Jan. 11, 1949. H. T. BATES ET AL 2,459,123

WATER HEATING DEVICE WITH CORROSION PROTECTIVE ANODE

Filed Sept. 10, 1946 4 Sheets-Sheet 1

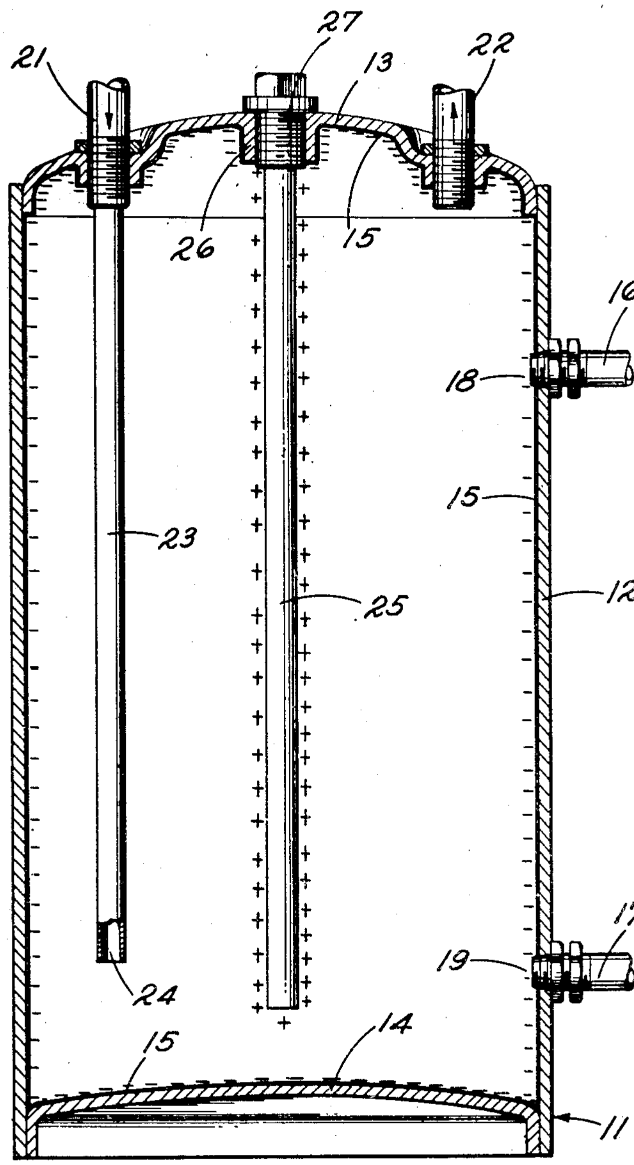

Fig. 1

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WATER HEATING DEVICE WITH CORROSION PROTECTIVE ANODE

Filed Sept. 10, 1946 4 Sheets-Sheet 2

