Oct. 1, 1968 C. L. PAULLUS ET AL 3,404,364

ELECTRICAL CONNECTOR

Filed July 19, 1966 6 Sheets-Sheet 1

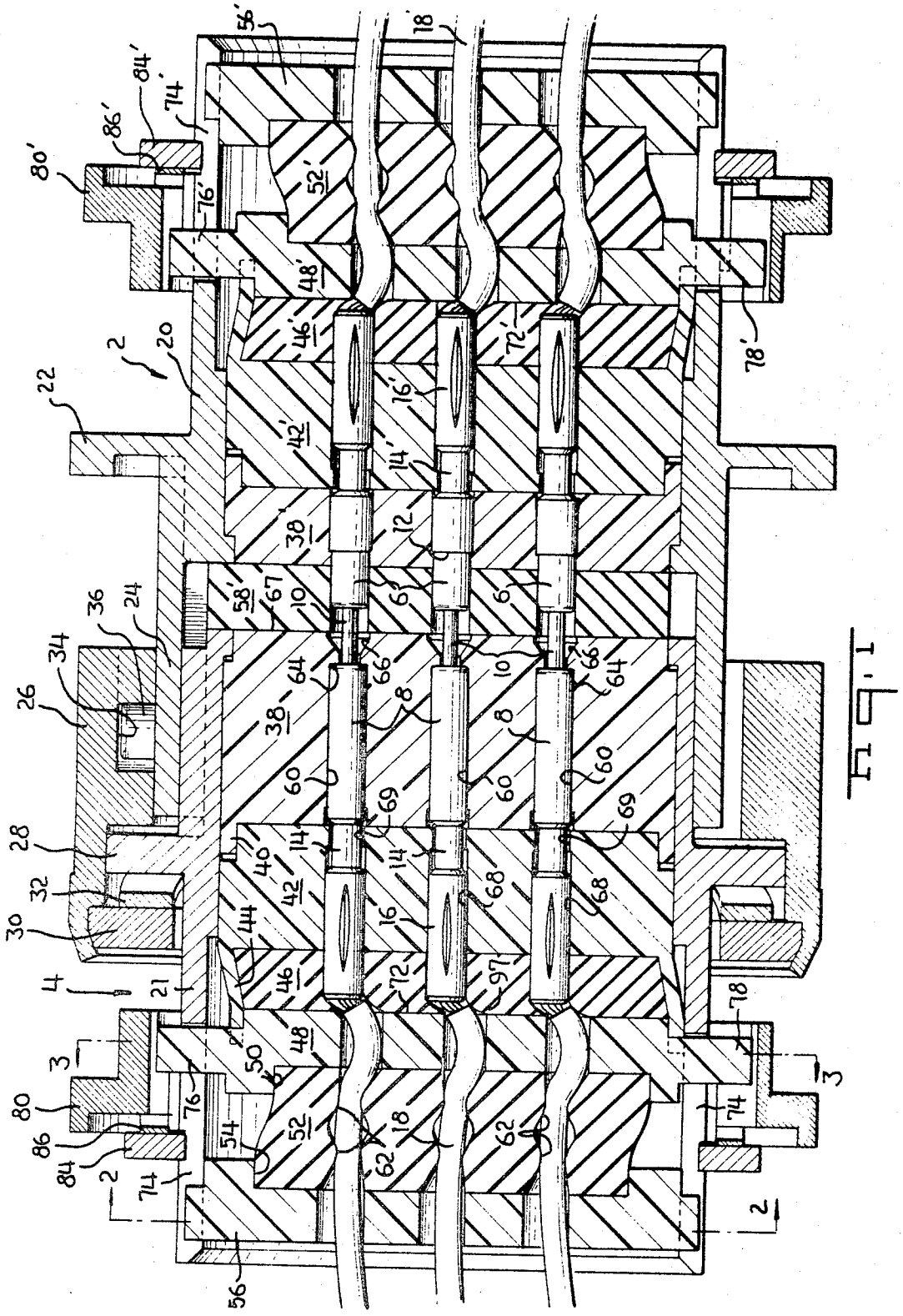


FIG. 1

Oct. 1, 1968 C. L. PAULLUS ET AL 3,404,364

ELECTRICAL CONNECTOR

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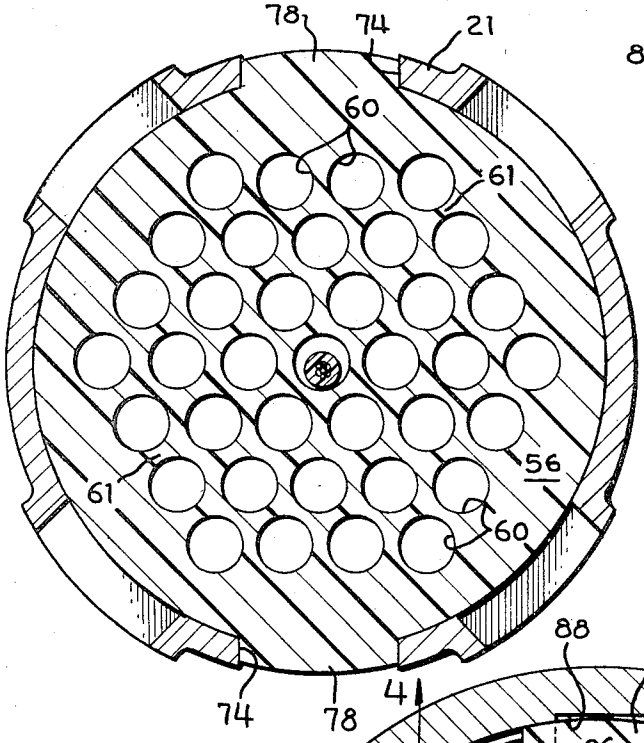


