

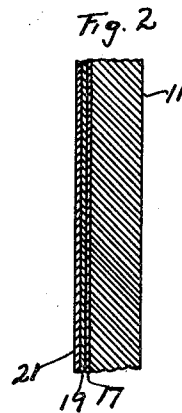
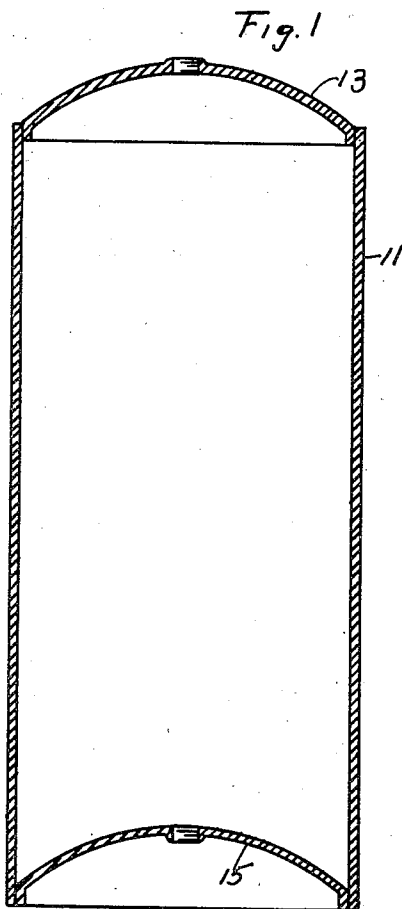
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CORROSION PREVENTION

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CORROSION PREVENTION

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1

My invention relates to prevention of corrosion of ferrous metal surfaces by water.

An object of the invention is to protect ferrous metal surfaces from corrosion by a protective composite metallic coating capable of withstanding electrolytic attack for long periods when subjected to ordinary waters.

Another object of the invention is to provide protection for ferrous metal surfaces by coating them with layers of different metals which are all anodic to iron but have different corrosion resisting properties.

Another object of my invention is to provide a hot water tank of ferrous metal that shall be constructed with an interior multi-layer coating of selected corrosion preventing metals as to be able to withstand the corrosive effect of water contained therein for relatively long periods of time.

Other objects of my invention will either be apparent from a description of a method and device embodying my invention or will be pointed out in the course of such description and set forth in the appended claims.

In the drawings,

Figure 1 is a view in vertical section through an ordinary domestic hot water tank, and

Fig. 2 is a fragmentary view, on an enlarged scale, of a small portion of the wall of the tank shown in Fig. 1.

Many metals, particularly iron and steel, require protection against corrosion, and the character and extent of the necessary protection generally depends upon the nature of the metal and of the environment to which the metal is exposed. The control of the environment is not always possible, particularly so in the case of domestic hot water tanks manufactured in large numbers and distributed over a large territory so that individual tanks will contain widely varying kinds of water. Hence the use of an effective protective film on the surface of a hot water tank is usually indicated.

While it may be possible to obtain a protective film on a base metal surface by the use of a noble metal, the cost of such metal is generally prohibitive and industry has heretofore used less noble metals, such as zinc and tin.

The method of providing a protective coating on the surface of domestic hot water tanks used heretofore is the "hot-dip" method, in which the surface of the tank is first cleaned and the tank is then dipped into molten zinc having a flux thereon, such as sal ammoniac, to clean the surface and cause the zinc to adhere, plus addi-

2

tives, such as tin, to give spangle. The thickness of a coating obtained by the "hot-dip" method is fixed, and repeated dippings will not add to the thickness nor cover any pin holes caused by minute pieces of sal ammoniac or by any one of the numerous other causes of pin holes in hot-dipped zinc coatings. A hot-dipped coating is therefore perforate, the number of pin holes or perforations in the coating being indeterminate and variable in different tanks even though the work is done under the same conditions. Therefore, two tanks made under like conditions by the same manufacturer and installed in the same locality may show wide differences in useful life, one tank lasting only a year or two before becoming so badly corroded as to have to be replaced, while another tank may last five or more years before having to be replaced.

Broadly speaking, the water with which a tank may be filled may be any one of three different kinds; namely, acid, basic or alkali, or neutral; and a coating of one kind of metal may give protection against corrosion by acid water but not by alkaline or basic water. Therefore, a plurality of tanks made to withstand the corrosive action of water to be contained therein should preferably be such as to be able to withstand the corrosive effects of any one of the two different kinds of water, a consideration which increases the problem of the manufacturer of such tanks.

I wish to point out here that when reference is hereinafter made to acid or alkaline water, the degree of acidity or alkalinity is very small. The water heated and stored in a domestic hot water tank is drawn from the same source as the water used for cooking and for drinking purposes, or in other words is potable water. Therefore, the degree of acidity or alkalinity is very small, a fact which must be kept in mind in the consideration of the further details of my invention.