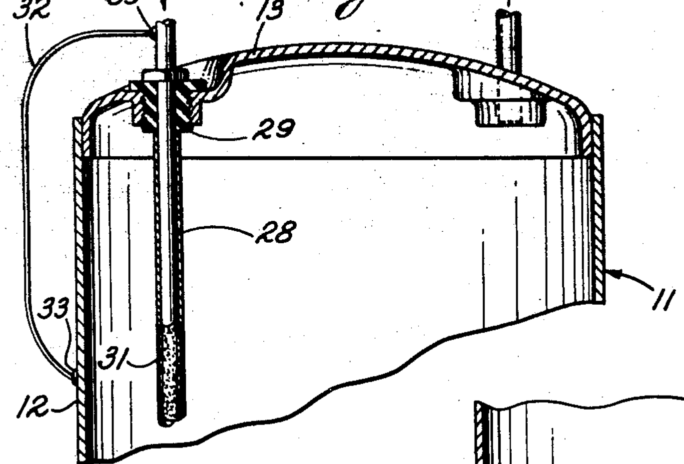

Fig. 2

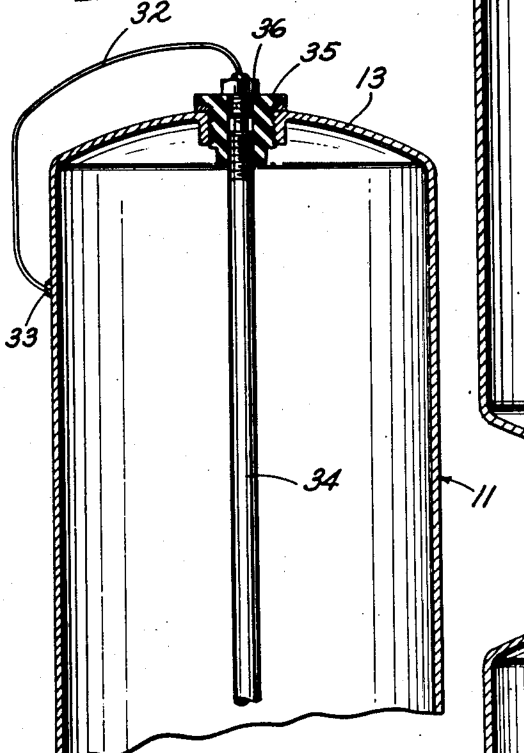

Fig. 3

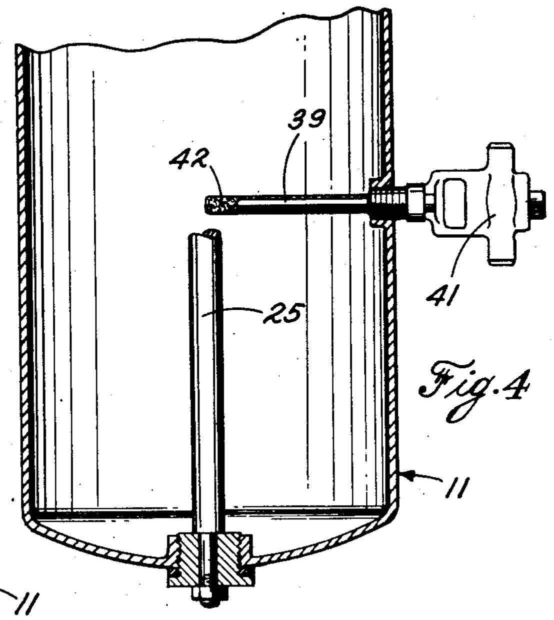

Fig. 4

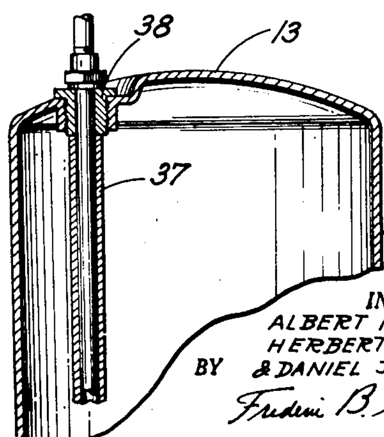

Fig. 5

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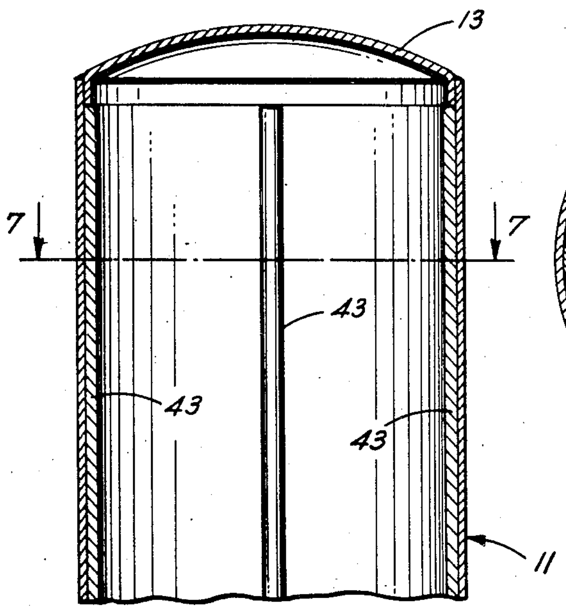

