

[54] SEALED ELECTRICAL CONNECTOR

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[58] Field of Search 339/96, 117, 118

[56] References Cited

UNITED STATES PATENTS

3,522,576	8/1970	Cairns.....	339/96
3,503,034	3/1970	Appleton	339/118 R
3,127,230	3/1964	Marquis et al.	339/118 R

FOREIGN PATENTS OR APPLICATIONS

1,114,876 10/1961 Germany.....339/117 R

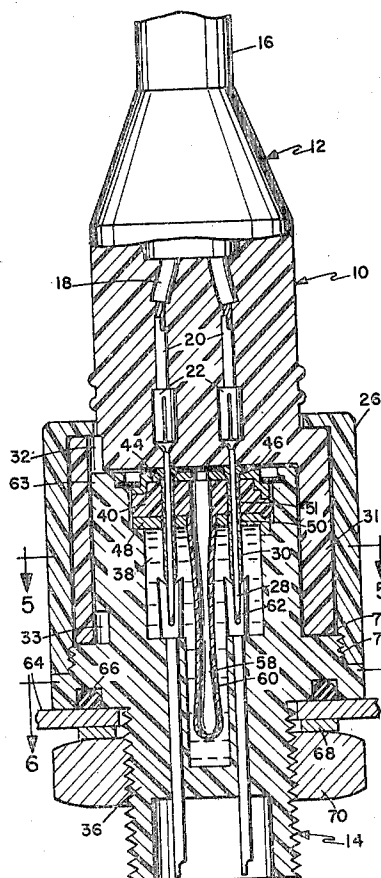
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[57] ABSTRACT

A reusable electrical connector for making an electrical connection in adverse environments in which the electrical connection is made by passing a contact through a self-sealing, precut opening into a sealed chamber filled with dielectric fluid to electrically contact a contact position in the fluid and which chamber has means for instantaneously adjusting in volume to changes in the ambient pressure or with the insertion or removal of the electrical contact to maintain interior portions in equilibrium with the pressure of the environment and to prevent the loss of fluid from the sealed chamber.

