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Falkner

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[54] **SUBSEA BUTTON-TYPE ELECTRICAL CONNECTOR**

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[51] **Int. Cl.** **H01r 13/54,** H01r 9/06

[58] **Field of Search** ..... 339/31, 60, 94 R, 94 M, 339/143, 149 P, 150 B, 34, 35, 200–202, 18, 96, 75 R, 75 M, 75 P

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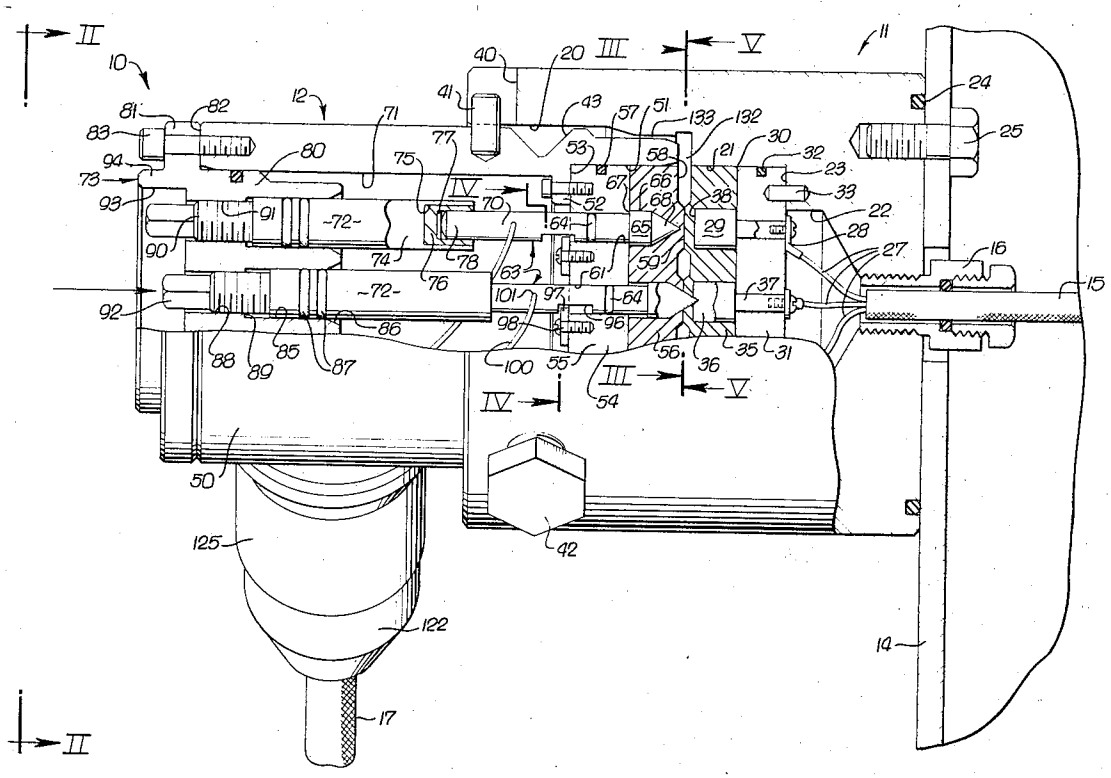
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[57] **ABSTRACT**

A multi-conductor electrical connector means for use in an adverse hostile environment such as a subsea installation, the connector means including a plurality of connector members and connector elements providing electrical connections for a plurality of circuits. Each connector member carried in a plug means is individually, separately adjustable to provide an effective electrical contact with its associated connector element to compensate for metal deformations in contacting surfaces under constant high pressures required in such hostile environment and to provide for the making and breaking of repeated electrical connections as may be required during installation and maintenance. A plug means for an electrical connector means in which an elongated contact member is non-rotatably advanced by a rotatable driven follower member.

