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3,038,849

INSOLUBLE TRAILING ANODE FOR CATHODIC PROTECTION OF SHIPS

Filed Oct. 7, 1958

2 Sheets-Sheet 1

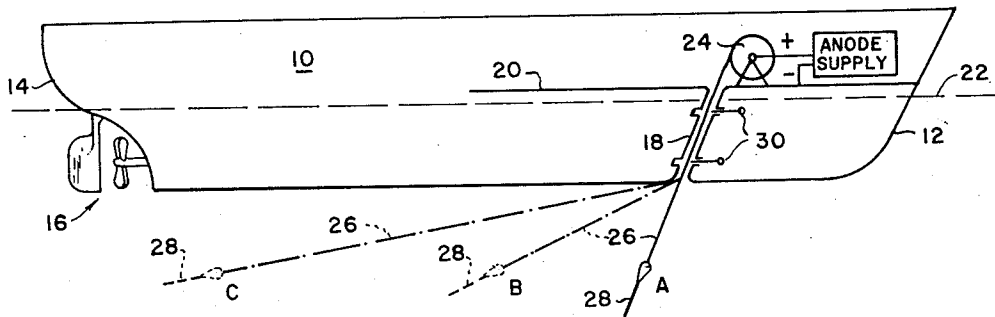


FIG. 1.

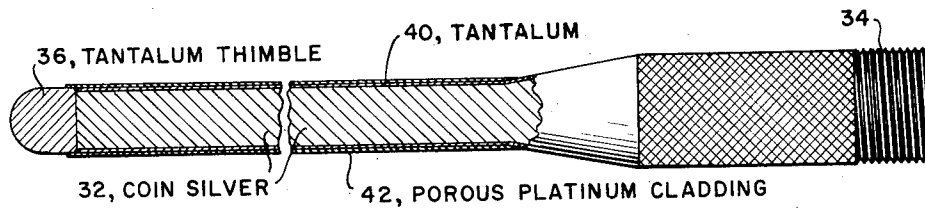


FIG. 2.

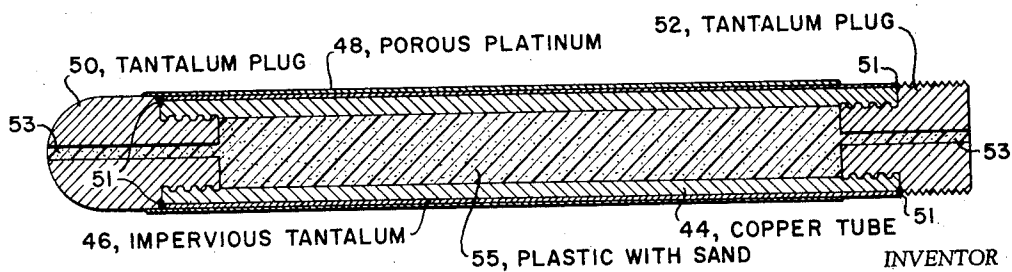


FIG. 3.

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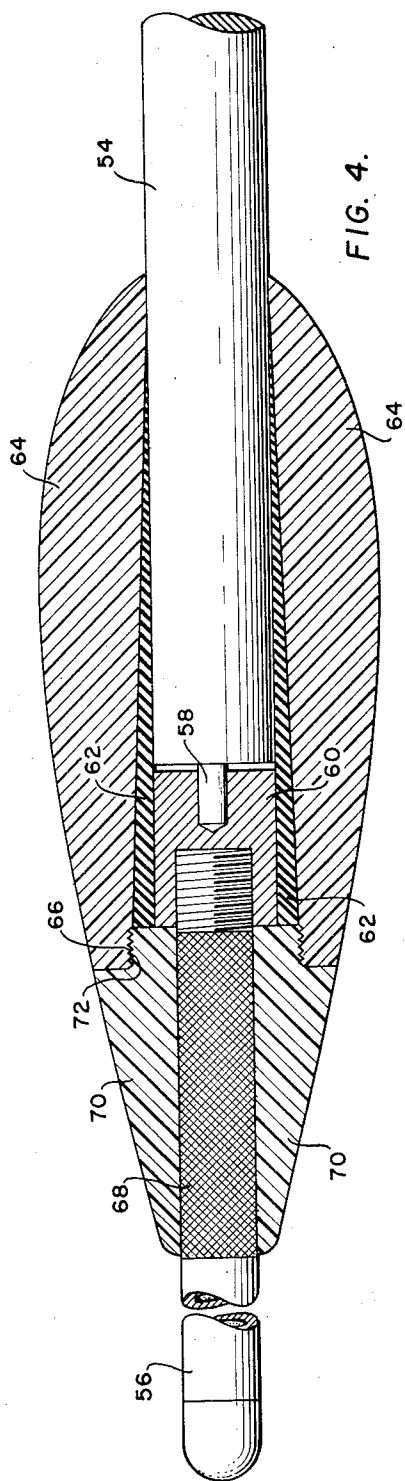


