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FLUID TIGHT ELECTRICAL CONNECTION

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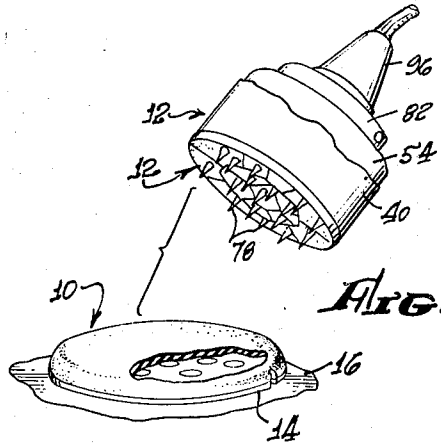


FIG. 1.

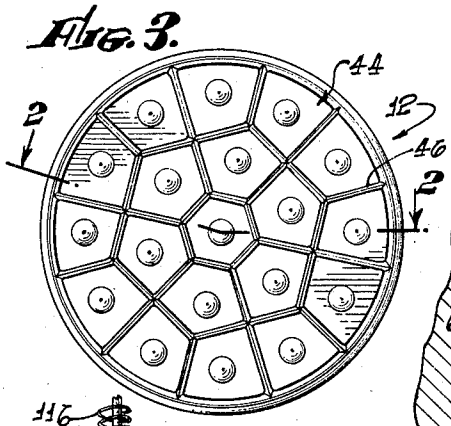


FIG. 3.

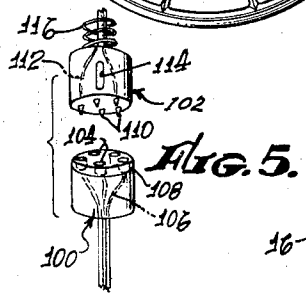


FIG. 5.

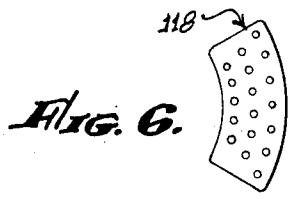


FIG. 6.

FIG. 4.

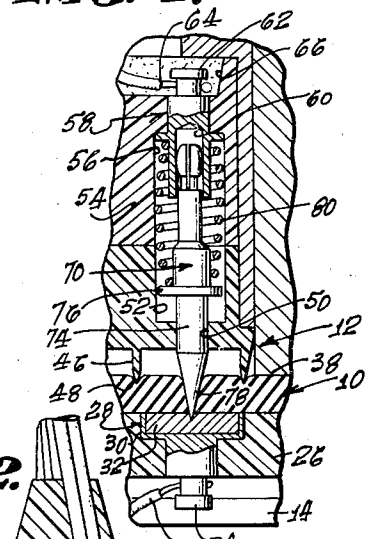
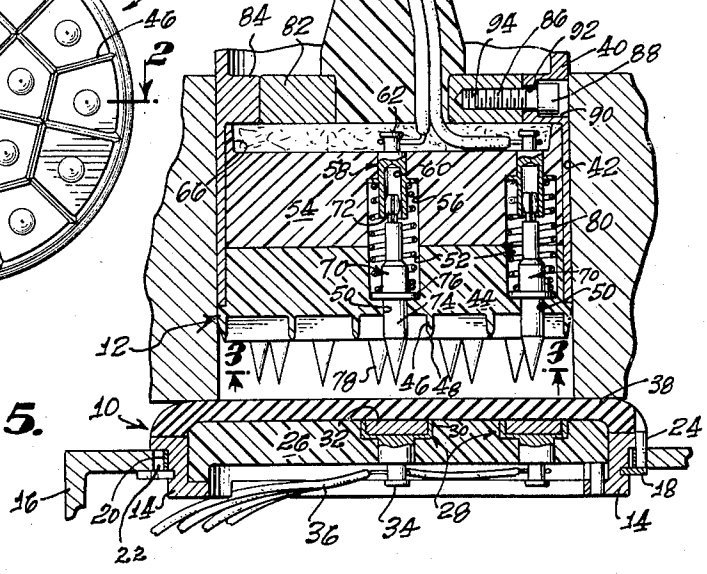


FIG. 2.