14 Claims, 6 Drawing Figures



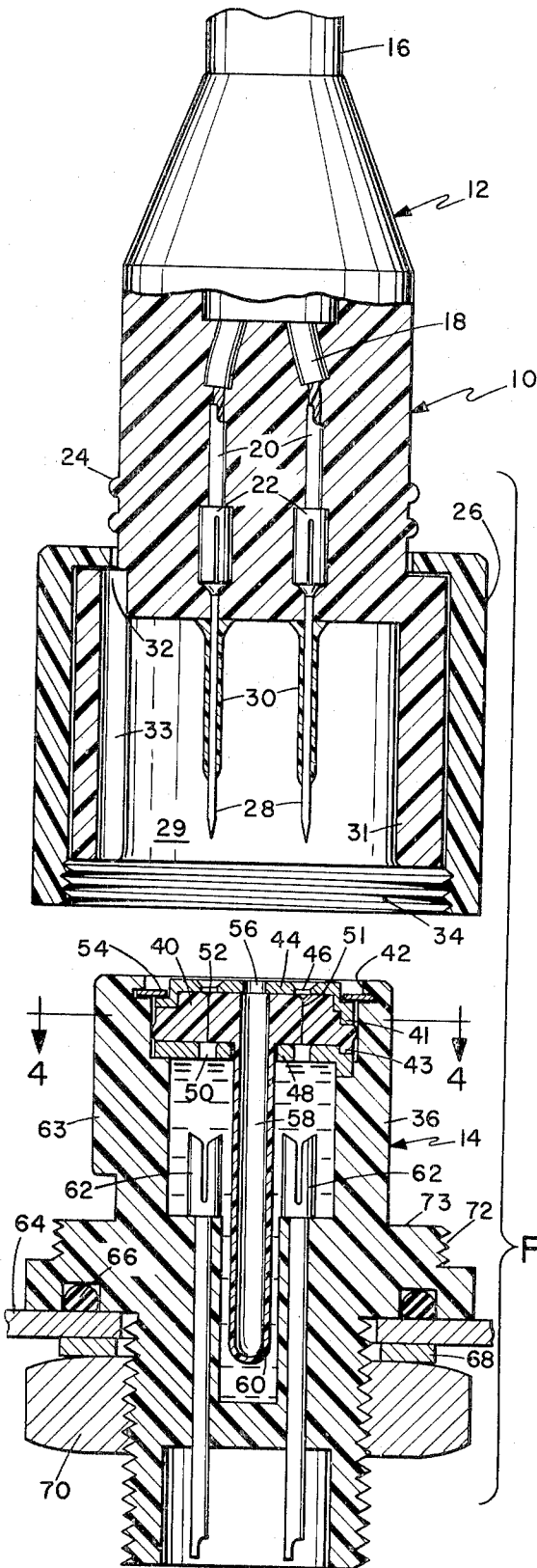


Fig. 1

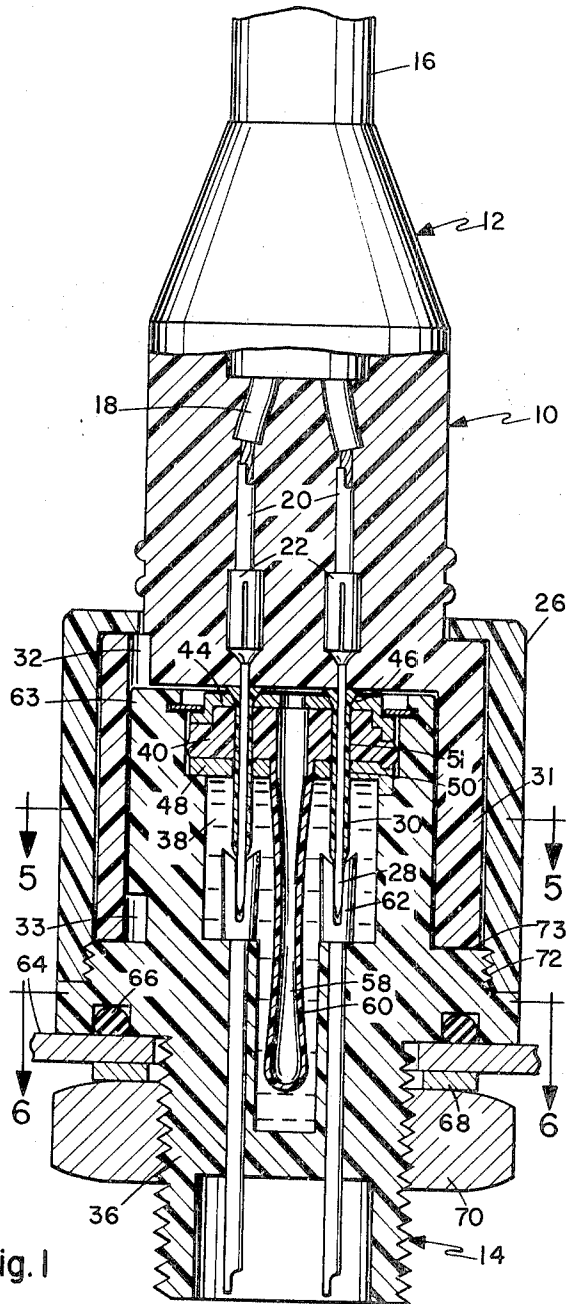


Fig. 2

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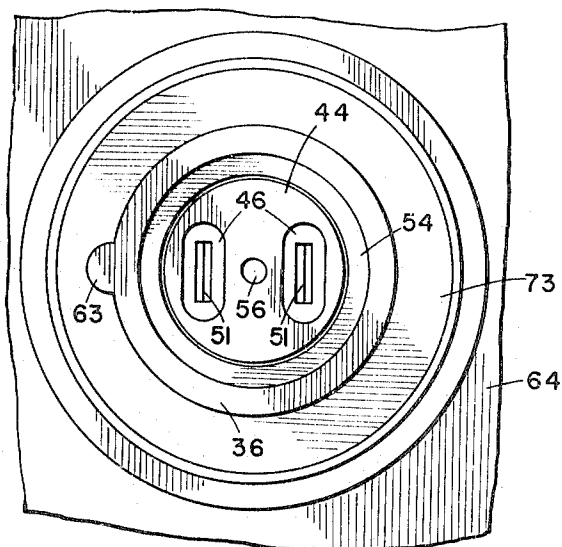


