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(71) Applicant: **THE BENDIX CORPORATION**
Executive Offices Bendix Center
Southfield, Michigan 48037(US)

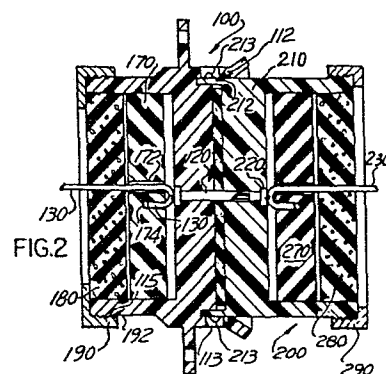
(72) Inventor: Nelson, Dean Richard
19 Seneca Street
Sidney New-York 13838(US)

(72) Inventor: Whallon Jr., William Prendergast
Pine Hill Road (RD 2)
Unadilla New-York 13849(US)

(74) Representative: Maguet, André et al,
Service Brevets Bendix 44, Rue François 1er
F-75008 Paris(FR)

(54) **Electrical connector assembly.**

(57) An electrical connector assembly having low mating force and moisture protection for an electrical connection between contacts (120, 220) in each of the two connector halves (100, 200) of the assembly, said electrical connector assembly including an interfacial seal (150) made of closed cell foam elastomeric material mounted between the forward faces of the connector halves (100, 200) and preferably rear mounted grommets (180, 280), preferably made of a silicone rubber such as polymethyl silane, and the preferred elastomeric foam material having a density of approximately .45 the density of a solid (non-foam) material.



Electrical connector assembly

The present invention relates to an electrical connector assembly of the type comprising : first and second mating connector housings, each having a forward face facing in the direction of the mating and passages extending therethrough and terminating at the forward face; and mateable electrical contacts having low mating force mounted in the passages of each of the connector housings and extending forwardly to the forward face. More specifically, the present invention relates to an electrical connector which has a low mating force and which provides an electrical interconnection of mated lines which is relatively resistant to moisture penetration (moisture-proof). Because of the salt contaminants inherent in moisture, moisture can create a galvanic action and oxidation, both of which have undesirable effects on the metallic conductors of contacts. Additionally, moisture undesirably affects the insulation resistance between circuits and the resistance of a given circuit.

Electrical connectors are known which have low mating forces. One such connector type is described in U.S. Patent No. 3,725,844. The connector includes contacts having a plurality or bundle of axially aligned wires, each having a forward angled or tapered end surface. The bundle of one contact interfits in an electrical connection with another bundle of similar structure. While this connector has a relatively low mating force, it does not necessarily provide a moisture-proof connection. While some applications allow for a connection which is not moisture-proof, in many instances, it is desirable to provide the moisture-proof connection between terminals.

In such instances, it is sometimes expensive or difficult to obtain a moisture-proof connection. Furthermore, the application of a moisture-proof arrangement to a connector sometimes adds undesirably to the mating force of the connector. Since the connectors themselves have a number of contacts and each contact has a finite mating force itself, the addition of even a small increment to the mating force is undesirable. Furthermore, in some applications, the maximum mating force is specified and the provision of a moisture-proof arrangement which has a significant mating force might reduce the number of contacts which otherwise

could be used.

In some of the prior art applications, a moisture-proof arrangement is provided by a rear mounted grommet made of solid silicone rubber. Associated with each passage through the silicone rubber grommet are spaced moisture-proofing webs which are yieldable to allow a larger contact to pass therethrough and then resiliently return to a smaller diameter to engage the wire in the portion of the web. While such a grommet proves acceptable in many applications, the rather small portion of the grommet that actually provides the moisture-proofing (the webs) is a limitation in some instances.

The prior art has also suggested a tower and recess arrangement to provide moisture resistance at an interfacial seal. Such towers, made from a grommetting material, provide a solution but are undesirably high in manufacturing cost because of relatively low yields of acceptable parts.

Accordingly, the connectors of the prior art have significant limitations with respect to electrical connectors that require both moisture-proof interconnection and a low mating force.

The present invention overcomes the disadvantages and limitations of the prior art arrangements by providing an electrical connector assembly comprising first and second mating connector housings, each having a forward face facing in the direction of the mating and passages extending therethrough and terminating at the forward face, and mateable electrical contacts having low mating force mounted in the passages of each of the connector housings and extending forwardly to the forward face, in which there is provided an interfacial seal mounted to the forward face of at least one of the connector housings, said interfacial seal including a compressible layer of an elastomeric material formed into a closed cell foam structure.

