United States Patent

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[73] Assignee **The United States of America as represented by the Secretary of the Navy**

[54] **PRESSURE-BALANCED ELECTRICAL ASSEMBLY**
11 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** ..... **339/117 R,** 339/104
[51] **Int. Cl.** **H01r 13/52**
[50] **Field of Search** 339/117, 60, 94; 174/88, 25, 88.3, 70.1

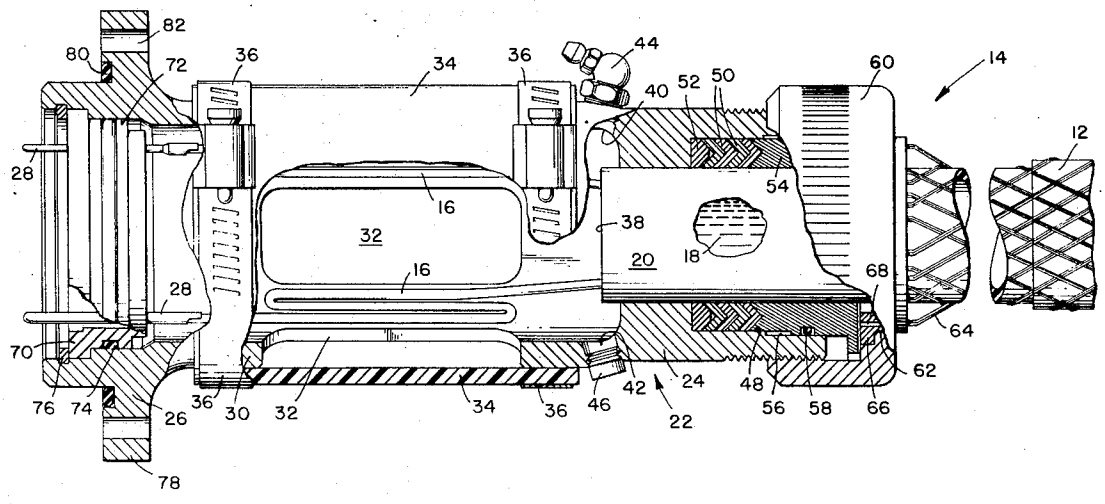
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ABSTRACT: A pressure-balanced electrical assembly for a grease-filled nonhosing cable comprising: an elongated generally tubular housing; one end of the housing being adapted to sealably receive the cable; the other end of the housing being sealed and having a feed-through terminal extending therethrough for connection to the end of a cable lead; an intermediate portion of the housing being fluid-sealed and pressure-exposed to the ambient environment, said intermediate portion being capable of receiving said lead therethrough for connection to the feed-through terminal; and an opening into the intermediate portion of the housing for pressure filling said portion with a semiliquid.



