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(54) Title: LOW-COST OPTICAL CONNECTOR

(57) Abstract: An optical connector for providing an optical connection for one or more optical fibre cables, in which the cables include optical fibres and one or more protective elements secured throughout a length of the cables. The optical connector includes an outer shell comprising a cavity and an opening, wherein the cavity is potted with a potting compound through the opening. A ferrule plate and an elastomeric member detachably coupled to the outer shell, wherein the ferrule plate comprises one or more apertures to secure one or more ferrules attached to one end of the optical fibres, and wherein the elastomeric member protects the one end of the optical fibres and at least a portion of the one or more ferrules at a mating juncture. The optical fibres, the protective elements, and the ferrules enclosing the optical fibres are in direct exposure to the potting compound.

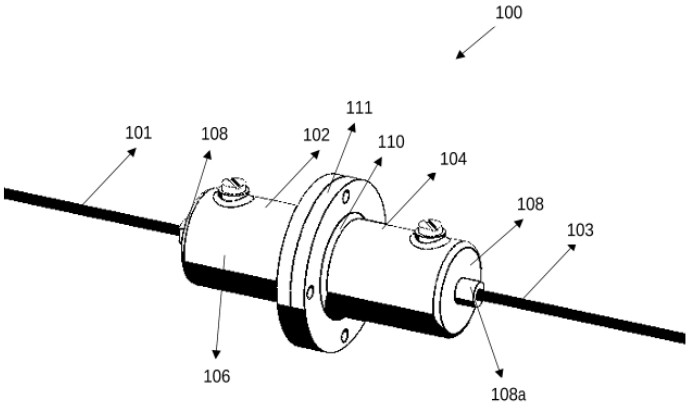

FIG. 1

FORM 2

THE PATENTS ACT 1970
(39 OF 1970)
&
The Patent Rules, 2003
Complete Specification
(See Section 10 and Rule 13)

1. TITLE OF THE INVENTION

LOW-COST OPTICAL CONNECTOR

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3. PREAMBLE TO THE DESCRIPTION

COMPLETE

The following specification particularly describes the invention and the manner in which it is to be performed.

DESCRIPTION

TECHNICAL FIELD

[001] The present disclosure relates generally to signal communication cables and connectors and more particularly to optical connectors.

BACKGROUND OF INVENTION

[002] The following description includes information that may be useful in understanding the present disclosure. It is not an admission that any of the information provided herein is prior art or relevant to the presently claimed disclosure, or that any publication specifically or implicitly referenced is prior art.

[003] Optical fibers are increasingly being used in signal communication cables for a variety of applications, including but not limited to broadband voice, video, data transmissions, etc. It may be important to interconnect the optical fibers and establishing an optical connection between the optical fibers. In this regard, optical connectors have been developed with an intent to provide such interconnection between the optical fibers. Specifically, subsea or underwater optical connections are inevitable in defense or underwater communication. Such optical connections may be provided by either a permanent splicing or the optical connectors. Preferably, the optical connectors are opted for such optical connections considering ease of installation and serviceability. However, cost of an optical connector and its installation, particularly at the subsea level may be high. Further, additional challenge of striking a balance between the cost of the optical connector and an extent of protection of the optical connections and/or the optical fibers exists at the subsea level.

SUMMARY OF INVENTION

[004] The following presents a simplified summary to provide a basic understanding of some aspects of the disclosed material handling system. This summary is not an extensive overview and is intended to neither identify key or critical elements nor delineate the scope of such elements. Its purpose is to present some concepts of the described features in a simplified form as a prelude to the more detailed description that is presented later.

[005] Various example embodiments described herein relate to an optical connector for providing an optical connection for one or more optical fibre cables, in which the cables include optical fibres and one or more protective elements secured throughout a length of the cables. The optical connector includes an outer shell comprising a cavity and an opening, wherein the

cavity is potted with a potting compound through the opening. A ferrule plate and an elastomeric member detachably coupled to the outer shell, wherein the ferrule plate comprises one or more apertures to secure one or more ferrules attached to one end of the optical fibres, and wherein the elastomeric member protects the one end of the optical fibres and at least a portion of the one or more ferrules at a mating juncture. The optical fibres, the protective elements, and the ferrules enclosing the optical fibres are in direct exposure to the potting compound.

[006] Various example embodiments described herein relate to an optical connector, wherein the potting compounds is one of an epoxy potting compound, an urethane potting compound, a silicone potting compound, or a polyacrylate potting compound.

[007] Various example embodiments described herein relate to an optical connector, wherein the one or more protective elements comprises at least one of High-density polyethylene (HDPE) sheath, Stainless Steel braids or Galvanized Improved Plow Steel (GIPS) braids, and stainless-steel tube or pipe or their combination, wherein one or more stands of the steel braids may be attached to the cavity.

[008] Various example embodiments described herein relate to an optical connector, wherein the outer shell comprises a groove and a slot, wherein the elastomeric member is positioned in the groove and the ferrule plate is positioned in the slot.

[009] Various example embodiments described herein relate to an optical connector, wherein the elastomeric member is positioned within the groove with a clearance to expand and contract under influence of a compressive force.

[0010] Various example embodiments described herein relate to an optical connector, wherein the optical connector further comprises: a protective cap to close the opening on the outer shell through which the potting compound is applied into the cavity.

[0011] Various example embodiments described herein relate to an optical connector, wherein the one end of the optical fibres and the at least one portion of the one or more ferrules comprises a mating end portion structured and polished to establish the optical connection with another set of optical fibres and ferrules at the mating juncture.

[0012] Various example embodiments described herein relate to an optical connector for providing an optical connection. The optical connector includes an outer shell comprising a cavity, an opening, a groove and a slot, wherein the cavity is filled with an epoxy resin applied through the opening, and wherein an optical fiber cable is contained within the cavity. A ferrule plate and an O-ring detachably coupled to the outer shell, wherein the ferrule plate comprises one or more ferrules structured to enclose at least one end of one or more optical fibres

extending from the optical fiber cable, and wherein the O-ring is positioned in the groove and the ferrule plate is positioned in the slot. The optical fiber cable, the one or more optical fibres and the one or more ferrules are in a direct exposure to the epoxy resin contained within the cavity.

[0013] Various example embodiments described herein relate to method for establishing an optical connection. The method includes positioning an optical fiber cable within a cavity of an optical connector. The optical fiber cable includes optical fibres, one or more ferrules and one or more protective elements secured throughout a length of the cables. The method further includes pouring an epoxy resin through an opening of the optical connector such that the epoxy resin fills the cavity with a direct contact to the optical fibres, the one or more ferrules and the one or more protective elements and securing an elastomeric member on the optical connector under influence of a compressive force, wherein the elastomeric member protects one end of the optical fibres and at least a portion of the one or more ferrules at a mating juncture. The method further includes coupling the one end of the optical fibres and at least a portion of the one or more ferrules at the mating juncture to at least one of another set of optical fibres or a junction box to establish the optical connection.

[0014] Various example embodiments described herein relate to method for establishing an optical connection. The method further includes creating a vacuum inside the cavity while pouring an epoxy resin through the opening of the optical connector.

[0015] The above summary is provided merely for purposes of summarizing some example embodiments to provide a basic understanding of some aspects of the disclosure. Accordingly, it will be appreciated that the above-described embodiments are merely examples and should not be construed to narrow the scope or spirit of the disclosure in any way. It will be appreciated that the scope of the disclosure encompasses many potential embodiments in addition to those here summarized, some of which will be further described below.

BRIEF DESCRIPTION OF DRAWINGS

[0016] The embodiments of the disclosure itself, as well as a preferred mode of use, further objectives and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings. One or more embodiments are now described, by way of example only, with reference to the accompanying drawings in which:

[0017] FIG. 1 illustrates a perspective view of two optical connectors establishing an optical connection between two optical fibers, in accordance with an embodiment of the present disclosure.

[0018] FIG. 2 illustrates a perspective close-up view of an end portion of an exemplary optical fiber cable within the optical connector, in accordance with an embodiment of the present disclosure.

