

[54] SELF-PURGING MULTI-CONTACT ELECTRICAL CONNECTOR

[72] Inventor: Chester B. Falkner, Whittier, Calif.
 [73] Assignee: Deep Oil Technology, Inc., Long Beach, Calif.
 [22] Filed: May 29, 1969
 [21] Appl. No.: 828,831

[52] U.S. Cl. 339/61 M, 339/94 M, 339/117 R, 339/177 R
 [51] Int. Cl. H01r 13/52
 [58] Field of Search 339/59-61, 94, 339/117, 177

[56] References Cited

UNITED STATES PATENTS

2,379,942 7/1945 Webber 339/60
 2,703,870 3/1955 Minto 339/94 M
 3,478,298 11/1969 Nelson 339/61 M

FOREIGN PATENTS OR APPLICATIONS

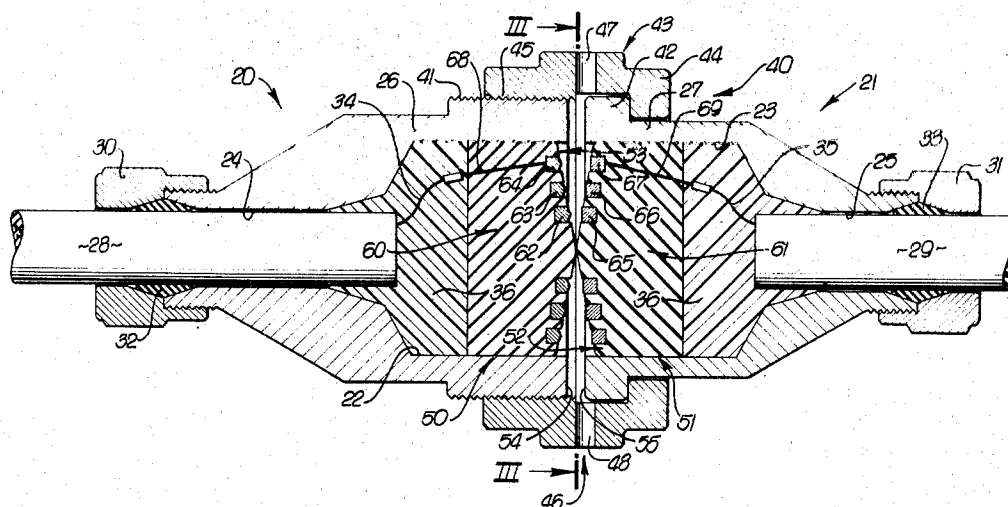
826,158 3/1930 Great Britain 339/8 P

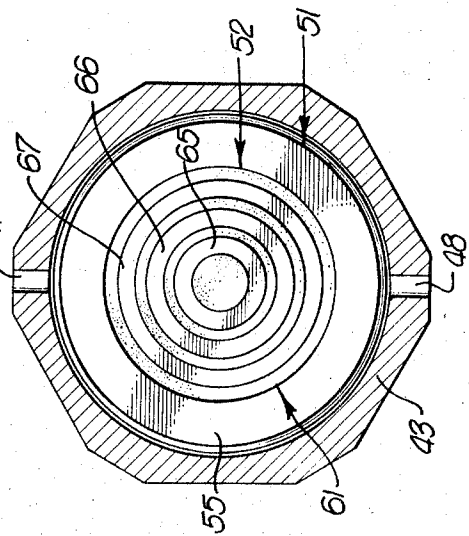
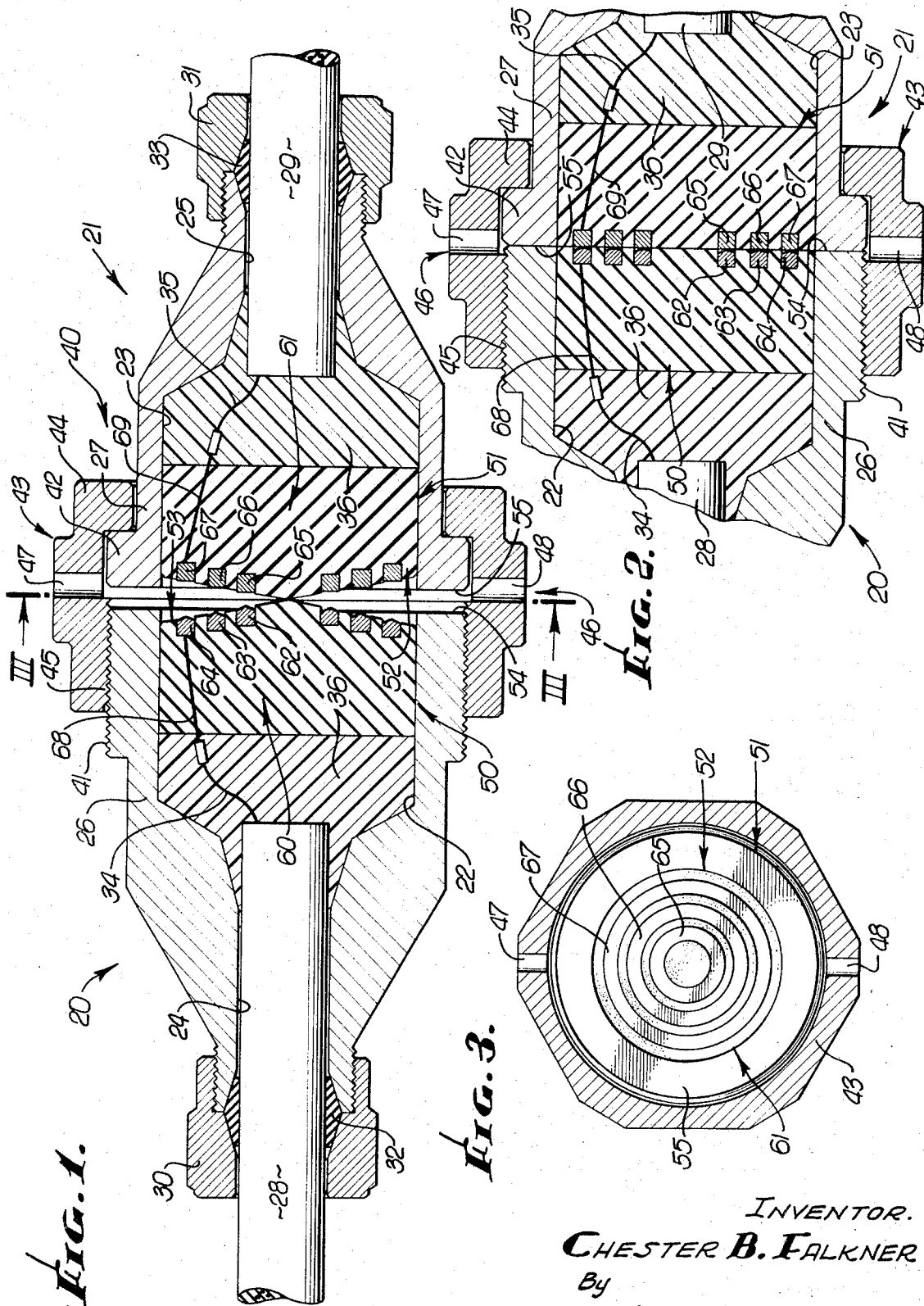
Primary Examiner—Ian A. Calvert
 Assistant Examiner—Joseph H. McGlynn
 Attorney—Miketta, Glenny, Poms & Smith

[57] ABSTRACT

A self-purging, multi-contact electrical connector for use in a hostile fluid environment which includes a pair of connector housings each of which is connected to an electrical wire and each of which defines a chamber, mechanical means for releasably interconnecting the housings, an elastomeric body sealingly carried in each of the housing chambers and each of the bodies having exposed, aligned, convex surfaces, and each of the bodies carrying at least one electrically conducting contact member exposed at the convex surface and electrically connected to the wires, so that progressive engagement of the elastomeric bodies through the interconnecting means purges hostile fluid environment from the housings engaging the contact members in pressure contact.