In the preferred embodiment of the invention, the electrical connector assembly additionally includes rear mounted grommet type moisture protections, preferably in the form of closed cell foam, to isolate the wires and the interconnections from moisture.

The electrical connector assembly of the present invention has the advantage due to its resistance to moisture to have a long life, to be more reliable and free of contaminating salts. In addition, it has the advantages : that the low mating force is

achieved while maintaining a moisture-proof connection between the cooperating elements; that said assembly is simple to assemble and disassemble; and that said assembly is of a low manufacturing and assembling cost.

5 One way of carrying out the invention is described in detail below with reference to the drawings which illustrate one specific embodiment and a slight modification thereof, in which:

FIGURE 1 is a cross-sectional view of a connector half of the present invention, before assembly of the contacts and insert assembly.

FIGURE 2 is a cross-sectional view of a mated connector assembly employing the principles of the present invention.

FIGURE 3 is an alternate embodiment for joining the connector halves.

15 FIGURE 4 is an enlarged view of a cross-section of the interfacial closed cell foam, cut along the line IV-IV in FIGURE 1.

FIGURE 1 shows a portion of a connector half 100 of the present invention. The connector 100 includes a body 110 and an interfacial seal 150. A passage 160 extends through the body 110 and the interfacial seal 150 between a front mating face 152 and a rear face 118.

The body 110 is preferably made of a molded plastic such as thermoplastic or thermoset resins. A preferred material for the body 110 is a polycarbonate resin sold by General Electric under the trademark Lexan, although other thermoplastic materials having moderate to high temperature characteristics may be used. Additional suitable materials include thermoplastic polyesters (sold under the trademark Valox and Gafite) and PBT and PET plastics sold under the duPont trademark Rynite.

The body 110 advantageously includes mounting projections 111 and forwardly projecting arms 112 which terminate in outwardly projecting ends 112a. Intermediate the length of the arms is an aperture 113 for receiving and releasably retaining an enlargement from the (other) mating connector half (not shown in this view; shown in FIGURE 2).

The body 110 includes a rear annular flange 114 having an external screw thread 115 and an internal surface 116 defining

a cavity for receiving a contact assembly.

The interfacial seal 150 is mounted (and preferably adhesively secured) to a forward face 119 of the body 110. The seal 150 is made of an elastomeric material, preferably a silicone rubber preferably polymethyl silane, but alternatively neoprene or polyvinyl silane, formed into a closed cell foam may be used. Such a closed cell foam of a silicone rubber material is available from Connecticut Hard Rubber Co., although additional sources are believed to include Rogers Corporation or Lauren Manufacturing Company. The materials chosen are resistant to passage of hydrocarbon which could degrade the electrical performance.

The interfacial seal 150 of the preferred embodiment is to be of approximately 1 mm in thickness and have a density of approximately 0.50 grams per cubic centimeters, although densities of 0.40-0.60 grams per cubic centimeters appears acceptable. The preferred silicone rubber (polymethyl silane) used has a density of approximately 1.12 grams per cubic centimeters in its solid (non-foam) configuration, but the preferred foam density is approximately 45% the density of the solid material, with the preferred range of density of the foam being 35%-55% of the solid material. If the foam is chosen of a lesser density, the material has too much of a sponge nature, so that the moisture-proofing qualities are reduced or eliminated. If the foam is of a density greater than approximately 55%, the compressibility of the material is reduced, leading to relatively large mating forces.

The passage 160 extends between the forward face 152 of the interfacial seal 150 and the rear face 118 of the body 110. Advantageously, there is an enlargement 165 of the passage 160 to receive an enlarged retention shoulder of the type present on many styles of conventional contacts.

Closed cell foam of the type used in the interfacial seal 150 is chosen for its moisture-resisting and compressibility characteristics. The closed cell foam has air pockets which are relatively small and discrete and without a convenient moisture path therebetween.

FIGURE 2 is a cross sectional view of an assembled electrical connector assembly including the first connector half 100 of the type described in connection with FIGURE 1 and a

second connector half 200.

