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PIPE PLUG ANODE

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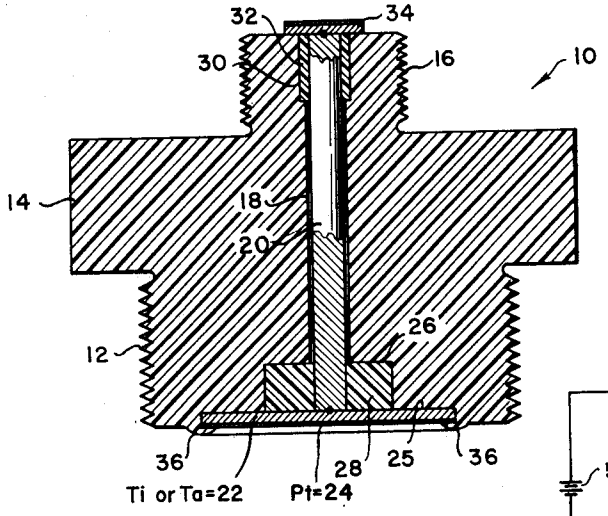


FIG 1.

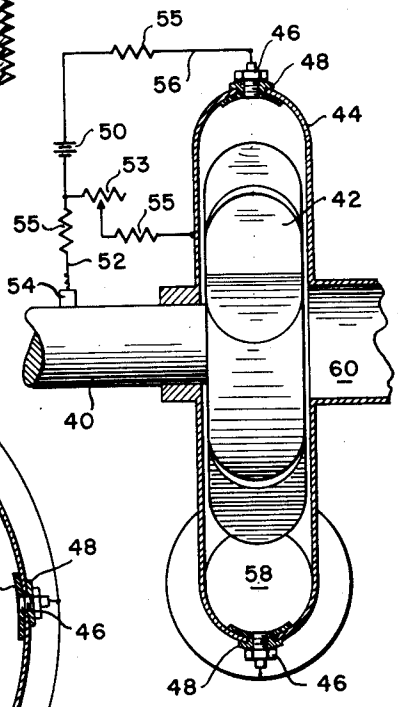


FIG. 3

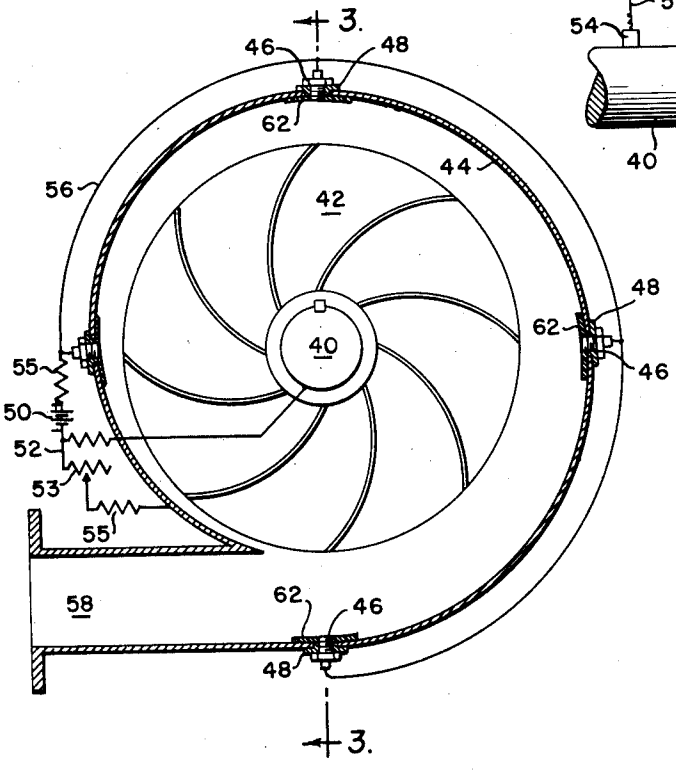


FIG. 2.

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PIPE PLUG ANODE

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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 a pipe plug anode for the cathodic protection of vessels in which fluid flows as, for example, metallic pumps in contact with a corroding electrolyte.