Fig. 6

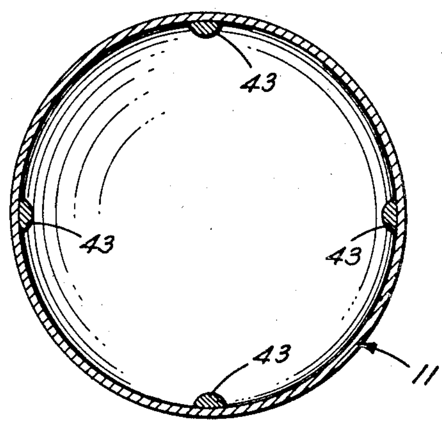

Fig. 7

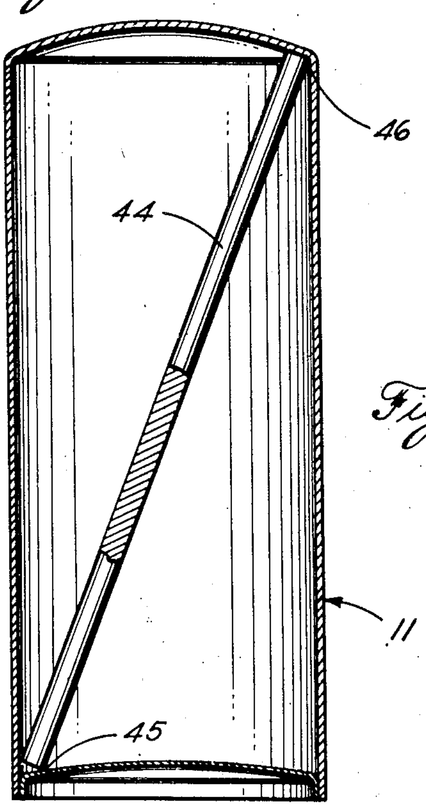

Fig. 8

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WATER HEATING DEVICE WITH CORROSION PROTECTIVE ANODE

Filed Sept. 10, 1946 4 Sheets-Sheet 4

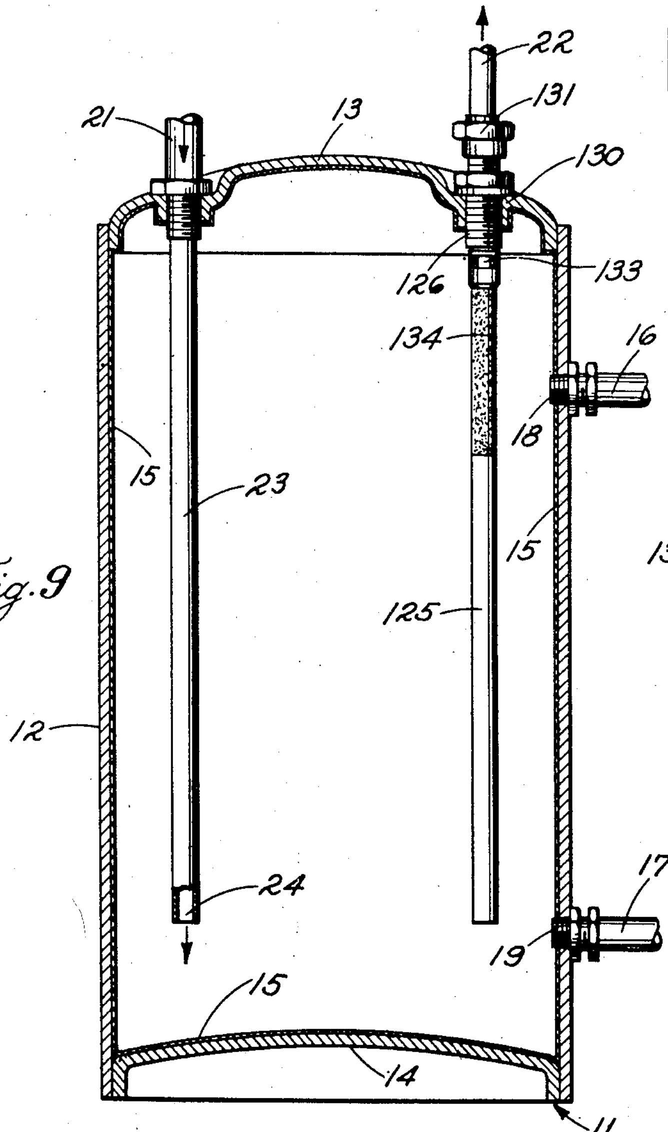

Fig. 9

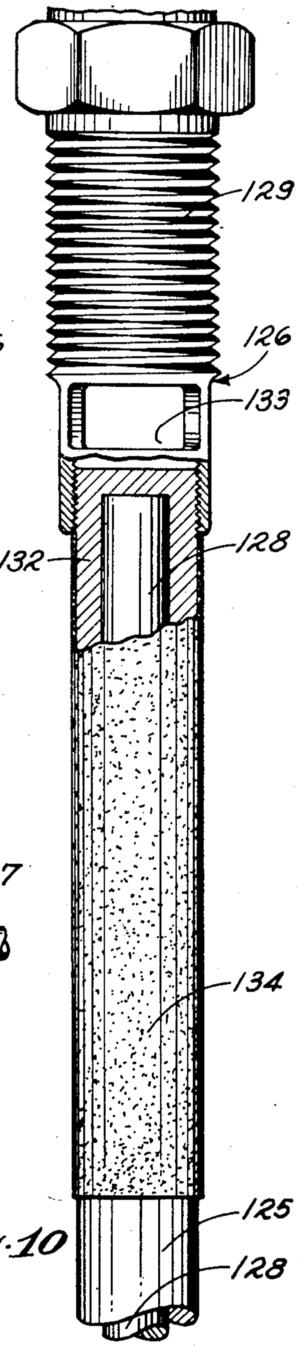

Fig. 10

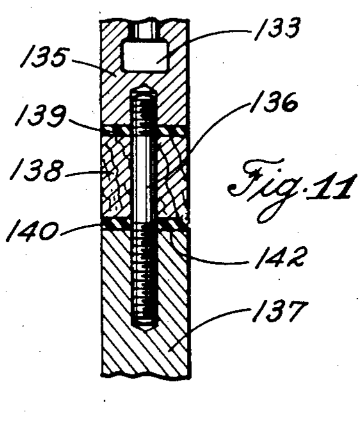

Fig. 11

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Patented Jan. 11, 1949 **2,459,123**

UNITED STATES PATENT OFFICE

2,459,123

WATER HEATING DEVICE WITH CORROSION PROTECTIVE ANODE

Herbert T. Bates, Lincoln, Nebr., and Daniel J. Fergus and Albert F. Craver, Cleveland, Ohio, assignors to The Cleveland Heater Company, Cleveland, Ohio, a corporation of Ohio

Application September 10, 1946, Serial No. 696,064

5 Claims. (Cl. 204—197)

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This application is a continuation-in-part of a copending application, Serial No. 656,140, filed March 21, 1946 (now abandoned).

This invention relates to anodic protection of zinc coated ferrous metal hot water storage vessels from excessive corrosion.

A specific object of the invention is to control corrosion of a zinc coated ferrous metal hot water tank by the use of an alloy anode that is predominantly magnesium, with the remainder of one or more metals higher than iron in the electromotive force series.

