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(54) An Undersea Optical Fibre Telecommunications Cable and a Method and Apparatus for Manufacture Thereof

(57) An undersea optical fibre cable with a protective metal casing around the optical fibres 1. The casing includes a stranded assembly 3 of high-tensile metal wires of polygonal cross-section 3A forming an arch structure. The side (4) which is turned towards the axis of the cable is shorter than the outwardly-turned side 5, and intermediate sides 6 touch or interlock. A metal outer tube 7 is formed by skelping a tape to produce a cylinder and then welding the longitudinal edges thereof. The metal casing is filled with a liquid 4A whose density is close to that of water and whose viscosity is close to that of glycerine. The overall density of the cable is slightly higher than that of water.

FIG.1

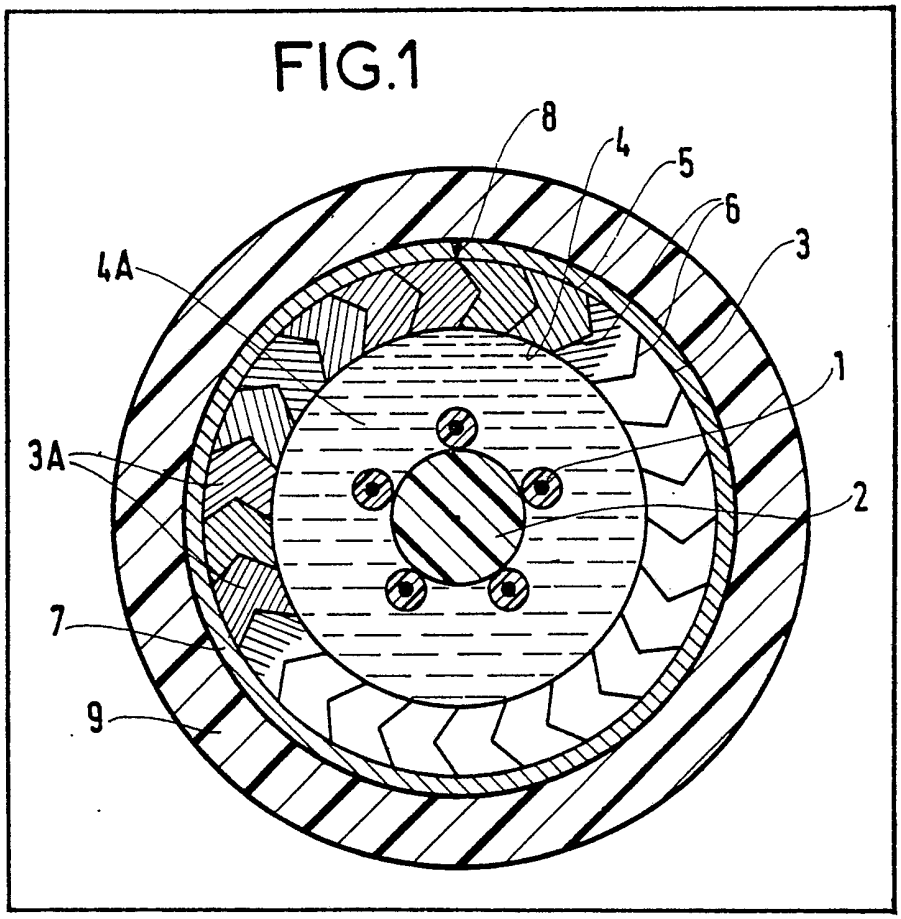

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FIG.1

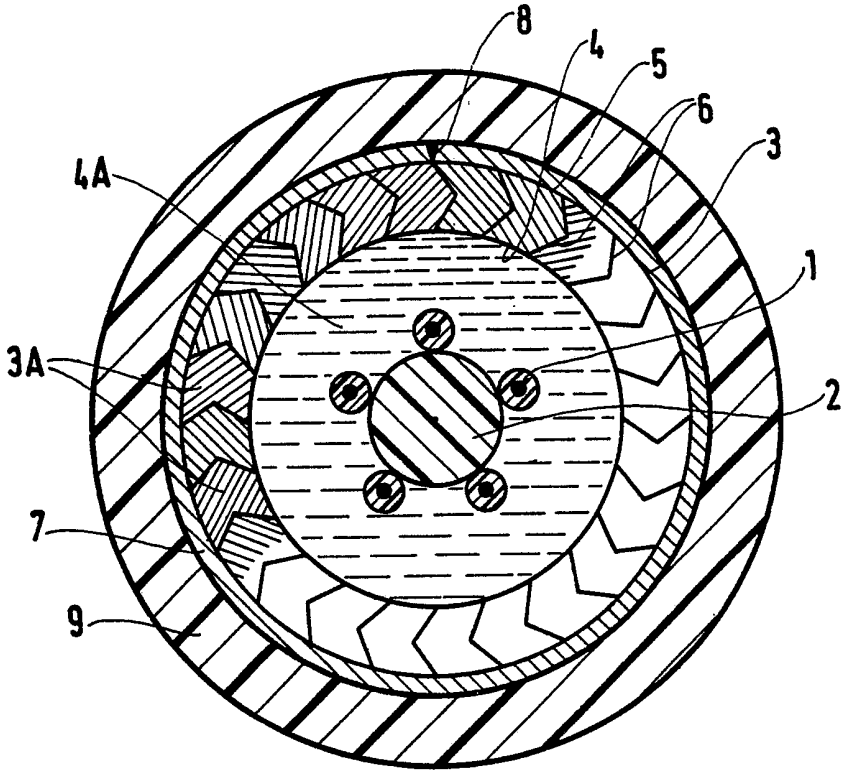


FIG.2

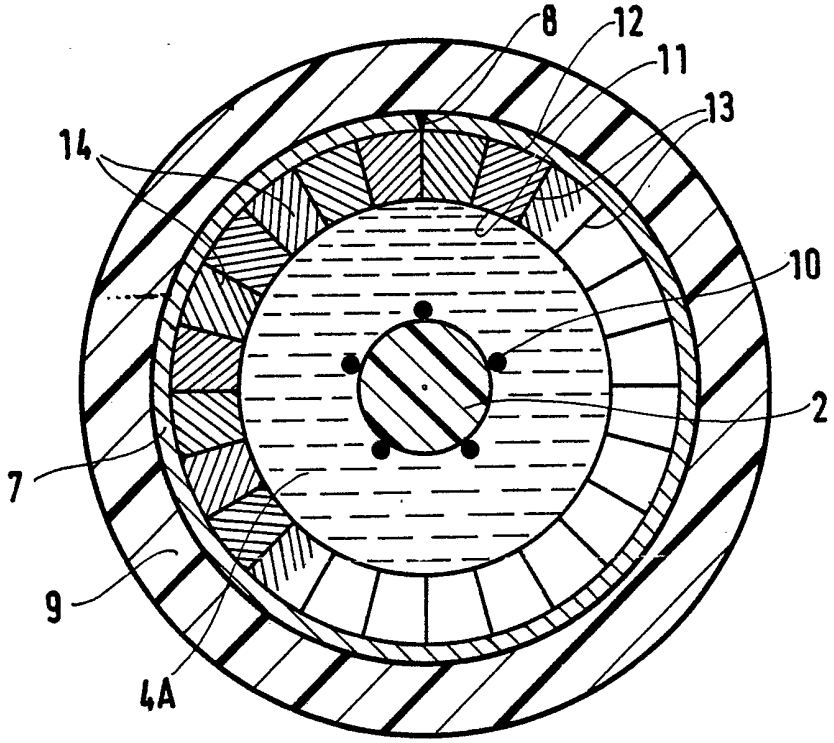
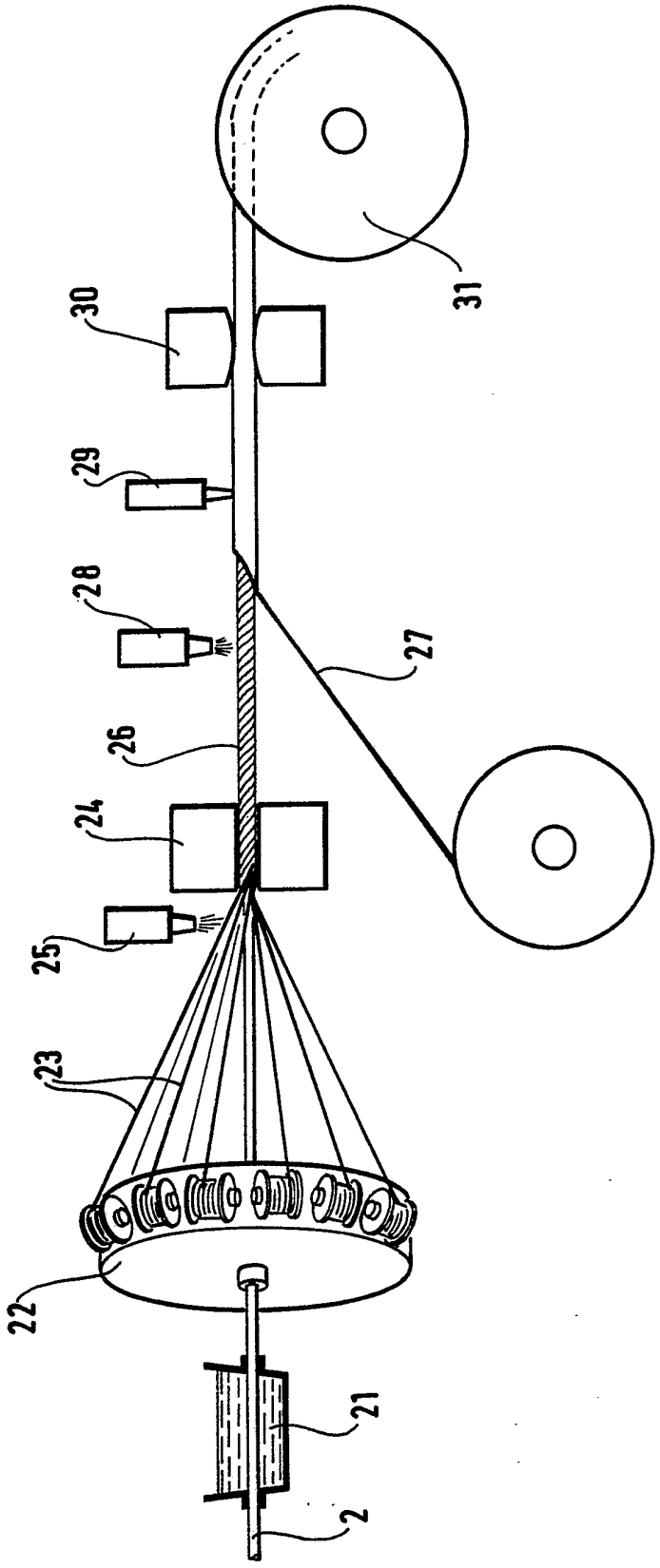


