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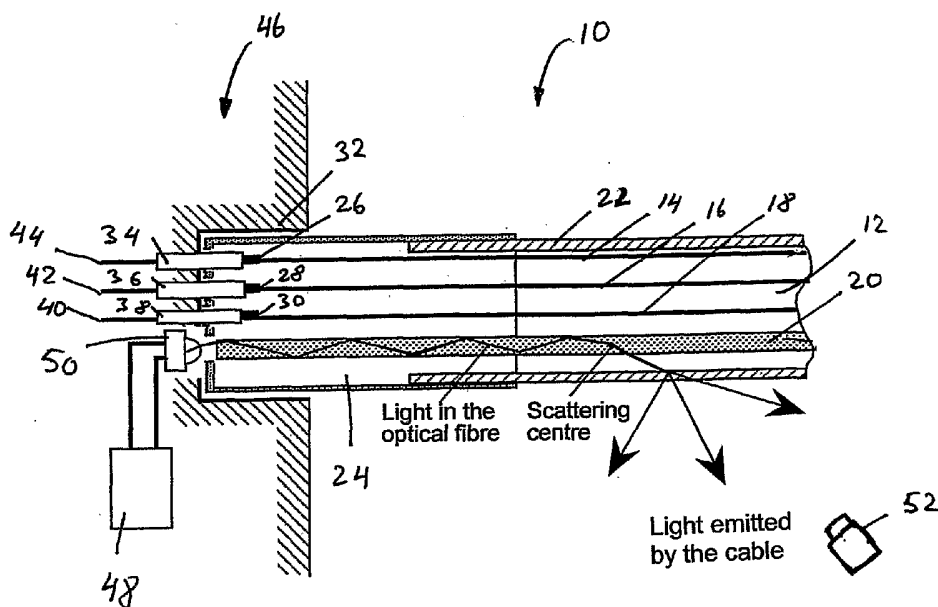
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(54) Title: AN OPTICALLY TRACEABLE TRANSMISSION CABLE FOR TRANSMITTING DATA OR ELECTRICITY AND A TRACEABLE CONDUIT



(57) Abstract: The present invention provides a traceable transmission cable for transmitting data or electricity. The transmission cable comprises a transmission lead for transmitting the data or electricity and an optical light guide for tracing the transmission lead. The optical light guide is positioned along a length of the transmission lead and is arranged for emission of light at at least one intermediate position along a length of the transmission cable so that the transmission cable can be traced. The present invention also comprises a connection device for connecting the transmission cable and a traceable conduit.



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AN OPTICALLY TRACEABLE TRANSMISSION CABLE FOR TRANSMITTING DATA OR ELECTRICITY AND A TRACEABLE CONDUIT

Field of the Invention

5 The present invention broadly relates to a traceable transmission cable and relates particularly, though not exclusively, to a telecommunication network having transmission cables which are traceable and identifiable. The present invention also relates to a traceable conduit.

10

Background of the Invention

 Telecommunication networks comprise a large number of transmission cables. Often large bunches of electrical transmission cables or optical fibres transmit data through a complicated network. The cables typically are terminated at termination points, local area network (LAN) hubs, or telephone exchanges and include patch cords.

 For example, large bunches of patch cords are often necessary to connect terminals of the network at such termination points. It is often necessary to reconfigure these networks and for this purpose it is necessary to identify the specific transmission cables, such as specific patch cords.

 Further, if the network is faulty, for example if one of the transmission cables is broken or damaged, the fault needs to be repaired by replacing or repairing the transmission line. It could be known from fault analysis to which terminal of the network the faulty transmission cable is connected. Therefore, it may be possible to identify a terminal at a LAN hub or another termination point to which the faulty lead is connected.

 However, either for re-configuration of the network or to repair a faulty transmission cable, it is necessary

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to identify specific cables such as the patch cords which often is very difficult as the individual cables of the bunches typically are of identical appearance. Often it is necessary to interrupt the network and to check by trial-
5 and-error which end of the transmission cables corresponds to a particular transmission cable which is connected to the identified terminal. Not only is this task time consuming, it also has further commercial disadvantages associated with the interruption of the network.

10 Further, it is often difficult to trace conduits in buildings, such as conduits for electrical cables, gas or water.

There is a general need for a technically advanced solution.

15

Summary of the Invention

The present invention provides in a first aspect a traceable transmission cable for transmitting data or electricity, the transmission cable comprising:

20 at least one transmission lead for transmitting the data or electricity and

at least one optical light guide being positioned along at least a portion of a length of the or each transmission lead and being arranged for emission of light
25 at at least one intermediate position along a length of the transmission cable so that the transmission cable can be traced.

Throughout this specification the term "lead" is used
30 for an electrical leads and optical leads such as an optical fibre or any optically guiding medium or electrically conducting medium that can be used to transmit data and/or electricity and/or light. The term

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"light" is not restricted to visible electromagnetic magnetic radiation but is also used for radiation that is not visible by the naked eye, such as infrared radiation.

The or each transmission lead may be one of a plurality of transmission leads and the transmission cable may be one of a network such as a telecommunication network. For example, the network may comprise a plurality of parallel transmission leads. The transmission cable may also comprise a patch-cord or may be a patch cord.

As the or each optical light guide can be used to trace the transmission cable, it is relatively simple to identify and trace an individual transmission cable within the plurality of transmission cables. Further, it may not be necessary to interrupt the network to locate a particular transmission cable.

The or each optical light guide may be a light guiding jacket of the transmission lead which may be a side-emitting jacket. Alternatively, the or each optical light guide may be an optical fibre which may be a side-emitting optical fibre.

The or each optical side-emitting fibre and the or each side-emitting jacket typically are formed from a polymeric material.

The or each optical fibre typically comprises a core portion of higher refractive index and may have transparent scattering particles incorporated into the core portion which have a refractive index close to that of the core portion. The core portion typically is surrounded by a cladding that has a lower refractive index than the core portion.

The or each side-emitting jacket typically comprises an inner portion of higher refractive index and may have

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transparent scattering particles incorporated into the inner portion which have a refractive index close to that of the inner portion. The inner portion typically is sandwiched between layers having a lower refractive index
5 than the inner portion.

Alternatively, the or each optical light guide may be arranged so that side emission is effected by at least one of the following: an optically rough surface, a bend which has a curvature small enough so that in use some light is
10 emitted away from the light guide, at least one reflection point or area, at least one cut or recess arranged to effect side emission, a layer or cladding surrounding a light guiding portion and which is sufficiently thin so that in use an evanescent light wave is generated or which
15 has imperfections that locally increase the refractive index and thereby cause side emission.

The refractive index of the scattering particles typically is within a few percent of that of a core portion or the inner portion of the optical fibre or the
20 side emitting jacket. The size of the scattering particles typically is in the range of 5 to 30 μm .

Additionally or alternatively the or each optical light guide may also have a free end through which in use the light is emitted at an intermediate position of the
25 transmission cable.