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FLUID TIGHT ELECTRICAL CONNECTION

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7 Claims. (Cl. 339—96)

This invention relates generally to electrical connectors; more particularly it relates to apparatus for effecting electrical connections under adverse environmental conditions of vibration and shock or in the presence of fluid.

It is an object of the present invention to provide an electrical connector which is capable of providing effective electrical connections despite the presence of conductive or corrosive fluid.

It is an object of this invention to provide an electrical connector wherein effective electrical contact is maintained under adverse environmental conditions of vibration, shock or relative movement between the connecting members.

It is an object of this invention to provide a multiple electrical connector wherein electrical leakage, shorting and arcing among connectors is minimized.

It is an object of the present invention to provide a multiple connector which is adapted for automatic connection and disconnection.

It is another object of this invention to provide an electrical connector wherein the member to which connections are made is provided with effective fluid sealing at all times.

It is another object of the present invention to provide a multiple electrical connector which automatically compensates for tolerance and alignment variations.

It is a further object of this invention to provide an electrical connector wherein pressurization may be maintained within the apparatus to which connections are made.

Other objects and features of this invention, as well as many advantages thereof, will become apparent to those skilled in the art from a consideration of the following description, the appended claims, and the accompanying drawings in which:

Figure 1 is a perspective view showing the plug section and receptacle section of a preferred embodiment of the present invention;

Figure 2 is an elevational sectional view, taken at line 2—2 of Figure 3, showing the plug and receptacle sections of Figure 1 in operative position with contacting elements disengaged;

Figure 3 is a view of the contacting face of the plug section, taken at line 3—3 of Figure 2;

Figure 4 is a fragmentary sectional view showing the contacting elements of Figure 2 in engaged relation;

Figure 5 is a perspective view of a modified form of the electrical connector of the present invention; and

Figure 6 is a plan view of a modified form of the receptacle section utilized with the present invention.

Referring to the drawings, and particularly to Figures 1, 2, 3 and 4, there is illustrated a preferred embodiment of the electrical connector of the present invention. The connector includes a receptacle section 10 and a plug section 12, these sections being adapted for mutual engagement. Base member 14 of receptacle section 10 is mounted to foundation 16 by means of flat annular snap ring 18, as shown in Figure 2. Annular

corrugated leaf spring 20 is disposed in annular space 22 between base member 14 and foundation 16. This feature permits limited lateral movement of the receptacle against the resilient urging of spring 20, thus permitting the receptacle section to move with the plug section when in engagement therewith, to maintain effective contact when there is relative movement or vibration between the respective foundation members to which these sections are mounted. Receptacle section 10 is rotationally indexed and blocked against rotation by a conventional pin and hole arrangement including pin 24, as shown in Figure 2. Body portion 26 is generally circular in configuration and has a recessed bottom portion. It is preferably fabricated of glass-reinforced silicon casting compound.

Cast in body portion 26 are a number of contact elements 28, each of which has a cup portion 30 filled with a soft metal matrix 32. Matrix 32 is preferably composed of a solder compound having a relatively high melting point. Mercury or other suitable material might be used in particular applications. The matrix has a sufficiently large area that alignment with its mating contact element 28 need not be precise, and close tolerances therefore need not be maintained. Each contact element has a terminal portion 34 extending outwardly from the bottom of body portion 26 and adapted to receive an electrical conductor 36 which is attached thereto, as by soldering. The recessed portion of body 26 may be filled with potting compound after connection of conductors 36, to provide improved rigidity, corrosion resistance, and to insure electrical insulation.

Rubber diaphragm 38 is molded over the upper surfaces of body portion 26 and base member 14. It is composed of soft silicon rubber which is self-sealing and is molded to the surface of body portion 26 and to the surfaces of matrices 32 by the application of heat sufficient to fuse the rubber but insufficient to fuse matrices 32.

