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(54) OPTICAL fibre cable having ribbon bundles with identifying binders

(57) An optical fibre cable has a plurality of optical fibre ribbon bundles 10 disposed in a tube 16. The ribbon bundles 10 are each bound by distinguishable binders 12. The binders 12 may be distinguished by different colours. The ribbon bundles 10 may be protected from moisture by a gel compound 14. The cable may have a waterproof tape layer 18 formed of a non-woven fabric coated in powder or tension yarns 30 applied to the tube to increase the tensile strength. The cable may have a steel tape layer 20 applied to the waterproof layer 18 or the tension yarn layer 30 and may have a polyethylene sheath 23 covering the steel tape. The cable may include tension members 22 installed outside the steel tape layer 20 and diametrically opposed to one another.

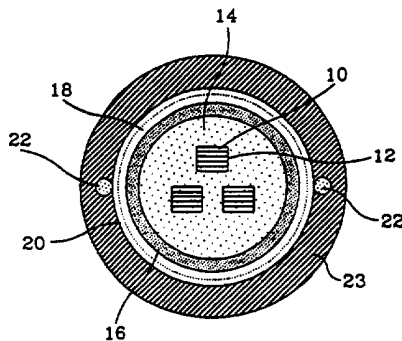


FIG. 4

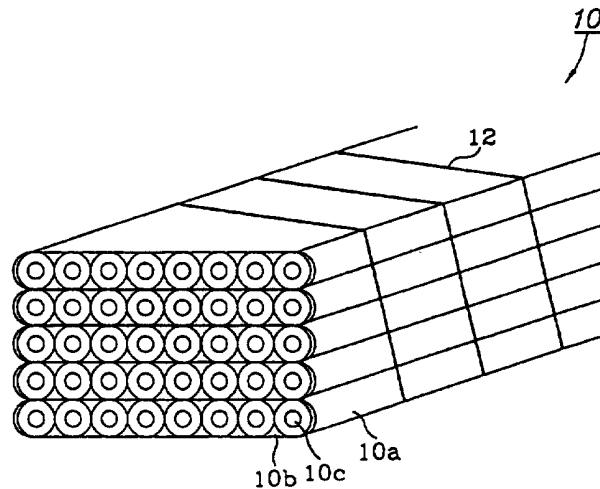


FIG. 6

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

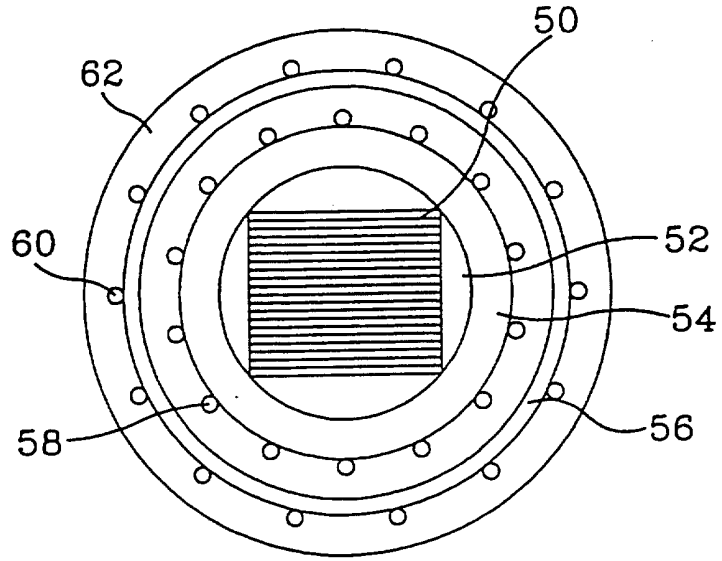


FIG. 1

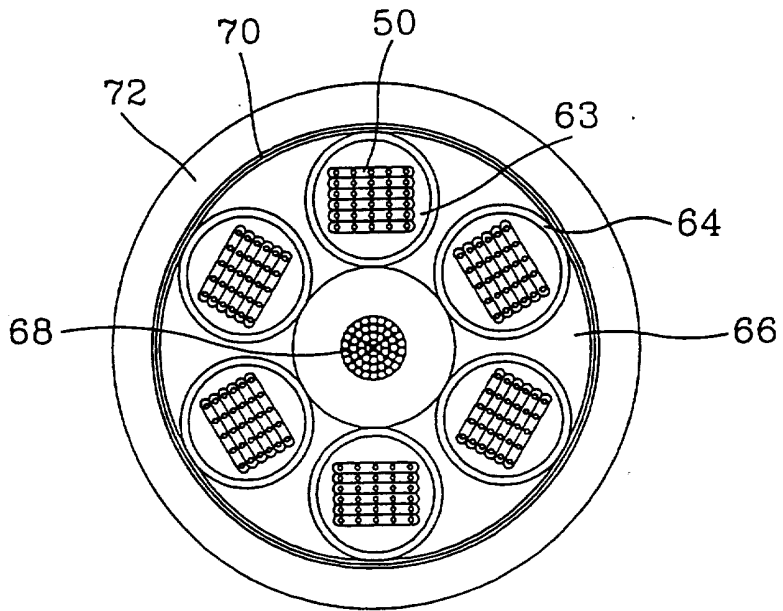


FIG. 2

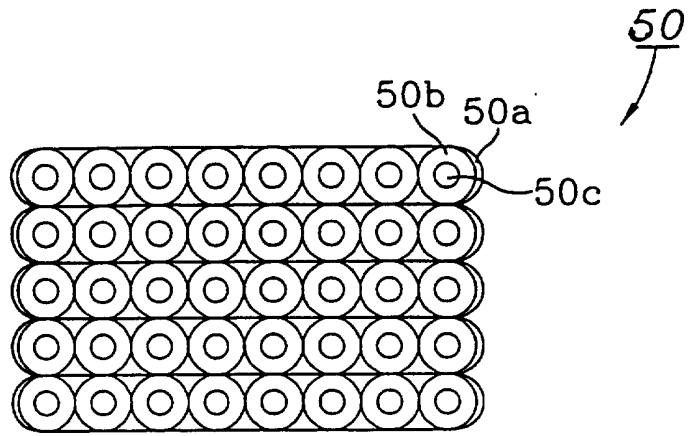


FIG. 3

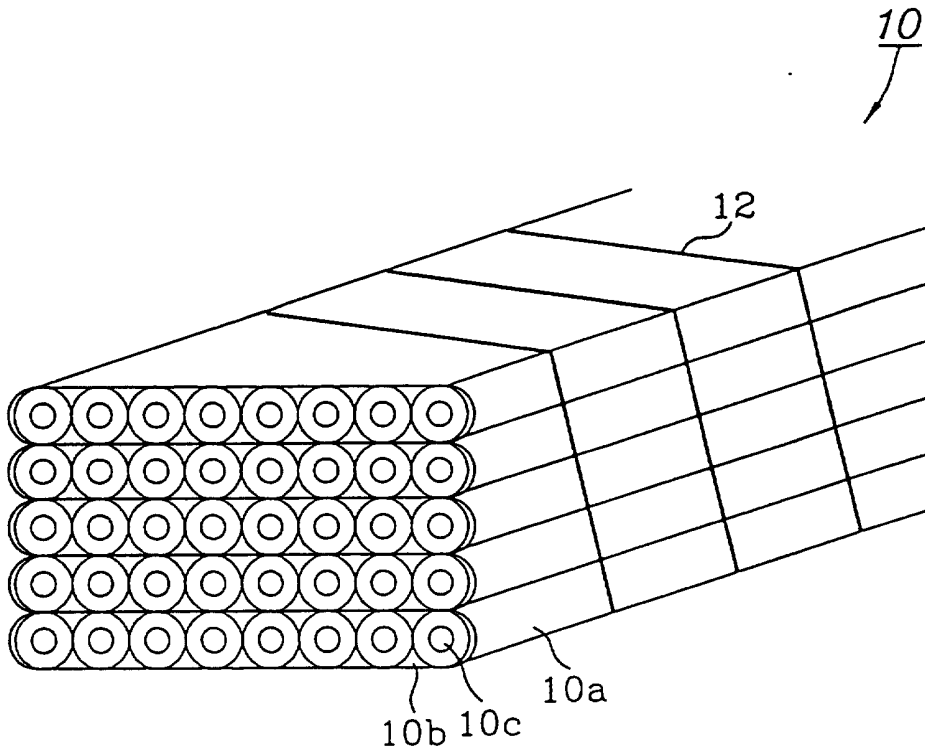


FIG. 6

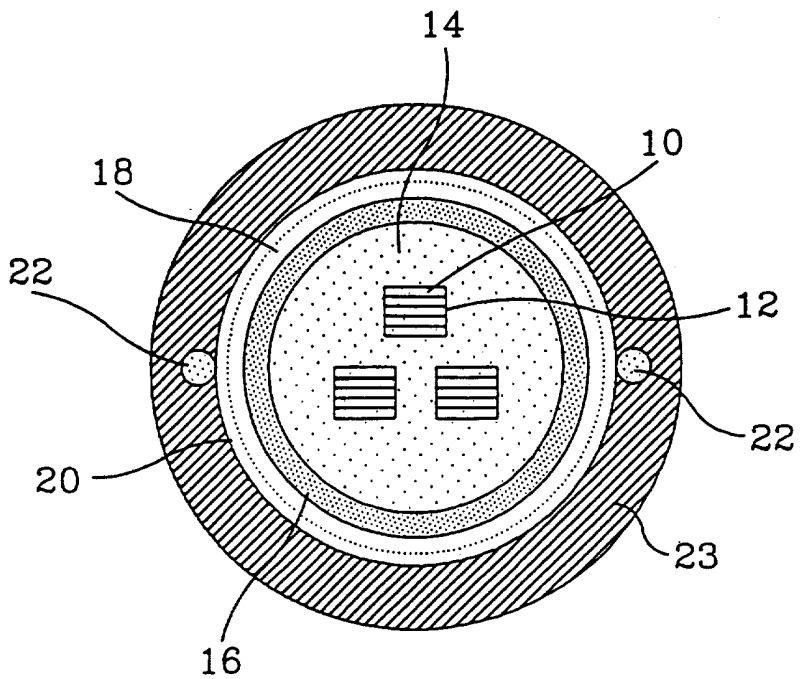


FIG. 4

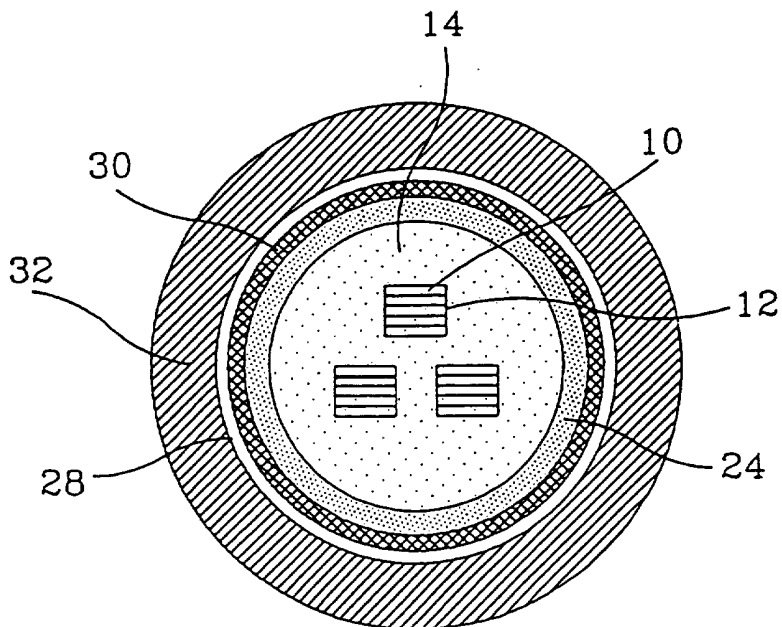


FIG. 5

LOOSE TUBE OPTICAL FIBRE CABLE USING OPTICAL FIBRE
RIBBON BUNDLES AND METHOD OF PRODUCING SUCH A CABLE

5 BACKGROUND OF THE INVENTION

The present invention relates loose tube optical fibre cables using a plurality of optical fibre ribbons and to a method of producing such a cable.

- 10 Fig. 3 is a sectional view showing the construction of a typical optical fibre ribbon bundle 50 used in a loose tube ribbon optical fibre cable. To produce such an optical fibre ribbon bundle 50, a plurality of optical fibres 50c, which are coated with ultraviolet-setting resin (UV-setting
15 resin) are primarily arrayed in parallel. The parallel-arrayed fibres 50c in turn are coated with UV-setting resin, so that an external UV-setting resin coating 50b is formed on the fibres 50c. The parallel-arrayed fibres 50c are thus formed into an optical fibre ribbon 50a.
20 Thereafter, a plurality of optical fibre ribbons 50a are layered on top of one another, thus forming an optical fibre ribbon bundle 50 as shown in Fig. 3.

