

[54] **ELECTRICAL CONNECTOR**

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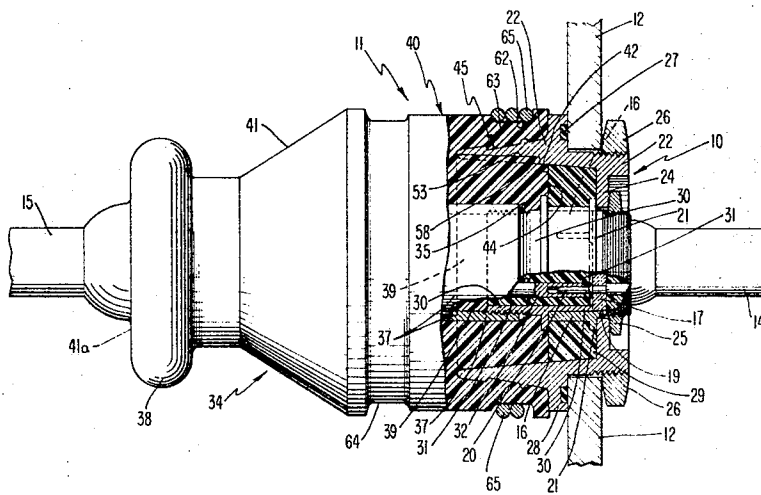
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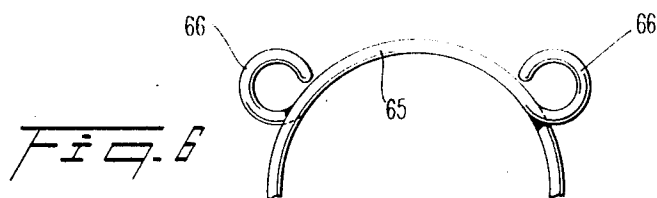
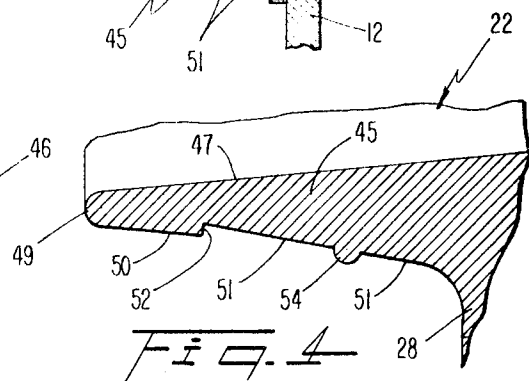
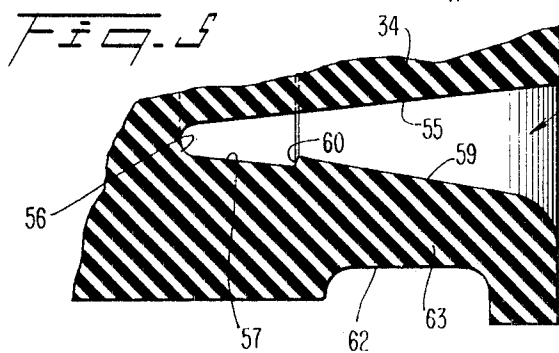
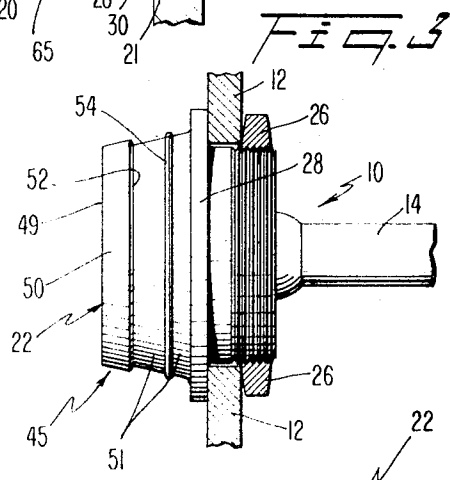
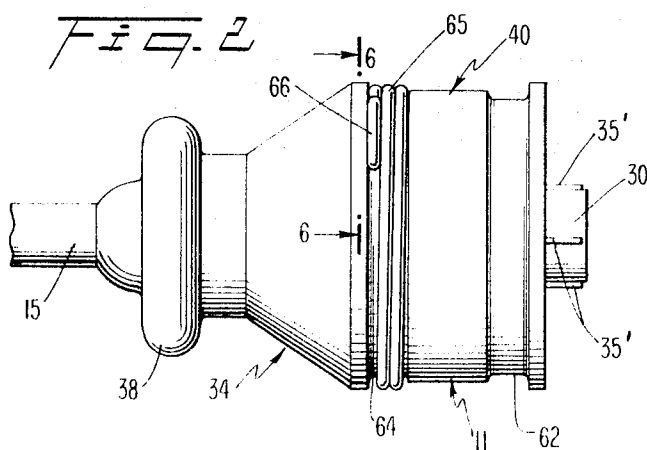
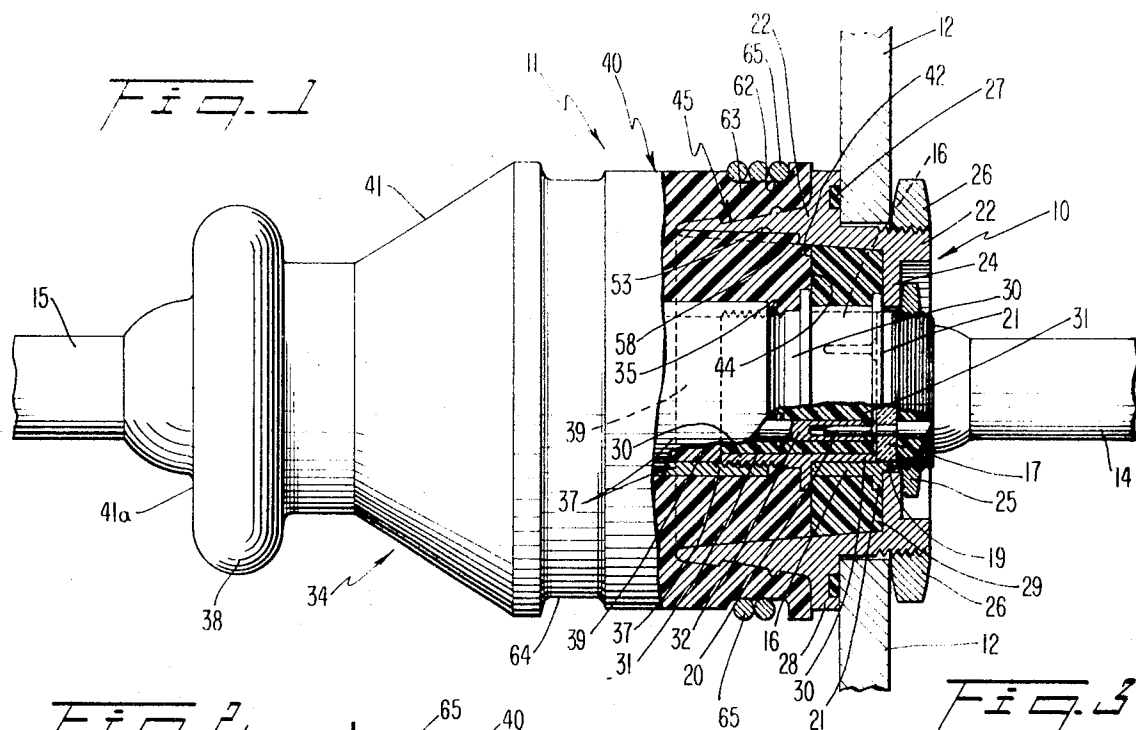
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ABSTRACT

A plug and socket type electrical connector adapted for use under liquid such as water or under damp conditions. The connector has encapsulating means for securely sealing the immersed connector parts when they are in mated position, to maintain the contacts and other elements thereof dry. The encapsulating means is pressure responsive, so that its sealing effectiveness increases as the assembly is subjected to increased external liquid pressure.

