United States Patent

Massa, Jr.

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[54] UNDERWATER SEPARABLE CONNECTOR

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[73] Assignee: **Massa Division, Dynamics Corporation of America**, Hingham, Mass.

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[52] **U.S. Cl.**.....**339/102 R**, 339/94 R, 339/143 R, 339/218 R

[51] **Int. Cl.**.....**H01r 13/52**

[58] **Field of Search**.....339/143, 89, 218, 136, 102, 339/94, 14, 60 M, 196, 59

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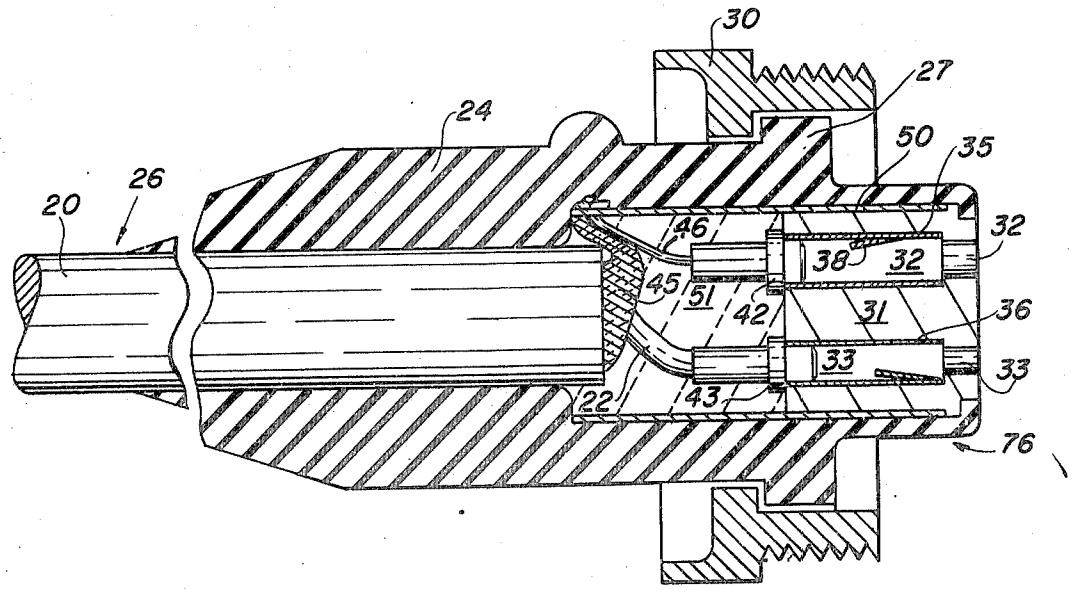
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[57] **ABSTRACT**

A shielded underwater cable terminates at a connector located inside a cylindrical metal sleeve. The sleeve serves the dual function of retaining a potting compound which mechanically protects the connector and of electrically shielding the connector region. In addition, the cable shield and sleeve are interconnected by plug and socket connectors also located inside the sleeve so that there is a positive electrical connection between the shields in two cables when two mating connector halves are put together.

