United States Patent [19]

Bonnamy

[11] **3,731,250**

[45] **May 1, 1973**

[54] METHOD OF MAKING ELECTRICAL CONNECTORS AND CONNECTORS THEREFOR

[75] Inventor: **Philippe J. F. Bonnamy**, 92 Boulogne, Billancourt, France

[73] Assignee: **Compagnie Francaise Des Petroles**, Paris, France

[22] Filed: **Nov. 30, 1971**

[21] Appl. No.: **203,173**

[30] **Foreign Application Priority Data**

Nov. 30, 1970 France.....7042940

[52] **U.S. Cl.**.....**339/12 V**, 174/21 US, 339/61 M, 339/116 R

[51] **Int. Cl.**.....**H01r 11/30**

[58] **Field of Search**.....339/12, 80, 81, 59, 339/60, 61, 117, 75, 114, 116, 144, 145, 94; 174/21 US

[56] **References Cited**

UNITED STATES PATENTS

3,665,509	5/1972	Elkins	339/12 V
3,478,298	11/1969	Nelson	339/61 M
3,657,681	4/1972	Falkner	339/61 M
3,588,781	6/1971	Williams	339/12

OTHER PUBLICATIONS

IBM Tech. Disclosure J. F. Smith "Interconnection Devices" 7–1966.

Primary Examiner—Marvin A. Champion
Assistant Examiner—Robert A. Hafer
Attorney—Richard C. Sughrue et al.

[57] **ABSTRACT**

A method of obtaining an electrical connection underwater and connectors for carrying out the method, without requiring precise alignment of the connectors by employing a breakable rigid container filled with gas at a reduced pressure within a sealable waterproof housing surrounding the metal contact of a movable connector. The contact of the movable connector is engaged with a metal contact of a stationary connector and the breakable envelope is broken, causing a reduction in the pressure within the waterproof housing to remove any water from between the metal contacts and retain the metal contacts in contact with each other and seal them from the surrounding environment.

