United States Patent [19]

Moulin

[11] **3,725,845**

[45] **Apr. 3, 1973**

[54] **ENVIRONMENT PROOF CONNECTOR**

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[73] Assignee: **Hughes Aircraft Company,** Culver City, Calif.

[22] Filed: **Mar. 30, 1971**

[21] Appl. No.: **129,410**

[52] **U.S. Cl.**.....**339/49 R,** 339/89 M, 339/184 M

[51] **Int. Cl.**.....**H01r 13/64,** H01r 25/10

[58] **Field of Search**.....339/47–49, 75, 339/89 R, 89 M, 94 R, 94 M, 103 R, 103 M, 176 M, 184 R, 184 M, 186 R, 186 M, 184, 186

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Assistant Examiner—Terrell P. Lewis
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[57] **ABSTRACT**

A multicontact connector intended primarily for geophysical surveying work is made totally hermaphroditic so that the entire connector can function either as a male or as a female member whereby the connector can be connected to its identical counterpart. Also disclosed is a connector insert from which hollow posts extend to individually enclose half of the contacts anchored in the insert, the posts being distributed in a pattern such that, when two such inserts are face to face and properly indexed, their respective arrays of posts clear one another.

3 Claims, 10 Drawing Figures

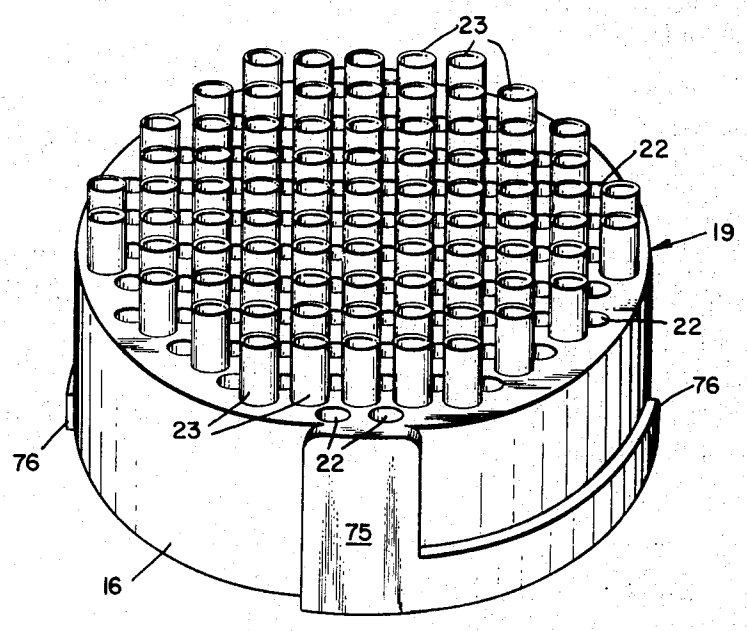


Fig. 1.

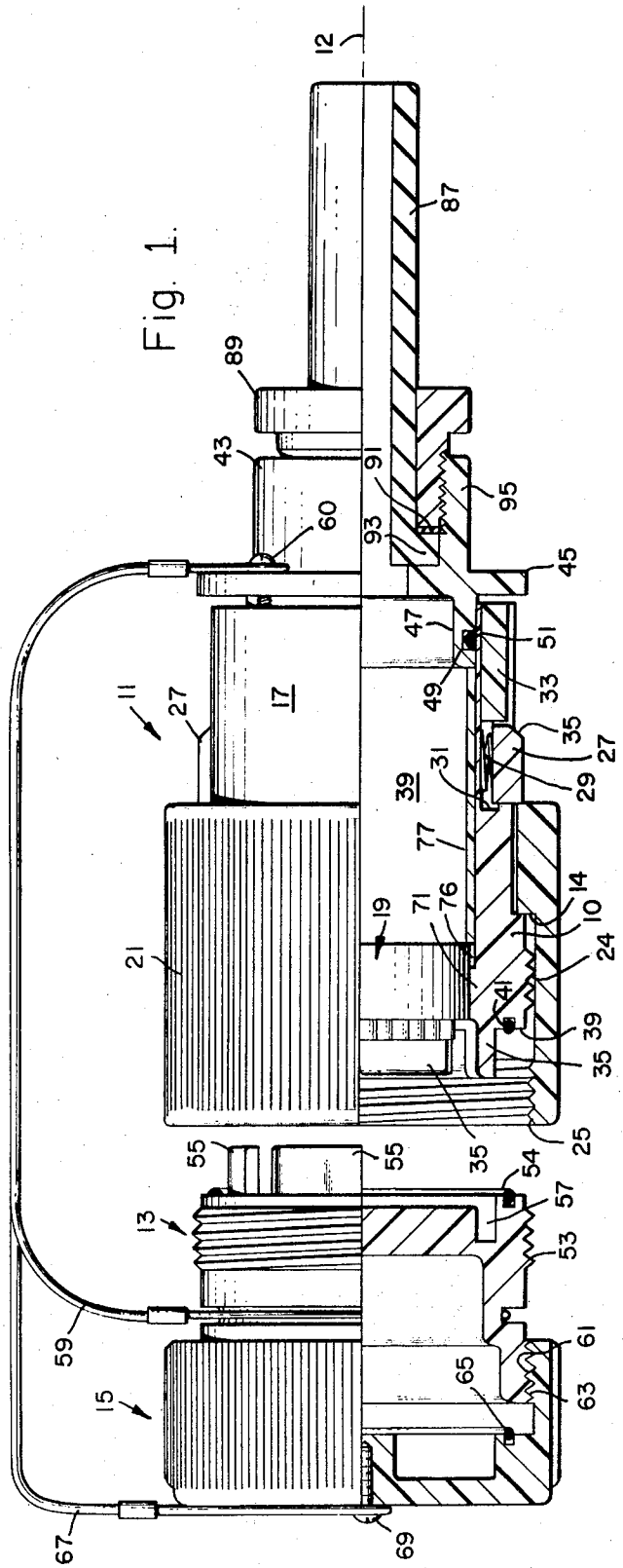
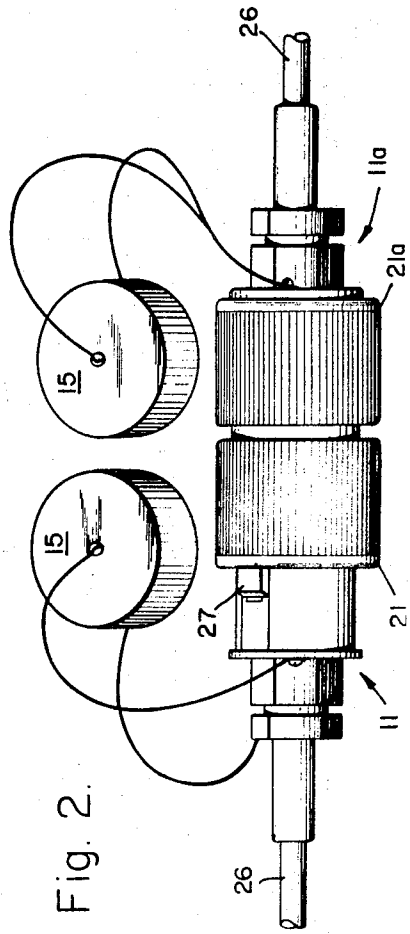


Fig. 2.