11 Claims, 5 Drawing Figures



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SHEET 1 OF 2

FIG - 1

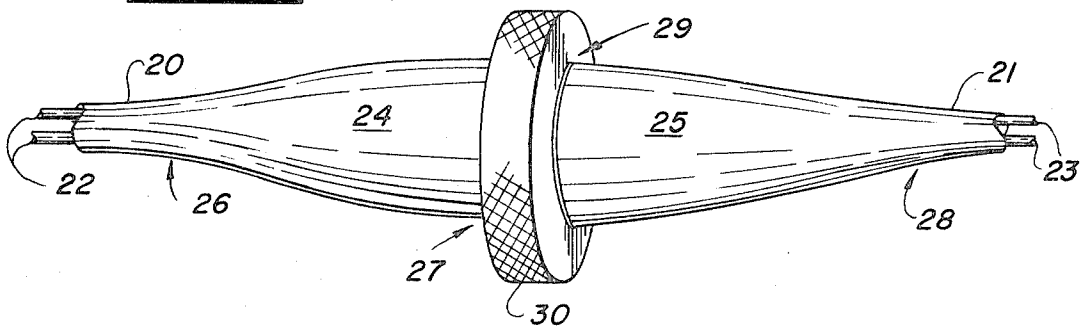


FIG - 2

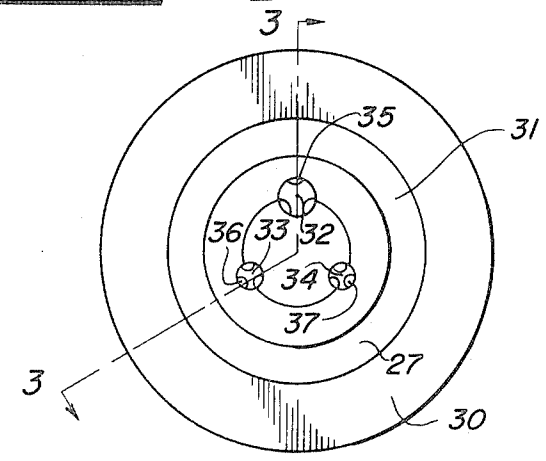
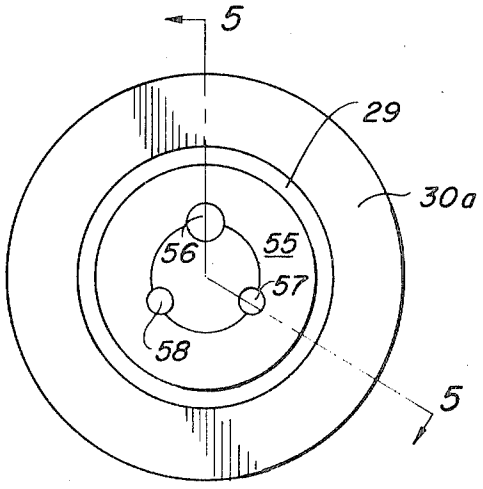