6 Claims, 5 Drawing Figures



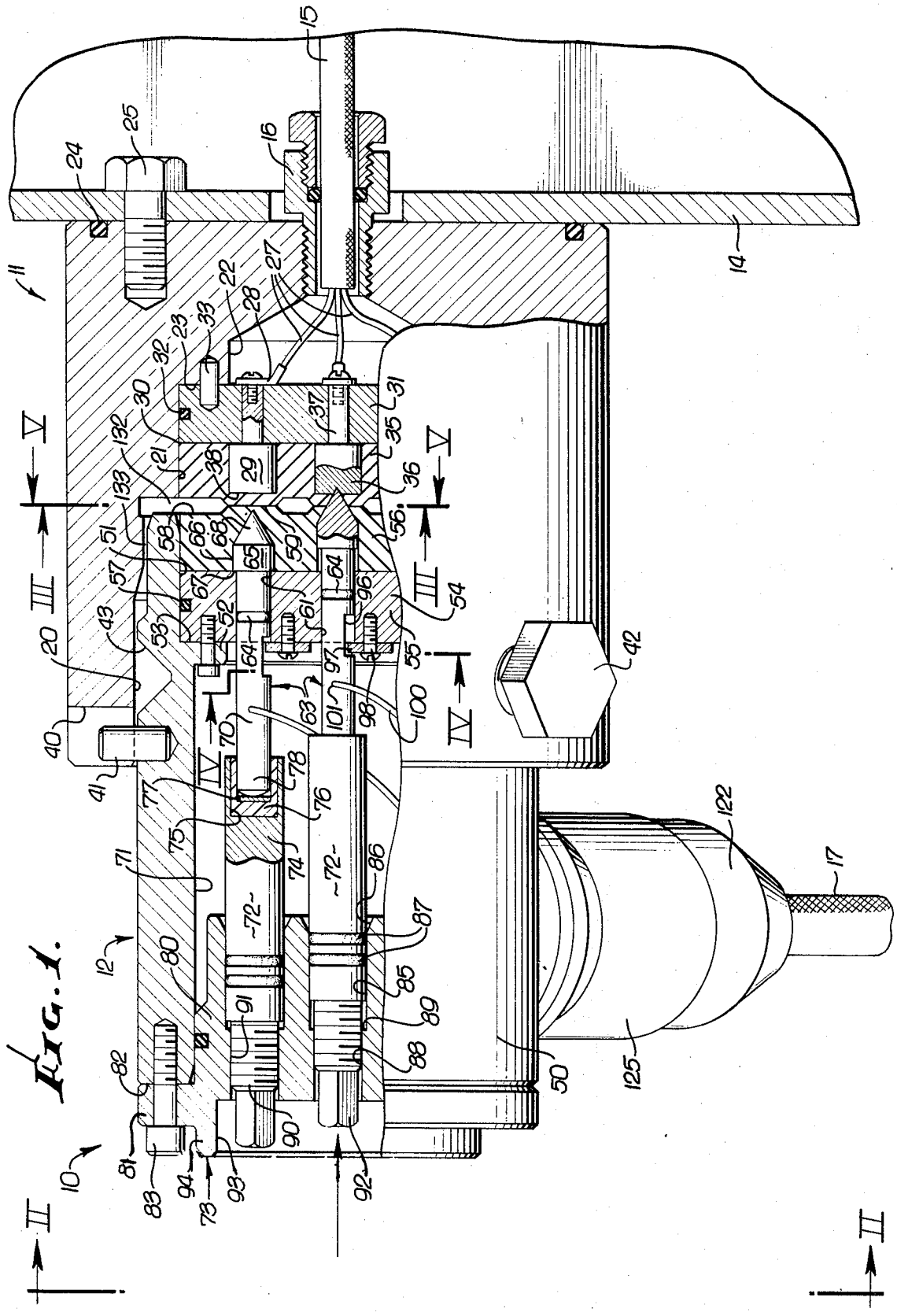


Fig. 1.

FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.

SUBSEA BUTTON-TYPE ELECTRICAL CONNECTOR

BACKGROUND OF INVENTION

Electrical connections made under conditions of hostile adverse environment such as connecting to a subsea wellhead or production control unit located at a sea floor, require relatively high pressures to maintain effective electrical contact under sealing conditions required to isolate the electrical contacting surfaces from the adverse environment. During installation and also during later maintenance of electrical connections at such well equipment, the electrical connector may be repeatedly connected and reconnected. Each time an electrical connection is made, electrical conducting contact surfaces of the metal conductors become deformed, particularly when one of the conductors may be of a softer metal relative to that of the other conductor. Within the physical limits of relative displacement of the connector receptacle and plug bodies of prior proposed sealed electrical connectors, deformation of the contacting metal of the cooperable conductor members rapidly reaches an unsatisfactory electrical contacting condition and such metal to metal contact is not correctable by further tightening of the receptacle and plug members of the connector means.