The connector 100 includes a contact 120 and a conductor 130 which are connected in electrical circuit relationship. The conductor 130 passes through a rear mounted grommet 180 and
5 over a retaining block 170. The grommet 180 is preferably a piece of closed cell foam silicone rubber approximately 5mm thick, a material which will yield sufficiently so that conductor-receiving apertures can be made slightly smaller than the diameter of the conductor. Insertion of the conductor into the aperture causes
10 it to expand and provide a dynamic compression seal around the wire, providing a moisture-resisting seal. Less desirable, though acceptable for some applications, is a grommet of conventional design wherein it is made of solid (non-foam) silicone rubber having larger passages with a plurality of conductor-gripping webs.

15 The retaining block 170 includes a through passage 172 for each conductor and a blind hole 174 for conductor termination.

The retaining block 170 and conductors 130 are placed in position by a retaining ring 190 which has internal threads 192 to engage the external threads 115 on the body 110. The rotation
20 of the ring 190 to engage the cooperating threads 115, 192 urges the conductor (at a medial, transverse area) into rear extending conductor wires which taper to a sharp point to pierce through the conductor wires and form an electrical connection between the conductor 130 and the contact 120.

25 The connector half 200 is similar in structure and function to the connector half 100. Thus, contact 220 is mounted within a body 210 and is coupled to a conductor 230. The conductor 230 passes through a retainer block 270 and a rear grommet 280 held in place by retainer ring 290.

30 The conductor half 200 does not have its own interfacial seal nor outwardly projecting arms. It has forwardly projecting piece 212 of smaller diameter than the arms 112 to interfit within the arms 112. The piece 212 includes projections 213 which fit within the aperture 113.

35 FIGURE 3 shows connector halves 100, 200 in mated relationship, but held together with a coupling nut 300. The nut 300 has an internal screw thread 310 which engages an external screw thread 215 on the connector half 200. This approach is conventional

for cylindrical connector and may include a rotational retarding system to reduce the chances that vibrational forces would work the coupling nut 300 out of a tight coupling with the half 200.

FIGURE 4 is an enlarged cross sectional view of the
5 interfacial seal 150. The passages 160 for receiving a contact are shown, along with a plurality of air pockets 155. The air pockets are understood to be substantially round and of random size and spacing, relatively smaller and substantially closer together than the passages 160 for contacts. The closed cell
10 foam is purchased in sheets, which are then punched with a pattern of passages in the desired configuration (causing some pockets 155a to intersect the passages 160). As an alternate, the foam could be formed by molding it to an appropriate shape with preformed passages.

Claims :

1. Electrical connector assembly comprising : first and second mating connector housings (100,200), each having a forward face facing in the direction of the mating and passages extending therethrough and terminating at the forward face; and
5 mateable electrical contacts having low mating force (120,220) mounted in the passages of each of the connector housings (100, 200) and extending forwardly to the forward face; characterized in that there is provided an interfacial seal (150) mounted to
10 the forward face (119) of at least one (100) of the connector housings (100,200), said interfacial seal (150) including a compressible layer of an elastomeric material formed into a closed cell foam structure.

2. Electrical connector assembly as claimed in claim 1, characterized in that the closed cell foam elastomeric material
15 is chosen from a group including silicone rubbers and neoprene.

3. Electrical connector assembly as claimed in claim 2, characterized in that the closed cell foam elastomeric material is silicone rubber.