FIG.3



SPECIFICATION

An Undersea Optical Fibre Telecommunications Cable and a Method and Apparatus for Manufacture Thereof

The present invention relates to an undersea optical fibre telecommunications cable. It also relates to a method and apparatus for manufacturing such a cable.

Optical fibres made of silica or silica doped with germanium, boron or phosphorus in particular provide a very attractive means of long-distance transmission of telephone and television data because they have low attenuation for short-wave infrared radiation (800 to 1300 nanometres). Therefore, it would have been desirable to use them for undersea links if, up till now, no obstacles had cropped up. In particular, fibres are very sensitive to the combined effects of moisture and pressure which prevail at great depths, and to mechanical stresses which further weaken them by microcurves or even the pure and simple breakage of the fibres under a relatively low tractive force. Further, for long distances, it is necessary to place repeaters at intervals along the line. This requires the use of remote-supply electric conductors because the fibres are not electrically conductive.

It has effectively been proposed in the past to protect optical fibres in a metal casing, but protection thus conferred is not sufficient in itself to warrant the use of optical fibres for undersea transmission.

Preferred embodiments of the invention remedy these disadvantages and provide an optical fibre undersea cable which can be sunk to great depths, has low attenuation per unit length, is sufficiently strong to withstand various laying or raising handling operations and to which metal conductors can be added.

The present invention provides in a first aspect an undersea optical fibre telecommunications cable, wherein:

the optical fibre or fibres are immersed in a liquid whose viscosity is close to that of glycerine;

the optical fibre containing liquid is housed in a casing formed by a stranded assembly of metal wires of generally polygonal cross-section, the axially directed sides of the polygonal sections being shorter than the outwardly directed sides and the intermediate sides being in contact with those of neighbouring wires to form an arch structure;

the casing is recovered with an outer metal tube formed by skelping a metal tape around the casing and welding the meeting edges of the tape; and

the density of the optical fibre containing liquid is close to that of water so that the overall density of the cable is slightly higher than that of water.

It also perferably includes at least one of the following features:

the metal wires have a substantially trapezoidal cross-section with the small bases turned towards the axis of the cable and large bases turned towards the outside of the cable;

the metal wires have interlocking V-shaped intermediate sides;

the optical fibre containing liquid is a paraffin oil, a silicone oil or a diarylalkane; and

it includes a plastics or metal axial core round which optical fibres are wound at a large pitch helix.