The corrosion of hot water storage tanks, and in particular those tanks used in automatic hot water heaters, has long been a troublesome factor in the overall life of the hot water heater. A galvanized steel tank as used for storing hot water will corrode under many aggressive water conditions and form objectionable discolored water, and will in time become perforated due to localized corrosion. The use of non-ferrous metals for cold water dip pipes, thermostats, water fittings, etc., tends to increase this corrosion, due to the electrolysis induced by unlike metals which add aggressive secondary factors.

Other and further objects, features and advantages of the invention will become apparent as the description proceeds.

This invention consists in employing a sacrificial anode of particular composition for use in suppressing corrosion in galvanized or zinc lined ferrous metal hot water heating tanks. We have found that a magnesium alloy anode, the essential active ingredients of which are magnesium and at least one of the group consisting of aluminum, zinc, manganese, and cadmium, wherein the magnesium is at least 60% of the total of said active component, operates successfully under all of the customary conditions of use of a zinc coated hot water heater. During use, wherein the magnesium alloy electrode is immersed in the water and electrically connected to the zinc coated ferrous metal tank, the electrode provides magnesium ions in the water. As will appear, cadmium is less desirable as an alloying element than the others mentioned, owing to its giving toxic qualities to the water.

We have obtained good results using corrosion-inhibiting bar composed of about 92% magnesium, about 6½% aluminum on the average, preferably between 5.8 and 7.2% aluminum, about 1% of zinc, preferably between .4 and 1.5% zinc, and a minimum of 0.15% manganese. We also consider an alloy to be satisfactory comprising

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substantially only magnesium and about 1½% of manganese.

Other compositions for the corrosion inhibiting bar or anode which we consider satisfactory are the following:

An alloy consisting of from .25% aluminum to 40% aluminum and substantially all the balance magnesium. For example, a 3% aluminum-magnesium alloy, a 6% aluminum-magnesium alloy, a 10% aluminum-magnesium alloy, a 20% aluminum-magnesium alloy or a 40% aluminum-magnesium alloy. An alloy consisting of 3% aluminum, 1.5% manganese and substantially all the remainder magnesium. Also an alloy consisting of 6% aluminum, 1.5% manganese and substantially all the remainder magnesium. A ternary alloy of magnesium with between .25% and 10% aluminum, and between .1% and 1.5% manganese, is satisfactory. Where about 10% aluminum or less is used, the manganese as indicated should be included. An alloy consisting of 10% zinc and substantially all the remainder magnesium. An alloy consisting of 5% tin and substantially all the remainder magnesium. Still another alloy which we have found satisfactory is one consisting of about 3% aluminum, 1% zinc, .3% manganese and substantially all the remainder magnesium.

In any case, the essential, active components of the alloy should be at least about 60% magnesium, to provide magnesium ions when the electrode is in use in the water heating tank, and the remainder of those active elements at least one of the group consisting of aluminum, zinc, manganese, and cadmium, particularly of the first three. As will appear, the alloying elements regulate the rate of corrosion of the magnesium.

From the examples given above, and those given hereafter, there is shown to be a range of alloying materials for a quaternary alloy are approximately 4.0%–8.7% consisting of the sum of zinc and aluminum, .15%–.3% manganese, and the remainder magnesium.

The metal piece used as the corrosion-inhibitor is so constructed and so connected electrically as to act as the anode of a simple galvanic battery or cell, and is accordingly hereinafter referred to as giving anodic protection.

In adapting the invention for practical use in the commercial supply of hot water storage vessels, we prefer to embody the invention in either the form of a rod or tube supported in or by the tank, or by superimposing this special metal on the cold water inlet dip tube or its equivalent.

A better understanding of the invention will be afforded by the following detailed description of illustrative constructions considered in conjunction with the accompanying drawings in which Fig. 1 is a view of a vertical, medial section of a storage water tank having anodic protection in accordance with an embodiment of our present invention.

Fig. 2 is a fragmentary view of a vertical section of a storage water tank having a dip tube coated to provide anodic protection.

Fig. 3 is a fragmentary view in section of a storage water tank corresponding to the view of Fig. 1; but, represented as cut by a vertical medial plane transverse to the plane of the section of Fig. 1 so that the inlet and outlet tubes are not visible, and illustrating external conductive electrical connection instead of direct electrical connection between the corrosion-inhibiting piece or bar and the tank metal.

Fig. 4 is a fragmentary view of a vertical, medial section of a storage water tank having anodic protection and also illustrating provision of anodic protection by coating of a thermostatic well or tube.

Fig. 5 is a fragmentary vertical, medial section of a storage water tank in which anodic protection is provided by a dip tube composed of suitable metal.

Fig. 6 is a vertical medial section of a storage water tank in which anodic protection is provided by magnesium anodes formed of strips secured around the inner periphery of the tank.

Fig. 7 is a view of a horizontal cross-section of the embodiment of Fig. 6 represented as cut by a plane 7—7 in Fig. 6.

Fig. 8 is a view of a vertical medial section of a storage water tank in which anodic protection is provided by a bar of suitable metal resting within the tank making electrical contact with the inner surface thereof.

Fig. 9 is a vertical, medial section of a storage water tank having a corrosion preventive anode carried by a hot-water outlet fitting.

