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(54) **DYNAMIC AND STATIC SUBMARINE CABLE AND MANUFACTURING METHOD THEREFOR**

(57) The present invention provides a dynamic and static submarine cable and a method for manufacturing the same, relates to the field of submarine cable technologies, and is intended to solve a technical problem of a long production cycle of the dynamic and static submarine cable. The dynamic and static submarine cable includes: a continuous cable core, where the cable core includes a dynamic section, a static section and a transition section connecting the dynamic section and the static section; a first armor layer, which is sleeved outside the dynamic section, the static section and the transition section; a transition device, which is sleeved outside the first armor layer corresponding to the transition section; and a second armor layer, which is sleeved outside the first armor layer corresponding to the dynamic section,

and has a first end covering part of the transition device and welded to an outer peripheral surface of the transition device. The dynamic and static submarine cable provided by the present invention is used for conduction and communication.

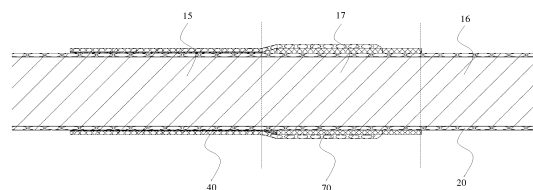


FIG. 1

Description

TECHNICAL FIELD

[0001] The present invention relates to the field of submarine cable technologies, and in particular, to a dynamic and static submarine cable and a method for manufacturing the same.

BACKGROUND

[0002] A dynamic and static submarine cable generally includes a dynamic cable and a static cable that are connected. The dynamic cable is arranged in seawater and constantly moves under the influence of environmental factors such as wind, waves and currents, etc. The static cable is buried in the seabed, and is less affected by the environmental factors, and thus no constant motion is caused. With the development and utilization of marine resources, offshore platforms such as offshore oil and gas platforms, offshore wind turbines, wave energy generators, and tidal energy generators are gradually increasing, and the demand for dynamic and static submarine cables is also gradually increasing.

[0003] Due to different working conditions, structures of the dynamic cable and the static cable are different. Taking an armor layer as an example, generally the dynamic cable is subjected to more impact and wear than the static cable, so the number of armor layers of the dynamic cable is more than that of the static cable. In the related art, the dynamic cable and the static cable are generally produced separately, and then a service joint box is used to connect the dynamic cable and the static cable to form a dynamic and static submarine cable.

[0004] However, there is a long production cycle for the above-mentioned dynamic and static submarine cable.

SUMMARY

[0005] In view of the above problem, embodiments of the present invention provide a dynamic and static submarine cable and a method for manufacturing the same, to shorten the production cycle of the dynamic and static submarine cable.

[0006] In order to achieve the above purpose, embodiments of the present invention provide the following technical solutions.

[0007] An embodiment of the present invention provides a dynamic and static submarine cable, which includes: a cable core, a first armor layer, a transition device and a second armor layer, where the cable core includes a dynamic section, a static section, and a transition section connecting the dynamic section and the static section, the dynamic section, the static section, and the transition section are of an integral structure; the first armor layer is sleeved outside the dynamic section, the static section, and the transition section; the transition

device is sleeved outside the first armor layer corresponding to the transition section; the second armor layer is sleeved outside the first armor layer corresponding to the dynamic section, and has a first end covering part of the transition device and welded to an outer peripheral surface of the transition device.

[0008] The dynamic and static submarine cable provided by the embodiments of the present invention has the following advantages:

in the dynamic and static submarine cable provided by the embodiments of the present invention, the first armor layer is sleeved outside the dynamic section, the static section, and the transition section of the cable core, and the transition device is sleeved outside the first armor layer corresponding to the transition section. The second armor layer is sleeved outside the first armor layer corresponding to the dynamic section, and the first section of the second armor layer is welded to the outer peripheral surface of the transition device. With such arrangement, transition between the armor layer of the dynamic section and the armor layer of the static section can be realized through the connection of the transition device and the second armor layer, thereby ensuring continuity of a production process of the dynamic and static submarine cable. There is no need to separately produce the dynamic cable and the static cable at a time of producing the dynamic and static submarine cable, thereby shortening the production cycle.

[0009] Embodiments of the present invention further provide a method for manufacturing a dynamic and static submarine cable, which includes:

providing a cable core, which includes a dynamic section, a static section, and a transition section connecting the dynamic section and the static section, where the dynamic section, the static section, and the transition section are of an integral structure; marking demarcation points of the dynamic section, the static section and the transition section on an outer peripheral surface of the cable core; stranding a first armor layer on an outer peripheral surface of the dynamic section, on an outer peripheral surface of the static section, and on an outer peripheral surface of the transition section; winding a metal tape around an outer peripheral surface of the first armor layer corresponding to the transition section, to form a heat transfer unit; having a welding unit sleeved on an outer peripheral surface of the heat transfer unit; stranding a second armor layer on an outer peripheral surface of the first armor layer corresponding to the dynamic section, and making a first end of the second armor layer cover part of the welding unit; and welding the first end of the second armor layer to an outer peripheral surface of the welding unit.

[0010] The method for manufacturing the dynamic and

static submarine cable provided by the embodiments of the present invention has the following advantages:
 in the method for manufacturing the dynamic and static submarine cable provided by the embodiments of the present invention, the cable core is continuously produced, and the cable core is divided into the dynamic section, the static section and the transition section by setting the demarcation points. The first armor layer is stranded on the outer peripheral surface of the dynamic section, on the outer peripheral surface of the static section, and on the outer peripheral surface of the transition section. The heat transfer unit is formed on the outer peripheral surface of the first armor layer corresponding to the transition section, and the welding unit is sleeved on the outer peripheral surface of the heat transfer unit. The second armor layer is stranded on the outer peripheral surface of the first armor layer corresponding to the dynamic section, and the first end of the second armor layer covers part of the welding unit and is welded to the outer peripheral surface of the welding unit. With such arrangement, transition between the armor layer of the dynamic section and the armor layer of the static section can be realized through the connection of the welding unit and the second armor layer, and the dynamic and static submarine cable can be produced continuously without the need to separately produce the dynamic cable and the static cable, thereby shortening the production cycle.

BRIEF DESCRIPTION OF DRAWING(S)

[0011] In order to illustrate the technical solutions in the embodiments of the present invention or in the prior art more clearly, the drawings required for describing the embodiments or the prior art will be briefly introduced below. Obviously, the accompanying drawings described below show some embodiments of the present invention, and persons of ordinary skill in the art may still derive other drawings from these accompanying drawings without creative efforts.

FIG. 1 is a cross-sectional diagram of a dynamic and static submarine cable provided by an embodiment of the present invention.

