April 21, 1970 J. R. BUCK 3,508,188

UNDERWATER ELECTRICAL QUICK DISCONNECT

Filed Aug. 27, 1968 3 Sheets-Sheet 1

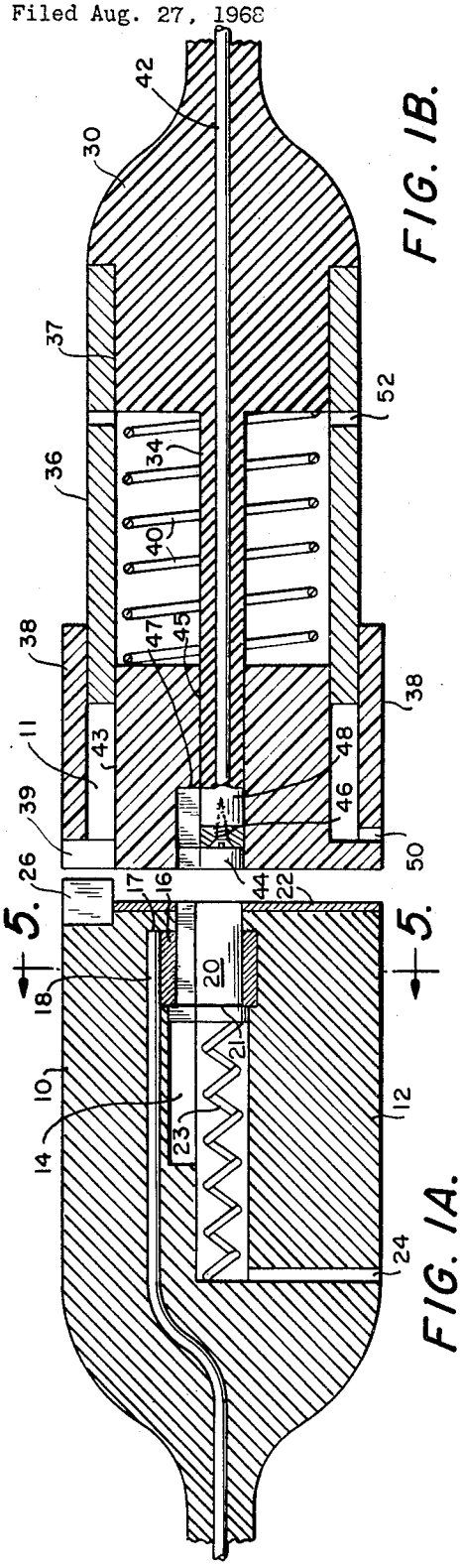

FIG. 1B.

FIG. 1A.

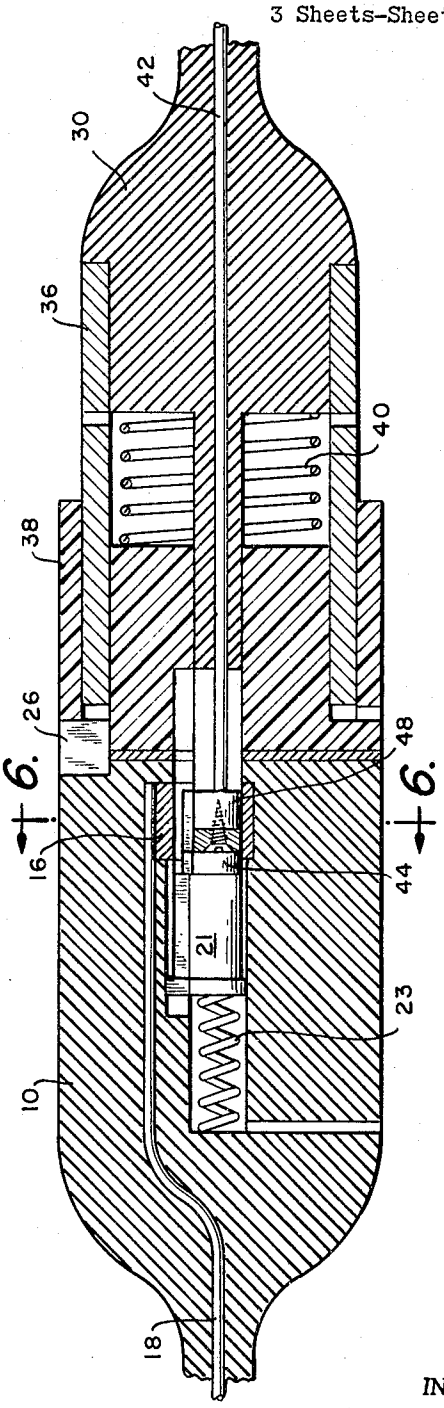

FIG. 2.