In practicing my invention I first clean the surface of a tank in an intermediate state of its manufacture and assembly, by a wheel brush or by blasting with iron or steel grit to obtain a roughened surface, and then make sure that all loose steel grit or particles are removed. After that, I spray on the surface of the tank at least one coating of a metal which is anodic to iron, and while it may be possible to use only a single coating of such metal, I may provide two or even three coatings. After this, I spray on the first coating, or coatings, one or more coatings

3

of a second different metal than the first metal, which second metal is anodic not only to iron but also to the first metal sprayed on the tank. After this, I may spray one or more coatings of the first metal in order to protect the second metal; or I may spray on the second coatings one or more coatings of another metal anodic to the second metal, after which I may spray on one or more coatings of the first metal. I do not desire to be limited to any specific thickness of the individual coatings, nor of the layers, nor of the number of coatings per layer, since it is an offset between a minimum amount of material which, when properly applied, will withstand corrosion for long periods of time or indefinitely, and an amount of material sufficient to stand up indefinitely under the conditions met with an actual use.

Referring now to Fig. 1 of the drawings, I have there shown an ordinary domestic hot water tank 11 having welded thereto an upper cover 13, the outer surface of which is convex, I provide further a lower closure 15, the outer surface of which is concave.

Refining now to Fig. 2 of the drawings, I have there shown a plurality of layers 17, 19, and 21 of respective different metals, each layer consisting of at least one coating of metal sprayed thereon.

By spraying I refer to the use of a gun having a flame, through which a wire of a metal anodic to iron is drawn, this gun being provided with air pressure means to shoot the particles on to the surface to be sprayed. This layer 17 may comprise at least one coating of zinc or two or three coatings of zinc. Layer 19 may comprise one or several coatings of aluminum, and layer 21 may comprise one or several coatings of zinc sprayed on the outer surface of layer 19.

It is to be noted that in the manufacture of the tank 11 I weld thereto the cover 13, after the welding of the tubular portion of the tank, this being done before the lower cover 15 is welded in place for ease of spraying. I spray also the inner convex surface of the lower closure 15 before placing it in proper operative position in the lower portion of the tank 11 and welding the engaging peripheries together. In doing this welding, I may invert the tank 11 and place a small amount of coolant, such as water, in the cover 15, it being understood that the closure therein for a cold water inlet pipe is suitably closed. The metal used in spraying is commercially pure and no flux or other additive need be used.

I may here point out that the electromotive force series of metals, including a number of other metals than those used by me, is substantially as follows: lithium, calcium, magnesium, aluminum, beryllium, manganese, zinc, chromium, iron, cadmium, nickel, tin, lead, bismuth, copper, silver, and gold. By this I mean that in case a coating of say nickel or tin is provided on an iron surface and subjected to electrolytic action, as will occur in a hot water tank filled with water, if the coating has pin holes therein, the iron will be electrolytically dissolved. However, if a coating of aluminum or zinc, or any other of the metals preceding iron in the list, is provided on the surface of a hot water tank and any electrolytic action occurs because of pin holes in the coating, the coating is the anode and is dissolved with attendant protection of the iron.

It will be noted from the above series of metals

4

that zinc is anodic to iron, that is zinc is a metal which is electrolytically dissolved when forming a galvanic couple with iron. Aluminum is anodic not only to iron but also to zinc, and has the further relatively important characteristic that it is inherently oxidizable, as is well known, that is an aluminum surface becomes inherently coated with aluminum oxide when in contact with oxygen, which condition is always present in ordinary water. To put it in other words, a coating of aluminum is self-healing, since the oxide coating on its outer surface is electric-insulating, thereby preventing the formation of a galvanic couple and flow of electric current.

While I have mentioned the use of aluminum as the metal to be used in the second layer to cover the layer of zinc, I do not desire to be limited thereto but may use magnesium instead. I may use a first layer of one or more coatings of zinc and then a layer of one or more coatings of aluminum, which may be covered with one or more coatings of zinc. Zinc is cathodic to aluminum and to magnesium, that is the aluminum and magnesium would tend to be dissolved, but both aluminum and magnesium are self-healing by developing an outer oxide coating which tends to prevent their electrolytic dissolution. The presence of an outermost layer of zinc provides a protective effect which increases the life of the coated tank.

Zinc is anodic to iron and will give protection when the water in a tank is very weakly alkaline and forms a protective coating of zinc hydroxide on the outer surface of the zinc, that is it is self-healing. This outer coating of zinc hydroxide is electric-insulating and any galvanic current generated will be greatly reduced in volume if not decreased substantially to zero. Zinc will protect the iron when the water in the tank is very weakly acid but is electrolytically dissolved in so doing.