Fig. 10 is an enlarged detailed view partially in longitudinal section of a portion of the corrosion preventive anode and the mounting therefore employed in the arrangement of Fig. 9, and

Fig. 11 is a detailed fragmentary view of a protective anode and mounting illustrating another method of providing surface insulation at the supported end of the anode. It will be understood, however, that while the apparatus lends itself to such arrangements as illustrated it is equally applicable to many modifications, and it is to be understood that all matter hereinafter set forth or shown in the illustrations is to be interpreted to be merely as illustrative and not in a limiting sense.

Like reference characters are utilized throughout the drawings to designate like parts.

The arrangement shown by way of illustration in Fig. 1 of the drawing comprises a fluid storage vessel such as a domestic hot water tank 11, for example, which has been formed from sheet metal with hollow, cylindrical, longitudinal sheet metal walls 12 and end walls or caps 13 and 14, forming the top and bottom walls respectively, in the case of a tank mounted with a vertical cylindrical axis. The walls 12, 13 and 14 of tanks are customarily composed of rolled steel. The end walls or covers 13 and 14 are secured to the cylindrical portion 12 in any suitable manner, as by means of riveting or welding, as will be well understood by those skilled in the art. The steel tank is coated with zinc or galvanized by a suitable process. Ordinarily, the zinc coating is formed on both the interior and exterior surface of the tank 11; but, for the sake of simplicity in the drawing, only the interior surface coating 15 has been illustrated, the thickness being shown in an exaggerated scale for the sake of clarity in the drawing.

It will be understood that such tanks are customarily employed for the storage of hot water which has been heated by a suitable source of heat, such as an automatic gas water heater, for example. The automatic gas water heater or the like is not shown in the drawing since such a heater forms no part of the invention. Connections to the gas heater such as the fragmentarily represented pipes 16 and 17 with the corresponding fittings 18 and 19, respectively, are provided. Inlet and outlet water connections, such as the cold water inlet pipe 21 and the hot water outlet pipe 22, are also provided, being joined to the tank by suitable means such as spuds or other fittings well known to those skilled in the art. Where the tank is mounted with its axis vertical, preferably the cold water inlet tube 21 has an extension referred to as a dip tube 23 with an outlet or mouth 24 in the lower portion of the tank 11. This causes the cold water from the central municipal water system to enter at the lower end of the tank as hot water is drawn from the upper end of the tank through the pipe 22 and avoids cooling the latter.

The dip tube 23 and the pipes 16, 17, 21 and 22 and any fittings which may be exposed to the interior of the tank 11 may also be composed of iron and, in some cases, may be composed of copper or other metals relatively noble with respect to iron with regard to their position in the electrochemical or electromotive series. In the case of iron pipe, even if the piping for the most part is galvanized or covered with a zinc protective coating, the end surfaces are liable to be uncoated iron so that even with a perfect galvanizing of the main surface of the tank 12 there is some tendency for corrosive action due to the presence of the two different metals in the tank exposed to the fluid such as water which is seldom absolutely pure and may contain sufficient ions for intensive local action and corrosion. And galvanized coatings of zinc are subject to imperfections exposing the ferrous metal.

In order to control such corrosion and inhibit it to the desired extent, a bar or rod 25 composed of the magnesium alloy is suitably secured within the tank 11. For example, as illustrated, the tank wall 13 is provided with a suitable inwardly turning flange or spud 26, into which is threaded a square-headed plug 27 which may be composed of cast iron or the like and into which has been firmly secured by welding or riveting or the like, the upper end of the magnesium bar 25. Care is preferably taken to obtain good electrical contact between the bar 25 and the plug 27, and in turn, between the plug 27 and the tank wall 13. Although the arrangement described is preferable from the standpoint of economy in the formation of the magnesium bar and greater tank strength with regard to withstanding pressure and less likelihood of leakage, it will be understood that my invention is not limited to the use of a separate plug 27 and if desired the bar 25 may be provided with a suitable head also composed of magnesium adapted to be threaded directly into the wall 13.

An advantageous feature of the employment of magnesium alloys is that they produce anode films, and the analysis will determine the resistance of the anode film, thus controlling the rate of magnesium consumption, that is, the rate of which the anode is consumed; and such anode films also tend to prevent local cell action at the anode. For example, tests have shown that the magnesium alloy anode produces a resistive anode film that prevents rapid deterioration of the anode, due to its high resistance. These tests employed a composition of 6.5% aluminum, 1% zinc, and .2 manganese. The composition of these magnesium alloys also results in the formation of cathode films which prevent easy access of oxygen to the cathode. This results in polarization or increased internal resistance of the cell represented by the magnesium alloy anode and the tank as a cathode, thereby decreasing magnesium consumption.

We have found that "cell" magnesium may be consumed more rapidly than one of the alloys which we have mentioned, such as for example, the alloy of 6% aluminum, 1% zinc and .2% manganese with substantially all the remainder magnesium, or the alloy of 3% aluminum, 1% zinc and .3% manganese and substantially all the remainder magnesium. In one example of "cell" magnesium which we have employed, the average impurities are .003% aluminum, .003% copper, .030% iron, .08% manganese, .001% nickel and .005% silicon, leaving 99.878% magnesium. In the production of commercial magnesium alloy such as the alloy containing 6% aluminum, 1% zinc and .2% manganese, or containing 3% aluminum, 1% zinc and .3% manganese, or containing 1.5% manganese, these impurities are reduced to a very low value. Because of the removal of these impurities, iron, nickel and copper, specifically, the consumption rate of the magnesium through local cell action is materially reduced.