22 Claims, 12 Drawing Figures

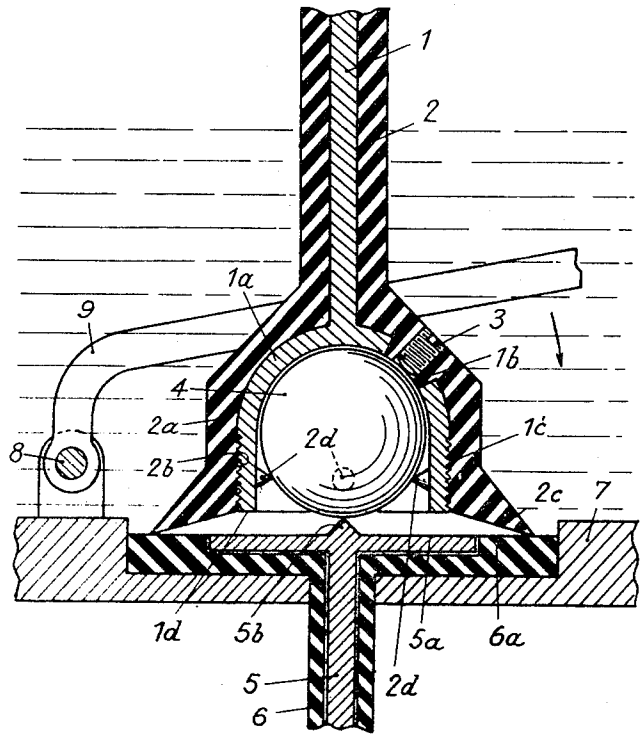


FIG. 3

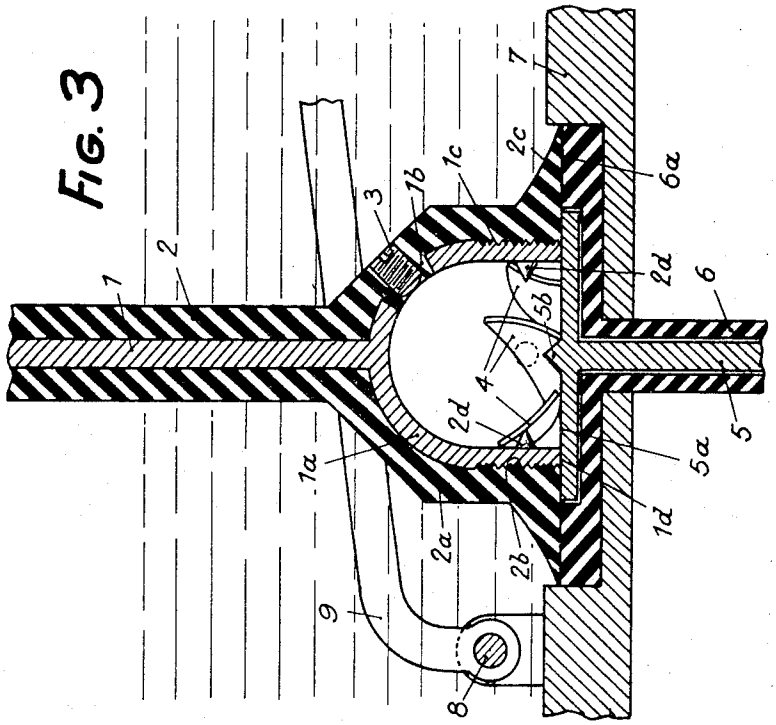

1
2
3
1b
1c
2c
7
6a
2d
6
5b
4
2d
5
5a
1a
1d
2a
2b
9
8

FIG. 1

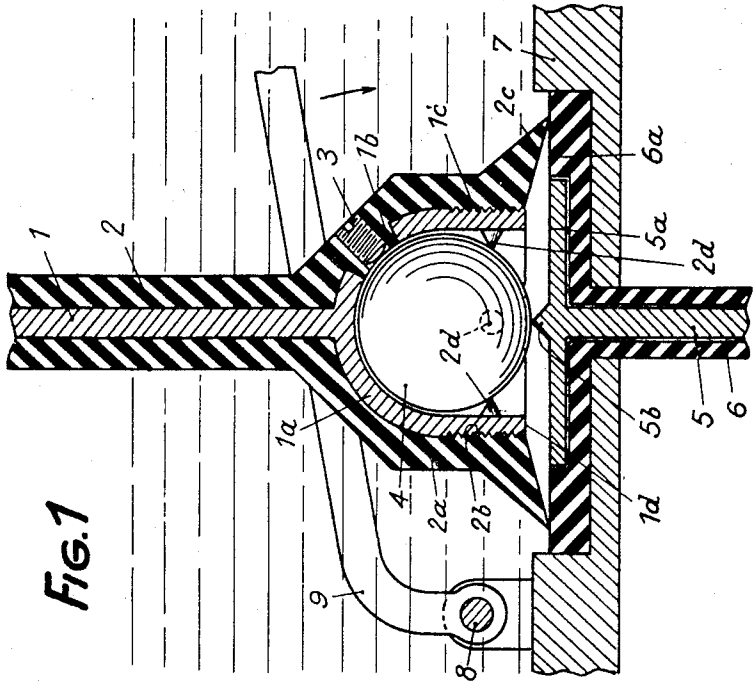

1
2
3
1b
1c
2c
7
6a
5a
2d
2d
5b
5
6
1a
4
2a
2b
1d
9
8

FIG. 2

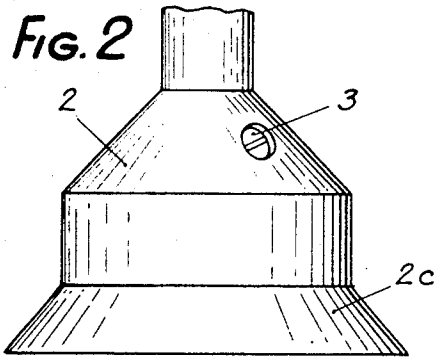