In a second aspect the present invention provides that a method of manufacturing an undersea optical fibre telecommunications cable wherein the optical fibres pass through a bath of a liquid whose density viscosity is close to that of glycerine and whose density is close to that of water such that the overall density of the cable is slightly higher than that of water; metal wires of high tensile strength and substantially polygonal cross-section are stranded round said fibres, said metal wires each having a side which is to be turned towards the axis of the cable, said side being shorter than that which is to be turned outwards and having identical facing intermediate surfaces, such that their intermediate surfaces press against one another to form a cylindrical inner casing; said liquid is inserted between said wires just before the wires are assembled to form said cylindrical inner casing; a metal tape is skelped around said cylindrical inner casing to form a metal outer tube whose longitudinal edges are then welded; and wherein said metal outer tube is drawn down onto said cylindrical inner casing.

In a third aspect the present invention provides apparatus for manufacturing an undersea optical fibre telecommunications cable, the apparatus including: means for supplying optical fibre; a bath of liquid whose density is close to that of water, such that the overall density of the cable is slightly higher than that of water and whose viscosity is close to that of glycerine; means for passing optical fibre through the bath; a rotating cage for stranding metal wires to form a cylindrical inner casing, a spray for spraying liquid on the metal wires just before they are assembled to form said cylindrical inner casing; means for supplying metal tape, means for skelping said tape to form a metal outer tube; means for longitudinally welding the longitudinal edges of said metal outer tube; and means for drawing said metal outer tube down onto said cylindrical inner casing.

Two optical fibre telecommunications cables in accordance with the invention and having a plastics core, together with a method of manufacture are described hereinafter by way of example and with reference to the figures of the accompanying drawings in which:

figure 1 illustrates the cross-section of a first variant of a cable;

figure 2 illustrates the cross-section of another variant of a cable; and

figure 3 illustrates apparatus for manufacturing such cables.

In figure 1, optical fibres 1, covered with a covering made of a plastics material such as a

fluorinated polymer, a polyamid, a silicone elastomer, are helically laid with a long pitch around and axial core 2 made of a plastics material, e.g. polyamid or polyethylene, the pitch of the helixes being such that the length of the optical fibres is slightly longer (by a few per cent) than the axial length, with a view to allowing them to take up the elongation due to traction forces. A casing 3 is formed from an arch of shaped steel wires 3A, having a generally polygonal cross-section. The axially directed side of the polygon is shorter than the outwardly directed side, while the intermediate sides 6 are of an interlocking V shape. The wires are cabled to constitute a rigid undeformable casing capable of withstanding externally applied pressure. The inside of the casing is filled with a liquid 4A whose density is close to that of water, whose viscosity is close to that of glycerine, and which does not chemically attack the optical fibre coverings. A paraffin oil, a silicon oil or diarylalkane, for example, constitute suitable liquids 4A.

The casing 3 made of high tensile steel wires is surrounded by a drawn copper tube 7 which has a longitudinal weld 8. The copper tube is itself surrounded by a polyolefin outer sheath 9 made, e.g. of polyethylene. The sheath 9 forms the outer covering of the cable which it protects against moisture and corrosion due to sea water.

Figure 2 illustrates the cross-section of a cable analogous to that in figure 1, but in which the optical fibres 10 are bare; further, the steel wires which form the rigid undeformable casing have trapezoidal cross-section, with their small bases 11 being turned inwards and their large bases 12 being turned outwards, the angles at the tops of the trapezia being such that their sides touch one another completely.

In figure 3, the optical fibres to be protected are wound in a helix around the axial core 2 and are optionally covered with individual coverings of plastics material. They pass with the core through a paraffin oil bath 21.

When the fibres leave the bath, they pass through the axis of a rotating cage 22 which is intended to form, around the fibres, a circle of high-tensile steel wires 23 of trapezoidal cross-section so that they press against one another during winding due to the rotation of the cage around the fibres. The wires may optionally have V-shaped indentations on those of their sides which are intended to press against one another, to cause these sides to interlock and to prevent them from slipping against one another as they are being positioned.

When the casing of steel wires is formed around the fibres to be protected, the casing is drawn a first time through a draw plate 24 whose diameter is equal to the final outer diameter of the casing, and filler liquid is sprayed by a spray 25 just before the inlet of the draw plate, with a view to lubricating the plate and to filling the inside of the fibre cable.

After the drawing operation, the casing 26 of steel wires which houses the fibres is protected by a copper, aluminium or steel tape 27 which is substantially wider than the perimeter of the casing. The tape is progressively skelped round the sheath, urged by rollers with appropriate cross-sections or by draw plates (not shown) until its edges touch, while a thin stream of liquid sprayed by a spray 28 flows to the bottom of the groove thus formed. The touching edges of the tape are then welded with an arc lamp 29 in a controlled atmosphere, or by means of a high-frequency device, then the tube thus formed is drawn down onto the casing 26 of steel wires by means of a second draw plate 30 so that it fits tightly round the casing, while the filler liquid spreads evenly inside due to the pressure exerted.