FIG. 4.

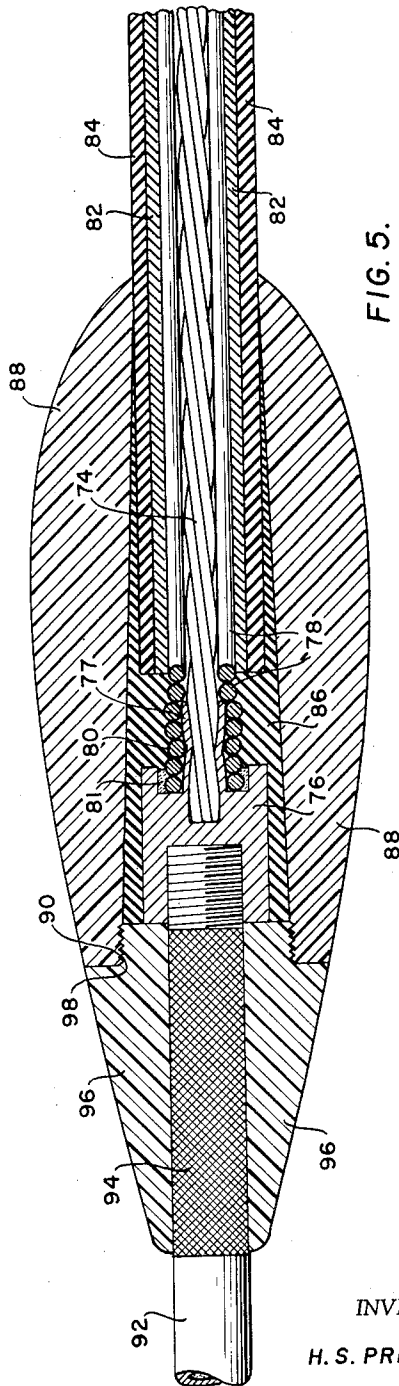


FIG. 5.

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1

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INSOLUBLE TRAILING ANODE FOR CATHODIC PROTECTION OF SHIPS

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3 Claims. (Cl. 204-196)

(Granted under Title 35, U.S. Code (1952), sec. 266)

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.

This invention relates to an insoluble trailing anode for cathodic protection of ships and more especially to an anode rod having a plurality of coatings whereby the cost of the rod may be appreciably reduced.

This invention also relates to a system and apparatus for retrieving a trailing cathodic protection anode and cable without damage despite variations in the speed of the towing ship.

In order to reduce the fatigue in the cable used in a cathodic protection system, a steel-cored cable is herein disclosed to provide a long and useful life for the system.

Due to the possibility of damage or bending of the anode rod, a combined detachable connection and corrosion proof seal between the anode rod and cable are further disclosed herein.

The corrosion of ship hulls exposed to sea water is due to galvanic action which involves the generation of an electric current between two metals or between heterogeneous sections of the same metal having different oxidation reduction potentials. The metal which becomes more corroded has a lower oxidation reduction potential and is referred to as anodic or the least noble in the electrochemical series and the metal which is less corroded and has a higher oxidation reduction potential is referred to as cathodic or more noble, e.g., in an ordinary galvanic battery zinc is the more corroded and is less noble while the copper is more noble and the least corroded of the two.

