United States Patent

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[54] **UNDERWATER CONNECTOR**
1 Claim, 4 Drawing Figs.

[52] **U.S. Cl.** ..... **339/60 M,** 339/94 M, 339/117 R, 339/182 R
[51] **Int. Cl.** **H01r 13/52**
[50] **Field of Search** 339/59–61, 94, 117, 182, 183

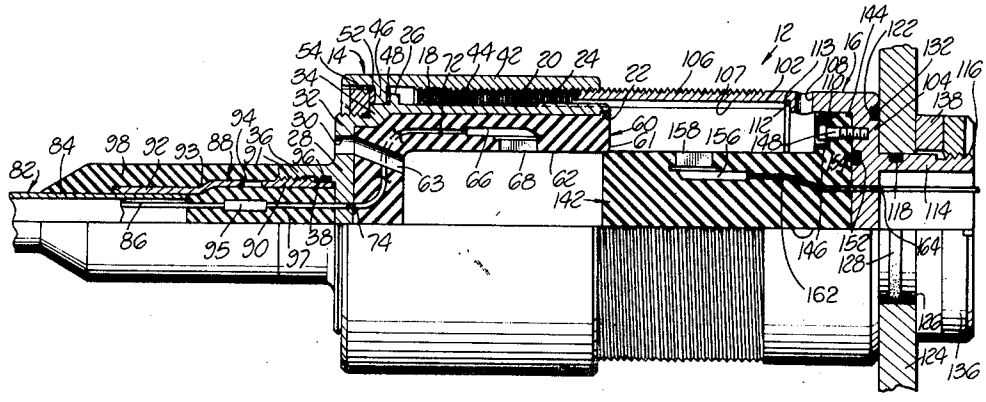
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ABSTRACT: The disclosure relates to an underwater electrical connector comprising a plug connector and receptacle connector which are mechanically mated positively locking the connectors together. Inserts in each of the connectors contain contacting surfaces. The inserts are slidably engaged to provide a squeegee wiping action, forcing water out of the connectors through ports during the mating. The contacting surfaces are mounted flush with the surface of the inserts.