FIG. 5

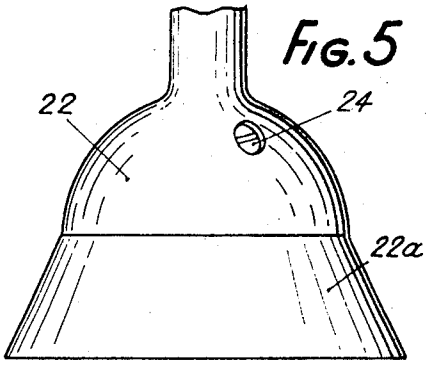


FIG. 8

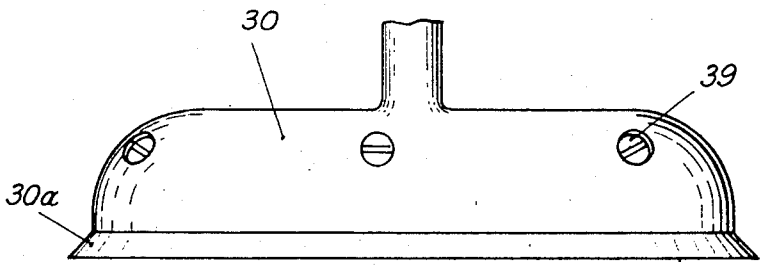


FIG. 10

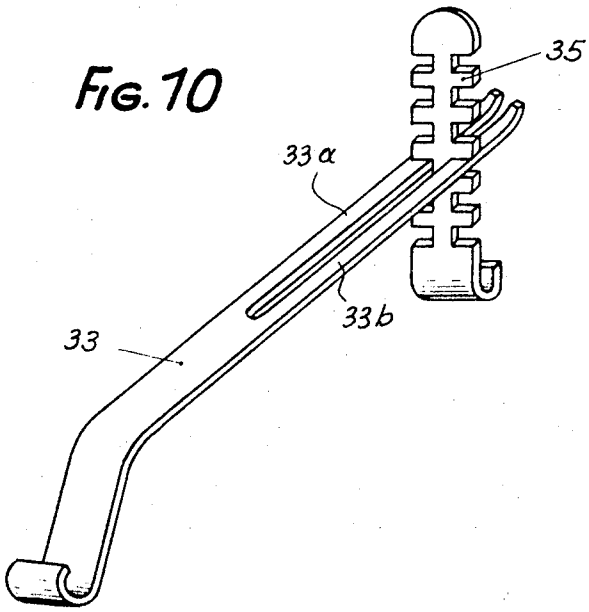


FIG. 4

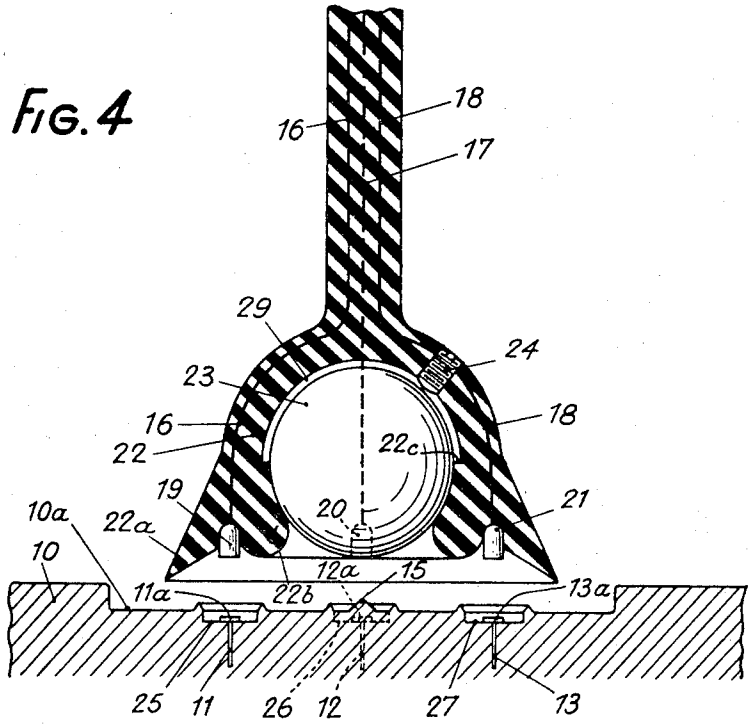

18
16
17
29
24
23
16
18
22
22c
19
20
21
10a
22a
10
12a
15
11a
22b
13a
25
11
26
12
27
13