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UNDERWATER ELECTRICAL QUICK DISCONNECT

Filed Aug. 27, 1968 3 Sheets-Sheet 2

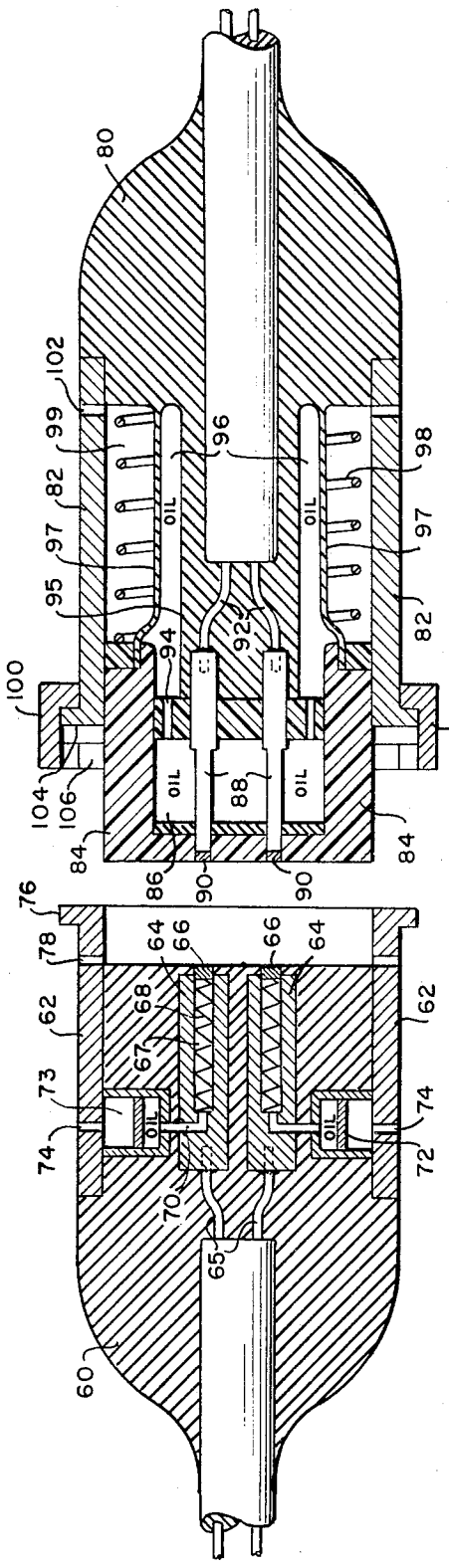

FIG. 3B.

FIG. 3A.