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SHEET 1 OF 2

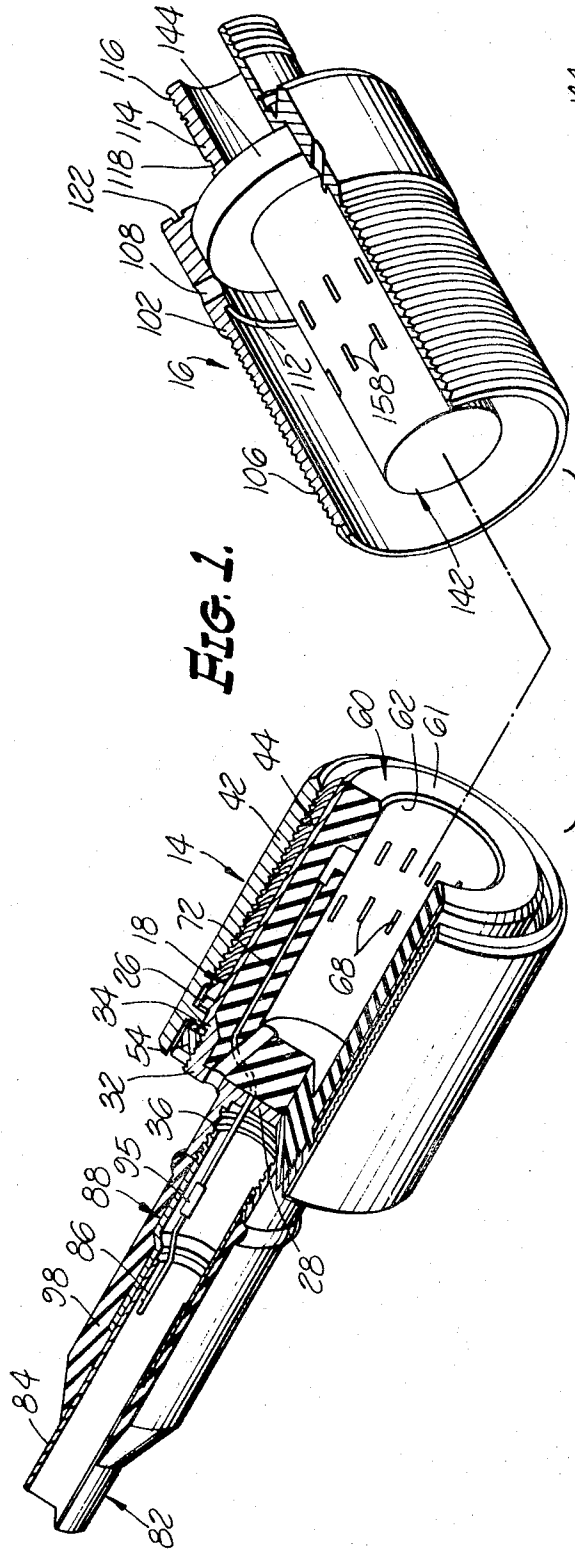


FIG. 1.

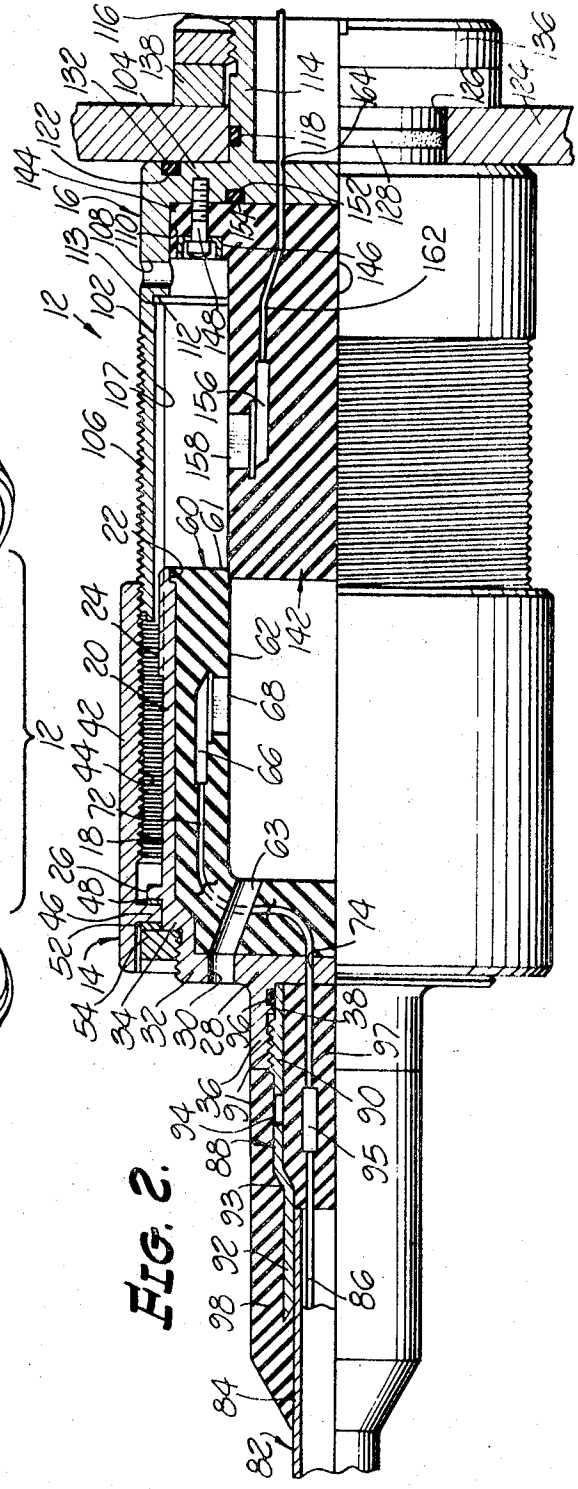


FIG. 2.

