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Submarine communications cable, and method and device for the production thereof

Description

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The invention relates to a submarine communications cable according to the preamble of Claim 1. The invention further relates to a method for producing a submarine communications cable according to the preamble of Claim 6.

10 Submarine communications cables have a core comprising optical fibres surrounded by a copper tube. This core is surrounded by armouring in order to increase its tensile and compressive strength, said armouring being formed from stranded steel wires, for example. The armouring is held together by a wrapping, for example a jacket layer, which is formed from a copper tube in the case of
15 submarine communications cables known from WO 2007/022117 A2. Said copper tube serves simultaneously as an electrical conductor. Finally, the external copper tube is surrounded by an external insulation.

One significant disadvantage of the known submarine communications cable
20 described above is posed by the outer copper tube of the jacket layer surrounding the armouring formed from steel wires. The production of the copper tube, and also the embedding of the cable core with the steel wires of the armouring surrounding it, is highly complex. In addition, the material costs of the outer copper tube make submarine communications cables more expensive. Finally, the
25 outer copper tube reduces the flexibility of the submarine communications cable known in the art.

The problem addressed by the invention is that of creating a relatively inexpensive submarine communications cable and also a method for the simple
30 and cost-effective production of same.

A submarine communications cable for solving the problem referred to above has the features of Claim 1. According to this, the jacket layer is formed from a

wrapped layer made of at least one thin, flexible band. The wrapped layer made of at least one thin, flexible band also increases the flexibility of the submarine communications cable. A wrapped layer of this kind can easily be formed and can be made of an inexpensive material, for example plastic, rubber or another elastomer. In this way, the cost-intensive production of a copper tube forming this layer can be dispensed with and material which is economical by comparison with copper can be used.

The wrapped layer made of at least one thin, flexible and/or elastic strip-like and/or flat band, which is also referred to as tape, can easily be wrapped around the armouring in order to stabilize it before the external insulation layer is applied. Serving as an electrical conductor are at least predominantly the tube which surrounds the optical fibres and comprises an electrically conductive material, preferably copper, and/or conductive strands of the armouring.

It is further provided that the at least one thin, strip-like and/or flat band should be formed by an at least slightly conductive, preferably semi-conducting, plastic, or a comparable material, such as rubber or an elastomer. Due to the at least slightly conductive band, the wrapped layer formed therefrom constitutes an additional conductor or an additional electrically conductive layer with a conductivity which exceeds that of the electrical insulation materials. As a result, the at least one band and the wrapped layer formed therefrom contribute to electrical field equalization, preferably for the elimination of electrical point effects.

It is conceivable for the plastic, or a comparable material, for forming the at least one band to be self-bonding. The plastic material, or similar, preferably has cold self-bonding properties or has an adhesive layer on at least one side. On account of this, the wrapped layer arranged around the armouring forms a continuously bonded or vulcanized, liquid-tight jacket layer which surrounds the armouring in the manner of a tube, thereby fixing and/or holding it together.

According to a preferred embodiment of the at least one thin band, it is provided that this can be formed from a material, preferably plastic, which expands, swells

and/or inflates, particularly following the formation of the wrapped layer. It is thereby ensured that preferably all cavities enclosed by the wrapped layer, in particular interstices between the braided wires of the armouring, are filled out by the material of the wrapped layer or the jacket layer. In this way, cavities under the wrapped layer in which liquids may be able to collect are avoided. This is particularly important in the case of submarine communications cables laid under water.

According to an advantageous development of the submarine communications cable, the at least one flat and thin, strip-like band is wrapped around the armouring in a helical manner. In this way, a self-contained jacket layer can be formed easily and reliably. The at least one band is preferably wrapped around the armouring with elastic pre-tensioning. The individual wires or strands of the armouring are held together in a particularly secure manner as a result. Particularly in the case of the braided wires of the armouring, this prevents the wires from springing open before the external insulation is applied. Moreover, the flexible elastic band can mould around the wires or strands which form the armouring as a result of the pre-tensioning, in particular it can enter the interstices between adjacent wires or strands.

A possible development of the submarine communications cable provides for the forming of the wrapped layer from multiple layers, preferably multiple layers wrapped around the armouring. If two, or more than two, thin, flexible bands are wrapped around the armouring in a helical manner, a seamless wrapped layer can be formed that is particularly reliable. This wrapped layer then produces a completely closed sleeve-like or tubular jacket layer. In particular, the jacket layer formed in this way is flexible.