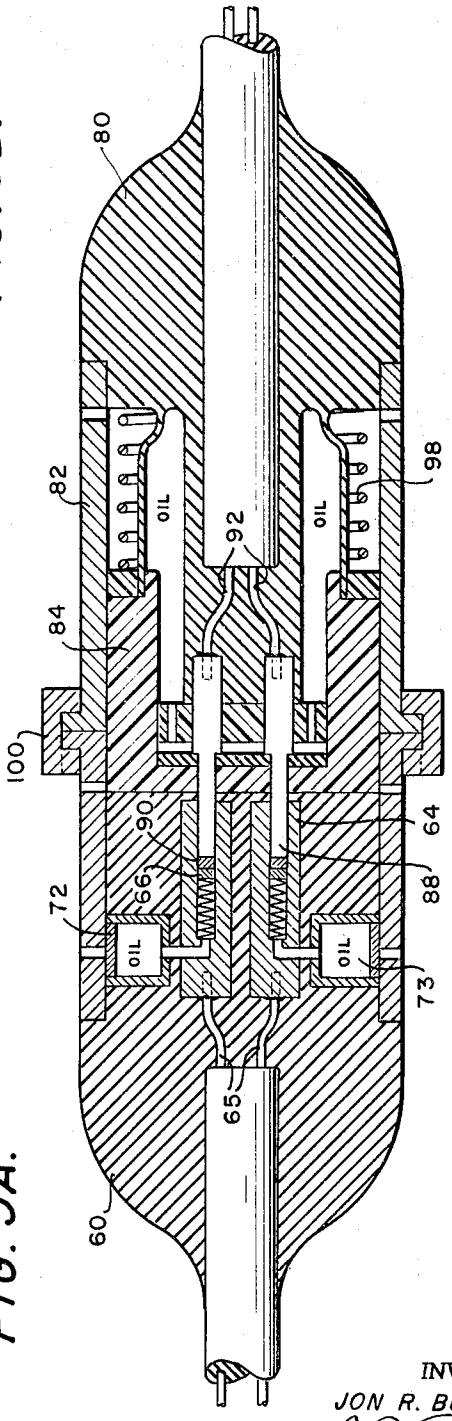

FIG. 4.

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UNDERWATER ELECTRICAL QUICK DISCONNECT

Filed Aug. 27, 1968 3 Sheets-Sheet 3

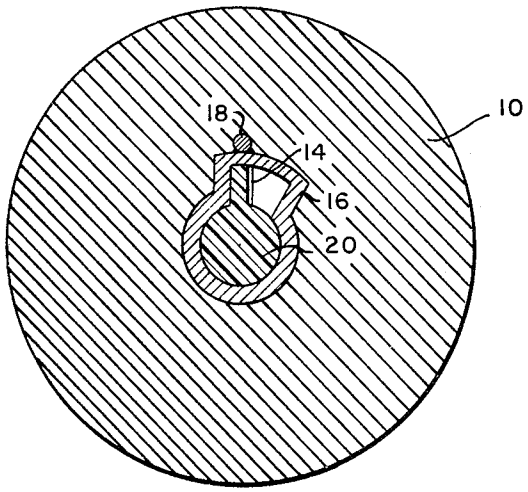

FIG. 5.

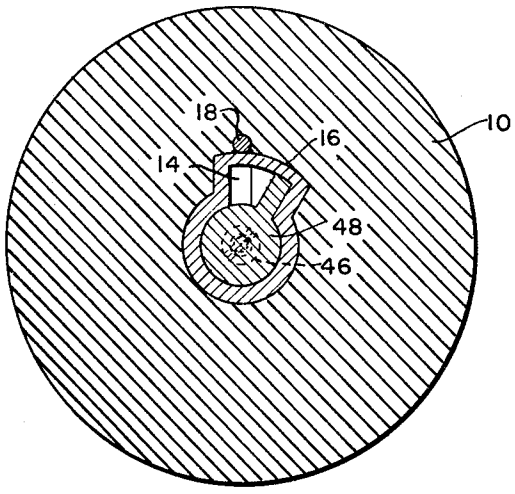

FIG. 6.

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3,508,188

UNDERWATER ELECTRICAL QUICK DISCONNECT

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Int. Cl. H01r 13/52, 33/36
U.S. Cl. 339—42 12 Claims

ABSTRACT OF THE DISCLOSURE

A water-tight electrical connector which can be connected and disconnected in an electrical conductive atmosphere without exposing the electrical contact members of the connectors to the ambient atmosphere. The connector is maintained water tight by the use of reciprocally mounted seals in each connector half of identical shape. When the two connector housings are connected one seal attached to the pin member of one of the housings forces a seal in the socket member back into its housing and prevents water from entering the socket when the pin is inserted.

BACKGROUND OF THE INVENTION

This invention relates to sealed, water-tight electrical connectors and in particular to connectors which may be coupled or uncoupled under water without exposing the electrical contacts to the water and thus allowing connection or disconnection without disconnecting the attaching cables from the electrical power source.

The prior devices provide sealed connectors in which the electrical contact elements are shielded from the ambient atmosphere at the time the electrical contact is made between the mating halves of the connector but they do not provide shielding of the contacts when the connector halves are separated.

Insulation of electrical conductors from the ambient atmosphere is important in undersea operations since exposed, current-carrying conductors present a hazard to divers or to equipment in this environment. Further in the case of deep submergence vehicles it is sometimes necessary to jettison equipment from the vehicle in emergency situations in which there is not time to disconnect electrical power from the equipment before it is jettisoned.