FIG. 6

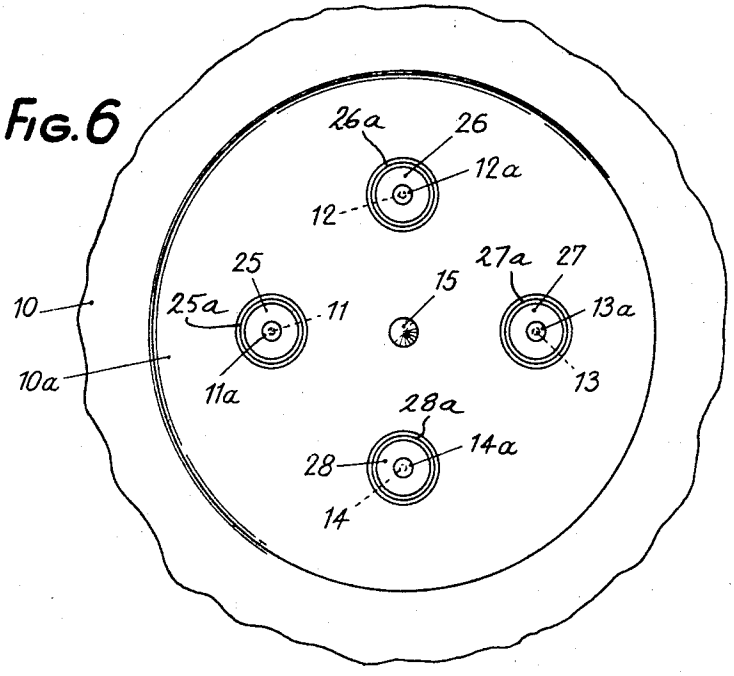

26a
26
12a
12
25
27a
27
15
25a
11
13a
10
10a
11a
13
28a
14a
28
14

FIG. 7

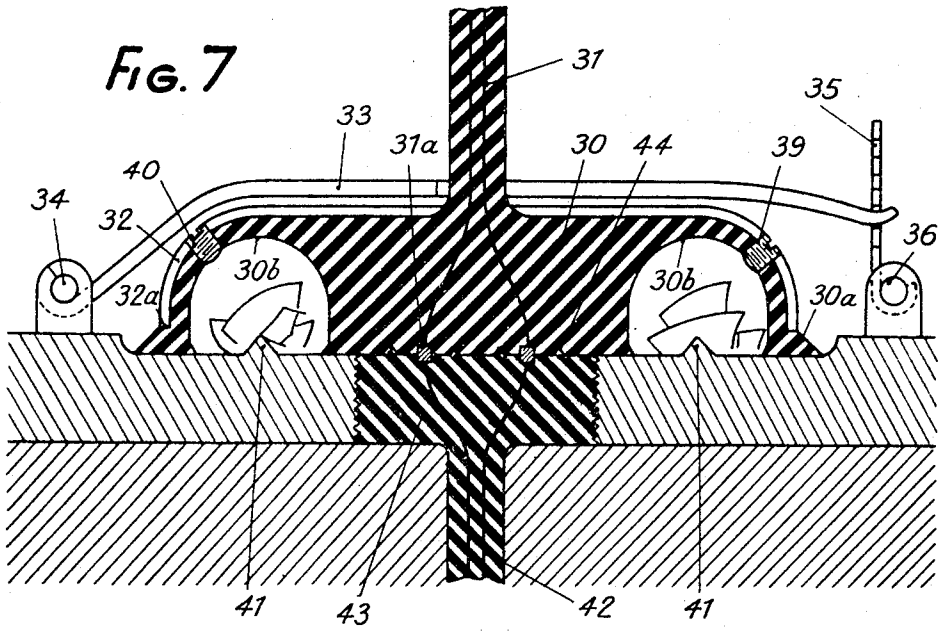

31
35
33
31a
30
44
39
40
34
32
36
32a
30b
30b
30a
41
43
42
41

FIG. 9

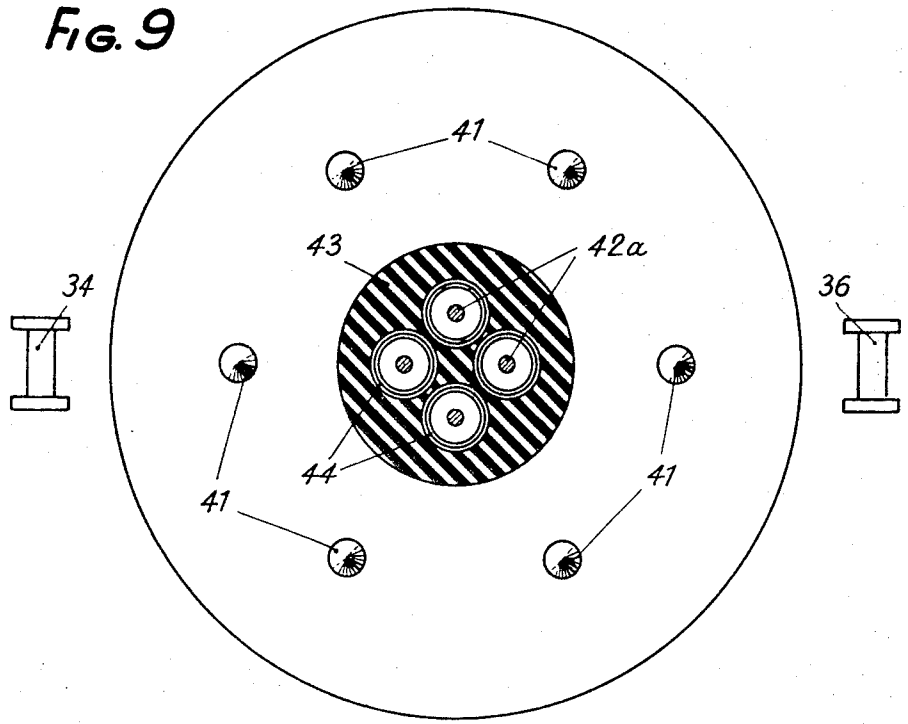

41
43
42a
34
36
41
44
41

FIG. 11

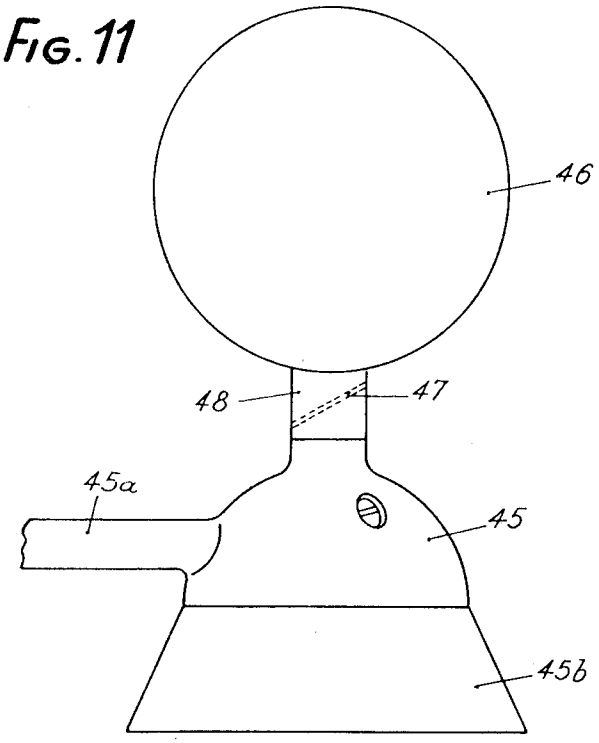
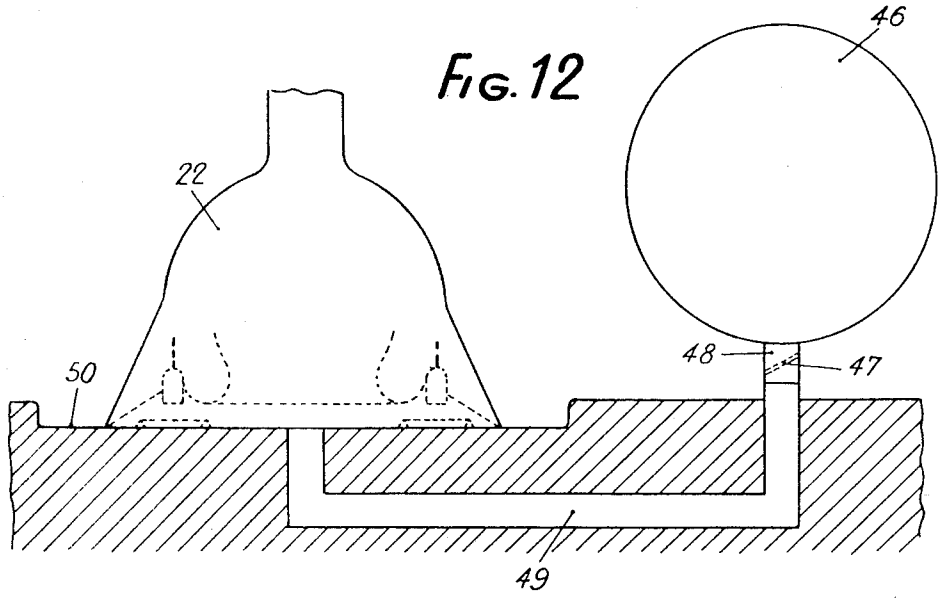