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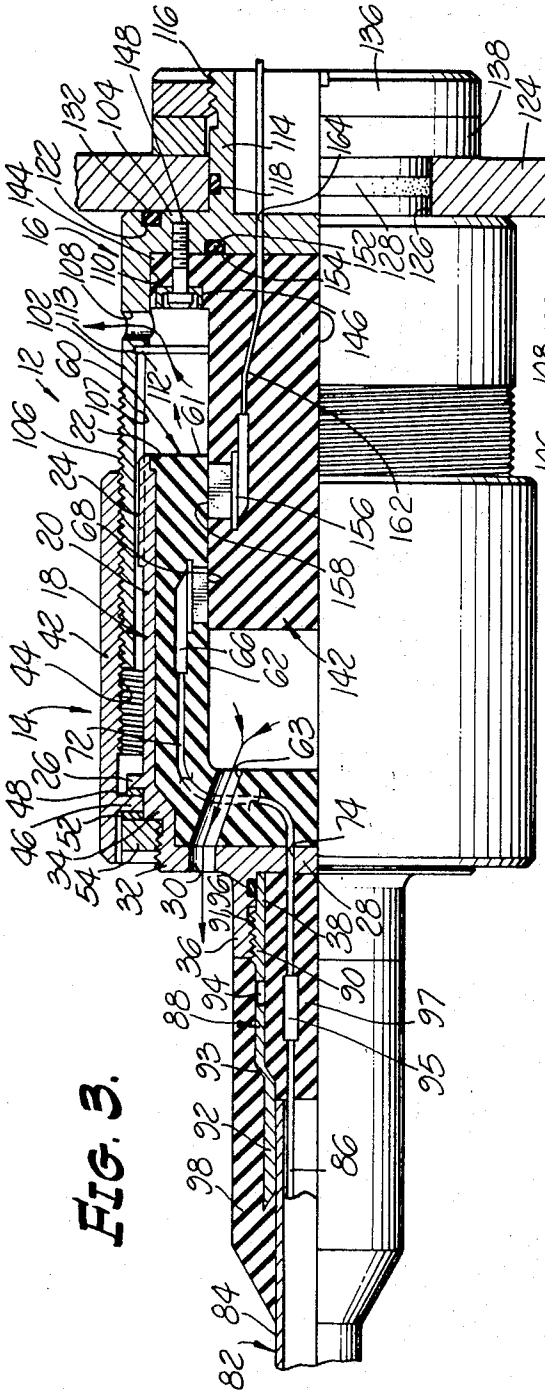


FIG. 3.

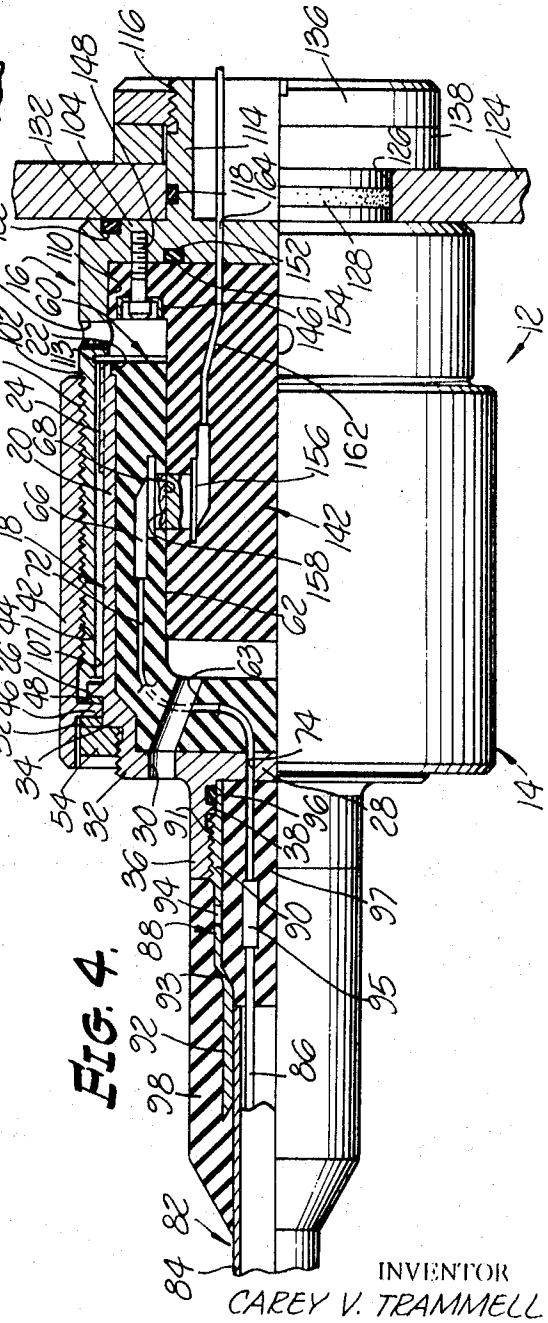


FIG. 4.