For example, electrically operated manipulator arms provided on some deep submergence vehicles may become entangled in equipment outside the vehicle or outside structures, being manipulated by the vehicle, may topple onto the manipulator arm thus trapping the vehicle in a situation endangering the safety of the crew. The manipulator arms are generally designed to be jettisoned quickly in order to free the vehicle in such situations. Previously the electrical connections to the manipulator arms were severed by cutting the cables. However, this method left electrical conductors exposed to the sea and if electrical power was not previously disconnected the exposed conductors would be short circuited through the ambient seawater and cause injury to personnel or damage to equipment inside the vehicle.

The present invention overcomes these disadvantages by providing a water tight connector which is easily separated when equipment to which it is attached is jettisoned and which protects the electrical contacts in the connector halves from the ambient seawater both during and after disconnect thus preserving the integrity of the vehicle and safety of personnel abroad.

SUMMARY OF THE INVENTION

The invention described herein provides an electrical connector suitable for underwater use in which each of the two connector halves is individually water-tight and in which the two halves may be joined or separated underwater without exposing the electrical conductors within the connector to the water. This continuous water-tight integrity of the connector halves is accomplished by making the male or pin half of the connector extensible from its water-tight housing and further providing in the female or socket half a sliding, spring-loaded seal.

On the forward end of the pin there is provided a pliable seal member which seals the pin housing when the pin is retracted. There is provided in the socket housing an opening having the same size and shape as the pliable seal member in the pin connector half. This opening in the socket housing is closed by a pliable seal which is slidably mounted within its connector half.

When the two connector housings are to be joined the connector housings are arranged so as to align the seal on the pin member with the opening in the socket housing. The pin is extended into the opening of the socket housing, forcing the sliding seal therein back into the housing. The opening in the socket housing is maintained water-tight by the insertion of the seal on the pin. Then the pin is pushed into the opening until the electrical contact mounted behind the seal of the pin contacts a mating socket within the socket housing which is exposed when the socket housing seal is slid back in the housing. The channel in which the socket housing seal slides is open at the rear end thereof to the ambient sea. As the seal is forced back into the housing by the pin the water in the channel is forced out through the opening. A similar opening is provided at the rear of the pin housing thus making both sides of the electrical connection pressure balanced by the ambient hydrostatic pressure.

In an alternate embodiment of the invention, pressure balance is achieved through the use of oil contained in chambers behind the sliding seals. The oil is exposed to the ambient sea across a flexible chamber wall or by means of a piston exposed on one side to the sea pressure and on the other to the oil in the chamber.

It is therefore an object of this invention to provide a water-tight electrical connector which may be safely connected or disconnected while connected to a source of electrical power.

It is a further object of this invention to provide a water-tight electrical connector in which the electrical contacts are maintained in a dry condition when connection is made underwater.

It is yet another object of this invention to provide a water-tight connector in which sliding seals maintain the connector housings in a continuous water-tight condition.

It is yet another object of this invention to provide a water-tight connector which is pressure balanced by the hydrostatic pressure.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1*a* is a view in longitudinal cross section of the socket housing of the preferred embodiment.

FIG. 1*b* is a view in longitudinal cross section of the pin housing of the preferred embodiment.

FIG. 2 is a view in longitudinal section of the assembled connector housings shown in FIGS. 1*a* and 1*b*.

FIG. 3*a* is a view in longitudinal section of the socket housing of an alternate embodiment of the invention.

FIG. 3*b* is a view in longitudinal section of the pin housing of an alternate embodiment of the invention.

FIG. 4 is a view in longitudinal section of the assembled connector housings of FIGS. 3*a* and 3*b*.

FIG. 5 is a view in cross section taken along line 5—5 of FIG. 1*a*.

FIG. 6 is a view in cross section taken along line 6—6 of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1*a* there is shown the female or socket half of the connector having a housing **10** which may be made of rubber or plastic or water impervious material. Extending into the housing from the housing face seal **22** is a central opening **12** which is generally cylindrical in shape and extends for a substantial length into the housing. Extending along a portion of the opening **12** is a slot **14** which connects with the opening as shown in FIG. 5 and which is generally rectangular in cross section at the rear thereof and has arcuate shape along the forward portion of the opening **12**. At the rear of the opening **12** there is a transverse opening **24** which extends from the opening **12** through the housing and communicates with the ambient atmosphere. Assembled in the opening **12** and its associated slot **14** is a key shaped seal member **20** which is biased toward the forward end of the opening by spring **23**. The seal member is retained in the housing by means of a shoulder **21** formed on the rear face of the seal. An electrical contact member **16** is formed so as to line the opening in the housing with an electrical contacting surface as shown in FIG. 5. Attached to the contact is an electrical conductor **18** which extends through the rear of the socket housing. There is provided on the forward face of the housing the key member **26** for aligning the socket housing with a mating connector half.

