Abstract: A series of layers of silver gauze are welded to a central silver nut to form a reference electrode. The electrode is threaded onto the end of a silver-plated phosphor bronze connecting rod which extends through a ship's hull by way of a waterproof stuffing tube. Interposed between the hull and the electrode is an insulating layer with the electrode spaced therefrom while the rod is provided with an electrically insulating outer layer to minimize the development of undesirable potentials between the rod and the stuffing tube. A holder cover is situated over the reference electrode, permitting free flooding of the area proximate the electrode without excessive turbulence so that the electrode can be employed to monitor and control the impressed cathodic protection system of the ship.
Fig. 2
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UNDERWATER REPLACEABLE REFERENCE ELECTRODE

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

1. Field of the Invention

The present invention relates to an improved current-cathodic protection system for the hull of a metallic ship, and more particularly pertains to an underwater reference electrode wherein the electrode can be replaced while the ship is in the water without any possibility of hull leakage.

2. Description of the Prior Art

In the field of automatic impressed current cathodic protection systems, it has been the general practice to employ a previously installed spare reference electrode when the primary electrode has deteriorated or has become unserviceable for any reason. In the event the spare should fail, the system must be controlled manually instead of by the reference electrode, which provides the control sensing element until the ship is dry docked. Another reference electrode structural arrangement is presently available wherein the spent electrode element is ejected out of the stuffing gland into the ocean from inside the ship. However, the problem of leakage has not been completely solved and the stuffing gland may require replacement, since it does not always mate properly with the new electrode. Thus, this arrangement cannot be used under deep submergence conditions such as in submarines.

SUMMARY OF THE INVENTION

The general purpose of this invention is to provide a replaceable reference electrode that has all the advantages of similarly employed prior art devices and has none of the above described disadvantages. To attain this, the present invention provides a unique structural reference electrode arrangement wherein the gauze layered electrode elements are welded to a silver plated bronze rod extending from within the ship. The rod is covered with an electrical insulator to minimize any potential between the rod and the stuffing tube.

An object of the present invention is to provide a reference electrode mounting on a ship's hull which is arranged so constructed that it can be readily replaced underwater without disturbing the watertight integrity of the hull.

Another object is to provide a simple, inexpensive, reliable and replaceable reference electrode suitable for use as the sensing element in an automatic impressed current cathodic protection system.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional elevation of an embodiment made in accordance with the principle of this invention; and

FIG. 2 is a plan view of the embodiment of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the embodiment of FIG. 1 the ship's hull 10 is provided with an aperture 11 in which is fitted one end of a stuffing gland body 12 that is welded in this position to the hull, the aperture 11 being aligned with the aperture 13 of the fiber glass holder base 14. When the base 14 is affixed to the hull, it is set in a layer of epoxy putty 15 which completely fills the area between the hull and the holder base to eliminate any voids or air pockets. The cylindrical passage 16 of the body is open from end to end and at the end that is anchored to the hull it is aligned with the aperture 13 in the holder base 14.

The passage 16, intermediate of its ends, has a shoulder 17 facing the free end of element or body 12 that is larger in diameter from the shoulder 17 to the free end of the body 12. A tubular liner sleeve 18 of electrically insulating material fits the aperture 13 of the holder 14 and the passage 16 from the base holder 14 to the shoulder 17.

A rod or pin 19 of electrically conducting material such as phosphor bronze or other suitable metal is provided with an insulating coating over an outer silver plating. The insulating coating can be a general purpose epoxy and need only extend between the upper threaded portion 20 and the lower threaded portion 21. The purpose of this coating is to prevent the generation of any potential between the pin 19 and the body 12 upon the intrusion of sea water. A rectangular washer 22 is welded or brazed on to the pin 19 so as to prevent turning of the pin when the reference electrode is threaded therein. The washer 22 is coated with an epoxy for the same reason as the reason for coating the pin. Packing material 23 of electrically insulating material is disposed around the rod 19 in the larger diameter part of the passage and abuts against the shoulder 17. This packing material may be V-packing rings of synthetic rubber, abutting end to end and against shoulder 17. The tubular stuffing gland 24 is threaded into the free end of body 12 to abut against the outer end face of the packing material 23 and to compress it against shoulder 17 and thereby deform such material against the wall of the passage and against the rod 19.