17 Claims, 6 Drawing Figures





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ELECTRICAL CONNECTOR

This invention relates to electrical devices and more particularly to connectors for separably connecting one or a plurality of electrical conductors.

The invention has among its objects the provision of a connector which may be employed under liquid such as water or under damp conditions.

Another object of the invention is the provision, in a separable connector of the type above indicated, of novel means for sealing the separable units against intrusion of liquid and other foreign media.

A further object of the invention is the provision of a connector wherein the separable parts when fully mated are securely sealed, and may be readily disconnected from each other.

Still another object is the provision, in a connector of the type described, of encapsulating or sealing means composed of mating annular portions, one such portion being carried by each separable part or unit of the connector.

Yet another object of the invention is the provision, in an electrical connector, of sealing means which is pressure responsive whereby to increase the effectiveness of the seal as the connector is subjected externally to increasing fluid pressure.

A still further object of the invention is to provide novel encapsulating means for waterproofing separable electrical connections at the hull of underwater vessels.

The above and further objects and novel features of the invention will more fully appear from the following description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustration only, and are not intended as a definition of the limits of the invention.

In the drawings, wherein like reference characters refer to like parts throughout the several views,

FIG. 1 is a view in longitudinal axial section through an illustrative encapsulated connector in accordance with the invention, the separable plug and panel mounted receptacle of the connector and the separable parts of the encapsulating means being shown fully mated and sealed to each other;

FIG. 2 is a view in side elevation of the connector plug and molded cable termination part of the encapsulating means shown at the left in FIG. 1;

FIG. 3 is a view in elevation of the connector receptacle carrying or panel fitting part of the encapsulating means;

FIG. 4 is a fragmentary enlarged view in longitudinal axial section of said panel fitting part;

FIG. 5 is a fragmentary enlarged view in longitudinal axial section through said molded cable termination part; and

FIG. 6 is a fragmentary view of one form of pressure spring which may be employed with the assembly of FIG. 1, the view being taken from the line 6-6 of FIG. 2.

The encapsulated connector of the invention has two main separable parts or assemblies 10 and 11, part 10 being shown as carrying a plurality of pin contacts and part 11 as carrying a similar number of socket contacts adapted to receive the pin contacts. It is to be understood that any number of mating socket and pin contacts may be employed, and that at least some of the sockets and pins may be mounted in the opposite manner from that shown, that is, with at least some of the socket contacts on connector part 11 and a corresponding number of the pin contacts on connector part 10.

The connector is of such construction that the socket and pin contacts carried by the separable parts are selectively mated and disconnected by purely axial movement of said parts with respect to each other. The connector assemblies 10 and 11 are provided with annular parts constituting encapsulating or sealing means, such annular parts when mated forming with the housings or shells of the two connector parts a closed space within which the socket and pin contacts are located. In the embodiment shown, one of the parts of the sealing means is in the form of an axially projecting hood integral with or rigidly connected to the housing of one connector part and made of rigid material. The other annular part of

the sealing means is formed with an annular groove complementary to said hood, is primarily elastomeric, and is integrally connected to the other connector part. Such two parts of the sealing means are fully engaged and sealed to each other when the connector parts are in fully mated position. When the connector is subjected to appreciable external fluid pressure, as by being immersed in water at a considerable depth, the elastomeric part of the sealing means is thrust inwardly against the hood part mating therewith so as to increase the effectiveness of the seal between such two parts.