The purpose of this invention is to provide a compact insulated impressed current anode structure for use in cathodic protection (corrosion protection) of internal piping, tanks, pumps and any application where a small anode is needed for protecting metals in contact with electrolytes under pressure or vacuum. The anode device is particularly adaptable for service where watertightness of the anode connection is required and where compactness is an important consideration.

Heretofore, high capacity, small size, pressure proof anodes have not been available for this function. Certain types of heat exchangers have been fitted with pipe plugs which in turn were drilled to receive a zinc or iron pencil for means of cathodic protection, but in many cases the bulk of material required to achieve adequate current output with sufficiently long life has been greater than was practical to install in a given space.

Many of these prior devices used a consumable zinc anode which galvanically generated an electric current to cathodically protect a tank or heat exchanger by virtue of its relatively higher electrochemical potential as compared to iron or copper alloys in the structure under protection. These consumable anodes had a limited driving voltage, due to their electrochemical characteristics, which required a large surface area to be exposed to the electrolyte in order to generate a sufficiently large cathodically protective current. Impressed current systems have also been proposed using consumable anodes which overcome the objection of limited current output but their short service life necessitated frequent renewal.

While an object to be cathodically protected, such as a ship in sea water, may require only 5 milliamperes per square foot of exposed surface, a ship's propeller or a high speed pump may require 25 to 50 milliamperes per square foot for adequate cathodic protection since the friction and turbulence of the water moving over the blades strips off the protective layers of hydrogen atoms. Also rapidly moving water will depolarize the cathode quicker by bringing large amounts of dissolved oxygen in contact with the hydrogen layer. Thus further increases in anode size were required for rapidly moving propeller blades or impellers.

In order to overcome these difficulties, it is the primary object of this invention to provide, as a single article of manufacture, an insoluble pipe plug anode which may be used in an electrically energized cathodic protection system that will supply an adequate protective current without rapid corrosion of the anode.

The invention consists of a dielectric chemically resistant plastic pipe plug which has a thin central rod for connection to a suitable electrical power source and an anode disc consisting of platinum coated tantalum connected to the central rod and mounted on the inner end of the pipe plug.

Another object of this invention is to minimize the flow resistance of the pipe plug anode to the electrolyte by mounting the disc parallel to the electrolyte flow across the pipe plug and eliminating extensions and projections from the plug that would otherwise be in the path of flow of the electrolyte.

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 wherein:

FIG. 1 is a view in cross-section of a preferred embodiment of the pipe plug anode;

FIG. 2 is a view, partly in cross-section and partly in schematic form, of an application of the pipe plug anode in a centrifugal pump cathodic protection system; and

FIG. 3 is a cross-section view of FIG. 2 taken along lines 3—3.

Referring now to the drawings, there is shown in FIG. 1 a unitary pipe plug **10** having a body made of a dielectric chemically resistant plastic with a standard pipe taper threaded section **12** providing an inner end-portion for the plug so as to make a watertight connection with a suitable mating bossing such as on a boat hull or pump casing, a nut section **14** which is molded or machined so that the pipe plug anode may be mounted or removed with simple tools, and an upper threaded contact section **16** providing an outer end-portion for the plug to receive a screw connector connected to an electrical power source.

The pipe plug **10**, in this case 1½ inch IPS, has a central hole **18** coaxial with the threaded section **12** to contain a connecting knurled stem **20**, preferably made of tantalum, having a diameter of ⅛ of an inch. It is important that the connecting stem **20** and hole **18** be relatively small as compared with the diameter of the threaded section **12** so that the plastic plug **10** will deform evenly around its circumference to fit the mating bossing as the nut section **14** is tightened to provide a uniform pressure-proof seal. In this case the ratio of the diameter of the threaded section **12** to the central hole **18** is about 8 to 1.