Prior proposed subsea electrical connectors for use in such hostile environment are disclosed in U.S. Pat. Nos. 2,700,141 2,703,870, and 3,657,681. In U.S. Pat. No. 2,700,141 movable and fixed electric contacts and puncturable discs or gaskets containing a sealing compound are carried in a pair of water tight separable members, the movable contacts puncturing and moving through the discs to make electrical connection with the fixed contacts. In U.S. Pat. No. 2,703,870 connecting pins penetrated discs of soft rubber having convex opposed faces to expel fluid from the space between said convex surfaces to protect the contact elements from the fluid. In my patent, U.S. Pat. No. 3,657,681 fluid was purged between opposed annular contact elements carried in exposed position on convex resilient surfaces. In application Ser. No. 197,324 filed Nov. 10, 1971 (owned by a common assignee) an electrical connector means is disclosed in which button-type contact members are used and protected with an elastomeric material which may be penetrated by one of the contact members upon drawing the receptacle and plug members together. In said application shim means are provided between the receptacle and plug members to regulate depth of penetration and during repeated coupling and uncoupling of the connector means, shims may be withdrawn to permit increased penetration of one conductor member with the other conductor member to assure effective electrical contact.

In each of such prior proposed electrical connector means, after a series of repeated connections have been made, some of the electrical contacts may be satisfactory and others may not be satisfactory. Thus the entire electrical connector means may require replacement.

In addition, such prior proposed electrical connector means employed a plurality of circumferentially arranged securement bolts for urging the mating housing portions into proper assembled relationship. In some instances, even though the circumferentially arranged securement bolts were tightened in preselected order

to provide uniform advancement and pressure of the circularly arranged contact elements, acceptable tolerances between the two mating housing portions often permitted non-uniform pressure engagement between the contact members with the result that circuits on one side may be satisfactorily completed while circuits on the opposite side were not satisfactorily in desired electrical contact. Such difference in pressure engagement about circularly arranged contact members became increasingly evident after several electrical connections had been made.

SUMMARY OF THE INVENTION

This invention relates to an electrical connector means particularly adapted for use in a subsea hostile environment and so constructed and arranged as to avoid disadvantages of prior proposed constructions and to provide positive precise electrical contact between contact members. The invention particularly relates to an electrical connector means wherein each contact member carried by a plug means is individually and separately axially movable into desired pressure contact with its corresponding contact element carried by a receptacle means, the pressure contact being determined by the displacement of the contact member rather than by the assembly under pressure of the plug and receptacle means.

An object of the present invention is to disclose a novel construction of a subsea electrical connector means of button-type wherein positive effective electrical contact between mating connector parts is readily achieved.

An object of the present invention is to disclose and provide a novel electrical connector means having a plurality of contacts and arranged to provide effective repeated electrical contact between cooperable contact members.

An object of the invention is to disclose an electrical connector means wherein electrical contact between axially opposed contact members and elements is obtained by separate individual adjustment of one of the contact members.

Another object of the present invention is to disclose and provide a novel means for axially displacing or advancing one of the contact members to provide an effective electrical contact with an opposed contact element.

A further object of the invention is to disclose a plug means for an electrical connector wherein contact members are individually and separately advanced, each by a rotatable follower member selectively adjustably turned through means external of the connector means.

A still further object of the present invention is to disclose a novel construction of a plug means for an electrical connector wherein said plug means includes cap means carrying a plurality of follower members having contact at their inner ends with electrical contact members.

A still further object of the invention is to disclose and provide a plug means for an electrical connector means wherein said plug means includes means to advance electrical contact members without rotation thereof.

Generally speaking, the present invention contemplates a receptacle means having a chamber within which is supported a plurality of contact elements

under a protective elastomeric cover. A plug means having a hollow body carries at one end contact members protected by a similar elastomeric cover and juxtaposed to the contact elements of the receptacle means. Each contact member is non-rotatably axially movable by a rotatable follower member threadedly carried by a cap means closing the other end of the hollow body. Turning of each follower member by a means of a wrench advances the associated contact member through the protective covers into selected pressure contact with the contact elements to achieve desired electrical metal to metal surface contact between the contact member and contact element.