In the illustrative embodiment, part 10 of the connector is a so-called receptacle, whereas part 11 thereof is a plug having a forward portion receivable within a passage in part 10. Part 10 of the connector is shown secured and sealed to a panel or wall 12 which may be the external wall of a water-tight vessel submerged beneath the surface of a body of water. The connector 10, 11 effects electrical connection between the one or more conductors of a cable 14 located within the vessel and the conductors of a cable 15 which extends through the water.

Part 10 of the connector has an inner shell 16 of tubular form and made, for example, of metal. Transversely of the shell 16 and intermediate its length there is positioned a glass or other electrically insulating contact mounting insert 17 which is secured to the shell by an annular connection 19, such as a glass-to-metal seal. A plurality of pin contacts 20 spaced from each other over the area of the insert 17 are connected at their outer ends to the conductors within the cable 14. Shell 16 is secured in panel fitting 22 of the connector encapsulating means by a flange 21 on shell 16, and a nut 25 threaded on the outer end of the shell which extends through the central opening in a radially inwardly extending flange 24 in fitting 22. Nut 25 forceably retains flanges 21 and 24 in engagement. If desired, shell 16 and fitting 22 may be secured together by welding or other suitable known means. Interfitting longitudinally extending ribs and grooves (not shown) may be provided on the fitting 22 and shell 16 to maintain such parts in fixed angular relationship about their axes. As shown, hull fitting 22 is secured by a nut 26 to the wall 12 of the hull of a vessel through which the fitting extends, said nut being threadedly received upon the inner end of the fitting. An O-ring 27 disposed in an annular groove in a flange 28 on casing 22 securely seals the latter to the wall 12. After the shell 16 has been mounted within member 22 and secured thereto as above explained, a preferably resilient potting compound 29 is molded into place around shell 16 within member 22.

The connector part 11 is provided with a tubular inner shell 30 which may be made, for example, of metal. Shell 30 carries an insert 31 of electrically insulating material supporting a plurality of socket contacts 32 located to receive the pin contacts 20. Connector part 11 has a main outer body 34 which is made of elastomeric, electrically insulating material such as rubber, neoprene, or the like. The axially inner portion 40 of body 34 is generally of circular cylindrical configuration. Axially outwardly of portion 40, the body 34 is provided with an annular hand grip portion 38. Body 34 may be molded about shell 30 and the latter may be retained within body 34 by means including a radially inwardly extending flange 35 on the axially inner end of body 34 fitting into an annular groove on the shell. Alternatively, body 34 may be preformed and shell 30 then telescoped within it. The shell 30 is, in effect, lengthened by having a sleeve 37 threadedly connected to its axially rear end. The axially inner end of sleeve 37 may form the rear transverse surface of the above-mentioned annular groove in the shell 30. After the conductors in cable 15 have been connected to the socket contacts 32 within shell 30, the space rearwardly of the insert 31 in shell 30 may be filled with a potting compound 39.

Interfitting longitudinally extending ribs and grooves (not shown) on the body 34 and shell 30 maintain such parts in fixed angular relationship about their axes. The shell 30 may be provided with one or a plurality of angularly spaced longitudinally extending ribs or keys 35' which are received within similarly disposed longitudinally extending grooves in

the shell 16 of connector part 10, thereby insuring that connector parts 10 and 11 are accurately oriented before they can be advanced toward each other into fully mated position. When the parts 10 and 11 of the connector are fully mated, the axially inner face 42 of the annular filler 29 is in secure engagement with the inner end face 44 of the body 34.