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UNDERWATER CONNECTOR

This invention relates in general to underwater electrical connectors, and more particularly, to a mulitple-contact electrical connector capable of being mated underwater.

BACKGROUND OF THE INVENTION

With the advent of rapid growth in oceanographic exploration it has become necessary to provide underwater electrical equipment which is both reliable and relatively inexpensive. While underwater electrical connectors have previously been developed which allow mating or unmating while submerged, the most successful underwater electrical connectors to date require that the mating occur above the water surface prior to an exposure to an underwater environment. With the use of electronic equipment a greater and greater depths, however, it has been mandatory that such mating and unmating occur below the water surface, thus, necessitating highly reliable underwater connectors.

Normally, underwater connector devices use a line-on-line (interference-type fit) or O-ring type sealing member to prevent the entrance of liquid into the electrified portions of the mated connectors, thus, relying primarily upon an interference or compression of resilient members for sealing of internal components. Connectors that can be mated or unmated while submerged have inadequate or no mechanical advantage to add in the mating or unmating of the connectors. Further, these connectors have been limited as to the number of electrical contacts which can be utilized due to the inadequacy of mating and unmating and the inability to overcome great fractional and hydrostatic mating forces without adequate mechanical advantage provisions. Moreover, once the mating has occurred, adequate locking provisions of the connectors has not been provided and component friction has been primarily utilized to hold the mated connectors together.

In order to overcome the attendant disadvantages of prior art underwater electrical connectors which may be mated or unmated while submerged, the present invention provides a mechanical advantage during underwater connector mating and unmating enabling the usage of the connectors at greater depths than has been previously utilized and allowing a greater number of electrical contacts to be included in the connector. Further, the connector enables the addition of a larger number of individual contacts to the body of the connector without a sizable increase in overall connector diameter thus, minimizing the ratio of connector diameter to contact density. Moreover, a positive mechanical lock is provided which prevents inadvertent premature disengagement of the connectors, thereby breaking or shorting out circuitry associated therewith.

SUMMARY OF THE INVENTION

More particularly, the invention relates to an underwater connector assembly having a plug connector and a receptacle connector. Means are provided for mechanically mating and positively locking the connectors together. Surfaces formed on inserts on the connectors are slidably engaged for providing a squeegee wiping action. Water within the connectors is forced out through ports during the mating and the interfering insert assembly wiped dry. Electrical contacting surfaces are formed flush with the insert surfaces.

The advantages of this invention, both as to its construction and mode of operation, will be readily appreciated as the same becomes better understood by references to the following detailed description when considered in connection with the accompanying drawing in which like reference numerals designate like parts throughout the figures.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded prospective view partly in cross section of a plug and a socket body incorporating the underwater electrical connector assembly in accordance with the invention.

FIG. 2 depicts a side view partly in section of the connector assembly of FIG. 1 as the connector members are initially mated.

FIG. 3 depicts a side view of the connector assembly of FIG. 2 with the connector members partially mated.

FIG. 4 depicts a side view partially in section of the connector members of FIGS. 1 and 3 with the members fully mated.

DESCRIPTION THE PREFERRED EMBODIMENT

Referring now to the drawings, there is shown in FIGS. 1 and 2 an underwater connector assembly 12 having a plug connector 14 for mating with a receptacle connector 16. The plug connector 14 comprises a shell 18 having a cylindrical forward section 20 which is opened at its forward end and contains an enlarged counterbore 22 thereat. Further, a polarizing key 24 is formed in the outer surface of the shell section 20. The section 20 further comprises a radial outwardly extending flange 26 near the rear end thereof. Further, the rearward end of the section contains an end wall member 28 having a port 30 extending therethrough, and a sidewall member 32 which is offset from the main walls of section 20 by means of a connecting section 34. The outer surface of the portion 32 is threaded. Further, the shell 18 contains a rearwardly extending cylindrical section formed by walls 36 which are internally threaded at its rear end opening, and is of smaller diameter than the section 20, and terminating at the opposite side of the end wall 28. The section 36 further comprises a flange 38 which extends radially inwardly.