Fig. 2

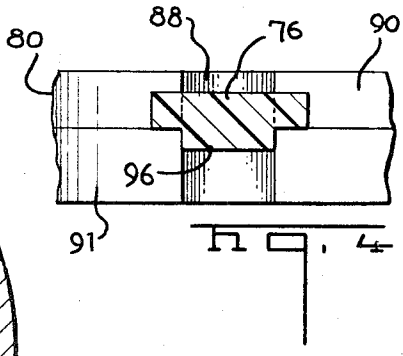


Fig. 4

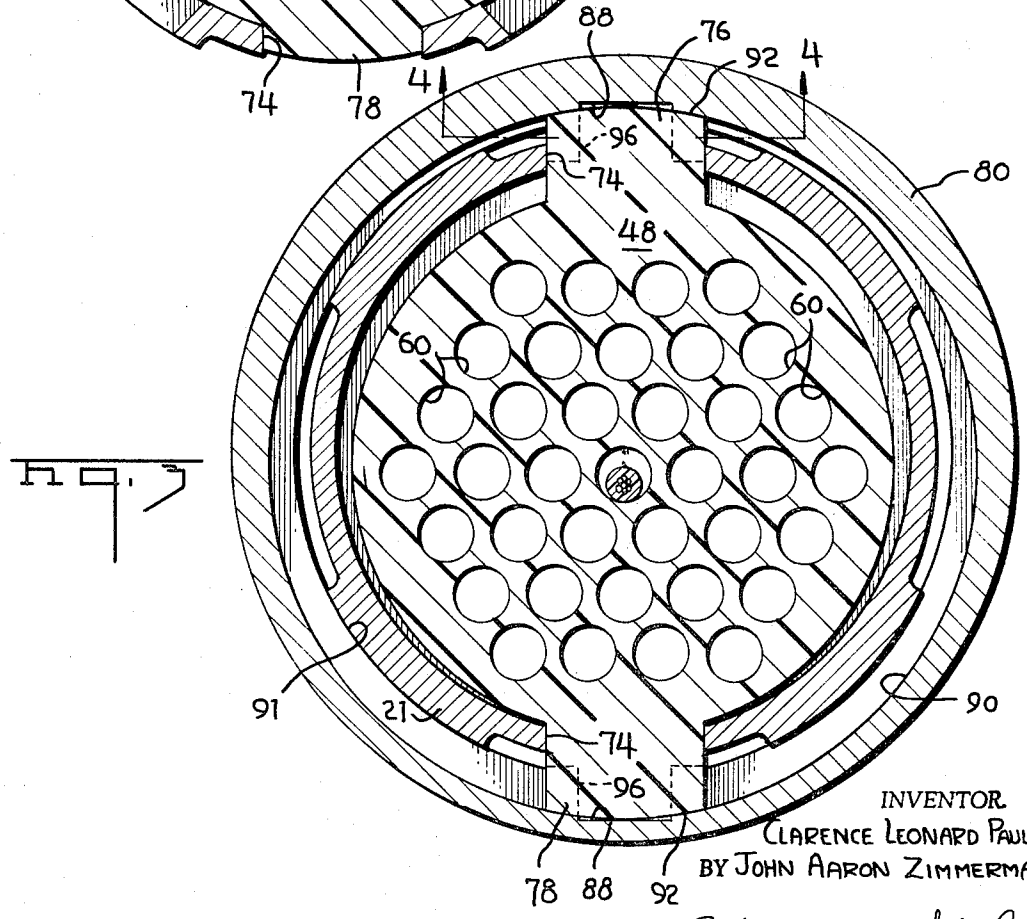


Fig. 3

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Oct. 1, 1968 C. L. PAULLUS ET AL 3,404,364

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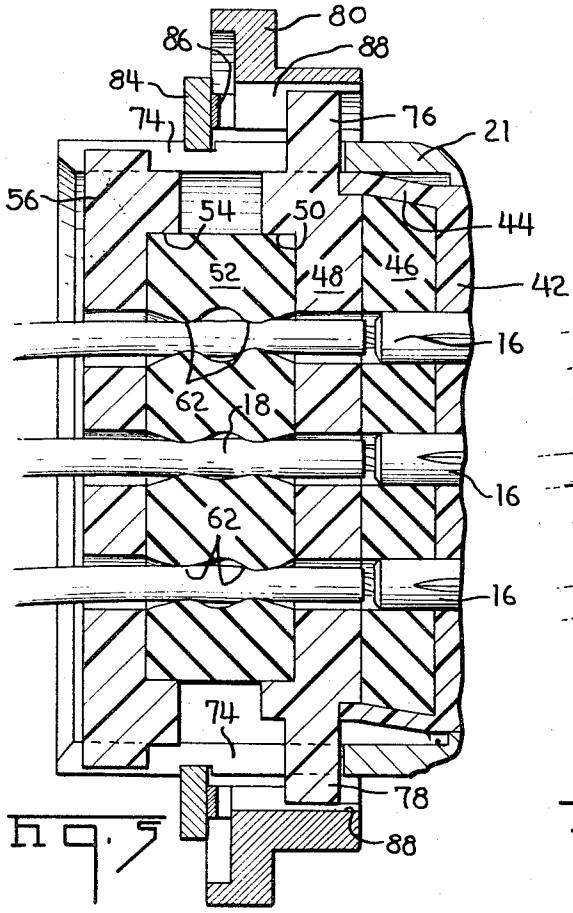