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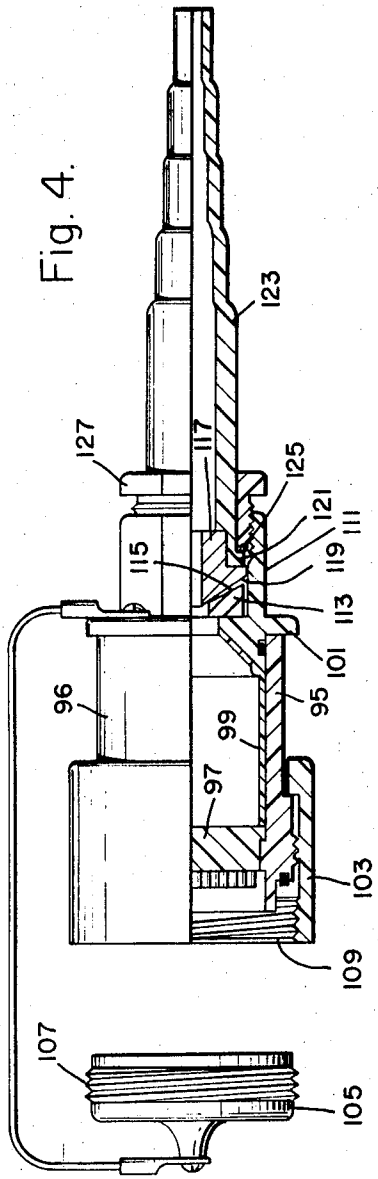
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Fig. 4.

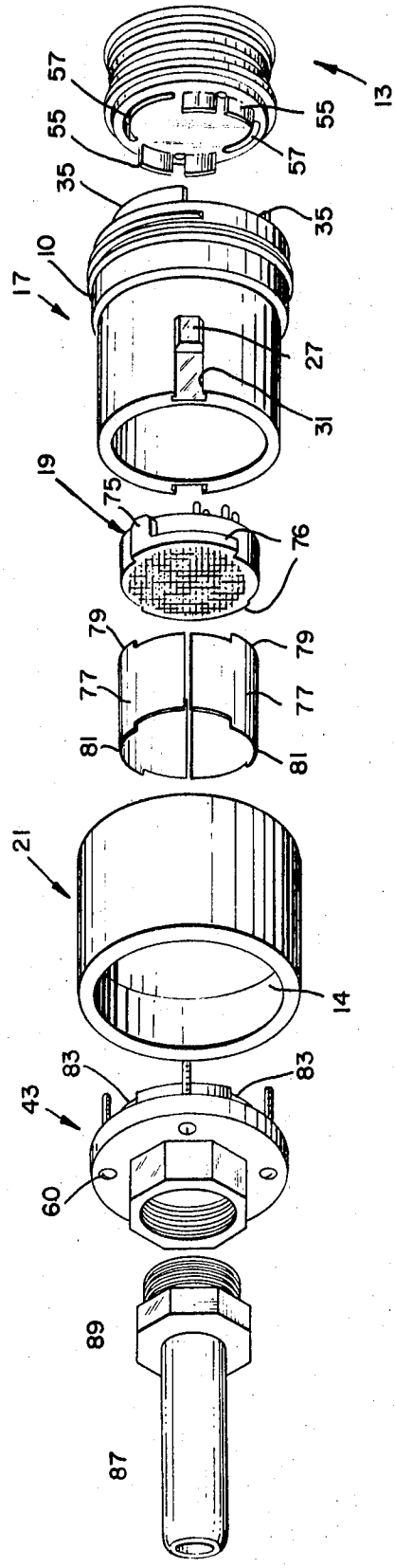
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Fig. 3.

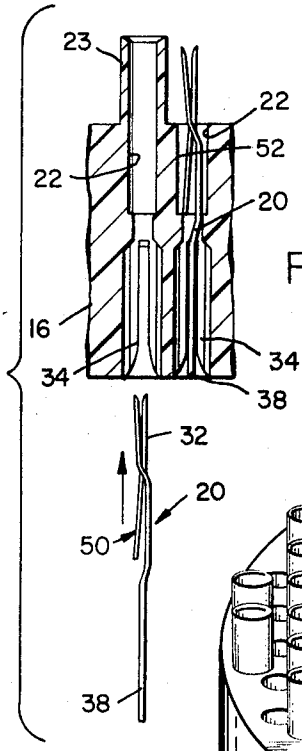


Fig. 7.

Fig. 8.

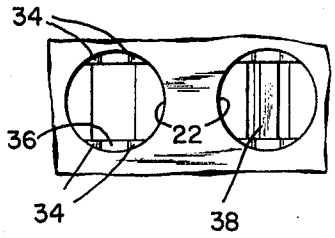


Fig. 5.