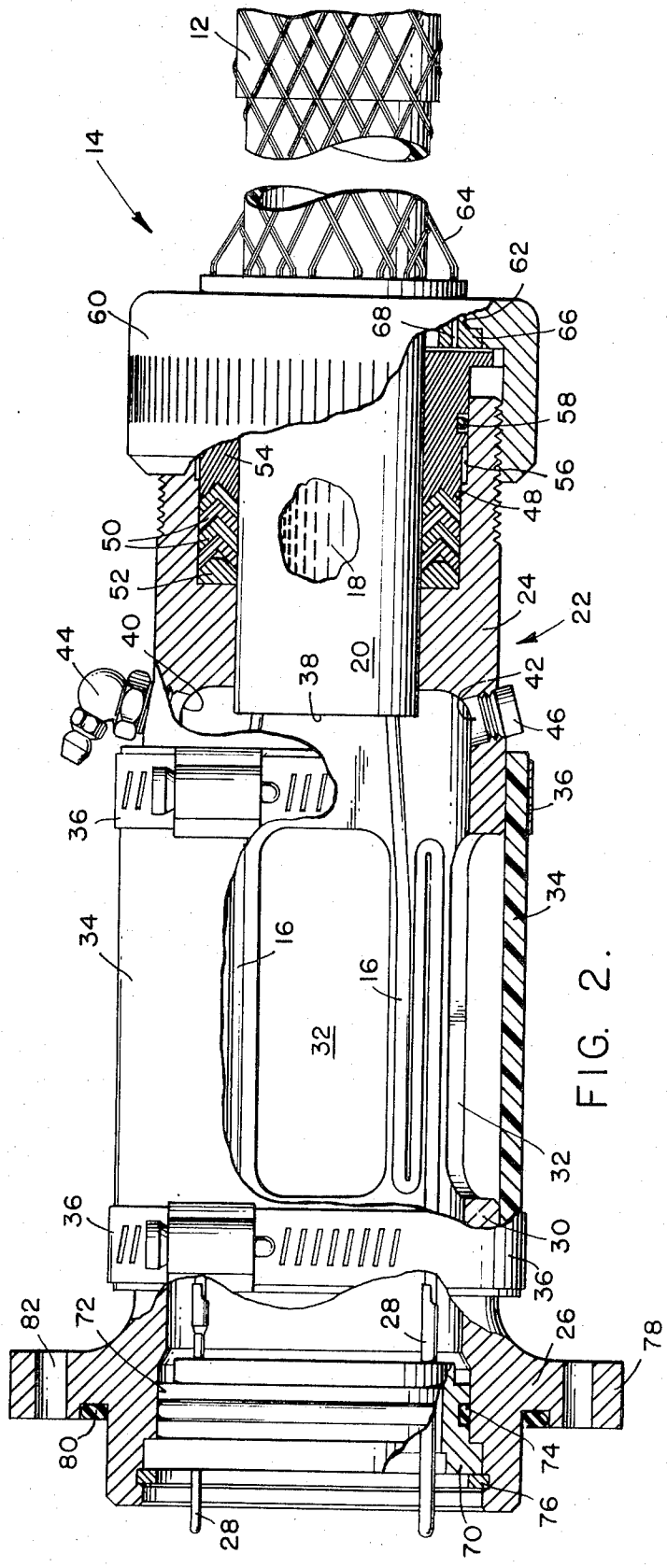


FIG. 2.

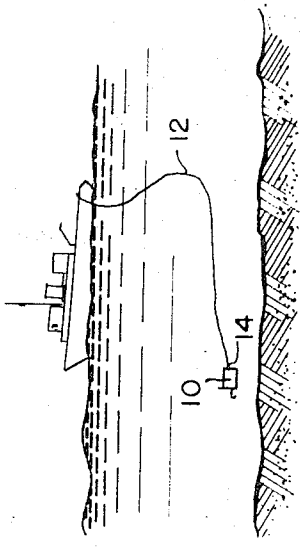


FIG. 1.

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PRESSURE-BALANCED ELECTRICAL ASSEMBLY

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

In deep ocean salvage or exploratory work a power cable is often used between the underwater device and a mother vehicle. In many instances this cable extends from the high sea-pressure environment through a connector into an atmospheric pressure within the underwater device or mother vehicle. A nonhosing cable is commonly employed for providing power in high-pressure submerged environments. Nonhosing electrical cable is commercially available and normally has a plurality of wires which are disposed in a flexible jacket which is filled with a greaselike material, such as "Duct-Seal" manufactured by Johns Manville. In the past the connection such a cable has been made by potting the cable wires in a connector housing. When the underwater device or mother vehicle operates at various depths there are pressure cycles which cause the potting material within the connector housing to flex. This flexing causes leak paths to develop along the inside wall of the housing or along the conducting wires. Eventually the cable wires become weakened and break and may be subjected to salt water.

SUMMARY OF THE INVENTION

The present invention overcomes the aforementioned problems associated with the prior art underwater connectors by providing an electrical connector assembly which is pressure-balanced between the wires of the cable and the ambient ocean environment. This is accomplished by providing a generally tubular housing, one end of which is sealed and has a feed-through terminal connector for connecting to one end of a cable wire. An intermediate portion of the housing is fluid-sealed and pressure-exposed to the ambient ocean environment and is capable of receiving the cable wire therethrough for connection into the terminal connector. The intermediate portion of the housing has an opening for introducing a liquid, such as grease, within the intermediate portion so that the cable wire within the intermediate portion will be within a pressure-balanced area with respect to the ambient ocean pressure. With such an arrangement the troublesome potting compound is eliminated and cyclic pressures have no detrimental effect on the cable wires.

STATEMENT OF THE OBJECTS OF THE INVENTION

An object of the present invention is to overcome the problems associated with the aforementioned prior art underwater electrical connectors;

Another object is to provide a pressure-balanced electrical connector assembly for a nonhosing cable wherein cyclic pressures have no detrimental effect on the cable wires.

A further object is to provide a deep submergence pressure-balanced electrical assembly which is highly reliable, low in cost, and easy to assemble.

Other objects and many of the attendant advantages of this invention will be readily appreciated as it becomes better understood by reference to the description and accompanying drawings which follow.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an ocean elevation view of an underwater vehicle being controlled from a surface vessel.

