

[54] **UNDERWATER WET ELECTRICAL CONNECTOR**

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[58] Field of Search **339/42, 117, 118, 339/60, 94, 34, 35, 182, 183**

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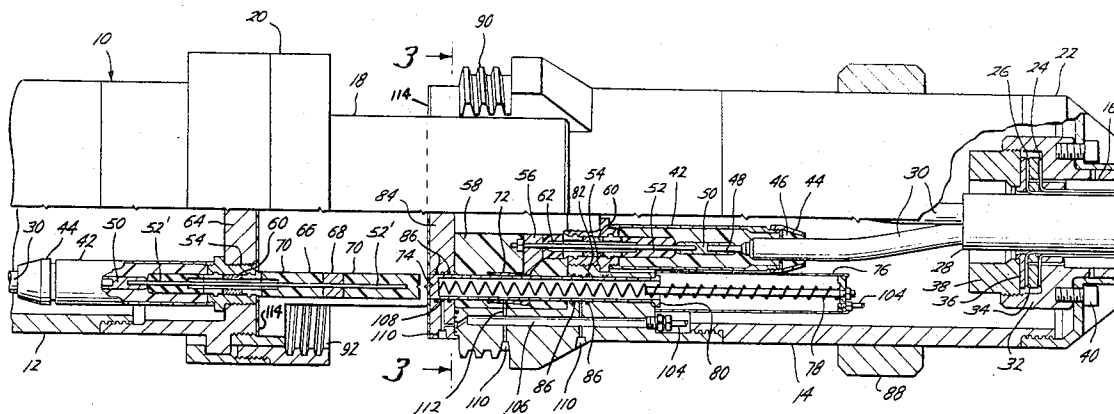
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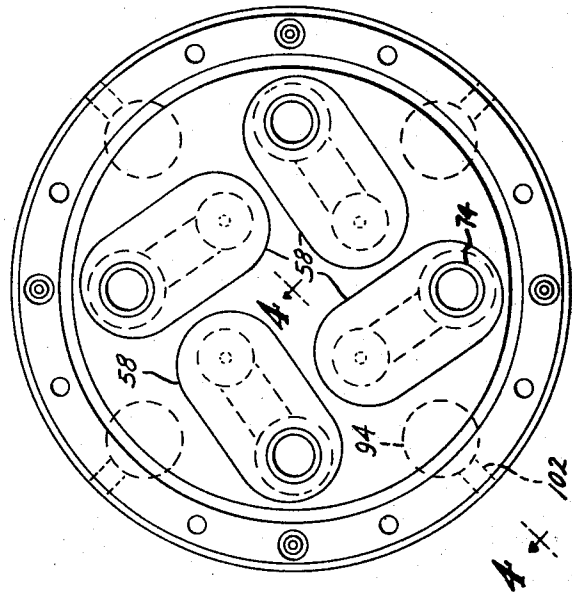
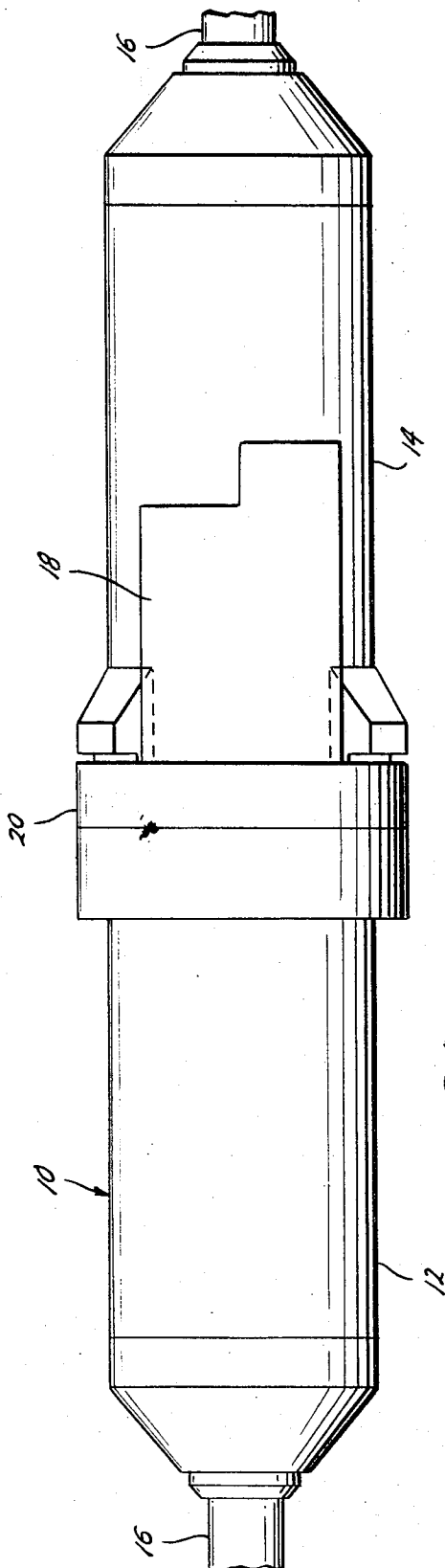
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[57] **ABSTRACT**