The protective anode is useful as previously mentioned where piping of the water system is composed of such metals as brass or copper. Water flowing through copper pipes tends to pick up minute quantities of the copper which eventually settle out within the tank. Consequently, dissimilar metals are provided within the tank and local action takes place resulting in corrosion. Our magnesium alloy anode provides protection against any such local action. Moreover, we provide an adequate quantity of magnesium to protect the tank against such corrosion as may be caused by imperfection therein. For example, under average water conditions we have found that a two-pound anode provides protection for a period of about five years against corrosion of a galvanized iron tank due to tank imperfections as well as that due to copper carried in from piping. Thus we provide enough magnesium to protect not only against the external problem but also against the internal problem.

It will be understood that the present invention is also applicable to galvanized steel or ferrous metal hot water tanks that are provided with additional protection, such as plastic or porcelain linings, as flaws may exist or develop in the linings.

In Fig. 1 we have illustrated an arrangement employing a separate magnesium bar or rod inserted into the tank **11** and making direct electrical contact therewith. It will be understood, however, that our invention is not limited to the specific arrangement illustrated. For example, if desired the corrosion controlling or inhibiting magnesium alloy may take a different form or may be electrically insulated from the tank **11** where it enters the tank. For example, as illustrated in Fig. 2, a dip tube **28** is provided which is electrically insulated from the upper tank wall **15** by means of a bushing **29** composed of suitable electrically insulating water and heat resistant material such as a ceramic material or a synthetic-plastic-impregnated fibrous material or the like. The dip tube **28** may be composed of any desired relatively inexpensive metal such as iron or steel, for example, and is coated with the magnesium alloy. In the arrangement of Fig. 2, in order to facilitate the return of electrons or to maintain the requisite flow of current for enabling the magnesium ions to enter the solution and neutralize acidity, an external electrical connection between the dip tube magnesium surface **31** and a tank **11** is provided. This may take the form of an electrical conductor or wire **32** making electrical contact with the dip tube **28** and the tank wall **12**, preferably being joined to the respective points by means of solder as indicated at points **33**.

Although we consider it desirable to provide adequate electrical contact between the corrosion-inhibiting or controlling metallic piece and the tank metal for maintaining a definite flow of current, the magnitude of such current flow may be relatively small. For example, in the case of a domestic galvanized hot water storage tank of thirty gallons capacity, we have found that adequate corrosion control and long tank life have been assured, utilizing a magnesium alloy bar insulated from the tank wall where it enters the tank wall and electrically connected to another portion of the tank wall by an external conductor, where the current flow in the external conductor was of the order of 10 to 100 milliamperes.

In our apparatus we avoid any material electrical limitations upon the flow of galvanic currents other than those imposed by the electrical dimensions and potentials of the electrolyte, the electrodes and the films formed thereon. We permit flow of the full current available from the potential developed, thereby affording a maximum protection, where required, as quickly as possible and preventing the incipience of flaws or the aggravation of existing flaws or spots of corrosion to such an extent as to require the consumption of more magnesium in the long run, and assuring that protection is being provided at a faster rate than any corrosion can take place. Thus we provide high initial protection to the tank rather than prolonging anode life unduly at the possible expense of the tank. The types of connection illustrated all embody what may be called a "direct" connection of the anode to the tank; i. e., an electrical connection without external potential interposed and without resistors of any substantial character interposed.

We believe that, especially in cases where it is desired to obtain corrosion control or protection uniformly throughout the entire surface of the tank as promptly as possible it is advantageous to utilize the separate electrical connection **32** between the corrosion controlling metal and a tank **11** with the corrosion controlling metal insulated from a tank at the point where it passes through the tank wall. This may be accomplished also where a separate magnesium anode is provided such as the anode **25** illustrated in Fig. 1. As illustrated in Fig. 3, a magnesium anode **34** is provided which is secured in the top wall 13 of the tank 11 by an insulating bushing 35. A suitable rod or other electrical connector 36 is provided for making electrical connection to the conductor 32 which is secured in electrical contact to the tank 11 by the solder 33.

Although in the arrangement of Fig. 2 we have illustrated the coating of a standard dip tube with magnesium alloy our invention is not limited thereto and if desired an entire dip tube 37 may be provided as illustrated in Fig. 5 which is composed of magnesium alloy. Fig. 5 illustrates an arrangement in which the dip tube 37 is secured within the tank top wall 13 by a metallic bushing 38 so that direct electrical contact is made between the magnesium alloy dip tube 37 and the tank 11. However, our invention is not limited thereto and whether the dip tube is solid or coated with magnesium alloy it may be provided with direct electrical contact to the tank 11 as illustrated in Fig. 5 or external electrical contact by means of a conductor 32 as illustrated in Fig. 2 according to the service in which the apparatus is utilized.