The anode consists of a 1 inch diameter, .020 inch thick disc **22** of tantalum with a porous, flash surface-coat **24** of .00025 inch thick platinum. Disc **22** is fitted in recess **25** and is perpendicular to and much larger diametrically than the ⅛" diameter stem. As shown in FIG. 1, the disc **22** is imbedded in an inner end of section **12** with the inner surface-coat **24** of the disc exposed (the term inner being with respect to the wall in which section **12** is screwed) so that it provides a relatively large cathodic protective surface in contact with the electrolyte and in line with the direction of flow of the electrolyte. A potting recess **26** provides room for a potting resin **28** to seal the disc **22** in recess **25**. This potting resin **28** may be Royalite cement or an epoxy resin.

A second potting recess **30** and resin **32** at the contact section **16** part of the pipe plug **10** seal the other end of the rod **18** and a contact **34** made of platinum coated tantalum for connection to a cable connector.

In making the pipe plug anode, the plastic plug **10** may be formed in a mold or machined to the shape shown in FIG. 1. The knurled stem **20** is spot welded to the anode disc **22**. The stem is buttered with Royalite cement or an epoxy resin and potting recess **26** is filled with the same cement or resin. The stem and anode subassembly is inserted into the hole **18** of plug **10** and positioned firmly so that anode **22** is set flush in recess **25**. The other recess **30** is now filled with cement or resin **32** and contact **34** is now spot-welded to other end of stem **20**. The fin-

ishing touches are provided by placing a heated ring adjacent the edge of anode 22 so that the plastic of the plug 14 softens and is upset to form a heat seal bead 36 around the periphery of the anode 22.

Platinum and palladium-platinum alloys, because of their unique physical and electrochemical properties, have been proposed as anode materials and have been successfully applied in several instances. In spite of their desirable properties of electrochemical inertness, electrical conductivity and mechanical workability, the high cost generally associated with these materials has nevertheless restricted their application to specialized fields; however, in more recent years, the availability of platinum-clad materials at much reduced costs has led to increased appearance of these anodes in cathodic protection systems. The cost of these platinum-clad materials was proportional to the thickness of the cladding specified and to the complexity of completely cladding difficult geometric shapes. The serious drawback to platinum-clad materials prior to relatively recent developments was that a pore-free cladding had to be applied over common basis materials such as silver or copper in order to prevent their electrochemical deterioration. Sealing the edges of clad silver or copper was also troublesome.

These objections to platinum-clad anodes were finally overcome by the commercial introduction of "rectifier" metals such as tantalum and titanium, which led to the development of platinum-coated anodes of these materials. Tantalum and titanium exhibit an interesting property when anodized in sea-water and most aqueous media. An insulating film is formed on the surface which gradually increases in electrical resistance until current can no longer pass into the electrolyte. This insulating film is stable up to certain puncture voltages, above which film rupture occurs and electrochemical deterioration of the exposed metal ensues. The film formed on titanium in sea-water is stable up to 12 volts applied across the film. Tantalum on the other hand exhibits stability up to 130 volts in certain acid media. However, the protective film on tantalum forms in steps whereby a new film forms at a characteristic voltage. When a rupture occurs at a particular voltage, instead of electrochemical deterioration taking place a new film usually of a different color forms at the next corresponding voltage level and so on up to 130 volts. These protective films can conduct electronic current when in contact with another metal despite their nonconducting nature in an electrolyte. These films are generally considered to be oxides.

The combination of platinum cladding or plating on titanium or tantalum has resulted in a low-cost anode capable of passing high current densities without deterioration of the basic metal. These platinum coatings no longer depend on continuity nor do they have to be pore-free to perform inertly. The low electrode-electrolyte interface resistance between platinum and sea-water or other conductive aqueous media permits the stable oxide layer to form on the supporting titanium or tantalum because the voltage across the oxide is kept within safe limits.

Referring to FIGS. 2 and 3, a cross-section view of a centrifugal pump is shown having a shaft 40, impeller blades 42, and a pump housing 44.

