United States Patent

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[54] METHODS OF UNDERWATER MECHANICAL ASSEMBLY OF ELECTRICAL CONNECTORS, AND THE LIKE

5 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **29/628,** 174/21, 339/117

[51] **Int. Cl.** **H01r 43/00,** H05k

[50] **Field of Search** ..... 29/628, 629; 339/117, 116, 89, 94, 60; 61/69; 174/8, 21 JS

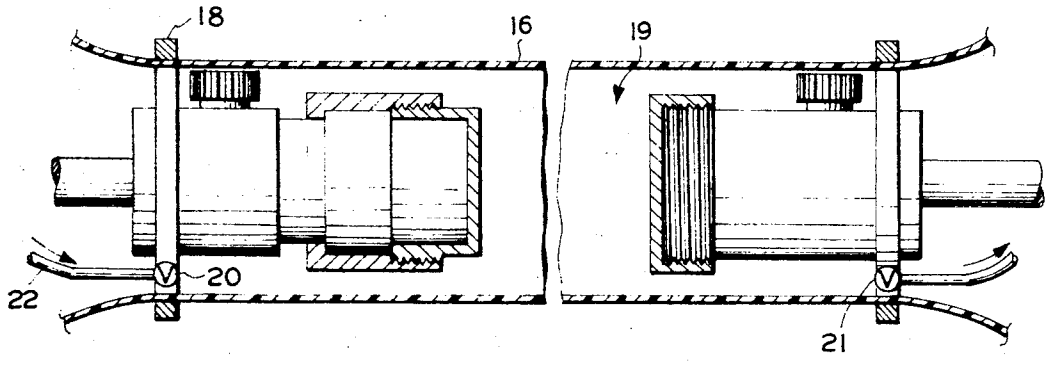
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ABSTRACT: A method of assembling electrical cables underwater without subjecting the electrical circuits to salt water is disclosed. A flexible membrane isolates a work area and the mechanical assembly and disassembly of parts takes place therein by grasping the membrane from the water side. The membrane may be a hollow toroid and the inner surface extending about the work area can be ruptured to produce more working area and less area that is purged of water before rupture. The outer membrane can be ruptured after the operation is terminated by mating the connectors in a waterproof seal.