7 Claims, 7 Drawing Figures





INVENTOR.

CHESTER B. FALKNER

By

Miketta, Jenny, Pons & Smith

ATTORNEYS.

FIG. 4.

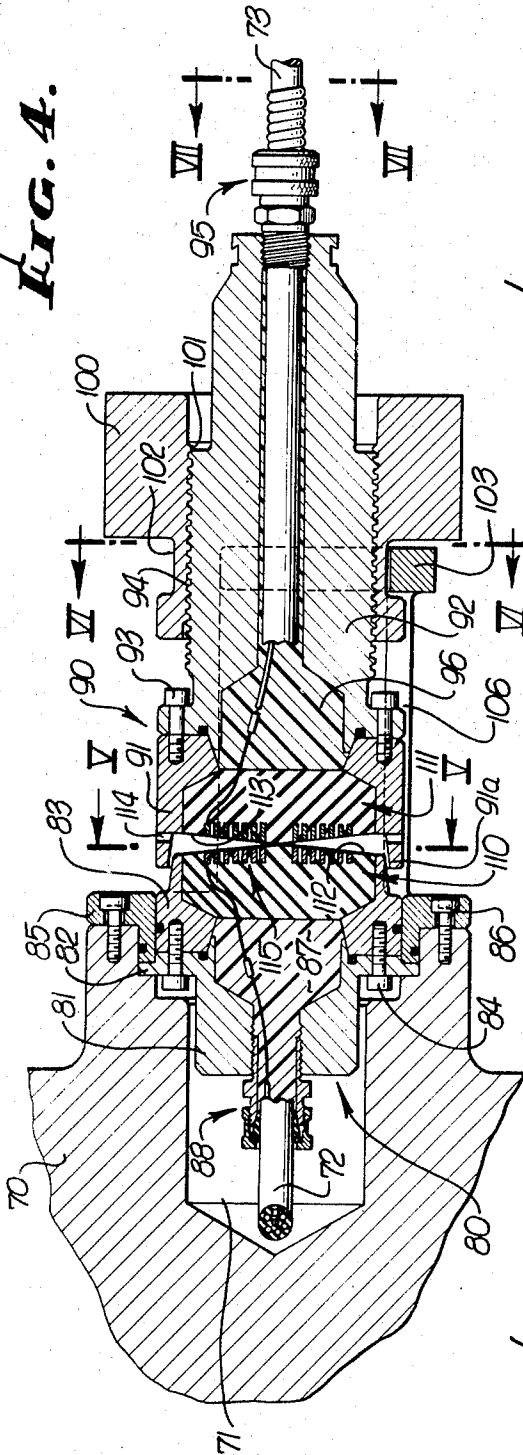


FIG. 5.

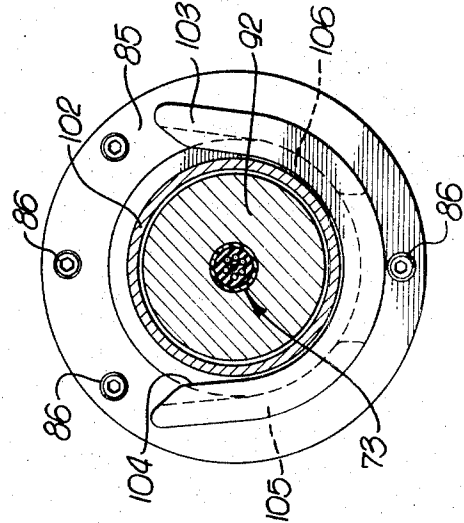


FIG. 6.