FIG - 4



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FIG - 3

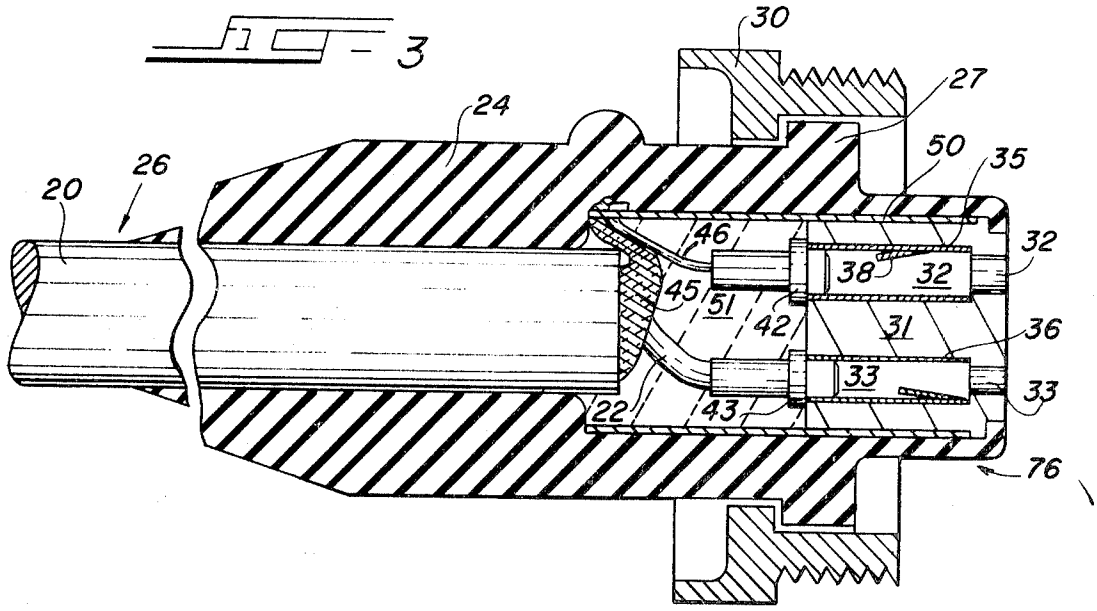
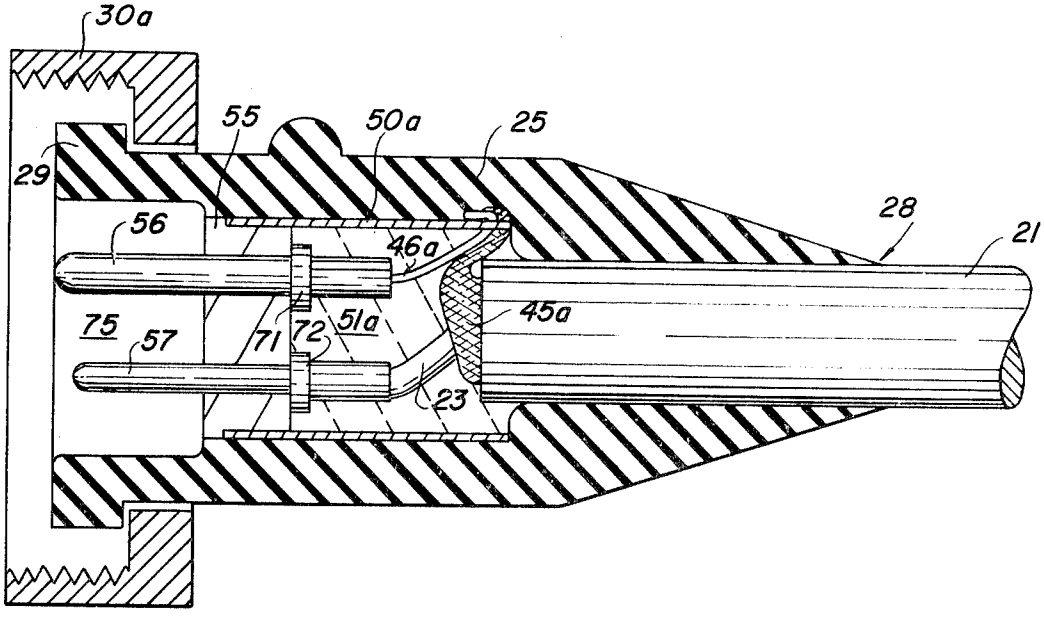


FIG - 5



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UNDERWATER SEPARABLE CONNECTOR

This invention relates generally to separable electrical connectors, and more particularly to new and improved connectors for use in underwater applications.

Reference is made to a copending application entitled "Underwater Separable Connector," Ser. No. 660,328, filed Aug. 14, 1967, by Frank Massa, and assigned to the assignee of this invention. This is an improvement over the invention shown in that earlier copending application.

Underwater electrical connectors of the described type generally have a rubberlike jacket which is bonded to the outer covering of an underwater cable. Inside the cable jacket is a metallic shield which provides electrical shielding protection for the wires inside the cable. The cable also includes a number of insulated wires or conductors which are attached to a first connector half having either a set of plug terminals or a set of socket terminals. Another similarly shielded cable has its insulated conductors connected to a similar second connector half which includes terminals that mate with the terminals in the first half. Thus, these two cables may be joined together by making a simple plug and socket connection.

It is desirable to arrange the connectors to also connect the shields in the two cables when the two connector halves are put together. Moreover, it is sometimes necessary to improve the ruggedness of the plug or pin terminals so that they will withstand a greater twisting force when the two mating connector halves are brought into engagement or disengagement.

Accordingly, an object of this invention is to provide a new and improved underwater separable connector. A more particular object is to provide means for interconnecting the cable shields in two cables through the plug and socket portions of the connector assembly which are also used for making electrical connections between the cables.