The connector parts 10 and 11 are provided with mating portions which, with the main portions of casing or fitting 22 and the body 34, form a secure seal about the pin and socket contacts. Such portions of the casing 22 and the body 34 are a hood 45 on the casing 22 of connector part 10 and an annular recess 46 in the body 34 of connector part 11. The configuration of the hood 45 is shown most clearly in FIG. 4, whereas the annular groove 46 in body 34 for receiving such hood is shown most clearly in FIG. 5. The hood 45 is of uniform section in each transverse plane throughout its angular extent. The radially inner surface 47 of the hood is of frusto-conical shape. In the illustrative embodiment each longitudinal geometrical element of the inner surface 47 lies at an angle of 5° with respect to the longitudinal axis of casing 22. The axially inner end 49 of the hood 45 is smoothly rounded in section, the radially outer portion of edge 49 merging with a frusto-conical axially inner and radially outer surface 50 of frusto-conical shape. Surface 50 converges in a direction opposite from surface 47 at a small angle, the longitudinal geometrical elements of surface 50 in the illustrative embodiment lying at an angle of 5° with respect to the longitudinal axis of casing 22. Axially outwardly of the surface 50, the radially outer surface 51 of the hood 45 is generally of frusto-conical shape which also converges in a direction opposite from surface 47. Surface 51 is shown inclined at an angle of 10° with respect to the longitudinal axis of hood 45 as the hood is shown in FIG. 4. Forming the juncture between the rear end of surface 50 and the forward end of surface 51 is a steep annular shoulder 52, each element in a radial axial plane through the hood 45 lying at 90° with respect to the respective element of surface 51. The surface 51 is interrupted intermediate its length by an annular rounded rib or bead 54 which is of generally half circular configuration in longitudinal axial section (FIG. 4).

The relaxed configuration of the annular groove 46 in the body 34 which receives the hood 45 is shown most clearly in FIG. 5. Groove 46 has a frusto-conical radially inner surface 55, a rounded portion 56 at the closed or blind end thereof, and a radially outer surface which is made up of portions 57 and 59, portions 57 and 59 being joined by an abrupt shoulder 60. In the illustrative embodiment the parts of the surface of the recess 46 in its relaxed condition are in all respects complementary to the corresponding parts of the hood 45 with the exception that the surface 59 of the recess which mates with the surface 51 of the hood is of unbroken frusto-conical shape. If desired, a suitable groove may be provided in surface 59 to mate with rib 54 on surface 51. In at least one location the radially inner surface 47 of the hood 45 is provided with a longitudinally extending groove 53 (FIG. 1) which receives a longitudinal rib 58 on the surface 55 of the recess 46 to insure the preliminary telescoping of the hood 45 in the groove 46 in the correct angular relationship.

When the connector parts 10 and 11 are aligned with each other and advanced into full engagement as shown in FIG. 1, the hood 45 enters fully into the annular groove or recess 46. The annular bead 54 engages the surface 59 and may resiliently deform it as shown in FIG. 1, so that a secure seal is formed between the hood 45 and the recess 46 at the location of the bead.

The body 34 of connector part 10 is made of elastomeric material, which, although rigid enough to be self-sustaining and strong, is sufficiently flexible to permit shoulder 52 to be snapped past the shoulder 60 in either direction and portion 63 of body 34 to be pressed radially inwardly by fluid pressure into sealing engagement with the hood 45 of connector part 10. The hood 45 has in effect a drive fit in recess 46. When the mated connector parts are submerged in water, especially to

an appreciable depth, the pressure of the water further thrusts the annular portion 63 of body 34 strongly inwardly so that it engages the radially outer surface of hood 45 throughout the surfaces 50 and 51 thereof, as well as forming a more secure seal between the bead 54 and the portion of surface 59 which it engages. The external pressure applied to the portion 63 also serves to tighten the seal at shoulder 52, 60 and at engaging surfaces 49 and 56.