Steel ships, particularly in sea water, corrode because the steel hull is anodic with respect to the copper or nickel alloy propellers and to carbon or noble metal alloys in the steel itself. Also, differences in velocity, concentration or oxygen of the seawater cause potential differences, which in turn cause corrosion of the hull. This corrosion may be prevented by passing an electric current from an auxiliary anode in the electrolyte near the ship to the hull, making the hull cathodic at such a rate that polarization occurs. Polarization is accompanied by a layer of hydrogen formed over the hull. This layer of hydrogen partially insulates the steel hull from the electrolyte and nullifies potential differences on the hull to inhibit corrosion. The pH of the adjacent water is raised to induce a predominantly calcium carbonate precipitate on the hull which is insulating, relatively permanent, and readily renewable.

In order to achieve uniform current density over the hull, an "Insoluble Trailing Anode for Cathodic Protection of Ships," copending patent application Serial No. 530,647, filed August 25, 1955, now Patent No. 2,863,819, issued December 9, 1958, by Herman S. Preiser, has been proposed. That proposed system included a ship an electric generator, an electric cable adapted to be towed behind the ship, and an insoluble electrode anode rod attached to the end of the cable and spaced at least 500 anode diameters away from the ship.

In cathodic protection system, the anode material will corrode rapidly unless an insoluble anode, such as disclosed in patent application Serial No. 530,647, supra,

2

comprising a conducting rod having a pore-free, platinum or platinum alloy coating of about 5 mils thickness or .005 inch is provided. If the platinum coating is made thinner or slightly porous, however, the conducting rod will become exposed to the electrolyte and will be rapidly corroded by the electric current.

In order to reduce the cost of the anode, it is the primary purpose of the present invention to provide an anode rod by first coating a conducting anode rod with a non-porous tantalum or titanium layer about 10 mils thick and then to apply a thin layer of platinum or platinum alloy about a 1/4 mil thick, which may be quite porous, over the tantalum or titanium. The conducting rod is protected from electrolysis by the tantalum or titanium layer which forms a protective, non-conductive oxide when electrolyzed in water. At the same time a metallic conductive path is provided from the rod to the insoluble platinum coating by the tantalum or titanium layer.

The anode rod should trail smoothly through the water which is accomplished by making the weight per foot of the rod equal to that of the cable. In one embodiment a four foot rod having a diameter of 1/4 inch was constructed. A difficulty with this type of rod is that its weight per foot is fixed which requires that it be used with a particular cable.

Another object of this invention is to disclose an anode rod comprising a conducting tube with the thick tantalum or titanium and thin platinum coatings, where the tube is adapted to be filled with an inert material such as a plastic filled with sand whereby the weight per foot of the rod may be easily adjusted to the desired value depending on the particular cable to which it is to be connected. In addition, the tube has a larger diameter which increases the mechanical stiffness of the rod and which has a hydrodynamic drag equal to that of the cable.

Other objects and advantages of the invention will hereinafter become more fully apparent from the following description of the annexed drawings, which illustrate a preferred embodiment, and wherein:

FIG. 1 is a pictorial view of a ship having an insoluble trailing anode and retrieving system in accordance with a preferred embodiment of the invention;

FIG. 2 is a view, partly in cross-section, of the insoluble trailing anode rod having the plural coatings;

FIG. 3 is a view, partly in cross-section of the tube form of the trailing anode rod with the plural coatings;

FIG. 4 is a view, partly in cross-section, of the detachable connection and corrosion proof seal between the trailing anode and the cable; and

FIG. 5 is a view, partly in cross-section of the combination steel-cored cable with a helically wound copper conductor and corrosion proof seal.

Referring now to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in FIG. 1 (which illustrates a preferred embodiment) a trailing anode system installed on a ship 10 having a bow 12, a stern 14, and a propeller and rudder assembly 16.

A rubber or plastic lined pipe 18 is attached to the hull of the ship, preferably near the bow 12, and extends upward to an internal water-tight deck 20 above the water line 22. A retrieving reel 24 is mounted on the internal deck 20 having a cable 26 wound thereon which extends down through the rubber or plastic lined pipe 18 and into the sea water below the ship where it is terminated by a trailing anode rod 28. One or more gate valves 30 may be used to partially close the pipe 18 so that sea water will not be forced up the pipe when the ship 10 is pounding in a heavy sea and to provide a watertight hull closure in cease of damage to pipe 18.

3

The anode rod 28 and cable 26 will hang vertically as at position A when the ship 10 is docked or moving slowly, but, due to their hydrodynamic resistance and residual drag, the rod and cable will move towards the stern 14 of the ship 10 to positions B and C. In an actual case at position C, the distance to the keel at 20 knots ship speed on a 200' cable length was 20'. The retrieving reel 24 will pay out the cable as the speed of the ship increases to a limiting position which prevents fouling of the rod and cable in the propeller and rudder assembly.