FIG. 2 is a side view of the electrical connector assembly with portions cut away to show various details thereof.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing there is shown in FIG. 1 an underwater device 10, such as an underwater vehicle, which is controlled from a surface ship by a cable 12. This operation is quite common in the Navy and the underwater vehicle is entitled CURV (cable underwater recovery vehicle). The cable 12, which is a nonhosing type, may be connected to the CURV vehicle 10 by a pressure-balanced electrical connector assembly 14, which is illustrated in FIG. 2. The nonhosing cable 12 is commercially available and includes a plurality of wires 16 which are packed by a grease 18, commonly referred to as "duck-seal," within a jacket 20. The nonhosing cable is particularly suitable for deep ocean work since the cable is pressure-balanced and the grease 18 is not extruded from the jacket 20 when there is any penetration thereof. In the CURV vehicle the connector assembly 14 may connect the cable wires 16 between the ambient ocean-pressure environment and an atmospheric-pressure environment within the vehicle.

As illustrated in FIG. 2, the electrical connector assembly 14 may include a generally tubular housing 22, one end portion 24 of the housing being adapted to sealably receive the cable 12 and the other end portion 26 being sealed and having a feed-through terminal connector 28 which is adapted at its inner end to be connected to a respective one of the cable wires 16 and is adapted at its outer end to mate with a plug (not shown) within the atmospheric environment of the CURV vehicle. An intermediate portion 30 of the housing is fluid-sealed and pressure-exposed to the ambient environment and is capable of receiving the cable wires 16 therethrough for connection to the terminal connectors 28.

A preferred means for fluid-sealing and pressure-exposing the intermediate housing portion 30 to the ambient environment includes the intermediate portion 30 having a plurality of elongated apertures 32, and a flexible boot 34 sealably mounted about the intermediate housing portion 30 and its apertures 32. The boot 34, which may be fabric-reinforced neoprene, may sealably engage the intermediate portion 30 on opposite sides of the apertures 32 by a pair of spaced-apart worm drive clamps which are commonly referred to as "hose clamps." It is preferable that the housing portion 24, which is adjacent to the intermediate housing portion 30, have an exterior diameter which is the same as or less than the exterior diameter of the intermediate housing portion so that upon loosening of the clamps 36 the boot 34 may be slipped from the intermediate housing portion to expose the apertures 32 and enable filling the intermediate housing portion 30 with a semiliquid, such as silicon grease.

As illustrated in FIG. 2 the cable 12 sealably extends through the receiving end 24 of the housing, and the jacket 20 and grease filling 18 of the cable terminates adjacent the intermediate housing portion 30 so as to form an interface 38 with the semiliquid within the intermediate housing portion. From the interface 38 the cable wires 16, which may be individually jacketed, extend through the intermediate portion 30 and the semiliquid therein to their connection with the terminal connectors 28.

It is desirable that the intermediate housing portion 30 be filled with the semiliquid under a slightly positive pressure above atmospheric, such as 10 p.s.i. above atmospheric pressure. This may be accomplished by providing a fill-opening 40 and a vent-opening 42 into the intermediate housing portion 30. A grease-fitting 44 may be threaded within the fill-opening 40 and a stopper plug 46 may be threaded within the vent opening 42. With this arrangement a grease gun may be applied to the fitting 44 and grease inserted into the intermediate housing portion 30 until all air is expelled through the vent-opening 42. The plug 46 may then be threaded into the vent-opening 42 and grease applied within the intermediate portion 30 until the desired positive pressure is attained.

In order to sealably receive the cable 12 in the receiving end portion 24 of the housing this housing portion may be provided with a counterbore 48. Within this counterbore and

about he cable jacket **20** there may be a series of annular packing glands **50** between a pair of male adapters **52** and **54**. The counterbore **48** may have a still further counterbore **56** in which an enlarged diameter portion of the adapter **54** and an O-ring **58** may be received for sealing purposes. In order to tighten the packing glands **50** for sealing action against the cable jacket **20** a capnut **60** with a central opening **62** may be threaded on the receiving end **24** of the housing. With such arrangement salt water intrusion into the intermediate portion **30** of the housing is prevented by the sealing actions of both the O-ring **58** and the packing glands **50**.

In order to take up some of the strain on the cable **12** and provide a fair-lead of the cable from the receiving end of the housing a "Kellem" grip **64** ("Chinese finger") may be connected to the receiving end of the housing. The wires of the "Kellem" grip **64** may be connected to an annular insert **66**. The annular insert **66** may be received within the central opening **62** of the nut **60** and may be retained in place by an annular flange which is received within a counterbore within the central opening **62** of the nut. The insert **66** may have a longitudinal aperture **68** for introducing the ambient pressure to the O-ring **58** and packing glands **50**.

At the terminal end **26** of the housing there may be located a plug **70** which is sealably disposed within a central opening **72** of the housing. Extending through the plug **70** are a plurality of feed-through terminal connectors **28**. These connectors, which are commercially available, are threaded within the plug **70** so as to make a pressure seal therethrough. Alternatively, the plug **70** may be a multipin connector in which the pins are fused in place, such as by glass, in the plug.

