22) that is separable from the first portion. The second sheathing portion (22) contains a plurality of electrical conductors (16). The first sheathing portion (20) defines at least one passage (23) for optical fibres (13).

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Optical Fibre Drop Cables

The invention relates to optical fibre drop cables for use in telecommunications systems and particularly, but not exclusively, to such cables for use in connecting between a customer's premises and a connection
5 point common to a number of such customers.

In the field of telecommunications networks, typically cables run from an exchange to a cabinet mounted at street level and from this cabinet cables are led to a customer's premises, usually by way of an aerial, or suspension installation comprising a cable suspended in catenary from poles
10 or surrounding buildings. These aerially suspended cables leading to the customer premises are known as the final drop wire.

Historically a final drop wire has typically comprised a number of insulated conducting wires contained in a sheath. More recently the development of optical fibres has made it desirable to replace the conducting
15 wires in drop wires with optical fibres, since the latter can transmit significantly more data. However, it is also desirable that the drop wire should carry an electrical supply in order that a telephone connected to the drop wire can be used in emergency situations when the mains electrical supply to the premises in which the telephone is located has been interrupted.
20 For this reason, it is desirable for a drop wire to include one or more optical fibres and a pair of insulated copper conductor wires.

The applicant's application GB-A-2270992 discloses a cable containing separable electrical conductors and optical fibres. The cable

comprises electrical power conductors for conveying mains voltage electrical supplies, a plurality of optical fibres and sheathing for the conductors and fibres. The sheathing is in the form of a figure of eight and defines two separate chambers; one for the electrical conductors and the other for the optical fibres. However, this cable is intended for underground routing and not for suspension installation. Furthermore, it is not suitable for conducting a relatively low voltage electrical supply for powering a telephone or otherwise as a final drop wire.

An aspect of the invention relates to an optical fibre drop cable for suspension installation, said cable comprising sheathing having a first portion containing a strengthening arrangement for supporting the cable in a said suspension installation and a second portion separable from said first portion and containing a plurality of electrical conductors, said first portion defining at least one passage for optical fibres.

In order that the invention may be well understood, some embodiments thereof will now be described with reference to the drawings, in which:

Figure 1 is a schematic cross-section of an optical fibre drop cable comprising an optical fibre and electrical conductors;

Figure 2 is a schematic cross-section of an optical fibre drop cable containing a plurality of optical fibres and electrical conductors;

Figure 3 is a schematic cross-section of an optical fibre drop cable comprising an optical fibre and electrical conductors; and

Figure 4 is a schematic representation of a drop cable installation including a cable as shown in Figure 1, 2 or 3;

Figure 5 is an enlargement of the portion of Figure 4;

Figure 6 is a schematic representation of a connecting box of the
5 installation of Figure 4; and

Figure 7 shows a push-fit connector arrangement included in the connecting box.

Figure 1 shows an optical fibre drop cable 10 containing a buffered
optical fibre 11 and two insulated electrical conductors 12. The buffered
10 optical fibre 11 comprises an optical fibre 13 and a plastics coating 14 that
protects the surface of the fibre 13 from scratching and abrasion. The plastics
coating may for example be a nylon coating and the fibre with coating will
typically have a diameter of approximately 1 mm. The insulated conductors
12 comprise copper wires 16 encapsulated in a colour-coded electrical
15 insulating coating 18, which may be of any suitable material as will be well
known to those skilled in the art. Typically, the copper wires will have a
diameter of approximately 0.4 mm and the outside diameter of the insulating
coating will typically be approximately 1.2 mm. One insulated conductor 12
is to serve as the live wire and the other as a neutral/earth wire in a circuit that
20 will typically carry 9 to 12 volts for powering a telephone connected with the
cable. It is to be understood that copper wires are given, only as an example
and that any suitable conducting material, such as aluminium could be used
instead.

The optical fibre 11 and electrical conductors 12 are housed in sheathing 19, which comprises a first portion 20 that contains the optical fibre 13 and a second portion 22 that is separable from the first portion and contains the electrical conductors 12. The optical fibre 11 is housed in a
5 passage 23 defined by the first portion 20 with the wall defining the passage circumferentially engaging the optical fibre along the length of the fibre.

The sheathing portions 20, 22 are substantially circular in cross-section and in side-by-side parallel relationship so as to define a shape approximating to a figure 8. At the point of connection between the sheathing
10 portions, there is a thickening, or web, 24. The web houses a tear, or rip, cord 26 which is offset with respect to a plane passing through the longitudinal axes of the first and second sheathing portions and runs along the cable substantially parallel to those axes. The rip cord 26 may be made of any material sufficiently strong to rip through the web 24 on application of a tear
15 force so as to permit separation of the first and second sheathing portions. One suitable material for the rip cord is a high strength Terylene (TM) string. The sheathing 19 may be made of any suitable sheathing material such as polyethylene, MDPE, HDPE or nylon. Typically, the first portion 20 of the sheathing would have a diameter of approximately 8 mm and the combined
20 height of the two sheathing portions would be approximately 12 mm.