An electrical connector designed for engagement and disengagement under water at very great depths with high voltage and amperage capacity. The connector incorporates a dummy piston to seal the female electrical contact, which is displaced by the male pin. Sealing means and hydrostatically compensated dielectrical oil supply means are disclosed.

9 Claims, 4 Drawing Figures



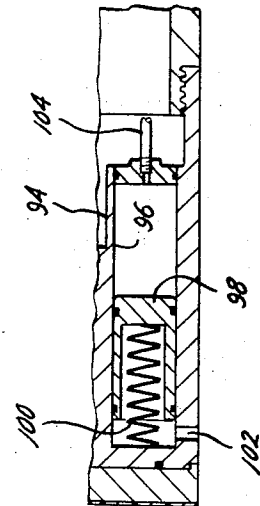
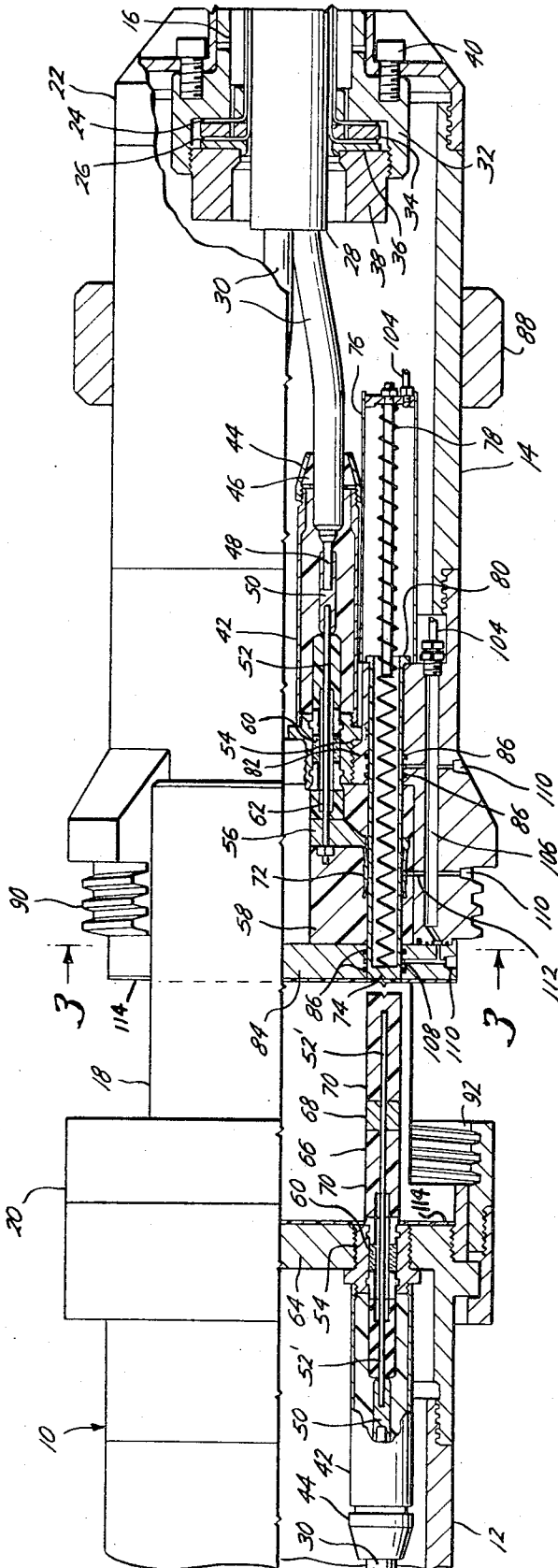


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UNDERWATER WET ELECTRICAL CONNECTOR

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BACKGROUND OF THE INVENTION

The present invention relates to an improved electrical connector particularly useful when making up an electrical connection between two cables while under water at great depths and designed for high voltage and high amperage capacity.