In the case of an advantageously configured submarine communications cable, the armouring is formed from multiple tensile elements arranged in a ring-like manner around the tube. The tensile elements may be arranged around the tube in one or more layers. The tensile elements are used to absorb tensile forces exerted on the submarine communications cable, so that they do not have to be absorbed

by other components of the submarine communications cable, in particular the tube around the optical conductors arranged therein. The tensile elements are preferably arranged around the tube in a stranded manner. The tensile elements can be strands or wires which are preferably identical to one another. The strands
5 or wires preferably have round cross sections. However, other cross-sectional forms and/or profiles of the tensile elements are also conceivable. The wires are preferably steel wires, for example steel wires made of stainless steel. These are capable of absorbing high tensile forces. But instead of the steel wires, any profiled strands made of other tensile materials, in particular high-tensile,
10 materials, can be provided, for example carbon fibre or glass fibre, aluminium, copper or similar. Strands made of high-tensile glass and/or carbon fibres are considered due to their high tensile strength and low elongation, if the armouring has to be non-conductive or only slightly conductive.

15 A method for solving the problem referred to above comprises the measures set out in Claim 6. According to this, the jacket layer is produced by wrapping at least one thin and/or flexible, in particular narrow, flat band around the armouring. The band is preferably also elastically expandable and compressible. A jacket layer of this kind can be formed more easily and cost-effectively than one made
20 of copper, in particular a copper tube.

It is also provided that the at least one thin band is wrapped around the armouring under tension and/or while elastically stretched. This ensures reliable fixing of the armouring which is particularly important in the case of armourings made of
25 stranded wires. In this case, the at least one band wrapped around the wires under tension and/or elastically stretched provides for the creation of a wrapped or jacket layer which is configured in the manner of a shrink tubing and has the properties of a shrink tubing. In this way, the wires or also the strands are compressed to form the armouring, thereby effectively preventing them from
30 being displaced or springing out of place.

A further possible advantageous embodiment of the method provides that the at least one strip-like thin band is wrapped around the armouring in a helical manner.

This can take place according to the winding principle. The armouring of the wrapped and jacket layer, which comprises multiple preferably braided armouring strands, can then be formed from the at least one band immediately following production of the armouring.

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Particularly preferable is a method that provides for the at least one band being wrapped around the armouring such that marginal regions of adjacent windings and/or of bands lying on top of one another overlap. In this way, a closed jacket layer or wrapped layer is created. If, alternatively or additionally, the overlapping marginal regions of the, or of each respective, band bond of their own accord when being wrapped around the armouring, a full-surface, liquid-tight, closed jacket layer or wrapped layer is created in a particularly reliable manner in the manner of shrink tubing.

15 A possible development of the method provides that the at least one band swells following the formation of the jacket layer or wrapped layer. The swelling of the at least one band forming the jacket layer or wrapped layer preferably only begins when the jacket layer or wrapped layer formed by the at least one band has been provided with the external insulation. It is also conceivable for the swelling of the at least one band to be started only when it comes into contact with liquid or moisture, or for the swelling of the band to be caused by moisture. The material of the at least one swelling band is then pressed onto the armouring which it surrounds. Above all when the armouring is made of round wires with interstices between adjacent wires, these interstices are closed, preferably completely but at least approximately, by the swelling material of the at least one band, thereby preventing cavities within the submarine communications cable.

Preferred exemplary embodiments of the invention are explained in greater detail below with the help of the drawing, in which:

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Fig. 1 shows a cross section through a submarine communications cable,

- Fig. 2 shows a greatly enlarged longitudinal section through a short section of a wrapped layer forming a jacket layer around the armouring;
- 5 Fig. 3 shows an alternative exemplary embodiment of the wrapped layer in a view analogous to Fig 2,
- Fig. 4 shows a schematic side view of a device in the region of a facility for the production of the wrapped layer surrounding the armouring,
- 10 Fig. 5 shows a plan view of the device in Fig. 4,
- Fig. 6 shows a schematic side view of a device for the production of a wrapped layer surrounding the armouring according to an alternative exemplary embodiment which is not part of the invention and
- 15 Fig. 7 shows a plan view of the device in Fig. 6.
- 20 Fig. 1 shows a cross section through a cable designed as a submarine communications cable. This submarine communications cable has multiple optical conductors 10 which are light-wave cables or fibre optic cables. The optical conductors 10 are housed loosely or in bundles – preferably with oversize – in an electrically conductive tube 11. In the submarine communications cable shown,
- 25 which is preferably installed between amplifiers, the electrically conductive tube 11 is used to supply power to the amplifier, which is why the submarine communications cable shown is also used as a submarine communications cable repeater. The optical conductors 10 lie either loosely in the slightly larger electrically conductive tube 11 or are located in a gel-like filling of the
- 30 electrically conductive tube 11. In this case, the gel-like filling at least partially fills up the interior 12 of the electrically conducting tube 11. The electrically conductive tube 11 is preferably formed from copper, but may also be made of another electrically conductive material, for example aluminium. The tube 11

with the optical conductors 11 contained therein creates a core of the submarine communications cable.