Another liner sleeve 25 of electrically insulating material fits the rod 19, outwardly beyond the packing means, and also the passageway of gland 24 to the outer end of the gland. An electrically insulating washer 26 fits over the rod 19 and abuts the other end of liner sleeve 25 and the outer face of the gland 24. A nut 27 is threaded on the rod 19 to confine the washer 26 against the outer end of the gland 24. A second washer 28 of electrically insulating material is fitted over the end of rod 19 to abut against the outer face of nut 27. A metallic cup-shaped collar or member 29 is threaded over the exterior of the free end of body 12 and has an aperture 30 in its end through which the rod 19 loosely passes, with the inner face of this end abutting against the washer 28 to confine it against the nut 27. A liner sleeve 31 surrounds the rod 19 and passes through the aperture 30, abuts washer 28 and extends outwardly away from the member 29, but does not extend entirely to the free end of the rod 19. A metal terminal connector 32 has an aperture through which the threaded free end of the rod 19 extends and the nuts 33 threaded on the end of the rod 19, on opposite sides of terminal 32, enable the terminal to be confined on the rod 19 against the outer end of liner sleeve 31. The terminal 32 is connected by wire 34 to the control device of the cathodic protection system.

Hull studs 35 extend outwardly of the hull, pass through openings in the base holder 14 and terminate in a threaded end which carries nuts 36 so as to secure the holder against the hull. The enlarged opening around the nut 36 is filled with epoxy 37 as is the area 38 immediately adjacent the holder 14, which provides a smooth flare to the hull. Disposed about the upper portion of the pin 19 is a fiber glass flange 39 which is secured by machine screws 40 threaded into the holder 14 and has its upper shoulder 41 bearing against a neoprene gasket 42 to form a waterproof seal against the upper surface of the holder 14. A second neoprene gasket 43 provides sealing of the pin 19 by being compressed between the flange 39 and rectangular pin washer 22.

A reference electrode 44 comprises a hexagonal silver head 45 having a central internally threaded portion 46 which mates with and is threaded on the upper pin 19 portion. The head 45 has an outwardly extending or body 12 and abuts which has been welded thereto the electrode element 48. The electrode element is of standard silver-silver chloride and consists of treated silver gauze, woven of silver wire approximately 10 mils in diameter to a No. 40 mesh. This silver wire is not less than 99.95 percent pure silver and the gauze is wrapped in a 1-
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inch wide fine-wire saran screen woven of saran wire (copolymer of vinylidene chloride and vinyl chloride) approximately 15 mils in diameter. Teflon spacers 49 recessed into the base holder 14 support the electrode element 48 horizontal or parallel to the hull 10. The base holder 14 has an enlarged central recess about the reference electrode and the holder circumferential recess wall is provided with threads 50. Disposed and threaded therein is a fiber glass holder cover 51 which is secured by a nylon thread lock 52. The holder cover has provided therethrough a plurality of openings 53 to admit the free passage of water into the plenum formed between the cover 51 and the holder 14 so as to immerse the reference electrode in the sea water without the generation of excessive turbulence due to the ships motion.

With regard to replacement of the reference electrode, it is quite clear that a diver merely unscrews the perforated cover 51, then unthreads the electrode, substitutes a new electrode element and then replaces the cover 51 without disturbing the stuffing gland and the packing.

I claim:

1. In an impressed current cathodic protection system for a ship, a replaceable reference electrode holder structure which comprises:

- a conductive hull of such ship,
- a metallic silver rod having an insulating coating of epoxy and threaded at both ends,
- a watertight means passing through said ship's hull and carrying therein said rod and having said threaded ends thereof extending out of and past said watertight means for providing communication of said rod between the interior and the exterior of such ship,

- a base holder of electrically insulating material disposed on the outer surface of said hull and having a central enlarged opening through which said rod extends, means for tightly securing said holder to said hull, a reference electrode threaded on the end of said rod, said reference electrode comprising a silver head portion having a central threaded aperture and an extending flange having welded thereto an electrode element formed of layers of silver gauze extending radially outwardly, and a perforated cover releasably disposed across and closing said central enlarged opening to form a plenum having therein said electrode.

2. The structure according to claim 1 further including Teflon plug spacer means carried by said base holder and extending outwardly thereof in abutting relation with said element for support thereof.

3. The structure according to claim 2 further including means for preventing rotation of said metallic rod during replacement of said reference electrode.

4. The structure according to claim 1 further including a plurality of neoprene gaskets disposed about said rod between said head portion and said base holder to prevent the entrance of water.

5. The structure according to claim 4 wherein said perforated cover is a circular disc whose peripheral wall is threaded to mate with similar threads on the wall of said central enlarged opening of said base holder.

6. The structure according to claim 5 further including a layer of insulating epoxy between said base holder and said hull.

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