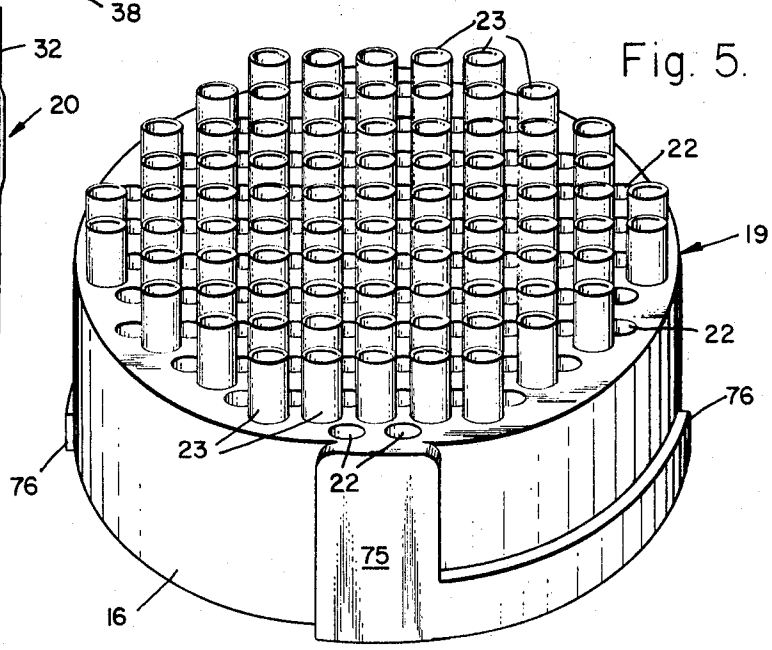
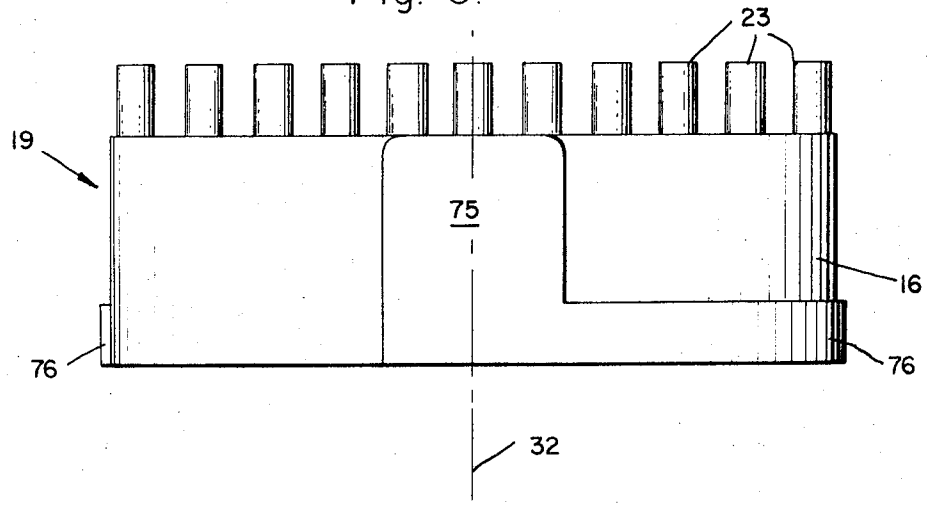


Fig. 6.



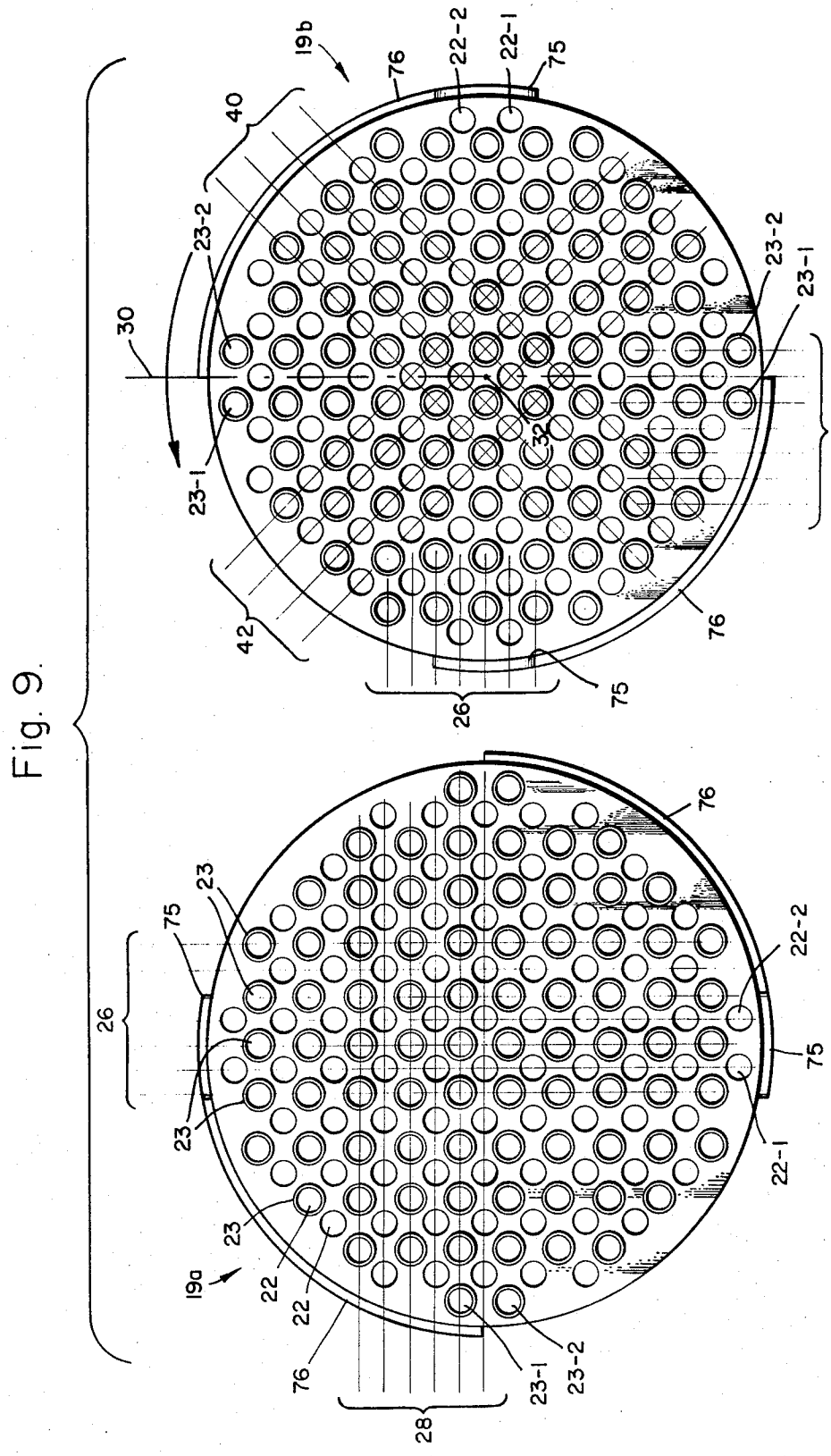


Fig. 9.