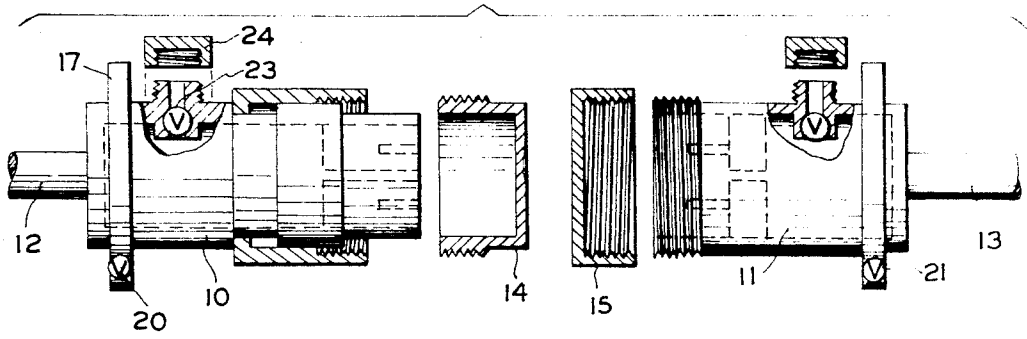


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SHEET 1 OF 2

FIG.1



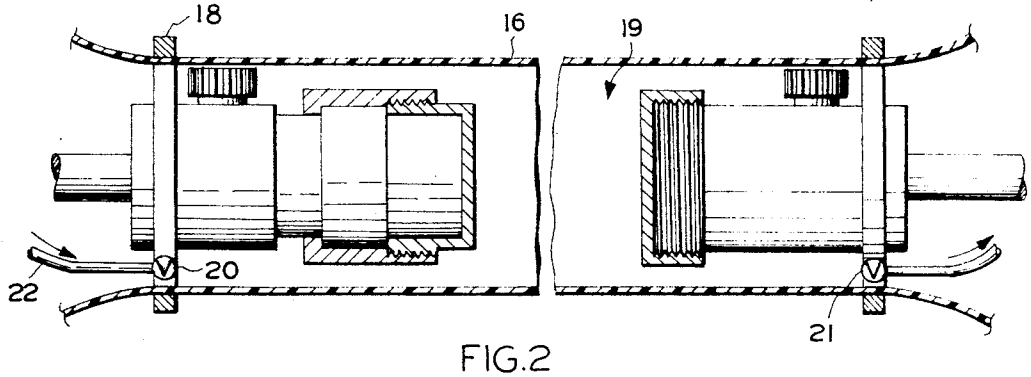


FIG.2

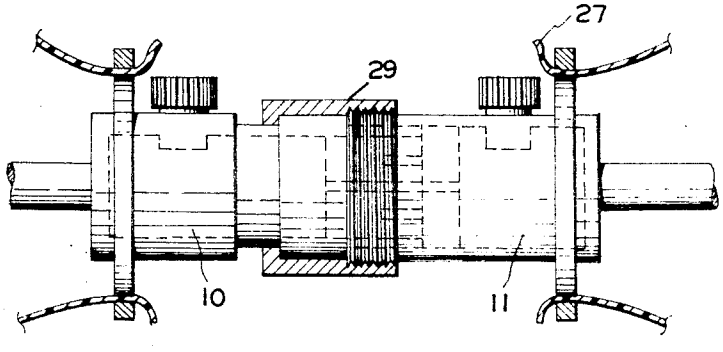


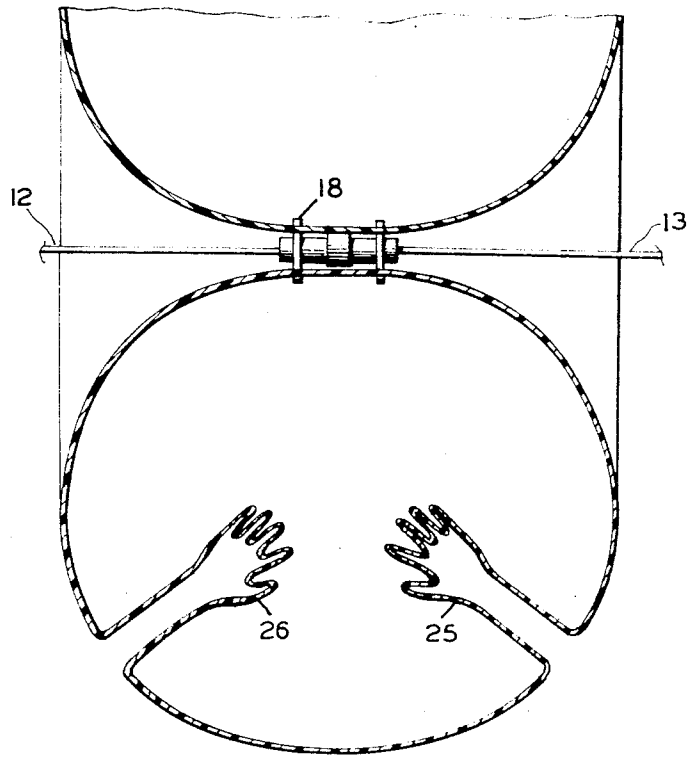
FIG. 3

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FIG.4



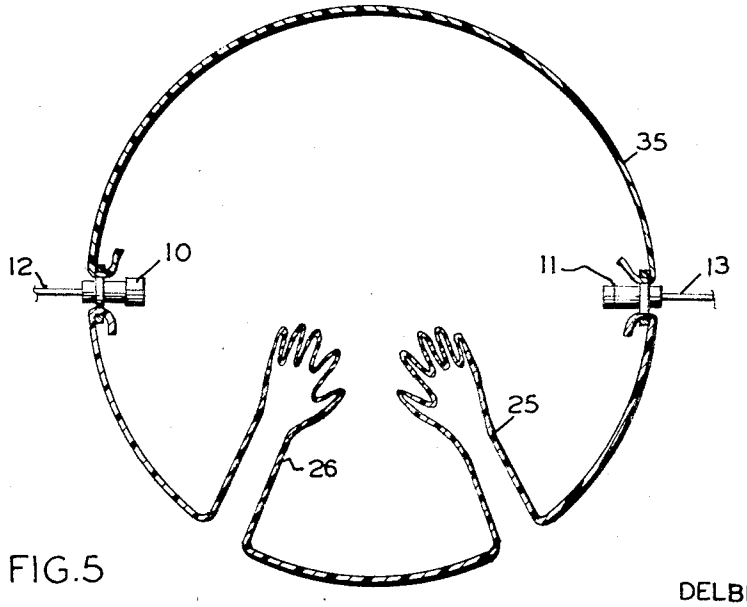


FIG.5

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METHODS OF UNDERWATER MECHANICAL ASSEMBLY OF ELECTRICAL CONNECTORS, AND THE LIKE

This invention relates to undersea construction techniques and more particularly it relates to the manual manipulation and assembly of electrical connectors, or the like, undersea without exposure to salt water.

In many kinds of undersea installations such as the drilling of gas or oil wells it is necessary to assemble or connect cables, valves, equipment the underwater apparatus from salt water not only to prevent corrosion but also to prevent undesired conductive paths from forming. The use of specially designed electrical connectors that prevent water from entering the contact areas during connection and disconnection are known, and described in my copending applications Ser. No. 862,599 filed concurrently herewith and Ser. No. 798,738, filed Feb. 12, 1969. However it is not always possible to provide special equipment, and the interconnection or assembly of more conventional equipment undersea is a problem not resolved in the prior art.

It is therefore an object of this invention to provide methods for interconnection, assembly or manipulation of conventional equipment such as electrical connectors underseas.

The invention provides for the envelopment of two waterproof electrical connector assemblies to be connected together about a work area disposed between the connectors by a flexible watertight membrane. Then the water is purged from the work area and the members may be grasped through the membrane from the water side for manipulation.