The electrically conductive tube 11 is surrounded on the outside by an armouring.
5 The armouring serves to stabilize the submarine communications cable and to protect the electrically conductive tube 11 which forms the core. For this purpose, the armouring has a tension-proof and/or compression-proof design. The armouring in the exemplary embodiment shown is formed from multiple cylindrical strands 13 having the same diameter between 0.1 mm and 5 mm and
10 also a tensile strength of at least 500 N/mm². The strands 13 are preferably steel wires. These may be solid steel wires, but many thin steel strands can also be braided to create the strand 13. The individual strands 13 lie tightly together, in other words virtually without a gap, around the tube 11. The strands 13 are preferably braided around the tube 11.

15 In the exemplary embodiment shown, the armouring surrounding the electrically conductive tube 11 is formed from only one layer of strands 13 arranged closely to one another, preferably braided. However, it is also conceivable for the armouring to be formed from strands 13 arranged in multiple layers. It is also
20 conceivable for the armouring to be formed not from cylindrical strands 13, but instead from strands having a different cross section, for example a rectangular or elliptical cross section, or even profiled strands.

The armouring is surrounded by a jacket layer. According to the invention, the
25 jacket layer is designed as a wrapped layer 14. The wrapped layer 14 is formed from at least one thin and flexible, strip-like and/or flat band 15. A band 15 of this kind is flexible and therefore constitutes a tape. The at least one band 15 is wrapped around the strands 13 in a helical and/or spiral manner to form the wrapped layer 14 surrounding the armouring. According to Fig. 2, the at least one
30 band 15 can be wrapped around the armouring in one layer, wherein narrow opposing marginal regions of adjacent turns of the band 15 overlap to form overlapping regions 16. In this way, the wrapped layer 14 created by the wrapped band 15 forms a self-contained tube around the strands 13 of the armouring.

According to Fig. 3, the wrapped layer 14 has a double-layer design. This double wrapped layer 14 is preferably formed from the band 15 and a second band 17. The second band 17 corresponds to the first band 15 and is preferably exactly the same size. The band 15 forms the first inner layer and the band 17 the second outer layer of the overall double wrapped layer 14.

It is also conceivable for the single wrapped layer 14 in Fig. 2 to be formed from two bands 15 and 17. The bands 15 and 17 are then wrapped alternately alongside one another to create the wrapped layer 14 around the armouring, such that one turn of the band 15 is followed by a turn of the band 17, and the turn of the band 17 is again followed by a turn of the band 15.

The band 15 or else the bands 15 and 17 are formed from a thin, pliable, flexible and/or elastic material which is stretchable or contractible material. The band 15 and/or 17 is therefore designed in the manner of a tape. The material to be considered for the band 15 and/or 17 is a semi-conductive, preferably slightly conductive, material, for example plastic, rubber or another elastomer. The thickness of the band 15 or 17 is less than 1 mm. In particular, the thickness of the band 15 or 17 is in the range between 0.5 mm and 0.01 mm. A thickness range of between 0.35 mm and 0.1 mm is particularly preferable. The tensile or compressive strength of the band 15 or 17 is greater than 5 N/cm, in particular greater than 20 N/cm.

It is also conceivable for the band 15 or 17 to be designed as a thin fabric band made of plastic with reinforcing fibres, in particular plastic fibres used as the reinforcement.

In the embodiment of the submarine communications cable, the wrapped layer 14 is formed from a semi-conductive band 15 and/or 17. This is preferably created by making the plastic or other elastomers, which are not inherently conductive, partially conductive, in order to create the band 15 and/or 17. For example, the plastic can be made conductive through the addition of carbon which can be

carbon black. The conductivity of a band 15 and/or 17 of this kind is greater than that of electrical insulation materials.

5 The wrapped layer 14 of the submarine communications cable is surrounded by a preferably water-tight insulation 18. In the case of the submarine communications cable shown in Fig. 1, the insulation 18 has a three-layer design, namely being made of an inner layer 19 surrounding the wrapped layer 14, a middle layer 20 and an outer layer 21. All three layers 19, 20 and 21 of the insulation 18 are preferably made of plastic, wherein the individual layers 19, 20 and 21 are
10 extruded. Even if all three layers 19, 20 and 21 are made of plastic, the individual layers 19, 20 and 21 can be made of different plastics and/or plastics with different properties. The wall thickness of the overall insulation 18, in other words, the combined thickness of all three layers 19, 20 and 21, can vary greatly according to the requirements, in particular ranging between 0.05 mm and 10 mm.
15 Insulation 18 made of fewer than three layers would also be conceivable.

In the case of the submarine communications cable depicted in Fig. 1 with armouring made of cylindrical strands 13, between adjacent strands 13 and the outer diameter of the tube 11, small, roughly triangular-shaped interstices 22 are
20 formed and between the strands 13 and the wrapped layer 14 surrounding all strands 13, slightly larger and also roughly triangular-shaped interstices 23. In order to avoid cavities, it is provided in the case of submarine communications cables that the interstices 22 and 23 should be filled at least for the most part. The interstices 22 are filled, for example, by wrapped or continuous, swelling threads,
25 in particular plastic threads, when the strands 13 are placed around the tube 11. The outer interstices 23 are filled through the formation of the bands 15 and/or 17 from a swelling plastic and, if necessary, additional swelling threads, or similar. Due to the presence of polymers in the plastic, the bands 15 and/or 17 are provided with swelling properties. The polymers form so-called super-absorber
30 particles which, when viewed microscopically, are fissured and/or porous. In this way, channels are produced in the direction of the particle cores which have capillary properties and thereby take up moisture or liquid, as a result of which the bands 15 and/or 17 swell up. The swelling plastic of the bands 15 and/or 17

leads to the outer interstices 23 between adjacent strands 13 of the armouring being filled after the wrapped layer 14 has been produced, in particular following the subsequent applications of the external insulation 18.