A strengthening arrangement is provided in the first portion 19 of the sheathing in the form of strengthening members 28 disposed adjacent the optical fibre 11. The strengthening members 28 are disposed in parallel

spaced apart relationship, one on each side of the optical fibre 11 and encapsulated in the first portion 20 of the sheathing. As shown in the drawing, the strengthening members are preferably disposed in a plane extending perpendicular to a plane passing through the respective longitudinal
5 axes of the sheathing portions 20, 22 and through the longitudinal axis of the first portion 20 of the sheathing. The strengthening members 28 have a substantially circular cross-section and extend generally parallel to the longitudinal axis the first portion 20 of the sheathing.

Preferably, the strengthening members are made of a dielectric
10 material such as glass reinforced plastic (GRP), although glass yarns may be used with similar advantage. Other non-preferred materials include aramid fibres. Although dielectric materials are preferred, metallic strengthening elements may be used. GRP strengthening materials are a preferred material since the material has a similar coefficient of thermal expansion to optical
15 fibres and thus changes in length of the strengthening members due to thermal effects, should not result in an increase in the forces transmitted to the optical fibre. Glass yarns offer a similar advantage. Materials such as aramid fibres and metallic elements have a different coefficient of thermal expansion to optical fibres and if these are used, account should be taken of the fact that
20 they will expand or contract differently to the optical fibres and measures taken to ensure that this does not result in an adverse loading on the optical fibre 13.

Further advantages are gained by having strengthening members made of an electrically non-conducting material such as GRP, glass yarn or aramid fibres. If the strengthening members are made of an electrically conducting material such as a stranded steel, it is necessary to increase the diameter of the sheathing for electrical insulation purposes. When electrically non-conducting strengthening members are used, there is no requirement to maintain an increased thickness of sheathing in the first portion 20 of the sheathing in order to meet any voltage withstand requirement. Thus, the diameter of the first portion of the sheathing can be reduced, which reduces the effect of ice and wind loads on the cable. It is believed that by using electrically non-conducting strengthening members, the diameter of the first portion 19 of the sheathing can be reduced by up to 2 mm as compared with the case when the sheathing is required to provide electrical insulation.

The optical fibre drop cable 40 shown in Figure 2 shows modifications which may be made to the optical drop fibre 10 singly or in combination. The first modification comprises the addition of two further strengthening members 28. The four strengthening members 28 of the optical fibre cable 40 are disposed on a common pitch circle and are spaced at 90° intervals on that circle, such that a plane passing through the longitudinal axes of the first and second portions 20, 22 of the sheathing passes through the longitudinal axis of two of the strengthening members and a second plane perpendicular to that plane passes through the longitudinal axes of the other two strengthening members. The second modification comprises the provision of two optical

fibres 11. As shown in the drawing, the optical fibres 11 are loosely housed in a circular passage 44. However, the first portion 20 of the sheathing may be formed so as to define a single passage or separate passages encasing the optical fibres in the same way as in the optical fibre cable 10 in Figure 1.

5 Figure 3 shows an optical fibre drop cable 60 that differs from the optical fibre drop cable 10 in that the optical fibre 11 is loosely housed in a hollow plastic tube 62 contained in a passage 63 defined by the first sheathing portion 20. This tube may contain more than one optical fibre although only one is shown in the drawing.

10 A possible modification (not shown) to the optical fibre cable drop 60 shown in Figure 3 comprises omitting the optical fibre(s) 11 from the tube 62. In this case, one or more fibres 11 are blown into the tube after installation of the optical fibre drop cable. Optical fibres to be installed by blown fibre methods may, for example, take the form disclosed in EP-A-0345968, EP-A-
15 0521710 or EP-A-0646818 and may be introduced into the tube 62 by known blowing processes such as the process described in EP-A-0108590. For blown fibre installation the tube 62 may be made of polyethylene with a carbon loaded radially inner surface to increase conductivity, as disclosed in US4952021. Blown fibre installation has the advantage that optical fibre(s)
20 are not subjected to stresses that arise during suspension of the cable.

 Another possible modification (not shown) to the optical fibre drop cables 10, 40, 60 comprises replacing the strengthening members 28 with a strengthening arrangement in the form of a reinforcing sleeve contained in the

first portion 20 of the sheathing. The sleeve would preferably be made of an electrically non-conducting material such as aramid fibres. However, the sleeve could be made of strands of a metallic element such as steel. The fibres or strands of such a sleeve would preferably be helically wound around the optical fibre(s) 11 and/or tube(s) 62 and electrical conductors 12 from two directions – a so-called SZ winding.

Figure 4 shows a drop installation 100 comprising any of the optical fibre drop cables 10, 40 and 60. For ease of description, reference will now be made only to the installation comprising the optical fibre drop cable 10.

The drop installation 100 includes a housing 101 containing a distribution arrangement for distributing connections to telecommunications lines that are to run to customer premises. The housing is fed from an exchange by means of a multifibre optical fibre cable 102 such as a known 48 fibre underground cable. A multifibre optical fibre cable 103 comprising sufficient fibres for connecting with ten telecommunications lines 104 (ten fibres for single fibre circuits or twenty fibres for twin fibre circuits), leads from the housing 101 to a connecting box, or manifold 105 of an adjacent pole 106. In addition, the reference numeral 103 indicates electrical conductors for conducting a voltage of 9 to 12 volts to the manifold.