Fig. 5

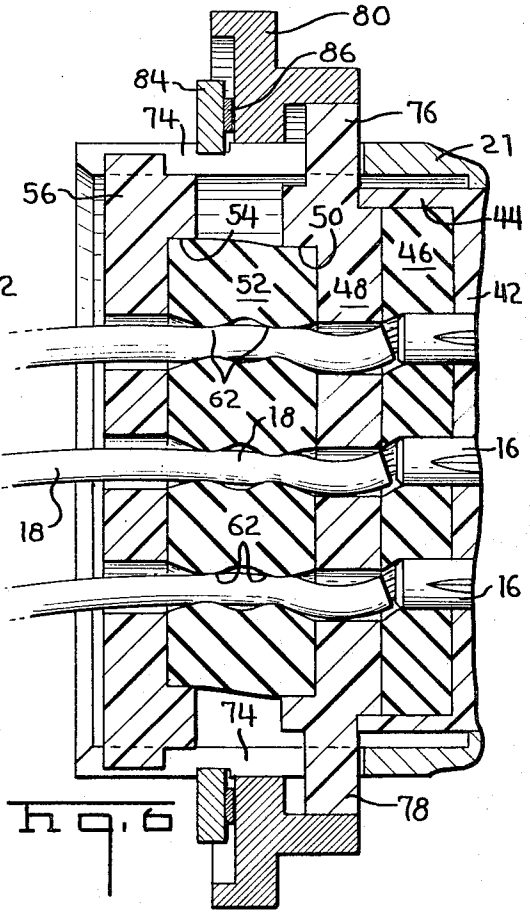


Fig. 6

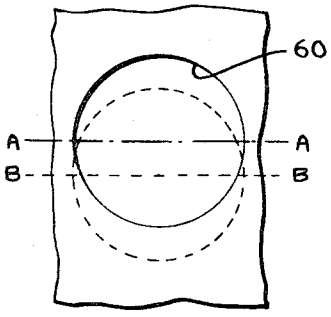


Fig. 8

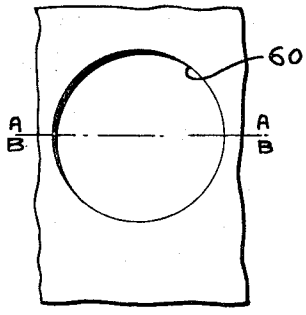


Fig. 7

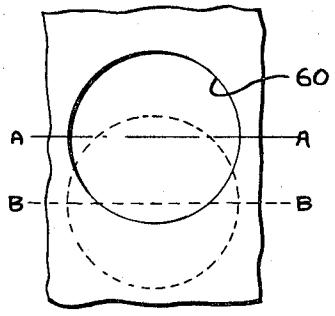


Fig. 9

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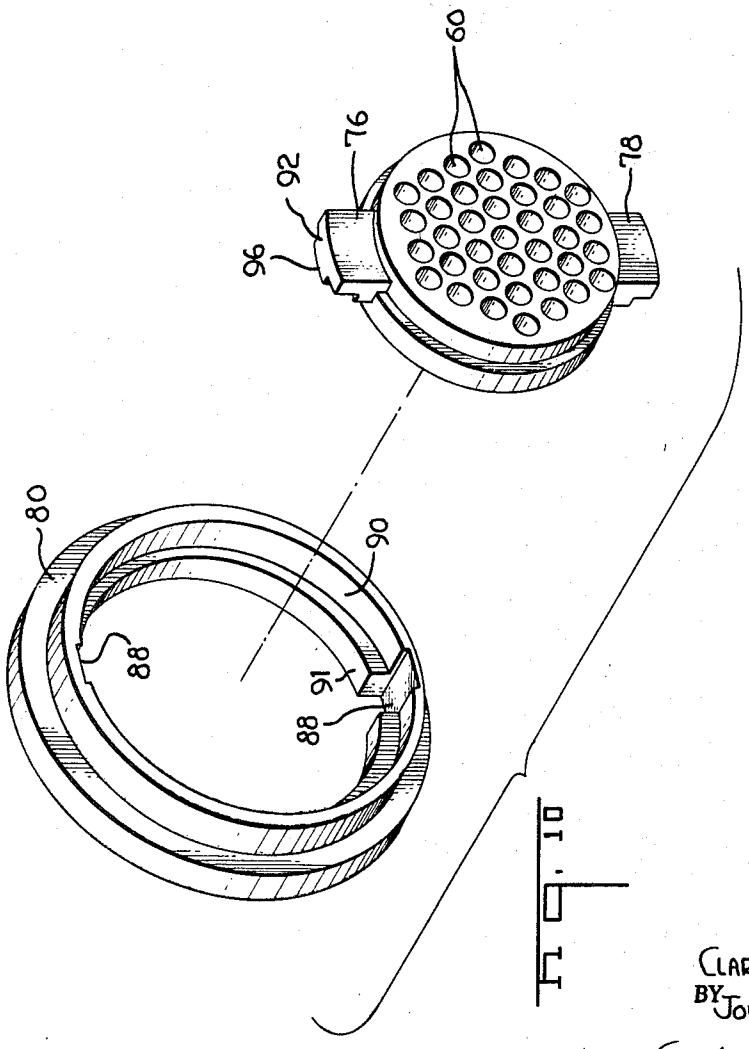


FIG. 10

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ELECTRICAL CONNECTOR

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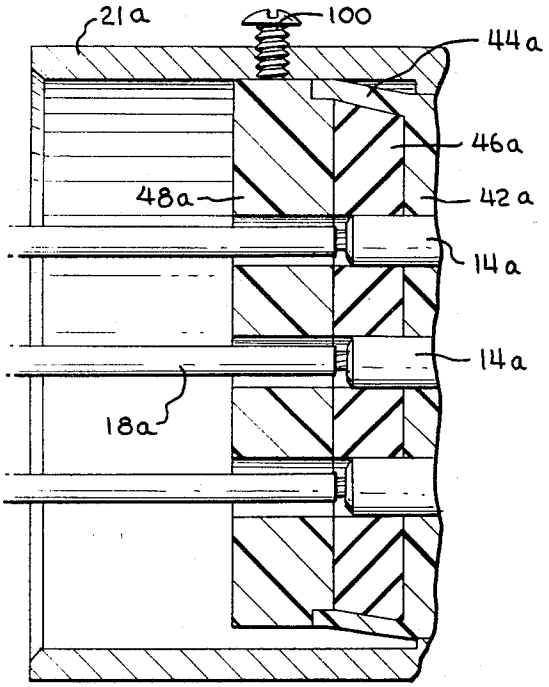