The primary purpose of the cable 26 is to remove the rod 28 far enough away from the ship 10 to insure an even current distribution over the surface of the ship, since experience with hull-mounted anodes has shown that, if the corrosion-inhibiting anode is placed too close to the hull, the driving voltage needed to protect the more distant parts of the hull will quickly destroy paint films over adjacent parts of the hull near the anode. The cable therefore removes the anode to a point where relatively equal resistance is obtained through the sea water to all parts of the hull thereby insuring uniform current distribution at a safe constant driving voltage despite variations in the speed of the ship.

Satisfactory cathodic protection may be obtained by supplying a current of 5 milliamperes per square foot of hull surface. A large ship, such as a Navy T-2 tanker having a dead weight tonnage of 16,000 tons and about 35,000 square feet of underbody, would require a current of 175 amperes through a cable, anode, sea path, and hull resistance of 0.4 ohm driven by a 70 volt, 12 kilowatt generator. The large current and low resistance requirements made necessary highly conductive cables and anode rods. The corroding action of the large currents on the anode rod required an insoluble coating of platinum or palladium or insoluble alloys thereof.

A coin silver rod having a .005 inch non-porous coat of platinum was disclosed in patent application Serial No. 530,647, supra, but further reduction in cost may be made in accordance with the present invention without any decrease in performance.

Referring to FIG. 2, a coin silver, copper, or highly conductive rod 32 is disclosed having a threaded end section 34 for attachment to a cable. A first coating 40 of tantalum or titanium of about .010 inch thick, which is non-porous, is clad on the rod 32 and then a very thin layer 42 or flash of platinum or palladium or insoluble alloys thereof of about 1/4 mil or .00025 inch in thickness is applied by cladding or plating over the tantalum or titanium layer 40. A tantalum or titanium thimble 36 is swaged to the other end of the rod and welded to the tantalum or titanium coat 40 to form a watertight joint.

In actual use the tantalum or titanium may be exposed to the electrolyte, but has the property of forming an inert oxide which is insulating to the flow of electrolytic currents. The electric current flow from the rod 32 through the tantalum or titanium layer 40 to the platinum layer 42 is maintained however.

If the tantalum or titanium coating 40 is used on a rod without the platinum layer 42, the insulating oxide film will build up to prevent electrolytic and electric current flow which will gradually decrease the electric current to zero. When the oxide build-up is complete over the tantalum or titanium coated rod, there will be no electric current flow up to about 12 v. When the voltage across the oxide film is raised up to about 15 volts, the oxide film will begin to puncture or break down and the rod will then be rapidly corroded away by electrochemical action.

If the platinum layer 42 is clad or plated over the tantalum or titanium coating, the platinum layer 42 will carry most of the current with a very small voltage drop and therefore the oxide film which is in parallel with the platinum layer 42 will be maintained over the tantalum or titanium in a safe voltage range and will prevent corrosion of the rod. The reduction in thickness of the

4

platinum layer 42 therefore affords an appreciable reduction in the material and fabrication cost of the rod without any decrease in performance.

In order to easily vary the weight per foot of the rod, a hollow trailing anode rod is shown in FIG. 3 comprising a copper or coin silver tube 44, a tantalum or titanium coating 46, and an outer layer 48 of platinum or palladium where the coatings are applied similar to the coatings shown in FIG. 2.

Two tantalum or titanium end plugs 50 and 52 having holes 53 are inserted in the ends of the tube 44 and crimped in place. The plugs 50 and 52 are welded to the tantalum cladding 46 at points 51. The plug 50 has a rounded end for smooth trailing in the water while plug 52 has a threaded end for connection to the cable.

After plugs 50 and 52 are attached to the tube 44, the center of the tube may be filled through holes 53 with a plastic 55 such as a polyester resin to which an inert filler such as sand may be added to make the weight per foot of the tube equal to that of the cable so that both the cable and rod will trail smoothly through the water without flexing of the joint between them.