A telecommunications line 104 runs from the manifold 105 to customer premises such as a building 107. In the drawing, two telecommunications lines 104 are shown; one extending to the right of the manifold and leading to the building 107 and the other extending to the left of

the manifold. As mentioned above, the optical fibre cable 103 contains sufficient optical fibres to connect with ten telecommunications lines 104 and thus there may be ten separate telecommunications lines extending from the manifold 105.

5 The telecommunications lines 104 each comprise a plurality of lengths of the optical fibre drop cable 10 connected end-to-end at respective connecting boxes 108 mounted on poles 106 and the building 107. The lengths of cable 10 are connected to the poles 106 by securing devices 110. In the drawing, only two poles are shown, but in practice there will be as
10 many poles as are required to support the cable en route between the manifold 105 and the customer premises. Typically the spacing between the poles is approximately 200 feet (61 metres), although it may be up to 100 metres.

As best seen in Figure 5, each securing device 110 comprises an elongate member 112 which is bent double to define two end portions 114,
15 116 that are helically wrapped around the first portion 20 of the sheathing in the same sense, and a bend, or loop, 118 that connects the end portions. The securing device 110 additionally comprises a tensile connecting member 120 having hooked end portions, one of which engages the loop 118 and the other of which engages a pole ring 122 fixed to the pole 106. The tensile
20 connecting member 120 may include means (not shown) for adjusting the tension in the cable 10 between the securing devices on adjacent poles 106. In this case, the tensile connecting member may comprise two portions each having threading at their ends remote from the hooked end portions and

interconnected by a nut such that rotation of the nut causes lengthening or shortening of the tensile connecting member.

As shown in Figure 5, in order to allow the end portions 114, 116 of the elongate member 112 to wrap around the first portion 20 of the sheathing, the second portion 22 containing the electrical conductors 12 is separated from the first portion 19. This separation is easily obtained by accessing the free end of the rip cord 26 at the adjacent end of the optical fibre cable 10 and using this to rip through the web 24 over a suitable distance. In the drawing a break is shown in the separated portion of the first portion 19 of the sheathing simply to allow a better view of the loop 118 and the tensile connecting member 120.

As shown schematically in Figure 6, a connecting box 108 has a hollow interior 130, that can be accessed by removing a cover plate (not shown). An opening 132 for a cable 10 is provided at each side of the box to serve as an entry point for an end of a cable 10. As an alternative to single openings 132, pairs of openings may be provided for individually receiving the separated sheathing portions. The connecting boxes 108 are secured to the poles 106 by any suitable means, such as screws 133. Each box contains a push-fit connector arrangement, or device, 134 by means of which the ends of the cables 10 are secured within the box. The push-fit connector arrangement 134 may utilise any suitable known push-fit technology and has two push-fit connection points 135 at spaced apart positions, one for each cable end.

The push-fit connection points 135 may each include two push-fit connectors such as the push-fit connector 136 as shown in Figure 7. Each push-fit connector 136 comprises a body 138 that defines a stepped through-passage 140. A gripping means 142 that comprises a ring having a plurality of circumferentially spaced apart radially and axially inwardly extending projections, or barbs is housed in a larger diameter portion 144 of the through-passage 140 at a position remote from the ends of the through-passage. The gripping means 142 is preferably made of metal, but may be made of a plastics material, and the barbs are able to deflect radially outwardly on insertion of an end of a sheathing portion 20, 22 into the through-passage 140 (from the right as viewed in the drawing), but dig into the sheathing if the cable is pulled in the direction opposite to the direction of insertion so as to resist subsequent withdrawal of the sheathing portion from the connection point 135. A collet 146 may be provided to permit withdrawal of the sheathing portion should it become desirable to break the connection. The collet 146 has a cylindrical leading-end portion 148 which projects into the through-passage 140 and is engageable with the barbs on axial inward movement relative to the gripping means 142 to deflect the barbs radially outwardly to release the grip on the sheathing portion and permit its withdrawal.

To form a connection between adjacent ends of the lengths of cables 10 in a connecting box 108, the separated first and second sheathing portions 20, 22 of the respective ends of the cables are fed through the openings 132

into the hollow interior of the connecting box 108. The sheathing and strengthening members 28 are cut back to expose the optical fibre 11 and insulated conductors 12 and then the ends of the sheathing portions are push-fitted into the respective push-fit connectors 136 until the cut end of the sheathing abuts a shoulder 150 defined by the through-passage 140. At this stage, the ends of the first and second portions of the sheathing are secured in the push-fit connectors 136 by the barbs of the gripping means 142 and the exposed optical fibre 11 and insulated conductors 12 protrude from the inner ends 152 of the through-passages to a connection region 154 of the connecting box. Here the electrical conductors and optical fibres of the cable ends are connected by any suitable conventional means. For example, the conductors 12 may be connected by stripping back the insulating coating 18 to expose the copper wires 16 and twisting the ends of the wires together. Alternatively, a terminal block in which the ends of the conducting wires are secured by means of screws may be used.