Fig. 11

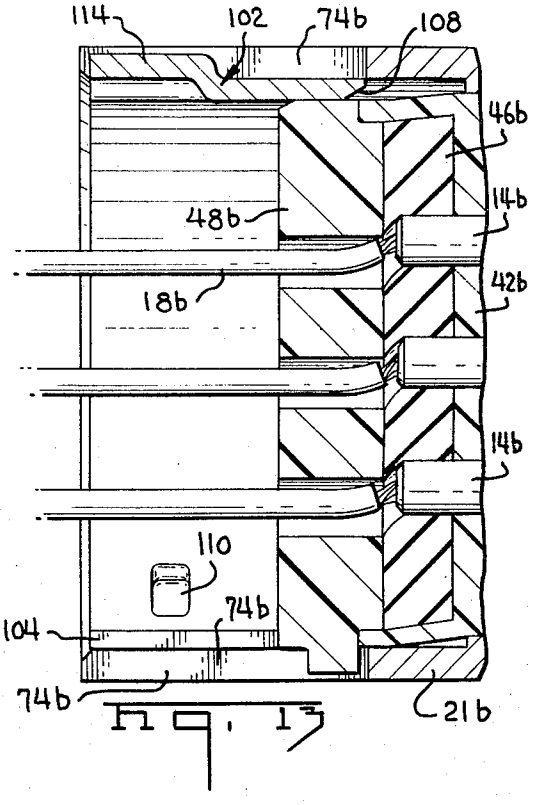


Fig. 13

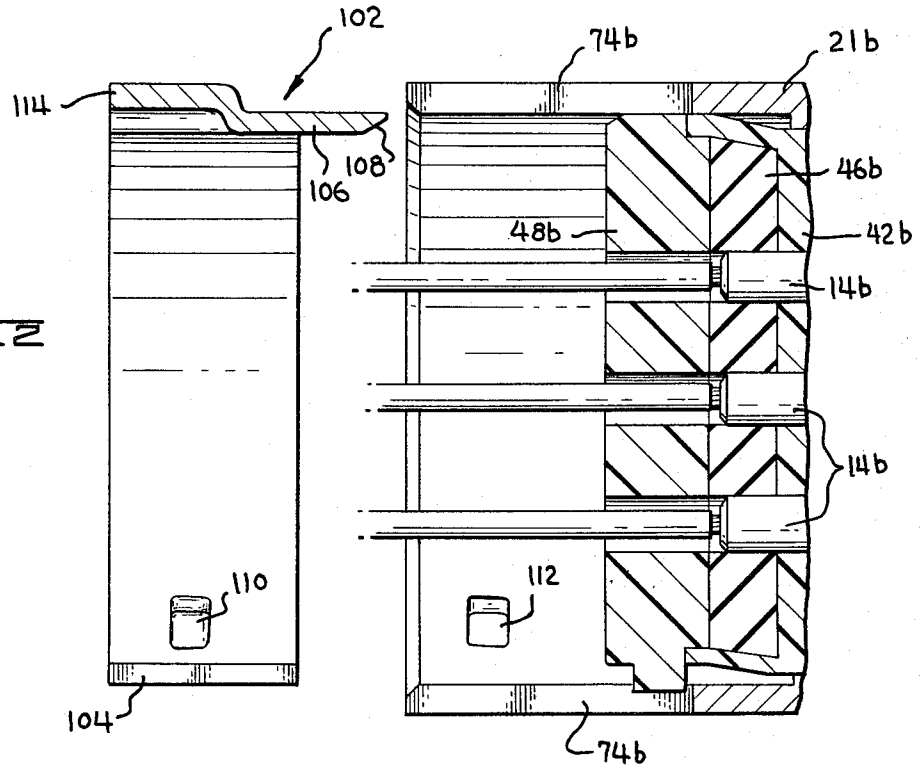


Fig. 12

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Fig. 14

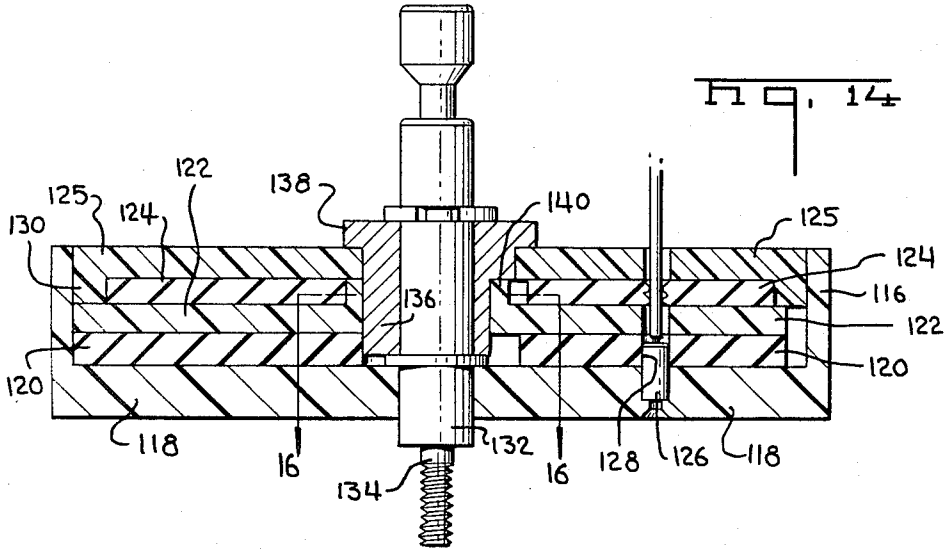


Fig. 15

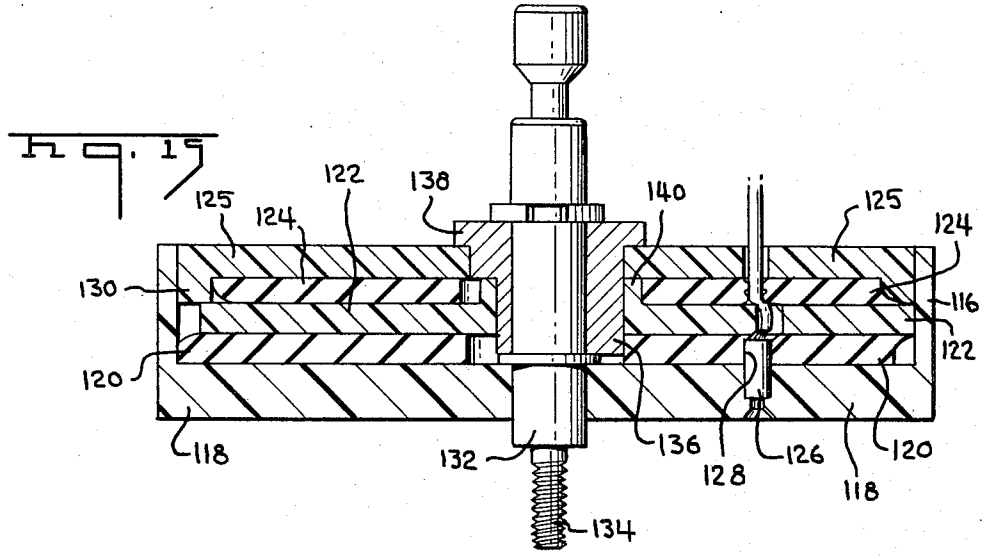
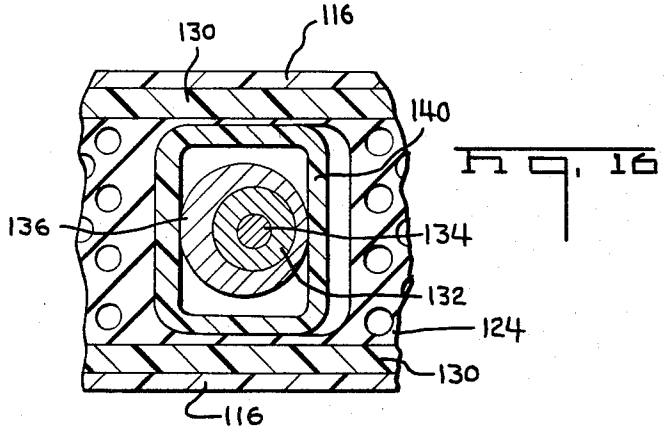


Fig. 16



United States Patent Office

3,404,364

Patented Oct. 1, 1968

3,404,364

ELECTRICAL CONNECTOR

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Continuation-in-part of application Ser. No. 439,817, Mar. 15, 1965. This application July 19, 1966, Ser. No. 567,331

11 Claims. (Cl. 339—61)

ABSTRACT OF THE DISCLOSURE

Multi-contact electrical connector comprises shell member and insert contained in shell. Insert has cavities extending therethrough which are adapted to receive contact terminals. Insert comprises a hard layer of material and a soft layer, these layers extending in planes disposed normally of the connector axis. Hard layer can be moved laterally by a short distance relative to the soft layer after insertion of the contact terminals thereby to render the cavities tortuous and prevent removal of the contact terminals.

Background of the invention

This application is a continuation-in-part of our abandoned application Ser. No. 439,817, filed Mar. 15, 1965, for Electrical Connector.

This invention relates to multi-contact electrical connectors of the type intended to effect disengageable electrical connections between a plurality of conductors.

Disengageable electrical connectors usually comprise a shell member, an insert within the shell, and a plurality of electrical contacts mounted in the insert. In high-quality connectors of this type, the contact terminals, which are quite often of the pin and socket type, are located relatively close to each other for the purpose of achieving the highest possible density of contacts in the connector and, therefore, the smallest possible over-all connector dimensions. It is also desirable in connectors of this type that the contact terminals be capable of being inserted into, or removed from, the insert individually in order to permit replacement of defective contacts and/or to facilitate assembly of the connector. The contacts also must be retained in the connector with an adequate amount of retention force so that they will not be accidentally removed or damaged during normal usage. It should also be mentioned that the individual contacts in the connector should be electrically isolated from each other by an adequate amount of insulating material to prevent flashover between adjacent contacts in the insert. The electrical isolation of each contact terminal in a connector is best achieved in connectors of the "sealed" type. The distinguishing characteristic of sealed connectors is that each contact terminal is separated from its neighbors in the connector insert by a continuous mass of insulating material rather than being merely separated by an air gap or by a discontinuous mass of insulating material.