FIG. 2 is a schematic structural diagram of a transition region of a dynamic and static submarine cable provided by an embodiment of the present invention.

FIG. 3 is a schematic structural diagram of a dynamic and static submarine cable provided by an embodiment of the present invention.

FIG. 4 is a schematic structural diagram of a cable core in an embodiment of the present invention.

FIG. 5 is a schematic structural diagram of an electrical unit in an embodiment of the present invention.

FIG. 6 is a schematic structural diagram of an optical unit in an embodiment of the present invention.

FIG. 7 is a schematic diagram of an outer layer structure of a dynamic section in an embodiment of the

present invention.

FIG. 8 is a schematic diagram of an outer layer structure of a static section in an embodiment of the present invention.

FIG. 9 is a schematic structural diagram of a half-ring part in an embodiment of the present invention.

FIG. 10 is a schematic axial cross-sectional diagram of a half-ring part in an embodiment of the present invention.

FIG. 11 is a schematic axial cross-sectional diagram of another half-ring part in an embodiment of the present invention.

Description of reference numerals:

[0012]

10: cable core; 11: electrical unit;
 111: conductor; 112: inner semi-conductive shielding layer;
 113: insulating layer; 114: outer semi-conductive shielding layer;
 115: semi-conductive water-blocking layer; 116: metal shielding layer;
 117: phase-splitting sheath layer; 12: optical unit;
 121: optical fiber; 122: water-blocking filling;
 123: outer casing; 124: inner semi-conductive sheath;
 125: optical unit armor layer; 126: water-blocking tape;
 127: outer semi-conductive sheath; 13: filler;
 14: first sheath layer; 15: dynamic section;
 16: static section; 17: transition section;
 20: first armor layer; 30: inner cushion layer;
 40: second armor layer; 50: second sheath layer;
 60: third sheath layer; 70: transition device;
 71: welding unit; 711: half-ring part;
 712: welding fixing area; 713: smooth transition area.

DESCRIPTION OF EMBODIMENTS

[0013] A dynamic and static submarine cable generally includes a dynamic cable and a static cable that are connected. Both the dynamic cable and the static cable include a cable core and an armor layer covering the cable core. Since the dynamic cable is arranged in seawater and the static cable is buried in the seabed, the static cable is subjected to less impact and wear than the dynamic cable. Therefore, the number of armor layers of the static cable is generally less than that of the dynamic cable, rendering different structures of the dynamic cable and the static cable. In the related art, the dynamic cable and the static cable are generally produced separately, and then a service joint box is used to connect cable cores and armor layers of the dynamic cable and the static cable to realize transition between the dynamic cable and the static cable so as to form a dynamic and static submarine cable. However, separately producing the dy-

dynamic cable and the static cable increases the production cycle, and the process of connecting the cable cores and the armor layers is time-consuming, which further increases the production cycle. In addition, connecting the dynamic cable core and the static cable core by the service joint box increases transmission loss of cable cores.

[0014] In view of the above problems, a dynamic and static submarine cable provided by embodiments of the present invention includes a continuous cable core, where a first armor layer is arranged outside the cable core, a transition device is arranged on the first armor layer corresponding to a transition section of the cable core, and one end of a second armor layer is welded to the transition device, thereby realizing transition from double armor layers to one armor layer, and ensuring continuity of a production process of the dynamic and static submarine cable. In addition, the dynamic section and the static section can be in the same cable core, so that the dynamic and static submarine cable can be produced continuously without separate production, and thus there is no need to connect the dynamic cable core and the static cable core, thereby shortening the production cycle and reducing the transmission loss of the cable core.

[0015] In order to make the above objectives, features and advantages of the embodiments according to the present invention clearer and understandable, the following clearly and completely describes the technical solutions in the embodiments according to the present invention with reference to the accompanying drawings in the embodiments according to the present invention. Apparently, the described embodiments are only some but not all of the embodiments according to the present invention. All other embodiments obtained by persons of ordinary skill in the art based on the embodiments according to the present invention without creative efforts shall fall within the protection scope of the present invention.

[0016] As shown in FIG. 1, an embodiment of the present invention provides a dynamic and static submarine cable, including a cable core 10, a first armor layer 20, a transition device 70 and a second armor layer 40. The cable core 10 includes a dynamic section 15, a static section 16 and a transition section 17 connecting the dynamic section 15 and the static section 16, and the dynamic section 15, the static section 16 and the transition section 17 are of an integral structure. The first armor layer 20 is sleeved outside the dynamic section 15, the static section 16 and the transition section 17. The transition device 70 is sleeved outside the first armor layer 20 corresponding to the transition section 17. The second armor layer 40 is sleeved outside the first armor layer 20 corresponding to the dynamic section 15, and has a first end covering part of the transition device 70 and welded to an outer peripheral surface of the transition device 70.

[0017] The first end of the second armor layer 40 is an end of the second armor layer 40 close to the static section 16, and a dynamic and static submarine cable section corresponding to the static section 16 can be understood

as a static cable, such as a section C as shown in FIGS. 2 and 3; a dynamic and static submarine cable section corresponding to the dynamic section 15 can be understood as a dynamic cable, such as a section A as shown in FIGS. 2 and 3; and a dynamic and static submarine cable section corresponding to the transition section 17 can be understood as a transition cable, such as a section B as shown in FIGS. 2 and 3. The transition device 70 may be ring-shaped, and the ring-shaped transition device 70 is sleeved outside the first armor layer 20 corresponding to the transition section 17.

[0018] The dynamic and static submarine cable provided by the embodiment of the present invention has the cable core 10. The dynamic section 15, the static section 16 and the transition section 17 in the cable core 10 are of an integral structure. The first armor layer 20 is provided on an outside of the cable core 10. By arranging the transition device 70 on the first armor layer 20 corresponding to the transition section 17, and welding one end of the second armor layer 40 to the transition device 70, the transition from the armor layer of the dynamic section to the armor layer of the static section can be completed, therefore, the continuity of a production process of the dynamic and static submarine cable is guaranteed. With such arrangement, the dynamic section and the static section can be in the same cable core, so that the dynamic and static submarine cable can be produced continuously without separate production, and thus there is no need to connect the dynamic cable core and the static cable core, thereby shortening the production cycle and reducing the transmission loss of the cable core 10.

[0019] Referring to FIG. 4, the dynamic and static submarine cable provided by the embodiment of the present invention includes the cable core 10. The cable core 10 includes a plurality of electrical units 11 and a plurality of optical units 12, and the plurality of electrical units 11 and the plurality of optical units 12 are stranded.

[0020] The electrical units 11 are applicable to conducting electricity and transmitting signals, and the number of the electrical units 11 may be 1, 2, 3, etc. In this embodiment, the number of the electrical units 11 is 3. The number of the optical units 12 may be 1, 2, 3, etc. In this embodiment, the number of the optical units 12 is 2.