Fig. 3

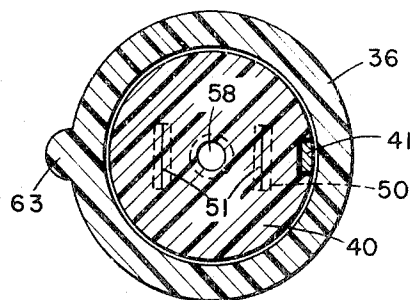


Fig. 4

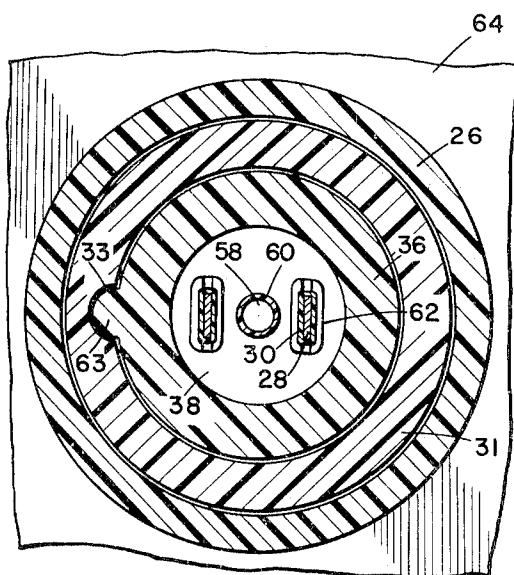


Fig. 5

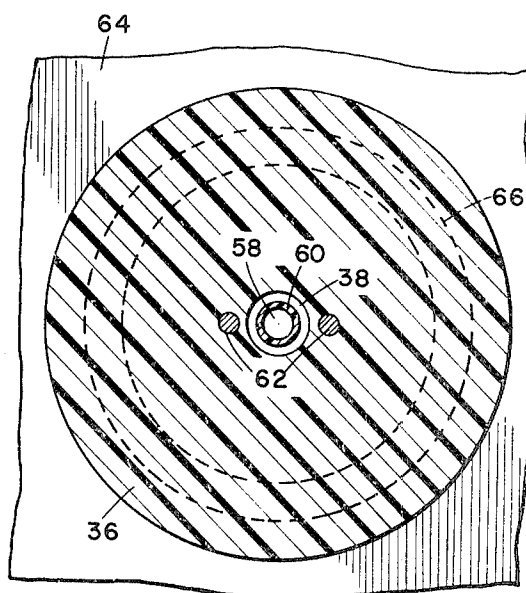


Fig. 6

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SEALED ELECTRICAL CONNECTOR

BACKGROUND OF THE INVENTION

There are many different types of electrical connectors for making electrical connections in adverse environments. Many of these electrical connectors are merely directed to making electrical connections in humid or wet conditions. Other connectors are designed to make electrical connections, for example in underwater environments or in explosive environments, and in these environments, a more critically designed electrical connector is required in order to perform satisfactorily.

There are known connectors that allow for the electrical mating to take place in a sealed nonconductive fluid medium. These types of connectors attempt to use the nonconductive fluid to prevent water contact with the electrical connection. While these connectors may be able to operate in high humidity or wet conditions, they are not satisfactory for use in underwater operations to any reasonable depths. Further these connectors can not be repeatedly connected and disconnected underwater without danger of shoring out the female conductor through the environment or without puncturing one-time useable seals. Also the known connectors of the fluid-filled type are either not compensated for changes in pressure or volume, which changes often occur when the male portion of the connector is inserted into the sealed chamber or where ambient pressure conditions change, or if they are compensated, it is accomplished by displacing movable sealed piston-type parts. The movable piston-type compensator requires that the piston seal fit tightly in the barrel. Thus in operation, the piston will not easily compensate for abrupt changes in fluid pressure or fluid volume, such as caused by the rapid withdrawal or insertion of the male portion of the connector and either a loss of nonconductive fluid or an inclusion of a part of the outside air or water takes place. In the case of grease-filled connectors, cavitation within the grease may take place. In addition, the barrel must be maintained clean and flawless for the compensator to work. Still further, known fluid-type filled connectors must be precisely filled and cannot tolerate any subsequent loss of the nonconductive fluid to remain usable.