If desired, the magnesium alloy anode may be mounted in some other portion of the tank, for example, in the lower end of the tank as illustrated in Fig. 4. In the case of automatic water heaters especially, wells or tubes 39 are ordinarily required which extend into the tank for containing suitable thermostatic elements or liquids serving to control the operation of a schematically represented valve 41 for controlling the flow of gas or other fuel to the water heater, not shown. Such tubes 39 are ordinarily composed of copper or other metal which is more noble or lower in the electromotive force scale than either iron or zinc and accordingly would tend to aggravate any voltaic action within the tank causing corrosion. Such action is, however, overcome by the presence of the magnesium alloy anode 25. However, if desired, the thermostatic tube 39 itself may be provided with a coating 42 of magnesium alloy, for example.

We consider it desirable that the rods, bars or metallic pieces of magnesium alloy make good contact with the metal of the tank 11 either directly or externally. However, our invention is not limited to a specific form, structure or mounting of such corrosion inhibiting or control anodes. For example, as illustrated in Figs. 6 and 7, magnesium strips 43 may be arranged longitudinally within the tank 11 against the inner surfaces thereof, being held against such surfaces by welding, brazing or by means of screws or the like. Positive fastening means are not, however, essential. As illustrated in Fig. 8, a relatively long rod 44 may merely be laid inside the tank 11. In this case good electrical contact with the interior surface of the tank 11 is insured by the length and weight of the rod 44 which tends to wedge the lower end 45 into one of the lower corners of the tank 11 to make contact therewith as well as causing electrical contact to take place at the upper end 46 with one of the side walls of the tank 11.

When the water encountered has a very low conductivity, such as water free from impurities or distilled water, we consider it advantageous to use an anode in the form of a coiled rod extending along the tank periphery.

Preservation of the life of the tank is of greater importance than preservation of the life of the anode, inasmuch as anodes can be replaced from time to time if consumed. However, we have

found that we are able to obtain relatively long anode life without in any way detracting from the effectiveness of he anodic protection afforded to the tank. We have found that long anode life is obtained from one of our preferred magnesium alloys, such as an alloy normally containing 6.5% aluminum, 1% zinc and .2% manganese or containing 3% aluminum, 1% zinc and .3% manganese, for example. We believe this to be the result of a high current efficiency, that is a large proportion of the total amount of magnesium consumed is expended in producing useful anti-corrosion current and a relatively small proportion of magnesium is lost through "local cell" action.

In the arrangement illustrated in Fig. 9, a corrosion-controlling or -inhibiting bar or rod 125 is provided which is composed of magnesium alloy, electrically and mechanically connected to a fitting 126 by which the hot water outlet pipe 22 is connected to the tank. Although the corrosion preventive alloy rod 125 may, if desired, be in the form of a tube, it is preferably a solid bar or a bar of corrosion preventive material supported by a core 128 in the hot water outlet fitting 126. If a core 128 is used it may be composed of iron, aluminum or other suitable metals.

The fitting 126, which may be composed of brass, is in tubular form having an external thread 129 fitting in a spud 130. It is provided with suitable means such as a ground joint and flange nut 131 for making a connection with the hot water pipe 22. A threaded socket 132 is provided at the lower end of the hot-water outlet fitting 126 to receive the corrosion controlling bar 125. Suitable lateral or side openings 133 are provided in the fitting 126 for egress of hot water from the tank 11, through the outlet pipe 22.

In order to avoid consumption of the supported end of the corrosion controlling bar or anode 125, the surface thereof adjacent the fitting 126 is insulated. For this purpose the supported end, in the illustrated case the upper end of the bar 125, is covered by a current inhibitor band or coating of an insulating material, impervious to hot water penetration. The invention is not limited to a single insulating material. Satisfactory results have been obtained with such substances as bitumastic paint, plastic coating such as Heresite, porcelain enamel, Irodite (zinc chromate) or rubber coating. The length of the insulating coating or band 134 is preferably as long at least, as the distance between the anode rod 125 and the nearest surface portion of the tank wall 12. The insulating coating 134 prevents active local action and necking of the magnesium alloy rod 125 where it is joined to the brass fitting 126.

For cutting down galvanic current and thus increasing anode life, the inner surface of the tank 11 may also be covered with a suitable insulating coating or current inhibitor such as any of those mentioned. For this purpose, the tank may also be bonderized or parkerized, that is, provided with a phosphate film on the zinc coating 15.

The invention is not limited to the specific arrangement illustrated in Figs. 9 and 10. For example, insulation of the anode supporting fitting or of the tank itself from the adjacent anode surface may be accomplished by separation of the supported end of the anode surface from the supporting member by means of a spacing insulator as shown in Fig. 11. The invention is not limited to supporting the surface-insulated corrosion-controlling bar by an outlet fitting, as it may also be secured directly to the tank wall or to a separate fitting or may be in the form of a dip-tube having its surface insulated at the supported end. Nevertheless, the use of a hot-water outlet fitting to support the anode has the great advantage that it is thereby rendered unnecessary to tap an additional hole into the tank for mounting a corrosion-controlling anode; furthermore, it is not necessary to utilize a special tank construction with an additional spud. In accordance with the invention, corrosion control may be applied to a standard tank construction as carried in stock by distributors and plumbers or even to tanks already installed on the premises of users. The hot-water fitting is merely substituted for the existing outlet fitting or for the hot-water connection previously employed. The rod **125** (threaded to the fitting **126**) is inserted through the hot-water opening already provided.