[0021] Referring to FIG. 5, in a specific embodiment, each electrical unit 11 includes, from inside to outside in a radial direction, an electrical unit core, an inner semi-conductive shielding layer 112, an insulating layer 113, an outer semi-conductive shielding layer 114, a semi-conductive water-blocking layer 115, a metal shielding layer 116 and a phase-splitting sheath layer 117, where the electrical unit core includes a plurality of stranded conductors 111. The conductors 111 may be copper conductors, aluminum conductors, or the like.

[0022] The inner semi-conductive shielding layer 112 covers an outer peripheral surface of the electrical unit core, and may be used to avoid partial discharge between the conductors 111 and the insulating layer 113. The in-

insulating layer 113 covers an outer peripheral surface of the inner semi-conductive shielding layer 112, and may be used to insulate the electrical unit core from external environment or adjacent electrical unit cores, thereby ensuring electrical performance of the dynamic and static submarine cable. Exemplarily, the insulating layer 113 may be formed by extrusion cladding.

[0023] The outer semi-conductive shielding layer 114 covers an outer peripheral surface of the insulating layer 113, and may be used to prevent partial discharge between the insulating layer 113 and the metal shielding layer 116 due to defects such as cracks on a surface of the insulating layer 113. The semi-conductive water-blocking layer 115 covers an outer peripheral surface of the outer semi-conductive shielding layer 114, and may play a role of blocking water. The metal shielding layer 116 covers an outer peripheral surface of the semi-conductive water-blocking layer 115. The metal shielding layer 116 may be a copper tape shielding layer, a steel tape shielding layer, an aluminum-plastic composite tape shielding layer and other composite tape shielding layers, and can shield electromagnetic interference. The phase-splitting sheath layer 117 covers an outer peripheral surface of the metal shielding layer 116, this can avoid direct contact between non-metallic shielding layers 116 of the plurality of electrical units, thereby avoiding abrasion between the non-metallic shielding layers 116 of the plurality of electrical units and playing a role of water resistance and blocking water. In this embodiment, the phase-splitting sheath layer 117 is an extruded sheath layer.

[0024] The optical unit 12 provided by an embodiment of the present invention includes an optical fiber 121 and a protective layer covering an outer peripheral surface of the optical fiber 121, and the optical unit may be used to transmit signals. Exemplarily, referring to FIG. 6, the optical unit includes an outer casing 123 and a plurality of optical fibers 121 arranged inside the outer casing. The outer casing may be a stainless steel tube. Water-blocking fillings 122 are further arranged between the plurality of optical fibers 121 in the outer casing 123. Along a radial direction of the outer casing 123, an outer peripheral surface of the outer casing 123 is covered sequentially with an inner semi-conductive sheath 124, an optical unit armor layer 125; a water-blocking tape 126; and an outer semi-conductive sheath 127.

[0025] In some embodiments, the cable core 10 further includes a central reinforcing member, and the plurality of optical units 11 and the plurality of electrical units 12 are stranded around the central reinforcing member. The central reinforcing member may be a metal wire or a non-metallic wire. Tension resistance and balance of the cable core 10 can be enhanced by arranging the central reinforcing member.

[0026] Further, the cable core 10 further includes fillers 13 filled in stranded gaps between the plurality of optical units 12 and the plurality of electrical units 11, and the fillers 13 may be filling strips, filling ropes and the like.

[0027] Referring to FIG. 4, in some specific embodi-

ments, the cable core 10 further includes a first sheath layer 14, and the first sheath layer 14 covers an outside of the stranded electrical units 11 and optical units 12. Arrangement of the first sheath layer 14 can ensure water-blocking performance of the cable core 10. In this embodiment, the first sheath layer 14 is an extruded sheath layer.

[0028] Referring to FIG. 1, the cable core 10 provided by the embodiment of the present invention axially includes the dynamic section 15, the static section 16 and the transition section 17 connecting the dynamic section 15 and the static section 16, and the dynamic section 15, the static section 16 and the transition section 17 are of an integral structure, where the dynamic section 15 corresponds to a dynamic cable, and the static section 16 corresponds to a static cable. With such arrangement, during the manufacturing process, cable cores of the dynamic cable and the static cable can be continuously produced without separate manufacturing, thereby shortening the production cycle. There is also no need to connect the dynamic cable core and the static cable core, thereby reducing transmission loss of the cable core 10 and improving performance stability of the cable core 10.

[0029] The first armor layer 20 is sleeved outside the dynamic section 15, the static section 16 and the transition section 17, and the first armor layer 20 is continuous. Both the first armor layer 20 and the second armor layer 40 may be formed by stranding or braiding metal wires such as steel wires. With such arrangement, in the manufacturing process, the first armor layer 20 of the dynamic and static submarine cable can be continuously produced without separate manufacturing, thereby shortening the production cycle.

[0030] Referring to FIGS. 1, 7 and 8, the dynamic and static submarine cable provided by the embodiment of the present invention further includes the transition device 70 and the second armor layer 40. The transition device 70 is sleeved outside the first armor layer 20 corresponding to the transition section 17. The second armor layer 40 is sleeved outside the first armor layer 20 corresponding to the dynamic section 15. The first end of the second armor layer 40 covers part of the transition device 70, and is welded to the outer peripheral surface of the transition device 70. With such arrangement, transition between the armor layer of the dynamic cable and the armor layer of the static cable can be realized.

[0031] Further, an inner cushion layer 30 may also be arranged between the second armor layer 40 and the first armor layer 20. With such arrangement, direct contact between the second armor layer 40 and the first armor layer 20 can be avoided, and mutual abrasion between the second armor layer 40 and the first armor layer 20 is thereby avoided.

[0032] Referring to FIG. 7, in some embodiments, an outer peripheral surface of the second armor layer 40 is further covered with a second sheath layer 50. The second sheath layer 50 may be an extruded sheath layer, and material of the second sheath layer 50 can be PE

material. An outer peripheral surface of the first armor layer 20 corresponding to the static section 16 is further covered with a third sheath layer 60. The third sheath layer 60 may be a wrapping sheath layer, and material of the third sheath layer 60 may be PP winding rope.

[0033] In a specific embodiment, referring to FIG. 9, the transition device 70 includes a heat transfer unit and a welding unit 71. The heat transfer unit covers an outside of the first armor layer 20 corresponding to the transition section 17, and the welding unit 71 is an annular structure and is sleeved outside the heat transfer unit. The first end of the second armor layer 40 is welded to an outer peripheral surface of the welding unit 71. The heat transfer unit can release heat during a welding process, and at the same time acts as an isolation buffer layer to ensure welding quality. The heat transfer unit is a metal tape wrapped around an outer peripheral surface of the first armor layer 20 corresponding to the transition section 17.