FIG. 12



METHOD OF MAKING ELECTRICAL CONNECTORS AND CONNECTORS THEREFOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a method of making electrical connections as well as electrical connectors therefor, which are intended to be applied against metallic surfaces to ensure perfect electrical contact between the connector and metallic surface, regardless of the surrounding conditions, the application of the connectors to the surfaces being capable of being performed either underwater or out of the water.

2. Description of the Prior Art

Electrical connectors which can be used underwater are subdivided into two classes: nonreconnectable, or permanent, underwater connectors and reconnectable connectors. The first type present the major inconvenience of necessitating reconnection out of the water when one of these connectors must sooner or later be disconnected and reconnected. This operation is all the more important when the underwater installation is situated at a deep level. This type of connector therefore is no longer suitable when water depth exceeds several tens of meters.

Reconnectable underwater electrical connectors, that is, connectors which can be connected or reconnected underwater, require a very precise adjustment between the male and female connectors, so as to reduce to a minimum the existing clearance in order to eliminate the presence of water. The connection, as well as the disconnection, of these connectors thus require a great effort on the part of the installer. It therefore follows that, after several handling operations, the adjustment is loosened, the tap-points become moist, and the negative poles corrode very rapidly.

SUMMARY OF THE INVENTION

The object of the present invention is to provide a method of making an electrical connection between at least two surfaces, one being a fixed surface and the other one being a mobile surface, according to which is arranged, around the mobile contact surface, a deformable envelope having waterproof walls and having an opening therein, as well as a closed and undeformable container containing a gas or vapor at a pressure lower than the pressure of the ambient environment surrounding the container. The lips or edge of the opening of the envelope is applied to the fixed surface and the container therein is broken. The dimensions of said envelope and said mobile surface are such that the envelope will press the mobile surface against the fixed surface due to the reduction in pressure within the envelope by the rupture of the container.

One feature of the method and apparatus according to the present invention invention which can be used out of the water, underwater, or in any other environment, resides in the fact that it does not require any precise adjustment and alignment of the male and female connectors. The contact surfaces can furthermore be made up of simple flat surfaces. To disconnect the tappoint, it suffices to place the outside environment into communication with the interior of the envelope by, for example, raising a part of the lips of the envelope by introducing a thin plate thereunder, or by providing a small opening in the wall of the envelope, which is closed off with a screw or valve. It suffices to unscrew the screw or open the valve in order to disconnect the surfaces which are in contact.

Another object of the present invention is to present an electrical connector which operates according to the above-described method and which utilizes two parts, one referred to as a fixed part, the other one referred to as a mobile or movable part, the fixed part being made up of an insulating part, in the form of a cupola, the edge of which is bordered by a lip, a rigid enclosure or container and a conductor inside the cupola, the height of the enclosure being at least equal to that of the cupola. The lip of the cupola is placed upon the insulating part surrounding the fixed conducting surface, and a force is applied to the cupola in the direction of the fixed part so as to bring about the rupture of the rigid enclosure or container, with the abrupt application of the movable contact surface to the first surface being assisted by the cupola due to the pressure differential prevailing within the enclosure delimited by the lip of the mobile part and the outside environment.

It has been noted that, by virtue of the pressure exerted upon the metal parts which are in contact, any trace of water between the metallic pieces will disappear and that the connector may be easily disconnected and then reconnected. For this purpose the screw which blocks communication between the interior of the cupola and the exterior is unscrewed. After having withdrawn the debris of the broken enclosure and after having put the screw back in place, a new container for example, a sphere, is placed into the cupola, and the assembly against the fixed part of the tap-point is then carried out, as previously described above.

Other objects and features of the invention will emerge from the specification with reference to the attached drawings which, without any limitations, represents a preferred embodiment for implementing an underwater reconnectable electrical connector and one of its variations.