The desiderata discussed above are antagonistic towards each other in the sense that the maximum achievement of some of the features discussed militates against the maximum achievement of other features. For example, the achievement of the highest possible density of the contacts in the connector is not compatible with many commonly used methods of achieving readily removable and insertable contacts in the connector. In many prior art connector designs, the contacts are retained in the insert by means of retention springs mounted on the contacts and the mere presence of such springs tends to increase the size of the cavity required for each contact thereby reducing the density or contacts which can be

achieved in a connector of a given size. The achievement of a high contact density in the connector is also incompatible with the provision of an adequate amount of insulating material between adjacent contacts since high density would be best achieved by having the contacts disposed very close together while the provision of adequate insulation would require that the contacts be spaced apart by a substantial amount.

It is an object of the present invention to provide an improved pin and socket type electrical connector. A further object is to provide a sealed connector having insertable contact terminals, a high density of terminals in the connector, and which can be made in a relatively small size. It is a further object to provide an improved method of retaining contact terminals in a connector insert. It is a further object to provide a retention system for contact terminals which does not require retention springs or other ancillary retaining devices on the terminals.

These and other objects of the invention are achieved in one embodiment thereof comprising a cylindrical shell member having an insert therein in which the contact terminals are mounted. The insert comprises a pair of discs bonded to each other at a common interface, one of these discs being proximate to the mating face of the connector and the other one of the discs being relatively remote from the mating face. The one insert, which is proximate to the mating face, is of a relatively soft elastically deformable material while the other insert is of a rigid and nondeformable material. A plurality of cavities extend through these insert discs and the contact terminals are mounted in the proximate insert with rearward ends adjacent to, but disposed forwardly of, the interface so that the wires extending from the terminals extend rearwardly past the interface and through the other insert. The hard insert, which is remote from the mating face, is laterally shiftable with respect to the connector axis and can be locked in its shifted position. Retention of the contacts in the proximate insert is thus achieved by shifting the remote insert laterally with respect to the connector axis and locking it in its shifted position. When this shifting of the remote insert is carried out, the portions of the proximate inserts, which are adjacent to the mating face are elastically deformed so that the cavities in this deformed zone extend obliquely with respect to the connector axis thereby preventing rearward movement of the contacts. The wires, being relatively flexible, assume the configuration of the cavities where they extend through the distorted zones of the proximate insert.

As will be shown hereinbelow, the retention system of the present invention permits the achievement of extremely close spacing of the contact terminals in the proximate insert without sacrifice of retention values of electrical isolation of the individual contact terminals from each other. It will also be shown below that the instant system can be achieved by a variety of shifting mechanisms and is applicable to connectors other than cylindrical connectors.

In the drawing:

FIGURE 1 is a sectional side view of an electrical connector assembly in accordance with the invention;

FIGURES 2 and 3 are views taken along the lines 2—2 and 3—3 of FIGURE 1;

FIGURE 4 is a fragmentary view taken along the lines 4—4 of FIGURE 3;

FIGURE 5 is a fragmentary sectional side view showing portions of the left-hand side of the connector of FIGURE 1 with the parts being shown in the positions they occupy when the contact terminals are inserted;

FIGURE 6 is a view similar to FIGURE 5 but showing intermediate positions of the parts;

FIGURES 7, 8, and 9 are fragmentary schematic views

illustrating the principle of the retention system of the invention;

FIGURE 10 is an exploded view showing the retention disc and the camming ring which form part of the retention system;

FIGURE 11 is a fragmentary cross-sectional view of the end portion of the connector incorporating an alternative embodiment of the invention;

FIGURE 12 is a view similar to FIGURE 11 showing a further embodiment;

FIGURE 13 is a view showing the connector of FIGURE 12 when the parts are in assembled relationship;

FIGURE 14 is a cross-sectional view of a rectangular connector incorporating a retention system in accordance with the invention;

FIGURE 15 is a view similar to FIGURE 14 but showing the portions of the parts when the contacts are retained in the connector; and

FIGURE 16 is a view taken along the lines **16—16** of FIGURE 15.

A preferred form of cylindrical electrical connector in accordance with the invention comprises a receptacle half **2** and a plug half **4**, these parts being shown in engagement with each other in FIGURE 1. The receptacle **2** has mounted therein a plurality of contact pins **6**, each of which has a reduced diameter cylindrical end portion **10**, a forwardly facing shoulder **12** intermediate its ends, a reduced diameter intermediate section **14'**, and a cylindrical wire barrel portion **16'** by means of which it is crimped onto a wire **18'**. The plug section **4** contains a plurality of socket contacts **8** adapted to receive the ends **10** of the contact pins. These socket contacts have intermediate reduced diameter sections **14** and wire barrel portions **16** which are crimped onto wires **18**. The precise manner in which these contact pins and sockets are mounted and retained in the connector is described more fully below.

The receptacle **2** comprises a cylindrical shell **20** having a radially extending flange **22** by means of which it can be mounted in a panel and a forwardly extending flange or hood **24** which extends over the mating face of the connector and fits telescopically onto the shell portion **21** of the plug half **4**. The two halves of the connector can be locked in coupled relationship by means of a coupling ring **26** which is rotatably mounted on a radially extending flange **28** of shell member **21**. This coupling ring is maintained on the shell by means of a locking ring **30** and a sinusoidal spring washer **32** interposed between ring **30** and flange **28**. The washer thus biases ring **26** leftwardly as viewed in FIGURE 1. Spiral grooves **34** extend inwardly on the inner surface of the ring **26** from the front end thereof and cooperate with pins **36** mounted on the hood portion **24** on shell **20**, the arrangement being such that the halves of the connector can be coupled by locating the pins **36** in the grooves **34** and rotating the coupling ring **26**.

Each part **2**, **4** of the connector is provided with an insert assembly comprising a plurality of discs. Since the insert assemblies of the two connector parts are similar in most respects, a description of one will suffice for both. Accordingly, only the insert assembly of the connector part **4** will be described in detail and the specific differences between the insert assemblies of the two parts will be pointed out.

The insert assembly of the connector half **4** comprises discs **38**, **42**, **46**, **48**, **52**, and **56**. The disc **38** is of a relatively firm epoxy resin and has a rearwardly extending peripheral flange **40** which overlaps the disc **42**. This disc **42** is advantageously of a relatively firm but slightly yieldable fluoro carbon elastomer such as Viton as marketed by E. I. du Pont. This disc should have a hardness of about 90 on the durometer. A scale but, as noted above, should be capable of undergoing some elastic deformation as will be explained below. The disc **42** also has a rearwardly extending peripheral flange **44** which surrounds the disc **46** and extends partially over the disc **48**.

The disc **46** is of a relatively soft and readily deformable material, for example, a suitable silicon rubber having a hardness of the durometer A scale in the range of about 45–55. For reasons which will be explained more fully below, this disc is not a right-circular cylinder but has an axis which extends obliquely of the connector axis.