[0034] In some possible embodiments, an inner peripheral surface and the outer peripheral surface of the welding unit 71 are respectively arranged with an anti-corrosion coating. By arranging the anti-corrosion coating, corrosion resistance of the welding unit 71 can be improved, thereby increasing service life of the welding unit 71. Exemplarily, material of the anti-corrosion coating is a composite material with good stability, which can maintain good anti-corrosion performance in both high temperature and low temperature environments.

[0035] Referring to FIG. 9, in some embodiments, the welding unit 71 is of a half type, including two half-ring parts 711. The two half-ring parts 711 are of a split structure. Inner ring surfaces of the two half-ring parts 711 are opposite, and two ends of one half-ring part 711 along a circumferential direction thereof are connected to two ends of the other half-ring part 711 along a circumferential direction thereof in a one-to-one relationship. Exemplarily, a mode of connecting the two half-ring parts 711 is welding. With such arrangement, the welding unit 71 can be directly sleeved outside the heat transfer unit, without inserting and moving the welding unit 71 from one end of the dynamic and static submarine cable to the outside of the heat transfer unit along an axis of the dynamic and static submarine cable, and the operation is thus more convenient.

[0036] Further, along an axial direction of each half-ring part 711, each half-ring part 711 includes a welding fixing area 712 and two smooth transition areas 713 respectively connected to two ends of the welding fixing area 712. A thickness of the welding fixing area 712 is greater than thicknesses of the smooth transition areas 713. The first end of the second armor layer 40 is welded to an outer peripheral surface of the welding fixing area 712. With such arrangement, heat generated during a process of welding the first end of the second armor layer 40 can be better transferred.

[0037] Referring to FIG. 10, in some specific embodiments, along the axial direction of each half-ring part 711, the thickness of the half-ring part 711 changes continu-

ously, that is, the thicknesses at junctions between the smooth transition areas 713 and the welding fixing area 712 do not change abruptly.

[0038] Further, referring to FIG. 10, on an axial cross-section of each half-ring part 711, the thicknesses of the smooth transition areas 713 decrease linearly along a direction away from the welding fixing area 712. With such arrangement, metal wires at the first end of the second armor layer 40 can better fit to the welding unit 71, thereby improving strength and stability of the welding.

[0039] Further, along the axial direction of each half-ring part 711, the thickness of the welding fixing area does not change. On the axial cross-section of each half-ring part 711, a minimum thickness of each of the smooth transition areas 713 is 20% of the thickness of the welding fixing area 712. The axial cross-section is a cross section of an axis passing through the half-ring part 711. Referring to FIG. 10, the minimum thickness of the smooth transition areas 713 is at ends of the smooth transition areas 713 away from the welding fixing area 712. Such arrangement can not only make the metal wires at the first end of the second armor layer 40 better fit to the welding unit 71, but also rapidly conduct and reduce welding heat and avoid damage to a structure of the cable core 10.

[0040] In some embodiments, the half-ring part 711 has a middle part protruding outwards, and is presented in a circular arch shape. Along the axial direction of the half-ring part 711, a thickness of the circular arch shaped structure located at an edge of the half-ring part is equal to 20% of a thickness of the circular arch shaped structure located at a middle of the half-ring part.

[0041] Exemplarily, a welding point between the first end of the second armor layer 40 and the welding fixing area 712 is further coated with an anti-corrosion coating, so as to improve anti-corrosion performance at the welding point. For the material of the anti-corrosion coating, reference may be made to the above description.

[0042] In some other specific embodiments, referring to FIG. 11, along the axial direction of the half-ring part 711, the thickness of the welding fixing area 712 and the thicknesses of the smooth transition areas 713 are all constant, and the thicknesses of the smooth transition areas 713 are equal to 20% of the thickness of the welding fixing area 712, and a transition portion is further arranged between the welding fixing area 712 and each smooth transition area 713.

[0043] An embodiment of the present invention further provides a method for manufacturing a dynamic and static submarine cable, including:

providing a cable core, which includes a dynamic section, a static section, and a transition section connecting the dynamic section and the static section, where the dynamic section, the static section, and the transition section are of an integral structure because of which the cable core can be continuously produced;

marking demarcation points of the dynamic section, the static section and the transition section on an outer peripheral surface of the dynamic section, an outer peripheral surface of the static section and an outer peripheral surface of the transition section, respectively;

stranding a first armor layer on an outer peripheral surface of the cable core;

winding a metal tape around an outer peripheral surface of the first armor layer corresponding to the transition section, to form a heat transfer unit, where exemplarily, the metal tape is evenly wound around the outer peripheral surface of the first armor layer corresponding to the transition section;

having a welding unit sleeved on an outer peripheral surface of the heat transfer unit;

stranding a second armor layer on an outer peripheral surface of the first armor layer corresponding to the dynamic section, and making an first end of the second armor layer cover part of the welding unit; and

welding the first end of the second armor layer to an outer peripheral surface of the welding unit.

[0044] Neither separate production of the dynamic cable and the static cable nor connection of the dynamic cable core and the static cable core is required by the method for manufacturing the dynamic and static submarine cable provided by the embodiment, thereby shortening the production cycle and reducing the transmission loss of the cable core.

[0045] Exemplarily, for structures and materials of the cable core and the welding unit in the above-mentioned method embodiments, reference may be made to the above-mentioned product embodiments, which will not be repeated here.

[0046] In some possible implementations, in the step of having the welding unit sleeved on the outer peripheral surface of the heat transfer unit, the welding unit includes two half-ring parts. The two half-ring parts are of a split structure. Inner ring surfaces of the two half-ring parts are opposite, and two ends of one half-ring part along the circumferential direction thereof are connected to two ends of the other half-ring part along the circumferential direction thereof in a one-to-one relationship. Exemplarily, a spot welding machine may be used to weld the two half-ring parts, so as to fix a position of the welding unit.

[0047] Exemplarily, in the step of welding the first end of the second armor layer to the outer peripheral surface of the welding unit, the first end of the second armor layer is welded to the welding fixing area of the welding unit, with welding points evenly distributed. During the welding process, metal wires at the first end of the second armor layer fit snugly to the smooth transition areas to ensure a reliable and stable welding process. Further, reservation and confirmation of a position of the second armor layer are also included before welding. The welding position is located in the middle of the welding fixing area.

After the welding is completed, an anti-corrosion coating may be applied to outsides of the welding points.