The or each optical light guide may be arranged for coupling to a data source that in use transmits data through the one or more transmission lead. For example, coupling may be effected so that the intensity of the
30 light emitted by the or each optical light guide is associated with the data transmitted through the or each transmission line. The light intensity of the light may be modulated in a manner that corresponds to a voltage

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amplitude of a digital signal transmitted through the or each transmission lead. The modulated light may be received by a suitable receiver and it is therefore possible to diagnose the status of the or each
5 transmission lead whilst on-line.

The optical light guide typically extends along more than 90% of the length of the or each transmission lead and may also extend along the entire length of the or each transmission lead.

10 The or each transmission cable typically comprises more than one transmission lead. For example, the transmission cable may comprise a predetermined number of transmission leads and the same or a smaller number of optical light guides. In one example the transmission
15 cable advantageously comprises a plurality of transmission leads and one optical light guide.

The or each transmission lead may be an electrical transmission lead. Alternatively, the one or more transmission lead may be an optical transmission lead such
20 as an optical fibre.

The transmission cable typically comprises a jacket that surrounds at least a portion of the or each transmission lead and at least a portion of the or each optical light guide. Alternatively, as described above,
25 the jacket may comprise the light guide and may surround at least a portion of the or each transmission lead.

The jacket typically is at least partially transmissive (eg. translucent) for the light that is in use is emitted by the or each optical light guide. The
30 jacket typically also is light diffusive.

It is often desirable to colour code the transmission cables to simplify installation, network reconfiguration, maintenance, etc. For example, patch cords in a LAN hub

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are often of a blue colour. The jacket typically is colour coded and at least partially transmissive for the light emitted by the or each optical light guide. For example, the jacket may comprise a polymeric material that is semi-transparent and slightly coloured.

In one embodiment the entire jacket transmits the light. In an alternative embodiment only a portion of the jacket is translucent for the light. For example, the jacket may comprise an opaque material and at least one at least partially transmissive window between the opaque material. The opaque material of the jacket may be coloured. The or each transmissive window may be transmissive for a predetermined wavelength range and may extend over the length of the transmission cable.

Alternatively or additionally, the jacket may have a coating which covers portions of the jacket and leaves other portions uncovered so that the light emitted from the or each optical light guide can be transmitted through the uncovered portions.

In one specific embodiment of the present invention the or each optical light guide has a first end and a second end, the second end comprising a mirror arranged to reflect at least a portion of light coupled into the light guide through the first end. The transmission cable typically has two ends and may comprise two optical light guides, each light guide having a mirror at a second end and the optical light guides may be positioned so that one mirror is positioned at or near a first end of the transmission cable and one mirror may be positioned at or near a second end of the transmission cable.

The present invention provides in a second aspect a connection device for connecting the above-described

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transmission cable to a suitable other device, the connection device comprising:

at least one terminal for receiving a transmission lead, the or each terminal being arranged for connecting
5 of the one or more transmission lead to a terminal of the suitable other electrical device and

at least one coupling for coupling to at least one optical light guide.

10 The connection device may comprise the transmission cable of the first aspect. Alternatively, the connection device may be connected to an electronic or photonic device and the suitable other device may comprise the transmission cable.

15 The connection device may be an electrical connection device for connecting an electrical transmission cable to the suitable other device. In this case the or each terminal typically comprises a contact arranged to be connected to a lead of the electrical transmission cable.

20 Alternatively, the connection device may be an optical device for connecting an optical transmission cable to the suitable other device. For example, the or each transmission lead may be an optical fibre. In this case the or each terminal may comprise an alignment
25 fixture to hold the end of the optical fibre in a predetermined position relative to the suitable other device, which may be an optical device such as a transmitter or an optical receiver, so that light can be transmitted between the suitable other device and the
30 optical fibre. The or each terminal may also comprise a tubular portion arranged to receive an end of a respective optical fibre and an end of an optical fibre associated with the suitable other device so that the ends of the

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optical fibre face each other in the tubular portion.

The connection device may be a plug. Alternatively, the connection device may be a receptacle arranged to receive the plug.

5 The connection device may comprise a light source arranged to direct light into the or each optical light guide. For example, the light source may comprise a light emitting diode (LED) or a laser diode.

10 Alternatively, the connection device may be arranged so that an external light source, such as an LED, or laser can direct light into the or each optical light guide.

15 The present invention provides in a third aspect a transmission system comprising the traceable transmission cable of the first aspect and the connection device of the second aspect.

20 Where the connection device comprises a light source, the system typically comprises a control device for the light source.

25 Where the connection device is arranged so that an external light source can direct light into the or each optical light guide, the system typically comprises the external light source and the control device for the light source.

30 The control device may be associated with an electronic or photonic device that in use transmits data through the one or more transmission lead. For example, the control device may control the light source in response to data transmitted by the electronic or photonic device.

The control device may be arranged so that the intensity of the light directed into the or each optical

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light source is modulated so that the or each optical light guide flashes, which can further facilitate identification and tracing of the transmission cable.

Further, the control device may be arranged so that
5 the intensity of the light directed into the or each optical light source is modulated at a frequency that is greater than 100 Hz such as a few Mhz. A suitable detector may be used to detect the modulation and thereby to trace the transmission cable.

10 Further, in a particularly advantageous implementation, the control device may be arranged so that the intensity of the light directed into the or each optical light guide is modulated simultaneously at a frequency that is less than 10 Hz and at a frequency that
15 is greater than 100 Hz such as a few Mhz. A modulation pattern may be selected to facilitate detectability. Such a modulation pattern has the advantage of simultaneously being readily detectable by the human eye and by an electronic detector.

20 In an other example, the control device may be arranged so that the intensity of the light directed into the or each optical light guide is modulated in accordance with a voltage modulation of the data that in use are transmitted through the one or more transmission lead.

25 The modulated light may be received by a suitable detector and it would be possible to diagnose the status of the one or more transmission lead individually and on-line.

The control device may also comprise a circuitry that
30 interrupts or otherwise affects the power delivered to the light source when the one or more transmission lead is faulty.

Further, the circuitry may be arranged so that the

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light source is switched if an activation signal is received. For example, each transmission cable may be allocated an electronic code and the control device may be arranged to direct power to the light source when a
5 respective code is received which significantly simplifies the identification of a respective transmission cable.

The present invention provides in a fourth aspect a method of tracing a transmission lead for transmitting
10 data or electricity, the method comprising:

 guiding light along and in proximity of the transmission lead using an optical light guide,
 emitting light at at least one position along a length of the optical light guide, and
15 tracing the transmission lead by receiving the emitted light.

For example, the step of tracing the transmission cable may comprise receiving the light by an eye of a
20 person so that the person can trace the transmission cable.

The method may also comprise the step of modulating the light intensity so that the emitted light flashes at a rate which facilitates tracing the transmission cable by
25 the eye of a person, for example, a brief intense flash every second.