5 In the overlapping regions 16, the overlapping marginal regions of adjacent turns of the bands 15 and/or 17, due to the elastic pre-tensioning of the bands 15 and/or 17, for example, during the wrapping of the strands 13 of the armouring, are elastically pre-tensioned and pressed onto one another so firmly that the wrapped layer 14 is, or becomes, impervious to liquid. In principle, the wrapped layer 14
10 then surrounds the strands 13 of the armouring like a shrink tubing. However, it is also conceivable for at least one side of each band 15 and/or 17 to be provided with an adhesive layer, so that the overlapping marginal regions of adjacent turns of the band 15 and/or 17 are bonded to one another in a liquid-tight manner in the overlapping regions 16. Alternatively or in addition, it is conceivable for the band
15 15 and/or 17 to be provided with cold self-bonding properties, so that the marginal regions lying above one another in the overlapping regions 16 of adjacent turns of the band 15 and/or 17 bond to each other of their own accord, particularly during the wrapping of the strands 13 with elastic pre-tensioning, or are even bonded to one another by vulcanization, and the overlapping regions 16
20 between adjacent turns of the bands 15 and/or 17 thereby become liquid-tight.

The wrapped layer 14 formed from flexible thin bands 15 and/or 17 thereby assumes the task of holding together the strands 13 of the armouring during the production process, which in the case of conventional submarine communications
25 cables is assumed by a jacket layer made of copper. Moreover, at least slightly conductive bands 15 and/or 17 lead to field-smoothing by the wrapped layer 14. The remaining functions of the copper material replaced by the bands 15 and/or 17 for forming the jacket layer, in particular the electrical conductivity and the formation of a hydrogen barrier, are assumed by the tube 11 made of copper or
30 another conductive material which surrounds the optical conductors 10. The submarine communications cable having a jacket layer formed from the band 15 and/or 17 as the wrapped layer 14 exhibits comparable properties to a submarine communications cable having a jacket layer formed from copper. In addition, the

wrapped layer 14 comprising the band 15 or bands 15 and 17 is also more flexible and cost-effective and can be produced more easily.

5 Figs. 4 to 7 show schematically portions of various devices for the production of the previously described submarine communications cable which are not part of the invention.

10 Figs. 4 and 5 show a facility for producing the wrapped layer 14 from a single band 15. The submarine communications cable being produced is drawn through the device in the production direction indicated by an arrow 24 and the tube 11 with the optical conductors 10, the armouring comprising the strands 13 wrapped around the tube 11, the wrapped layer 14 and the external insulation 18 are produced step by step.

15 Figs. 4 and 5 show the partially completed submarine communications cable following the completed braiding of the armouring formed from a bundle of strands 13 taking place in a stranding machine which is not shown. There follows on the braiding machine, viewed in the production direction 24, a supply reel 26 of a facility for the production of the wrapped layer 14. The ring-like supply reel 26 is arranged around the submarine communications cable which is being produced so that a horizontal rotational axis of the supply reel 26 lies on a longitudinal centre axis 27 of the submarine communications cable being produced. A supply of the thin, flexible band 15 is wound on the supply reel 26. Alongside the supply reel 26 in the radial direction is arranged an obliquely directed deflection comprising a preferably freely rotatable roller 28. The roller 28 is connected to the supply reel 26, so that the supply reel 26 and the roller 28 form a unit. The roller 28 is directed obliquely in such a manner that the band 15 drawn off the supply reel 26 tangentially is deflected at the roller 28 by 45°, for example, specifically such that it is wound around the armouring of the submarine communications cable downstream of the supply reel 26, as viewed in the production direction 24, at a stranding angle of 45°. Deviating from the stranding angle of 45° as shown, the stranding angle may also be larger or smaller, particularly within the range between 25° and 89°.

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The supply reel 26 with the roller 28 fastened thereto is driven in a continuously rotating manner around the longitudinal centre axis 27 of the submarine communications cable being produced. The speed of the supply reel 26 with the roller 28 is adjusted to the production speed of the submarine communications cable, in other words to the feed rate thereof in the production direction 24 as the wrapped layer 14 is applied, in such a manner that a closed wrapped layer 14 with overlapping regions 16 made up of overlapping marginal regions of the individual turns of the band 15 are produced according to the depiction in Fig. 2.