The manifold 105 may be of similar construction to a connecting box 108. The manifold 105 would contain an additional opening through which the optical fibre cable 103 is fed and ten openings 132 to permit ten telecommunications lines 104 to feed from the manifold. The ends of the telecommunications lines 104 can be secured in the manifold 105 by means of push-fit connectors, such as the push-fit connectors 136 in the same way as in the connecting boxes 108, or by any other suitable means. Similarly, connections between the electrical conductors feeding into the manifold and

the optical fibres of the optical fibre 103 may be made with the electrical conductors 12 and optical fibres 11 by any suitable conventional means. As shown in Figure 4, the lengths of optical fibre drop cable 10 suspended between the poles 106 are connected to the poles by the securing devices 110, which are secured to the cable at spaced apart positions remote from its ends. The tension in the cable suspended between the poles can be adjusted after suspension of the cable by means of the adjusting means of the tensile connecting members 120 if such means are provided. The end portions 10E (Figure 5) of the first portion of the sheathing and its contents between the securing devices 110 and the connecting boxes 108 are untensioned.

The helical winding of the ends 114, 116 of the elongate member 112 can be adapted such that it will grip the sheathing with a predetermined force so that the sheathing will slip when the tension in the cable 10 reaches or exceeds a predetermined level. Once the cable slips, the previously untensioned portions 10E will be tensioned and the connection points 136 are arranged such that the cable will be released, breaking the connection with the adjacent lengths of cable when the tension in the portion 10E reaches a second predetermined level which is no greater than the tension load that causes the slippage of the cable and is preferably substantially less. The tension load at which the elongate member 112 permits slippage of the cable is selected such that the cable will slip at a loading less than that required to break the cable. It is expected that the strength of the cable would be such that it would break under a load in the region of 2KN, that the elongate member 112 would be

arranged to permit slippage of the cable under a load in the region of 1.2 to 1.5KN and the push-fit connectors would be arranged to permit the cable connections to break at a load in the region of 170N, although it is to be understood that these loads are given as examples and should not be taken as limiting.

In the drop installation 100, the ends 10E are described as being secured to the connecting box 106 by means of a push-fit arrangement. It will be appreciated that this arrangement whilst advantageous in terms of simplicity and ease of fitting, should not be taken as limiting. The ends 10E may be secured by any suitable means, such as a spring-loaded cable clamp that will provide sufficient security to hold the ends 10E in place and avoid any tensile load being transmitted to the joints between the optical fibres 11 and conductors 12 during normal operating conditions and at the same time reliably permit breakage of the connection at a tensile loading no greater than that required to cause slippage of the cable through the securing devices 110.

If the telecommunications line 104 is to be constructed using an optical fibre drop cable 60 as shown in Figure 3, with the optical fibre(s) being installed by blown fibre technique, it is necessary to provide a substantially gas-tight passage along which the optical fibres are to be blown. In this case, the first portion 20 of the sheathing is cut back such that when its end is push-fitted into a push-fit connector 136, the cut end of the plastics tube 62 protrudes from the end 152 of the through-passage 140 into the connection region 154. The ends of the tubes 62 protruding into the connection region

can then be interconnected to provide a gas-tight passage for the optical fibre(s) by means of a suitable length of tubing inserted therebetween. Alternatively, means defining a passage could be provided between the push-fit connection points 135 and arranged such that the ends of the tubes 62 can
5 be inserted therein to provide a continuous air-tight passage for the optical fibre(s).

It is to be understood that whilst the optical fibre drop cables are described as being used in the drop installation 100, which provides for a controlled breakage of the telecommunications line, this is not essential and
10 the cables could be used in any suitable conventional drop installation.

Whilst it is not essential that the optical fibre drop cables 10, 40, 60 are installed in an arrangement such as the arrangement 100 that provides controlled breakage of the telecommunications line under a load less than that required to break the cable, it will be appreciated that such an arrangement is
15 advantageous. This is because the loading which will cause the optical fibre drop cable to slip and the connection between adjacent ends to break can be chosen to be less than that required to break the cable, which is a useful safety feature in the event of a high vehicle driving into the telecommunications line 104 or a tree or other structure falling on it. Furthermore, since the
20 connections between a length of the optical fibre drop cable and adjacent lengths in the line are broken in the event of such events, damage to the telecommunications line should be localised thereby reducing the time required for and cost of repair. In addition, since the telecommunications line

can be designed to break on application of a predetermined loading, the cable can be made significantly stronger than might otherwise be the case, thereby providing greater protection for the optical fibre(s) contained in the cable. In particular, the cable can be made stiffer and thus able to better withstand the effects of variable loading due to wind force and the settling of moisture or ice formation.