[0048] After the step of welding the first end of the second armor layer to the outer peripheral surface of the welding unit, the following are further included:

having a second sheath layer cover an outer peripheral surface of the second armor layer; and

having a third sheath layer cover an outer peripheral surface of the first armor layer corresponding to the static section.

[0049] Exemplarily, for structures of the second sheath layer and the third sheath layer, reference may be made to the above-mentioned product embodiments, which will not be repeated here.

[0050] In some embodiments, armor layers of the dynamic and static submarine cable include not only the first armor layer and the second armor layer, but also a third armor layer, a fourth armor layer and so on. At this point, after the step of welding the first end of the second armor layer to the outer peripheral surface of the welding unit, the following is further included:

having a further transition device sleeved outside the second armor layer, where the further transition device may be sleeved at any position outside the second armor layer, and for the structure of the further transition device, reference may be made to the above-mentioned product embodiments, which will not be repeated here; and then

stranding the third armor layer on the outer peripheral surface of the second armor layer, and welding a first end of the third armor layer to an outer peripheral surface of this outermost welding unit, with a second end of the third armor layer aligned with an end of the second armor layer. Similarly, the above steps may be repeated when more armor layers such as a fourth armor layer and a fifth armor layer are included.

[0051] Embodiments or implementations in the present specification are described in a progressive manner. Description of each embodiment focuses on a difference from other embodiments, and references may be made to each other for same or similar parts among respective embodiments.

[0052] Those skilled in the art should understand that in the disclosure of the present invention, terms such as "longitudinal", "transverse", "upper", "lower", "front", "rear", "left", "right", "vertical", "horizontal", "top", "bottom", "inner", and "outer", etc. refer to orientations or positional relationships based on orientations or positional relationships illustrated in the accompanying drawings, which are only to facilitate and simplify descriptions of the present invention, rather than to indicate or imply that the system or element referred to must be of a particular orientation or must be constructed and operate in a particular orientation, and therefore the above terms should not be construed as limiting the present invention.

[0053] Reference throughout the present specification to "an embodiment," "some embodiments," "an illustra-

tive embodiment," "an example," "a specific example," or "some examples" means that a particular feature, structure, material, or characteristic described in connection with the embodiment or example is included in at least one embodiment or example of the present invention. Thus, the indicative descriptions of the above terms in the present specification are not necessarily referring to the same embodiment or example. Furthermore, the particular features, structures, materials, or characteristics described may be combined in any suitable manner in one or more embodiments or examples.

[0054] Finally, the above embodiments are merely intended for describing the technical solutions of the present invention, but not for limiting the present invention. Although the present invention is described in detail with reference to the foregoing embodiments, persons of ordinary skill in the art should understand that they may still make modifications to the technical solutions described in the foregoing embodiments or make equivalent replacements to some or all technical features thereof, and these modifications or replacements do not make the essence of corresponding technical solutions depart from the scope of the technical solutions of the embodiments of the present invention.

Claims

1. A dynamic and static submarine cable, comprising:

a cable core comprising a dynamic section, a static section, and a transition section connecting the dynamic section and the static section, wherein the dynamic section, the static section, and the transition section are of an integral structure;
a first armor layer sleeved outside the dynamic section, the static section and the transition section;
a transition device sleeved outside the first armor layer corresponding to the transition section; and
a second armor layer sleeved outside the first armor layer corresponding to the dynamic section, and having a first end covering part of the transition device and welded to an outer peripheral surface of the transition device.

2. The dynamic and static submarine cable according to claim 1, wherein the transition device comprises a heat transfer unit and a welding unit, and the heat transfer unit covers an outside of the first armor layer corresponding to the transition section;

the welding unit is of an annular structure and is sleeved outside the heat transfer unit; and
the first end of the second armor layer is welded to an outer peripheral surface of the welding unit.

3. The dynamic and static submarine cable according to claim 2, wherein an inner peripheral surface and the outer peripheral surface of the welding unit are respectively arranged with an anti-corrosion coating.

4. The dynamic and static submarine cable according to claim 2 or 3, wherein the welding unit comprises two half-ring parts, and each of the half-ring parts comprises, along an axial direction thereof, a welding fixing area, and two smooth transition areas respectively connected to two ends of the welding fixing area; and a thickness of the welding fixing area is greater than thicknesses of the smooth transition areas, and the first end of the second armor layer is welded to an outer peripheral surface of the welding fixing area.

5. The dynamic and static submarine cable according to claim 4, wherein on an axial cross-section of each of the half-ring parts, the thicknesses of the smooth transition areas decrease linearly along a direction away from the welding fixing area.

6. The dynamic and static submarine cable according to claim 5, wherein a minimum thickness of each of the smooth transition areas is 20% of the thickness of the welding fixing area.

7. The dynamic and static submarine cable according to any one of claims 1 to 6, wherein the cable core comprises a plurality of electrical units and a plurality of optical units, and the plurality of electrical units and the plurality of optical units are stranded;

each of the electrical units comprises, from inside to outside in a radial direction, an electrical unit core, an inner semi-conductive shielding layer, an insulating layer, an outer semi-conductive shielding layer, a semi-conductive water-blocking layer, a metal shielding layer, and a phase-splitting sheath layer, wherein the electrical unit core comprises a plurality of stranded conductors; and
each of the optical units comprises an optical fiber and a protective layer covering an outer peripheral surface of the optical fiber.

8. The dynamic and static submarine cable according to claim 7, wherein the cable core further comprises a first sheath layer, and the first sheath layer covers an outside of the stranded electrical units and optical units.

9. A method for manufacturing a dynamic and static submarine cable, comprising:

providing a cable core comprising a dynamic section, a static section, and a transition section

connecting the dynamic section and the static section, wherein the dynamic section, the static section, and the transition section are of an integral structure;

marking demarcation points of the dynamic section, the static section and the transition section on an outer peripheral surface of the cable core; stranding a first armor layer on an outer peripheral surface of the dynamic section, on an outer peripheral surface of the static section, and on an outer peripheral surface of the transition section; winding a metal tape around an outer peripheral surface of the first armor layer corresponding to the transition section, to form a heat transfer unit; having a welding unit sleeved on an outer peripheral surface of the heat transfer unit; stranding a second armor layer on an outer peripheral surface of the first armor layer corresponding to the dynamic section, and making an first end of the second armor layer cover part of the welding unit; and welding the first end of the second armor layer to an outer peripheral surface of the welding unit.

10. The method for manufacturing the dynamic and static submarine cable according to claim 9, wherein after the step of welding the first end of the second armor layer to the welding unit, the method further comprises:

having a second sheath layer cover an outer peripheral surface of the second armor layer; and having a third sheath layer cover an outer peripheral surface of the first armor layer corresponding to the static section.