Aluminum protects the iron in a weakly acid solution and forms a protective coating on its outer surface, which coating is electrically insulating, and any galvanic current generated will be greatly reduced in volume, so that any electrolytic dissolution will be greatly reduced if not entirely prevented. Aluminum is, however, readily attacked by alkaline water.

Magnesium is anodic to iron, to zinc, and to aluminum and protects the iron when in a weakly alkaline solution and also protects itself by forming an electric-insulating coating on its outer surface which reduces its disintegration very considerably. Magnesium protects the iron in a weakly acid solution but is disintegrated in so doing.

My invention thus provides a method of covering the surface of an iron tank with a plurality of layers of different metals, each metal being anodic to iron and the successive outer layers being anodic to the under layer except where the outermost layer is the same as the innermost layer.

As was hereinbefore stated, the dipping of a ferrous object into molten zinc fails of ensuring that all of the surface of the ferrous object will be covered, so that generally there will remain pin holes in the zinc coating which will permit electrolytic corrosion. If the pin hole is relatively very small, the action of the zinc in protecting the iron surface will be effective, but there has been found the general result in hot-zinc-dipped tanks that sooner or later the iron

5

surface will be attacked, the size of the pin hole will increase, and the inner surface of the iron tank will soon be attacked, with resultant decrease in the thickness of the wall at that point. Also the particles of flux left on the metal promote electrolysis, whereby the iron of the tank is attacked.

It has been hereinbefore stated that tin is mixed with the zinc to give spangle, and iron and zinc are anodic to tin, so that both iron and zinc will be electrolytically disassociated when they form a galvanic couple with tin, with decrease of thickness of the hot-dip zinc coating and ultimate corrosion of the wall of the tank in a relatively short time.

While it may be possible to produce a continuous imperforate layer with just one coating of zinc sprayed on, I may spray on two or even three coatings, and the thickness of the layer may be any desired value. A second coating will have a tendency to cover up any pin holes in the first coating, since the spray gun may be in a different position regarding a particular point on the surface of the iron during the second coating operation than it was in during the first coating operation. The chances of obtaining an imperforate layer of zinc are therefore much better where a plurality of such coatings are sprayed on than has been the case when a ferrous object was dipped in molten zinc.

After having sprayed on one or more coatings of zinc, I then may spray on one or more coatings of aluminum or of magnesium. As will be noted by reference to the electromotive force series of metals, both aluminum and magnesium are anodic to iron as well as to zinc, and as has already been hereinbefore stated, aluminum and magnesium are metals which when subjected to surface contact with oxygen, quickly oxidize, thereby presenting a surface which provides a protective coating which stops its own dissolution. This holds true particularly in acid water, but not in basic or alkaline water. I may spray on one or more coatings of zinc on the aluminum layer in order to protect the aluminum layer and thereby prevent attack by water and deterioration of the aluminum surface for a greater length of time than would be the case if the outer layer of zinc were not provided. If the water is acid, the zinc may be attacked, but the exposed aluminum coating will be very resistant to attack. If the water is alkaline, the zinc coating will be resistant to attack and will protect the other layers and the iron tank. The corrosion-preventing covering provided by my invention, thus either gives complete protection indefinitely or at the worst gives protection many times longer than has been had with the coatings used heretofore. The guiding principle is to use successive coatings of metals, all of which are anodic to iron and each of which is anodic to the next toward the iron. When properly applied, that scheme will achieve the object of the invention, but it will be good practice to add a final outer coat of zinc carefully sprayed on by repeated applications to insure complete coverage, for it will give a greater factor of safety against an unfortunate accumulation of manufacturing errors and extraordinarily adverse conditions. The final coat of

6

zinc, sprayed on in repeated coatings, will give the tank greater protection than was ever afforded by the commercial hot-dip method, and it will be backed up by the multiple coatings in accordance with this invention and insure that the tank will have a longer period of service under the most adverse conditions.

All other methods and devices coming clearly within the scope of the appended claims are to be considered as part of my invention.

I claim as my invention:

1. The combination with a ferrous metal member having a surface thereof to be protected against the corrosive action of hot potable water, of means for protecting said surface against corrosion, comprising a composite coating of metals on said surface and including innermost and outermost layers of zinc and an intermediate layer of a metal from the group consisting of aluminum and magnesium.

2. The combination with a ferrous metal member having a surface thereof to be protected against the corrosive action of hot potable water, of means for protecting said surface against corrosion, comprising a composite coating of metals on said surface and including innermost and outermost layers of zinc and an intermediate layer of aluminum.

3. The combination with a ferrous metal hot water tank of a corrosion preventing composite coating lining including innermost and outermost layers of zinc and an intermediate layer of a metal from the group consisting of aluminum and magnesium.

4. The combination with a ferrous metal hot water tank of a corrosion preventing composite coating lining including innermost and outermost layers of zinc and an intermediate layer of aluminum.

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