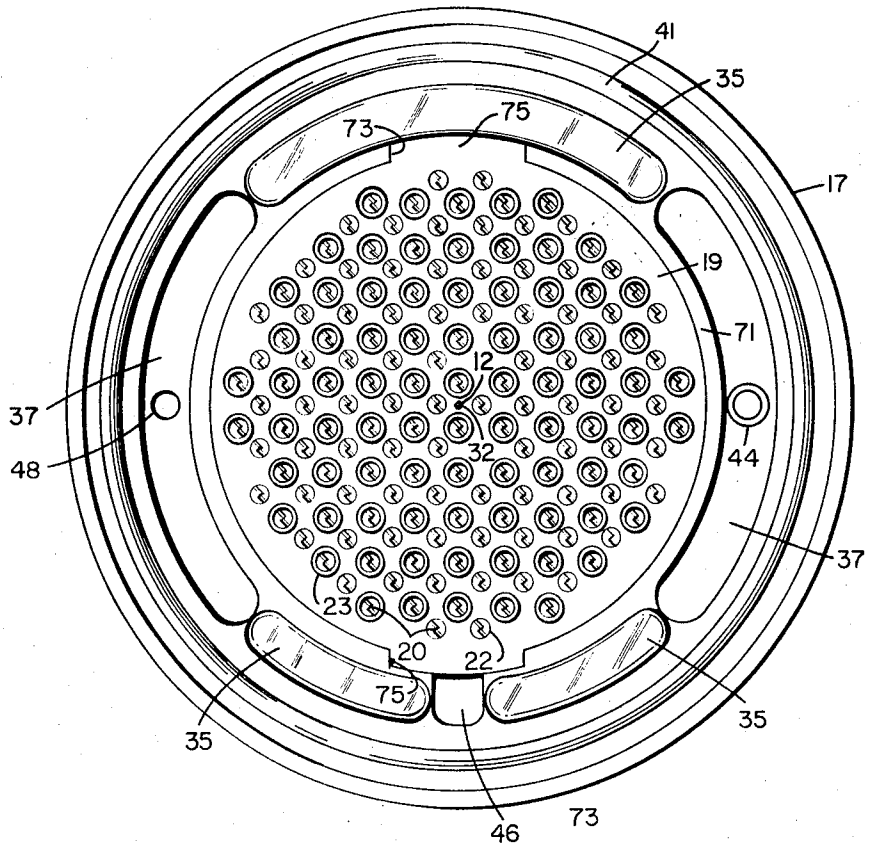


Fig. 10.

ENVIRONMENT PROOF CONNECTOR

In geophysical mapping of terrain, frequently for oil, geophones are distributed over the terrain in a pattern, each of them being connected through an individual cable to a central multiconductor cable which may be a mile long and which leads to an instrument truck. Terrain characteristics are determinted by detonating an explosive charge and recording in the truck electrical signals produced by the geophones in response to earth vibrations induced by the explosive.

Due to the extremely difficult terrain, which may be either a marsh subject to inundation or a parched desert, the long central cable cannot usually be laid by mechanical means such as a cable laying truck. Instead, it must be placed in short sections by a team of laborers. Typically each laborer is given a load of 100 pounds, which will include a secton of cable terminating in connectors at its opposite ends. In laying the cable, the first man in the team will take his 100 pound load of cable and connectors off the truck and will string it from the truck in the direction to be surveyed. The next man will take his section of cable, connect it at one of its ends to the end of the just laid first cable section and will then lay the remainder of the second cable section in the same direction as the first cable section. Successive cable sections are similarly connected to the free end of the previously laid cable section until the necessary length of cable has been laid.

Usually locally available laborers are recruited for laying the cable and these laborers will in most instances be totally unskilled and unfamiliar with electrical connectors and with the method of their assembly. For example, they may not know the difference between a male and a female connector and if they do know the difference, they will be prone to lay two cable sections end to end so that connectors of the same sex, both male or both female, end up next to one another. Therefore, it has been found desirable to eliminate this possible source of error by making the connectors at both ends of the cable sections identical so that it does not matter which end of the cable section is grabbed hold of when an attempt is made to connect it to the previously laid cable secton. Another desirable feature for geophysical connectors is to make them capable of engaging an identical counterpart in either of two positions so as to reverse the circuit connections made through them. Thus having connected the system and made one reading, any one of its pairs of engaged connectors may be reengaged in their second mode of engagement, a second charge exploded, and a second set of readings taken, the two sets of readings having the effect of canceling errors.

After the first explosive charge, or pair of charges, has been detonated and readings recorded, the geophones will be repositioned in a second pattern further along the direction in which mapping is to be carried out. Consequently, additional sections of cable must be carried from the truck and successively connected to the previously laid sections of cable until it has been sufficiently extended to reach the newly positioned geophones. Since the exploration will typically progress in a long substantially straight pattern, there will come a point where the cable cannot be extended any further by adding additional sections. At this point the truck is driven ahead and a portion of the initially

laid sections of the cable are disconnected, picked up and carried downstream from the last laid cable sections where they are connected thereto so as to further extend the cable in the direction in which the surveying operation is to progress. Thus, it may be seen that in the process of geophysical exploration, cable sections have to be connected and disconnected several times each day. Due to the large amount of handling to which the connectors are subject, they are susceptable to damage. This is aggravated by the fact that cable sections may be left in the field, as well as on the truck, unconnected to other cable sections for extended periods of time so that, unless means are provided to protect their contacts, they are subject to corrosion, abrasion and other damage.

One approach which has been used to make the cable sections reversible has been to use a pair of connectors at each of its ends, one of them being male and the other female. This clearly accomplishes the intended purpose but at the expense of requiring four connectors for each cable section.

Another approach has been to use identical connectors at opposite ends of the cable section, each connector having its contacts divided into two groups and containing equal numbers of male and female contacts. This approach is believed to have two disadvantages. Firstly, while the female contacts are fully recessed in the connector and are therefore relatively well protected, the male contacts are exposed pins which are, at best, protected only by a single wall which surrounds them. Thus, they are protected only collectively rather than individually and may therefore be damaged, particularly bent, by a hard object being carelessly pulled across them. Another disadvantage of the last type of connector is that, because they are identical, no way has been found to so engage them to one another as to seal out the elements without the provision of some external means such as short length of hose pulled over a pair of such connectors after they have been engaged. Yet another disadvantage inherent in the type of connector just described is that there is only one position in which they are capable of engaging one another. In other words, all of the male connectors in one such connector must be aligned with all of the female connectors in the other such connector. As mentioned previously, there is a demand for a connector which can be engaged with its identical counterpart in either one of two positions so as to permit connections to be reversed thus allowing certain errors which might have been made during one reading to be cancelled during the next reading.

Accordingly, it is a principal object of the present invention to provide a truly hermaphroditic connector which can be securely engaged with its identical counterpart, preferably in either one of two positions without any external fastening devices.

It is a related object of the invention to provide an insert which will support and protect all of a set of contacts in such a manner that they will all engage an identically supported array of contacts in another such insert.

Yet another object of the invention is to provide an improved cover for protecting such a connector from damage when it is not engaged to another connector, and further to protect the cover itself from damage when it is not being used.

A further object of the invention is to provide a connector which, when connected to its identical counterpart, is watertight, so that all of their contacts are protected from moisture, even when they are immersed in water to a depth of the order of 100 feet.