It is therefore advantageous to have a new and improved reusable, electrical connector for making repetitive electrical connections in adverse environments to charge electrical connectors in which the pressure of the fluid is maintained with the environment and the charged electrode is not open to either an explosive atmosphere or a corrosive atmosphere.

SUMMARY OF THE INVENTION

In an exemplary embodiment of the sealed electrical connector of this invention, a first body has a sealed chamber with a dielectric fluid and a first electrical connector positioned in the chamber. This connector is normally a female conductor and can in operation be electrically charged. A second electrical connector, that normally is a male conductor with an insulated body and an exposed conductor tip, passes into the sealed chamber through a precut opening in a resilient self-sealing, wiper diaphragm. The end of the second electrical connector contacts the female conductor in the fluid environment making the electrical connection. The precut opening in the diaphragm functions as a wiper to wipe the second electrical connector clean prior to entry into the dielectric fluid in the sealed chamber. The diaphragm or flexible member is held in position under compression by backing means, that aids in maintaining a sealed condition either with or without the second electrical connector positioned in the opening. The precut opening is a slit with a notch at the outer edge to direct penetration of the male conductor therethrough.

The sealed chamber has means for adjusting its volume in response to pressure changes or in response to the second electrical connector being inserted or removed from the chamber. With the female connector positioned in the chamber, it can be maintained in a charged condition at all times and the second or male electrical connector may be in-

serted through the sealable opening into the fluid to make an electrical connection even at considerable depths underwater. The female connector is not subject to contact with the outer environment and thus does not short during connection or disconnection, and is not subject to corrosion in adverse environments. Further the precut slits forming the sealable openings make the connector reusable as the penetration of the male connector therethrough does not damage the opening.

It is therefore an object of this invention to provide a new and improved sealed electrical connector.

It is another object of this invention to provide a reusable electrical connector in which the connection is made within a nonconductive fluid medium such as a nonconductive oil, grease or fluid gel.

It is another object of this invention to provide a new and improved sealed electrical connector having an internal fluid chamber in which all interior portions remain in equilibrium with the ambient pressure of the environment.

It is another object of this invention to provide a new and improved sealed electrical connector in which one of the electrical connections can remain electrically charged when disconnected in the environment without danger of electrical inner action with the environment.

It is another object of this invention to provide a new and improved sealed electrical connector that is reusable and in which one conductive member is never exposed to the corrosive properties of the environment thus maintaining a clean mating surface.

It is another object of this invention to provide a new and improved reusable, electrical, sealed connector having a fluid chamber, in which the amount of fluid contained in the connector need not be precisely measured or exactly maintained.

It is another object of this invention to provide a new and improved sealed electrical connector in which the female portion of the electrical connector can remain electrically charged during repeated connecting and disconnecting in an explosive and conductive environment and which device is pressure compensated.

Other objects and many advantages of this invention will become more apparent upon a reading of the following detailed description and an examination of the drawings, wherein like reference numerals designate like parts throughout and in which.

FIG. 1 is an exploded view of an embodiment of the sealed electrical connector with portions sectioned along the axis.

FIG. 2 is an axial sectional view of the assembly sealed electrical connector.

FIG. 3 is a top plan view of the lower body of FIG. 1.

FIG. 4 is a sectional view taken along line 4—4 of FIG. 1.

FIG. 5 is a sectional view taken on line 5—5 of FIG. 2.

FIG. 6 is a sectional view taken on line 6—6 of FIG. 2.

Referring now to the drawings, the embodiment 10 of the sealed electrical connector has a first body 14 and a second body 12. The second body 12 has male, blade-type, electrical connectors 28 that are inserted through appropriate slit openings into a sealed chamber in the first body 14 to make electrical contact with a female electrical connector 62.

The second body normally forms the end of an electrical cable 16 and is made of neoprene or other suitable materials that are molded with conductors 18 passing therethrough and being soldered or otherwise electrically connected to electrical conductors 20. Electrical conductors 20 comprise an electrical connection in which a male conductor 28 is soldered into a female electrical conductor 22. The major portion of the length of the electrical connector or conductor 28 is covered by a suitable insulating material such as Teflon. The lower end of the second body 12 has a cylindrical cavity 29 defined by a sidewall 31 that has a keyway 33 and a water exit 32. A locking sleeve 26 is mounted on the body 12 and may be held in position by, for example, rings 24 and has a threaded end 34 for engaging the threads 72 on the first body 14.