It will be understood that generally there are advantages of having the strengthening arrangement provided in the first portion of the sheathing adjacent the optical fibres as opposed to the possibility of supporting the cable by way of an existing aerial installation, or providing a strengthening arrangement auxiliary to the cable or in the second portion of the sheathing. These are that the strengthening arrangement can directly control the thermal and tensile performance of the cable and provide better protection for the optical fibre(s) by virtue of its close proximity to it/them. It also provides the advantage that if the sheathing portions are to be separated for installation in an arrangement such as that shown in Figures 4 and 5, no special measures need be taken to protect the optical fibre(s) in the region in which the sheathing portions are separated.

The optical fibre drop cables of the embodiments are low fibre count cables intended to be used in aerial installations as a final drop wire. It is envisaged that such a low fibre count cable may comprise only one or two optical fibres. Furthermore, the electrical conductors are intended to carry

only a low voltage, preferably in the region of 9 to 12 volts, and only two conductors are needed for this purpose.

CLAIMS

1. An optical fibre drop cable for suspension installation, said cable comprising sheathing having a first portion containing a strengthening
5 arrangement for supporting the cable in a said suspension installation and a second portion separable from said first portion and containing a plurality of electrical conductors, said first portion defining at least one passage for optical fibres.
2. A cable as claimed in claim 1, having at least one said passage
10 containing at least one optical fibre having a length and circumferentially engaged along said length by a wall defining said passage.
3. A cable as claimed in claim 1, having at least one said passage having at least one optical fibre loosely housed therein.
4. A cable as claimed in claim 1, having at least one passage
15 containing a tubular member for receiving at least one optical fibre.
5. A cable as claimed in any one of the preceding claims, wherein said strengthening arrangement is made of a dielectric material.
6. A cable as claimed in claim 5, wherein said strengthening members comprise a glass reinforced plastics material.
- 20 7. A cable as claimed in any one of the preceding claims, wherein said strengthening arrangement comprises spaced apart strengthening members extending in the lengthwise direction of the first portion.

8. A cable as claimed in claim 7, comprising two said strengthening members disposed in opposed spaced apart relationship and wherein the or each said passage is disposed therebetween.

9. A cable as claimed in claim 8, wherein said first portion has a longitudinal axis, said second portion has a longitudinal axis and said strengthening members are disposed in a plane passing through the longitudinal axis of said first portion perpendicular to a plane passing through a plane that passes through said longitudinal axes.

10. A cable as claimed in any one of the preceding claims, further comprising a separation arrangement for facilitating selective separation of said first and second portions of the sheathing.

11. A cable as claimed in claim 10 wherein said separation arrangement comprises a tearing element contained in said sheathing between said first portion and said second portion for tearing through said sheathing to facilitate selective separation of said first and second portions of the sheathing.

12. A cable as claimed in claim 10, wherein said first portion has a longitudinal axis, said second portion has a longitudinal axis, and said tearing element is offset with respect to a plane passing through said axes.

13. A cable as claimed in claim 11 or 12, wherein said sheathing defines a third portion connecting said first portion and said second portion and said rip cord is housed in said third portion.

14. A cable as claimed in any one of the preceding claims, wherein said first and second portions of the sheathing each have a generally circular

cross-section and said portions are arranged such that said sheathing has a cross-section that is substantially in the shape of a figure 8.

15. A cable as claimed in any one of the preceding claims, comprising a said housing for optical fibres.

5 16. A cable as claimed in claim 15, wherein said housing contains at least one optical fibre.

17. A drop installation including a telecommunications line comprising an optical fibre drop cable as claimed in any one of the preceding claims suspended from a plurality of spaced apart aerial locations.

10 18. An installation as claimed in claim 17, wherein said telecommunications line comprises a plurality of lengths of said optical fibre cable connected in end-to-end relationship at said aerial locations by respective connection devices, said telecommunications line being secured to each said aerial location by respective securing devices secured to the line at
15 two spaced apart positions such that the portion of the line between said positions is untensioned and includes a said connection device, said securing devices being arranged to permit transmission of a tensile load to a said untensioned portion of the line when a tensile load on the line adjacent thereof on either side of the aerial location reaches a first predetermined level and
20 said connection devices being arranged to cause the end-to-end connection of the lengths of optical fibre cable connected thereby to break when the tensile load transmitted said untensioned portion reaches a second predetermined

amount that is less than a tensile load required to break the optical fibre cable and no greater than said first predetermined level.

19. An installation as claimed in claim 18, wherein each securing device is arranged to frictionally grip said sheathing and to allow said line to
5 slip relative thereto to transmit said tensile load.

20. An installation as claimed in claim 18 or 19, wherein said first and second portions of the lengths of cable are separated from one another at respective regions of the lengths of cable at which the securing devices engage the telecommunications line.

10 21. An installation as claimed in claim 20, wherein the securing devices comprise two end portions of a bent-double elongate member, which end portions are helically wrapped around the first portion of the sheathing at a respective region of separation at which said first and second portions of the sheathing have been separated.

15 22. An installation as claimed in 20 or 21, wherein the regions of separation of the first and second portions of the sheathing extend to the respective connection device, wherein the first and second portions are separately connected with the connection device.

20 23. An installation as claimed in claim 22, wherein said connection devices comprise respective push-fit connectors for the first and second portions of the sheathing.