In accordance with the invention the above and other objects are attained by an electrical connector which is operatively and securely engageable to its identical counterpart by virtue of a connector shell having a first coupling means integral therewith and a second coupling means secured to the connector shell and movable thereon between a first position and a second position so that the second coupling means of either of a pair of such connectors in its first position is operative to engage the first coupling means of the other of such connectors whose second coupling means is in its first position. More specifically, the first coupling means on the connector shell may be a series of threads formed thereon while the second coupling means may be a coupling ring having a matching set of internally running threads formed thereon. Each coupling ring is movable upon its connector shell between a forward position, in which the coupling ring is operative and a retracted position in which the coupling ring is inoperative and the external threads on the connector shell are exposed and operative. Given a pair of such connectors, they may be secured to one another by placing the coupling ring on one of them in its forward position and the coupling ring on the other connector in its retracted position, whereupon the two connectors are secured to one another by threadably engaging the forwardly located coupling ring with the exposed external threads of the connector whose coupling ring is in its retracted position.

In accordance with another feature of the invention there is provided an insert for anchoring and protecting substantially all of an array of electrical contacts. The insert basically includes a block defining a plurality of openings arranged in an ordered array of columns and rows for anchoring a corresponding plurality of contacts and a set of hollow posts extending from alternate rows of those openings, each post serving to protect a contact mounted in and extending from a respective one of the openings in those alternate rows while respective pairs of rows of posts serve to protect the contacts mounted in and extending from the row of openings between them.

In further keeping with this aspect of the invention, the openings and their associated posts are so arranged that when a pair of such inserts are placed face to face and turned substantially 90° relative to one another, the posts on one of the inserts fit between the posts on the other.

In further keeping with the invention, a dust cover and a protective cap therefor are provided to prevent contamination of the connector contacts when the connector is not connected to another connector. Specifically, the dust cover of the present invention is cylindrical and threaded at one end to be threadable into the coupling ring of the connector when the coupling ring is in its extended position. Additionally, the dust cover is also threaded at its opposite end on which it normally carries a cap threaded thereon. The dust cover and the cap are both attached to the connector by a chain or similar means to prevent their loss. When the connector is to be engaged to another connector, the dust cover is unscrewed and disengaged therefrom and the dust cover cap is switched from the back end of the dust cover where it normally resides to its front end, to protect the threads which have just been engaged with the coupling ring from contamination. Thus, the next time the connector is disengaged and needs to be sealed, the dust cover cap is removed from the front end of the dust cover to its back end and the front end of the dust cover may again be screwed into the coupling ring.

Yet another advantageous optional feature of the present invention is the provision of latching means to facilitate the disengagement of one connector from another. In accordance with this feature of the invention, the latching means is operative selectively to lock the coupling ring in its forward position so that when the coupling ring is being turned to disengage the connector of which it is a part from another connector, the coupling ring will exert an axial force tending to separate the two connectors.

The invention will be described in greater detail with reference to the drawings in which

FIG. 1 is a cross section through a connector incorporating features of the invention and through its associated dust cap and dust cap cover.

FIG. 2 illustrates a pair of connectors of the type shown in FIG. 1 engaged to one another, with the coupling ring of one of them in its retracted position and the coupling ring of the other connector in its forward, or operative, position.

FIG. 3 is an exploded perspective view of the connector illustrated in FIG. 1.

FIG. 4 is a partially cutaway side view of an alternative embodiment of the connector shown in FIG. 1.

FIG. 5 is a perspective view of an insert suitable for use in the connectors of FIG. 1 and FIG. 4 and having a plurality of hollow posts which rise around half of the contacts anchored in the insert in such a manner as to protect substantially all of them.

FIG. 6 is a side view of the insert illustrated in FIG. 5.

FIG. 7 is a partial cross section along lines 7—7 of FIG. 5, illustrating the manner in which individual contacts are anchored in the insert.

FIG. 8 is an enlarged bottom view of a portion of the insert shown in FIG. 5, illustrating the configuration of the openings in which its contacts are anchored.

FIG. 9 is a top view of a pair of inserts of the type shown in FIG. 5, placed side by side but oriented 90° relative to one another, to illustrate the manner in which their hollow posts clear one another when the inserts are placed face to face.

FIG. 10 is an end view of the connector shown in FIG. 1 to illustrate the arcuate tangs which extend from the end of the connector shell around the insert and its contacts so as to provide, in combination with the corresponding tangs of another connector, a complete protective wall around the contacts when the connectors are engaged to one another.

Referring now to the figures, particularly to FIGS. 1, 2 and 3, an exemplary connector 11 is illustrated in FIG. 1, together with a dust cover 13 and dust cover cap 15 attached thereto. Referring first to the connector 11, it is principally comprised of a cylindrical connector shell 17 having external threads 24 at its forward end, an array of contacts 20 (see FIG. 7) mounted in an

insert 19 at the forward end of the shell 17 and a coupling ring 21 having internal threads 25 at its forward end and mounted upon the connector shell 17 to be axially movable between an extended position, shown in FIG. 1, and a retracted position. In keeping with a principal feature of the invention, the internal and external threads 25 and 24 match one another so that when the coupling ring 21 of a given connector 11 is in its forward position, it is operative to engage the external threads 24 of its identical counterpart connector whose coupling ring 21 is in its retracted position so as to couple the two connectors to one another. The manner in which a connector 11 may be connected to its identical counterpart 11*a* is illustrated in FIG. 2 where a pair of connectors 11 and 11*a* are shown at the ends of a pair of cable sections 26. The coupling ring 21 of the first electrical connector 11 is pushed into its forward position in which its internal threads 25 are exposed and operative to engage the external threads 24 of the other connector 11*a*. The coupling ring 21*a* is pushed back into its retracted position in which its internal threads 25 are out of the way and inoperative. Since the connectors 11 and 11a are identical, it does not matter whose coupling ring is used to engage them to one another, so that if desired, in the situation depicted in FIG. 2, the connectors could be equally well engaged by placing the coupling ring 21 in its rearward inoperative position and using the coupling ring 21*a* to fasten the two connectors to one another. Thus, it may be seen that by the provision of the axially slidable coupling ring 21, the connector 11 is made truly hermaphroditic, in that it can serve either as a male member (with its coupling ring 25 pushed back) or as a female member (with its coupling ring 21 in its forward position).