Disc **48** is of a firm and substantially non-yieldable material such as a hard epoxy resin and is bonded at interface **72** to the disc **46** in a manner such that substantial relative movement of the disc **48** can take place with respect to the disc **46** without failure of the bond. A suitable adhesive for bonding these discs comprises a dipersion of 70% silicone polymer and 30% xylene. A catalyst comprising equal parts by weight of dibutyltin di-2-ethylhexoate and xylene is used with this bonding agent. When the parts are bonded, 4.5 parts by weight of the catalyst are mixed with 100 parts of the adhesive and the mixture is thoroughly stirred. A relatively thin film (about 15 mils) of this adhesive-catalyst mixture is applied to the surfaces and allowed to air dry for about one-half hour to permit the solvent to evaporate. The parts are thereafter pressed firmly together.

The disc **52** is again of a soft silicone rubber since it must undergo substantial deformation while the disc **56** is again of a hard material such as epoxy resin. Advantageously, the disc **52** fits into suitable recesses **50**, **54** on the adjacent sides of the discs **48**, **56** respectively.

The discs **38'–56'**, as noted previously, are of the same general form as the discs **38–56** although it will be noted that one of these discs **38'** is not as thick as its counterpart **38**, the reason for this difference being that the pins must project beyond the face of the connector. The insert assembly of the receptacle **2** of the portion **2** of the connector also differs of the insertion portion of the connector in that a soft interfacial sealing disc **58'** of silicone rubber or the like is bonded to the face of the disc **38'**. The purpose of this sealing disc is to seal the adjacent contacts of the connector from each other when two parts of the assembly are engaged with each other.

Advantageously, all of the adjacent discs of each connector half are bonded to each other at their interfaces with the silicone adhesive described above although the bond **72** between the discs **46** and **48** is of particular importance in the practice of the present invention. It is also desirable to bond the peripheral surfaces of discs **38**, **42**, **38'**, and **42'** to the interior surface of the shell member in order to enhance the pressure-tight integrity of the connector.

The several discs are provided with the cavities generally indicated at **60** for reception of contact terminals and the wires. These cavities are spaced together relatively closely with their axes forming equilateral triangles as is apparent from inspection of FIGURE 2. It will also be apparent from FIGURE 2 that the minimum wall thickness as indicated at **61** between adjacent cavities is substantially less than the diameters of the cavities themselves, a condition which will usually exist if maximum contact density is to be achieved.

The cavities **60** are not uniform throughout their lengths in the several discs but vary to some extent to conform to the shape of the contact terminals. Thus, the cavities in the disc **38** have rearwardly facing shoulders **64** which limit rightward movement of the contact sockets **8** upon insertion. The cavities in this disc **38** are also conical as shown in **66** adjacent to the mating face **67** of the connector in order to provide a guiding surface for the contact pins when the two parts of the connector are coupled. The cavity portions **68** in the disc **42** have a diameter substantially equal to the diameter of the wire barrel portion **16** of the contact terminals but have a restricted neck **69** at their forward ends through which the

reduced diameter portions 14 extend. The cavities in the disc 46, 48 are again substantially cylindrical and are of a diameter substantially equal to the maximum diameter of the contact terminals. The cavities in the disc 52 are advantageously provided with a pair of spaced-apart constrictions 62 that form a seal for the wires extending from the terminals.

At the time the inserts are assembled to the shell members, the disc member 48 will be in the relative position of FIGURE 5 in which its cavities are in alignment with the cavities of the other discs of the insert. Under these circumstances, the contact terminals can be inserted from the left in FIGURE 5 until the rearward ends of these terminals are disposed forwardly of the interface 72 of the discs 46, 48. Retention of the contacts is achieved by shifting the disc 48 downwardly from the position of FIGURE 5 to the position of FIGURE 1. Such shifting is achieved by means of a pair of ears 76, 78 that extend from opposite sides of the disc 48 and through slots 74 on opposite sides of the shell 21. These ears are engaged by a camming ring 80 that is rotatable mounted on the shell 21. The ring 80 is maintained in position by means of a locking ring 84 and is biased rightwardly in FIGURE 1 by means of a sinusoidal spring washer 86 interposed between the locking ring 84 and the camming ring.

Ring 80 is eccentrically counterbored on its right-hand side as viewed in FIGURE 1 to provide an eccentric camming surface 90 adjacent to its inner diameter 91 (see FIGURE 10). The ears 76, 78 have arcuate peripheral surfaces 92 conforming to the radius of this camming surface 90 so that upon rotation of the ring with respect to the ears, the disc 48 is moved laterally with respect to the connector axis. Disc 48 can be locked in either of its extreme positions of movement by means of bosses 96 on the rearward sides of the ears which cooperate with grooves 88 on the ring. Thus in FIGURE 3, the disc 48 is locked in the position shown by virtue of the fact that the bosses 96 are seated in the grooves 88 and the ring that is maintained in engagement with the ears of the disc 48 by the spring washer 86.

When a connector in accordance with the invention is assembled, the ring 80 is rotated to the position shown in FIGURES 3 and 5 thereby to bring the cavities of all of the individual discs in alignment with each other. The contact terminals are then inserted through the disc 56 until their forward ends move against the shoulders 64 of the cavities at which time their rearward ends will be disposed slightly forwardly of the interface 72. The camming ring 80 is then pushed leftwardly against the biasing force of spring 86 to unseat the bosses 96 from the grooves 88 and is thereafter rotated through 180 degrees. Such rotation of the camming ring causes a downward displacement (as viewed in the drawing) of the disc 48. The portions 97 of the disc 46 which are immediately adjacent to the disc 48 are pulled downwardly by virtue of the bonded interface 72 with the result that the cavities assume a tortuous configuration as viewed in cross section. The downward movement of the disc 48 has the effect of stressing the zone 97 (which lies between interface 72 and the plane defined by the rearward ends of the cavities) of disc 46 in shear and the bond at interface 72 should, therefore, be of sufficient strength to withstand the stresses imposed.

FIGURES 7–9 schematically illustrate the manner in which the individual cavities are rendered tortuous upon downward movement of the disc 48. In FIGURE 7, the cavity in the disc 48 is in alignment with the cavity in the disc 46 and the centerlines A—A and B—B coincide with each other. FIGURES 8 and 9 show the progressive downward movement of the cavity portion in the disc 48 and the progressive lowering of the centerline B—B.

When the rings 80, 80' are in the positions shown in FIGURE 1, the contact terminals are retained in the insert assemblies by virtue of the tortuosity of the cavities between the rearward ends of the terminals and the ends of the insert assemblies. The contacts, being rigid, are unable to move through the carved sections of the cavities in the vicinity of the interface 72. The wires, being relatively limber, adapt themselves to the discontinuities of the cavities when the discs are shifted. In the disclosed embodiment, the wires are slightly bent or curved as a result of the shifting of the disc 48. This condition will not always be present; if the wires are of a relatively small diameter with respect to the diameter of the contacts or the cavities, the wires may extend straight and axially from the contacts although the cavities will be shown somewhat tortuous as in FIGURE 1. The contacts are retained in the cavities under these circumstances by virtue of the fact that they cannot pass through the portions of the cavities in the displaced or shifted disc 48. The disc 52, like the disc 46, should be of a relatively deformable material and should be firmly bonded to the disc 48 since it must undergo some elastic deformation when disc 48 is shifted from the position of FIGURE 5 to the position of FIGURE 1.