Alternatively, the step of tracing the transmission cable may comprise receiving the light by a detector that is sensitive for the emitted light. For example, the
30 detector may be arranged to emit an optical or acoustic signal that is a measure for the intensity of the detected light.

The step of guiding light may comprise sending an

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activation signal to a control device to direct power to a light source.

The step of guiding light may also comprise modulating the light in accordance with a voltage modulation of the data that in use are transmitted through a lead of the transmission cable.

The present invention provides in a fifth aspect a traceable conduit comprising at least one optical light guide being arranged for emission of light at at least one position along a length of the conduit so that the conduit can be traced.

For example, the conduit may be a gas or water line or pipe. Alternatively, the conduit may be a tube in which at least one electrical cable or optical fibre may be positioned.

In one example the conduit is a conduit in a building and the optical light guide enables tracing of the conduit in the building.

The invention will be more fully understood from the following description of specific embodiments of the invention. The description is provided with reference to the accompanying drawings.

25

Brief Description of the Drawings

Figure 1 shows a cross-sectional representation of a transmission system according to a first embodiment of the invention,

Figure 2 shows a cross-sectional representation of a transmission system according to a second embodiment of the invention,

Figure 3 shows a cross-sectional representation of a

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transmission system according to a third embodiment of the invention,

Figure 4 shows a cross-sectional representation of a transmission system according to a fourth embodiment of the invention,

Figure 5 shows a cross-sectional representation of a transmission system according to a fifth embodiment of the invention,

Figure 6 shows a cross-sectional representation of a transmission system according to a sixth embodiment of the invention,

Figure 7 shows a cross-sectional representation of a transmission system according to a seventh embodiment of the invention, and

Figure 8 shows a cross-sectional representation of a conduit according to an embodiment of the invention.

Detailed Description of Specific Embodiments

Referring initially to Figure 1, a transmission system and a method of tracing a transmission cable are now described.

The system 10 comprises a transmission cable 12. In this embodiment the transmission cable 12 is an electrical cable and comprises three transmission leads 14, 16 and 18 (shown without insulation) which are arranged to transmit data in a network such as a telecommunication network. The transmission cable 12 comprises an optical light guide which in this example is provided in form of an optical tracing fibre 20 that is side emitting. In this case the optical tracing fibre 20 is side-scattering. The transmission cable further comprises a light diffusing jacket 22 and is connected to a connection device which in this embodiment is a plug 24. Each lead 14, 16 and 18 is

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connected to a respective terminal which comprises pins 26, 28 and 30.

In this embodiment, the plug 24 is connected to another connection device, in this case a receptacle 32, which comprises sockets 34, 26 and 38 into which the pins 26, 28 and 30 are inserted and which are connected to respective transmission leads 40, 42 and 44 (shown without insulation). In this embodiment the receptacle 32 is associated with an electronic device 46. The electronic device 46 comprises a control device 48 which controls a light emitting diode (LED) 50. The LED 50 is arranged to couple light into the optical tracing fibre 20.

For example, the transmission cable 12 may be one of a bunch of parallel transmission cables and may also be a patch cord. The LED 50 emits light that is guided in the optical tracing fibre 20. As the optical tracing fibre is side-scattering, light is emitted to the sides of the optical cable and is diffused by the light diffusing jacket 22. Therefore, it is possible to trace the cable either by directly receiving the diffused light by eye or by using a suitable detector 52.

The side-scattering fibre 20 comprises scattering particles that are distributed throughout the core of the fibre. When guided light in the side-scattering fibre 20 encounters scattering particles, the light is diffused and a portion of the light is directed through the diffusing jacket 22. The average distance that the light travels along the optical fibre before escaping from the core is inversely related to the concentration of the scattering particles. If the concentration of the scattering particles is uniform then the amount of light escaping from the optical fibre per unit length decreases approximately exponentially with distance along the

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optical fibre. The light escaping from this type of side-scattering optical fibre tends to be much more intense in the forward than reverse directions. Detection of the cable 12 from the side is enhanced by making the jacket 22 from a diffusing material. Alternatively or additionally, the side-scattering fibre 20 may have a side-scattering sheath. For further details about side-scattering optical fibre reference is made to international patent application PCT/AU02/00631.

10 In this embodiment the optical tracing fibre 20 is composed of a polymeric material. The optical tracing fibre 20 has a diameter of 0.75 mm. The jacket 22 is made from a material that transmits and diffuses the light emitted by the optical tracing fibre 20. For example, if 15 the LED 50 emits blue light the jacket 22 may comprise blue pigment particles in a transparent polymer matrix. The blue pigment causes the jacket 22 to appear blue when viewed in reflection under ordinary room light.

In this embodiment the device 46 is an electronic 20 device that is arranged to transmit data through the transmission cable. Alternatively, the device 46 may be a LAN hub or another termination point. The control device 48 is coupling to a data source (not shown) of the device 46. The control device 48 modulates the light intensity of 25 the light guided through and emitted from optical tracing fibre 20 in a manner that corresponds to a voltage amplitude of a digital signal transmitted through the one or more transmission lead. The modulated light may be received by a detector 52 and it is therefore possible to 30 diagnose the status of the or each transmission and on-line.

In a variation of this embodiment, the control device 48 is arranged to modulate the light emitted from the

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side-scattering fibre 20. When using a detector, such as detector 52 to detect the emitted light, it is advantageous to modulate the light entering the optical tracing fibre at a high frequency, for example several
5 megahertz, as this improves the signal to noise ratio and increases the ease and reliability of detection. It may be advantageous to use infra-red rather than visible light. With adequate signal to noise there may be enough
10 scattered light to locate a cable out of direct view e.g. inside a bundle of cables or behind a piece of equipment.

In another variation the control device 48 is arranged so that the LED 50 is switched if an activation signal is received. In this variation each transmission cable of a network (not shown) is given an electronic code
15 and control devices, such as control device 48, are arranged to direct power to a respective light source, such as LED 50, when a respective code is received.

In a further variation of the embodiment, the control device 48 comprises an automatic control circuitry that
20 activates the LED 50 when a fault in the data transmission occurs that is likely to be related to a faulty transmission lead. Therefore, it would be relatively easy to identify the faulty transmission cable that comprises the faulty lead.

25 In a further variation of the embodiment, the control device 48 comprises manual control circuitry that activates the LED 50. This simplifies the tracing of a transmission cable 12 that is plugged into receptacle 32.

The detector 52 is used to detect the light emitted
30 from the side-scattering optical fibre 20. The detector 52 may emit an optical or acoustic signal that is a measure for the overall intensity of the detected light. The sensitivity of the detector 52 directional. Typically the

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directionality of the detector 52 is adjustable. For example, broad directional sensitivity is selected to identify a general area in which a particular transmission cable is located and a narrow directional sensitivity is subsequently selected to identify the precise location of the particular transmission cable. Typically the detector 52 has a filter that substantially transmits only light of the wavelength emitted by the LED 50 as this improves the sensitivity of the detector and reduces the response to background light.