Further objects, features and details of the invention will be described hereinafter with reference to the embodiment set forth in the accompanying drawing, wherein:

FIG. 1 is an elevation view sketch, partly in section, of a mating connector assembly,

FIG. 2 is an elevation view sketch, partly in section and partly broken away, of a membrane encompassing two matable connector assemblies,

FIG. 3 is an elevation view sketch, partly in section, of two connector assemblies which are mated within a flexible diaphragm,

FIG. 4 is an elevation view, partly in section, of a toroidal diaphragm assembly surrounding a work port, and

FIG. 5 is an elevation view, partly in section, of an inflated double wall diaphragm having an inner diaphragm wall ruptured to produce a large work area isolated from the water.

Referring now to FIG. 1, two mating electrical connectors 10 and 11 are coupled to cables 12. The connectors are of the conventional waterproofed type that when mated prevent any entry of water into contact with the circuit connections, and have caps 14, 15 for waterproofing the connectors when not mated by serving to seal each connector 10, 11 separately.

In connection with this invention is is necessary to provide on each connector 10, 11, means for affixing a flexible waterproof diaphragm member 16 (FIG. 2) thereto such as clamp members 17, 18, so that a watertight work area 19 is produced inside the diaphragm member 16 including the regions where the connectors are to be mated.

Also it is desirable to have provided in the mounting means two access ports with valves 20, 21 therein fashioned to permit purging of water from the work area 19, by means of hose 22 for example connected to a compressed fluid source supplying air or other nonconductive substance (not shown). If desired, a further valve arrangement 23 can be provided for permitting pressure inside the plug to be equalized with the outside pressure. This becomes important to prevent leakage at the gaskets if the water depth at the installation becomes great, and to allow removal of covers when there is a pressure differential.

In general the connectors are assemblied out of the water by coupling the sealing caps 14, 15 and 24 thereon. The inside pressure is made equivalent to that of the depth of installation before sealing with cap 24. Any leaks can be detected with this pressurized assembly by immersing in water at the surface.

In addition an inflatable toros of inflatable flexible material such as plastic or rubber is provided in collapsed condition with parts such as clamps 18 and a gas pressure cartridge sealed inside. In addition ballast can be added to offset inflation buoyancy. Transparent observation parts may be located in the membrane, and internally extending special diaphragm cavities 25, 26 may be provided as shown in FIGS. 4 and 5, for access inside by a diver's hand for manipulation of the parts through a suitable tough thin membrane.

The diver may proceed in the following manner. The toroidal cavity may be loosely inflated with part of the pressurized gas or liquid in the container (not shown). Then one connector is inserted into one side of the toros where the internal clamp 18 may be affixed by reaching through a cavity 25, 26. Then the other connector likewise has its clamp affixed to provide the arrangement shown in FIG. 2. The work area 19 is then filled with salt water, which is purged by passing a gaseous or liquid from a pressure cartridge through hose 22 and valve 20 which purges the water out valve 21. When purged the valves are closed.

At this stage, the inner cavity wall may be ruptured as shown in FIGS. 3 at 27, by engaging a sharp surface of the connector or by a tool packed inside the toros to produce a spherical shape 35. This provides a large working area devoid of water as shown in FIG. 5 where the assembly and manipulations can be effected to remove caps 14, 15 and join the connectors 10, 11 as shown in FIG. 3 by screwing on watertight collar 29 to connector 11. After this the outer surface of the membrane may be ruptured to remove parts and the connection is made and left undersea without salt water contamination.

Similarly an undersea disassembly may take place by storing an uninflated toros assembly about one cable in the vicinity of the connector.

The toros is the most efficient shape of the encompassing flexible member for underwater use, but the shape may be changed if desired, and the same method may be used to assemble valves and the like.

What I claim is:

1. The method of manually manipulating mechanical assemblies without exposure to surrounding atmosphere comprising the steps of

enveloping at least one of aid assemblies with a flexible membrane in said atmosphere,

b. purging the work area enveloped by said membrane of residual atmosphere, and

c. distorting the membrane to reach in and manipulate one of said assemblies by grasping the membrane from the atmosphere side, wherein the membrane is hollow and including the step of inflating said flexible membrane in said atmosphere to achieve the shape of a toroid surrounding said work area.

2. The method defined in claim 1 including the step rupturing an inner wall of the inflated hollow membrane surrounding said work area.

3. The method defined in claim 1 including the step of rupturing an inner portion of the membrane to convert the toroid into a sphere.

4. The method of manually connecting electrical connectors of two electrical cables under salt water without exposure of the electrical connections on either side to the water comprising the steps of

a. protecting the electrical connectors on each cable with a waterproof member,

b. enveloping the two connectors underwater with a flexible waterproof membrane,

c. purging the work area enveloped by said membrane of water, and

d. distorting the membrane manually to reach into the purged work area removing the waterproof members and connecting the connectors of the two cables with a waterproof connection.

5. The method in claim 4, including the step of pressurizing at least one of said connectors covered with the waterproof member to a pressure substantially that of the water at the depth at which the connection is to be made.