The discs 38 and 42 perform an important function in maintaining the individual contact terminals in their proper and intended positions when the discs 46 and 48 are in the positions of FIGURE 1. This function of discs 38 and 42 can be appreciated if it is recognized that each socket contact 8 must be in substantial axial alignment with its corresponding pin contact 6 when the two parts 2, 4 of the connector are coupled. Thus, if one or more of the contacts 6, 8 in either part of the connector is improperly oriented with its axis extending slightly obliquely of the connector axis, the contacts will not mate and it will be impossible to couple the two connector parts. The disc 46, when it is stressed in shear as shown in FIGURE 1, imposes a downwardly directed force on the individual contacts which would ordinarily tend to cock them slightly so that their axes would not be parallel to the connector axis but would extend obliquely thereof. The discs 38, 42 counteract this downward force composed by the disc 46 and hold the contacts in their proper positions. The discs 38', 42', of course, perform the same function for the pin contacts 6.

The diameters of the cavities in the discs 38, 42 should conform relatively closely to the diameters of the contacts in order to maintain the contacts in their proper attitudes notwithstanding the downwardly directed forces imposed on the contacts by disc 46. Manufacturing tolerances and adequate clearance to permit insertion of the contacts must be taken into account, but these clearances and tolerances are quite small in connectors of the better grades.

It should also be mentioned that the contacts should be retained in the cavities by discs 38 and 42 prior to shifting of the disc 48. In other words, the discs 38, 42 should be such that they exert a slight constrictive force on the contacts in order to hold them in position during assembly and before the disc 48 is shifted to the position of FIGURE 1. This temporary retention of the contacts can be achieved by making the cavities of a diameter substantially equal to the diameter of the contacts.

Insofar as the alignment maintenance feature discussed above is concerned, the discs 38, 42, and 38', 42' could be consolidated as a single disc of firm insulating material such as an epoxy resin. The discs 42 and 42' are provided as separate pieces of firm but slightly deformable material in the specific embodiment shown because of the fact that the flanges 44, 44' of these discs must undergo some elastic deformation when disc 48 is shifted from the position of FIGURE 5 to the position of FIGURE 1. These flanges 44, 44' are provided in order to seal the periphery of the insert assembly in the vicinity of the discs 46, 48 and 46', 48' and particularly to protect the interfacial seals 72, 72'.

The discs 46, 46' are generally trapezoidal axial cross

section (i.e. as viewed in FIGURE 1) and are cylindrical, like the other discs, although the planes defining the ends of discs **46**, **46'** extend obliquely of the connector axis rather than normally thereof. This shape of the discs **46**, **46'** permits the achievement of a minimum overall diameter of the connector in that the total clearance required between the interior surfaces of the shell members and the surfaces of the flanges **44**, **44'** is equal only to the amount by which the discs **48**, **48'** are moved during rotation of the camming ring. This feature of the disclosed embodiment will be apparent from an inspection of FIGURES 1 and 5 from which it will be seen that there is no clearance between the flanges **44**, **44'** on the lower side of the disc **46** in FIGURE 1 and there is similarly no clearance on the upper side in FIGURE 5. If the discs **48**, **48'** had ends extending in planes at right angles to the axes of the discs, the amount of clearance required would be considerably greater than that shown.

The invention permits the achievement of a connector having a high contact density without sacrifice of voltage breakdown strength or other electrical or mechanical values. As is apparent from FIGURES 2 and 3, the individual cavities in the connector shown are relatively close together with the minimum wall thickness between adjacent cavities as indicated at **61** being substantially less than the diameter of the individual cavities. The amount of displacement of the disc **48** (when it is moved from the position of FIGURE 5 to the position of FIGURE 1) may be substantial as compared to the minimum wall thickness between adjacent cavities. In one typical connector, for example, the spacing between adjacent cavities on triangular centers is 0.085" and the diameters of the cavities are 0.060" so that the minimum wall thickness between adjacent cavities is 0.025". In this particular connector, the disc **48** is shifted by the amount in the range of about 0.020" to 0.025", the actual amount of shifting being dependent upon variations due to manufacturing tolerances in the parts. It can thus be seen that there could be an overlap of one cavity in disc **46** and an adjacent cavity in disc **48**. The individual contacts are, however, physically isolated from each other after displacement of disc **48** by virtue of the bonded interface **72** and the deformation in the zone **97** of disc **46**. The disclosed embodiment of the invention is thus a "sealed" connector in the technical sense of the term.

An important characteristic of an electrical connector is the "creepage path" between adjacent contacts. This path can be defined as the distance between adjacent contacts through air. For example, the creepage path between the upper contact and the middle contact in FIGURE 1 extends from the rearward end of the upper contact through the upper cavity to the rearward face of the disc **56**, thence across the rearward face of the disc **56** to the center cavity thence inwardly to the rearward end of the center contact **16**. Aside from the seal obtained at **62**, there is no insulating material separating the two contacts along the creepage path. As is apparent from FIGURE 1, this creepage path can be made quite long in a connector in accordance with the invention and the position of disc **48** does not affect this creepage point. In other words, this creepage path is the same when the disc is in the position of FIGURE 1 as it is when the disc is in the position of FIGURE 5.

In the foregoing description, it is assumed that the disc **46** is in an unstressed condition when the parts are as in FIGURE 5 and is in a shear stressed condition when the parts are as in FIGURE 1. It should be mentioned that these two discs can be bonded in a manner such that disc **46** would be unstressed in FIGURE 1 and stressed (i.e., elastically deformed) in FIGURE 5.

Alternative arrangements can be provided for shifting the disc **48** from the position of FIGURE 5 to the position of FIGURE 1 to achieve retention of the contacts as described above. FIGURE 7 shows one alternative embodiment in which the camming ring is eliminated in a simple screw arrangement is provided to shift the disc **48***a* (the parts in FIGURE 11 being identified by the same reference numerals as the parts of the previously described embodiment but differentiated by the post script *a*). A screw **100** is threaded through a shell **21***a* and bears against the disc **48***a* so that tightening of this screw has the effect of moving the disc **48***a* downwardly to achieve retention. In this embodiment and in the embodiment of FIGURES 12 and 13, the discs **52** and **56** have been eliminated although it will be understood that these discs can also be provided in these embodiments.

In the embodiment of FIGURE 12, a wedge member in the form of a resilient split ring or bushing **102** is utilized to shift the disc **48***b* downwardly from the position of FIGURE 12 to the position of FIGURE 13. The bushing **102** has an axial extending gap and is of cylindrical shape so that it will fit within the shell **21***b*. An ear **106** extends from this bushing and has a bevelled leading edge **108** adapted to move against a corresponding bevel on the disc **106**. Bosses **110** are provided on the bushing which enter correspondingly shaped openings **112** in the shell to lock the bushing in the shell and an additional boss **114** is provided which is adapted to enter the slot **74***b* of the shell thereby to properly orient the bushing when it is assembled to the shell member.