[0019] FIG. 3 illustrates a perspective schematic view of one of the optical connectors of FIG. 1, in accordance with an embodiment of the present disclosure.

[0020] FIG. 4 illustrates a partial exploded view of one of the two optical connectors of FIG. 1 showing the ferrule plate, in accordance with an embodiment of the present disclosure.

[0021] FIG. 5 illustrates a partial exploded view of the two optical connectors of FIG. 1 showing the elastomeric member, in accordance with an embodiment of the present disclosure.

[0022] FIGS. 6 and 7 illustrates a partial fragmentary schematic view of the optical connector of FIG. 3 without the potting compound, in accordance with an embodiment of the present disclosure.

[0023] FIG. 8 illustrates a cross sectional view of the two optical connectors of FIG. 1 establishing an optical connection between two optical fiber cables in accordance with an embodiment of the present disclosure.

[0024] FIG. 9 illustrates a flowchart of method for establishing the optical connection, in accordance with an embodiment of the present disclosure.

[0025] The figures depict embodiments of the disclosure for purposes of illustration only. One skilled in the art will readily recognize from the following description that alternative embodiments of the structures and methods illustrated herein may be employed without departing from the principles of the disclosure described herein.

DETAILED DESCRIPTION

[0026] Various embodiments of the present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all embodiments of the invention are shown. Indeed, the invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. The term “or” is used herein in both the alternative and conjunctive sense, unless otherwise indicated. The terms “illustrative,” “example,” and “exemplary” are used to be examples with no indication of quality level. Like numbers refer to like elements throughout.

[0027] The phrases “in an embodiment,” “in one embodiment,” “according to one embodiment,” and the like generally mean that the particular feature, structure, or characteristic following the phrase may be included in at least one embodiment of the present disclosure and may be included in more than one embodiment of the present disclosure (importantly, such phrases do not necessarily refer to the same embodiment).

[0028] The word “exemplary” is used herein to mean “serving as an example, instance, or illustration.” Any implementation described herein as “exemplary” is not necessarily to be construed as preferred or advantageous over other implementations.

[0029] If the specification states a component or feature “can,” “may,” “could,” “should,” “would,” “preferably,” “possibly,” “typically,” “optionally,” “for example,” “often,” or “might” (or other such language) be included or have a characteristic, that particular component or feature is not required to be included or to have the characteristic. Such component or feature may be optionally included in some embodiments, or it may be excluded.

[0030] Conventionally, optical connections at the subsea level may be of permanent connection type or a detachable connection type. For example, an optical fiber cable may be permanently attached to a junction box via the optical connectors in the permanent connection type, or the optical fiber cable may be detachable attached to another optical fiber cable via the optical connectors in the detachable connection type. In both optical connection types, in order to securely couple the optical fibres, the optical connectors are being employed. Such optical connectors may include a plurality of coupling components internally and externally to securely couple the optical fiber cables under both the optical connection types. Specifically, optical connectors may include high tolerance coupling components when employed at the subsea level to withstand high pressure levels. In this regard, a cost of manufacturing and implementing the optical connectors at the subsea level may be considerably high due to the use of plurality of high tolerance coupling components and a complex assembly process to couple these components to establish both optical connection types.

[0031] Further, the optical fiber cable may include one or more protective elements which may be intended to guard one or more optical fibres bundled within the optical fiber cable. The one or more protective elements, for example, may be a steel tubing/shell or a thermoplastic polymer tubing/shell or an aramid yarn. The one or more protective elements may be used as an outer shell for the one or more optical fibres to protect the optical fibres under extreme weather condition or under high pressure in the subsea level. In this regard, when the detachable optical connection type is implemented, the high tolerance coupling components of the conventional optical connectors may secure an end portion of the optical fiber cables such that

a location at which the optical fibres mate each other are protected. However, in the event of any failure under the extreme weather condition, the high tolerance coupling components of the conventional optical connector may ensure safety of only the outer shell of the optical fiber cable and not the optical fiber in itself. For example, when the optical fiber cables are installed in the subsea level, there exists a possibility of the optical fiber cable breaking under high pressure in multiple locations. In such scenarios, a water entering through any location of the optical fiber may travel through the protective elements and may be arrested at a junction in which the optical connector is implemented using the high tolerance coupling components abutting the protective elements. However, when the protective elements fail due to erosion, then the water may enter the optical fiber at the junction of the optical connector as the high tolerance coupling components fail to have a direct contact with the optical fiber at the junction. In this regard, existing optical connectors may fail to protect the optical fiber under extreme weather conditions. Therefore, the conventional optical connectors may pose many disadvantages in terms of increased cost and labor with a lack of full-scale protection of the optical fiber when subjected to failure.

[0032] Through applied effort, ingenuity, and innovation, many of the above identified problems have been solved by developing solutions that are included in embodiments of the present disclosure, many examples of which are described in detail herein. The present disclosure relates to an optical connector for providing an optical connection for one or more optical fiber cables with a minimum number of components without compromising the safety of the optical fiber cables in extreme weather conditions. The optical connector includes an outer shell comprising a cavity and an opening with the cavity is potted with a potting compound through the opening. A ferrule plate and an elastomeric member detachably coupled to the outer shell, wherein the ferrule plate comprises one or more apertures to secure one or more ferrules attached to one end of the optical fibres. The elastomeric member protects the one end of the optical fibres and at least a portion of the one or more ferrules at a mating juncture. The optical fibres, the one or more protective elements, and the one or more ferrules enclosing the optical fibres are in direct exposure to the potting compound. In this regard, the optical connector uses a potting compound which is in direct contact to protect the optical fibres inside the cavity and the elastomeric member to protect a portion of the optical fibres outside the cavity at the mating juncture of another optical fiber or a junction box. Therefore, the construction of the optical connector with the outer shell with potted cavity and elastomeric member may replace the use of multiple high tolerance coupling components, thereby cutting down the cost and eliminating the need of the complex assembly process to couple these

components. Further, unlike the conventional optical connector, the optical connector of the present disclosure provides a protection up to a level of the optical fibers since the structure facilitates direct contact with the potting compound.

[0033] According to an embodiment, the optical connector further comprises: a protective cap to close the opening on the outer shell through which the potting compound is applied into the cavity.

[0034] According to an embodiment, the elastomeric member is positioned in the outer shell with a clearance to expand and contract under influence of a compressive force from another optical connector or the junction box such that the elastomeric member contracts at the mating juncture closing a gap between two optical connectors or between the optical connector and the junction box.

[0035] According to an embodiment, one end of the optical fibres and at least one portion of the one or more ferrules comprises a mating end portion structured and polished to establish the optical connection with another set of optical fibres and ferrules at the mating juncture.

[0036] In the following detailed description of exemplary embodiments of the disclosure, specific representative embodiments in which the disclosure may be practiced are described in sufficient detail to enable those skilled in the art to practice the disclosed embodiments. For example, specific details such as specific method orders, structures, elements, and connections have been presented herein. However, it is to be understood that the specific details presented need not be utilized to practice embodiments of the present disclosure. It is also to be understood that other embodiments may be utilized and that logical, architectural, programmatic, mechanical electrical and other changes may be made without departing from the general scope of the disclosure. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the present disclosure is defined by the appended claims and equivalents thereof.

[0037] FIG. 1 illustrates a perspective view of two optical connectors 102, 104 establishing an optical connection between two optical fiber cables 101, 103 in accordance with an embodiment of the present disclosure. The exemplary embodiment 100 discussed herein with FIG. 1 is for two optical connectors 102, 104 establishing the optical connection, however, it is well understood by a skilled person that the optical connection may be established between an optical connector and a junction box or other scenarios in which optical connectors 102, 104 are used for establishing the optical connections. Therefore, it is to be understood that the solution proposed in present disclosure are not to be limited to coupling of only two optical

connectors 102, 104 to establish the optical connection and such disclosure of the coupling of the two optical connectors 102, 104 are for the purpose of illustration and ease of explanation.