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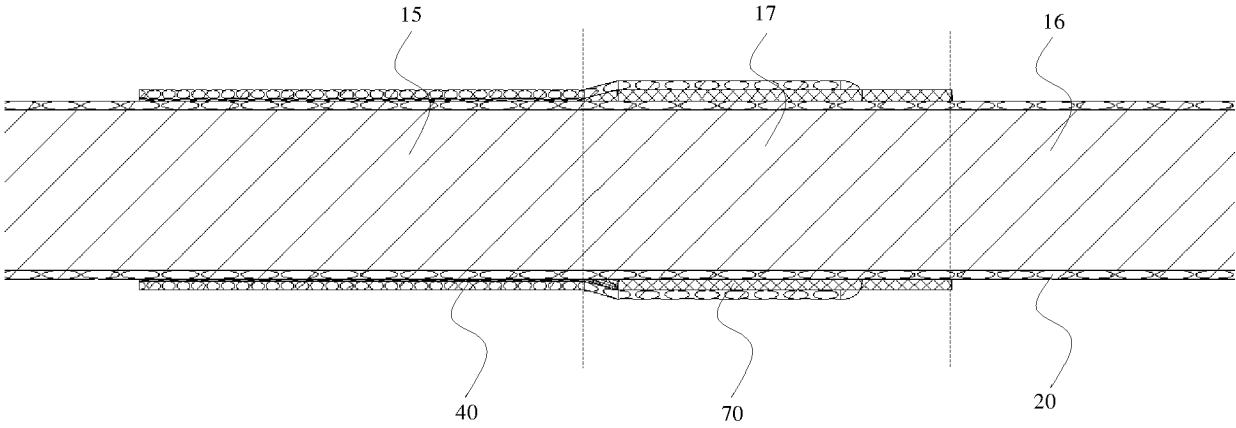