Figure 2 shows another embodiment of the invention. The Figure shows a transmission system 60 which comprises a plug 61 and a LED 62 which is connected to the control device 48. The control device 48 may be associated with an electronic device, such as the electronic device 46 shown in Figure 1, and may function in the above-described manner. Alternatively, the control device 48 may be a separate unit, such as a hand-held device, which is operated by an engineer to detect a fault and to trace the transmission cable 12 within a group of cables.

In contrast to the embodiment shown in Figure 1, the transmission cable 12 of the system 60 has jacket 64 that comprises opaque regions 66 and areas 68 which are transmissive for the light that in use is emitted from the optical tracing fibre 20.

Figure 3 shows a further embodiment which is related to the embodiment shown in Figure 2. The Figure shows a system 70 and in this case the side-scattering optical fibre 20 is arranged for coupling from inside plug 71 to an external optical fibre 73 which is arranged to guide light from external LED 74 through the external optical fibre 73 into the side-scattering optical fibre 20. The plug 71 may incorporate features (not shown) that assist

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the aligning of the exit of external optical fibre 73 relative to the entrance of side-scattering optical fibre 20. The figure shows the side-scattering optical fibre with a 180 degree bend inside the plug 71. It will be appreciated that this particular angle is for purposes of illustration only and other bend angles such as 90 degrees are suitable.

In a variation of the embodiment, the external optical fibre 73 may be replaced by a lens and/or prism system to couple the light from LED 74 to the side-scattering optical fibre 20.

In an alternative embodiment, the external LED 74 is comparable in size side-scattering optical fibre 20 and is placed in close proximity to the tip of the side-scattering optical fibre 20 without the use of an external optical fibre 73 or equivalent. In a further variation, the external light source has a highly collimated beam (for example a laser) and is coupled to the side-scattering optical fibre 20 by pointing it at the tip of the optical fibre 20 without the use of an external optical fibre 73 or equivalent.

Figure 4 shows another variation of the transmission system. In this example the system 80 comprises a fluorescence source 82 which is arranged to emit fluorescence light when irradiated with light of a suitable wavelength. For example, light generated by the LED 74 may be directed to the fluorescence source 82 from a side portion of the fluorescence source 82. The fluorescence source 82 is in this embodiment coupled to the optical fibre 20 so that the generated fluorescence light is coupled into the optical fibre 20. The system 80 also comprises a mirror 84 which is optically bonded to the fluorescence source 82 and which is arranged to

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reflect the fluorescence light in a direction towards the optical fibre 20. In further variations of this embodiment the system 80 may comprise at least one other mirror at another surface portion of fluorescence source 82 to
5 further increase the amount of the fluorescence light that is coupled into the optical fibre 20.

Figure 5 shows a further embodiment of the transmission system. The transmission system 90 comprises in this embodiment electrical leads 92, which are shown
10 with their insulating jackets, positioned in a jacket 94. In this example, the jacket 94 is itself an optical light guide and comprises a core layer 96 of higher refractive index which is sandwiched between two layers 98 of lower refractive index. In this embodiment the jacket 94 is
15 optically side-scattering and composed of a polymeric material. The optical side-scattering is effected in the same manner as described above in the context of the side-scattering optical fibre 20. The jacket 94 may otherwise have the same properties as the jacket 22 described above.

20 Figure 6 shows a system transmission system according to a further embodiment of the present invention. The transmission system 100 is closely related to the transmission system 60 illustrated in Figure 2 and described above. The transmission system 100 comprises a
25 mirror 104 positioned in a second plug 106. The mirror is coupled to end-face 108 of the optical fibre 20 in a manner such that light guided in the optical fibre 20 and towards the mirror 104 will be reflected back. This embodiment has the advantage that less or no light is lost
30 and consequently the illumination of the optical fibre 20 is brighter and typically also more uniform at any area along the fibre 20. In one specific example the system 100 comprises a pair of the optical fibres 20 arranged so that

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for one fibre the LED is positioned in plug 61 and the mirror in plug 106 and for the other optical fibre the LED is positioned in plug 106 and the mirror is positioned in plug 61.

5 Figure 7 shows a transmission system according to a further embodiment of the invention. The transmission system 110 is similar to transmission system 80 illustrated in Figure 4 and described above. In this embodiment, however, the transmission system comprises two
10 optical fibres 112 and 114 which are terminated at respective positions along the length of the transmission cable 12. In this case the optical fibres 112 and 114 may have properties similar to that of the optical fibre 20 shown in Figure 4. Alternatively, the optical fibres 112
15 and 114 may be arranged to emit light only at their terminations so that the transmission cable may be traced by detecting the light emitted at the terminations. It will be appreciated that in variations of this embodiment the transmission cable may have any other number of
20 optical fibres.

 Figure 8 shows a conduit according to an embodiment of the present invention. The conduit 120 comprises a range of components which are similar to those of the transmission system 80 illustrated in Figure 4 and
25 described above. In this embodiment the conduit 120 comprises a tube 122. The tube 122 may be used for guiding a fluid, such as gas or water in a building, or may be used to for guiding electrical cables or optical fibres. The optical fibre 20 enables tracing of the conduit in a
30 manner analogous to that possible with the transmission system 80. It will be appreciated that in variations of this embodiment the conduit may also comprise a light guiding (and emitting) jacket similar to jacket 96

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illustrated in Figure 5 and described above and may further comprise any suitable feature of the transmission systems illustrated in Figures 1 to 3 and 5 to 6.

Although the invention has been described with
5 reference to particular examples, it will be appreciated by those skilled in the art that the invention may be embodied in many other forms. For example, the optical transmission cable may have any number of leads and any number of optical tracing fibres and associated
10 components. Further, the system may comprise one or more lasers that replace the LED. It is also to be appreciated that the optical tracing fibre may not necessarily be an optical side-scattering fibre, but may alternatively be an optical fibre that has a free end through which guided
15 light is emitted.

Further the transmission leads 14, 16 and 18, which are shown without insulation in Figures 1 - 4 and 6, and transmission leads 40, 42 and 44, also shown without insulation, may be replaced by optical fibres. In this
20 case, the terminals of the plug 24 do not comprise contacts but may comprise tubes arranged to receive two ends of respective optical fibres so that the ends of the respective optical fibres face each other in the tubes. Alternatively, the terminals of the plug 24 may comprise
25 alignment fixtures to hold the end of the optical fibres 14, 16, and 18 in a predetermined position relative to an optical transmitter or an optical receiver so that light can be transmitted between the optical transmitter or receiver and the optical fibre.