[0038] In the exemplary environment 100 as shown in FIG. 1, a first optical connector 102 is coupled to a second optical connector 104 to establish the optical connection. The first optical connector 102 and the second optical connector 104 may include an outer shell 106 containing the optical fiber cable. In some examples, the optical connector 102 may be used to establish the optical connection between multiple optical fiber cables to transmit data over optical fibers by turning electronic signals into light. The optical connection is established by mating at least one end of a first optical fiber or a first group of optical fibers with at least one end of a second optical fiber or a second group of optical fibers and so on to transmit the data. In some examples, the optical connection is established by mating at least one end of an optical fiber or a group of optical fibers with a junction box to establish the optical connection. According to an embodiment, at least one end of the optical fibers structured to establish the optical connection with another set of optical fibers or the junction box is positioned within the outer shell 106. Such a construction with at least a portion of the optical fiber cables within the outer shell 106 may be provided to ensure that mating ends of the optical fibers of the optical fiber cables are protected against extreme weather conditions or environments such as at a subsea level.

[0039] In some examples, the outer shell 106 is made of a stainless-steel material such as, but not limited to, SS316 stainless steel or SS304 stainless steel which are resistant to corrosion when exposed to elevated temperature and pressure. In some examples, the outer shell 106 may be cylindrical with a first end 108 with an aperture (not shown) to receive the optical fiber cable 101 and a second end 110 which radially extends as a circular plate structure 111 formed integrally on the outer shell 106. In some examples, the first end 108 includes a cylindrical boss 108a with the aperture to receive the optical fiber cable 101 and a screw (not shown) to tighten a portion of the optical fiber cable 101 abutting the first end 108. Such a provision may be provided to ensure that the optical fiber cable 101 has a relatively high pull-strength and to avoid stretching. For example, the pull-strength may be a maximum holding strength imparted to the optical fiber cable 101 when subjected to a maximum pulling tension. The circular plate structure 111 includes multiple holes to receive fasteners such as screws, nuts, bolts, and washers. In some examples, the circular plate structure 111 includes structural provisions to operate as bayonet type connector in which plug part is pushed into the socket part and turned to make a tight connection as generally known in the art. As shown in FIG. 1, the circular plate structure 111 of the outer shell 106 of first optical connector 102 is coupled with another

circular plate structure 111 of the second optical connector 104 to establish the optical connection between the two optical fiber cables.

[0040] FIG. 2 illustrates a perspective close-up view of an end portion of an exemplary optical fiber cable 101 within the optical connector 102, in accordance with an embodiment of the present disclosure. The exemplary embodiment discussed herein with FIG. 2 illustrates a particular type of optical fiber cable 101, however, it is well understood by a skilled person that any optical fiber cable generally known in the art for establishing the optical connection through the optical connector 102 may be used. Therefore, it is to be understood that the solution proposed in present disclosure are not to be limited to coupling of only the type of optical fiber cables discussed herewith the description and such disclosure of the type of optical fiber cables and their components, material used are for the purpose of illustration and ease of explanation without narrowing the scope of the present disclosure.

[0041] Generally, as known in the art, the optical fiber cable 101 may of three types such as simplex, duplex, and multifiber based on the number of optical fibers enclosed within the cable. For example, Simplex cables are fiber optic cables with a single optical fiber and multifiber cable is a fiber optic cable with several optical fibers. It is understood that the optical connectors 102, 104 of the present disclosure are capable of being used with one or more of the types of optical fiber cables as mentioned.

[0042] Generally, as known in the art, an optical fiber 208 consists of three concentric elements, the core, the cladding and the outer coating. The core is usually made of glass or plastic. The core is the light-carrying portion of the fiber. The cladding surrounds the core. The cladding is made of a material with a slightly lower index of refraction than the core. This difference in the indices causes total internal reflection to occur at the core-cladding boundary along the length of the fiber. Light is transmitted down the fiber and does not escape through the sides of the fiber. Three types of optical fibers are known such as Multimode step-index fibers, multimode graded-index fiber and single mode fiber. It is understood that the optical connectors 102, 104 of the present disclosure and the associated optical fiber cables are capable of being used with one or more of the types of optical fibres as mentioned.

[0043] According to an embodiment, the optical fiber 208 is protected by one or more protective elements 202, 204, 206. The protective elements 202, 204, 206 ensure that the core of the optical fiber 208 is protected to facilitate uninterrupted communication under extreme weather conditions or environment such as at the subsea level. The dimensions and the materials of these protective elements 202, 204, 206 may vary based on the type of application or type of optical fibres or cables being employed. As shown in FIG. 2, the one or more

protective elements 202, 204, 206 include least one of High-density polyethylene (HDPE) sheath 202, Stainless Steel braids or Galvanized Improved Plow Steel (GIPS) braids 204, and stainless-steel tube or pipe 206 or their combination. In some examples, the optical fiber cable enclosing these protective elements 202, 204, 206 may be an Ultraviolet (UV) stable High density Polyethylene type cable. The end portions of the one or more protective elements 202, 204, 206 and the optical fiber 208 may be exposed as shown in FIG. 2. According to an embodiment, exposed end portions 211 are positioned inside the outer shell 106 of the optical connector 102 of FIG. 1. In some examples, the exposed end portions 211 may be the mating portions of the optical fiber cable 101 for establishing the optical connection. In some examples, a tip or one end of the optical fiber 208 which is exposed may be structured to mate with another optical fiber or a junction box through the optical connector 102 to establish the optical connection.

[0044] FIG. 3 illustrates a perspective schematic view of one of the optical connectors 102, 104 of FIG. 1, in accordance with an embodiment of the present disclosure. According to an embodiment, the outer shell 106 of the optical connector 102 includes a cavity 302 and an opening 304. As previously discussed, the exposed end portions 211 are positioned inside the outer shell 106 of the optical connector 102. For example, the exposed end portions 211 are positioned inside the cavity 302 of the outer shell 106. As shown in FIG. 3, the optical fiber cable 101 is inserted through the first end 108 of the outer shell 106 and terminates at the second end 110 of the outer shell 106 on the circular plate structure 111. It is seen that the one or more protective elements 202, 204, 206 and the optical fibers 208 are exposed within the cavity 302 and unexposed (i.e., contained) within the optical cable outside the cavity 302. Such an arrangement is provided to ensure safety of the protective elements 202, 204, 206 and the optical fiber 208 at the juncture of the optical fiber cable 101 in which the optical connector 102 is installed.

[0045] According to an embodiment, a potting compound 306 is poured or applied inside the cavity 302 through the opening 304 provided in the outer shell 106. For example, the potting compound 306 may be an epoxy potting compound, an urethane potting compound, a silicone potting compound, or a polyacrylate potting compound. In some examples, Epirez Epoxy Compound (8837) may be used as a potting compound 306 which offers high impact resistance and dimensional stability. According to an embodiment, the optical fibres 208, the one or more protective elements 202, 204, 206 are in direct exposure to the potting compound 306 inside the cavity 302. For example, the optical fiber cable 101 is inserted and the exposed end portions 211 of the optical fiber 101 within the cavity 302 is exposed to the potting

compound 306 when it is poured through the opening 304 on the outer shell 106 into the cavity 302. The potting compound 306 may spread evenly throughout the cavity 302 and fill the cavity 302 with a direct contact with the protective elements 202, 204, 206 and the optical fibers. In some examples, the potting compound 306 is dispensed into the cavity 302 automatically by a dispenser or manually by use of a piston-cylinder. In some examples, the potting compound 306 and a hardener are mixed in proper ratios by the dispenser automatically and dispensed at a proper speed through the opening 304 in order to fill the cavity 302. The potting compound 306 may be hardened after a specified time period encasing the exposed end portions 211 of the optical fiber cable.