Surrounding the section 20 and spaced therefrom is an engaging nut 42 having internal threads 44 and a radially inwardly extending flange 46. The flange 46 is secured between a washer 48 and one side of the flange 26 at its forward facing portion and a washer 52 fastened to the rearward-facing side by means of a nut 54 having threads which engage the threads on the member 32.

Secured within the member 20 is a molded neoprene insert 60 whose outer surface engages the inner surface of section 20, end wall member 28, member 32, and section 34. The insert 60 further comprises a forward-facing surface 61 which is flush with the forward end of the counterbore 22 and an inner surface area 62. The insert further comprises a port 63 which is aligned with port 30. Formed within the insert 60 are a plurality of blade contacts 66, having contact surfaces 68 formed flush with the inner surface area 62. Each of the blade contacts are connected to a conductor 72 which extends through an opening 74 in the end wall 28. The blade-contacting surfaces 68 are shown in FIG. 1 to be arranged in two sets of radially spaced rows, the adjacent surfaces being separated by 36° and staggered from adjacent row at 18°0 intervals, although other arrangements are possible. The contact arrangement as depicted in the drawings prevents temporary mating of nonassociated contacts during mating which could result in short circuits or damage to equipment.

An electrical cable 82 having a neoprene cable jacket 84 and a plurality of conductors 86 is coupled to the plug connector 14 through a removable endbell 88. The endbell 88 has a forward portion 90 which is threaded at its forward outer portion 91 and a reduced diameter rearward portion 92 which is connected to the forward portion 90 by a transitional section 93. Further, the forward portion 90 contains a potting hole 94. The cable jacket 84 is surrounded by the rear portion 92 of the endbell 88 and terminates just short of the transitional section 93. The conductors 86 are connected to the conductors 72 of the plug assembly 14 by means of conventional wire splices 95 in the vicinity of the forward portion 90 of the endbell. After the conductors 72 and 86 have been spliced together, the endbell 88 is threaded into the member 36 until the forward portion 90 of the endbell abuts the end wall member 28. An O-ring 96 between the end wall 28 and the flange 38 prevents leakage into the electrical termination area of the plug assembly 14. A dielectric potting compound 97 is then injected through the potting hole 94. Finally, an elastomer molding

compound 98 such as neoprene is molded to the exterior portions of the jacket 84 and the endbell 88 and flush with the rearward face of the member 36 to form a complete watertight seal.

The receptacle connector 16 comprises an outer shell 102 which forms a cylindrical cup together with an end wall 104. Along the forward end of the outer surface of the shell 102 are formed threads 106 which mate with the inner threads 44 of nut 42 of the plug connector 14. Within the inner surface of the shell 102 there is formed a polarizing keyway 107 for mating with the polarizing key 24 of the plug connector 14. Further, a water escape port 108 protrudes through the shell 102. The shell 102 is further formed of a reduced inner diameter section 110 which forms a forwardly extending shoulder 112 with the main portion of the shell 102. Adjacent the shoulder 112, at the end of the keyway 107, is a relief 113 which facilitates the machining of the keyway 107 in the receptacle shell.

The shell 102 further comprises a rearwardly opening cylindrical section 114 which terminates at the end wall 104 and contains a threaded portion 116 at the rear end thereof. Further, an annular groove 118 is formed in the outer surface of the shell 114 and an annular groove 122 is formed in the rearward-facing portion of the end wall 104.

The receptacle connector 16 may be mounted on a mounting bulkhead or hull 124, having an opening 126 therein through which the reduced diameter portion 114 of the shell extends. An O-ring 128 secured within the annular groove 118 provides a proper sealed fit between the shell 114 and the opening in the mounting bulkhead 124. Further, the rearward-facing portion of the end wall 104 abuts the forward-facing portion of the bulkhead 124 and a tight-sealing fit is formed therebetween by means of an O-ring 132 in the annular groove 122. After the shell portion 114 has been inserted through the bulkhead 124, the receptacle connector may be secured to the bulkhead by means of a mounting nut 136 which is secured to the threads 116 on the outer surface of shell 114, together with a spacer 138 interposed between the rearward-facing portion of the bulkhead 124 and the forward-facing surface of the mounting nut 136.