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The Claims:

1. A traceable transmission cable for transmitting data
5 or electricity, the transmission cable comprising:
at least one transmission lead for transmitting the
data or electricity and
at least one optical light guide being positioned
along at least a portion of a length of the or each
10 transmission lead and being arranged for emission of light
at at least one intermediate position along a length of
the transmission cable so that the transmission cable can
be traced.
- 15 2. The transmission cable as claimed in claim 1 wherein
the or each optical light guide is a light guiding jacket
of the or each transmission lead.
3. The transmission cable as claimed in claim 1 wherein
20 the or each optical light guide is an optical fibre.
4. The transmission cable as claimed in claim 2 wherein
the or each light guiding jacket is a side-emitting
jacket.
- 25 5. The transmission cable as claimed in claim 3 wherein
the or each optical fibre is a side-emitting optical
fibre.
- 30 6. The transmission cable as claimed in claim 4 or 5
wherein the or each optical light guide comprises
transparent scattering particles.

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7. The transmission cable as claimed in any one of the preceding claims being one of a plurality of transmission cables.

5 8. The transmission cable as claimed in any one of the preceding claims being one of a network of transmission cables.

9. The transmission cable as claimed in any one of the
10 preceding claims being a patch cord.

10. The transmission cable as claimed in any one of the preceding claims wherein the optical light guide extends along more than 90% of the length of the or each
15 transmission lead.

11. The transmission cable as claimed in any one of the preceding claims comprising a plurality of transmission leads and one optical light guide.

20 12. The transmission cable as claimed in any one of the preceding claims wherein the or each optical light guide has a free end through which in use the light is emitted at an intermediate position of the transmission cable.

25 13. The transmission cable as claimed in any one of the preceding claims wherein the or each transmission lead is an electrical transmission lead.

30 14. The transmission lead as claimed in any one of claims 1 to 12 wherein the or each transmission lead is an optical fibre.

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15. The transmission cable as claimed in claim 3 or 5 to 14 when dependent on claim 3 comprising at least one jacket that surrounds at least a portion of the or each transmission lead and at least a portion of the or each optical fibre.

16. The transmission cable as claimed in any one claims claim 2 or 4 to 14 when dependent on claim 2 comprising at least one jacket that surrounds at least a portion of the or each transmission lead.

17. The transmission cable as claimed in claim 15 or 16 wherein the or each jacket is at least partially transmissive and diffusive for the light.

18. The transmission cable as claimed in any one of claims 15 to 17 wherein the or each jacket is colour coded.

19. The transmission cable as claimed in claim 15 or 16 wherein only a portion the or each jacket is translucent for the light.

20. The transmission cable as claimed in any one of the preceding claims wherein the or each optical light guide has a first end and a second end and wherein the second end comprises a mirror arranged to reflect at least a portion of light coupled into the optical light guide through the first end.

21. The transmission cable as claimed in claim 20 having two ends and comprising two optical light guides, each optical light guide having a mirror at a second end and

- 24 -

wherein the optical light guides are positioned so that one mirror is positioned at or near a first end of the transmission cable and one mirror is positioned at or near a second end of the transmission cable.

5

22. The transmission cable as claimed in claims 4 or 5 wherein the or each optical light guide is arranged so that side emission is effected by at least one of the following: at least one optically rough surface, at least
10 one bend which has a curvature radius small enough so that in use at least some light is emitted away from the light guide, at least one reflection point or area, at least one cut or recess arranged to effect side emission, a layer or cladding of lower refractive index surrounding a light
15 guiding portion of higher refractive index and which is sufficiently thin so that in use an evanescent light wave is generated or which has imperfections that locally increase the refractive index and thereby cause side emission.

20

23. A connection device for connecting the transmission cable as claimed in any one of the preceding claims to a suitable other device, the connection device comprising:
at least one terminal for receiving a transmission
25 lead, the or each terminal being arranged for connecting of the one or more transmission lead to a terminal of the suitable other electrical device and
at least one coupling for coupling at least one optical light guide.

30

24. The connection device as claimed in claim 23 being an electrical connection device for connecting an electrical transmission cable to the suitable other device.

- 25 -

25. The connection device as claimed in claim 23 being an optical connection device for connecting an optical transmission cable to the suitable other device.

5

26. The connection device as claimed in any one of claims 23 to 25 comprising a plug.

27. The connection device as claimed in any one of claims
10 23 to 25 comprising a receptacle.

28. The connection device as claimed in any one of claims 23 to 27 comprising a light source arranged to direct light into the or each optical light guide.

15

29. The connection device as claimed in any one of claims 23 to 27 being arranged so that an external light source can direct light into the or each optical light guide.

20 30. A transmission system comprising the transmission cable as claimed in any one of claims 1 to 22 and the connection device as claimed in any one of claims 23 to 29.

25 31. The transmission system as claimed in claim 30 when dependent on claim 28 comprising a control device for the light source.

30 32. The transmission system as claimed in claim 31 wherein the control device is arranged so that the intensity of the light directed into the or each optical light guide is modulated so that the or each optical light guide is flashing.

- 26 -

33. The transmission system as claimed in claim 31 or 32 wherein the control device is arranged so that the intensity of the light directed into the or each optical light guide is modulated at a frequency that is greater than 100 Hz.

34. The transmission system as claimed in claim 31 or 32 wherein the control device is arranged so that the intensity of the light directed into the or each optical light guide is modulated in accordance with a voltage modulation of the data that in use are transmitted through the one or more transmission lead.

35. The transmission system as claimed in claim 31 or 32 wherein the control device is arranged so that the light source is switched if an activation signal is received.

36. A method of tracing a transmission lead for transmitting data or electricity, the method comprising:
guiding light along and in proximity of the transmission lead using an optical light guide,
emitting light at at least one position along a length of the optical light guide, and
tracing the transmission lead by receiving the emitted light.

37. The method as claimed in claim 36 wherein the step of tracing the transmission cable comprises receiving the light by an eye of a person.

38. The method as claimed in claim 36 wherein the step of tracing the transmission cable comprises receiving the

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light by a detector that is sensitive for the emitted light.

39. A traceable conduit comprising at least one optical
5 light guide being arranged for emission of light at at
least one position along a length of the conduit so that
the conduit can be traced.