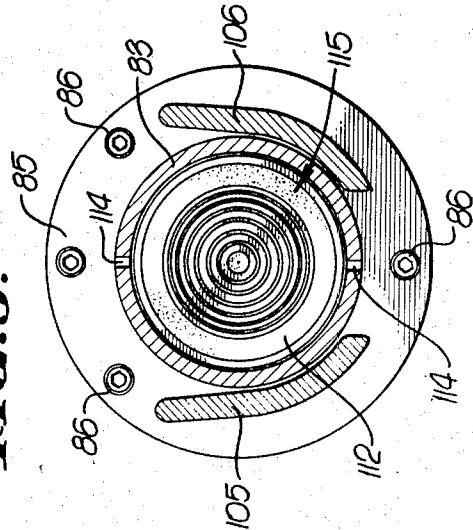
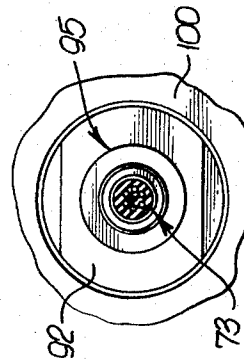


FIG. 7.



INVENTOR.
CHESTER B. FALKNER

By
Miketta, Glenn, Pome & Smith
ATTORNEYS.

SELF-PURGING MULTI-CONTACT ELECTRICAL CONNECTOR

BACKGROUND OF THE INVENTION

The present invention is directed to an electrical connector which can be used and made up in a hostile environment. While the exemplary embodiments described herein were derived in connection with the provision of a sub-sea electrical connector, it will be apparent to those skilled in the art that a connector of the present type may be used in any hostile fluid environment such as outer space, a nuclear irradiated atmosphere, or the like.

The problem involved in effecting a good electrical connection between two cable or wire terminating devices in a fluid environment is the prevention of the entrapment of such environment between the electrical contact members or elements or within a closed housing or pair of housings that define the terminator connection.

An object of the present invention is to provide a multi-contact electrical connector which self-purges the hostile environment prevailing during connection between the two members comprising the connector. It is also an object to provide a multi-contact connector which need not be rotationally oriented to effect the connection such as by the provision of concentric, annular, radially-spaced contact members. The integrity of the electrical connection is also assured by the provision of line pressure contact between the annular elements so as to overcome any oxide film on the contacts which may exist prior to connection and also to prevent contaminants from being entrapped between two of the contact members or elements. It is also an object to provide elastomeric bodies for carrying the contact members which provide electrical insulation between the contact members and the wires connected thereto and which will not allow foreign material, such as particles of sand, to prevent proper interfacial contact between the bodies. It is also an object to provide a connector which has considerable tensile strength so that the electric cable in which such connector is used may also be used for tensile loading.

SUMMARY OF THE INVENTION

A self-purging, multi-contact electrical connector for use in a hostile fluid environment comprising, a pair of connector housings each connected to an electrical wire and defining a chamber, means for releasably interconnecting the housings, an elastomeric body sealingly carried in each of the housing chambers, each of the elastomeric bodies having exposed alignment convex surfaces, and each of the elastomeric bodies carrying at least one electrically conducting contact member exposed at the convex surface thereof and electrically connected to the wires, so that progressive engagement of the elastomeric bodies purges the hostile fluid environment from the connector and engages the electrical contact members in pressure contact.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side sectional view of an exemplary self-purging, multi-contact electrical connector, shown in the pre-connected condition, constructed in accordance with the present invention;

FIG. 2 is a detailed sectional view of a portion of the connector of FIG. 1 shown in the fully assembled or connected position;

FIG. 3 is a sectional view taken along the plane III—III OF FIG. 1;

FIG. 4 is a second exemplary embodiment of a self-purging, multi-contact electrical connector constructed in accordance with the present invention including modified means for interconnecting the connector housings as well as other modifications;

FIG. 5 is a sectional view taken along the plane V—V of FIG. 4;

FIG. 6 is a sectional view taken along the plane VI—VI of FIG. 4; and

FIG. 7 is a sectional view taken along the plane VII—VII of FIG. 4.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIGS. 1 through 3, there is shown a first exemplary embodiment of a self-purging, multi-contact electrical connector for use in a hostile environment constructed in accordance with the present invention. Such exemplary embodiment generally comprises a pair of connector housings, indicated generally at 20, 21; means 40 for releasably interconnecting the housings; elastomeric bodies carried by each of the housings, indicated generally at 50, 51; and electrically conducting contact members or elements, indicated generally at 60, 61.