In the arrangement of Fig. 11 there is a hot-water outlet fitting **135** similar to the fitting **126** shown in Fig. 10, except that the fitting **135** has a smaller lower-end threaded opening receiving a stud bolt **136**. The bolt **136** in turn carries a corrosion-controlling bar or anode **137** like the bar **125** of Fig. 9 except for the details of connection to the stud bolt **136**. A spacer **138** and preferably also a pair of insulating washers **139** and **140** are provided for separating the anode **137** from the fitting **135**.

The spacer **138** is composed of relatively non-conducting non-metallic material such as wood or a plastic composition. To insure good electrical insulation where a relatively inexpensive possibly water-permeable substance is used for the spacer **136**, the washers **139** and **140** are provided. These are composed of a relatively high quality insulating material which is water resistant, such as natural rubber of a corresponding synthetic compound, or other good insulating material such as various synthetic plastics, for example. Preferably the stud bolt **136** is drawn up tightly enough to compress the insulator **140**, and exclude water from the surface **142**, lying between the exposed cylindrical surface of the bar **137** and the stud bolt **136**, which may be composed of iron, brass, copper or aluminum.

The lower end of the stud bolt **136** may be mated with a tapped socket in the bar **137** or may be provided with lugs, ribs or the like, in which case the magnesium alloy bar **137** may be cast around the stud **136**. If a cored anode is desired, the stud **136** is made of sufficient length to serve as a core and extends nearly but not quite to the bottom of the bar or rod **137**. Especially if the core is composed of brass or iron, it is important that the rod **137** or **125** be closed at the lower end and cover the lower end of the core to avoid local galvanic action. The core may also take the form of a wire secured to the stud bolt **136** or to the fitting **135** or **126**.

In order to assure full effectiveness of the corrosion-controlling rod **125** or **137** for the maximum period of time after it has begun to disintegrate, if having a composition subject to disintegration, we prefer to provide a core in the form of an aluminum rod or wire, which minimizes local action after portions thereof become exposed.

Certain embodiments of the invention and certain methods of operation embraced therein have been shown and particularly described for the purpose of explaining the principle of operation of the invention and showing its application, but it will be obvious to those skilled in the art that many modifications and variations are possible, and it is intended therefore, to cover all such modifications and variations as fall within the scope of the invention which is defined in the appended claims.

The mechanical features of the fitting disclosed herein are the subject of a separate application Serial No. 28,385, filed May 21, 1948, in the name of Albert F. Craver.

What we claim is:

1. A hot water heating device into which water is charged, heated, and from which heated water is discharged, including a ferrous metal tank adapted to contain conventionally available water to be heated and maintained hot for indeterminate periods of time, a zinc lining on the interior of the tank, an alloy electrode inside the tank and directly electrically connected therewith, the electrode being predominantly magnesium, the remainder consisting essentially of approximately .15% to 1.5% manganese.

2. A hot water heating device into which water is charged, heated, and from which heated water is discharged, including a ferrous metal tank adapted to contain conventionally available water to be heated and maintained hot for indeterminate periods of time, a zinc lining on the interior of the tank, an alloy electrode inside the tank and directly electrically connected therewith, the electrode being predominantly magnesium, with approximately 4.0%–8.7% consisting of the sum of zinc and aluminum, .15%–.3% manganese, and the remainder magnesium.

3. In combination, a hot water heating device into which water is to be charged and from which heated water is to be discharged, comprising a ferrous metal tank adapted to contain conventionally available water to be heated and maintained hot for indeterminate periods of time, a zinc lining on the interior of the tank, and a magnesium alloy electrode in the tank to suppress corrosion of the zinc and ferrous metal when the tank contains water, the electrode being directly electrically connected with the tank, the essentially active elements of the magnesium alloy electrode being at least 60% magnesium to provide magnesium ions when the electrode is in use in the water heating tank, and the remainder of said essentially active elements being adapted to regulate the rate of consumption of the magnesium and being at least one of the group consisting of aluminum, zinc, manganese and cadmium.

4. In combination, a hot water heating device into which water is to be charged and from which heated water is to be discharged, comprising a ferrous metal tank adapted to contain conventionally available water to be heated and maintained hot for indetermine periods of time, a zinc lining on the interior of the tank, and a magnesium alloy electrode in the tank to suppress corrosion of the zinc and ferrous metal when the tank contains water, the electrode being directly electrically connected with the tank, the essentially active elements of the magnesium alloy electrode being at least 60% magnesium to provide magnesium ions when the electrode is in use in the water heating tank, and the remainder of said essentially active elements being adapted to regulate the rate of consumption of the magnesium and being at least one of the group consisting of aluminum, zinc and manganese.

5. In combination, a hot water heating device into which water is to be charged and from which

heated water is to be discharged, comprising a ferrous metal tank adapted to contain conventionally available water to be heated and maintained hot for indeterminate periods of time, a zinc lining on the interior of the tank, and a magnesium alloy electrode in the tank to suppress corrosion of the zinc and ferrous metal when the tank contains water, the electrode being directly electrically connected with the tank, the essentially active elements of the magnesium alloy electrode being magnesium, aluminum and manganese, the aliuminum being not greater than about 10% and the manganese being from about .1% to 1.5% and the remainder of said essentially active element being magnesium.

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