The first body 14 has a body portion 36 that may be made of plastic, neoprene or other suitable materials. In this embodiment, the first body is in the form of a bulkhead connector that fits through a bulkhead 64 and is held in position by locknut 70 and washer 68. O-ring 66 makes the necessary seal around the bulkhead opening. It should be understood that this invention can be employed in a female connector connected to the end of a cable or in other suitable types of electrical connectors.

Positioned in the body or housing 36 is a sealed chamber 38 having a dielectric fluid therein, which dielectric fluid may comprise a nonconductive oil, grease or gel that is capable of flowing in the manner of a fluid. The female electrical connector 62 is shaped to receive the blade-shaped male connector 28 and is connected to conductors that pass through the lower portion of the housing 36 for electrical connection to circuits within the bulkhead 64. In this embodiment, the electrical power can normally be connected in the "on" condition to the female connector. The outer end of the housing 36 has an opening in which is positioned a wiper member 40 that has the general shape of a diaphragm and that is made of suitable non-conducting material such as neoprene or other suitable flexible and resilient materials. The wiper member 40 has precut slits 51 cut therethrough that are shaped to the shape of the thin blade electrical connectors 28. Backing plates 44 and 48 are positioned above and below the wiper member 40 and are held in position by lockring 54. The backing plates 44 and 48 have aligned openings 46 and 50 that are also shaped to receive and pass the electrical connectors 28. The precut slit 51 is notched at 52 for directing the blade contact 28 into the precut slit 51. The precut slit 51, coupled with the thickness of the wiper 40 and coating with the backing plates 44 and 48, seal the chamber 38 from leakage of the fluid into the outer environment and for leakage from the outer environment into chamber 38. Further when the male electrical connector 28 is passed through slit 51, the slit 51 wipes the electrical connector 28 relatively clean of corrosive fluids and the like, which is aided by the Teflon surface 30, and further seals the connector 28 in the slit 51 against passage of dielectric fluid. Also the openings 46 in backing plate 44 are shaped to the outer configuration of the upper ends of insulation 30, thereby creating a sealing contact therebetween.

Positioned in the chamber 38 is a flaccid boot member 60 that may be made of neoprene or other suitable materials and is normally integral with the wiper member 40. The boot 60 has a cavity volume 58 that communicates through vent 56 to the outer environment. This boot that has a bellows-type structure, allows volume changes of the chamber 38 in response to changes in the pressure of the outer environment thus maintaining an equalized pressure condition between the fluid in chamber 38 and the pressure in the outer environment. This prevents pressure differential problems within the connector that occur, for example, underwater. Further the boot 60 quickly changes shape upon the insertion or removal of the electrical connector 28 preventing fluid loss. It is to be recognized that the boot 60 is immediately responsive to any changes in pressure or volume and movements of expansion or contraction or changes in shape occurs quickly without substantial force and friction.

The backing plate or retaining plate 44 has a key portion 41 that coats with a key slot in the wiper 40, which wiper 40 in turn has a key portion 43 that coats with the key slot in backing plate 48. This allows quick and easy alignment of the slits 51 with the female connectors 62 and to be retained in this aligned position by the locking ring 54.

In operation, the male connectors 28 are inserted through the slits 51 in the manner previously described with body 14 passing into the cylindrical cavity 29 of body 12. The locking sleeve 26 is then threadably engaged with the bulk head connector, drawing the two bodies together at 73 forming a rigid connection. The key projection 63 on the housing 36 fits into the keyway 33 of the second body holding the male connectors 28 in alignment with slits 51 and with the female con-

tors 62. The hole 32 allows for water exit during the making of the electrical connection, which water escapes through the space between body 14 and housing 36 and backing plate 44.