The housings 20, 21 of the first exemplary embodiment are generally cylindrical in configuration and define chambers 22, 23, and axial cylindrical openings 24, 25, respectively. The chambers 22, 23 are defined by cylindrical walls 26, 27. The housings 20, 21 are connected to wires 28, 29 which are disposed within axial cylindrical openings 24, 25 in the housings. The wires 28, 29 are in fluid-tight connection with their respective housings through the provision of threaded end nuts 30, 31 which coact with wedge members 32, 33 so as to radially clamp the wire passing therethrough to form a fluid-tight connection in a manner known in the art.

Each of the wires 28, 29 have a plurality of conductors disposed therein each of which is electrically insulated from one another in the ordinary manner. The sheath portion of the wires 28, 29 terminates within the chambers 22, 23 and the individual conductors, which may be without insulating material, project axially therefrom, such as conductors 34, 35 exemplarily shown in FIG. 1 for wires 28, 29, respectively. The housing chambers are partially filled with a solid insulating material, indicated generally at 36, such as an epoxy resin, in which the conductor wires are embedded.

The means 40 for releasably interconnecting the housings 20, 21 in the exemplary embodiment comprise threaded portion 41 on housing wall 26 and a shoulder 42 on housing wall 27. Such means also includes a threaded collar or clamping nut 43 also having a shoulder 44, the nut being mounted on housing 21 and having an internally threaded portion 45 so that when threaded on portion 41 of housing 20 the nut will axially move the housings 20, 21 together to effect the connection. The nut 43 is provided with means 46 for permitting the escape of the hostile fluid environment from the chambers 22, 23 of the housings 20, 21 when the housings are joined through interconnecting means 40, and in the exemplary embodiment such escape means comprises holes 47, 48. It will of course be understood, that various means for releasably interconnecting the housings may be provided, such as spring operated latching means, hydraulic pressure operated latching means, pins and complementary J-slots, or the like.

The self-purging multi-contact electrical connector also includes elastomeric bodies 50, 51 disposed in the chambers 22, 23 of housings 20, 21, respectively. Such elastomeric material may be, for example, Buna-N rubber. The cylindrical and end surfaces of the elastomeric bodies 50, 51 are in sealing engagement with the walls 26, 27 of the housings 20, 21 and the epoxy material 36, respectively. Each of the elastomeric bodies has an exposed generally aligned convex surface indicated generally at 52, 53, respectively. The term "convex" is used herein to describe a surface having a center portion which is axially forward or displace from the adjacent radial annular area such as a conical, spherical, or similar shape.

The elastomeric bodies 50, 51 are arranged so that the central portion of the exposed surfaces 52, 53 are axially forward of the ends 54, 55 of the housing walls 26, 27, respectively, and the annular, radially outward portion of the exposed surfaces are axially rearward of the ends 54, 55 of the walls. The volume of the space defined by a transverse plane engaging the wall edges, the sloping annular surface of the elastomeric body and the inner surface of the cylindrical walls of the hous-

ing is less than the volume of the central portion of the elastomeric body which is forward of such transverse plane. It will thus be seen that when the ends 54, 55 are in engaging contact through the tightening of the clamping nut 43 which draws the housings together, as seen in FIG. 2, the elastomeric bodies have a volume greater than the chamber defined by the housing walls and the epoxy material 36. Consequently, the elastomeric body is deformed or in compressive load so that there is pressure contact between the exposed surfaces 53, 52 of the bodies.

The first exemplary embodiment of the electrical connector also includes electrical conducting members or elements 60, 61 which are carried by the elastomeric bodies 50, 51, respectively. At least a portion of these connecting members are exposed so as to define contact surfaces which are in pressure engagement, due to the deformation of the elastomeric bodies, when the housings are tightly connected. In the preferred embodiment, such electrically conducting contact members comprise a plurality of annular, radially-spaced, concentric electrical conductor elements 62, 63, and 64 in elastomeric bodies 50 and 65, 66 and 67 in elastomeric body 51. Each of the annular contact elements is electrically insulated from the adjacent element by the interposed elastomeric material of the bodies 50, 51. Each of the annular contact elements is also electrically connected through leads, such as leads 68, 69, to the annular contact elements 64, 67, respectively.