Electrical connectors for use in undersea environments have generally been made up under dry conditions and then submerged. It has been known to utilize a male connector member to push salt water out of a vent in the female connector member under wet conditions, with relatively low voltage and amperage capacities. SUMMARY

The underwater wet electrical connector of the present invention generally includes a male plug and a female receptacle designed for mating and disengagement in an undersea environment. The male plug includes at least one male pin extending from the plug which includes a contact terminal thereon. The contact terminal is electrically insulated from the body of the male plug and means for attaching the terminal to an appropriate electrical conductor cable is provided. The female receptacle includes a female contact socket designed to mate with the male pin and which includes a contact block arranged therein. When disengaged, a dummy piston slides into the contact socket to prevent the entrance of sea water. As the male plug is mated with the female receptacle, the piston is displaced by the male pin into an oil filled cavity. The female contact block includes means for appropriately connecting it to a conductor cable leading from the female receptacle.

The female contact socket is included in an elastomer molding which surrounds the contact block and the dummy piston, as well as the male pin when inserted therein. This elastomer molding provides a squeezing interference fit to prohibit the entrance of sea water when the connection is made up, as well as to wipe any moisture on the surface of the male pin therefrom as it is inserted. An oil supply means is provided, along with double O-ring seals on either side of the female contact block, to further prevent the entrance of sea water and to provide a dielectric material to cover the surface of the male pin and the dummy piston when either is in the female contact block.

Mechanically, the connector must have at least the strength of the cable itself and thus be capable of suspending in excess of 5,000 feet of cable, without buoyant members, and while submerged. A method of securing the armor wire in the cable to the connector is provided. A polarizing key is also provided to assist in making up the connector under water, as well as to help protect the male pins. The connector must also be capable of withstanding the hydrostatic pressure without leakage.

Electrically, the connector of the present invention is designed for use undersea, and designed to be mated and disconnected undersea, at depths in excess of 5,000 feet, while at the same time carrying an electrical pressure of at least 4,160 volts and 50 amps when

mated. These parameters are necessary if it is desired to undertake large-scale underwater construction or salvage projects, since these types of projects require large amounts of power. At the present time, there are no ways to provide this power, primarily because there are no suitable connectors available.

Thus, it is an object of the present invention to provide an underwater wet electrical connector particularly useful in mating and disconnecting electrical cable in an undersea environment of at least, 5,000 feet, and when mated carrying a relatively high voltage with high current capacity. It is a further object of the present invention to provide such a connector which includes a means for excluding sea water from the female receptacle, and particularly the female contact, while providing an electrical connector that will not be damaged by direct exposure to hydrostatic pressure and sea water. It is a further object of the present invention to provide a means in such an electrical connector to displace salt water from the electrical insulating surfaces.

Other and further objects, features and advantages will be apparent from an examination of the following description of the presently preferred embodiment of the invention, given for the purpose of disclosure, when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Like character references designate like parts throughout the several views of the drawings:

FIG. 1 is a side view of the electrical connector of the present invention when fully mated and mechanically connected,

FIG. 2 is a partial sectional side view of the electrical connector prior to mating,

FIG. 3 is a sectional view taken along the line 3—3 of FIG. 2, and

FIG. 4 is a partial sectional view taken along the line 4—4 of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, the reference numeral 10 generally designates the underwater wet electrical connector of the present invention, consisting generally of the male plug 12 and the female receptacle 14, from each of which extends the electrical cables 16. Extending from the male plug 12 and lying alongside the female receptacle 14 is a polarization key 18 which is utilized in a conventional manner to prevent mismatching of the various male and female conductors. The polarization key 18 also serves to protect the male pin from damage, since it extends beyond the end of the male plug. An internally threaded collar 20 is utilized to mechanically fasten the male plug and the female receptacle together.

Referring now to FIG. 2, the electrical cable 16 is shown entering the end bell 22 of the female receptacle 14. The cable 16 includes two sets of armor wire, 24 and 26, as well as internal insulation 28 and one or more individually insulated conductors 30. The outer layer of armor wire 24 is bent up, at a smooth radius to the die block 32, while the inner layer of armor wire 26 is subsequently bent up over the thrust washer 34. An additional thrust washer 36 is applied to the armor wire 26, and an anvil 38 applied to the thrust washer 36. The

members are securely fastened together and the whole attached to the end bell 22 by appropriate fastening means 40. The interstices are preferably sealed with an appropriate insulating potting compound. The mechanical connection between the cable 16 and the male plug 12 is identical.