Plug section 12 is provided with an external sleeve 40 which is adapted to be slidably received in cylindrical bore or guide 42. Grid member 44, preferably fabricated of nylon, is mounted in sleeve 40 and has defined in its lower portion a network of grid ridges 46, which are geometrically arranged in a honeycomb type of construction to define a number of recesses, as shown in Figure 3. End portion 48 of each grid ridge is tapered, as shown, for reasons hereinafter indicated. A number of longitudinal parallel bores are provided in grid member 44. Each bore has a reduced portion extending from the center of a recess defined by ridges 46 to the interior of member 44, and has an enlarged portion extending to the upper surface of grid member 44, as shown.

Body member 54, preferably constructed of nylon, is mounted in sleeve 40 above grid member 44 and has bores 56 registering with bores 50 of member 44 to provide continuous bores. Mounted in the reduced upper portion of each bore 56 is a terminal member 58, which has a terminal portion 62 extending above the recessed upper surface of body member 54 to receive an electrical connection 64 attached thereto, as by soldering. Each terminal member 58 has a sleeve portion extending into bore 56 and defining an axially extending cylindrical opening, as shown in Figure 3. Terminal members 58 are preferably constructed of corrosion-resistant steel and gold plated for long life and corrosion-resistance. Recess 66 in the upper portion of member 54 is preferably filled with potting compound to provide structural strength, sealing against corrosion, and electrical installation.

A pointed contact member 70 is disposed within each of the above described bores. Each contact member has a slotted rounded end portion 72 adapted to slidably engage axial opening 60 of terminal member 58. The interior

of opening 60 and end portion 72 are preferably plated with gold to provide corrosion-resistance and improved electrical contact. Slotting gives end portion 72 a spring-like quality which improves its contact with terminal member 58. Integral flange 76 engages grid member 44 to limit the extension of pointed head 74 beyond grid ridges 46. A helical compression spring 80 in each bore has one end in contact with flange 76 and the other end bearing against terminal member 58, as shown, to exert a predetermined force urging pointed head 78 outwardly from grid member 44 against retention by flange 76. Spring 80 is reduced in diameter at its ends to provide improved electrical conduction between terminal 58 and contact member 70, because it has been found in practice that the quality of electrical contact between end portion 72 and terminal member 58 varies considerably with wear and with tolerance variations. The reduced end diameters of the spring obviously provide good electrical contact with the terminal member and the contact member 70. Spring 80 is plated with copper and with gold to withstand corrosion and to improve electrical conduction, because it carries a considerable portion of the electrical current.

Annular support ring 82 encircles upwardly extending connectors 64 and abuts flange portion 84 of sleeve 40. Radially extending screws 86 secure ring 82 to sleeve 40 and index these members in relation to one another. Each screw 86 has its head 88 disposed within counter bore 90 and extends through bore 92 to engage threads 94 in ring 82. Sleeve 40 is rotationally indexed with respect to guide bore 42 by a conventional key arrangement (not shown). A body 96 of resilient potting compound is formed about upwardly extending connectors 64 to provide structural strength with sufficient resiliency to allow movement of connectors 64 relative to plug section 12.

In the operation of the embodiment described above, sufficient force is exerted upon plug section 12 to force points 78 through diaphragm 38 into matrix elements 32, while compressing springs 80 and impressing grids 46 into diaphragm 38. Guide cylinder 42 and the indexing elements previously discussed insure registration of points 78 with matrix elements 32. As hereinbefore indicated, this registration need not be precise because of the relatively large areas of the matrices. Rubber diaphragm 38 prevents arcing between points 78 and matrix elements 32 during the connecting operation and insures a substantially dry contact despite the presence of fluid on the diaphragm and points. The diaphragm, being formed of self-sealing rubber, grips points 78 as they pass through the diaphragm and while they are engaged with the matrix elements, thereby insuring that water or other fluids cannot effect the electrical contact. Diaphragm 38, being capable of retaining air or gas if suitably constructed and mounted, permits the pressurization of the apparatus on which the receptacle is mounted. The diaphragm also serves to greatly reduce the possibility of shorting between adjacent pointed contact members 78. In Figure 4, the elements are shown with a point 78 and a matrix element 32 in engaged relation. The diaphragm seals the connection itself from fluids. Compression of spring 80 results in a resilient force urging point 78 against matrix element 32 to insure good electrical contact under conditions of shock and vibration. Contact would otherwise tend to be erratic under such adverse environmental conditions. Springs 80 also serve to compensate for tolerance variations in contact heights.