As it may be seen from FIGS. 5 and 7, the connector 11 contains a large number of contacts 20, so that when a pair of such connectors are engaged in the manner just described, there is a considerable frictional force between their respective sets of contacts, tending to hold them together. To make it easier to uncouple such a connector from its counterpart, it may be provided with a latch 27 anchored in the connector shell 17 immediately behind the coupling ring 21 when the latter is in its forward position. The latch 27, of which there will typically be two, serves to prevent the coupling ring 21 from travelling axially backward on the shell 17 as the ring is being unscrewed from the threads 24 of the connector to which it has been engaged. Consequently, referring to FIG. 2, the connectors there shown may be conveniently disengaged by grabbing the shell portion of the connector 11*a* and turning the coupling ring 21 of the other connector 11. By virtue of the action of the latch 27, as the coupling ring 21 is being unscrewed, it exerts an axial force against the shell of the connector 11*a* and is operative to disengage the connectors from one another.

In order to permit the coupling ring 21 to be moved from its forward position to its rearward position, the latch 27 is provided with a spring 29, both of them being retained in a slot 31 in the side of the connector shell 17. As seen in FIG. 3, the slot 31 and the latch 27 are keyed so that once the latch 27 is slipped into the slot it cannot pop out, although it is urged axially outwardly by the spring 29. A latch retaining spacer 33 is slipped into the slot 31 behind the latch 27 to hold it in place therein. The trailing edge of the latch 27 is tapered at 35 so that when the coupling ring 21 is turned from its rearward position to its forward position, it cams the latch 27 inward against the pressure of the spring 29 and rides over the latch into its forward position. The ring 21 is stopped in its forward position on the shell 17 by the cooperative action of a shoulder 10 on the shell and a rim 14 on the ring.

As a further protective measure for the contacts in the connector, a pair of radially opposed arcuate tangs 35 extend axially forward from the front end of the connector shell 17 (FIGS. 1, 3 and 10). Each of the tangs 35 extends substantially 90° circumferentially around the insert 19 and the contacts held therein, so that when the electrical connector is engaged with its identical counterpart as in FIG. 2, their tangs 35 together define a substantially continuous protective wall around the contacts. The connector shell 17 is also provided with a pair of diametrically opposed arcuate slots 37 to provide clearance for the arcuate tangs 35 of the other connector to which it is engaged. The tangs 35 also serve a keying function to insure that whenever a given connector 11 is engaged with its identical counterpart connector, their respective shells 17 will be rotated 90° relative to one another. As will become more apparent in connection with the more detailed description of the insert 19, the reason why this is desirable is that the particular insert 19 which is preferred for use in the connector 11 is so arranged that it is engageable with its identical counterpart only when the inserts are turned 90° relative to one another. Naturally, other keying means may also be used to achieve the 90° relationship and, conversely, where a different type of insert is used, and where the protective function of the tangs 35 is not necessary, the tangs may be dispensed with entirely.

An approach often used with connectors intended for a wet environment is to provide a seal between each of the contacts and the insert in which they are anchored. This approach has the disadvantage of making it difficult to remove the contacts from the insert. A different approach is pioneered in the connector of the present invention. In particular, no attempt is made to provide a seal between the individual contacts of the connector and the insert 19 in which they are anchored. Indeed, as may best be seen in FIG. 7, each of the contacts is anchored in an opening which extends clear through the insert. This has the advantage that any dirt which may accidentally enter the opening will not be captured therein but will fall through it and into the relatively large space 39 which remains inside the connector shell 17. Instead of trying to provide a seal between the contacts and the insert 19, provision is made to insure that moisture will be kept out of the connector both when it is engaged with its identical counterpart and when it is not so engaged. To keep moisture out when the connector is engaged with its counterpart, it is provided with a moisture-sealing ridge 39 at the front end of the connector shell 17 and extending entirely around the insert 19 so that when the connector is engaged with its counterpart, their respective moisture-sealing ridges sealingly abut one another. Preferably the moisture sealing ridge 39 includes an O ring seal 41. The back of the connector shell 17 is

sealed by means of a cap **43** having a radially extending disk portion **45** and an axially extending front cup portion **47** having a circumferential slot **49** with an O ring seal **51** therein. Thus, when the connector **11** is engaged to its counterpart, it is sealed both at the front and at the back. As a result of the face to face engagement of the O rings **41** of the pair of connectors **11**, when the coupling ring **21** of one of them is tightened around the shell **17** of the other, a seal can be attained even under 100 ft. of water.

To provide a moisture seal at the front end of the connector **11** when it is not engaged with another connector is the function of the dust cover **13**. As illustrated in FIGS. **1** and **3**, it is a short cylindrical cup-like member whose front end is made to resemble that of the connector **11**. Consequently the dust cover **13** is fastened to the front end of the connector **11** in exactly the same manner in which another connector would be fastened thereto. More specifically, the front end of the dust cap **13** includes an external thread **53** which matches the internal thread of the coupling ring **21**, an O ring seal **54** of the same size as the connector shell forward O ring seal **41**, and a pair of diametrically opposed arcuate tangs **55** extend axially, with slots **57** between them so as to receive the arcuate tangs **35** of the connector **11**. The dust cover **13** is secured to the connector **11** by a short length of cable **59**, whose opposite end is secured to the connector cap **43** by means of a screw **60**.

Provision is also made to prevent the dust cover threads **53** from being damaged or soiled when it is not in engagement with its associated connector **11**. Toward this end it is provided with a dust cover cap **15** having matching threads **61** and **63** to permit the cap to be screwed onto the back of the dust cover. When the dust cover **13** is not in use, its cap **15** is unscrewed from the back threads **61** and is screwed onto the front threads **53**. An O ring seal **65**, extending around the cap **15**, serves to insure that moisture does not reach its front threads **53** nor any of the other portions of the front end of the dust cover **13**. The cap **15** is attached to the connector **11** by means of a cable **67**, whose opposite ends are anchored to the cap **15** by means of a screw **69** and to the connector rear cap **43** by means of the screw **60**.

As mentioned previously, it is desirable to have the insert **19** of a given connector **11** engage the insert **19** of another such connector with which the fist connector is engaged so that the two inserts are turned **90** degrees relative to one another. Consequently, it is necessary to key the insert **19** so that its orientation within the shell **17** is precisely determined. For this purpose, the connector shell **17** is provided at its front end with a radially inwardly extending ledge **71** having a pair of diametrically opposed slots **73** therein (see FIGS. **1** and **10**). The insert **19** is provided with a pair of axially extending diametrically opposed keying bosses **75** which fit snugly into the keying slots **73**. A pair of circumferentially running ledge portions **77** extend clockwise from each of the keying bosses **75** and serve as stop surfaces to hold the insert **19** in place against the ledge **71**. A pair of arcuate spacers **77** which together define a thin cylinder hold the insert **19** in place within the connector shell **17** and against its ledge **71**. The spacers **71** are in turn held securely in place against axial movement along the shell **17** by means of the forwardly extending cup portion **47** of the connector rear cap **43**. To aid in the assembly of the connector **11**, each of the spacers **77** is provided with a keying tang **79** and **81** at its front and back end, respectively. The front keying tangs **79** fit between the ledge portions **77** of the insert **19** while the rear tangs **81** fit into a pair of diametrically opposed arcuate slots **83** in the front cup portion **47** of the rear cap **43**. Thus, the spacers **77** can be used as fingers between which the insert **19** may be grabbed, with the rear ends of the "fingers" being engaged by the cap **43** so that the spacers **77** and the insert **19** held between them may be pushed into the shell **17** and turned by means of the cap **43** until the insert **19** drops into place at the front end of the shell. When the cap **43** is pushed all the way into the shell **17**, its disk portion **45** abuts against the rear end of the shell and closes the slots **31** thereby capturing the latch **27** and the latch retaining spacer **33** therein. The cap **43** is held in place by a set of screws, of which the screw **60** is one, threaded into the wall of the connector shell **17**.