A receptacle insert assembly 142 is formed of a cylindrical block of a dielectric material whose diameter is such that an interference fit for squeegee wiping action with the opening 62 of insert 60 is obtained. The assembly 142 has a rearward enlarged diameter portion 144 which fills the opening in the rear portion of the shell 102. Sockets 146 are formed in the portion 144 so as to allow screws 148 to be inserted through the portion 144 and into the forward-facing section of the end wall 104, thus, securing the member 142 to the wall 104. Further an annular groove 152 in the forward surface of end wall 104 contains an O-ring 154 for sealing the surfaces between the member 144 and the end wall 104.

A plurality of blade contacts members 156 having contact surfaces 158 flush with the outer surface of the assembly 142 are secured within the member 142. Conductors 162 connect the blade contacts 156 to peripheral equipment (not shown in the drawings), and pass through openings 164 in the end wall 104.

The interference surfaces of the plug insert assembly 60 and the receptacle insert assembly 142, which are slidably engaged for squeegee wiping action are normally lubricated with a nonconductive media. As can be readily seen in FIG. 2, upon initial engagement of the plug connector and the receptacle connector, the plug-engaging nut 42 is gripped while the plug-polarizing key is aligned with the receptacle keyway 107. Then the plug connector is pushed forward until the polarizing key 24 enters the keyway. Then the engaging nut is torqued clockwise, forcing the receptacle insert assembly in the plug insert assembly, as can readily be seen in FIG. 3. Since the plug and receptacle insert assembly are designed with an interference fit, as further engagement of the connectors continue, water inside the connector is forced out of the connector portion through the ports 30–63 and 108, and the interfering insert assembly surfaces are wiped dry.

Referring now to FIG. 4, as can readily be seen, torque is continued on the plug-engaging nut until the plug shell bottoms on the receptacles shell. The plug and receptacle blade contact surfaces 68 and 158 are now on line, thereby assuring electrical integrity. To unmate the connector assembly, the torque-engaging nut is rotated in a counterclockwise direction. Spinner holes may be added to the plug-engaging nut to provide a means for additional mechanical advantage when torquing. In order to protect the contacts from water corrosion when the connectors are unmated, protective covers may be installed in the connector.

Thus, as can readily be seen, a positive mechanical lockup is provided through the plug-engaging nut which prevents inadvertent premature disengagement of the connectors and allows making and breaking electrical circuits while the electrical connectors are completely submerged in fluid. The connector assembly may be used on submarines, diving bells, and underwater cables and other underwater applications where a positive-locking, multiple-contact electrical connector is required. Further, as can be readily seen, the interference fit allows a wiping effect between respective contacts.

What is claimed is:

1. An underwater connector assembly comprising;

a plug connector having an insert assembly mounting therein, said plug connector insert assembly being formed of a cylindrical member having a hollow cylindrical opening therethrough, said plug connector contacting surface being flush with said plug connector opening surface;

a receptacle connector having an insert assembly mounted therein, said receptacle connector insert being formed of a cylindrical member, said receptacle connector contacting surface being formed on the outer surface of said receptacle connector insert;

means for mechanically mating and positively locking said plug connector and said receptacle connector together;

surfaces formed on said insert assemblies for slidably engaging to provide a squeegee wiping action and to force water within said connectors out through ports formed in said connectors and;

at least one contact surface formed flush on said plug connector insert assembly and said receptacle connector insert assembly for connection with each other when said plug connector and receptacle connector are fully mated;

said plug connector insert and said receptacle connector insert each have a plurality of contacting surfaces which are radially offset from each other, said contacting surfaces on one of said inserts being adapted to mate with a respective contacting surface on the other insert, said contacting surfaces on said inserts being arranged in a plurality of sets of radially spaced rows and staggered from adjacent rows for preventing temporary mating of nonassociated contacts during mating.

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