The resilient mounting of receptacle section 10, effected by annular corrugated leaf spring 20, provides further insurance of effective electrical contacts despite relative movement between the receptacle section and plug section caused by shock, vibration or other factors.

Impression of grids 46 into diaphragm 38 isolates each pointed contact member 70 with respect to the other

pointed contact members. As previously described, and as shown in Figure 3, the grid network provides a continuous ridge around each member 70. Impression of the grid ridges into the diaphragm breaks the continuity of any film of water or other fluid on the diaphragm surface. Tapered end portions 48 of the grid ridges improve the flow of the rubber of the diaphragm as it is displaced around the ridges, resulting in less stress and damage to the rubber and closer contact. From the foregoing discussion, it will be understood that current leakage between pointed contact members 70, and the possibility of a short circuit between any two contact members, are practically eliminated.

Plug section 12 is held against receptacle section 10 while the eletcrical connections are maintained. It has been found in practice that a force of 300 to 350 pounds is required to impress 19 pointed contact members into matrix elements to a depth of approximately 0.050 inch, to impress the grid ridges into the diaphragm approximately 0.035 inch, and to deflect springs 80 approximately ⅛ of an inch, so that so that each deflected spring exerts a force of 14.5 pounds as compared with 7½ pounds before compression.

In disengaging the electrical connections, plug section 12 is withdrawn from receptacle section 10. As points 78 are withdrawn through diaphragm 38, the diaphragm maintains a firm gripping action on each point, thus insuring that no fluid can enter to contact the matrix elements and insuring against arcing between matrix elements and insuring against arcing between matrix elements and pointed contact members. After disengagement, the self-sealing diaphragm closes the breaks because of its elastic memory, and the receptacle remains sealed against fluids.

In Figure 5 is shown a modified form of the present invention. Receptacle section 100 consists of a number of soft metal matrix terminals 104 and their respective leads 106 cast in a cylindrical body of molding compound. Self-sealing diaphragm 108, similar to diaphragm 38 described above, is molded over the surfaces of the matrix terminals and the surface of the cylindrical body, as shown. Plug section 102 consists of a corresponding number of pointed contact members 110 and their respective leads 112 similarly cast in a body of molding compound. Index slot 114 serves as a vertical stop for plug member 104 and insures proper registration of contact members 110 with matrix terminals 104, when plug member 102 is in operative position in a bore or other guide means. Helical spring 116 is provided to exert predetermined pressure to force points 110 through rubber diaphragm 108 into matrix terminals 104. The spring is adapted to bear against a structure (not shown) which provides a foundation.

In Figure 6 is shown generally a receptacle member 118 having a configuration different from the circular configuration shown in the other figures. Receptacle section 118 has the configuration of a segment of an annular ring to adapt it to a particular application. It will be apparent that the receptacle section and the plug section of this invention may be of any desired configuration.

Although specific embodiments of the present invention have been described and illustrated in detail, it is to be clearly understood that the same are by way of illustration and example only; it is to be understood that the invention is not limited thereto, as many variations will be apparent to those versed in the art and the invention is to be given its broadest possible interpretation within the terms of the following claims.

We claim:

1. An electrical connector comprising a receptacle section having a plurality of matrix elements mounted therein, a fluid tight diaphragm covering said matrix elements, a plug section having a series of pointed contact members confronting said matrix elements, a network of ridges extending from said plug section to provide a continuous

ridge around each of said contact members, guide means for insuring registration of said contact members with said matrix elements, and means for exerting predetermined force to impress said pointed contact members through said diaphragm into said matrix element and to impress said ridges into said diaphragm.