24. An installation as claimed in any one of claims 18 to 23 when dependent on claim 12 or 13, wherein at each said end-to-end connection, a

part defining a connecting passage is arranged such that said connecting passage extends between the ends of the respective housings of the lengths of cable to define a substantially gas-tight passage for optical fibres.

25. An installation as claimed in claim 24, wherein said parts are a
5 part of the respective connecting devices.

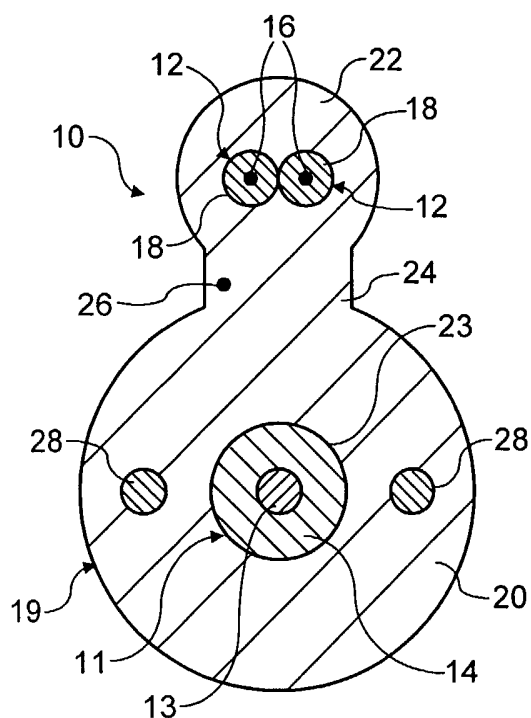


FIG. 1

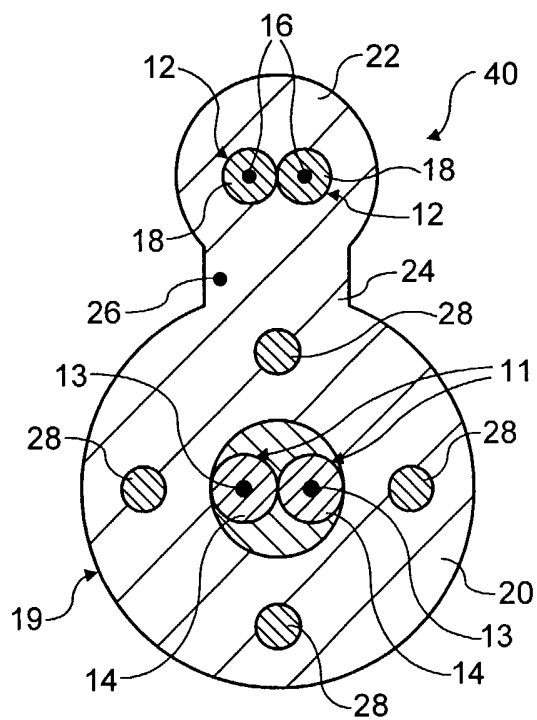


FIG. 2

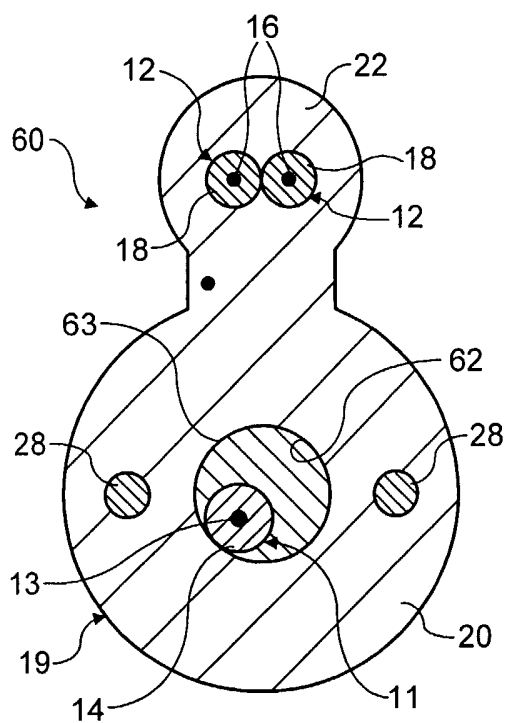