[0046] According to an embodiment, a vacuum may be created inside the cavity 302 while pouring or before pouring the potting compound 306 through the opening 304 of the optical connector 102. For example, air and moisture are removed from the cavity 302 so that when the potting compound 306 is hardened, air bubbles are not formed resulting in a weak bonding to the components inside in the cavity 302. For example, Anaerobic Vacuum Chambers may be provided to create the required vacuum inside the cavity 302 while the potting compound 306 is dispensed or mixed in proper ratios inside the cavity 302. Such air-free or void-free vacuum potting may provide a strong bonding with the components inside in the cavity 302, thereby protecting it from stress, vibration, or other extreme environments with elevated pressure and temperature. In some examples, the cavity 302 is treated by spraying a primer and cleaning an interior surface of the cavity 302 for oil and water for better adhesion of potting compound 306 to the interior surface of the cavity 302 and the optical fiber cable 101. According to an embodiment, the optical connector 102 may include a protective cap 308 to close the opening 304 through which the potting compound 306 is poured into the cavity 302. The cap 308, for example, may be cork type or screw type caps. The opening 304 may include threads or grooves and the screw type cap twists into grooves closing the opening 304. In some examples, the cork type cap may be fitted into the opening 304 through interference fits tightly sealing the opening 304. In some examples, the opening 304 may also be sealed using the same potting compound 306 as dispensed in the cavity 302 or a different potting compound 306.

[0047] According to an embodiment, the optical connector 102 includes a ferrule plate 402 and an elastomeric member 502 detachably coupled to the outer shell 106. FIG. 4 illustrates a partial exploded view of one of the two optical connectors 102, 104 of FIG. 1 showing the ferrule plate 402, in accordance with an embodiment of the present disclosure. The ferrule plate 402 comprises one or more apertures 403 to secure one or more ferrules 401 attached to one end of the optical fibres 208. For example, the ferrules 401 are cylindrical structures that holds

the optical fiber 208. The ferrules 401 my include a hollowed-out center that forms a tight grip on the optical fiber 208. Ferrules 401 may be made from ceramic, metal, or high-quality plastic. The ferrules 401 may be of different diameters structure to hold a single optical fiber or a group of optical fibers. In some examples, the core and cladding of the optical fiber 208 with the protective elements 202, 204, 206 removed is inserted through the hollowed-out center and usually bonded by an adhesive such as an epoxy or any other bonding materials. According to an embodiment, the one end of the optical fibers attached to the ferrules 401 or at least one portion of the ferrules 401 may include a mating end portion structured and polished to be suitable for the optical connection with another ferrule of a complementary/second optical connector 104 enclosing another set of the optical fiber 208. According to embodiment, the one or more apertures 403 of the ferrule plate 402 extending therethrough is axially aligned with the one or more ferrules 401 to firmly hold the one or more ferrules 401 with the optical connector 102.

[0048] FIG. 5 illustrates a partial exploded view of the two optical connectors 102, 104 of FIG. 1 showing the elastomeric member 502, in accordance with an embodiment of the present disclosure. As previously discussed, the elastomeric member 502 detachably coupled to the outer shell 106. For example, the elastomeric member 502 may be O-rings which are provided as sealing component in the shape of a doughnut designed to fixed to be seated on the optical connector 102 under influence of a compressive force. For example, the O-rings may be made of a rubber material. The elastomeric member 502 may facilitate coupling of the optical connector 102 with another complementary/second optical connector 104 without any gaps between the two optical connectors. In other words, the elastomeric member 502 may seal a gap which may exist after the coupling of the two optical connectors. The gap may exist in a mating juncture between the two optical connectors. The elastomeric member 502 may expand and compress under the influence of the compressive force imparted by the coupling of the optical connector 102 with another complementary/second optical connector 104. The two optical connectors 102, 104 may be connected using suitable fasteners as known in the art with the elastomeric member 502 sandwiched between the two optical connectors.

[0049] According to an embodiment, an outer shell 106 includes the cavity 302, the opening 304, a groove 503 and a slot 404. As shown in FIGS. 4 and 5, the ferrule plate 402 is positioned in the slot 404 and the elastomeric member 502 is positioned in the groove 503. The elastomeric member 502 may have a cylindrical surface coaxial with the cylindrical surface coaxial of the groove 503. The elastomeric member 502 may be disposed around the circumferential surface of the groove 503 and is secured to the groove 503 with a clearance.

As discussed, previously, the elastomeric member 502 may compress and expand within the groove 503 under the influence of the compressive force imparted by the coupling of the optical connector 102 with another complementary/second optical connector 104. The compression and expansion caused the elastomeric member 502 to close the gap which may exist at the mating juncture. As discussed previously, the mating juncture is a location at which the mating end portion of the optical fibres 208 and the at least one portion of the one or more ferrules 401 abuts the ferrules 401/optical fibers 208 of the complementary/second optical connector 104 to establish the optical connection. Therefore, a gap in the mating juncture may cause a failure of the optical connection particularly when installed at the subsea level. According to an embodiment, the elastomeric member 502 protects the one end of the optical fibres 208 and at least a portion of the one or more ferrules 401 considered to be at the mating juncture to establish the optical connection.

[0050] FIGS. 6 and 7 illustrates a partial fragmentary schematic view of the optical connector 102 of FIG. 3 without the potting compound 306, in accordance with an embodiment of the present disclosure. As shown in FIG. 6, the cavity 302 of the outer shell 106 includes the exposed end portions 211 of the optical fiber cable 101 in which the ferrule 401 is attached to the tip or one end of the optical fiber 208. The ferrule plate 402 is shown to receive the ferrule 401 to ensure proper alignment of the optical fiber 208 with the complimentary/second optical connector 104. As shown in FIG. 6 and FIG. 7, one of the protective elements which may be the Stainless-Steel braids or Galvanized Improved Plow Steel (GIPS) braids 204 may be connected to an interior surface of the cavity 302. For example, each strand of the steel braids or a group of strands may be connected to the interior surface 601 of the cavity 302 through suitable fasteners 602, for example, a nut, a bolt, and a washer. In some examples, the strands of the steel braids may be distributed randomly inside the cavity 302 while potting using the potting compound 306. Such a provision may be provided to ensure that the optical fiber cable 101 has a relatively high pull-strength and to avoid stretching. For example, the pull-strength may be the maximum holding strength imparted to the optical fiber cable 101 when subjected to the maximum pulling tension.

[0051] FIG. 8 illustrates a cross sectional view of the two optical connectors 102, 104 of FIG. 1 establishing an optical connection between two optical fiber cables 101, 103 in accordance with an embodiment of the present disclosure. As shown in FIG. 8, the optical fibers of the first optical connector 102 and the second optical connector 104 are abutting each other at the mating juncture at which the elastomeric member 502 is compressed or squeezed within the groove to close the gap at the mating juncture providing a protecting to the mating

end of the optical fibers 208. According to an embodiment, as shown in FIG. 8, the optical fiber cable 102, the one or more optical fibres 101 and the one or more ferrules 401 are in a direct exposure to the potting compound 306 contained within the cavity 302. For example, the potting compound 306 may be an epoxy resin. It is seen from FIG. 8 that the potting compound 306 is dispensed and distributed evenly through the cavity 302 having a direct contact with the exposed end portions 211 of the optical fiber 208 which includes the protective elements 202, 204, 206 and at least a portion of the optical fiber 208 to be employed at the mating juncture to establish the optical connection. In this regard, the optical fiber cable 102 and the optic fiber 208 at the location of the optical connector 102 is protected through the potting compound 306 within the outer shell 106 with the mating end portion of the optical fiber 208 protected through the elastomeric member 502s. Accordingly, the optical connector 102 is designed and structured using fewer components such as the outer shell 106, the ferrule plate 402, the potting compound 306 and elastomeric member 502 to protect at least a portion of the optical fiber 208 dedicated to establishing the optical connection. In this regard, at the event of failure of the protective elements 202, 204, 206 of the optical fiber cable 101, the optical fiber 208 would still be protected as the cavity 302 in which the optical fiber 208 is positioned is potted with the potting compound 306. For example, at the subsea level, if the water enters the protective elements 202, 204, 206, the optical fiber 208 may be unaffected since the potting compound 306 may stop the intrusion of water as it is in direct contact with the optical fiber 208. In this regard, the optical connector 102 of the present disclosure is robust, cheap and provided protection up to the level of optical fiber 208 in addition to the protective elements 202, 204, 206 under extreme weather conditions or environment.