Various other objects and advantages of the present invention will be readily apparent from the following description of the drawings in which an exemplary embodiment of th invention is shown.

IN THE DRAWINGS

FIG. 1 is a side elevational view, partly in section, of an electrical connector embodying this invention, said section being taken in a longitudinal plane passing through the axis of the connector and through a support wall, one of the contact members being shown in normal retracted or initially assembled position and the other contact member being shown in projected or advanced position for making electrical contact with a contact element.

FIG. 2 is a view taken from the vertical plane indicated by line II—II of FIG. 1, FIG. 2 being partly in section and showing a cable connection to the electrical connector.

FIG. 3 is a fragmentary sectional view taken in the vertical plane indicated by line III—III of FIG. 1.

FIG. 4 is a fragmentary vertical sectional view taken in the plane indicated by line IV—IV of FIG. 1.

FIG. 5 is a fragmentary vertical sectional view taken in the plane indicated by line V—V of FIG. 1.

An electrical connector generally indicated at 10 embodying this invention is shown in FIG. 1. Generally, connector means 10 includes a receptacle means 11 which cooperably receives a plug means 12 in such relation that fluid is purged from the connection and electrical contact of the electrical conducting elements is made under protected conditions. Receptacle means 11 may be suitably mounted on a wall 14 which may be a wall of a subsea wellhead unit, a subsea production control unit, or a bulkhead. An electrical cable 15 extends through a suitable weather and seal tight fitting 16 in wall 14 for connection to receptacle means 11. An electrical cable 17 is connected to plug means 12 as described in detail later. It will be understood that the cables 15 and 17 may be of any suitable construction for use in a hostile environment and that various forms of entrance connections to the receptacle means and the plug means may be utilized.

Receptacle means 11 is of a construction similar to the corresponding receptacle or housing portion of said copending application Ser. No. 197,324. Receptacle means 11 provides a stepped chamber means including an outer chamber 20, an intermediate chamber 21 of reduced diameter and located interiorly of outer chamber 20, and an inner still further reduced diameter chamber 22 forming with chamber 21 an annular shoulder 23. Inner chamber 22 communicates with fitting 16 for cable 15. Receptacle means 11 may be made of any suitable material for example metal, to provide a housing capable of withstanding pressures of the hostile environment. Receptacle means 11 includes on its back face an annular seal means 24 seated against the exterior surface of wall 14 and suitably secured by bolts 25.

Cable wires 27 from cable 15 are provided with an electrical connection at 28 in chamber 22 with contact elements 29 provided in a composite contact carrier member 30 located in chamber 21 and seated against shoulder 23. Carrier member 30 includes a hard nondeformable dielectric base portion 31 of water resistant material such as a hard neoprene or micarta material. Base portion 31 carries seal means 32 for sealing engagement with side walls of chamber 21. Base portion 31 is also provided with a location or registration pin 33 receivable within aligned bores in base portion 31 and in receptacle means 11.

Carrier member 21 also includes a top portion 35 of relatively soft resilient dielectric material such as a soft neoprene. The top portion 35 is seated and bonded against the outwardly facing surface of the base portion 31 and completely imbeds the cylindrical heads 36 of connector elements 29. Connector heads 36 have an inwardly facing shoulder seated against base portion 31 and shank portions 37 extend through base portion 31 for the electrical connection at 28. The soft resilient portion 35 serves as a protective cover for the connector elements 29, each outwardly directed contacting face 38 of each contactor head 36 being protected by a selected thickness of the resilient dielectric material and forms thereover an embossment which appears as a button.

The contactor elements 29 may be arranged in any suitable preselected pattern, in this example a generally circular pattern with a contactor element also located at the center of the circle. The registration pin 33 extending into aligned bores in the receptacle body and the carrier member 31 precisely orients the contact elements 29 with respect to the receptacle means 11.