2. An electrical connector comprising a receptacle section having a plurality of matrix elements mounted therein, a fluid tight diaphragm covering said matrix elements, a plug section having a plurality of longitudinally extending internal bores, a plurality of contact members, one disposed in each of said bores, each of said contact members having a pointed head extending outwardly from said body, a flange on each of said contact members engaging said body to limit the outward extension of said contact member, resilient means in said bore urging said pointed head outwardly from said body against retention by said flange, means for connecting each of said contact members to an external circuit, guide means for insuring registration of said contact members with said matrix elements, and means for exerting predetermined force to impress said pointed contact members into said matrix element and to compress said resilient means.

3. An electrical connector comprising a receptacle section having a plurality of matrix elements mounted therein, a fluid tight diaphragm covering said matrix elements, a plug section having a plurality of longitudinally extending internal bores, a plurality of contact members, one disposed in each of said internal bores, each of said contact members having a pointed head extending outwardly from said body a distance limited by engagement of an integral flange with said body, resilient means in each of said bores urging said pointed head outwardly from said body, means for connecting each of said contact members to an external circuit, a network of ridges extending from said body a shorter distance than said pointed contact members to provide a continuous ridge around each of said contact members, guide means for insuring registration of said contact members with said matrix elements, and means for exerting predetermined force against said plug section to impress said pointed contact members into said matrix element while compressing said resilient means and impressing said ridges into said diaphragm.

4. An electrical connector comprising a plug section having a plurality of longitudinally extending internal bores, a plurality of contact members, one disposed in each of said internal bores, each of said contact members having a pointed head extending outwardly from said body a distance limited by engagement of an integral flange with said body, resilient means in each of said bores urging said pointed head outwardly from said body, means for connecting each of said contact members to an external circuit, a network of ridges extending from said body a shorter distance than said pointed contact members to provide a continuous ridge around each of said contact members, a receptacle section having a dielectric base member, a plurality of matrix elements mounted in terminal elements cast in said base member and registering with said contact members, a conductor electrically connected to each of said terminal elements, a fluid tight rubber diaphragm molded over said matrix

elements, guide means for insuring registration of said contact members with said matrix elements, and means for exerting predetermined force to impress said pointed contact members into said matrix elements while compressing said resilient means and impressing said ridges into said diaphragm.

5. The electrical connector according to claim 4, wherein said base member for said receptacle section is resiliently mounted for limited translational movement relative to its foundation, whereby effective electrical contact is maintained between said pointed contact members and said matrix elements upon limited relative movement between said receptacle section and said foundation.

6. The electrical connector according to claim 4, and further including a corrugated annular leaf spring disposed in an annular space defined between said receptacle section and its mounting, whereby effective electrical contact is maintained between said pointed contact members and said matrix elements upon limited relative movement between said receptacle section and said mounting section.

7. In a multi-conductor electrical connector having a plug section and a receptacle section adapted for mutual engagement, the combination comprising a metal sleeve for said plug section, a cylindrical nylon member mounted in said sleeve, said member having a network of grid ridges confronting said receptacle section, said member defining a plurality of longitudinally extending internal bores, each of said bores having a reduced portion intersecting the surface of said member confronting said receptacle section in an opening within a recess defined by said grid ridges, a contact member having a flange intermediate of a pointed head and a shank, said flange engaging said cylindrical nylon member to limit the extension of said pointed head beyond said body, a conductive element having an axial opening slidably receiving said shank of said contact member within said bore in said body, said conductive element extending exteriorly of said body to receive a conductor, a helical spring exerting predetermined force against said flange within said bore urging said pointed head outward from said body, a dielectric base for said receptacle section, a series of matrix elements mounted in terminal elements cast in said base and registering with said contact members, a conductor electrically connected to each of said terminal elements, a fluid tight rubber diaphragm molded over said matrix elements, means for guiding said plug section to insure registration of said contact members with said matrix elements, and means for exerting predetermined force urging said plug section against said receptacle section to impress said pointed contact members through said diaphragm into said matrix elements while compressing said helical springs and impressing said ridges into said diaphragm.

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