FIG. 1

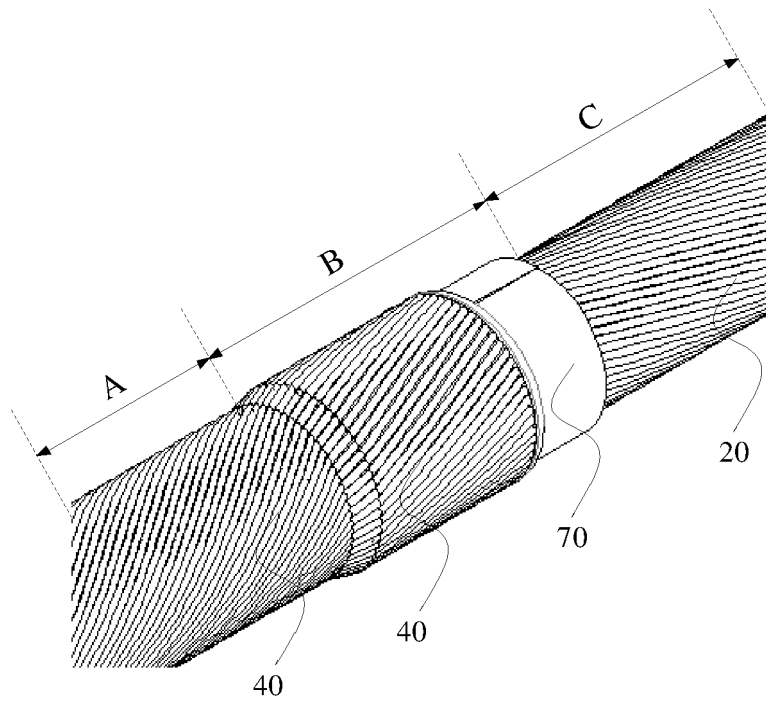


FIG. 2

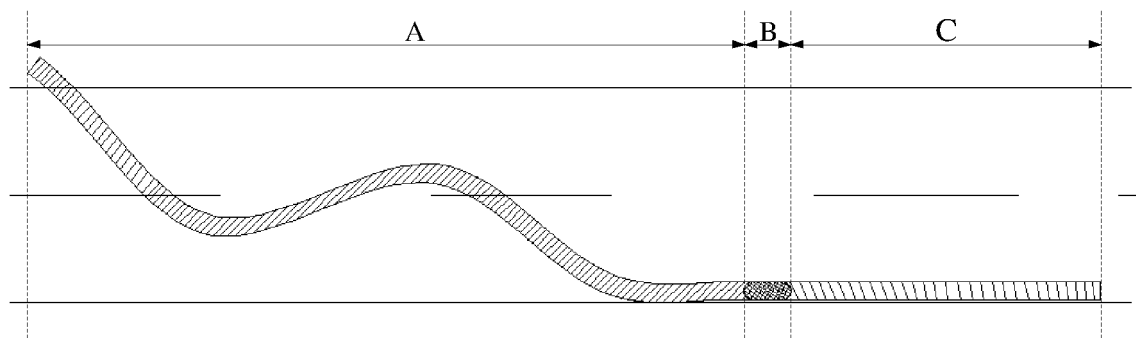


FIG. 3

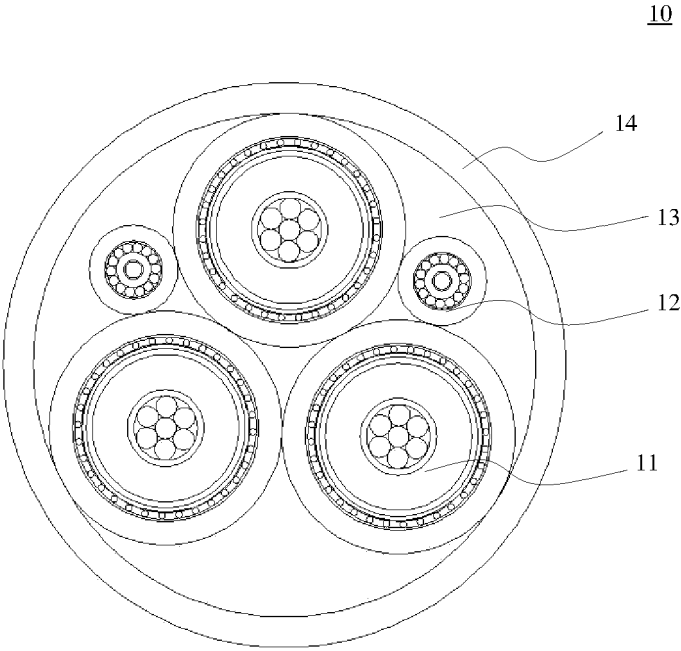


FIG. 4

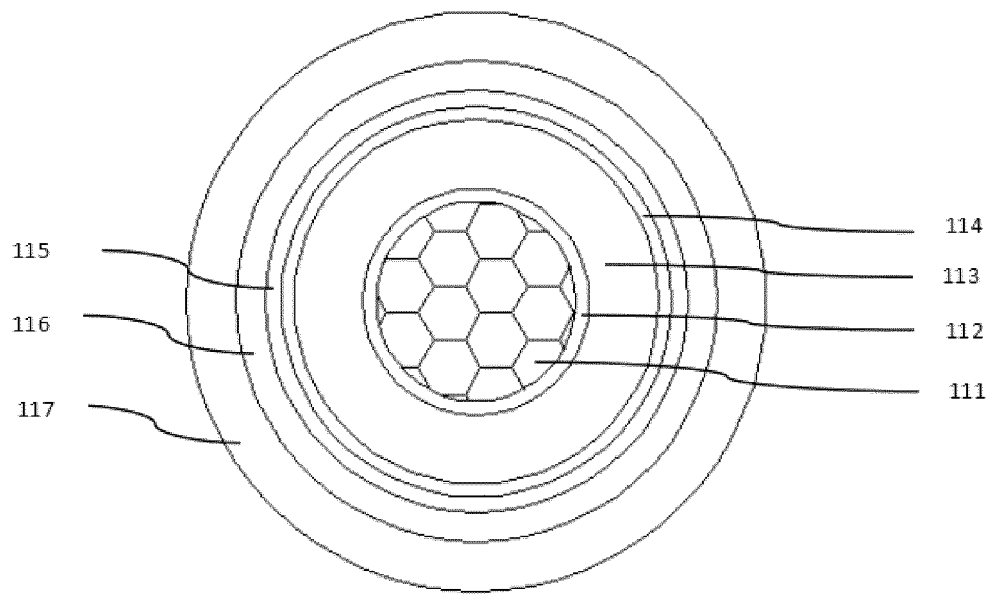


FIG. 5

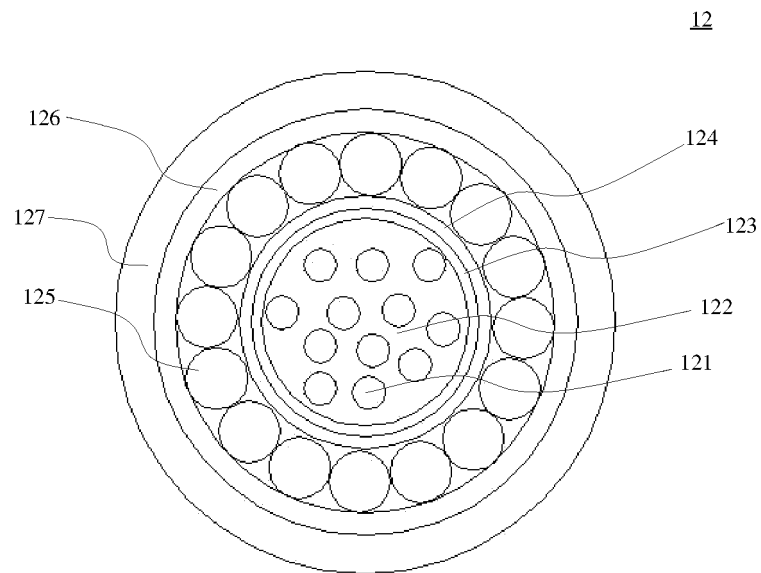


FIG. 6

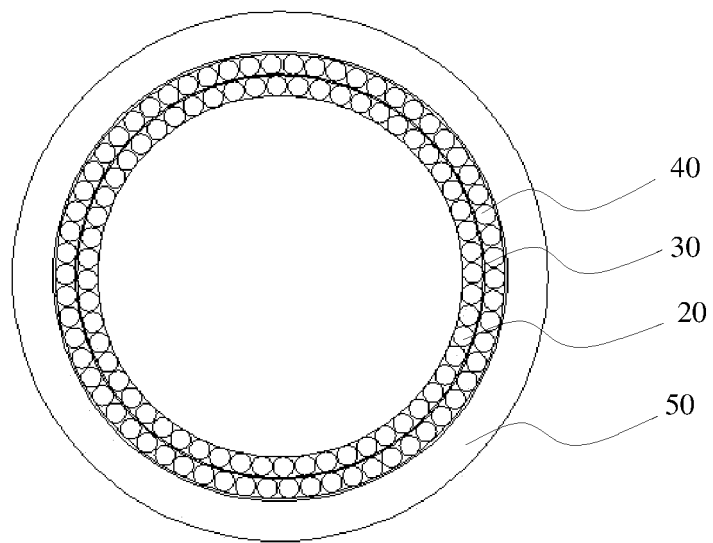


FIG. 7

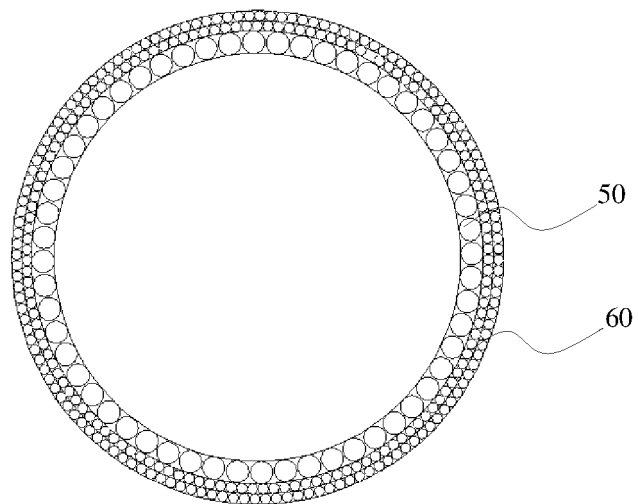


FIG. 8

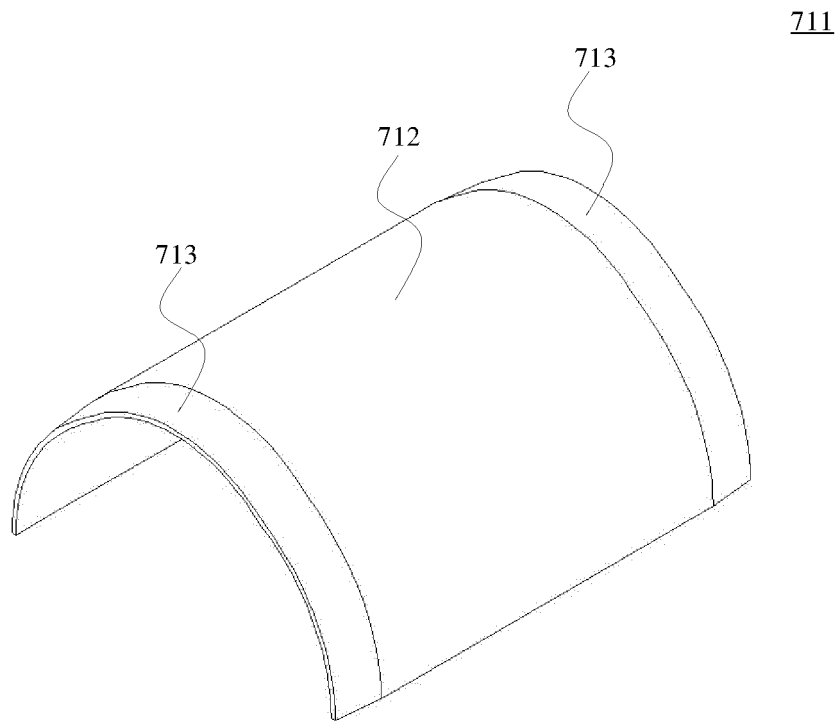


FIG. 9

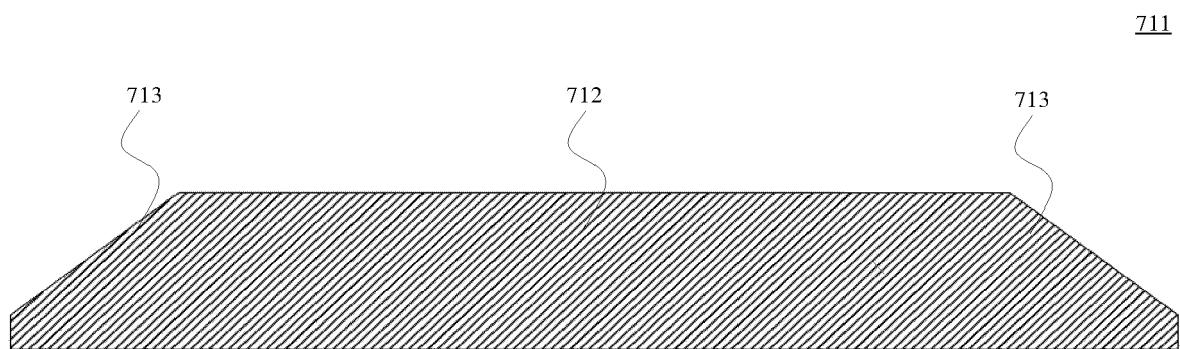


FIG. 10

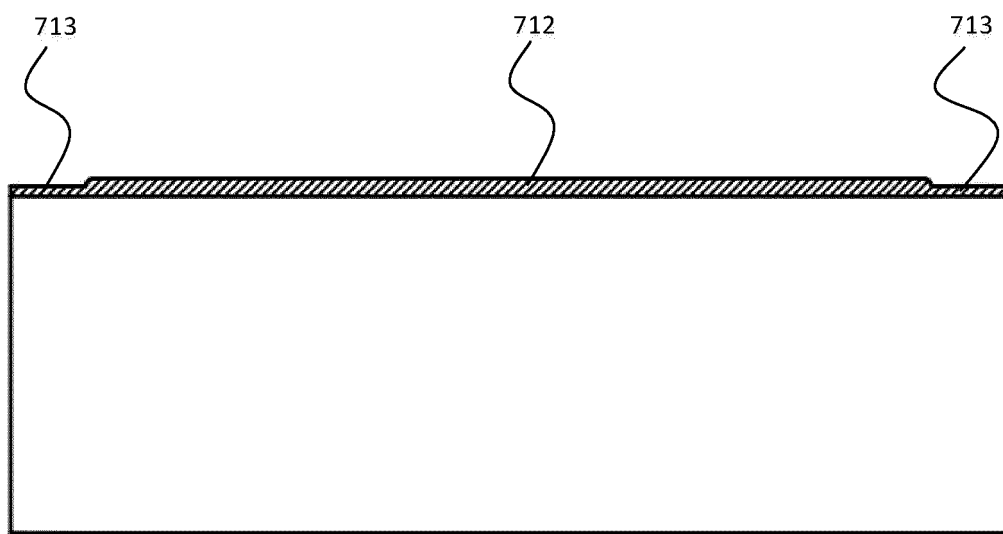


FIG. 11

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2021/105165

A. CLASSIFICATION OF SUBJECT MATTER

H01B 7/14(2006.01)i; H01B 7/22(2006.01)i; H01B 7/24(2006.01)i; H01B 7/18(2006.01)i; H01B 9/00(2006.01)i; H01B 11/22(2006.01)i; H01B 13/26(2006.01)i

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)

H01B

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)

CNPAT, WPI, EPODOC, CNKI: 海, 缆, 动, 静, 过渡, 连接, subsea, submarine, cable, dynamic, static, transi+, connect+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 111477393 A (CHINA NATIONAL OFFSHORE OIL CORP. et al.) 31 July 2020 (2020-07-31) description, paragraphs 35-56, and figures 1-5	1-6, 9, 10
Y	CN 111477393 A (CHINA NATIONAL OFFSHORE OIL CORP. et al.) 31 July 2020 (2020-07-31) description, paragraphs 35-56, and figures 1-5	7, 8
Y	CN 111292889 A (ZHONGTIAN TECHNOLOGY SUBMARINE CABLES CO., LTD. et al.) 16 June 2020 (2020-06-16) description, paragraphs 36-39, and figures 2-4	7, 8
A	CN 208849433 U (QINGDAO HANHE CABLE CO., LTD.) 10 May 2019 (2019-05-10) entire document	1-10
A	CN 109727718 A (JIANGSU HENG TONG HIGH VOLTAGE MARINE CABLE CO., LTD.) 07 May 2019 (2019-05-07) entire document	1-10
A	CN 206023162 U (ZHONGTIAN MARINE SYSTEM CO., LTD.) 15 March 2017 (2017-03-15) entire document	1-10

☒ 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

“E” earlier application or patent but published on or after the international filing date

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“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“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

“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

“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

“&” document member of the same patent family

Date of the actual completion of the international search

17 January 2022

Date of mailing of the international search report

25 January 2022

Name and mailing address of the ISA/CN

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Facsimile No. (86-10)62019451

Authorized officer

Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No. PCT/CN2021/105165

C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 101805668 B1 (SAMSUNG HEAVY IND.) 06 December 2017 (2017-12-06) entire document	1-10

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2021/105165

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 111477393 A	31 July 2020	None	
CN 111292889 A	16 June 2020	None	
CN 208849433 U	10 May 2019	None	
CN 109727718 A	07 May 2019	None	
CN 206023162 U	15 March 2017	None	
KR 101805668 B1	06 December 2017	None	

Form PCT/ISA/210 (patent family annex) (January 2015)