Receptacle means 11 includes a longitudinally extending slot 40 at its open end for reception of an alignment pin 41 carried by plug means 12 to orient the plug means with respect to the receptacle means 11. Receptacle means 11 also carries a plurality of circumferentially arranged securement bolts 42 provided with internal cam faces for cam engagement with an annular groove 43 in the outer cylindrical surface of plug means 12, said groove 43 being generally V shaped in section so that as bolts 42 are tightened the plug means 12 will be urged inwardly of the receptacle means 11.

The above-described receptacle means 11 and cooperable engagement of a plug means with such a receptacle means is described in copending application Ser. No. 197,324.

The present invention relates to the construction and operation of plug means 12 in association with receptacle means 11. Plug means 12 may comprise a generally cylindrical connector body 50 having an open end 51 with an internal radially inwardly extending flange 52 provided with a forwardly directed annular seat 53 for seating a carrier body 54. Carrier body 54 is made of dielectric material similar to that of carrier member 30 and includes a relatively hard base portion 55 and a relatively soft resilient portion 56. Carrier body 54 snugly fits within open end 51 and may be provided with an O-ring seal means 57, carrier member 31 and carrier body 54 being of the same diameter and positionable

in coaxial opposed relation when the plug means **12** and receptacle means **11** are assembled. Resilient portion **56** has an outer face configuration **58** corresponding to the surface configuration on the resilient protective cover **35** of the receptacle means and provides opposed button contacting areas **59** directly opposed to the corresponding button contact areas on the carrier member **31.**

Base portion **55** of carrier body **54** is provided with a plurality of circularly arranged and central through bores **61** of uniform diameter. Each through bore **61** slidably carries a contact member **63** provided with O-ring type seal means **64** for sealing engagement with through bore **61.** Each contact member **63** includes an enlarged head **65** having an enlarged cylindrical portion **66** providing an annular shoulder for seating engagement as at **67** against base portion **55.** Each head **65** includes a conical portion **68** having a pointed contact end protectively covered by a button portion of resilient material **56.**

Means for individually and separately advancing each contact member **63** through resilient portion **56** and into electrical contact with its respective contact element on the receptacle means may comprise an elongated shank portion **70** on each contact member **63,** shank portion **70** extending rearwardly beyond flange **52** and into a rearwardly facing chamber **71** formed in plug means **12.** Within chamber **71** is provided a follower member **72** for each contact member **63.** Each follower member **72** includes a cylindrical body **74** of larger diameter than shank portion **70** to provide at its inner end an end facing recess **75** within which is received the outwardly directed end **78** of the shank portion **70.** Between walls of recess **75** and end **78** is a cup-shaped insert **76** of dielectric material to provide electrical insulation and at the bottom of the cup-shaped insert is a washer **77** to provide bearing contact with end **78** of shank portion **70.** Such bearing contact permits rotation of follower member **72** with respect to shank portion **70** as later described.

Means for supporting the follower members **72** in axial alignment with their respective contact member **63** may comprise a cap means **73** having a body portion **80** received within said chamber **71** and having an external flange means **81** seated on the end face of carrier body **50** as at **82** and secured thereto by headed screw bolts **83.** Cap body **80** is provided with a plurality of follower bores **85,** each follower bore **85** having a bore portion **86** adapted to receive follower member **72** in sliding rotatable relation. Seal means comprising a pair of spaced O-rings **87** carried in each follower member provides a seal at each follower between chamber **71** and the environment exterior to cap means **73.** Bore **85** includes an outer section **88** of slightly reduced diameter than section **86** to provide a shoulder **89** affording a stop for follower **72** when moved in an outward direction.

Each follower member **72** includes an externally threaded portion **90** which engages internal threads as at **91** provided in the reduced bore section **88.** Outwardly of threaded portion **90** each follower member **72** is provided with a wrench engaging end portion **92** of suitable polygonal section and adapted to receive a socket on a socket wrench for turning thereof. Socket engaging ends **92** of each follower member are located in a circular recess **93** defined by an axially extending annular flange **94** formed on cap means **73,** said flange **94** protecting the socket engagement ends **92** of the follower members.