When an optical fibre cable is produced using such an
25 optical fibre ribbon bundle 50, it is possible greatly to increase the number of cores or the number of optical fibres 50c of the cable and collectively to connect the optical fibres 50c in a terminal, thus improving work efficiency while connecting the optical fibres.

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- Fig. 1 is a sectional view showing the construction of a typical single loose tube ribbon optical fibre cable. As shown in Fig. 1, the single loose tube ribbon optical fibre cable comprises one loose tube 54 which receives one
35 optical fibre ribbon bundle 50. The interior of the tube 54 is filled with a compound 52, so that the bundle 50 received in the tube 54 is protected from moisture. A plurality of tension members 60 (e.g. tension wires) are uniformly arrayed outside the tube 54, preventing the

bundle 50 from being influenced or damaged mechanically or environmentally. The cable is encased by a sheath 62, which protects the interior of the cable from external influences.

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In the above optical fibre cable, one optical fibre ribbon bundle 50 is received in one loose tube 54, so that the number of cores or the number of optical fibres 50c of the cable is inevitably limited. It is difficult to receive
10 more than 300 cores in the cable. In this regard, when an optical fibre cable having a large number of cores (at least 8 or 12 cores) is produced according to the typical method, the layered optical fibre ribbons 50a in the bundle 50 may be easily damaged when the cable is bent. In
15 addition, it is difficult to distinguish the optical fibres 50c from each other since the fibres 50c are arrayed in parallel and are layered in the bundle 50.

Fig. 2 is a sectional view showing the construction of a
20 typical loose tube multi-ribbon optical fibre cable. As shown in Fig. 2, the loose tube multi-ribbon optical fibre cable is encased by a sheath 72 which protects the interior of the cable from outside influences. A plurality of loose tubes 64, each receiving one optical fibre ribbon bundle
25 50, are arrayed inside the sheath 72. The interior of each loose tube 64 is filled with a compound 63, so that the optical fibre ribbon bundle 50 received in each tube 64 is protected from moisture. A plurality of nonconducting tension members 70 are applied on the loose tubes 54,
30 forming a tension member layer on the tube. The tension member layer prevents the optical fibre cable from being influenced or damaged mechanically or environmentally.

A compound 66 fills in the space defined between the tubes
35 64 inside the tension member layer thus protecting the loose tubes 64 from moisture. A plurality of central tension members 68 extend on the central axis of the cable thus preventing the optical fibre cable from being influenced or damaged mechanically or environmentally.

The above loose tube multi-ribbon optical fibre cable effectively increases the number of cores of the cable. However, the cable has a large outer diameter since the cable has the plurality of loose tubes 64. Due to the enlarged diameter of the cable, the cable wastes labour, reduces work efficiency and takes a great deal of time to be laid.

It is therefore an object of the present invention to provide a loose tube ribbon optical fibre cable and method of producing such a cable in which the above problems can be overcome.

SUMMARY OF THE INVENTION

Accordingly, the present invention provides a loose tube ribbon optical fibre cable comprising:

a loose tube; and

a plurality of optical fibre ribbon bundles disposed within the loose tube and each bound by a respective one of a plurality of distinguishable binders.

The cable may further comprise a gel compound filling the interior of the loose tube to protect the bundles from moisture.

25

The cable may further comprise a waterproof tape layer formed on the loose tube to inhibit the introduction of moisture into the tube. The waterproof tape layer may be formed of a non-woven fabric coated with powder.

30

The cable may further comprise a plurality of tension yarns applied on the loose tube to form a tension yarn layer on the tube and to increase the tensile strength of the cable.

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The cable may further comprise a steel tape layer formed on the waterproof tape layer or tension yarn layer to protect the loose tube mechanically. A protective polyethylene sheath may cover the steel tape layer.

Preferably, the cable may further comprise a plurality of tension members installed outside the tube to increase the tensile strength of the cable. For example, two tension members may be installed outside and on diametrically opposite sides of the steel tape layer to increase the tensile strength of the cable.

The said binders may be distinguishable by being different in colour.

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Preferably, the optical fibre ribbon bundles are twisted individually or twisted together.

The loose tube may be made from a corrosion-resistant plastics material.