Referring now particularly to the female receptacle 14, each of the insulated conductors 30 enters a terminal chamber 42 and is sealed therein by the terminal sleeve nut 44 and the terminal sleeve compression insert 46. The conductor 48 is connected by the swaged fitting 50 to the conductor pin 52. The conductor pin 52 leads through a threaded pressure seal 54 to the female contact block 56, which is mounted within the female contact socket 58. The threaded pressure seal 54 is mounted in the pressure wall 82 and includes a fused glass insulator 60, which is fused to the body of the threaded pressure seal and to a stainless steel cylinder 62 in the center. The conductor pin 52 is preferably made of a high-strength copper alloy material which is not readily matable with fused glass hence the necessity for the stainless steel cylinder 62, which is swaged to the pin 52. The area at each end of the fused glass insulator 60 is filled with an appropriate dielectric, such as polyurethane.

The construction of the male plug within the pressure wall 64 is essentially the same as that heretofore described in the female receptacle, hence like parts have been designated with like reference numerals. The male connecting pin 52', however, does not attach to the female contact block, but instead extends into the male pin 66. This pin is exposed to salt water when the electrical connector is not mated. At the center of the male pin 66 is a male contact terminal 68 which is mechanically, and electrically, attached to the pin 52'. On either side of the male contact terminal 68 are appropriate insulators 70, such as molded diallyl phthalate (DAP).

Referring again to the female receptacle 14, the female contact block 56 includes a contactor portion 72 which surrounds a dummy piston 74 therein. The female contact block 56, at the contactor portion 72 may include longitudinal slots therein, in a conventional manner to provide a tighter engagement with the male pin 66, when inserted therein. Both the contactor portion 72 and terminal 68 may be gold plated. The dummy piston 74 is hollow and slides within the female contact socket 58, and may be displaced into the oil filled cavity 76. The piston is preferably constructed of a relatively slick dielectric, such as Teflon. A spring 78 normally biases the piston 74 within the female contact socket 58, and the piston 74 is prevented from being pushed out of the female receptacle 14 by the shoulder 80. Mounted in the female pressure head 82 as well as in the female end plate 84 in extensions of the socket are sealing means, here shown as two pairs of O-rings 86. These O-rings 86 prevent the entry of sea water between the piston 74 and the female receptacle 14, and as will be explained hereafter, wipe any sea water from the male pin 66 as it is mated within the female receptacle 14 contact socket 58. Upon assembly, the entire inner area of the female receptacle 14, as well as the male plug 12, are completely filled with an appropriate dielectric potting compound, such as polyurethane. Further, a neoprene or similar coating 114

may be applied to the pressure wall 64 and end plate 84.

As shown in FIG. 2, a sacrificial aluminum ring 88 may be suitably attached to the electrical connector 10. A portion of the female receptacle 14 includes threads 90 which mate with the internal threads 92 in the collar 20. The polarizing key 18 on the male plug 12 fits between a milled-out portion of the threads 90 of the female receptacle.

When mating the male plug with the female receptacle, the polarizing key is brought to the appropriate position adjacent the receptacle 14, and the male and female members are brought together. The male pin 66 displaces the dummy piston 74 and pushes it back into the cavity 76 as the pin is inserted into the female receptacle. The O-rings 86 wipe any sea water on the male pin 66 off as it is pushed therethrough. The electrical contact is complete when the male contact terminal 68 is engaged by the contactor portion 72 of the female contact block 56. The female contact socket on either side of the contactor 72 is preferably constructed of an elastomer molding which provides a squeezing interference fit both with the dummy piston 74 and with the male pin 66. This further excludes the entrance of sea water.

To prevent electrical surface tracking along the dummy piston 74 or the male pin 66, a dielectric oil supply means is provided to further displace both sea water and air. Referring now to FIG. 4, the dielectric oil supply means includes a compensator 94 which generally includes a cylinder 96 filled with dielectric oil, and a piston 98 therein. The back side of the piston is loaded by the spring 100 and is vented through the port 102 to the sea water. Oil from the compensator 94 is led through appropriate passageways to oil grooves 108 between each of the O-rings 86. Plugs 110 are used to seal the outer ends of the passageways from sea water. A further passageway 112 leads to the female contact block 56, contactor portion 72 to provide further dielectric oil at that point. Since the compensator 94 is vented through port 102, hydrostatic pressure on each end of the dummy piston 74 is balanced. However, the spring 100 adds a positive pressure to the dielectric oil relative to the surrounding sea water.