In the preferred embodiment, the contact elements 65, 66, and 67 have planar faces and the contact elements 62, 63, and 64 have annularly convex faces so that upon pressure engagement there is line contact between the complementary elements. In this manner, the deposition of oxide films or the like, from the hostile fluid environment, will not prevent proper electrical metal-to-metal contact between the contact members. Also, foreign particles or contaminants which may be present in the environment in which the housings are connected will not be trapped between the contact surfaces as they approach one another during the connection. Moreover, any contaminant particle, such as a grain of sand, will not prevent proper electrical contact since such particle will readily embed in the relatively soft elastomeric material between the metallic contact elements when forced from between such elements.

In operation, assume that the wires and the connector housings are disposed or submerged in a hostile fluid environment which is desirably purged from between the electrical contact elements in order to effect a good electrical connection. The housings are brought adjacent one another so that the clamping nut 43 may be threaded on the threaded portion 41 of the housing 20. As shown in FIG. 1, the clamping nut has been threaded an amount so as to bring the central portions of the elastomeric bodies 50, 51 into contact. Further threading of the clamping nut 43 will be seen to axially move the housings 20, 21 toward one another initially causing deformation of the central portion of the elastomeric bodies and forcing the environment radially outwardly. Progressive axial engagement will first bring contact elements 62 and 65 into operative engagement. The radially outwardly disposed annular contact elements are then progressively brought into engagement while the environment is being forced outwardly between the ends 54, 55 of the housing walls 26, 27 and through the openings or holes 47, 48 in the clamping nut 43. It will be seen that immediately preceding abutment of the ends 54, 55 there will be surplus of elastomeric material so that prior to and immediately preceding contact between the wall ends the entire space between the exposed surfaces 53, 54 of the elastomeric bodies is evacuated of the environment. The completely assembled connector is shown in FIG. 2 where it will be seen that the electrical contact elements are in pressure engagement due to the deformation of the elastomeric bodies and all of the environment has been purged. Moreover, since the elastomeric material is under compressive load, the pressure within the housings is normally greater than the ambient pres-

sure thereby preventing entry of the fluid environment into the connected housings.

The above-described first exemplary embodiment provides an electrical connector useful in numerous applications which, by way of example, may be a combination towing and electrical cable, a cable or line mooring an instrumented buoy in the ocean, or the like. The second exemplary embodiment of the present invention is more specifically directed to an electrical connector which may be used to connect an electric power cable to a down-hole submersible pump in oil or water producing wells, or connect an electric power and control cable to a sub-sea blowout preventer assembly or a wellhead used in oil well production. Such second exemplary embodiment of an electrical connector is shown in FIGS. 4 through 7, to which attention is now directed.

In FIG. 4, there is shown an electrical connector constructed in accordance with the present invention in conjunction with a sub-sea apparatus having a body, a portion of which is shown at 70. The body includes a cavity 71 into which an electrical wire 72 projects for external connector to a power wire or cable 73.

The connector includes a housing 80 comprising a base portion 81 having a flanged portion 82 secured to a cylindrical wall portion 83 through a plurality of fasteners 84. The base portion 81 and cylindrical wall portion 83 of the housing 80 is secured to the body 70 of the sub-sea apparatus through an annular retainer member 85 bearing against the flange portion 82 of base portion 81 and retaining the housing 80 to the body 70 through a plurality of bolts 86. The chamber defined by the housing is partially filled with solid epoxy material 87. The wire 72 is secured to the housing 80 through suitable end clamp members indicated generally at 88.

A second housing member 90 is provided including a cylindrical wall portion 91 secured to a base portion 92 through a plurality of fasteners 93. Base portion 92 is generally cylindrically elongated and includes a threaded portion 94. Base portion 92 has an axial cylindrical opening for receiving cable 73 suitably secured therein through clamping members indicated generally at 95. The end of the cable 73 terminates in potted epoxy resin indicated at 96. Suitable sealing members are provided for effecting a water-tight engagement of housing base member 92 and cylindrical wall portion 91.