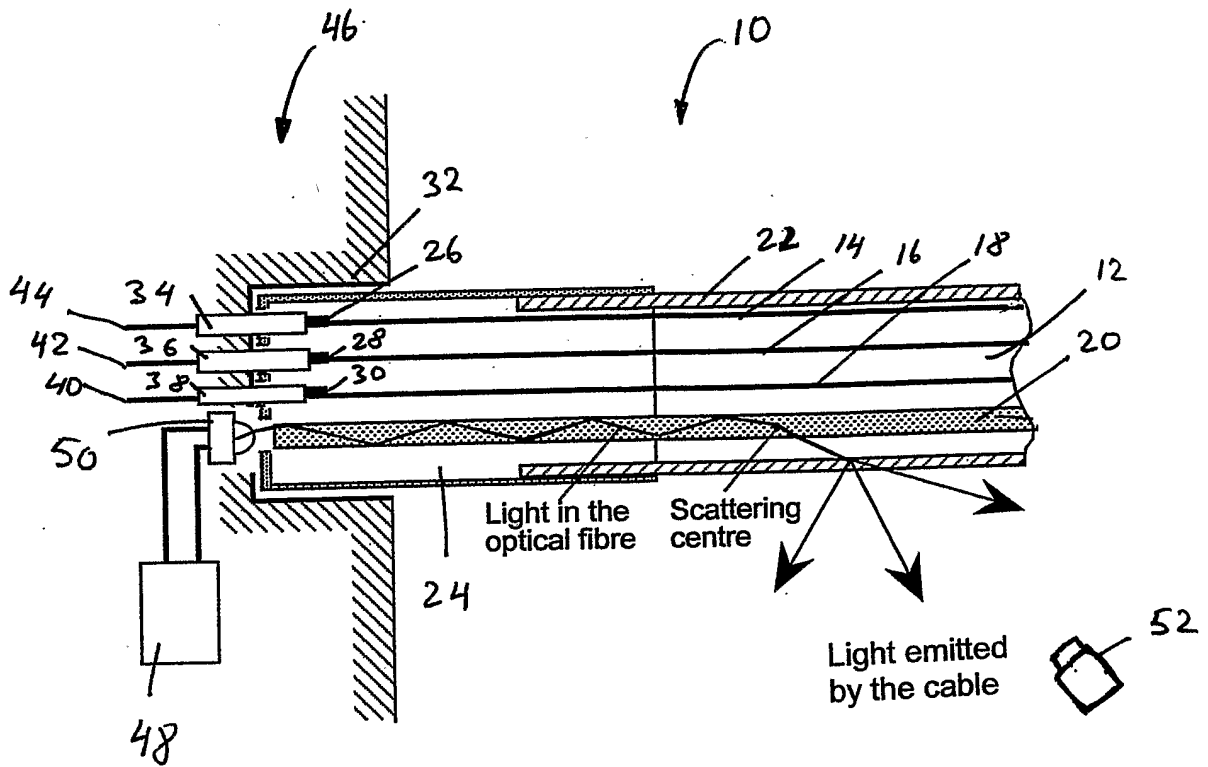


FIG. 1

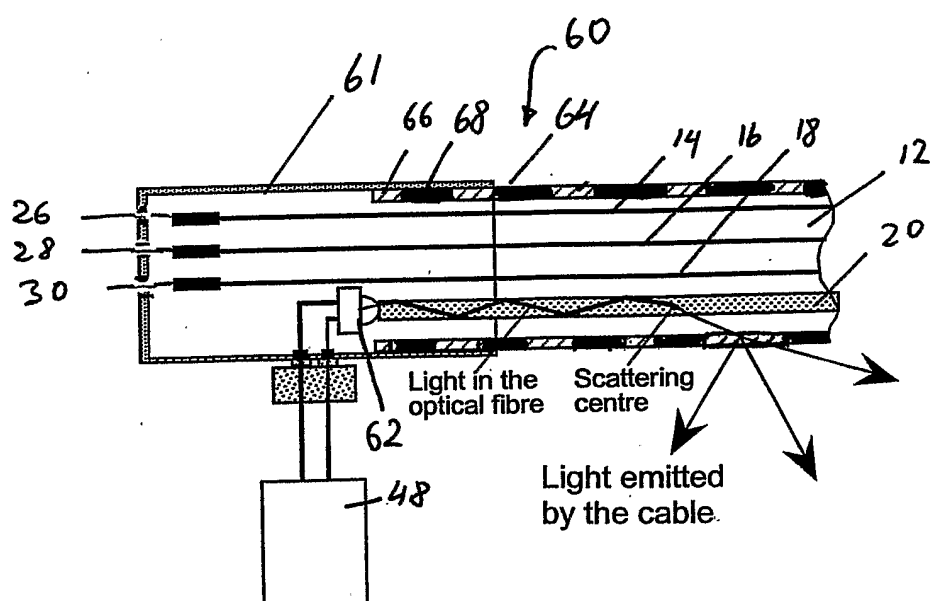


FIG. 2

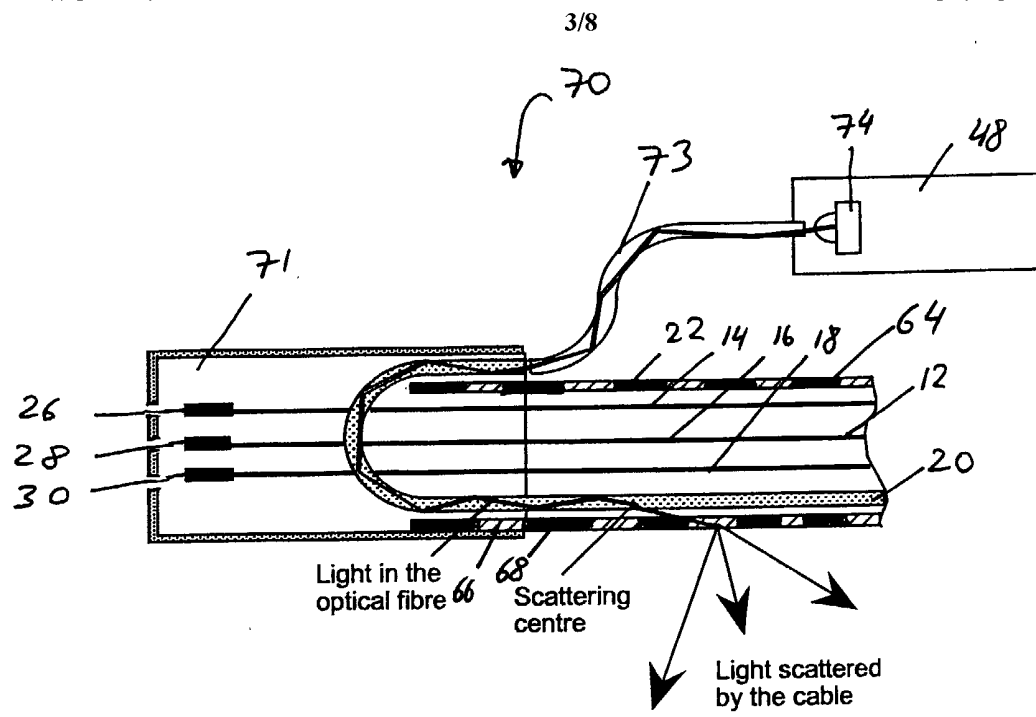


FIG. 3

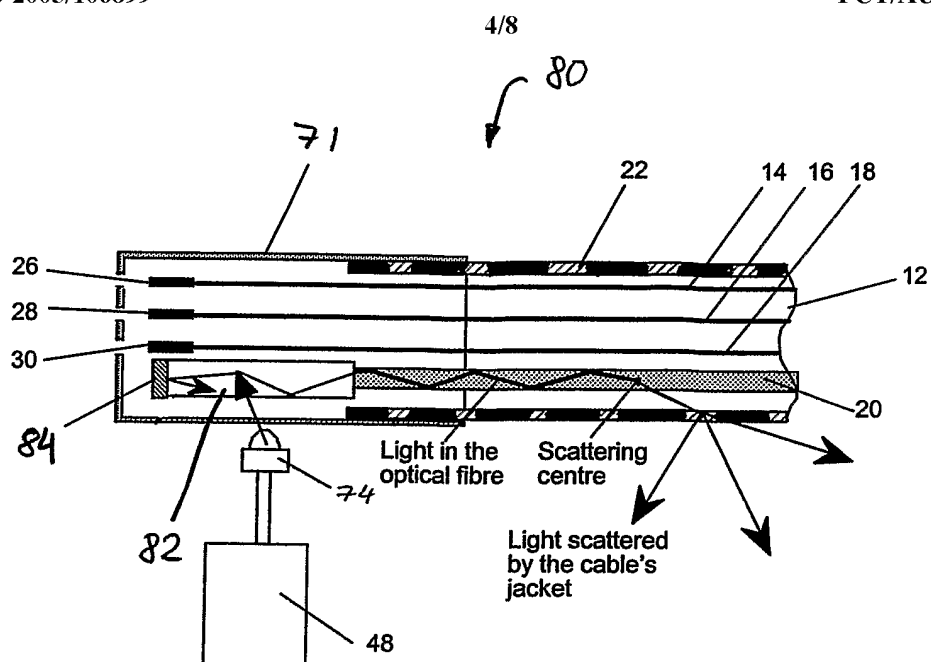


FIG. 4

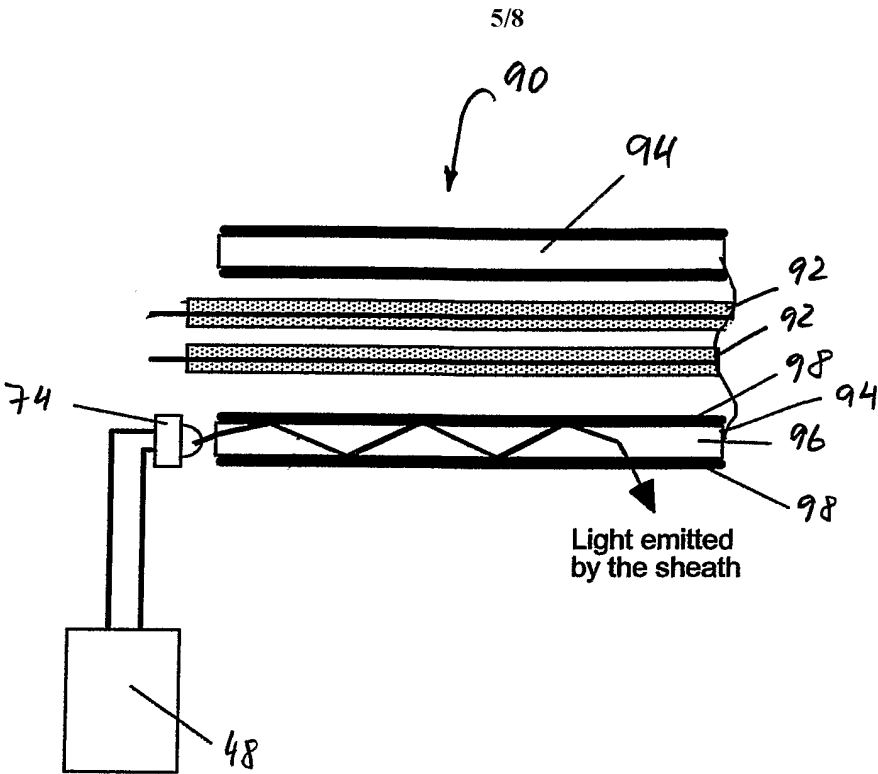


FIG. 5

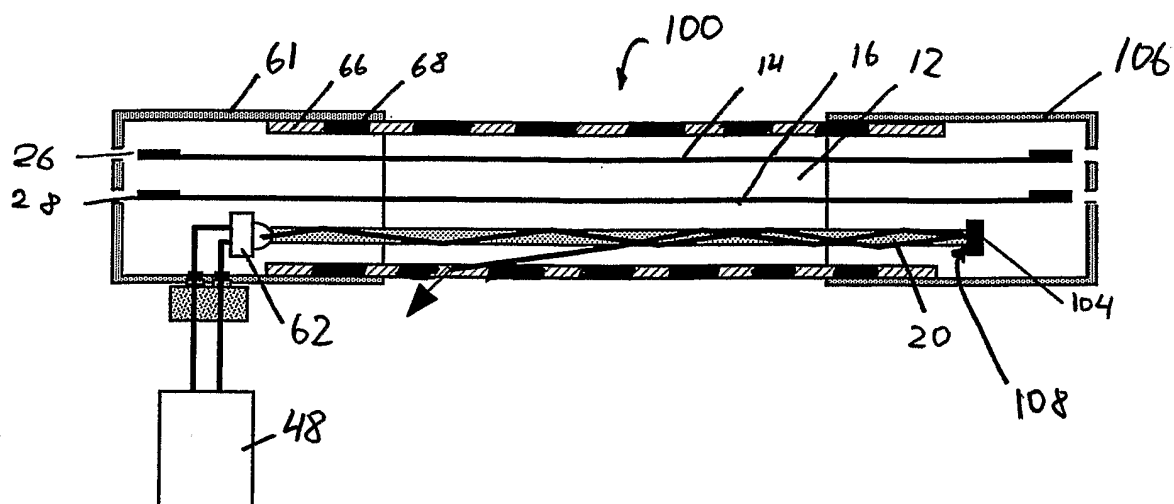


FIG. 6

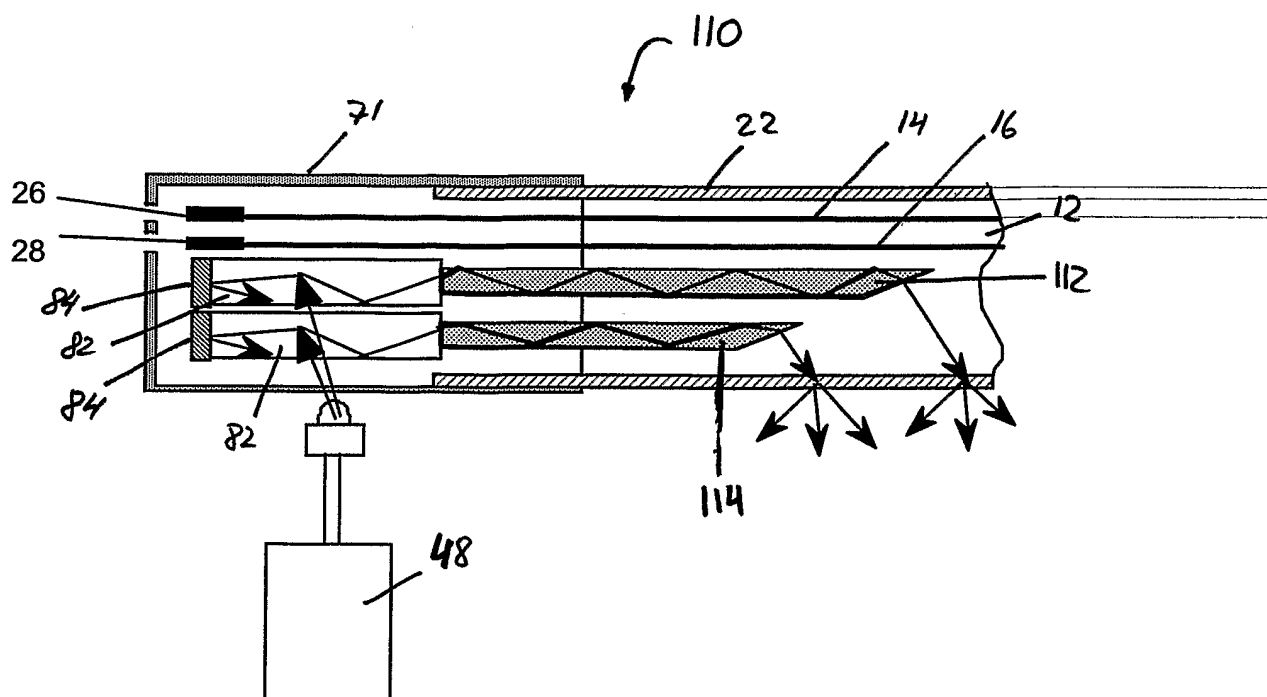


FIG. 7

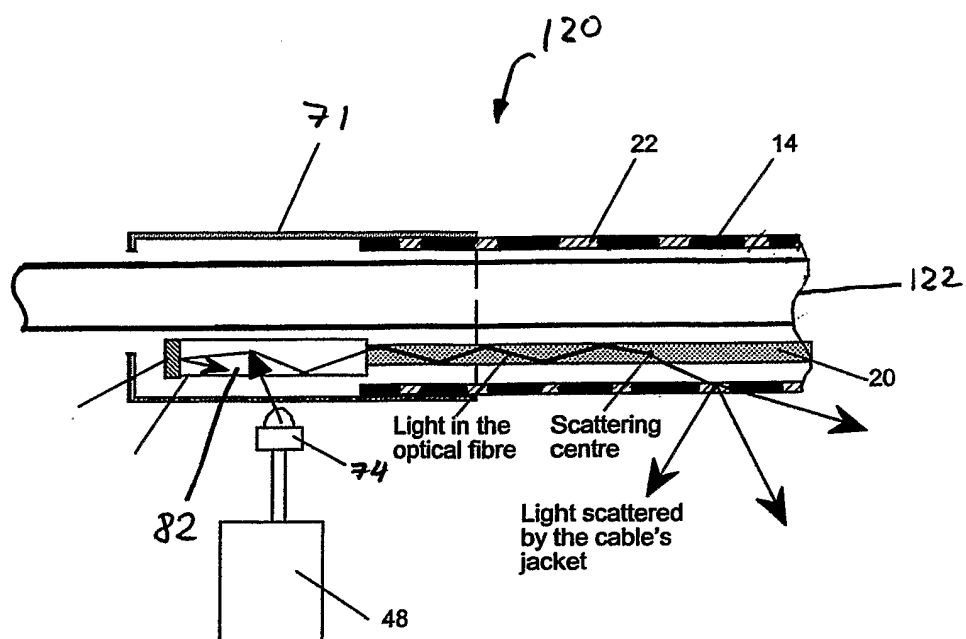


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2005/000603

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. 7: H01B 7/36, 11/22, H01R 3/00

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)

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)
DWPI and keywords (cable, optic fibre, trace, scatter and similar terms); USPTO and keywords (light guide, cable, data, break, side, trace and similar terms); Espacenet and keywords (optic, cable, fault and similar terms) and (H01R and optical)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 4413597 A1 (TKM TELEKOMMUNIKATION UND ELEKTRONIK GMBH) 26 October 1995 See English abstract and figures (claims 6, 7 and 11 are inventive step only)	1,3,5-11, 13,14,36-39
P,X	US 2004/160774 A1 (LIONETTI et al) 19 August 2004 See whole document(claims 2, 4, 6 and 16 are inventive step only)	1-11,13-16, 18,22,36-39
P,X	US 2005/052174 A1 (ANGELO et al) 10 March 2005 See abstract and figure (claims 31-35 are inventive step only)	23,24,26, 28-39

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex

* Special categories of cited documents:	
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search
