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PROCESS FOR PROTECTION AGAINST ELECTROLYTIC
CORROSION OF VESSEL HULLS AND
THE LIKE IN FRESH WATER
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Fig. 1.

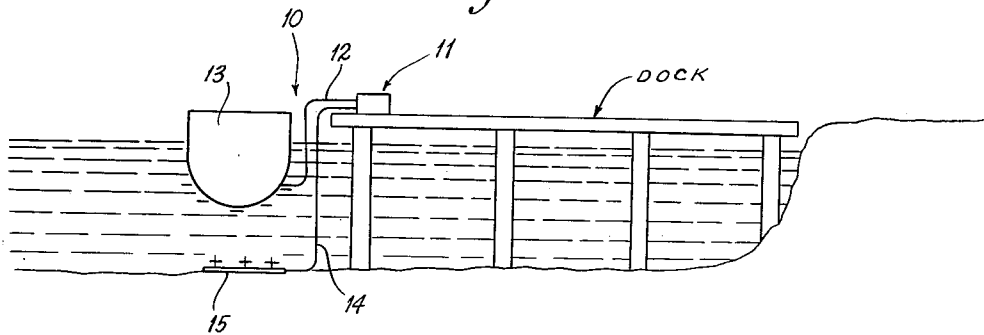
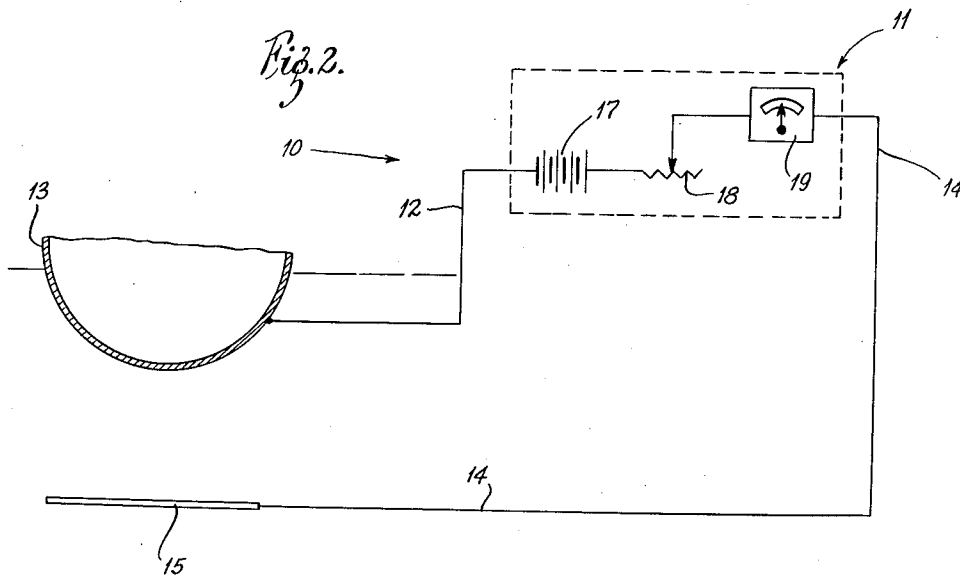


Fig. 2.



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PROCESS FOR PROTECTION AGAINST ELECTROLYTIC CORROSION OF VESSEL HULLS AND THE LIKE IN FRESH WATER

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6 Claims. (Cl. 204-23)

This invention relates to improvements in a process for protection against electrolytic corrosion of submerged metallic structures, including the hulls of vessels, metal dock pilings, and the like. In particular, this invention relates to an electric circuit which establishes the submerged metallic structure to be protected as a cathode with a submerged zinc anode to establish a flow of current through marine fresh water to inhibit electrolytic corrosion of metallic structure and to form a light plating thereon.

In the past, many different types of electrolytic systems have been employed with the object of preventing electrolytic corrosion of submerged metallic structures. Such efforts have been in the nature of providing magnesium sacrificial anodes to polarize the structure to be protected and from a calcareous cathodic coating. Other forms have taken zinc plates suspended in ballast seawater internally in metal vessel hulls in which coatings containing a considerable amount of calcium are formed with zinc as well as magnesium.

The electrolytic corrosion systems have found their main application in sea water. For effective action, the current densities are usually in the order of several milliamperes per square foot to considerably higher values at which values the calcareous deposits are formed. In the instant invention in spite of the fact that marine fresh water because of its lower mineral content is a much poorer electrolyte than sea water, it has been found that effective plating may be obtained at quite low current densities of the general order of a tenth of a milliamperere per square foot.