Means is provided for axially interconnecting the housings 80, 90 which includes the threaded portion 94 of the base portion 92 of housing 90 and a generally cylindrical collar 100 having internal threaded means 101 engaging the external threads 94 on the housing portion 92. Collar 100 has a reduced diameter portion 102. Such means also includes a wall 103 laterally spaced from the body 70 and having a U-shaped opening 104 for receiving the reduced diameter portion 102 of collar 100 and restraining the collar against axial movement. The U-shaped opening 104 is in axial alignment with the cavity 71 in the body 70 of the apparatus and the wall 103 is supported by a pair of arms 105, 106 in its laterally spaced position.

It will now be seen that with the housing 80 secured to the body 70 of the apparatus, the housing 90 to which is attached the power cable 73 may be positioned and supported by the wall 103 so that the housings are in general axial alignment. Rotation of the collar 100, which is restrained against axial movement, will produce axial forward movement of housing 90 so as to bring the two housing members into engagement.

Elastomeric bodies 110, 111 are disposed in the cylindrical portions 83, 91 of housings 80, 90, respectively. The elastomeric bodies are in most respects similar to those previously described having exposed convex surfaces 112, 113. It will be noted that the exposed convex surface 112 of elastomeric body 110 has its outermost annular portion at the end of cylindrical wall 83 so that the entire exposed surface is forward of the end of the cylindrical wall 83. The exposed surface 113 of the elastomeric body 111, on the other hand, is recessed from the end of the cylindrical wall 91 the portion 91a of the wall projecting forwardly of the outer annular por-

tion of the elastomeric body having a plurality of openings 114 for permitting the escape of the hostile fluid environment from the housings. It will also be seen that this portion 91a of the cylindrical wall has an enlarged inner diameter so as to receive the end of the wall 83 when the housings are engaged to provide axial alignment as well as inhibiting extrusion of the elastomeric body.

In the second exemplary embodiment, the electrically conducting contact elements, indicated generally at 115 may also comprise a plurality of annular, radially-spaced concentric rings which are electrically insulated from one another. Each of the rings is carried by the elastomeric bodies so that one face thereof is exposed. In contrast to the shape of the exposed face of the annular contact elements of the first exemplary embodiment, each contact element 115 has a generally frusto-conical or inclined face which is flush with the conical exposed surface of the associated elastomeric bodies 110, 111. In all other respects, the contact elements of the second exemplary embodiment are connected to the wires 72, 73 and are pressure engaged when the connection is made as in the first exemplary embodiment.

An important novel feature of the preferred embodiment of the present invention is the non-orientation characteristic of the electrical connector. In other words, in many prior art electrical connectors wherein multiple contacts are made, they require that one of the two mating or engaging housing members be rotationally aligned so that the proper jack will enter the proper socket. In contrast to this requirement for orientation in the prior art devices, the connector of the present invention, through the utilization of the annular contact elements, is not dependent upon any predetermined orientation of the housing members.

In the examples of the invention described above it is important to note that the opposed faces of the elastomeric bodies are brought together in positive interfacial pressure engagement to purge the hostile fluid environment from between the faces, that such pressure engagement effectively isolates the conductor faces making electrical contact and possible electrical paths between adjacent conductor faces caused by the fluid environment (such as salt water) are effectively destroyed and eliminated. Interfacial pressure contact between conductor faces is effective to break or penetrate any oxide layer formed on the conductor faces.

Other modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than the two exemplary embodiments shown and described.

I claim:

1. A self-purging, multi-contact electrical connector for use in a hostile fluid environment comprising:

a pair of connector housings, each such housing being connected to an electrical wire means and having walls defining a chamber with an open end;

means cooperable with said walls for releasably interconnecting said housings;

an elastomeric body carried in each of said housing chambers in engagement with said walls, said elastomeric bodies having exposed, aligned corresponding pressure engagement surfaces at least one of which projects beyond the plane of its respective chamber open end and disposed upon contact with the other pressure engagement surface to expel fluid progressively outwardly;

each of said elastomeric bodies carrying at least one electrically conducting contact member exposed at said pressure engagement surface and electrically connected to said wire means;

means permitting escape of fluid environment during progressive engagement of said elastomeric bodies so as to purge the hostile fluid environment from said connector,

said contact members being urged into pressure contact by said elastomeric bodies to provide an electrically conductive connection; and

space means provided between said walls and said pressure engagement surfaces adjacent said open ends for permitting flow of said elastomeric body under pressure contact.