In keeping with an aspect of this invention, these and other objects are accomplished through a use of an electrically conductive, cylindrical sleeve which serves both as an electrical shield extension of the cable shield and an enclosure for receiving a potting compound. The cable shield is electrically connected to the sleeve and to a plug or socket terminal. The potting compound is poured into the sleeve enclosure where it sets up solid, without heat, to consolidate the region between the cable jacket and a base of the plug or socket terminal assemblies. When the two connector halves are brought together, the enclosure becomes an important part of the shielding, and the cable shields are electrically joined together by the plug and socket terminals.

These and other objects and features of the invention are provided by a preferred embodiment, which is described in the following specification and attached drawings, in which:

FIG. 1 is a perspective view of two cable sections which are joined together by the inventive connector;

FIG. 2 is a plan view of one end of a shielded two-conductor underwater cable terminated in a waterproof socket;

FIG. 3 is a cross-sectional view of the waterproof socket, taken along the line 3—3 of FIG. 2;

FIG. 4 is a plan view of the end of the mating portion or plug end of the underwater connector which is attached to a two-conductor shielded underwater cable; and

FIG. 5 is a cross-sectional view of the plug-end connector taken along the line 5—5 of FIG. 3.

FIG. 1 shows two underwater cables 20, 21 each of which includes any suitable number of wires—such as the exemplary two wires shown at 22, 23. These cables preferably have waterproof, rubberlike outer jackets. The wires are, respectively, connected to terminals in a socket half of a connector 24 and a plug half of a connector 25. Then, a waterproof jacket is molded over each of these connector halves. For example, the socket half 24 is covered by a jacket beginning at 26 with a waterproof bond to the cable 20 and ending at 27 in a molded flange (not visible in FIG. 1). Likewise, the plug half 25 is also covered by a jacket beginning at 28 with a waterproof bond to the cable 21 and ending at a molded flange near 29. A pair of mating threaded ring clamps fit over the jacket flanges. When these threaded ring clamps are joined and the knurled ring 30 is turned, the jacket flanges are squeezed together to make a waterproof bond between the two halves 24, 25.

For a better understanding of the socket half 24 of the connector, reference may be made to FIGS. 2 and 3 which show a rigid electrical block 31 provided with three counterbored holes 32, 33 and 34. Three tubular, metallic sockets 35, 36 and 37 are located inside the three holes 32–34. Each tubular socket contains three peripherally spaced, pierced tabs (as at 38). These tabs are bent or inclined toward the center line of the tubular sleeves. Thus, there is a mechanical contact pressure between the socket and plug.

The tubular sleeves or sockets 35–37 are electrically and mechanically connected by soldering (or other suitable means) to shouldered terminal lugs 42 and 43. The diameter of one of the terminal sockets 35 is preferably made larger than the diameter of the remaining sockets to provide a positive means for polarizing the cable terminal.

The insulated cable conductors 22 are electrically connected by soldering or clamping to the terminal lugs 43. The other cable conductor 22 (which does not appear in FIG. 3) is connected to another terminal lug in the counterbored hole 34 (FIG. 2).

The cable 20 includes a metallic shielding 45 just beneath the waterproof jacket. This shielding is connected by wire 46 to one of the sockets, preferably the larger socket 35. Those who are skilled in the art will readily understand the nature of and need for this shielding. It is somewhat like a woven sleeve of metallic wire. This woven sleeve mechanically protects the wire against damage and electrically shields the cable from stray potentials in the ambient surroundings.

Means are provided for extending the electrical shielding into the region of the socket terminals. This shielding means also provides the second function of containing the potting material which strengthens the terminal area.

In greater detail, an electrically conductive sleeve 50 is located, as shown, surrounding the periphery of the insulating block 31 and extending back through the connector terminal region to the jacket of cable 20. The shield 45 from the underwater cable 20 is electrically connected to the end of the sleeve 50 by any suitable means. An electrical connection is also made between the sleeve 50 and the terminal lug 35 by means of the electrical conductor 46.