The male connectors pass through the slots 51 with the electrical contact area 28 making the electrical connection. It may be observed that in FIG. 2, the insulator coating 30 is well within the chamber 38 before an electrical connection is made, and in complete insertion sealably contacts opening 46. Since the slit 51 is precut, then the opening through the wiper 41 is not made by puncturing or the like and accordingly the slit does not have ragged edges and can be reused. Further the Teflon coating 30 tends to reduce tearing of slit 51 in movement therethrough. Thus the electrical connection can be made repeatedly without adversely effecting the sealing capability of the wiper 40. Since the electrical connection is made at all times in the dielectric fluid 38, the female connectors may be electrically connected to a power source at all times and the electrical connection to the male plug can be made or disconnected in an adverse environment, such as underwater, without danger of electrical inner action with the environment. Further it is to be noted that the female connector is never exposed outside the dielectric fluid in chamber 38 and thus is not exposed to corrosive properties in the environment and always provides a clean mating surface. With the insertion of male connectors 28, the fluid 38 in chamber 29 moves to compress the boot member 60. With the expansion and contraction and volume-adjusting capabilities of the boot 60, the amount of fluid in chamber 38 need not be precisely measured or exactly maintained. It is possible to insert additional fluid in chamber 38 in the embodiment of FIG. 1, in the normal filling operation, to cover possible losses of dielectric fluid 38 through openings 51 and 52 that might occur during use in removing male connectors 28. The capabilities of the system are such that the boot 60 will allow for sufficient volume changes to equalize pressure at large depths underwater and allow for displacement of the fluid with the connection and disconnection of the electrical coupling. While two electrical connectors are illustrated, it should be understood that a single electrical connector can be used or other multiple numbers of electrical connectors can also be used in the sealed electrical connector of this invention.

Having described my invention, I now claim:

1. A sealed electrical connector comprising, first and second bodies, said first body having a sealed chamber for containing dielectric fluid sealed therein, a first electrical connector positioned in said sealed chamber, said second body having a second electrical connector, said second electrical connector including an insulated projection with an exposed conductor tip, sealable opening means in said chamber for passing said second electrical connector into said sealed chamber for said conductor tip to electrically contact said first electrical contact in the dielectric fluid, and said sealed chamber has means for increasing and decreasing the volume of said chamber by changing the shape of a flexible member without stretching said member or otherwise creating a pressure differential from the inside to the outside of the chamber.
2. A sealed electrical connector as claimed in claim 1 in which, said sealed chamber has a nonexpandable housing, and said volume increasing and decreasing means comprises a flexible member sealably covering a hole through said housing.
3. A sealed electrical connector as claimed in claim 1 in which, said increasing and decreasing means includes a flexible member that is open to the environment outside said first body.
4. A sealed electrical connector as claimed in claim 1 in which, said increasing and decreasing means includes a flexible member positioned in said chamber.

5. A sealed electrical connector as claimed in claim 1 in which,
 said second electrical connector has a given cross-sectional configuration,
 and said sealable opening means includes a resilient member having a precut slit-shaped opening shaped to said given cross-sectional configuration, the sides of which sealably compress to close said opening.

6. A sealed electrical connector as claimed in claim 5 in which,
 said sealable opening means is spaced from said first electrical connector a distance greater than the length of the exposed conductor tip.

7. A sealed electrical connector as claimed in claim 1 in which,
 said sealed chamber has a nonexpandable housing with an opening through the wall of said chamber,
 a resilient diaphragm sealing member for being positioned in said opening,
 and said sealable opening means includes a compressed precut opening through said diaphragm that is biased to the sealed condition.

8. A sealed electrical connector as claimed in claim 7 in which,
 said precut opening comprises a slit having notched edge surfaces for guiding said second electrical conductor to said slit.

9. A sealed electrical connector as claimed in claim 7 including,

backing means for holding said diaphragm member in position.

10. A sealed electrical connector as claimed in claim 9 including,
 said backing means comprises plates positioned on each side of said diaphragm,
 and said plates having openings therethrough aligned with said precut opening.

11. A sealed electrical connector as claimed in claim 10 in which,
 said increasing and decreasing means comprises a flexible member that projects into said sealed chamber forming a cavity,
 and said diaphragm and backing means having aligned openings that open said cavity to the environment outside said first body.

12. A sealed electrical connector as claimed in claim 11 in which,
 said flexible member is integral with said diaphragm.

13. A sealed electrical connector as claimed in claim 12 in which, said second electrical connector includes at least one thin blade electrode.

14. A sealed electrical connector as claimed in claim 13 including,
 coupling means for securing said first electrical connector with said second electrical connector,
 and said coupling means having an opening therethrough for communicating with said cavity.

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