FIGURES 14–16 show an embodiment of a rectangular connector in accordance with the invention in which the shifting means for one of the insert members is mounted on a conventional jack screw. This connector comprises a rectangular shell member **116** and a plurality of plate like insert members **118**, **120**, **122**, **124**, and **125**. Advantageously, the insert member **118** is relatively hard, the members **120** and **124** are of a soft silicone rubber or the like and the insert member **122** is of a firm epoxy of a composition similar to that of the disc member **48**. The insert member **125** is, again, of a preferably firm material. A plurality of cavities **128** (of which only one is shown) extend through the insert assembly for the reception of contact sockets **126**, the thickness of the insert members being such that the rearward ends of the sockets **126** are disposed adjacent to the interface between the insert members **120**, **122**. A jack screw **134** extends centrally through the connector and has a bushing **132** mounted thereon. A camming member **136** is rotatably mounted on this bushing and has a hexagonal flange **136** on its external surface portions so that it can be rotated about the bushing **132** by a suitable wrench. The contact terminals are inserted into the cavities when the parts are in the position of FIGURE 14 and the cam **136** is then rotated from the position of FIGURE 14 to the position of FIGURE 15 to cause leftward movement of the insert member **122** as indicated. The cavities are thus rendered tortuous at the interface between the insert members **120**, **122** and the contacts are retained in the cavities. Various interfaces and particularly the interface between the insert members **120**, **122**, should be bonded to each other as previously described with reference to the embodiment of FIGURE 1. It is desirable to provide a flange **140** on the insert member **122** to increase the bearing area which engages the cam **136**. The insert member **125** can be provided with a flange **130** to contain the insert member **124**.

In all of the disclosed embodiments of the invention, the wires extend through the disc **48** and the contacts are retained by virtue of the fact that they cannot pass through the cavities after these cavities are rendered tortuous by shifting of the disc **48**. As an alternative, the shiftable disc can be located such that the reduced portions **14** of the contacts extend through the disc **48**. With the arrangement of this type, the contacts would again be inserted into the shiftable disc when in its normal position and shifting of the disc would provide retention of the contacts in that the frontal portions of the contacts would not be able to move rearwardly past the shifted disc. The previously discussed advantage of close center-

to-center spacing in a sealed connector are achieved in this alternative embodiment.

What is claimed is:

1. An electrical connector adapted to receive contact terminals in a direction of an axis thereof, said connector comprising a shell member and insert means in said shell, said insert means comprising a firm non-yieldable section of insulating material having yieldable material integral therewith on at least one side thereof, means for restraining said yieldable material against substantial lateral movement, a plurality of contact receiving cavities extending through said insert means, and means for shifting said non-yieldable section of said insert means laterally with respect to said axis of said connector and an axis extending through said cavities with concomitant deformation of said yieldable material after insertion of contacts into said cavities thereby to render said cavities tortuous and prevent removal of said contacts.

2. An electrical connector as set forth in claim 1 wherein said yieldable material comprises a yieldable section of said insert means bonded to said non-yieldable section.

3. An electrical connector as set forth in claim 1 wherein said yieldable material is provided on each side of said non-yieldable section.

4. An electrical connector as set forth in claim 1 wherein said connector is cylindrical, said non-yieldable section comprising a non-yieldable disc.

5. An electrical connector as set forth in claim 1 wherein said connector is rectangular.

6. A multi-contact electrical connector comprising a shell member and insert means in said shell, said insert means comprising a pair of inserts bonded to each other at a common interface, one of said inserts being of a relatively soft, elastically deformable material and the other insert being of a relatively hard rigid material, a plurality of registered cavities extending through said insert means for reception of contact terminals, means for laterally displacing said inserts relative to each other thereby to render said cavities tortuous in longitudinal cross section and to prevent removal of contacts disposed in said cavities.

7. An electrical connector adapted to receive contact terminals in a direction of an axis thereof, said connector comprising a shell member and insert means in said shell, said insert means having a plurality of cavities extending therethrough, said cavities being symmetrical about their longitudinal axes and being located on closely spaced centers, said cavities being adapted to receive said contact terminals and portions of conductors secured to said contact terminals whereby, the effective creepage path between adjacent contact terminals in said insert means extends from the rearward end of one of said terminals to the rearward end of said insert means thence to an adjacent cavity and forwardly in said adjacent cavity to the rearward end of an adjacent terminal, said insert means comprising a relatively firm non-yieldable portion and a relatively yieldable portion integral with said non-yieldable portion, said yieldable and non-yieldable portions extending through out a transversely extending plane of said connector, and means for moving said non-yieldable portion laterally with respect to said axis of said connector whereby said cavities are rendered tortuous and said terminals are retained in said insert means without substantial change in the length of said creepage path.

8. A multi-contact electrical connector adapted to receive contact terminals in a direction of an axis thereof, said connector comprising a shell member and insert means in said shell member, said insert means comprising first and second insert members bonded together at a common interface, said first insert member being relatively remote from the mating face of said connector and said second insert member being relatively proximate to said mating face, said first insert member being of a firm non-deformable material and said second insert member being of a relatively soft elastically deformable material, a plurality of registered cavities in said insert members, said cavities in said second insert member being adapted to receive said contact terminals, said cavities in said first insert member being adapted to reecive conductors extending from said terminals, means for moving said first insert member laterally with respect to said axis of said connector by an amount sufficient to prevent rearward movement of said contact terminals through said first insert member, said second insert member being deformable in a zone lying between said interface and the rearward ends of said contact terminals whereby, said terminals are isolated from each other after lateral movement of said first insert member.

9. A device as set forth in claim 8 wherein said shell member is cylindrical, said first insert member having ear means extending through said shell, said means for moving said first insert member laterally comprising camming means rotatably mounted on said shell and engageable with said ear means.

10. A device as set forth in claim 8 including a third insert member disposed adjacent to said second insert member and between said second insert member and said mating face, said third insert member being of a firm material and being capable of maintaining said contact terminals against lateral movement in said cavities.

11. A multi-contact cylindrical connector adapted to receive contact terminals in a direction of an axis thereof, said connector comprising a shell member and insert means in said shell, said insert means comprising two insert discs, one of said discs being proximate to the mating face of said connector and the other of said discs being remote from said mating face, said discs being bonded to each other at their common interface, said one disc being of a relatively soft elastically deformable material and said other disc being of a relatively firm non-yieldable material, a plurality of cavities extending through said discs, a pair of ears on diametrically opposite sides of said other disc, said ears extending through openings in said shell, and a camming ring on said shell, said camming ring having an eccentric camming surface in engagement with said ears whereby, upon rotation of said camming ring, said other disc is displaced laterally with respect to said axis of said connector thereby to dislocate the portions of said cavities in said other disc with respect to said one disc and with concomitant lateral dislocation of said one disc in a zone adjacent to said interface whereby, the portions of said cavities in said zone assume an oblique attitude relative to said axis of said connector, and contacts contained in the cavities of said one disc are prevented from moving rearwardly in said connector.

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