After the electrical connections are completed, the end of the cable 20 is pushed into the open end of the sleeve 50. Then, a potting compound 51, such as epoxy, is poured into the sleeve 50 in order to encapsulate the entire terminal region, contained within the conducting sleeve 50. The encapsulated region ends at the insulating block 31 and at the exposed end of the cable 20. After the encapsulation of this region, a rubber compound or other suitable elastomer 24 is molded to the cable jacket at 26 and to the periphery of the sleeve 50 and associated assembled terminal structure.

A projecting circular flange portion 27 is preferably formed in the molded rubber structure. This flange provides a means for mechanically securing the connector jacket 24 to a similar peripheral mating flange portion of the connector 25. A retaining ring 30 is provided with threads on a seat which fits against the shoulder of the peripheral flange 27. These threads mate with threads on a retaining ring 30a on the connector portion 25.

The construction of the plug portion of the waterproof connector is illustrated in FIGS. 4 and 5. Here, another circular disk of electrical insulating material 55 is also provided with three holes which receive the terminal pins 56, 57 and 58. These pins are preferably provided with enlarged flange portions which set off the region of the terminal lugs 71 and 72.

The pins may be inserted from the inside surface of the insulating disk. The diameters of the holes are such that the full diameters of the pins 56–58 are snugly fitted throughout the entire thickness of the insulating disk 55. This fit insures a maximum strength for the terminal pins.

The same reference numerals, with the letter "a" suffix, identify parts in the connector half **25** of FIG. **5** which correspond to similar parts in the connector half **24** in FIG. **3**. Since these parts have already been described, it is thought that no further comments need be made in connection with the connector half **25**.

During a final molding operation, a rubberlike compound is applied over both of the assemblies described thus far in order to form the waterproof outer jackets which cover the rigid insulator blocks **31**, **55** and the shield-sleeves **50**, **55***a*. This compound forms a long tapered portion flaring smoothly from the cable to the jacket flange. A relatively heavy wall of rubber is molded to form a recessed cuplike cavity **75** within which the plug terminals **56**, **57** are contained.

A similar heavy wall of rubber is formed as a plug **76** for containing socket terminals. The diameter of the molded rubber cavity **75** surrounding the plug terminals of FIG. **5** is chosen to produce an interference fit relative to the diameter of plug **76** (FIG. **3**).

When the two mating portions **24**, **25** are connected together, the cable shields of the two cables are electrically connected to each other through the plug or pin **56** and the socket terminal **35**. The cross-sectional view of FIGS. **3** and **5** shows that the electrically conducting sleeves **50** and **50***a* form an effective extension of the cable shields so that the shielding is electrically completed throughout the terminal region. Thus, after the connectors are completely engaged, the shielding is practically continuous except for a very small clearance portion of the interface of the plug **76** and cavity **75**. The plug and cavity form a waterproof seal owing to the interference fit. Moreover, the threaded retaining ring clamps **30** and **30***a* located over the cylindrical bodies of the connector halves may be tightened after electrical and mechanical engagement of the connector halves. The ring clamps apply pressure against the mating flange portions **27** and **29**, thus squeezing them together and preventing accidental disengagement of the connectors during vibration or when tension forces are applied to the cables.

The invention is described below in connection with a particular embodiment which illustrates the basic principles of the invention. However, it should be obvious to those who are skilled in the art that various modifications are possible without departing from the principles shown and described herein. Therefore, the appended claims should be construed to cover all equivalents reasonably falling within the true spirit and scope of the invention.