Other objects and features of the invention will emerge from the specification with reference to the attached drawings which, without any limitations, represents a preferred embodiment for implementing an underwater reconnectable electrical connector and one of its variations.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is an axial cross-section view of a reconnectable underwater electrical connector before connection;

FIG. 2 is an elevation view of the electrical connector of FIG. 1;

FIG. 3 is an axial cross-section view of the connector of FIG. 1 after connection;

FIG. 4 is an axial cross-section view of a variation of the connector according to the present invention prior to connection;

FIG. 5 is an elevation view of the connector of FIG. 4;

FIG. 6 is a plan view of the fixed contact part of the connector shown in FIG. 4;

FIG. 7 is an axial cross-section view of a variation of the connectors of FIG. 4;

FIG. 8 is an elevation view of the connector in FIG. 7;

FIG. 9 is a plan view of the fixed part of the connector shown in FIG. 7;

FIG. 10 is a perspective view of the removable levers cooperating with the connector in FIG. 7;

FIG. 11 is a schematic view of a further variation of the connector of FIG. 1; and FIG. 12 is a schematic view of a variation of the connector of FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The mobile part of the reconnectable electrical connector of FIG. 1 is made up of an electrical conducting piece 1 which terminates in a cupola 1*a* provided with an opening 1*b* therethrough, a threaded part 1*c* and a contact surface 1*d*. This conducting piece is insulated on its outer surface from the surrounding environment by an insulating member 2 which terminates in a threaded corolla 2*a* having the exact shape of conductor 1, the threaded portion 2*b* engaging the threaded portion 1*c* of conductor 1. The corolla 2*a* of insulating member 2 has a lip 2*c* formed therearound and a plurality of lugs 2*d* passing through openings (not shown) of conductor 1. A hollow sphere 4 containing a gas or vapor at a reduced pressure is held within the housing formed by the cupola 1*a* by lugs 2*d* of the flexible corolla 2*a*.

The fixed part of the electrical connector includes a conducting piece 5 which terminates in a flat surface 5*a* provided with a point 5*b*. This conductor is surrounded by an insulating member 6 having a surface 6*a* on the same level as that of surface 5*a* and is embedded in a support 7.

A screw 3, preferably made of nonconducting material, provides for the sealing of the corolla 2*a* which has an opening corresponding to and on the same axis as opening 1*b* of the conducting cupola 1*a*. The extension of insulating member 2, with lip 2*c* and screw 3, are shown in FIG. 2.

The operation of the above-described construction will now be described. The mobile conductor 1 is placed adjacent the fixed or stationary conductor 5 by means of the application of lip 2*c* upon the surface 6*a*. The operator exerts a certain pressure on the mobile conductor 1 and insulating member 2 in the direction of the fixed conductor 5, causing the sphere 4 to yield and break, due to the pressure of the point 5*b*, as shown in FIG. 3. The reduced pressure prevailing in the sphere 4 is transferred into the chamber formed by the flexible wall of the lip 2*c*, surfaces 5*a*, 6*a*, and the inside wall of the cupola 1*a*. The lip 2*c* is pressed against the surface 6*a* and the surface 1d of the cupola 2*a* is flattened forcefully against the surface 5*a*, resulting in a secure, water-tight electrical connection. Thin radial channels can be made on the surface 1*d* of cupola 1a so as to transfer the reduced pressure to the volume included between surface 1*d*, the lip 2*c*, and the surface 5*a*. Thus, even when the fixed connector 5 is located underwater, not even the smallest drop of water will remain between the surfaces 1*d* and 5*a* which are in contact.

If, because of prior deterioration due to whatever cause, the surfaces 1*d* and 5*a* are no longer flat, the sphere 4 can contain a small quantity of mercury which would improve the contact between the surfaces by spreading across surface 5*a*. Furthermore, it is to be noted that the lugs 2*d* can partly retain the debris of the sphere 4, and can reduce the number of sphere fragments by starting rupture lines. In addition, screw 3 and point 5*b* on contact surface 5*a* can be used to facilitate the rupture.

In the case of very high external pressures, necessitating envelope spheres of sufficient strength to resist pressure, there can arranged on the support 7, a horizontal axle or pivot pin 8, serving as a support for a lever 9, constructed in the form of a fork, for example, whose two legs rest upon the corolla 2*a* on each side of the conductor 1, so as to facilitate the rupture of the sphere 4. This lever also assures the maintenance of a good electrical connection in case the connector assembly is submerged in rather shallow water where the pressure reduction created inside the cupola 1*a* is still small. The lever 9 can be installed permanently or it can be installed in a removable manner. A simple blocking device for the lense 9, likewise removable, is shown in FIGS. 7 and 10.

In the embodiment shown in FIGS. 4–6, the fixed support part 10 is constructed of insulating material. The support 10 contains four conductors 11–14, terminating in small flat conductive surfaces 11*a*–14*a*, with each surface having a central point 15. The mobile part is made up of four conductors, of which only three conductors 16, 17, and 18 appear in the cross-section. These conductors terminate in flat-surface studs 19–21, which are places within an insulating envelope 22. This envelope 22 has an outside lip 22*a* and an inside flange 22*b*. The latter serves to retain sphere 23. Screw 24 plays the same role as screw 3, described above.