15

The present invention also provides a method of producing a loose tube ribbon optical fibre cable comprising:

binding each of a plurality of such optical fibre ribbon bundles with a respective one of a plurality of distinguishable binders; and

20

disposing the bound optical fibre ribbon bundles in a loose tube.

25 The bundles are preferably formed by:

arraying a plurality of optical fibres in parallel and forming an external ultraviolet-setting resin coating on the optical fibres, thus forming an optical fibre ribbon;

layering a plurality of such optical fibre ribbons on top of one another, thus forming an optical fibre ribbon bundle.

30

The method may further comprise:

twisting the bound optical fibre bundles while packing a gel material into the gaps between the bundles to form twisted bundles;

35

receiving the twisted bundles in the loose tube;

filling the interior of the loose tube with a gel compound to protect the bundles from moisture; and

covering the loose tube with a polyethylene sheath and installing a tension member or tension yarn on the loose tube.

5 BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described by way of example with reference to the accompanying drawings in which:

Fig. 1 is a sectional view showing the construction of
10 a conventional single loose tube ribbon optical fibre cable;

Fig. 2 is a sectional view showing the construction of a conventional loose tube multi-ribbon optical fibre cable;

Fig. 3 is a sectional view showing the construction of
15 an optical fibre ribbon bundle used in a conventional optical fibre cable;

Fig. 4 is a sectional view showing the construction of a loose tube ribbon optical fibre cable according to the present invention;

20 Fig. 5 is a sectional view showing the construction of a loose tube ribbon optical fibre cable according to a second embodiment of the present invention; and

Fig. 6 is a perspective view showing the construction of an optical fibre ribbon bundle used in an optical fibre
25 cable according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

To produce the optical fibre ribbon bundle 10 of this invention, a plurality of optical fibres 10c, which are
30 coated with UV-setting resin respectively, are arrayed in parallel. The parallel-arrayed fibres 10c in turn are coated with UV-setting resin, so that an external UV-setting resin coating 10b is formed on the fibres 10c. The parallel-arrayed fibres 10c are thus formed into an optical
35 fibre ribbon 10a. Thereafter, a plurality of optical fibre ribbons 10a are layered on top of one another, thus forming an optical fibre ribbon bundle 10.

In the loose tube ribbon optical fibre cable according to

the first embodiment of the invention, two or more optical fibre ribbon bundles 10 are received in one loose tube 16, which is made of a degradation- and corrosion-resistant engineering plastics. The optical fibre ribbon bundles 10
5 are bound with a plurality of distinguishable binders 12 respectively, and are thus distinguishable from each other.

A gel compound 14 fills the interior of the loose tube 16 and protects the bundles 10 from moisture. The gel
10 compound 14 is anticorrosive and chemically unreactive. A waterproof tape is applied on the loose tube 16, thus forming a waterproof tape layer 18 on the tube 16 and preventing moisture from being introduced into the tube 16. The waterproof tape is made of a non-woven fabric coated
15 with powder. The cable also includes a steel tape layer 20, which is formed by winding a steel tape on the waterproof tape layer 18 and prevents the tube 16 from being influenced mechanically or environmentally. In this case, the steel tape is repeatedly applied on the
20 waterproof tape layer 18 in a direction perpendicular to the cores of the cable.

A plurality of tension members 22 (e.g. tension wires) are provided outside the steel tape layer 20 and prevents the
25 bundles 10 from being influenced mechanically or environmentally. A polyethylene sheath 23 encases the cable thus protecting the interior of the cable.

The above optical fibre cable is produced in the following
30 manner. Two or more, preferably two, four, eight or twelve, optical fibres 10c, each of which is coated with UV-setting resin, are arrayed in parallel. Thereafter, an external ultraviolet-setting resin coating 10b is formed on the optical fibres 10c, thus forming an optical fibre
35 ribbon 10a.

A plurality of optical fibre ribbons 10a are layered on top of one another to form an optical fibre ribbon bundle 10. A plurality of optical fibre ribbon bundles 10 are bound

with different colour binders 12 respectively, so that the bundles 10 are distinguishable from each other. In this case, binding tapes or binding yarns are preferably used as the binders 12.

5

Thereafter, the bundles 10 are twisted with gel filling in the gaps between the bundles 10, thus forming twisted bundles 10. The twisted bundles 10 in turn are received in one engineering plastic loose tube 16. A gel compound 14
10 fills in the interior of the loose tube 16, thus protecting the bundles 10 from moisture.