It has been found in this invention that calcareous coatings are very undesirable since they tend to form in nodules and foul the surface to the point where the exterior smoothness is destroyed and a drag on the vessel in its movement through the water is encountered. Also, marine organisms feed on these calcareous deposits. In particular, such calcareous growth is undesirable because the paint surface is caused to be blistered or pitted away.

By means of this invention it has been established that it is necessary to limit the current density considerably below that which is employed in electrolytic protective devices in seawater even though the electrolyte in inland fresh waters is considerably weaker. Thus, where the paint surface is desired to be protected and maintained as long as possible while still providing protection for exposed metallic surfaces, it has been found that the current density should be low to prevent the build up of calcareous deposits. At the same time, with the maintenance of the low current density, there can be established an effective polarization of the cathodic metallic structure to be protected whether it be a vessel hull or a metal dock piling, or the like, and an effective plating upon the surface can be made. At higher current density, above about 0.3 milliamperere per square foot, it is found that calcareous deposits are obtained and also the paint blisters and peels off more readily than without any protective system at all. The effective current density can be quite low and with good anti-fouling paint surfaces protection can be established at as low as 0.05 milliamperere per square foot.

This invention will be particularly described with respect to the protection of metallic vessel hulls, but it will be readily understood that other metallic structures, such

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as dock pilings, and the like, that are submerged in fresh water can be similarly protected in a like manner. The protective system is simple in nature as it calls in its essential simplicity for the supply of an impressed direct current connected at one side through insulated electrical conduits to the hull of the vessel as the cathode and at its other side through insulated electrical conduits to a zinc anode submerged in the water and spaced from the vessel hull. The zinc anode desirably takes the form of sheet zinc which, for example, may be galvanized zinc that may be very simply placed in the water underneath the vessel.

It has further been found that the effective protection afforded by this invention proceeds after the system has been disconnected. Thus, on pleasure craft which are moored for a very large percentage of the time, the system can be installed and run during periods of docking. While the vessel is being used, the plated coating which has been built up through the protective system provides a natural barrier to electrolytic corrosion, and when the vessel returns to the dock, the system can be connected again and the coating will be replenished.

The system is quite simple in its nature and can be varied to meet vessels or structures of varying sizes within the limits of current density supplied through this invention.

Accordingly, it is an object of this invention to provide a process for the prevention of electrolytic corrosion of submerged metallic structures by providing a source of direct current and connecting the structure as a cathode on one side of the source of current and a zinc anode on the other side submerged in the water and spaced from the structure to be protected and establishing a current density in the range of 0.05 to 0.3 milliamperere per square foot on the structure to be protected.

It is a further object of this invention to provide a process for the electrolytic protection of vessels in inland marine fresh waters by connecting the vessel hull beneath the surface of the water with the source of direct current and making the hull a cathode and establishing the other side of the current source through an electrical lead to a zinc anode submerged in the water and maintaining a current density upon the submerged vessel hull while the vessel is moored to between 0.05 and 0.3 milliamperere per square foot and at a point to prevent the build up of calcareous deposits and to prevent blistering of the paint while plating exposed hull surfaces.

Still another object of this invention is to provide a process for the electrolytic protection of vessel hulls in inland waters which provides establishing an electric circuit with the vessel hull as a cathode and a zinc anode submerged in water underneath the vessel hull and establishing an increasing current density upon the submerged vessel hull as the protective paint surface upon the hull is subjected to wear.

Yet a further object of this invention is to provide a process for the protection against electrolytic corrosion of vessel hulls and the like in inland marine fresh waters which comprises establishing the vessel hull as a cathode in an external circuit utilizing a direct current source connected to a zinc anode submerged in the water underneath the vessel hull in which the anode is in plate form and has an area from $\frac{1}{10}$ to $\frac{1}{30}$ of the area of the submerged portion of the vessel hull and maintaining the current density upon the submerged vessel hull between 0.05 and 0.3 milliamperere per square foot.

Still a further object of this invention is to provide a process for the protection against electrolytic corrosion of submerged metallic structures which can be simply carried out with a minimum of equipment and without the requirement of complex system controls.

Further objects of this invention will appear in the

detailed description which follows and will be otherwise apparent to those skilled in the art.

For the purpose of illustration of this invention, there is shown in the accompanying drawing a schematic diagram of the system of this invention. It is to be understood that this diagram is for the purpose of example only, however, and that the invention is not limited thereto. Thus, instead of the vessel hull to be protected, other submerged articles could obviously be employed and when referring to a metal hull, such application should be understood.

In the drawings:

FIGURE 1 is a schematic diagram of the electrical connection to the vessel and the anode; and

FIGURE 2 is an electrical diagram showing the arrangements of the battery or other source of direct current with the variable resistor and an ammeter to vary the current flow between the vessel hull and the anode.