In the version of FIGS. 4–6, the insulation between the studs 19–21, following their contact with surfaces 11*a*–14 after rupture of the sphere 23, is accomplished by pressing the insulating material 22 into the depressions 25–28 surrounding studs 19–21 and corresponding surfaces 11*a*–14*a*. Small ridges 25*a*–28*a* around the edges of the depression 25–28 improve the tightness of the seal between the studs 19–21.

The mobile connector can be oriented in the same way as the cup whose surface is 10*a* for alignment therewith.

In order to give the mobile connector a certain rigidity, a metallic fitting 29 can be provided which rests within the insulating envelope 22 upon the upper part 22*c* of the flange 22*b*.

In the embodiment shown in FIGS. 7–9, the insulating piece 30 of the mobile connector part contains the conductors 31 which lead to studs 31*a*. A rigid cover 32 covers the insulating piece 30 and rests, at the edge 32*a* of its contour, upon lip 30*a*. A lever 33, has one of its ends supported on axle 34 while the other end is retained in a notch of a blocking piece 35 articulated around an axle 36, as before, thus making it possible to facilitate the rupture of the hollow spheres, located in the cavities 30*b* of the insulating piece 30. The lever 33 also makes it possible to maintain the application of the mobile part of the electrical connector upon the fixed part in rather shallow water. It is clear that legs 33*a* and 33*b* of the lever 33 shown in FIG. 10, can be made of two separate pieces, with each of these separate pieces cooperating with a blocking piece 35, the two levers 33*a* and 33*b* being arranged on either side of the central part carrying the conductors 31.

The screws 39 and 40 play the same role and operate in the same manner as screws 3 and 24, in FIGS. 1 and 4, in the embodiments described hereinabove.

In the embodiment of FIGS. 7–9, the fixed part of the connector is designed to facilitate the rupture of six spheres housed in cavities 30*b*. Thus, six small cones or points 41 were shown in FIG. 9. The studs 42*a* of the connectors 42, against which the studs 31*a* contact, as in FIG. 7, extend from the insulating piece 43. A small circular ridge 44 surrounds each of the studs 42*a* as in the example of FIG. 6.

The six small spheres contained in recesses 3*b* could be replaced with a single sphere, and a single screw 39 for reducing the pressure within the connector assembly.

The construction of the envelope of the spheres may be of any desired shape and from any desired material. The sphere can be made of glass, heat-hardenable materials, or others. The thickness of the spheres is obviously greater when the connector is used at great depth. When these electrical connectors are used at shallow depths or on the surface, the use of the lever is not necessary, since a slight manual effort will make it possible to crush the sphere. It goes without saying that the sphere can be replaced by an enclosure having any other shape and that a sufficient number of cavities may be provided in order to ensure sufficient force of application in applying the mobile connector upon the fixed connector, when the ambient atmospheric or hydrostatic pressure is very small.

Although only one general structure for practicing the subject invention, along with some of its variations have been described, it is clear that numerous modifications can be made in the various elements constituting these connectors, as well as in the method described, without going beyond the framework of the invention.

The spherical container 23 of FIG. 4 could be eliminated completely and replaced with one or more outside having a reduced pressure, these containers being connected by one or more conduits traversing the corolla 22, and employing one or more outside valves, thus making it possible, after application of the lip 22*a* upon surface 10, to communicate the enclosure formed by the corolla 22 and surface 10*a* with the outside containers.

As shown in FIG. 11, the conductors of the mobile connector extend from conduit 45*a* into insulating piece 45, which has a lip 45*b* at the lower edge thereof. The insulating piece 45 may include an arrangement of studs of conductors similar to the one shown in FIG. 4, if desired. The insulating piece 45 is surmounted by a rigid envelop 46 which forms or contains a hollow enclosure separated from the interior of insulating piece 45 by a breakable or movable partition or valve 47. The partition 47 can also be replaced by a simple valve and the neck 48 may be screwed upon a rigid conduit connecting with piece 45. The screw connection can be used to crush the partition 47 when the threading of the neck 48 upon the rigid part of insulating piece 45 is already tight. The operation of the connector is identical to the one described earlier. The water contained in the enclosure delimited by lip 45*a* and its support surface passes into the rigid cavity 46 when the partition 47 is broken, due to the pressure reduction in cavity 46, thus causing the collapse of lip 45*b*.

FIG. 12 schematically shows a version similar to the one shown in FIG. 11 but where the neck 48 of the rigid envelope 46 is connected with a channel 49 leading into the cup 50 of the fixed connector upon which will be applied the lip of the mobile connector 22. It is clear that identical channels could lead to the surface of the fixed connector of FIGS. 7–9, at the positions and at the location of points 41. The number of rigid envelopes 46 here can be any number.

With regard to the shape of the conductor plugs which are in contact, this shape may be adapted to that of the cup so that the contact of the studs of the removable plug against the fixed studs will be accomplished with very slight horizontal sliding, so that a ridge of stud 19, for example, will scrape the surface of stud 11a before being immobilized face to face.