2. The self-purging electrical connector of claim 1 wherein said at least one electrically conducting contact member carried by one of said elastomeric bodies comprises a plurality of annular axially offset, radially-spaced concentric members, each of said concentric members being electrically connected to at least one conductor from said associated electrical wire means.

3. The self-purging electrical connector of claim 1 wherein one of said connector housings is integral with a sub-sea oil production apparatus and said means for releasably interconnecting said housings comprises, external threaded means carried by said other housing, a generally cylindrical collar having internal threaded means engaging said other housing external threaded means and having an intermediate reduced diameter portion, a wall laterally spaced from said apparatus including a U-shaped opening in alignment with said one apparatus housing for receiving said reduced diameter collar portion, whereby rotation of said axially constrained collar effects axially movement of said other electrical connector housing so as to produce pressure engagement of said elastomeric bodies.

4. The self-purging electrical connector of claim 1 wherein each of said elastomeric body convex surfaces extend axially beyond said opening at the center thereof and axially inwardly of said opening adjacent the housing wall, said elastomeric body filling said chambers when said connector is in a closed position so as to expel the hostile fluid environment before contact of said housing wall ends, whereby entrapment of fluid within said housings is avoided.

5. The self-purging electrical connector of claim 4 wherein each of said elastomeric bodies comprises a volume exceeding the volume of said housing chamber, so that when said housing wall ends are in proximate contact said elastomeric bodies are under compressive load.

6. In a self-purging, multi-contact electrical connector for connection and use in an atmosphere deleteriously affecting the effectiveness of electrical contact in the connector including a pair of connector housings each having a chamber of selected volume, a multi-conductor electrical wire connected to each of said housings, and means for mechanically coupling said housings, the improvement comprising:

an electrically-insulating, deformable body carried in and substantially filling each of said chambers, each of said bodies having an exterior convex face including a plurality of annular coaxial openings in registry when said connector housings are coupled;

an electrical contact member carried in each of said openings, each of said contact members being electrically connected to one of said wire conductors, and each of said contact members having a contact face axially offset from the adjacent contact face whereby mechanically coupling of said housings effects radially progressive pressure contact of said body exterior faces so as to purge the atmosphere from between said faces and out of said connector whereby said bodies are held under pressure confinement;

the volume of said deformable bodies under pressure engagement exceeding the volume of said chambers; and space means in said housing accommodating the excess volume of the deformable bodies while maintaining the deformable bodies under compression.

7. A self-purging, multi-contact electrical connector for use in a hostile fluid environment comprising:

a pair of connector housings, each such housing connected to an electrical wire means and defining a chamber;

means for releasably interconnecting said housings;

an elastomeric body sealingly carried in each of said housing chambers, said elastomeric bodies having exposed, aligned corresponding pressure engagement surfaces arranged to expel fluid progressively outwardly;

7

each of said elastomeric bodies carrying at least one electrically conducting contact member exposed at said pressure engagement surface and electrically connected to said wire means;

at least one electrically conducting contact member carried by one of said elastomeric bodies comprising a plurality of annular, radially-spaced concentric members, each of said concentric members being electrically connected to at least one conductor from said associated electrical wire means:

said plurality of annular concentric contact members in one of said elastomeric bodies having substantially flat faces

8

and the annular concentric contact members in the other of said elastomeric bodies having annularly convex faces so that complimentary contact members when engaged provide aligned pressure contact;

means permitting escape of fluid environment during progressive engagement of said elastomeric bodies so as to purge the hostile fluid environment from said connector.

said contact members being urged into pressure contact by said elastomeric bodies to provide an electrically conductive connection.

* * * * *

15

20

25

30

35

40

45

50

55

60.

65

70

75