In FIGURE 1 the system for electrolytic corrosion protection is generally indicated by the reference numeral 10. As shown, it very simply comprises the use of a source of direct current through a control apparatus 11 which is connected by a conduit 12 to the metal hull 13 of a vessel. The other side of the source of current is connected through an insulated cable 14 to a zinc anode 15.

In FIGURE 2 the direct current control source 11 is shown more particularly as including a battery 17 connected in series with a variable resistor 18 and a milliammeter 19. It is to be understood, however, that instead of the battery source 17, a rectifier such as a conventional battery charger can be employed. Thus, a rectifier operating off conventional 115 volts alternating current for rectifying 50 to 60 cycles alternating current to 6 to 8 volts direct current can be employed and plugged into conventional shore line installations when the boat is in harbor.

To illustrate the operation of this invention, a description will be made for an actual operating example. Tests were made on a vessel in a Mississippi River harbor in which the approximate area of the vessel hull below the water line was 300 square feet. This water is typical of marine fresh water which means naturally occurring inland bodies of water to which this invention pertains. In this installation made according to the electrical connections shown in FIGURES 1 and 2, an anode was employed which was of galvanized sheet steel containing a zinc coating. This anode measured 3' x 6'. The installation was started after the boat had been pulled out on shore and considerable pitting of the steel had been noted. In the original application a current of 400 milliamperes was used which was approximately 1.35 milliamperes per square foot current density. About ten weeks later the boat, after being put back into the water, was pulled out on shore again, and it was noted that the pitting had stopped but that some of the paint had blistered and was peeling.

The boat was then sanded and painted on the bottom and put back into the water. The current was then set at 150 milliamperes or approximately 0.5 milliamperes per square foot current density. About six weeks later, numerous calcareous spots were observed. This material was noted to be very hard and rough. The boat, however, was kept in the water and approximately a week later it was noted that the calcareous spots were enlarged and that some of the paint was blistering. The current was then lowered to 50 milliamperes or approximately 0.17 milliamperes per square foot current density. About five weeks later it was noted that no further calcareous spread was obtained. The current was then adjusted to 30 milliamperes or approximately 0.1 milliamperes per square foot current density.

The last setting was in the fall and the boat was then left in the water all winter and examined again in the middle of the next summer. The calcareous deposits were observed to be the same. Some portions of the boat

hull were observed to be without paint due to normal wear, but were observed to be protected by a plating. The boat was then pulled out of the water shortly thereafter and no pitting or corrosion was in evidence. In addition, no calcareous deposits were noted upon a closer inspection other than those which had formed at the higher current density of 0.5 milliamperes per square foot and prior to the reduction to 0.17 milliamperes per square foot. After painting the hull of the vessel, the current was adjusted to 30 milliamperes or approximately 0.1 milliamperes per square foot. Examination some three and one-half months later in the fall of the year disclosed no calcareous deposit and the hull of the vessel was in good condition. Although the current density used with the vessel fresh coat of paint was 0.1 milliamperes per square foot, this current density could be adjusted as low as 0.05 milliamperes per square foot with good results while the paint coating is still in good condition and before substantial wear has developed.

In the application of this invention it has been found that the effective action of the system for the electrolytic protection against corrosion occurs very well when the vessel is moored and subjected to the system for 50% of its time. When the vessel is away from the moored area and cannot be protected by the system, the electroplated coating protects it. While the vessel is moored and subjected to the system, the hull is additionally protected by polarization by hydrogen in the exposed areas. Although not being bound by the theory of this invention, it is believed that the flow of electric current as indicated causes hydrogen to form a film which excludes oxygen and prevents galvanic cell action wherever there is exposed metal.

The protection by polarization has been employed in such systems before, but is accompanied by the deposit of a calcareous salt. For the reasons pointed out above, this is disadvantageous for the purpose of this invention and such systems using magnesium and zinc which have heretofore been proposed are undesirable. The maintenance of the current density to a value below that at which the calcareous deposits form and yet which is sufficient to form a plating is an important feature of this invention.

For effective protection, it has been found that the system when operating may be used where the anode is as far as 5 to 50 feet away. Obviously, however, the further away the anode is, the higher the impressed voltage will have to be to maintain the proper current density.

In the placement of the anode, it has been found that the anode may be simply laid to rest under the vessel, or in the general region of the vessel, upon the river or lake bed. The ultimate covering of the anode by silt, etc., surprisingly, has been found not to be disadvantageous, since the normal muds and sands encountered serve quite well as a conductor and are actually more conductive even than the water electrolyte.