What is claimed is:

1. A method of obtaining electrical connection between at least two conducting surfaces, one surface being fixed, the other surface being mobile, comprising the steps of:
   a. providing a deformable watertight envelope having an opening with a deformable lip therearound around the mobile surface,
   b. positioning an undeformable container containing a gas or a vapor at a pressure lower than that of the ambient environment within said envelope,
   c. applying the opening of the envelope around the fixed surface,
   d. rupturing said container to cause a reduction in the pressure within said envelope, the volume within said envelope and said mobile surface being such that the envelope flattens the mobile surface against the fixed surface under the effect of the reduction in pressure created by the rupture of the container.

2. The method as recited in claim 1, further comprising the steps of positioning the closed container, containing the gas vapor at lower pressure, outside of said deformable envelope, connecting a closed opening of said container with the interior of said deformable envelope and opening said closed opening.

3. The method as recited in claim 2, further comprising the steps of communicating said closed and undeformable container with the interior of said deformable envelope by means of a channel positioned outside said envelope and not traversing it, and leading to the vicinity of said fixed conducting surface.

4. The method as recited in claim 2, further comprising the step of breaking said closed opening to open said closed container.

5. An electrical connector comprising, in combination, a fixed contact and a mobile contact, said fixed contact formed of at least one conductor terminating in a contact surface surrounded by an insulating surface, said mobile contact being made up of an insulating part in the shape of a housing bordered by a lip, a rigid and breakable container contained in said housing, said container containing a gas or vapor at a pressure below that of the surrounding environment, and at least one conductor inside said housing, the height of the container being at least eQual to that of said housing.

6. An electrical connector as claimed in claim 5, wherein the mobile and fixed contact surfaces are flat.

7. An electrical connector as claimed in claim 5, wherein the conductor terminates in a cupola upon which is applied the insulating wall of said housing.

8. An electrical connector as claimed in claim 7, wherein the cupola part of the conductor has an opening formed therethrough which is closed off by the insulating part, and a screw extending through the insulating part.

9. An electrical connector as claimed in claim 5, wherein a point is formed on the surface of the fixed part opposite the rigid container.

10. An electrical connector as claimed in claim 5, wherein the fixed part is contained in a cup having walls bordering on the lip of the insulating part of the mobile part when said mobile part is positioned upon the fixed part due to the rupture of the rigid enclosure.

11. An electrical connector as claimed in claim 5, wherein the container is a sphere.

12. An electrical connector as claimed in claim 5, wherein the container holds a small quantity of mercury.

13. An electrical connector as claimed in claim 5, wherein the conductor or conductors of the mobile piece are sunk into the insulating part, said conductors terminating in studs whose extreme end surfaces extend from the insulating part at the periphery of said housing between the external lip and an internal flange.

14. An electrical connector as claimed in claim 13, wherein the fixed part further comprises a small cup around each contact surface, the edges of which present a circular ridge surrounding the extremities of the studs of the mobile part when the latter is applied upon the fixed part and, provide sealing between the studs by their penetration into the external lip and the internal flange of the cupola.

15. An electrical connector connection tap-point as claimed in claim 5, where the conductor or conductors are sunk in the central portion of said insulating part and said housing includes a plurality of cavities distributed between said lip and the central portion of the insulating part, a rigid breakable container being inserted in each cavity.

16. An electrical connector connection tap-point as claimed in claim 15, where the insulating part is covered with a rigid cap whose edge is supported upon the external lip of the insulating part.

17. An electrical connector as claimed in claim 5, wherein said fixed parts include two axles fixed thereon, a lever movably connected to one of said axles and adapted to extend across the mobile part of the connector, the other end of said lever being maintained by a bolt articulated upon the other axle of the fixed part.

18. Ane electrical connector as claimed in claim 17, wherein said lever and said bolts are removable.

19. An electrical connector comprising in combination, a fixed part and a mobile part, said fixed part including at least one conductor terminating in a contact surface surrounded by an insulating surface, said mobile part including an insulating part in the form of a housing bordered by a lip and having at least one conductor cooperating with said conductor or conductors of said fixed part, said housing being connected by an external channel to a rigid container whose internal volume is at a lower pressure, said container being breakable at least at the location separating said container from said housing.

20. An electrical connector as claimed in claim 19, wherein said fixed parts include two axles fixed thereon, a lever movably connected to one of said axles and adapted to extend across the mobile part of the connector, the other end of said lever being maintained by a bolt articulated upon the other axle of the fixed part.

21. An electrical connector comprising in combination, a fixed part and a mobile part, said fixed part including at least one conductor terminating in a contact surface surrounded by an insulating surface, said mobile part including an insulating part in the form of a housing bordered by a lip and at least one conductor cooperating with said conductor or conductors of said fixed part, a channel located in the fixed part leading to said housing and connected to a rigid external envelope whose interior volume is at a lower pressure than that of the surrounding environment and is at least breakable at the place separating said container from said channel.

22. An electrical connector as claimed in claim 21, wherein said fixed parts include two axles fixed thereon, a lever movably connected to one of said axles and adapted to extend across the mobile part of the connector, the other end of said lever being maintained by a bolt articulated upon the other axle of the fixed part.

* * * * *