A waterproof tape, which is made of a non-woven fabric coated with powder, is applied on the loose tube 16 thus
15 forming a waterproof tape layer 18 and preventing moisture from being introduced into the tube 16. Thereafter, a steel tape is applied on the waterproof tape layer 18 and forms a steel tape layer 20, so that the tube 16 is prevented from being influenced mechanically or
20 environmentally.

A plurality of tension members 22 are uniformly arrayed outside the steel tape layer 20 thereby preventing the bundles 10 from being influenced mechanically or
25 environmentally. The cable is, thereafter, encased by a polyethylene sheath 23 which protects the interior of the cable.

In the above optical fibre cable, two or more optical fibre
30 ribbon bundles are bound with a plurality of distinguishable binders respectively prior to being received in one loose tube, thus being distinguishable from each other. The optical fibre cable effectively receives more than 300 cores. In addition, two or more optical
35 fibre ribbon bundles are received in one loose tube, so that it is possible to reduce the bending losses of the optical fibre ribbons and thereby to improve the bending characteristics of the cable. Another advantage of the above optical fibre cable resides in that the outer

diameter of the cable can be reduced since the plurality of optical fibre ribbon bundles are received in a single loose tube.

5 Fig. 5 shows the construction of a loose tube ribbon optical fibre cable according to the second embodiment of this invention. An optical fibre ribbon bundle 10 used in the above optical fibre cable is shown in Fig. 6. To produce the optical fibre ribbon bundle 10, a plurality of
10 optical fibres 10c, which are coated with UV-setting resin respectively, are arrayed in parallel. The parallel-arrayed fibres 10c in turn are coated with UV-setting resin, so that an external UV-setting resin coating 10b is formed on the fibres 10c. The parallel-arrayed fibres 10c
15 are thus formed into an optical fibre ribbon 10a. Thereafter, a plurality of optical fibre ribbons 10a are layered on top of one another, thus forming an optical fibre ribbon bundle 10.

20 In the loose tube ribbon optical fibre cable according to the second embodiment, two or more optical fibre ribbon bundles 10 are received in a single loose tube 24, which is made of a degradation- and corrosion-resistant engineering plastics. The optical fibre ribbon bundles 10 are bound
25 with a plurality of different colour binders 12, thus being distinguishable from each other. In this case, binding tapes or binding yarns are preferably used as the binders 12.

30 A gel compound 14 fills the interior of the loose tube 24 thus protecting the bundles 10 from moisture. The gel compound 14 is anticorrosive, nonconductive, moisture-resistive and chemically unreactive. A plurality of tension yarns are uniformly applied on the loose tube 24
35 thus forming a tension yarn layer 30 on the tube 24. The tension yarn layer 30 prevents the bundles 10 from being influenced mechanically or environmentally. The cable also includes a steel tape layer 28, which is formed by winding a steel tape on the tension yarn layer 30 and also prevents

the tube 24 from being influenced mechanically or environmentally. A polyethylene sheath 32 encases the cable, protecting the interior of the cable.

5 The optical fibre cable according to the second embodiment is produced in the following manner. Two or more, preferably two, four, eight or twelve, optical fibres 10c, each of which is coated with UV-setting resin, are arrayed in parallel. Thereafter, an external ultraviolet-setting
10 resin coating 10b is formed on the optical fibres 10c, thus forming an optical fibre ribbon 10a. Then, a plurality of optical fibre ribbons 10a are layered on top of one another, thus forming an optical fibre ribbon bundle 10.

15 A plurality of optical fibre ribbon bundles 10 are bound with different colour binders 12, so that the bundles 10 are distinguishable from each other. Thereafter, the bundles 10 are twisted with gel filling in the gaps between the bundles 10, thus forming twisted bundles 10. The
20 twisted bundles 10 in turn are received in an engineering plastics loose tube 24. A gel compound 14 fills in the interior of the loose tube 24, thus protecting the bundles 10 from moisture.

25 A plurality of tension yarns are uniformly applied on the loose tube 24, forming a tension yarn layer 30 on the tube 24. The tension yarn layer 30 prevents the bundles 10 from being influenced mechanically or environmentally. Thereafter, a steel tape is applied on the tension yarn
30 layer 30 and forms a steel tape layer 28, so that the tube 24 is again prevented from being influenced mechanically or environmentally. The cable is, thereafter, encased by a polyethylene sheath 23 which protects the interior of the cable.