Each follower member **72** may thus be engaged by a socket wrench and rotated whereby the follower member is axially moved to advance contact member **63** associated therewith towards its mating contact element and into selected pressure engagement therewith. Means to prevent rotation of each contact member **63** includes an elongated flatted recess **96** provided in shank portion **70** adjacent the face of base portion **54.** Receivable within each flatted recess **96** may be a fixed lug member **97** secured to base portion **54** by a suitable screw bolt **98.** Turning of contact member **63** is thereby prevented and entanglement of electrical leads **100** connected to said contact member **63** at **101** is thereby prevented.

Means for entry of electric leads **100** to chamber **71** from cable **17** is best shown in FIG. **2** wherein a cable fitting **110** includes a side outlet body **111** secured against a flatted surface **112** of cylindrical body **50** and at an entrance opening **113** formed therein. Internal cable **114** extends through an internal cable socket **115** and through suitable bushing seal means generally indicated at **116** of suitable make and manufacture for providing a sealed entrance into chamber **71.** The other end of intermediate cable **114** is encapsulated in a suitable dielectric block **118** where connections **119** are made to cable lines **120** provided in cable **17.** Cable lines **120** extend through another dielectric body **121** and both dielectric bodies **121** and **118** are protectively housed within a rigid cable socket member **122** having external threads **123** for sealing engagement with internal threads **124** provided on an attachment fitting **125.** Attachment fitting **125** is secured by screw bolts **126** to side outlet body **111.** It should be noted that the inner end of attachment fitting **125** is provided with a conical face **128** extending beyond the securement lugs **129** and having O-ring type seals for pressure sealing engagement with an outwardly flared face **130** provided by the side outlet **111.** Thus a suitable side connection is provided for cable **17** to the contact members within the plug means **12,** such side entry permitting exposure of the socket engagement portions **92** of the follower members so that access thereto for turning is readily provided.

In installation of a connector means **10** described above, receptacle means **11** is secured to a supporting structure such as wall **14** in well known manner. Plug means **12** with each connector member **63** is retracted position is then inserted into the chamber **20** of receptacle means **11** in proper alignment as determined by registration pin **41** and slot **40.** Securement bolts **42** are then sequentially tightened in a pre-selected order so as to substantially uniformly advance plug means **12** and the resilient portion **56** into pressure engagement with the opposed button resilient portion **35** of the receptacle means. Upon such pressure engagement of the button contacting faces, it will be apparent that fluid is purged from between said faces and is displaced into the annular space **132** between opposed end faces of the carrier means **30** and **54.** Excess fluid flows through the annular passageway **133** provided between the interior walls of chamber **20** of the receptacle means and external walls of the plug means **12,** such passageway being provided by relatively loose clearance between the plug means **12** and the receptacle means **11.** After the securement bolts **42** have been tightened so that the

plug means **12** is in a selected initial position, each connector member **63** is then axially advanced by rotation of follower members **72** and by means of a socket wrench engaging the engagement portion **92** on the follower members. The conical head **68** on each connector member **63** pierces in pressure sealing engagement the protective covers between the conical head **68** and the opposed face of connector element **29.** Desired electrical contact is determined by any suitable electrical measuring instrument. Thus initial proper electrical contact of each connector member and connector element is assured.

The connector means **10** may be disconnected by withdrawal of securement bolts **42** and upon withdrawal of the plug means **12** from the receptacle means **11** the protective covers over contact elements **29** tend to self seal upon such withdrawal of each conical head. When the connection is made again, the protruding conical heads again pierce the protective covers over the connector elements and are again individually tested for proper electrical contact. It will be understood that during repetitive making and breaking of the contacts, that each time the contact is made, hostile fluid between the protective covers is purged because of the pressure engagement thereof. In the event the relatively soft contactor element becomes deformed at the point of contact with the conical connector head **68** as indicated by electrical testing, the follower element may be further tightened to axially drive the connector members **63** into further pressure engagement with connector element **29.**

It will be understood that deformation of the contacting surfaces on connector elements **29** may vary for each connector element and that such variation is readily compensated for by the individual adjustment of each conductor member **63.** Repetitive making and breaking of electrical contact between connector member **63** and connector elements **29** may continue until the connector member **63** can no longer be advanced into desired pressure engagement and as restricted by the length of the slot **96** therein. It will be apparent from the construction of the plug means **12** that when such condition occurs disassembly of the carrier body **54** from the connector body **50** is readily accomplished by removing cap means **73,** unloosening the carrier body securement screws and withdrawing the carrier body with the connector members **63** from the plug means **12.**

It will be understood that various modifications and changes may be made in the construction and operation of the plug means **12** described above and all such changes and modifications come within the scope of the appended claims are embraced hereby.