[0052] FIG. 9 illustrates a flowchart of method for establishing the optical connection, in accordance with an embodiment of the present disclosure. As illustrated in FIG. 9, the method 900 includes one or more blocks illustrating a method for controlling oxygen supply equipment. The method 900 may be described in the general context of computer executable instructions. Generally, computer executable instructions may include routines, programs, objects, components, data structures, procedures, modules, and functions, which perform specific functions or implement specific abstract data types.

[0053] The order in which the method 900 is described is not intended to be construed as a limitation, and any number of the described method blocks may be combined in any order to implement the method. Additionally, individual blocks may be deleted from the methods without departing from the spirit and scope of the subject matter described.

[0054] An optical connection may be established between optical connectors or between an optical connector and a junction box. For example, a first optical connector is coupled to a second optical connector to establish the optical connection. The first optical connector and the second optical connector may include an outer shell containing the optical fiber cable. In some examples, the optical connector may be used to establish the optical connection between multiple optical fiber cables to transmit data over optical fibers by turning electronic signals into light. The optical connection is established by mating at least one end of a first optical fiber or a first group of optical fibers with at least one end of a second optical fiber or a second group of optical fibers and so on to transmit the data. The process of establishing the optical connection begins at block 902 in which the optical cable may be positioned within a cavity in the outer shell of the optical connector. The optical cable includes optical fibres, one or more ferrules and one or more protective elements secured throughout a length of the cables. The protective elements ensure that the core of the optical fiber is protected to facilitate uninterrupted communication under extreme weather conditions or environment such as at the subsea level. The dimensions and the materials of these protective elements may vary based on the type of application or type of optical fibres or cables being employed. The one or more protective elements include least one of High-density polyethylene (HDPE) sheath, Stainless Steel braids or Galvanized Improved Plow Steel (GIPS) braids, and stainless-steel tube or pipe or their combination. At block 904, an epoxy resin which is a potting compound is poured or dispensed through an opening of the optical connector such that the epoxy resin fills the cavity and directly contacts the optical fibres, the one or more ferrules and the one or more protective elements. In some examples, the potting compounds are dispensed into the cavity automatically by a dispenser or manually by use of a piston-cylinder. In some examples, the potting compound and a hardener are mixed in proper ratios by the dispenser automatically and dispensed at a proper speed through the opening in order to fill the cavity. The potting compound may be hardened after a specified time period encasing the exposed end portions of the optical fiber cable. According to an embodiment, a vacuum is created inside the cavity while pouring an epoxy resin through the opening of the optical connector.

[0055] At block 906, an elastomeric member is secured on the optical connector under influence of a compressive force. The elastomeric member protects one end of the optical fibres and at least a portion of the one or more ferrules at a mating juncture. The mating juncture may be a location at which the mating end portion of the optical fibres and the at least one portion of the one or more ferrules abuts the ferrules/optical fibers of the complementary/second optical connector to establish the optical connection. In other words, the elastomeric member may seal

a gap which may exist after the coupling of the two optical connectors at the mating juncture between the two optical connectors. The elastomeric member may expand and compress under the influence of the compressive force imparted by the coupling of the optical connector with another complementary/second optical connector. The two optical connectors may be connected using suitable fasteners as known in the art with the elastomeric member sandwiched between the two optical connectors. The optical fibres of the first optical connector and the second optical connector are abutting each other at the mating juncture at which the electrometric member is compressed or squeezed within the groove to close the gap at the mating juncture providing a protecting to the mating end of the optical fibers. At block 908, the one end of the optical fibres and at least a portion of the one or more ferrules at the mating juncture are coupled to at least one of another set of optical fibres or a junction box to establish the optical connection. In this regard, process includes establishing the optical connection by securing the optical fiber cable using the outer shell, potting compound, and elastomeric member of the optical connector.

[0056] The various embodiments described above are provided by way of illustration only and should not be construed to limit the claims attached hereto. Those skilled in the art will readily recognize various modifications and changes that may be made without following the example embodiments and applications illustrated and described herein, and without departing from the true spirit and scope of the following claims.

CLAIMS

I/We claim:

1. An optical connector 102, 104 for providing an optical connection for one or more optical fibre cables 101, 103 in which the cables 101, 103 include optical fibres 208 and one or more protective elements 202, 204, 206 secured throughout a length of the cables 101, 103, and wherein the optical connector 102 comprises:

an outer shell 106 comprising a cavity 302 and an opening 304, wherein the cavity 302 is potted with a potting compound 306 through the opening 304; and

a ferrule plate 402 and an elastomeric member 502 detachably coupled to the outer shell 106, wherein the ferrule plate 402 comprises one or more apertures 403 to secure one or more ferrules 402 attached to one end of the optical fibres 208, and wherein the elastomeric member 502 protects the one end of the optical fibres 208 and at least a portion of the one or more ferrules 401 at a mating juncture; and

wherein the optical fibres 208, the one or more protective elements 202, 204, 206, and the one or more ferrules 401 enclosing the optical fibres 208 are in direct exposure to the potting compound 306.

2. The optical connector 102, 104 of claim 1, wherein the potting compound 306 is one of an epoxy potting compound, an urethane potting compound, a silicone potting compound, or a polyacrylate potting compound.

3. The optical connector 102, 104 of claim 1, wherein the one or more protective elements 202, 204, 206 comprises at least one of High-density polyethylene (HDPE) sheath 202, Stainless Steel braids or Galvanized Improved Plow Steel (GIPS) braids 204, and stainless-steel tube or pipe 206 or their combination, wherein one or more stands of the steel braids 204 may be attached to the cavity 302.

4. The optical connector 102, 104 of claim 1, wherein the outer shell 106 comprises a groove 503 and a slot 404, wherein the elastomeric member 502 is positioned in the groove and 503 the ferrule plate 402 is positioned in the slot 404.

5. The optical connector 102, 104 of claim 4, wherein the elastomeric member 502 is positioned within the groove 503 with a clearance to expand and contract under influence of a compressive force.

6. The optical connector 102, 104 of claim 1, wherein the optical connector 102 further comprises: a protective cap 308 to close the opening 304 on the outer shell 106 through which the potting compound 306 is applied into the cavity 302.

7. The optical connector 102, 104 of claim 1, wherein the one end of the optical fibres 208 and the at least one portion of the one or more ferrules 401 comprises a mating end portion structured and polished to establish the optical connection with another set of optical fibres and ferrules at the mating juncture.

8. An optical connector 102, 104 for providing an optical connection, the optical connector comprises:

an outer shell 106 comprising a cavity 302, an opening 304, a groove 503 and a slot 404, wherein the cavity 302 is filled with an epoxy resin applied through the opening 304, and wherein an optical fibre cable 101 is contained within the cavity 302;

a ferrule plate 402 and an O-ring 502 detachably coupled to the outer shell 106, wherein the ferrule plate 402 comprises one or more ferrules 401 structured to enclose at least one end of one or more optical fibres 208 extending from the optical fibre cable 101, and wherein the O-ring 502 is positioned in the groove 503 and the ferrule plate 402 is positioned in the slot 404; and

wherein the optical fibre cable 101, the one or more optical fibres 208 and the one or more ferrules 401 are in a direct exposure to the epoxy resin contained within the cavity 302.

9. A method for establishing an optical connection comprising:

positioning 902 an optical fibre cable within a cavity of an optical connector, wherein the optical fibre cable includes optical fibres, one or more ferrules and one or more protective elements secured throughout a length of the cables;

pouring 904 an epoxy resin through an opening of the optical connector such that the epoxy resin fills the cavity with a direct contact to the optical fibres, the one or more ferrules and the one or more protective elements;

securing 906 an elastomeric member on the optical connector under influence of a compressive force, wherein the elastomeric member protects one end of the optical fibres and at least a portion of the one or more ferrules at a mating juncture; and

coupling 908 the one end of the optical fibres and at least a portion of the one or more ferrules at the mating juncture to at least one of another set of optical fibres or a junction box to establish the optical connection.