Housing 44 has a peripheral outlet 58 and a central inlet 60 as is shown on FIG. 3 to allow a corrosive fluid such as seawater to be pumped. Pipe plug anodes 46 are arranged around the periphery of the outside wall of the pump housing 44 in threaded bossings 48. Consequently, the surface-coat of the anode will be substantially flush with the end of the plug at the inner side of the wall, and the nut and contact sections of the plug will be on the outer side of the wall.

A battery or other D.C. power source 50 has its negative terminal 52 connected by a brush 54 to the shaft 40 while the positive terminal 56 is connected to the anodes 46. A negative connection is also made to the casing through a variable resistance 53. Suitable shunts 55, 0.1 ohm in this case, are connected in the positive line to the anode and negative return lines to pump impeller and casing. By means of a suitable portable voltmeter (not shown), calibrated in amperes, the current division to the impeller and casing can be measured.

With the cathodic protection system connected as shown in FIGS. 2 and 3, a current of about 50 milliamperes per square foot of impeller and shaft surface are required for a fluid flow through the pump of 15 feet per second. As an example for a pump of 3200 g.p.m. flow, a total current of 2 amperes at about 8 volts is required from D.C. power source 50.

This large current maintains the hydrogen polarization film and forms metallic salt deposits on the impeller blades, shaft, and pump housing to eliminate the flow of corrosive currents. In order to prevent concentration of the protective current at the housing areas near the pipe plug anodes, dielectric shields 62 are applied to an area around each anode for several anode diameters. These shields may be made of polychloroprene rubber, vinyl, or epoxy-coal tar resins.

The current distribution to the impeller and casing is also regulated to some extent by varying resistor 53. The current ratio between casing and impeller is adjusted generally in the order of 1:3.

The electric current also evolves free oxygen and chlorine at the pipe plug anode which are very corrosive to many compounds. After extensive testing and experimentation at Portsmouth and Boston Naval Shipyards, it has been found that only a few materials have been found to have the required corrosion resistance and mechanical strength.

It is preferred to mold the pipe plug anode out of an acrylo-nitrile-butadiene styrene copolymer or glass-fiber reinforced polyester resin copolymer.

The pipe plug anode thus provides an insoluble cathodic protective anode which allows a large current output in a compact space while offering negligible resistance to rotating parts or fluid flow.

In addition the plastic pipe plug anode uses standard pipe fittings and provides an excellent pressure or vacuum proof seal by virtue of its ability to deform easily and evenly around its circumference.

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 example 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 article of manufacture adapted to be screwed in a wall as part of a cathodic protection system, comprising a plastic plug, said plug comprising a three-section insulating body consisting of a round first threaded section providing an inner end-portion for said plug and adapted to be screwed in a wall, a nut section contiguous to said threaded section and adapted to be operated by standard tools for tightening the plug in the wall, and a round second threaded contact section contiguous to said nut section providing an outer end-portion for said plug and adapted to receive a standard screw connector, said first threaded section having an inner end face, said plug having a central hole coaxial with said threaded sections, a metallic stem water-tightly non-detachably fixed in said hole having a small diameter as compared with said first threaded section whereby the plug may deform around its circumference as the plug is tightened in the wall, said stem being slightly shorter than said insulating body, an anode disc having a diameter larger than said stem and hole but smaller than said first threaded section, said anode disc being electrically and non-detachably mechanically secured to the end of said stem adjacent said inner end face, said end face being provided with a recess of a size fittingly receiving said anode disc with a surface of the

anode disc exposed and substantially flush with said end face, said anode consisting essentially of a metal chosen from the group consisting of titanium and tantalum and having a platinum coating on the last said surface, and a contact member electrically and non-detachably mechanically secured to the outer end of said stem and in contact with said second threaded section, said contact member having a diameter larger than said stem and hole but smaller than said second threaded section.

2. The plug anode as defined in claim 1 wherein the body of the plastic plug is made of a plastic consisting of one of the group consisting of acrylonitrile-butadiene, styrene co-polymer and fiberglass reinforced polyester resin.

3. The plug anode as set forth in claim 1 further comprising a bead of the material of the body of the plug

overlapping the edge of said anode disc thereby sealing the anode disc within the structure of the plug.

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