I claim:

1. A separable underwater electrical connector for use in deep water, said connector comprising two connector portions having plug and socket terminal means respectively, each of said connector portions including a rigid block of insulating material, a plurality of pin terminal means located within the rigid insulating block in one portion of said connector, a plurality of socket terminal means located within the rigid block in the other portion of said connector, a metallic sleeve surrounding the periphery of and extending beyond each of said rigid blocks of insulating material, waterproof jacketed cable means including an electrical shield surrounding a plurality of insulated electrical conductors, means for electrically connecting said shield in each of said cable means to a corresponding one of said metallic sleeves and to one of said electrical terminals in the corresponding portion of said separable connector, said insulated electrical conductors being connected to other of said electrical terminal means, and a rigid potting compound filling the terminal region bounded by the inside surface of said metal sleeve, a surface of said insulating block, and the exposed end of said cable.

2. The invention in claim **1** and a waterproof elastomer compound molded over the outside surface of said metallic sleeve and sealed to the outside jacket of said cable.

3. The invention in claim **2** wherein said elastomer is molded over the metallic sleeve on one connector half to form an electrically shielded plug, said elastomer being molded over and projecting beyond the sleeve on the other connector half to form a shielded terminal region having a cavity therein, whereby said two connector halves are almost completely shielded throughout the terminal region.

4. A plug end portion of a separable underwater connector for use in deep water, said plug comprising a rigid block of insulating material having a front surface and a rear surface, holes in said insulating block, electrically conducting pin terminals having enlarged flange portions thereon, said pins snugly passing through said holes in said insulating block, and resting with said flange portions against the rear surface of said block with the pins projecting beyond the front surface of said insulating block, a jacketed underwater cable containing at least one insulated electrical conductor surrounded by a shield located beneath said jacket, a metallic sleeve sealed to the periphery of said insulating block with the open end of said sleeve projecting away from the rear surface of said insulating block toward the end of said shield of the jacketed cable sufficient to effectively provide shielded continuity between the sleeve and shield, means for electrically connecting said shield to said metallic sleeve and to one of said pin terminals, means for electrically connecting said insulated conductor to another one of said pin terminals, and a rigid potting compound means filling the terminal region contained within said metal sleeve and extending from the rear surface of said insulating block to the end of said cable jacket.

5. The invention in claim **4** and means comprising an elastomer compound molded over the outside surface of said metallic sleeve and sealing the outside jacket of said cable.

6. The invention in claim **5** further characterized in that said elastomer compound is molded to form a cup-shaped extension cavity surrounding the terminal pins projecting beyond the front surface of said insulating block.

7. The invention in claim **6** further characterized in that the open end of said cup-shaped cavity is terminated by a flangelike peripheral projection extending outwardly at right angles to its open end.

8. A socket end portion of a separable underwater connector comprising a rigid block of insulating material having a front surface and a rear surface, counterbored holes in said insulating block with the smaller portion of the counterbored holes passing through the front surface of said insulating block, socket terminal means in each hole, the dimensions of said socket terminal assemblies enabling an insertion of said terminals snugly into the counterbored holes from the rear surface of said insulating block, a jacketed waterproof cable containing at least one insulated electrical conductor surrounded by a shield located beneath said jacket, a metallic sleeve sealed to the periphery of said insulating block with the open end of said sleeve projecting away from the rear surface of said insulating block and extending toward the end of said shield of the cable sufficient to effectively provide shielded continuity between the sleeve and shield, said cable shield being electrically connected to said metallic sleeve and to one of said socket terminals, said insulated conductor being electrically connected to another one of said socket terminals, and a rigid potting compound filling the region contained within said metallic sleeve and extending from the rear surface of said insulating block to the exposed end of said cable jacket.

9. The invention in claim **8** further characterized in that an elastomer compound is molded around the outside surface of said metallic sleeve and sealed to the outside jacket of said cable.

10. The invention in claim **9** further characterized in that said elastomer compound is molded to form a projecting cylindrical wall plug portion surrounding the outer periphery of said rigid insulating block and at least part of said sleeve.

11. The invention in claim **10** further characterized in that the base section of said projecting cylindrical wall portion is terminated by a flangelike peripheral area extending outwardly in a plane normal to said plug.

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