The security of sealing between the connector parts 10 and 11, particularly when the connector is subjected to low external fluid pressure, is increased by the provision of a manually operated seal-securing spring 65 which, when in operative position as shown in FIG. 1, compressively embraces the portion 63 of the body 34. Two broad annular grooves 62 and 64 are provided in the portion 40 of body 34, the groove 62 generally overlying the bead 54 when the parts are mated as shown in FIG. 1, and the groove 64 being disposed axially outwardly of the blind end 56 of the recess 46. The spring 65 has a relaxed inner diameter somewhat less than the root diameter of groove 62 and equal to or greater than that of groove 64 and may be selectively positioned in either of such grooves by temporarily enlarging the spring by thrusting together loops 66 on the ends thereof. When the spring 65 is disposed in groove 62, it thrusts the portion 63 of the body 34 radially inwardly to insure a seal between its surface 59 and the surface 51 and bead 54 on hood 45. The presence of the spring 65 in groove 62 does not interfere with the above described action of fluid pressure upon part 63 to augment the effectiveness of such seal. To the contrary, spring 65 adds to the effectiveness of the pressure responsive seal.

When it is desired to disassemble the connector 10, 11 after its removal from water, the spring 65 is temporarily radially enlarged, removed from the seat 62, and slid axially rearwardly into groove 64. Following this the connector part 11 may be pulled away from connector part 10 by the application of a moderate axially directed pull upon the enlarged portion 38 of the body 34 of connector 11, so as to snap shoulder 52 past the shoulder 60 on body 34.

There is thus provided a novelly constructed separable means for encapsulating separable parts of electrical connectors in mated relation and the like, which means are especially advantageous when the encapsulated structure is submerged or otherwise subjected to considerable external pressure. The novel intermeshing parts of the encapsulated means provided by the invention creates an initial annular sealing or constriction zone within the spring 65 which is effective at relatively low external pressures to prevent the entrance of moisture or the like and to thereby keep dry the further inward mating surfaces of the intermeshing parts when subjected to high external pressure, such as in deep water. The hydrostatic pressure exerted axially against the surfaces 41, 41a forces the material of body 34 into the tapered annular space between surfaces 47, 55 and the outer surface of shell 30, 37 to thereby improve the sealing capacity of the unit under pressure. The same external axial force acts to more firmly engage the surfaces 42, 44. At the same time hydrostatic pressure acting radially inwardly against surface 40 of elastomeric body 34 presses the surface 57, 59 against surface 50, 51 and a portion of the inner surface of body 34 against shell 30, 37. In addition to improving the sealing ability in response to external pressure, the novel encapsulating means of the invention acts to absorb and deflect stresses which might otherwise be harmful to the encapsulated connector parts. The encapsulating means hereby provided makes it possible to utilize a wide selection of available non-water-tight connectors for installations requiring waterproof and pressure-tight connector mating. The invention thus makes available a very wide range of connector insert arrangements and shells for use with reliability in oceanic and similar applications.

Although only one embodiment of the invention has been illustrated in the accompanying drawings and described in the foregoing specification, it is to be expressly understood that various changes may be made therein without departing from

the spirit and scope of the invention, as will now be apparent to those skilled in the art. For example, the opening in panel or hull 12 may be enlarged sufficiently to pass the body 34, in which event the fitting 22 could be secured thereto by a flange thereon without the hull 12 and a ring nut outside the hull. It will be understood that capsule body 34 is in effect a termination or extension of the water-tight cable 15 and may be so dimensioned that portion 63 thereof will be slightly stretched as it is seated on portion 45 of fitting 22.

What is claimed is:

1. An electrical connector device comprising first and second tubular selectively mateable main supporting members, an insulating contact supporting insert mounted in each main supporting member, a contact mounted on each said insert for selective engagement with each other, and means for sealing the main supporting members together when they are fully mated to form a closed space between them, said sealing means comprising tubular parts affixed to the main supporting members and having sealed telescoping relationship when said members are fully mated, one of said telescoping tubular parts is rigid and the other is made of elastomeric material, said rigid part of the sealing means being a tubular hood receivable within a longitudinally extending annular, generally complementary, recess in the elastomeric part, and means for pressing the outer radial portion of the elastomeric part radially inwardly into engagement with said rigid tubular hood, thereby to prevent the intrusion of foreign media into the zone of the mating contacts.