In addition to serving to seal the back end of the connector shell **17**, and to hold the spacers and the latches **27** in place, the cap **43** also serves the additional important function of securely anchoring the end portion of the cable **26** to the connector. With this regard, it should be realized that the connector **11** is designed to withstand a pull of several thousand pounds against the cable without damage. The coupling of the cable **26** to the cap **43** is achieved in the exemplary connector **11** by means of a strain relief bushing **87**, a compression nut **89**, and a thrust washer **91** The bushing **87** is long and flexible, and has an internal diameter designed to snugly fit around the cable **26** and has an outwardly flared end **93**. The cap **43** has a rearwardly extending internally threaded cup portion **95** which receives the externally threaded front end of the compression nut **89**. When the compression nut **89** is turned into place in the cup **95** of the cap **43**, it clamps the flared end **93** of the bushing **87** into the cap **43**, and secures the bushing **87**, as well as the cable therein, against being pulled out of the connector **11**.

An alternative connector incorporating some of the features of the present invention, while eliminating others for the sake of simplicity, is illustrated in FIG. **4**. Since the connectors of FIG. **4** and FIG. **1** are quite similar, only their differences will be explained in detail. The basic combination of the connector of FIG. **4** is the same as that of FIG. **1** and includes a connector shell **96**, a coupling ring **103** movable between an extended and a retracted position upon the shell **95**, and an insert **97** seated at the front end of the shell **96** and held there by a pair of spacers **99** retained by means of a cap **101**. The connector of FIG. **4** differs from the connector **11** in that the latches **27** have been eliminated. Another simplification is that the two-piece cap **13** and **15** of FIG. **1** has been replaced by a one-piece dust cover **105** having external threads **107** adapted to be received in matching internal threads **109** at the front end of the coupling ring **103** when the latter is in its extended position.

Another modification of the connector of FIG. **4** is at its rear end where an improved provision is made for securely attaching a cable to the connector. In particu-

lar, the cap **101** has a rearwardly extending cup portion **111** similar to the corresponding portion **95** of the connector **11**. Seated at the bottom of the cup portion **111** is a rigid cup-shaped compression ring **113** having a radially inwardly sloping cam surface **115**. A flexible gland seal **117** is seated next to the compression ring **113** and has a front surface **119** sloped generally parallel to the surface **115** of the ring **113**. The flared end **121** of the bushing **123** is compressed between the gland seal **117** and a thrust washer **125** which is pressed against the flared bushing end **121** by a compression nut **127** similar to the compression nut **89** of FIG. **1**. As the threaded end of the compression nut **127** is screwed into the matchingly threaded rear end of the cap **101**, the front portion of the gland seal **117** is pressed against the cam surface **115** of the compression ring **113** and is cammed radially inwardly, thereby becoming squeezed onto the cable which runs through its center. In this way, the cable is grabbed very securely by the gland seal **117** and would require a very great axial force to rip it from the connector.

Referring now to FIGS. **5–10**, the insert **19** preferred for use in the exemplary connector, comprises a block **16** defining, or having therein, a plurality of openings **22** arranged in an ordered array of columns and rows **26** and **28** for anchoring a corresponding plurality of contacts **20**. In accordance with the invention, a set of hollow posts **23** extends from alternate ones of the columns **26** and from alternate ones of the rows **28** of the openings **22**, each post **23** serving as a socket to protect a contact **20** mounted in an extending from a respective one of the openings **22** in the aforesaid alternate columns and alternate rows **26** and **28**. Moreover, respective pairs of the columns of posts **26** serve to protect the contacts **20** mounted in and extending from the columns **26** of openings **22** between them and similarly, respective pairs of rows **28** of posts **23** serve to protect the contacts **20** mounted in and extending from the rows of openings **22** between them.

Naturally, if the contacts **20** and the insert **19** did not have to engage a corresponding set of contacts in a similar insert, it would be desirable to have a hollow protective post **22** extend around each one of them. This, of course, is not possible, because if each of the contacts in a given insert were surrounded by a protective post **23**, none of them would be accessible by contacts in the insert. It is a particular advantage of the insert of the present invention that a sufficient number of protective posts **23** are provided to effectively protect all of the contacts which are anchored in the insert, yet at the same time permitting all of the contacts to engage ehtir counterparts in another similar, or even identical, insert. How this is achieved is shown in FIG. **9** by illustrating on the left a first insert **19***a* with its columns **26** of posts **23** oriented vertically, and by showing to its immediate right, an identical insert **19***b* rotated 90° counterclockwise, so that its columns **26** and posts **23** extend horizontally. A comparison of the connectors **19***a* and **19***b* in FIG. **9** will reveal that when they are turned 90° relative to one another as shown in FIG. **9**, one of them will have a post **23** at every opening **22** where the other one does not. Stating it differently, the geometrical arrangement of openings and posts is such that when a pair of inserts **19** are turned by 90° relative to one another, their posts complement one another and mesh perfectly when the inserts are placed face to face. If, for example, the inserts **19***a* and **19***b* which are shown side by side in FIG. **9** with their faces up, are turned so that their hollow posts **23** extend toward one another, each hollow post on one insert will be in line with a post-less opening in the other. Note for example the posts **23-1** and **23-2** at the left edge of the insert **19***a* in FIG. **9** which, when the insert **19***a* is turned over and against the insert **19***b*, will be against the openings **22-1** and **22-2** of the latter. It will also be observed that the pair of identical inserts **19***a* and **19***b* will fit or intermesh not only in the position shown in FIG. **9**, but also in a second relative position in which the insert **19***b* is turned 180° relative to the position in which it is shown in FIG. **9**. The simplest way to appreciate the reason for this is that the insert **19***b*, as well as the insert **19***a* of course, is symmetrical about the diameter **30** which extends through the longitudinal axis **32** of the insert **19**, about which it is turned into its second engaging position with the insert **19***a*.