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In the above optical fibre cable according to the second embodiment, two or more optical fibre ribbon bundles are bound with a plurality of different colour binders respectively prior to being received in one loose tube,

thus being distinguishable from each other. The optical fibre cable effectively receives more than 300 cores. In addition, two or more optical fibre ribbon bundles are received in one loose tube, so that it is possible to
5 reduce the bending losses of the optical fibre ribbons and thereby to improve the bending characteristics of the cable. Since the plurality of optical fibre ribbon bundles are received in one loose tube, the outer diameter of the cable can be reduced. Another advantage of the above
10 optical fibre cable resides in that the optical fibres can be easily and collectively connected in a terminal.

CLAIMS:

1. A loose tube ribbon optical fibre cable comprising:
a loose tube; and
5 a plurality of optical fibre ribbon bundles disposed within the loose tube and each bound by a respective one of a plurality of distinguishable binders.
2. A cable according to claim 1 in further comprising a
10 gel compound filling the interior of the loose tube to protect the bundles from moisture.
3. A cable according to claim 1 or claim 2 further comprising a waterproof tape layer formed on the loose tube
15 to inhibit the introduction of moisture into the tube.
4. A cable according to claim 3 in which the waterproof tape layer is formed of a non-woven fabric coated with powder.
20
5. A cable according to claim 1 or claim 2 further comprising a plurality of tension yarns applied on the loose tube to form a tension yarn layer on the tube and to increase the tensile strength of the cable.
25
6. A cable according to any one of claims 3-5 further comprising a steel tape layer formed on the waterproof tape layer or tension yarn layer to protect the loose tube mechanically.
30
7. A cable according to claim 6 further comprising a protective polyethylene sheath covering the steel tape layer.
- 35 8. A cable according to any preceding claim further comprising a plurality of tension members installed outside the tube to increase the tensile strength of the cable.
9. A cable according to claim 6 or claim 7 further

comprising two tension members installed outside and on diametrically opposite sides of the steel tape layer to increase the tensile strength of the cable.

5 10. A cable according to any preceding claim in which the said binders are distinguishable by being different in colour.

11. A cable according to any preceding claim in which the
10 optical fibre ribbon bundles are twisted individually or twisted together.

12. A cable according to any preceding claim in which the loose tube is made from a corrosion-resistant plastics
15 material.

13. A method of producing a loose tube ribbon optical fibre cable comprising:

binding each of a plurality of optical fibre ribbon
20 bundles with a respective one of a plurality of distinguishable binders; and

disposing the bound optical fibre ribbon bundles in a loose tube.

25 14. A method according to claim 13 in which the plurality of binders are distinguishable by being different in colour.

15. A method according to claim 13 or claim 14 in which
30 the bundles are formed by:

arraying a plurality of optical fibres in parallel and forming an external ultraviolet-setting resin coating on the optical fibres, thus forming an optical fibre ribbon;

layering a plurality of such optical fibre ribbons on
35 top of one another, thus forming an optical fibre ribbon bundle;

16. A method according to any one of claims 13-15 further comprising:

twisting the bound optical fibre bundles while packing a gel material into the gaps between the bundles to form twisted bundles;

receiving the twisted bundles in the loose tube;

5 filling the interior of the loose tube with a gel compound to protect the bundles from moisture; and

covering the loose tube with a polyethylene sheath and installing a tension member or tension yarn on the loose tube.

10

17. A loose tube ribbon optical fibre cable substantially as described with reference to and/or as illustrated in FIGs. 4-6 of the accompanying drawings.

15 18. A method of producing a loose tube ribbon optical fibre cable substantially as described with reference to and/or as illustrated in FIGs. 4-6 of the accompanying drawings.



Application No: GB 9705829.1
Claims searched: 1-18

Examiner: Richard Nicholls
Date of search: 13 May 1997

**Patents Act 1977
Search Report under Section 17**

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): G2J (JGCA1)

Int Cl (Ed.6): G02B

Other: Online databases : WPI, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	US 5165003 A (SUMITOMO) see especially figures 3 and 4 and column 6 lines 40-60 and column 2 lines 39-41	1 at least
X	US 5212756 A (SIECOR) see especially figures 6 and 9 and column 3 lines 65 - column 4 line 10	1 at least

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E Patent document published on or after, but with priority date earlier than, the filing date of this application.