2. Apparatus as defined in claim 1 wherein the annular portion of the elastomeric part disposed radially outwardly of said annular recess therein is relatively thin and is elastically deformable by radially inwardly directed pressure so as to engage the outer surface of the hood more forcibly when the mated parts of the connector are subjected to external pressure.

3. Apparatus as defined in claim 1 wherein the means for pressing the outer radial portion of the elastomeric part radially inwardly comprises an annular member telescoped about and compressively engaging the outer surface of the elastomeric part adjacent the open end of the annular recess therein.

4. Apparatus as defined in claim 1 comprising means for constantly urging the main supporting members axially toward each other when the members are fully mated.

5. Apparatus as defined in claim 4 wherein the means for constantly urging the main supporting members toward each other when the members are fully mated comprises interfitting formations on the hood and the elastomeric part, said formations having annular surfaces inclined with respect to the longitudinal axes of the supporting members.

6. Apparatus as defined in claim 1 wherein said annular member is a coil spring.

7. Apparatus as defined in claim 6 wherein the spring is selectively displaceable longitudinally of the elastomeric part from its operative position near the open end of the annular recess to an inoperative position axially rearwardly of the recess whereby to allow the main supporting members to be axially separated.

8. The combination comprising mateable plug and receptacle assemblies of an electrical connector, a rigid tubular fitting, means for securing one of said assemblies centrally in

said fitting, an elastomeric tubular cable termination member having an annularly axially extending recess in the open end thereof complementary to an annular end portion of said fitting, having a wall which is generally wedge-shaped in longitudinal radial section and wherein the inner and outer surfaces of said annular end portion of the fitting diverge from each other in the direction of said one assembly and each of said surfaces extends at a small axis of said fitting, and means for mounting the other said assembly in the bore of said cable termination member in position to mate with said one assembly when said annular end portion of the fitting is seated in said recess.

9. A combination as defined in claim 8 wherein the elastomeric cable termination member has a compression fit around said annular end portion of the fitting in said recess.

10. A combination as defined in claim 8 wherein the outer surface of said annular end portion of the fitting and the surface of said recess adjacent thereto have engageable generally radially extending annular surfaces whereby said fitting and termination member are yieldably maintained in assembled relation.

11. A combination as defined in claim 10 wherein said radially extending surfaces made an acute angle with the axis of said fitting and member.

12. The combination comprising first and second mateable electrical connector assemblies, said first assembly comprising a tubular shell, a contact supporting insert in said shell and at least one electrical contact extending through said insert, a tubular fitting surrounding and secured to said shell, an annular space between said tubular fitting and said shell, a solid ring of compound filling the annular space in said fitting around said shell, said fitting having an annular end portion extending beyond the outer surface of said ring, said second assembly comprising a tubular shell adapted to telescopically mate with said first-named shell, a contact supporting insert therein and at least one electrical contact adapted to mate with said first-named contact, a cable comprising at least one conductor connected to said second-named contact, and an elastomeric tubular body terminating said cable, closely surrounding the outer end portion of said second-named shell and having an annular recess in the end thereof in which said annular end portion of the fitting has a close telescopic fit when said assemblies are mated wherein at least a portion of the surface of said tubular fitting is in pressure contact with at least a portion of the surface of said recess in said elastomeric body.

13. A combination as defined in claim 12 wherein said ring is resilient and is engaged by the end surface of said elastomeric body when said assemblies are mated.

14. A combination as defined in claim 12 wherein said recess and said annular end portion of the fitting have complementary formations which cooperate to resist separation of said assemblies when the same are mated.

15. A combination as defined in claim 12 comprising releasable resilient means for compressing said body radially inwardly against the outer surface of said fitting.

16. A combination as defined in claim 12 wherein said recess and said annular end portion of the fitting are complementarily shaped.

17. A combination as defined in claim 16 wherein said recess and said annular end portion of the fitting are generally wedge-shaped in longitudinal radial section.

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