The plug **70** may be sealed to the central opening **72** by an O- ring **74**, and may be retained in place by a retainer ring **76**.

The outer ends of the terminal connectors **28** are adapted for insertion in a multisocket connector (not shown) within the atmospheric environment of the underwater device. In order to mount the terminal end **26** of the housing to the underwater device the terminal end may be provided with an annular flange **78**. This flange may have an O-ring **80** for making sealing engagement with the exterior surface of the underwater device, and may have openings **82** for receiving bolts (not shown) which are threaded into the underwater device.

In the operation of the pressure-balanced underwater connector **14** the cable **12** is stripped of its jacket **20** and its inner grease so as to expose a required length of cable wires **16** for extending between the interface **38** and the terminal connectors **28**. With the boot **30**, male adapters **52** and **54**, and the nut **60** all removed, the cable is inserted within the housing **22** until the cable jacket and grease therein forms an interface at **38**. The ends of the cable wires **16** are then soldered to the interior end of the terminal connectors **28**. The aforementioned components of the connector assembly are then assembled as shown in FIG. **2** and a semisolid, such as silicon grease, is inserted through fitting **44** into the intermediate housing **30** about the cable wires **16** until all air is expelled through the vent-opening **42**. The plug **46** is then threaded in the vent-opening **42** and grease is applied through the fitting **44** until a positive pressure exists between the intermediate housing portion **30** and the outside atmospheric environment. The connector assembly **14** may then be mounted to the underwater device and submerged to its operating depth. At the operating depth the flexible action of the boot **34** balances the pressure between the intermediate housing portion **30** and the outside ocean environment.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

I claim:

1. A pressure-balanced electrical connector assembly for a cable of the type having at least one electrical wire in a flexible jacket filled with a liquid, comprising:

a generally tubular housing;

one end of the housing being adapted to sealably receive the cable;

the other end of the housing being sealed and having a feed-through terminal connector extending therethrough for connection to the end of a cable wire;

an intermediate portion of the housing being capable of receiving said wire therethrough for connection to the terminal connector;

the intermediate housing portion having at least one aperture; and

a flexible boot sealably mounted about the intermediate housing portion and its aperture so as to fluid-seal and pressure-expose the intermediate housing portion to the ambient environment.

2. A connector assembly as claimed in claim **1** comprising:

said intermediate portion having an opening to the ambient environment for pressure-filling the intermediate portion with a liquid.

3. A connector assembly as claimed in **1** comprising:

a housing portion adjacent to the intermediate housing portion having an exterior diameter no greater than the exterior diameter of the intermediate housing portion so that the boot can be slipped from the intermediate housing portion to expose said aperture.

4. A combination as claimed in claim **1** including:

said cable, the cable having a jacket which contains at least one electrical wire and a grease filling;

said cable sealably extending through the receiving end of the housing;

the cable jacket and grease filling terminating adjacent the intermediate housing portion so as to be capable of forming an interface with liquid in the intermediate housing portion; and

said wire extending through the intermediate housing portion.

5. A connector assembly as claimed in claim **2** comprising:

a grease-fitting threaded within the liquid-filling opening of the intermediate housing portion; and

a vent-opening in said intermediate housing portion.

6. A connector assembly as claimed in claim **5** comprising:

the receiving end of the housing having a counterbore;

a male adapter and packing glands received within said counterbore;

an annular insert engaging the male fitting and connected to a Kellem grip for said cable; and

a capnut with a central opening threaded on the receiving end of the housing for tightening the annular insert, male adapter, and packing glands.

7. A connector assembly as claimed in claim **7** comprising:

the terminal end of the housing having an opening;

a plug sealably disposed within the terminal end opening; and

said feed-through terminal connector extending through the plug.

8. A connector assembly as claimed in claim **7** comprising:

a housing portion adjacent to the intermediate housing portion having an exterior diameter no greater then the exterior diameter of the intermediate housing portion so that the boot can be slipped from the intermediate housing portion to expose said aperture; and

a pair of worm drive clamps sealably retaining the flexible boot about the intermediate housing portion.

9. A combination as claimed in claim **8** comprising:

said cable, the cable having a jacket which contains at least one electrical wire and a grease filling;

said cable sealably extending through the receiving end of the housing;

The cable jacket and grease filling terminating adjacent the intermediate housing portion so as to be capable of forming an interface with liquid in the intermediate housing portion and

said wire extending through the intermediate housing portion.

10. A combination as claimed in claim **9** comprising:

said intermediate housing portion being filled with a grease.

11. A combination as claimed in claim 10 comprising:

said intermediate portion having an opening to the ambient environment for pressure-filling the intermediate portion with said grease.

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