The preferred insert illustrated in FIG. **9** may also be viewed as having its openings **22** distributed in an array of equispaced columns and rows **40** and **42**, as shown for the connector **19***b* in FIG. **9**, with the rows and the columns being located in pairs equidistantly about the axis **32** of the insert. With reference to the columns **40** and **42**, it will be observed that a hollow post **23** extends from alternate openings in each of the columns and each of the rows in a checkerboard pattern, so that as with a checkerboard, a 90° rotation of one insert relative to the other about its axis **32**, causes unlike elements, e.g., an opening with a post versus an opening without a post, to occupy corresponding positions.

Although the particular geometry of the insert **19**, illustrated in FIGS. **5–9**, is desirable for use in the exemplary connector herein described, where engageability in two different positions of a pair of connectors is desired, the basic feature of the insert **19**, whereby hollow protective posts extend from less than all of the openings in the insert to afford effective protection from damage to essentially all of the contacts mounted therein, has broader applicability and may be incorporated into inserts which are differently configured and whose openings **22** are differently laid out than illustrated in FIG. **9**. Moreover, although the insert **19** is shown to be removable from the shell **17**, it could also be made to be an integral part thereof. Therefore, the word "insert" as used herein should be understood to include a contact supporting body, whether it is truly a separate insert, as shown herein, or is an integral part of a connector shell.

Turning now to the manner in which contacts may be mounted in the openings **22** of the insert **19**, reference should be made to FIGS. **7** and **8**, which illustrate the openings **22** as anchoring identical hermaphroditic contacts **20** having a bifurcated blade **32** such that a pair of identical contacts **20** will engage one another when their shanks are in axial alignment but turned about their axes **90** degrees relative to one another, with the bifurcated blades **32** of each contact **20** sliding between the bifurcated contacts of the other. To securely retain the contact **20**, the openings **22** are provided with two pairs of diametrically opposed ridges **34**, with each pair of ridges forming between them a slot **36**, which are so spaced as to receive and snugly

engage between them the shank of the contact. A rearwardly extending blade **50** on the contact snaps in place over a ledge **52** in the opening **22** to keep the contact in place therein.

While the primary utility of the exemplary connector disclosed herein is as a hermaphroditic connector, it should be understood that it has sufficient advantages in terms of ruggedness and freedom from damage, both during and between use, as to make it also adaptable to use as a sexed connector in which all of its contacts are either male or female. For example, if such were the case, all of the female contacts could be located in those openings from which a hollow post **23** extends, and all of the male contacts, typically pins, would extend from the post-less openings, which would nevertheless be protected by the array of posts rising around them.

In FIG. **10**, an insert of the type illustrated in FIG. **9**, is shown in place, with its axis **32** lying on the longitudinal axis **12** of the connector. As explained previously, the tangs **35** and the slots **37** between them, serve to insure that when the connectors are face to face with their axes colinear, their respective shells will be turned substantially **90** degrees relative to one another about their axes, so that their respective inserts will intermesh. Optionally, a set screw **44** may be located in one of the slots **37** and a slot **46** may be cut in one of the arcuate tangs **35**, the set screw **44** and the slot **46** being located 90° apart on the arc of a common circle, centered on the axis of the connector shell **17**, so as to permit a pair of connectors to mate in only one of their two possible mating positions. If it is desired that a pair of connectors be permitted to mate in the other of their two possible mating positions, the set screw **44** may be located in a position diametrically across from its position shown in FIG. **10**, and to facilitate a changeover, a tapped hole **48** may be provided in the other slot **37** for this purpose. Where a set screw **44** is thus provided, the connector can be quickly converted to engage in either a first position only, or a second position only, or in either of two positions.

A connector substantially as shown in the figures was constructed with a shell diameter of about 2¾ inches and with a shell length of about 5 ½ inches. It was found that the connector could be made superior to those having metal shells in terms of freedom from binding if the connector were made to have a plastic shell as well as a plastic coupling ring. Indeed, in the connector thus built, the only metal parts were the contacts, the set screw **44**, and the fastening screws **60**. The connector shell **17**, coupling ring **21**, latch **27**, latch retainer **33**, end cap **43**, compression nut **89**, compression ring **119**, were all fabricated from Arylon T, a brand of Polyaryl Ether of Uniroyal Chemical, a Division of Uniroyal, Inc. This type of plastic was chosen because of its high strength and low coefficient of expansion, the latter being particularly important in preventing binding between parts which are threaded into one another and which are subjected to great variations in ambient temperature.

Noryl GFN2, a brand of modified phenylene oxide made by the General Electric Company was selected as the material for the insert **19**, while the bushing **87** and the gland seal **117** were molded from Kraton types 3302 and 3226, respectively, both being a brand of styrene-butadiene block copolymer, made by the Shell Chemical Company.

From the foregoing, it may be seen that a connector having many advantages over those presently existing has been contributed to the art of connectors by the present invention. Thus, a connector has been shown capable of engaging its identical counterpart, in either one of two alternative positions, if desired, yet each connector has been made capable of protecting itself from the environment, both when it is so connected and when it is not. And, by virtue of a novel type of insert, greatly improved protection has been provided for individual contacts which heretofor were subject to damage during periods when the connector was neither coupled to another connector nor otherwise capped.

What is claimed is:

1. An electrical connector engageable with its identical counterpart comprising in combination:

a. a connector shell having a longitudinal axis;

b. a connector insert mounted at the forward end of said shell and having an axis of symmetry extending across said longitudinal shell axis in a plane normal to said shell axis;

c. a plurality of openings in said insert, each extending parallel to said longitudinal shell axis and at least some of them supporting the shanks of contacts therein, said openings being distributed in an array of equispaced columns and rows, said columns being located in pairs equidistantly about said axis of symmetry;

d. a hollow post extending integrally from said insert at openings in alternate ones of said columns in a checkerboard pattern symmetrical about said axis of symmetry so that, when a pair of said connectors are face-to-face, with the axes of their respective connector shells collinear, and the axes of symmetry of their respective inserts turned substantially 90° with respect to each other, their inserts intermesh; and

e. means for coupling said connector to its identical counterpart with the longitudinal shell axis of said connector being collinear with the corresponding axis of its counterpart and with the axis of symmetry of its insert turned substantially 90° relative to the corresponding axis of the insert of its counterpart about said collinear axes.

2. The electrical connector of claim **1** characterized further in that said connector shell is tubular and said connector insert is disk shaped.

3. The connector of claim **1** characterized further in that said means for coupling said connector to its identical counterpart is operative to interlock said connector to its identical counterpart in either one of two diagonally opposite positions in each of which the axis of symmetry of the insert of said connector is at substantially 90° relative to the corresponding axis of the insert of its counterpart.

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