I claim:

1. In a multi-contact button-type electrical connector for use in a hostile environment, the combination of:

a receptacle means provided with a chamber having an open end;

a carrier member within said chamber provided with a plurality of contact elements having a resilient protective cover thereover;

a plug means receivable within said open end and chamber of said receptacle means;

a carrier body carried by said plug means in alignment with said carrier member on said receptacle means,

said carrier body including a plurality of through bores,

a contact member slidable in each through bore and having a pointed contact head aligned with a contact element in said receptacle means,

a protective cover embedding said pointed head and adapted to contact the cover on said contact element;

and means for individually and separately advancing each contact member into a selected electrical contact with its respective contact element;

said last mentioned means including a follower member having an inner end in force applying relation to an end of a contact member,

said follower member having an outer end having means for receiving forces to move said follower member and said contact member axially into electrical contact with said contact element.

2. In a multi-contact button-type electrical connector for use in a hostile environment, the combination of:

a receptacle means provided with a chamber having an open end;

a carrier member within said chamber provided with a plurality of contact elements having a resilient protective cover thereover;

a plug means receivable within said open end and chamber of said receptacle means;

a cap means for said plug means;

a carrier body carried by said plug means in alignment with said carrier member on said receptacle means,

said carrier body including a plurality of through bores,

a contact member slidable in each through bore and having a pointed contact head aligned with a contact element in said receptacle means,

said cap means including a follower bore for each contact member;

a protective cover embedding said pointed head and adapted to contact the cover on said contact element;

and means for individually and separately advancing each contact member into a selected electrical contact with its respective contact element;

said separately advancing means including a follower member extending through said follower bore into engagement with its respective contact member and operable externally of said plug means;

and means interconnecting said follower member and contact member for permitting relative rotation therebetween during axial movement of said contact member.

3. In a multi-contact button-type electrical connector for use in a hostile environment, the combination of:

a receptacle means provided with a chamber having an open end;

a carrier member within said chamber provided with a plurality of contact elements having a resilient protective cover thereover;

a plug means receivable within said open end and chamber of said receptacle means;

a cap means for said plug means;

a carrier body carried by said plug means in alignment with said carrier member on said receptacle means,

said carrier body including a plurality of through bores,

a contact member slidable in each through bore and having a pointed contact head aligned with a contact element in said receptacle means,

said cap means including a follower bore for each contact member,

a protective cover embedding said pointed head and adapted to contact the cover on said contact element;

and means for individually and separately advancing each contact member into a selected electrical contact with its respective contact element;

said separately advancing means including a follower member extending through said follower bore into engagement with its respective contact member and operable externally of said plug means;

and means for limiting rotation of each of said contact members during axial movement thereof,

said follower members having threaded engagement with said cap means for axial movement of said follower member to drive said contact member into selected depth of penetration of said contact element for making electrical contact of desired characteristics.

4. In an electrical connector for use in a hostile environment and including a receptacle means having an internal contact element, a plug means having an internal contact member alignable with the contact element, means for holding said receptacle and plug means in fixed relative non-rotational assembly, opposing faces of the contact element and contact member being in spaced relationship, and protective cover means between said opposing faces, the improvement comprising:

means to restrict said internal contact member to non-rotational axial movement;

and a rotatable follower member carried by the plug means and having an inner end aligned with one end of the contact member and an outer end external of said plug means,

said inner end having means for receiving the adjacent end of the contact member for relative rotation therebetween during longitudinal movement of the follower member and the contact member into electrical contact with the contact element, and dielectric means within said inner end receiving means for electrically insulating said follower member from said contact member.

5. In an electrical connector as stated in claim **4** wherein

a recess is provided in the end of said follower member,

and cup-shaped dielectric means in the recess receive the end of the contact member.

6. In a connector as stated in claim **5** including

a thrust bearing washer in said cup-shaped dielectric means for bearing engagement with the end of the contact member received in said recess.

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