Referring now to FIG. 3, it will be noted that a plurality of female contact members 58 have been shown and in this instance four are shown for a grounded three phase AC system. Further, the position of the compensator 94 and its orifice 102 is shown with relation to the remainder of the female contact socket. When multiple female contact members are utilized, similarly, multiple oil filled compensators 94 may be utilized. It is presently preferred that the various compensators 94 be manifolded together to increase the total dielectric oil capacity; however, one large compensator alone could be used.

Upon disassembly, the threaded collar 20 is disengaged from the threads 90, and the male plug pulled from the female receptacle. As the male pin 66 is withdrawn from the female contact socket 58, the dummy piston 74 replaces the pin 66. The entrance of sea water into the female contact socket 58 is prevented both by the O-rings 86 and the oil ring 108, as well as by the squeezing interference fit of the female contact socket 58. Complete withdrawal of the male

pin leaves the female receptacle 14 effectively sealed from the sea water and, of course, electrically and mechanically disconnected from the male plug 12. Under environmental conditions, it is anticipated that various forms of conventional manipulators, or other mechanical aids, may be used to remotely mate and disengage the electrical connector.

Thus, it is seen that the present invention has provided an underwater wet electrical connector particularly useful at great ocean depths with high voltage and heavy amperage capacity. The present invention, therefore, is well adapted to carry out the objects and attain the ends and advantages mentioned, as well as others inherent therein. While a presently preferred embodiment of the invention has been given for the purpose of disclosure, numerous changes in the details of construction, and combination, shape, size and arrangement of parts may be resorted to without departing from the spirit and scope of the invention as hereinafter claimed.

What is claimed is:

1. An underwater wet electrical connector for use in making up electrical connections in an under sea environment including:

a male plug,
at least one male pin extending from the plug,
a male contact terminal mounted on each pin,
dielectric means electrically insulating the male contact terminal from the male plug,
means for electrically connecting an electrical cable conductor to each male contact terminal,
a female receptacle,

a female contact socket arranged to receive and mate with each male pin within the female receptacle,

a female contact block mounted within the socket, the female contact block having a contactor portion arranged to receive the male contact terminal and provide an electrical conducting path therebetween when the male pin is inserted into the female contact socket,

dielectric means electrically insulating the female contact block from the female receptacle,
means for electrically connecting an electrical cable conductor to each female contact block,

a piston reciprocally mounted in the female contact socket arranged to prevent the entrance of sea water into the female contact socket when the male pin is not inserted therein,

means retaining the piston in the female contact socket when the male pin is not inserted therein and receiving the piston when displaced from the female contact socket when the male pin is inserted therein,

seal means adjacent the exterior of the female receptacle and mechanically alternatively sealing the piston and the male pin when inserted in the female contact socket, and

a dielectric oil compensator having biasing means therein providing a positive pressure on the oil at all times, said compensator being mounted within the female receptacle and hydraulically interconnecting an oil supply means with the piston and with the male pin when inserted in the female contact socket.

2. The invention of claim 1 including:
the dielectric oil supply means providing dielectric oil interiorly of the seal means at the interface between the piston and the female contact socket and the male pin and the female contact socket as either is inserted in the female contact socket.

3. The invention of claim 1 wherein the female contact socket includes an elastomer molding interiorly of the seal means providing a squeezing interference fit on the piston and on the male pin when inserted in the female contact socket.

4. The invention of claim 3 including:

a compensator cylinder,
a compensator piston having first and second sides, the first side of the piston being mechanically biased toward the second side and being vented to the under sea environment,
the second side of the piston and the cylinder being filled with dielectric oil, and
piping means directing the oil from the cylinder to the piston and to the male pin as either is inserted in the female contact socket.

5. The invention of claim 1 wherein the seal means includes O-ring seals arranged to wipe sea water from the male pin as it is inserted in the female contact socket.

6. The invention of claim 3 including:

a compensator mounted within the female receptacle and hydraulically interconnecting the dielectric oil supply means, and the piston, and arranged to hydrostatically balance the piston in the female receptacle.

7. The invention of claim 6 including:

a compensator cylinder,
a compensator piston having first and second sides, the first side of the piston being mechanically biased toward the second side and being vented to the under sea environment,
the second side of the piston and the cylinder being filled with dielectric oil, and
piping means directing the oil from the cylinder to the piston and to the male pin as either is inserted in the female contact socket.

8. The invention of claim 2 wherein the seal means includes O-ring seals arranged to wipe sea water from the male pin as it is inserted in the female contact socket.

9. The invention of claim 1 including:

anchor means for mechanically interconnecting the electrical cable to the male plug and to the female receptacle.

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