Figs. 6 and 7 show an alternative facility for production of the wrapped layer 14. The facility in this case is provided as a tangential band unwinder with two parallel supply reels 29 and 30 of the same size. The supply reel 29 holds a supply of the band 15 and the supply reel 30 a supply of the preferably identical second band 17.

The supply reels 29 and 30 are arranged on opposite sides of the longitudinal centre axis 27 of the submarine communications cable being produced. The supply reels 29 and 30 in this case lie on two parallel planes equidistant alongside the longitudinal centre axis 27. The supply reels 29 and 30 are rotatable about a common rotational axis 31. This rotational axis 31 runs perpendicularly through the longitudinal centre axis 27 of the submarine communications cable being produced, in other words, the rotational axis 31 intersects with the longitudinal centre axis 27 at right angles. Each supply reel 29 and 30 is assigned an obliquely directed roller 32, 33 in the exemplary embodiment shown. The rollers 32, 33 of the opposite supply reels 29, 30 are oriented obliquely in an anticlockwise direction, namely such that their longitudinal centre axes, viewed in the production direction 24, meet upstream of the point at which the bands 15 and 17 are wrapped onto the strands 13 of the armouring. The rollers 32 and 33 are also permanently connected to the respective supply reel 29 and 30.

The rollers 32 and 33 are just as freely rotatable about their longitudinal centre axis as the supply reels 29 and 30. The rotational axis 31 of the two supply reels 29 and 30, by contrast, can be rotatably driven by a drive unit not depicted in any

detail in Figs. 6 and 7 on a plane running perpendicularly through the longitudinal centre axis 27 of the submarine communications cable being produced. As a consequence of the rotational axis 31 of the two supply reels 29 and 30 rotating about the longitudinal centre axis 27, both bands 15 and 17 are wrapped simultaneously around the strands 13 of the armouring according to the stranding principle, and the wrapped layer 14 is produced in the process. The bands 15 and 17 run onto the armouring at diametrically opposite points, so that in the case of a single wrapped layer 14 according to the depiction in Fig. 2, a turn of the band 15 alternating with a turn of the band 17 lie alongside one another successively with a slight overlap of their marginal regions to produce the overlapping regions 16.

The facility shown in Figs. 6 and 7 with the tangential band unwinder exhibiting two supply reels 29 and 30 also allows of a double-layered formation of the wrapped layer 14, in that a first layer of the wrapped layer 14 surrounding the strands 13 is initially formed from the band 15, and this first layer of the wrapped layer 14 is subsequently wrapped by a second layer from the band 17. This then results in the double wrapped layer 14 shown in Fig. 3.

The method according to the invention for producing the wrapped layer around the strands 13 to create an armouring around the tube 11 is explained in greater detail below:

In the case of the method according to the invention, the jacket layer around the strands 13 is not formed by a copper layer, as previously, but by a single or multi-layer wrapped layer 14. This wrapped layer 14 is formed by at least one band 15, possibly also by two bands 15 and 17, or where necessary by more than two bands. The flexible and/or pliable bands 15 and/or 17 are made of a thin, flat plastic strip. The band 15 and/or 17 therefore has a film-like configuration. The film-like band 15 and/or 17 can therefore also be referred to as a tape. A band 15 and/or 17 of this kind is pliable and, above all, very flexible. The band 15 and/or 17 is wrapped around the strands 13 of the armouring by the devices depicted in Figs. 4 to 7. This wrapping of the band 15 and/or 17 around the strands 13 is executed in a helical and/or spiral manner, in that the band 15 and/or 17 is wrapped around

the strands 13 at an angle of less than 90° to the longitudinal centre axis 27 of the submarine communications cable being produced to form the armouring, for example using the winding or stranding principle. In this way, the single or double-layered wrapped layer 14 shown in Figs. 2 and 3 is produced.

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The band 15 and/or 17 is preferably wrapped tightly around the armouring under tension. This means that the wrapped layer 14 created from the band 15 and/or 17 can enclose the armouring with elastic pre-tensioning and thereby reliably hold the braided strands 13 of the armouring together in the manner of a shrink tubing.

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Moreover, the overlapping marginal regions of adjacent turns of the band 15 and/or 17 are pressed against one another in the overlapping regions 16 due to the elastic pre-tensioning when the bands 15 and/or 17 are wrapped around the strands 13, as a result of which a wrapped layer 14 is produced which is at least watertight.

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It is also conceivable for the band 15 and/or 17 to be stretched in its elastic region during the wrapping-around of the armouring, so that it holds the strands 13 together with constant pre-tensioning. The elastic stretching of the band 15 and/or 17 as it is wrapped around the strands 13 can also result in the activation of specific properties of the bands 15 or 17, for example the swelling capacity of the bands 15 and/or 17. The swelling of the bands 15, 17 in a case like this does not start until the wrapped layer 14 has been produced. In this way, the external interstices 23 between the adjacent strands 13 of the armouring can above all be reliably filled by the swelling band 15 and/or 17.