Referring now to FIG. 1*b* there is shown the male or pin half of the connector which mates with the socket half described above. The connector pin housing is formed by a three part assembly comprising a base portion **30**, a sleeve portion **36** and a forward shuttle portion **38**. The base member **30** is made of molded neoprene or similar material and includes a spindle portion **34** which extends through the length of the housing. The sleeve member **36** is cylindrical in shape and is made of a relatively stiff material for example urethane. The sleeve is assembled on the base portion over a reduced diameter section **37** on the base member **30** and is bonded to the base member. The shuttle member, which is cylindrical in cross section, has a concentric groove **41** whose width is slightly larger than the thickness of the sleeve member. The shuttle member is thus allowed to slide along the sleeve member to the extent of the depth of the groove. The shuttle member has a central opening therethrough which at the rear portion is the same size and shape as the spindle member of the base portion of the housing and at the forward portion is key shaped as shown in FIG. 6. The shuttle is biased toward the forward portion of the housing by means of spring member **40**.

On the forward end of the spindle member **34** there is attached a key shaped electrical contact member **47**. The contact member is electrically connected to a conductor **42** which extends through the spindle and the base portion of the housing. Attached to the forward end of the electrical contact member **48** is a seal member **44** of the same size and shape as the key shaped opening in the shuttle member and which forms a water-tight seal for the housing. There is further provided in the shuttle member a transverse opening **50** which communicates between the groove and the ambient atmosphere. The sleeve portion of the housing is also provided with transverse opening **52** communicating between the inside of the sleeve and the ambient atmosphere. On the forward face of the shuttle there is provided a slot **39** of substantially the same size and shape as the key member **26** on the socket housing for aligning the two connector halves.

The electrical contact members of both connector halves are sealed from the ambient atmosphere by means of their respective seal members when the connector halves are disconnected. The front and rear surfaces of each seal member are both exposed to the ambient pressure thus eliminating a pressure differential across the sliding seals. When the two connector halves are to be joined they are aligned by inserting the alignment key **26** in the slot **39**. Connection is made by exerting a force on the pin connector housing which allows the sleeve member to advance into the groove **41** in the shuttle. As the housing advances the seal member **44** in the pin housing enters the key shaped opening in the socket housing and forces the sliding seal member **20** in the socket housing back into its opening **12** against the pressure of the spring **23**. The spindle member is extended into the socket housing until electrical contact member **48** is aligned with the socket electrical contact **16** whereupon the two conductors **18** and **42** are electrically connected. The two connector halves are maintained in contact by rotating the pin housing with respect to the socket housing which rotates the pin contact **48** within the arcuate opening in the socket housing as shown in FIG. 6. The rear surface **47** of the contact pin is retained in the socket housing by shoulder **17** acting against the inside surface of face seal **22**. Thus in the above described operation the electrical contact members of the two housings have been joined without exposing either contact to the ambient atmosphere and the assembled connector remains in a water-tight condition.

Referring now to FIGS. 3*a*, 3*b*, and FIG. 4 there is show alternate embodiment of the invention having multiple pins and sockets and further providing for use of a second fluid for pressure balance of the connector which is contained within a closed chamber in each connector half.

There is shown in FIG. 3*a* the socket half of the connector having a housing **60** and a cylindrical sleeve member **62** attached to the housing. Within the housing there is plurality of electrical socket members **64** connected to electrical conductors **65** extending through the rear of the housing. Sliding seal members **66** are slidable within chambers **67** and biased toward the forward end of the connector housing by spring member **68**.

Chambers **67** communicate by means of channel **70** with a second chamber **73** divided into two portions by a piston member **72** slidably mounted within chamber **73**. The outer portion of chamber **73** communicates with the ambient atmosphere through channel **74** extending through the housing sleeve.