FIG. 3

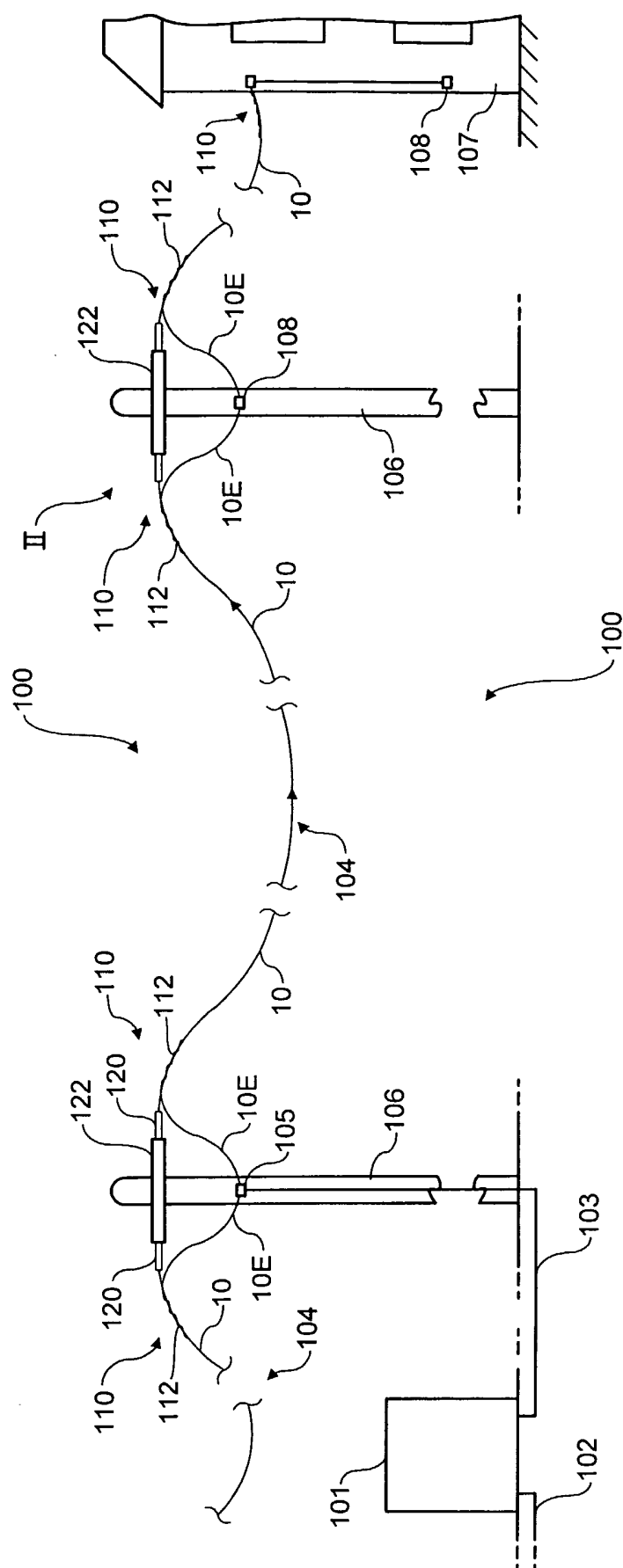


FIG. 4

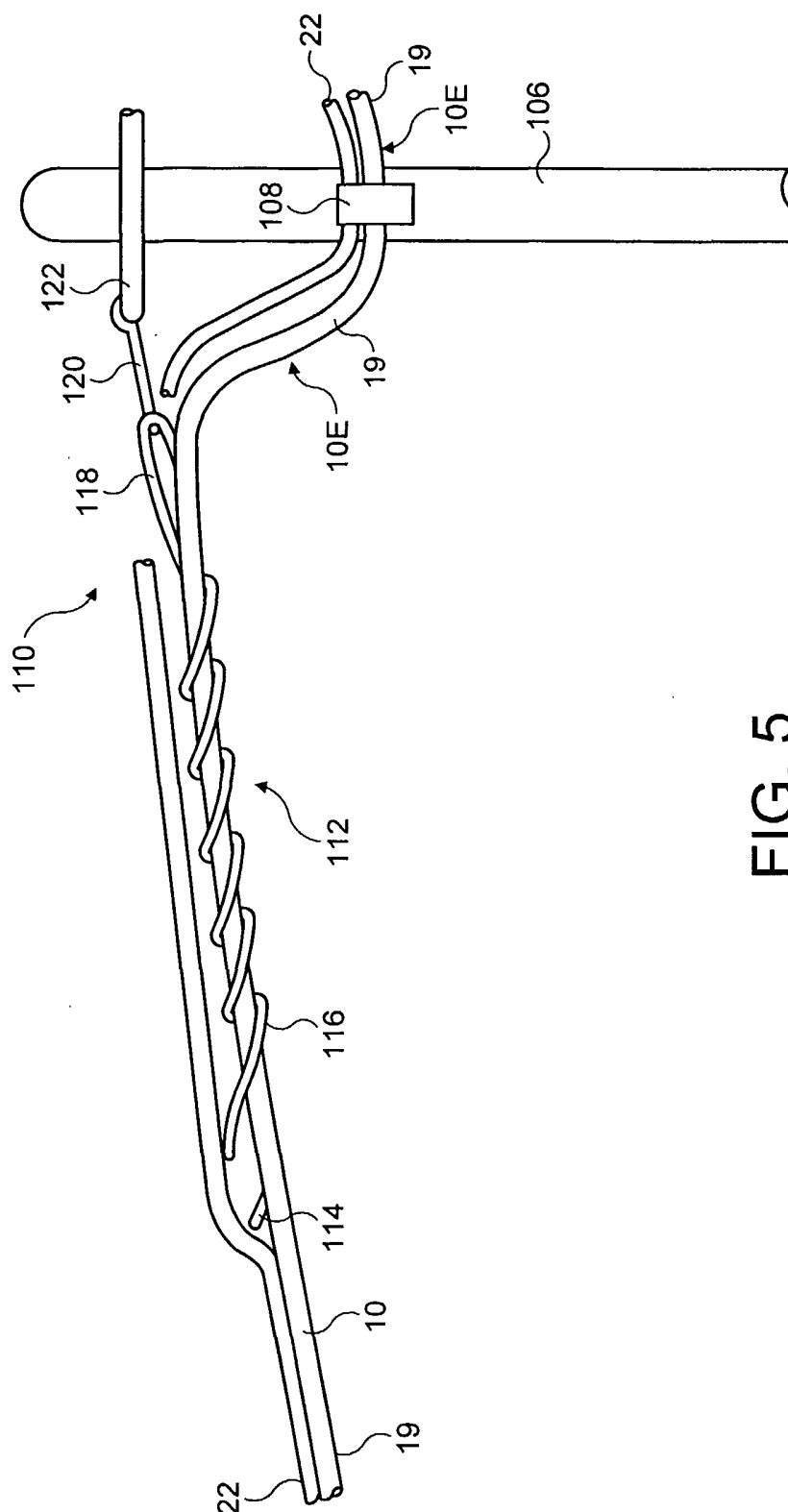


Fig. 5

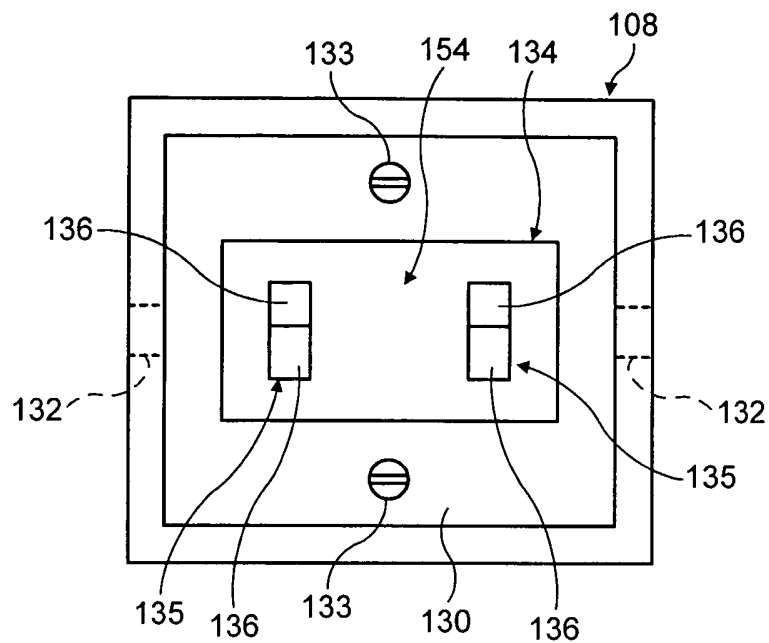


FIG. 6

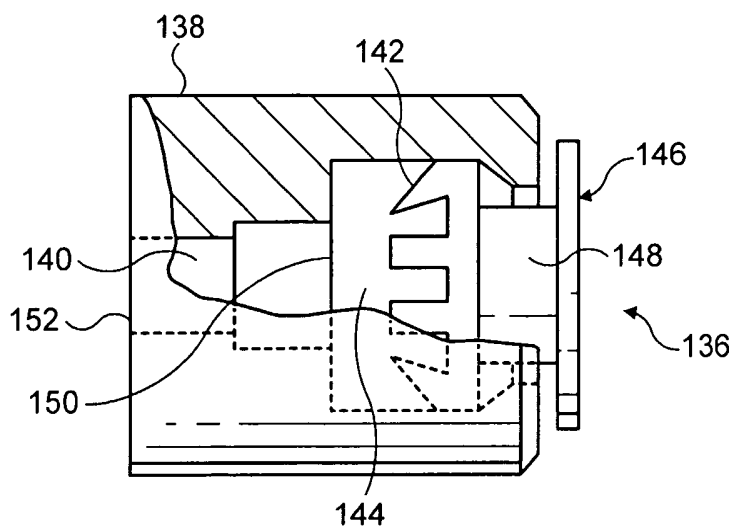


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No

PCT/GD J2/05153

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 7 G02B6/44 H02G3/04

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 7 G02B H02G

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)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 189 718 A (BARRETT MICHAEL J ET AL) 23 February 1993 (1993-02-23) column 1, line 58 -column 2, line 15 figure 1	1-6, 14-16
Y	---	7-12, 17-19, 21,23-25
Y	EP 0 780 713 A (PIRELLI GENERAL PLC) 25 June 1997 (1997-06-25) column 1, line 42 -column 2, line 37 column 4, line 27-43 column 5, line 15-38 figures 1-3 --- -/--	7-9, 17-19, 21,23-25



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

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Date of the actual completion of the international search

10 February 2003

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INTERNATIONAL SEARCH REPORT

Internati pplication No
PCT/GD 02/05153

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