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It is also conceivable for the band 15 or 17 to acquire self-bonding, in particular cold self-bonding, properties due to the elastic stretching, thereby resulting in cold bonding, for example, or vulcanization of the overlapping marginal regions of adjacent turns of the band 15, 17 in the overlapping regions 16.

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The invention is not limited to the design of the submarine communications cables shown in Fig. 1.

List of reference numbers

	10	optical conductor
	11	tube
5	12	interior
	13	strand
	14	wrapped layer
	15	band
	16	overlapping region
10	17	band
	18	insulation
	19	inner layer
	20	middle layer
	21	outer layer
15	22	interstice
	23	interstice
	24	production direction
	26	supply reel
	27	longitudinal centre axis
20	28	roller
	29	supply reel
	30	supply reel
	31	rotational axis
	32	roller
25	33	roller

P a t e n t k r a v

- 5 **1.** Meddelelseshavkabel med optiske ledere (10), der er omgivet af et elektrisk ledende rør (11), en armering, som udvendigt omgiver røret (11), og som er omgivet af et indhylningslag og en udvendig isolering, hvor indhylningslaget er dannet af mindst et viklingslag (14) af mindst et tyndt fleksibelt og/eller elastisk strimmellignende bånd (15, 17), og **kendetegnet ved, at** det mindst ene bånd (15, 17) er dannet af et i det mindste delvist ledende kunststof eller et kunststof, som er mere ledende end et sådant til elektrisk isolering.
- 10 **2.** Meddelelseshavkabel ifølge krav 1, **kendetegnet ved, at** kunststoffet af det mindst ene bånd (15, 17) er selvklæbende, især koldt selvklæbende, og/eller kunststoffet af det mindst ene bånd (15, 17) har mindst et ensidet klæberlag.
- 15 **3.** Meddelelseshavkabel ifølge krav 1 eller 2, **kendetegnet ved, at** det mindst ene bånd (15, 17) er udformet på en udvidende og/eller opsvumlende måde.
- 20 **4.** Meddelelseshavkabel ifølge et af de foregående krav, **kendetegnet ved, at** det mindst ene tynde, strimmellignende bånd (15, 17) på en vindel- og/eller spirallignende måde med fortrinsvis elastisk forspænding er viklet rundt om armeringen, som omgiver røret (11), og/eller det mindst ene viklingslag (14) er dannet af flere lag af bånd (15, 17), som er viklet rundt om armeringen.
- 25 **5.** Meddelelseshavkabel ifølge et eller flere af de foregående krav, **kendetegnet ved, at** armeringen er dannet af flere ringlignende trækelementer, især trækfaste strenge eller tråde, som er anbragt rundt om røret (11), fortrinsvis anbragt på en strenget måde.
- 30 **6.** Fremgangsmåde til fremstilling af et meddelelseshavkabel, hvor et rør (11), som i det indre er forsynet med optiske ledere (10), forsynes med en udvendig armering, og der omkring armeringen anbringes et indhylningslag og en udvendig isolering (18), **kendetegnet ved, at** indhylningslaget fremstilles ved at vikle mindst et tyndt bånd (15, 17) rundt om armeringen ved spænding og/eller ved elastisk strækning, hvor det mindst ene bånd (15, 17) dannes af et i det

mindste delvist ledende kunststof eller et kunststof, som er mere ledende end et sådant til elektrisk isolering.

5 **7.** Fremgangsmåde ifølge krav 6, **kendetegnet ved, at** det mindst ene bånd (15, 17) føres rundt om armeringen på en vindellignende og/eller spirallignende måde, fortrinsvis i henhold til viklings- eller strengeprincippet.

10 **8.** Fremgangsmåde ifølge krav 6 eller 7, **kendetegnet ved, at** det mindst ene bånd (15, 17) vikles rundt om armeringen på en sådan måde, at kantområder af naboliggende vindinger af det mindst ene bånd (15, 17) overlapper hinanden for at danne overlappingsområder (16).

15 **9.** Fremgangsmåde ifølge et af kravene 6 til 8, **kendetegnet ved, at** flere bånd (15, 17) vikles rundt om armeringen samtidigt, fortrinsvis med samme strengevinkel og/eller overlapning af kantområderne af hvert bånd (15, 17).

20 **10.** Fremgangsmåde ifølge et af kravene 6 til 9, **kendetegnet ved, at** overlappende kantområder af det mindst ene bånd (15, 17) ved vikling rundt om armeringen danner væsketætte overlappingsområder (16) og/eller ved vikling af det mindst ene bånd (15, 17) rundt om armeringen kantområderne af naboliggende vindinger af båndet (15, 17) fastklæbes i overlappingsområdet (16), fortrinsvis automatisk.