Referring to FIG. 4 a detachable trailing anode joint is shown between the cable 54 and the trailing anode rod 56, which rod may be any one of the types previously described. The conductor part 58 of the cable 54 is soldered or otherwise connected to a cylindrical tantalum connector 60 at one end. The other end of the tantalum connector 60 is threaded for attachment to a trailing anode rod 56. A molded rubber tapered seal 62 is formed around the connector 60 and the end of the cable 54. A Teflon (polytetrafluoroethylene) collar 64 having an inner threaded end 66 is machined to fit around the seal 62 and over the end of the cable 54.

The threaded end 68 of the rod 56 is knurled to allow a sleeve 70 made of a cast polyester resin with fiberglass reinforcing or a high impact polyvinyl chloride resin to be molded thereon. The sleeve 70 also has a threaded section 72 to mate with the Teflon collar thread 66.

Longitudinal flexing of the copper conductor in the cable due to the pitch and roll of the ship may be minimized by a cable shown in FIG. 5 having a central steel wire core 74 attached to a tantalum connector 76 by crimping the connector 76 at tube 77 at the trailing end of the cable. A concentric rope lay, bunch stranded copper conductor 78 for carrying the electric current is formed around the steel core 74, and, near the terminal end of the copper, the bunches are twisted into a tighter helix form as at 80 and connected by soldering 81 to the tantalum connector 76. The steel core acts as a tension member to support the trailing anode rod while the helically wound copper conductor will withstand a great deal of flexing without breaking.

In a typical embodiment of the helically wound cable, the plow steel core 74 was made of 37 AWG #23 wires which were rope lay stranded in a herringbone design. Six similarly constructed annealed copper members 78 are concentrically or bunch wound around core 74 with a proper lay to insure maximum flexibility. For a 175 ampere trailing anode as described, supra, the total conductor cross-section was equal to AWG #2/0. The insulator 82 was a heat resistant rubber of .078 inch thickness. The outer layer 84 was a cord reinforced chloroprene or polyvinyl chloride rubber jacket of 0.115 inch thickness which was molded to the insulation 82 and the rubber seal 86. The overall diameter of this cable was 0.82 inch.

A Teflon collar 88 is molded around the seal 86 and the end of the cable and has an internal thread 90 on the extended part thereof. A rod 92 is shown having a knurled section 94 and a plastic sleeve 96, which may be a cast polyester resin with fiberglass reinforcing or a high impact polyvinyl chloride resin, molded on the knurled section 94. An external thread 98 is molded on the sleeve 96 to mate with the Teflon collar thread 90 to keep the sea water and corroding materials such as oxygen and chlorine out of the internal joint.

5

It should be understood, of course, that the foregoing disclosure relates to only a preferred embodiment of the invention and that it is intended to cover all changes and modifications of the examples of the invention herein chosen for the purposes of the disclosure, which do not constitute departures from the spirit and scope of the invention.

What is claimed is:

1. An insoluble trailing anode for the cathodic protection of ships comprising an electrically conductive tube, a tantalum end plug mounted at each end of said tube, a thick non-porous coating on said tube made of one of the group consisting of tantalum and titanium, a thin, porous platinum layer on said coating, and means within said tube for varying the weight per foot of said anode comprising a polyester resin and a sand filler whereby the hydrodynamic drag of said anode may be made equal to that of a trailing cable from a ship.

2. A detachable trailing anode joint comprising a cable having a central conductor which extends from one end of said cable, a trailing anode having a threaded end and a polyester resin sleeve mounted on said anode adjacent said threaded end, a cylindrical connector having a hole in one end soldered to said extended central conductor and a threaded hole on the other end detachably connected to said threaded end of said anode, a rubber seal molded about said connector and the end of said cable, and a Teflon collar molded about said seal and said end of said cable and having threaded means to detachably

6

connect to said sleeve whereby a water-tight, corrosion resistant detachable joint is provided.

3. A detachable trailing anode joint comprising a cable comprising a central tension member, a coaxial, helically wound conductor around said member, and an insulator around said conductor; a connector having at one end a central hole for containing said tension member and a tube extending out from said connector coaxial with said hole crimped to said tension member; said conductor soldered to said connector adjacent said tube; a rubber seal molded around said connector, conductor, and insulator; a Teflon collar molded about said seal and the end of said cable; a trailing anode having a threaded end and a plastic sleeve mounted on said anode adjacent said threaded end; and said connector having a threaded hole in the other end thereof for detachable connection to said anode.

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