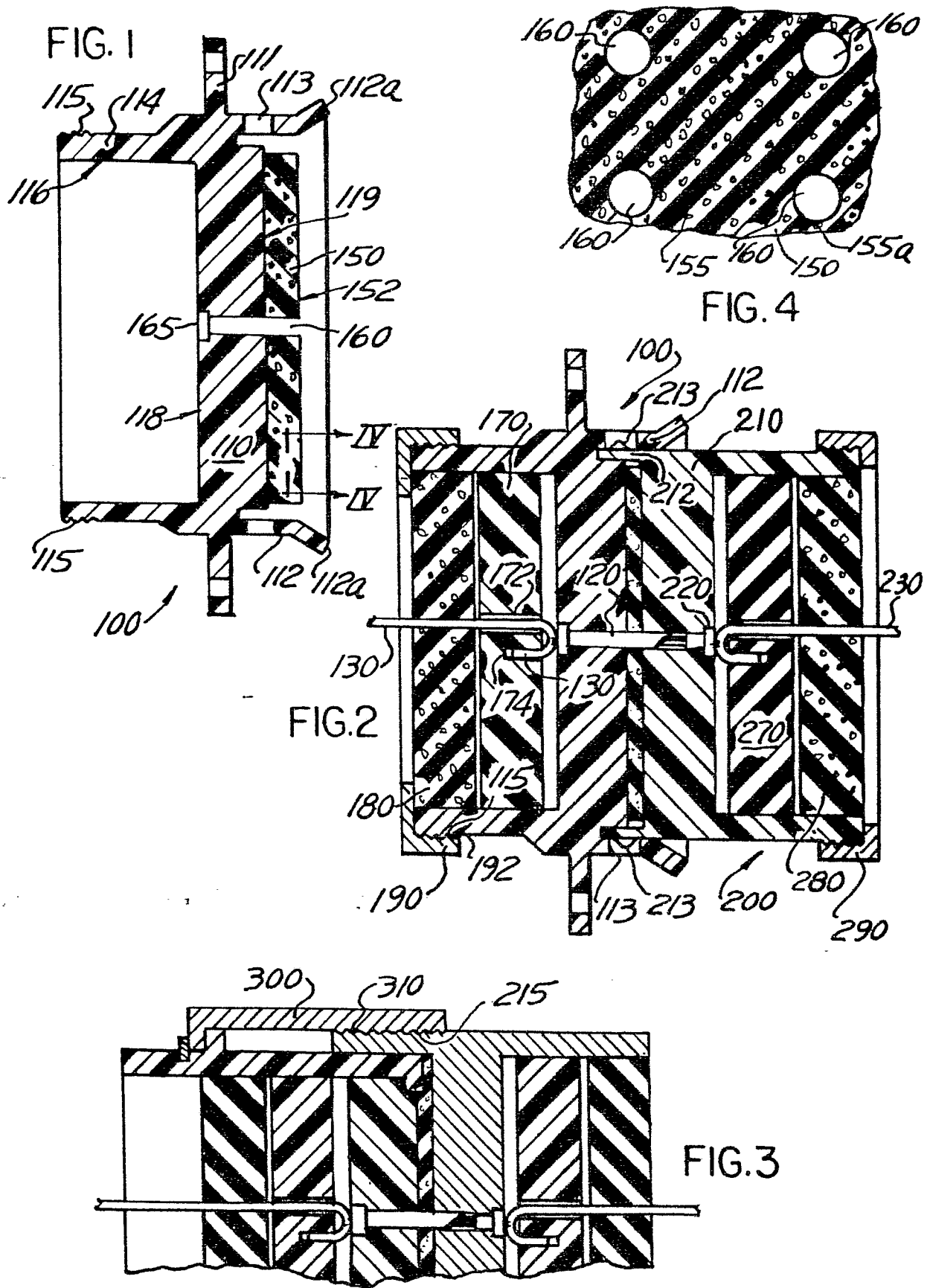
4. Electrical connector assembly as claimed in claim 2, characterized in that the density of the closed cell foam elastomeric material is chosen to be in the range of approximately
20 35%-55% of the density of a solid piece of the same material.

5. Electrical connector assembly as claimed in claim 3, characterized in that the density of the closed cell foam elastomeric material is approximately 45% of the density of a solid
25 piece of silicone rubber.

6. Electrical connector assembly as claimed in claim 1, characterized in that each of the connector housings (100,200) includes a rear-mounted moisture-resisting grommet (180;280).

7. Electrical connector assembly as claimed in claim 6, characterized in that said grommet (180;280) is made of a closed cell foam elastomeric material.

8. Electrical connector assembly as claimed in claim 1, characterized in that the compressible layer of closed cell foam
35 elastomeric material is formed from a sheet of polymethyl silane.





DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
A	<u>US - A - 4 114 974 (G.E.C.)</u> * Abstract; figures *	1,6	H 01 R 13/52
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	<u>US - A - 4 083 902 (RAYCHEM)</u> * Column 2, lines 28-59; figures *	1	
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	<u>GB - A - 995 022 (BENDIX)</u> * Page 2, line 127 - page 3, line 6; figures *	6	

			TECHNICAL FIELDS SEARCHED (Int.Cl. ³)
			H 01 R 13/52 13/523 13/502
			CATEGORY OF CITED DOCUMENTS
			X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
			&: member of the same patent family, corresponding document
☒ The present search report has been drawn up for all claims			
Place of search	Date of completion of the search	Examiner	
The Hague	01-10-1980	RAMBOER	