In FIG. 3*b* there is shown the pin connector half, similar in construction to that of FIG. 1*b*, and comprising a base housing **80** a sleeve portion **82** and a shuttle member **84**. The shuttle member is slidable within the sleeve member and is biased toward the forward end of the connector housing by spring **98**. Electrical contact pins **68** are mounted in a spindle member **95** and are connected to conductors **92** which extend through the rear of the housing. On the forward end of the contact pins there are provided seal members **90** of substantially the same size and shape as seal member **66** in FIG. 3*a*. There is provided in the shuttle member a cavity **86** which communicates with the chamber **96** formed by spindle member **95** and a flexible diaphram member **97** which is a molded portion of the base housing **80** connected to the shuttle member at its forward end. Channel **94** provides communication between chamber **86** and chamber **96**. There is provided a third chamber **99** formed by the outer

surface of flexible member **97** and the inside surface of sleeve member **82**. There is provided in the sleeve member an opening **102** connecting the third chamber with the ambient atmosphere. The sleeve member **82** terminates in a flange **104** upon which there is rotatably mounted a locking collar **100**.

In operation the connection of the two connector halves is substantially the same as that described above in connection with FIGS. 1*a* and 1*b*. The pin sealing members **90** are aligned with the socket seals **66** and the base portion **80** of the pin housing is advanced to cause the pins **88** to be inserted in the sockets **64** of the socket connector half and the shuttle **86** is forced back into its cavity within the housing sleeve **82**. As the shuttle member is inserted into the opening in the face of the socket housing water trapped within the opening is forced out through channel **78** in the sleeve of the socket housing. As the socket seal members **66** are forced back into opening **67** the oil within opening **67** is forced out through channel **70** and into the lower half of chamber **73**. As oil is forced into chamber **73** piston member **72** is forced upward and expels water in the upper portion of the chamber out through opening **74** in the housing body.

Referring now to the pin connector, as the housing base **80** is pressed forward, the shuttle moves back within the sleeve member thus forcing oil from chamber **86** through channel **94** and into chamber **96**. As is shown in FIG. 4 as oil is forced into chamber **96** the flexible diaphram member **97** is extended to increase the volume of chamber **96**. Seawater trapped within chamber **99** is then expelled through channels **102** in the housing sleeve. When the pins **88** are fully inserted into socket **64** the key **76** on the socket housing enters opening **106** in the collar member **100** of the pin housing. When the connector halves are fully mated the locking collar **100** is rotated so as to lock key **76** within the locking collar as shown in FIG. 4.

The hydrostatic pressure of the ambient seawater acting on the housing openings is transferred through the oil on opposite sides of the connector faces thus completely pressure balancing the assembled connector. In a manner similar to that described above in connection with FIGS. 1*a* and 1*b*, electrical connection of the pins in their sockets has been made without exposing the electrical contact portions of the connectors to the ambient atmosphere and the assembled connector remains completely water-tight and pressure balanced.

Thus there is provided herein a water-tight electrical connector suitable for underwater use in which the connection may be made underwater without exposing the electrical contacts to the ambient atmosphere. Further the connector halves may be separated underwater with power applied to the electrical conductors with complete safety to personnel and equipment in the vicinity from electrical hazards.

It is to be understood that the invention is not limited to the exact details of construction shown and described for obvious modifications will occur to persons skilled in the art.

What is claimed is:

1. A separable water-tight electrical connector comprising:

first housing means having a central opening therein, said opening extending from the forward face of said housing for a substantial length within said housing means;

a seal member slidably mounted within said central opening and forming a water-tight seal for the forward end of said opening;

spring means mounted in said central opening for forcing said seal member toward the forward face of said housing;

electrical contact means surrounding the forward portion of said central opening and forming the inner surface thereof;

electrical conductor means attached to said electrical contact means and extending through the rear portion of said first housing means;

second housing means having a central opening therein for a substantial portion of the length of said housing means;

shuttle means having a central opening therethrough slidably mounted in said central opening of said second housing means;

spring means mounted within the central opening in said housing means for urging said shuttle means toward the forward face of said housing;

spindle means attached to said second housing means in the central opening thereof and extending through the central opening in said shuttle means;

second seal means of the same size and shape as the seal means in said first housing means attached to the forward end of said spindle means for sealing the central opening in the shuttle;

electrical contact means attached to said spindle means adjacent said seal means for connecting in mating engagement with the electrical contact means in said first housing; and

electrical conductor means attached to said electrical contact means and extending through the rear of said second housing means.