29 June 2005

Date of mailing of the international search report
06 JUL 2005

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2005/000603

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 297409 B1 (PIRELLI AVI SpA) 26 October 1994 See claim 1	
A	US 5617497 A (KINGSTONE) 1 April 1997 See abstract and figure	
X	US 2003/129872 A1 (TOLMIE) 10 July 2003 See abstract and figure	23,24,26,28, 29
X	US 6688779 B2 (NISHITA) 10 February 2004 See abstract and figure	23,24,26,28, 29

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2005/000603

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

The international application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept. In coming to this conclusion the International Searching Authority has found that there are different inventions as follows:

1. Claims 1-22 and 30-39. It is considered that the combination of a transmission lead and an optical guide that emits light at an intermediate position of the transmission lead comprises a first "special technical feature".
2. Claims 23-29. It is considered that a connection device for a transmission lead and an optical light guide comprises a second special technical feature. The connection device being only suitable for the traceable transmission cable, rather than specific to it.

Since the abovementioned groups of claims do not share any of the technical features identified, a "technical relationship" between the inventions, as defined in PCT rule 13.2 does not exist. Accordingly the international application does not relate to one invention or to a single inventive concept, a priori.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2005/000603

Box No. IV Text of the Abstract (Continuation of item 5 of the first sheet)

A traceable transmission cable (12) for transmitting data or electricity.

The transmission cable comprises a transmission lead for transmitting the data or electricity and an optical light guide (20) for tracing the transmission lead. The optical light guide is positioned along a length of the transmission lead and is arranged for emission of light at at least one intermediate position along a length of the transmission cable so that the transmission cable can be traced. The present invention also comprises a connection device for connecting the transmission cable and a traceable conduit.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/AU2005/000603

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report			Patent Family Member			
DE	4413597	NONE				
US	2004160774	NONE				
US	2005052174	NONE				
EP	0297409	AR 240104	AU 16945/88	BR 8803335		
		JP 1035407	NZ 225087	US 4902096		
US	5617497	AU 33935/97	AU 69540/94	CA 2162138		
		CA 2238273	EP 0700530	EP 0865623		
		HK 1003949	US 5333228	US 5528714		
		US 5617496	US 5838860	WO 9428451		
		WO 9748997				
US	2003129872	US 6283792	US 6478625	US 6612857		
		US 6821146	US 2002006748	US 2003008560		
		US 2005032413				
US	6688779	EP 1217407	JP 2002190344	US 2002102066		
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.						
END OF ANNEX						