10. The method of claim 9, further comprising:

creating a vacuum inside the cavity while pouring an epoxy resin through the opening of the optical connector.

Dated this 19th day of March 2022

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ABSTRACT

LOW-COST OPTICAL CONNECTOR

An optical connector for providing an optical connection for one or more optical fibre cables, in which the cables include optical fibres and one or more protective elements secured throughout a length of the cables. The optical connector includes an outer shell comprising a cavity and an opening, wherein the cavity is potted with a potting compound through the opening. A ferrule plate and an elastomeric member detachably coupled to the outer shell, wherein the ferrule plate comprises one or more apertures to secure one or more ferrules attached to one end of the optical fibres, and wherein the elastomeric member protects the one end of the optical fibres and at least a portion of the one or more ferrules at a mating juncture. The optical fibres, the protective elements, and the ferrules enclosing the optical fibres are in direct exposure to the potting compound.

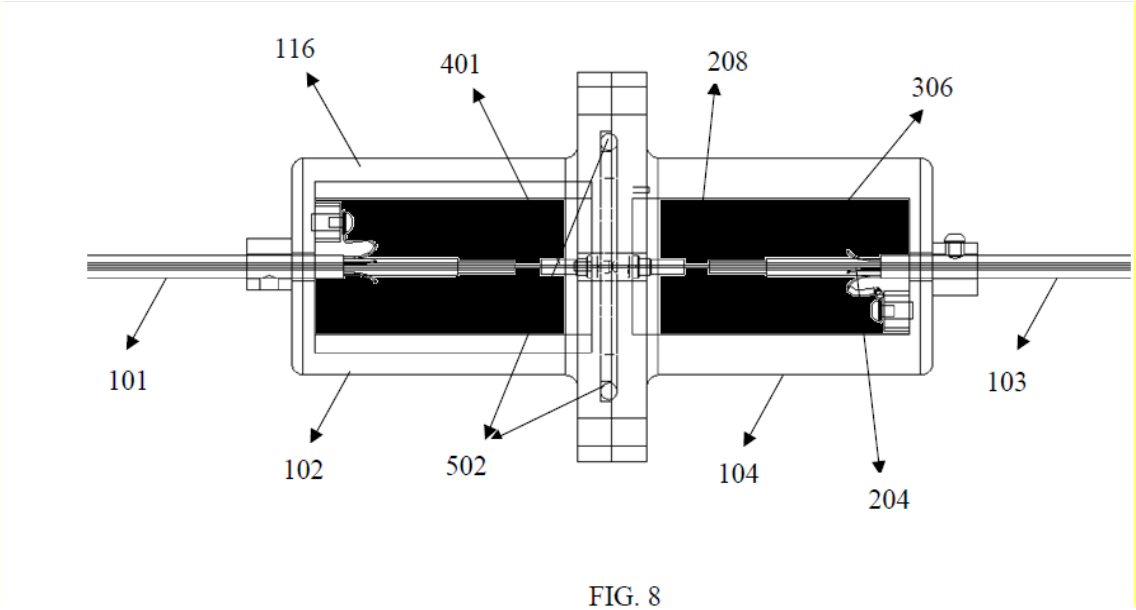

FIG. 8

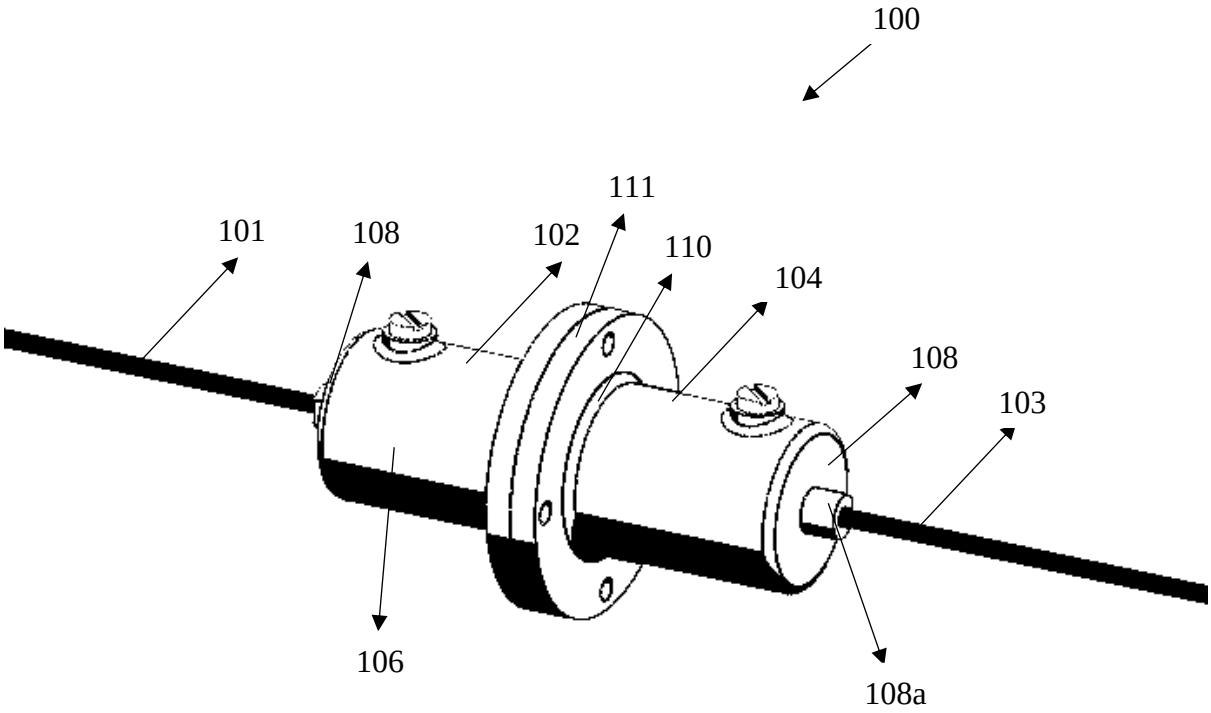

FIG. 1

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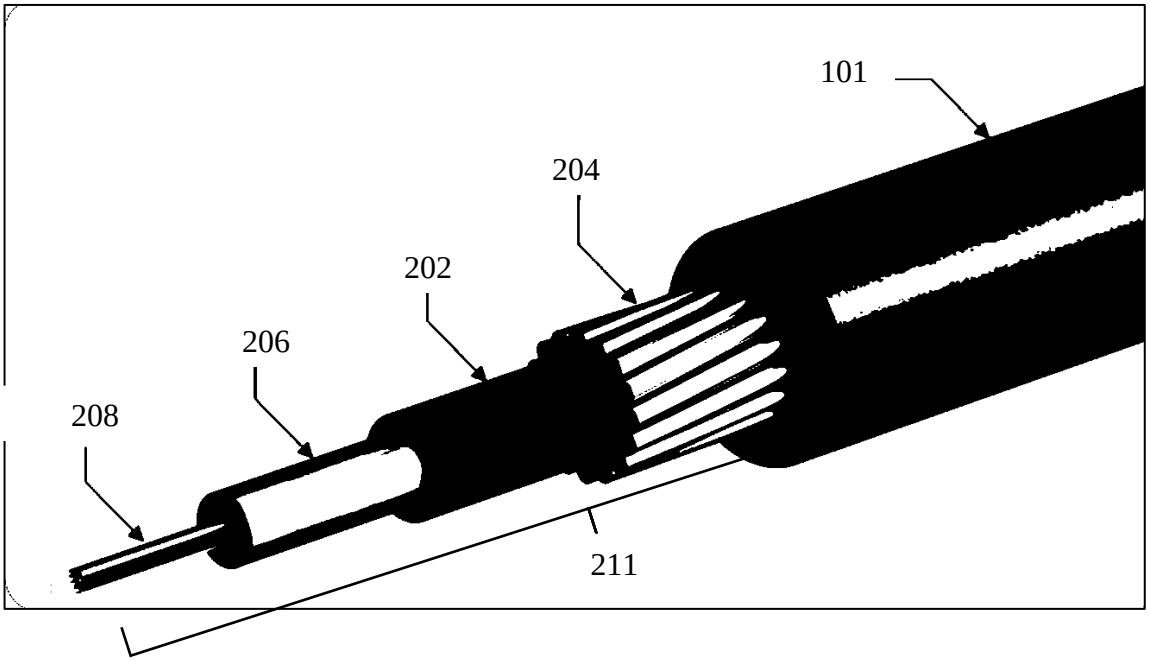