2. A separable water-tight electrical connector as defined in claim **1** and further comprising: means for balancing the pressure across said connector.

3. A separable water-tight electrical connector as defined in claim **2** wherein said means for balancing the pressure across said connector comprises:

a transverse fluid-conducting channel extending through said first housing means between the ambient atmosphere and the central opening in said housing for exposing the rear face of said seal member to the ambient atmosphere; and

a transverse fluid conducting channel in said second housing means extending between the ambient atmosphere and said central opening for exposing the rear face of said shuttle member to the ambient atmosphere.

4. A separable water-tight electrical connector as defined in claim **3** and further comprising means for aligning said first and second housing means so as to place the central opening in said first housing means in register with the central opening in said second housing means.

5. A separable water-tight electrical connector according to claim **4** wherein said means for aligning said first and second housing means comprises:

a key member extending from the forward face of said first housing means; and

a keyway formed on the forward face of said shuttle member of substantially the same size and shape as said key member whereby insertion of said key member in keyway places the opening in said first housing means in register with the central opening in said second housing means.

6. A separable water-tight electrical connector as defined in claim **5** and further comprising means for releasibly attaching said first housing means to said second housing means.

7. A separable water-tight electrical connector comprising:

a first housing having at least one opening in the forward face thereof and at least one chamber within said housing means in communication with the opining and said ambient atmosphere;

at least one electrical socket member mounted in said opening and open at the forward face of said first housing, said socket member forming the interior wall of said opening;

a seal member slidably mounted in said socket member for sealing the open end thereof;

spring means mounted in said socket member for urging said seal member toward the open end of said socket;

a dielectric sealing fluid in said chamber and said socket for sealing said sockets from the ambient atmosphere;

means for separating said chamber into separate sections, one section containing said sealing fluid and the other section open to the ambient atmosphere, said means for separating said chambers being of such a character so as to vary the proportionate size of said sections;

electrical conductors attached to said socket members extending through said housing at a point remote from the forward face thereof;

a second housing having at least one opening in the forward face thereof and having a chamber therein, said chamber being in communication with the ambient atmosphere at one end and with the opening in said housing at the other end;

at least one electrical contact pin mounted in the forward face of said housing and extending exterior thereto;

a shuttle member slidably mounted at the forward end of said housing and having at least one opening therethrough in register with the contact pin in said housing, said shuttle member forming a second chamber surrounding said contact pins and in communication wtih one section of the chamber in said housing;

a seal member attached to the forward end of said electrical contact pin for sealing the opening in said shuttle member;

spring means mounted in the chamber in said housing for urging said shuttle member toward the forward face of said housing;

means for separating the chamber in said housing into two separate sections, one of said sections being in communication with said second chamber and the other of said sections being in communication with the ambient atmosphere, said means for separating said chambers being movable therein to vary the proportionate size of said sections;

a dielectric sealing fluid contained in the section of said chamber in communication with said second chamber; and

electrical conductors attached to said electrical contact pins and extending through said second housing at a point remote from the forward face thereof.

8. A separable water-tight electrical connector as defined in claim **7** wherein the means for separating the chambers in said first and second housings comprises a piston reciprocally mounted in each of said chambers and having one side thereof exposed to the ambient atmosphere and the other side to said sealing fluid.

9. A separable water-tight electrical connector as defined in claim **7** wherein said means for separating the chambers in said first and second housings is a flexible diaphram in each of said chambers exposed on one side to the ambient atmosphere and on the other side to said sealing fluid.

10. A separable water-tight electrical connector as defined in claim **7** wherein said means for separating the chamber in said first housing comprises a piston member reciprocally mounted in said chamber and exposed on one side to the ambient atmosphere and on the other side to the sealing fluid and the means for separating the chamber in said second housing is a flexible diaphram mounted in said chamber and exposed on one side to the ambient atmosphere and on the other side to said sealing fluid and attached at one end to said shuttle member and at the other end to said second housing.

11. A separable water-tight electrical connector as defined in claim **10** and further comprising means for aligning said first housing with said second housing so as to place the electrical contact pin in said second housing in register with the electrical socket member of said first housing.

12. A separable water-tight electrical connector as defined in claim **11** and further comprising means for releasibly attaching said first housing to said second housing.

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U.S. Cl. X.R.

339— 94, 117