It will be apparent from the above description that there has been provided a process for the prevention of electrolytic corrosion of vessel hulls and other submerged metallic structures in inland waters that can be simply employed with a minimum of complicated controls. The drain on current is extremely low and, in some circumstances, may be so low that an impressed current may not even be required to maintain the proper current density. Within the low current density ranges taught by this invention, effective protection can be provided without the requirement of constantly tending the system so to speak. Thus, the vessel may be kept connected to the system for long periods of time while it is moored without the requirement of constant attendance. The system can also be disconnected and effective protection obtained by the coating built up by the previous operation of the system. Also, because of the simplicity of the system, it can be readily employed by relatively unskilled technicians.

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Various changes and modifications may be made within the process of this invention as will be readily apparent to those skilled in the art. Such changes and modifications are within the scope and teaching of this invention as defined by the claims appended hereto.

What is claimed is:

1. A process for preventing electrolytic corrosion of submerged metallic structures in marine fresh waters which comprises connecting through insulated electrical conduits the metallic structure as a cathode in an external circuit with a metallic zinc material as an anode, positioning said anode in the water underneath the cathode and controlling the current through said circuit and the water as an electrolyte at a current of about 0.05 to 0.3 milliamperes current density per square foot of cathode surface to form a coating on the cathode while substantially eliminating the formation of any calcareous deposits.

2. A process for preventing electrolytic corrosion of submerged metallic structures in marine fresh waters which comprises establishing the submerged metallic structure as a cathode and a submerged metallic zinc material as an anode with a source of direct current connected by insulated electrical conduits therebetween, spacing said anode from the cathode underneath the water, and establishing from said direct current source through the conduits and cathode and anode and through the water as an electrolyte an impressed current of about 0.05 to 0.3 milliamperes current density per square foot of cathode surface to form a coating on the cathode while substantially eliminating the formation of any calcareous deposits.

3. A process for preventing electrolytic corrosion of painted submerged metallic structures in marine fresh waters which comprises establishing the submerged metallic structure as a cathode and a submerged metallic zinc material as an anode with a source of direct current connected by insulated electrical conduits therebetween, spacing said anode from the cathode underneath the water, and establishing from said direct current source through the conduits and cathode and anode and through the water as an electrolyte an impressed current of about 0.05 to 0.3 milliamperes current density per square foot of cathode surface to form a coating on the cathode while substantially eliminating the formation of any calcareous deposits while the paint coating is in good condition and increasing the current density when the paint wears to from about 0.1 to 0.3 milliamperes current density per square foot of cathode surface to form a coating on the cathode while substantially eliminating the formation of any calcareous deposits.

4. A process for preventing electrolytic corrosion of submerged metallic structures in marine fresh waters which comprises establishing the submerged metallic structure as a cathode and a submerged metallic zinc material as an anode with a source of direct current connected by insulated electrical conduits therebetween, said

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anode being in plate form and having an area of about one-tenth to one-thirtieth of the submerged metallic structure to be protected, spacing said anode from the cathode underneath the water, and establishing from said direct current source through the conduits and cathode and anode and through the water as an electrolyte an impressed current of about 0.05 to 0.3 milliamperes current density per square foot of cathode surface to form a coating on the cathode while substantially eliminating the formation of any calcareous deposits.

5. A process for preventing electrolytic corrosion of painted submerged metallic structures in marine fresh waters which comprises establishing the submerged metallic structure as a cathode and a submerged metallic zinc material as an anode with a source of direct current connected by insulated electrical conduits therebetween, said anode being in plate form and having an area of about one-tenth to one-thirtieth of the submerged metallic structure to be protected, spacing said anode from the cathode underneath the water, and establishing from said direct current source through the conduits and cathode and anode and through the water as an electrolyte an impressed current of about 0.05 milliamperes current density per square foot of cathode surface to form a coating on the cathode while substantially eliminating the formation of any calcareous deposits while the paint coating is in good condition and increasing the current density when the paint wears to form about 0.1 to 0.3 milliamperes current density per square foot of cathode surface to form a coating on the cathode while substantially eliminating the formation of any calcareous deposits.

6. A process for preventing electrolytic corrosion of the submerged portions of steel vessel hulls in marine fresh waters which comprises connecting the submerged portion of the vessel hull as a cathode when it is moored in an external circuit through insulated electrical conduits with a metallic zinc material as an anode, positioning said anode in the water supported by the water bed underneath the cathode and controlling the current through said circuit and the water as an electrolyte at a current of about 0.05 to 0.3 milliamperes current density per square foot of cathode surface to form a coating on the cathode while substantially eliminating the formation of any calcareous deposits and disconnecting the vessel hull from the electrical conduit when it is moved from its mooring.

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