Then, before the metal tube is stored on a drum 31 or in a tank, a plasticizing machine (not shown) coats it with a polyolefin or polyvinyl chloride protective covering which keeps out moisture.

Although undersea cables and the method of installing and manufacturing them described hereinabove with reference to the figures appear to be preferable for embodying the invention, it will be understood that various modifications can be made thereto without going beyond the scope of the invention, it being possible to replace some components of the cables, some operations of the method and some devices of the equipment by others which would perform analogous technical functions. In particular, the cable can also include electrical conductors. The optical fibres could be immersed in the liquid otherwise than by passing through a bath, e.g. by a spray rack for spraying the liquid.

Claims

1 An undersea optical fibre telecommunications cable, wherein:

the optical fibre or fibres are immersed in a liquid whose viscosity is close to that of glycerine;

the optical fibre containing liquid is housed in a casing formed by a stranded assembly of metal wires of generally polygonal cross-section, the axially directed sides of the polygonal sections being shorter than the outwardly directed sides and the intermediate sides being in contact with those of neighbouring wires to form an arch structure:

the casing is covered with an outer metal tube formed by skelping a metal tape around the casing and welding the meeting edges of the tape; and

the density of the optical fibre containing liquid is close to that of water so that the overall density of the cable is slightly higher than that of water.

2. A cable according to claim 1, wherein the metal wires have a substantially trapezoidal cross-section with the small bases turned towards the axis of the cable and large bases turned towards the outside of the cable.

3. A cable according to claim 1, wherein the metal wires have interlocking V-shaped intermediate sides.

4. A cable according to any one of claims 1 to 3, wherein said liquid is a paraffin oil, a silicone oil or a diarylalkane.

5. A cable according to any one of claims 1 to 4, including a plastics or metal axial core round which optical fibres are wound at a large pitch helix.

6. An undersea optical fibre telecommunications cable substantially as herein described with reference to and as illustrated in figure 1 or figure 2 of the accompanying drawings.

7. A method of manufacturing an undersea optical fibre telecommunications cable according to any preceding claim, wherein: the optical fibres pass through a bath of a liquid whose viscosity is close to that of glycerine and whose density is close to that of water such that the overall density of the cable is slightly higher than that of water; metal wires of high tensile strength and substantially polygonal cross-section are stranded round said fibres, said metal wires each having a side which is to be turned towards the axis of the cable, said side being shorter than that which is to be turned outwards and having identical facing intermediate surfaces, such that their intermediate surfaces press against one another to form a cylindrical inner casing; said liquid is inserted between said wires just before the wires are assembled to form said cylindrical inner casing; a metal tape is skelped around said cylindrical inner casing to form a metal outer tube whose longitudinal edges are then welded; and said metal outer tube is drawn down onto said cylindrical inner casing.

8. A method according to claim 7, wherein said liquid whose density is close to that of water and whose viscosity is close to that of glycerine is inserted in the already partially skelped metal tape but before said metal tape is completely closed to form an outer tube around said inner casing.

9. A manufacturing method according to claim 7 or 8, wherein the optical fibres are wound at a large pitch helix around a plastics or metal axial core before passing through the bath of a liquid whose density is close to that of water and whose viscosity is close to that of glycerine.

10. A method of manufacturing an undersea optical fibre telecommunications cable substantially as herein described with reference to figure 3 of the accompanying drawings.

11. Apparatus for manufacturing an undersea optical fibre telecommunications cable according to the method of claim 7, 8, 9 or 10, the apparatus including means for supplying optical fibre; a bath of liquid whose viscosity is close to that of glycerine and whose density is close to that of water, such that the overall density of the cable is slightly higher than that of water; means for passing optical fibre through the bath; a rotating cage for stranding metal wires to form a cylindrical inner casing; a spray for spraying liquid on the wires just before they are assembled to form said cylindrical inner casing; means for supplying metal tape; means for skelping said tape to form a metal outer tube; means for longitudinally welding the longitudinal edges of said metal outer tube; and means for drawing said metal outer tube down onto said cylindrical inner casing.

12. Apparatus for manufacturing an undersea optical fibre telecommunications cable according to claim 11, further including means for inserting said liquid whose density is close to that of water and whose viscosity is close to that of glycerine into the already partially skelped metal tape, but before it is completely closed to form a metal outer tube round said inner sheath.

13. Apparatus for manufacturing an undersea optical fibre telecommunications cable according to claim 11 or 12, further including means for winding the optical fibres at a large pitch helix around a plastics or metal axial core before passing them through the bath of the liquid whose density is close to that of water and whose viscosity is close to that of glycerine.

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