25 **11.** Fremgangsmåde ifølge et af kravene 6 til 10, **kendetegnet ved, at** det mindst ene bånd (15, 17) svulmer op efter dannelsen af et viklingslag (14), som danner indhylningslaget, fortrinsvis viklingslaget (14) svulmer op først efter dets fremstilling og/eller efter færdiggørelsen af den udvendige isolering (18), som omgiver viklingslaget (14).

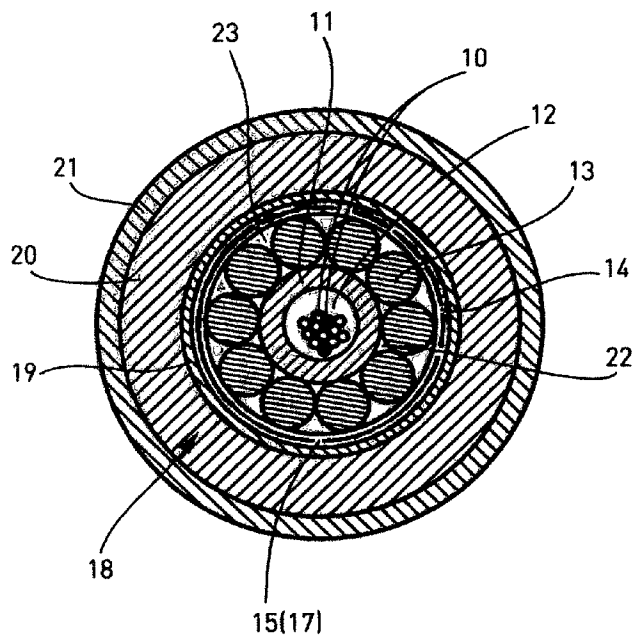


Fig. 1

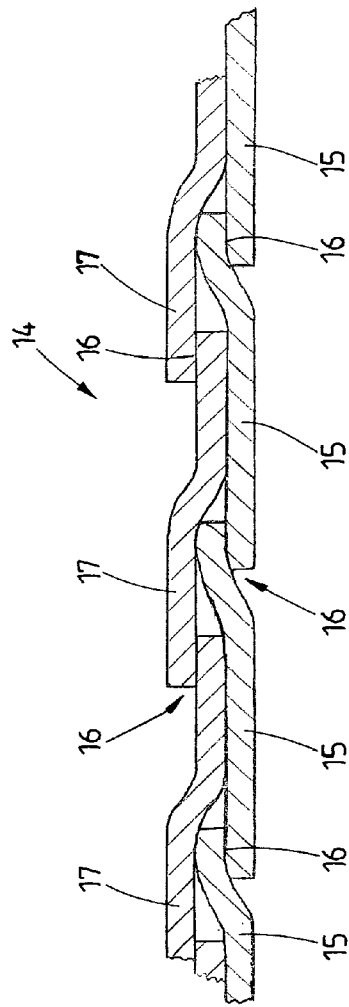


Fig. 3

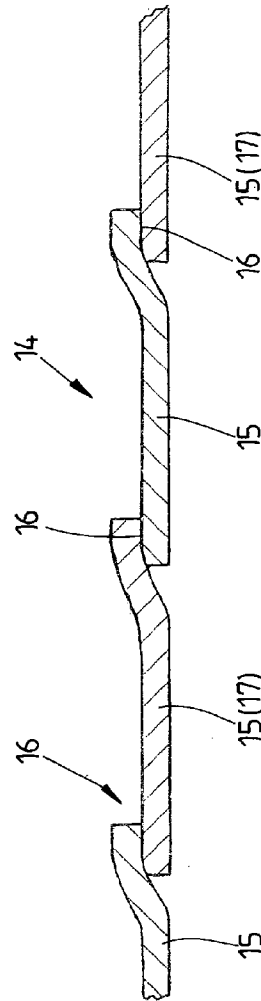


Fig. 2

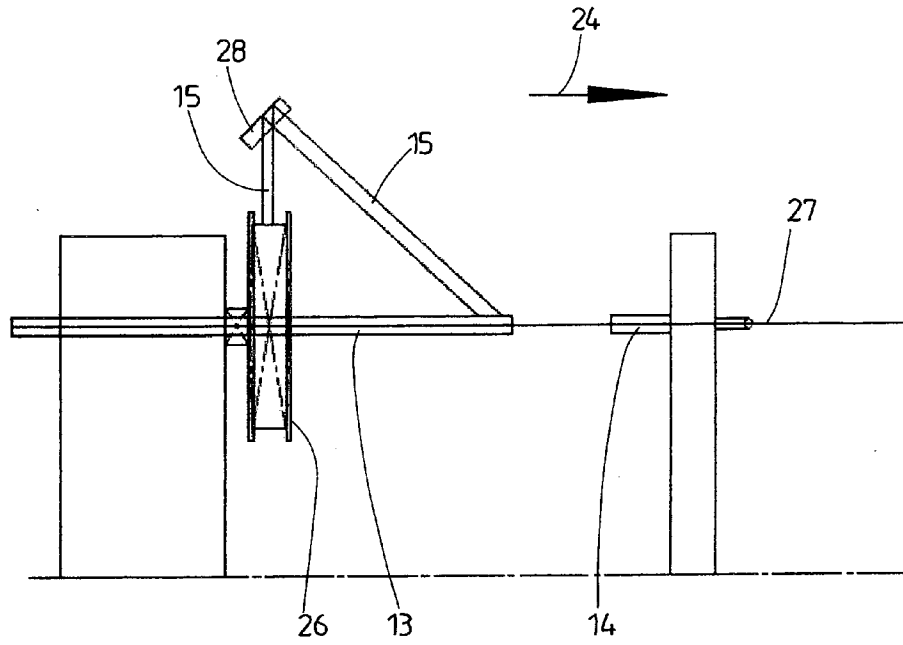


Fig. 4

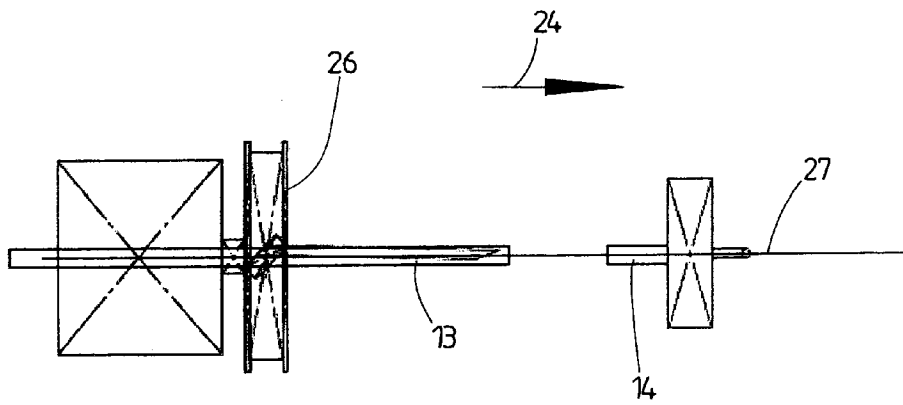


Fig. 5

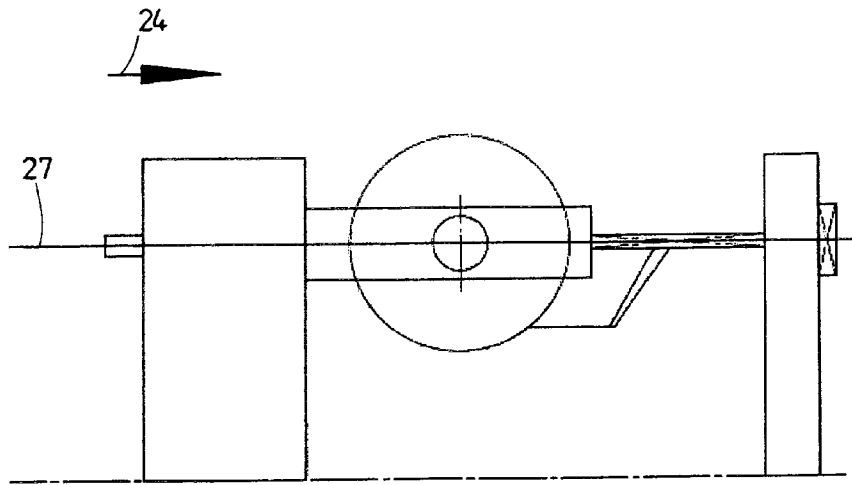


Fig. 6

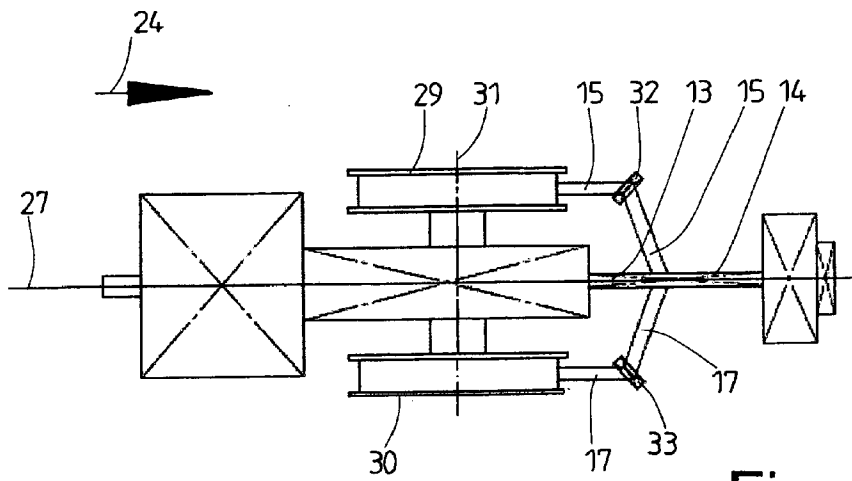


Fig. 7