FIG. 2

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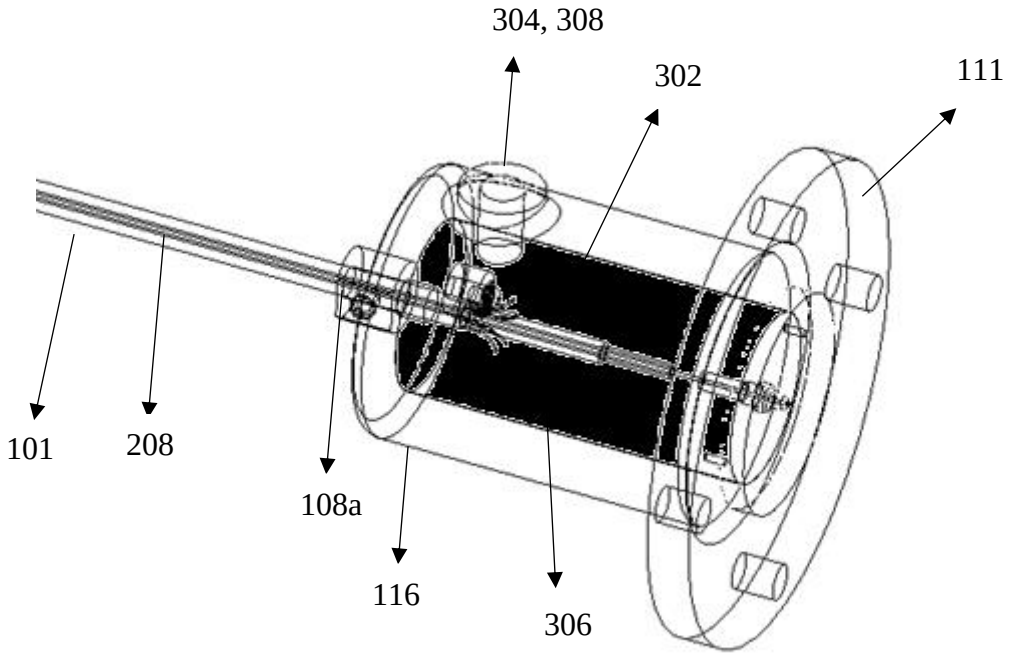

FIG. 3

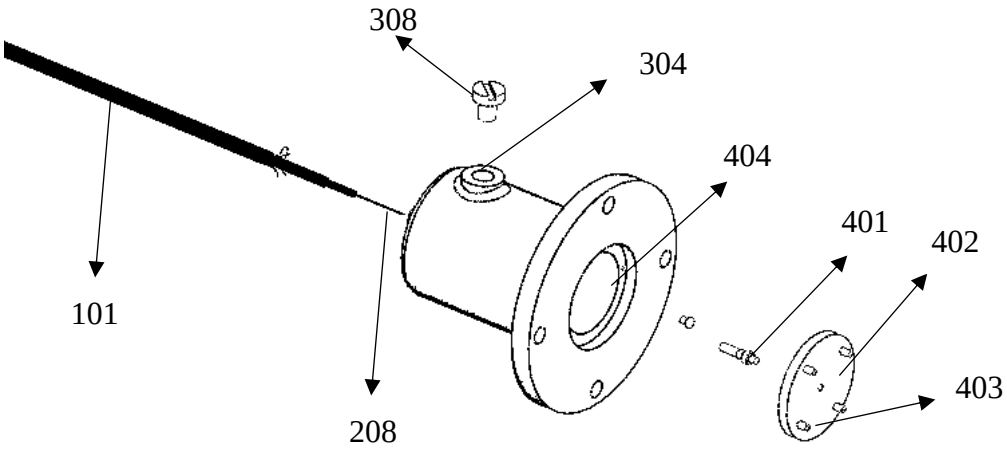

FIG. 4

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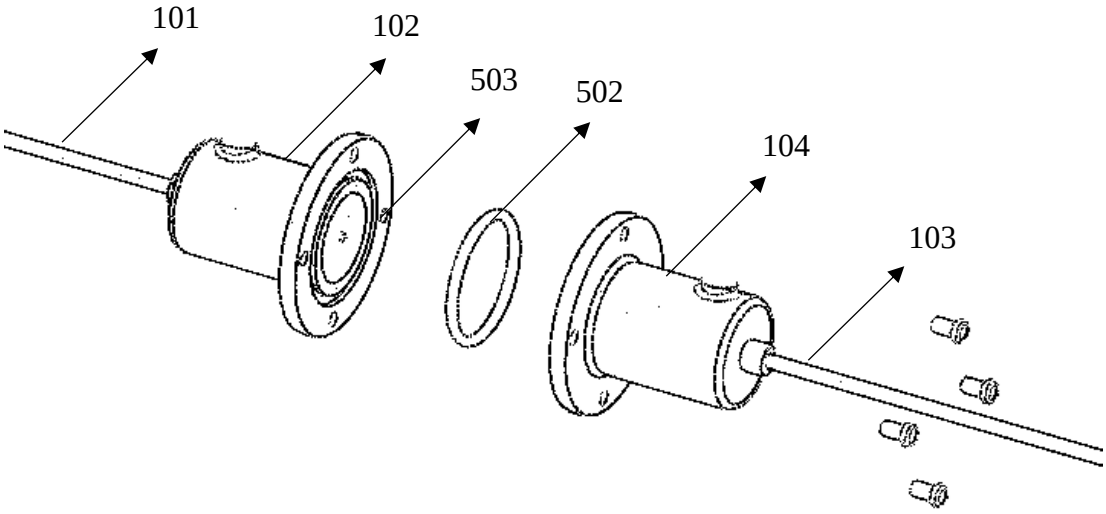

FIG. 5

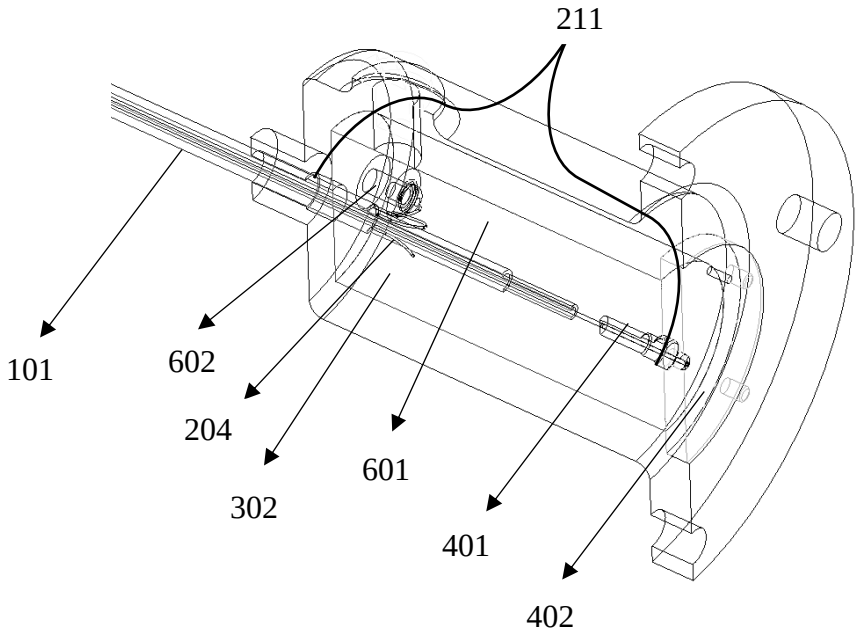

FIG. 6

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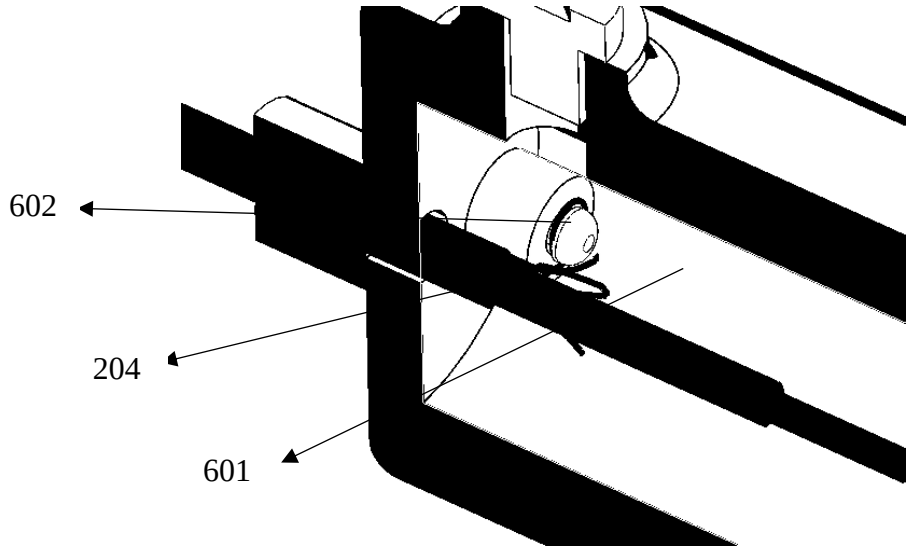

FIG. 7

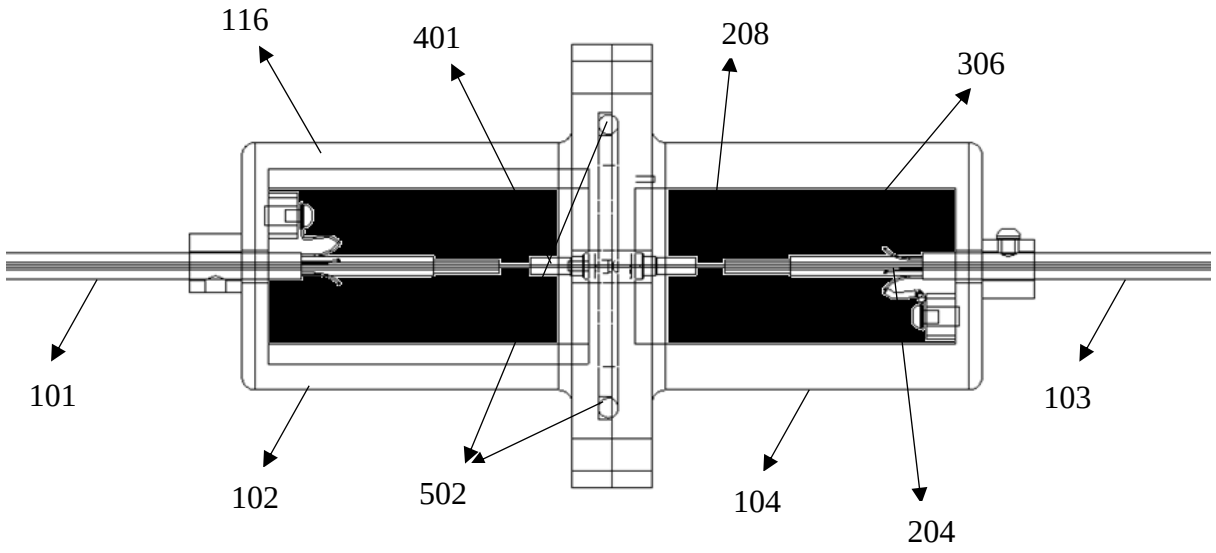

FIG. 8

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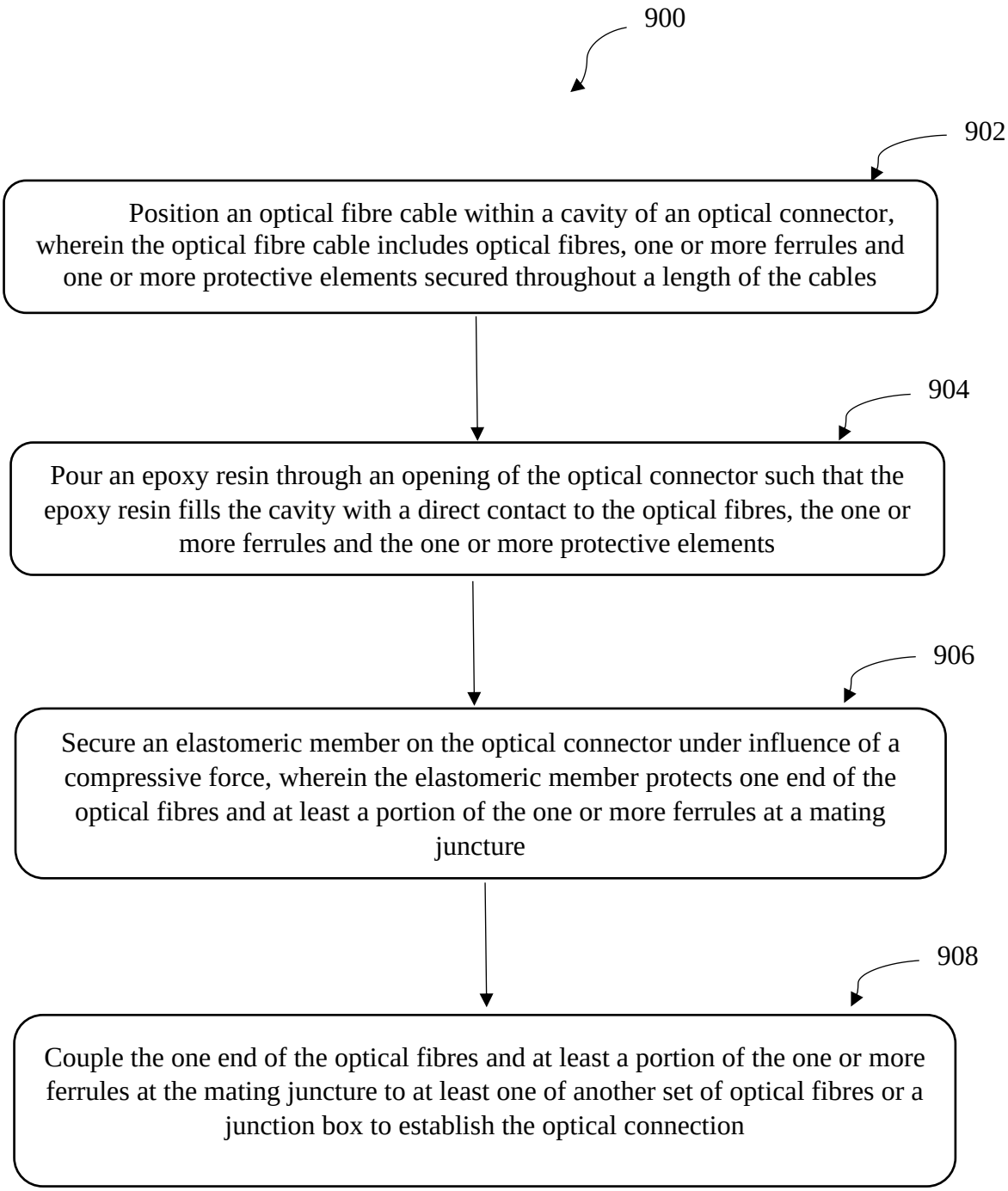

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