

PATENT SPECIFICATION

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(54) A WATER HEATER

(71) We, RHEEM INTERNATIONAL, INC., a corporation organised and existing under the laws of the State of Delaware, United States of America, of 767 Fifth Avenue, New York, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates generally to an improved construction for hot water heaters. These water heaters typically include a storage tank formed as an upright cylinder made of steel or ferric metal plate and an anode used to protect the tank from galvanic corrosion. This invention relates specifically to a water heater construction in which a non-sacrificial anode protects the tank more effectively, efficiently and safely than prior non-sacrificial anodes.

Non-sacrificial anodes generally include one or more elongated filaments of electrically conductive metal impressed with a small electrically positive potential so as to produce direct current from the anode to the metal tank. The current counteracts the corrosive activity of the water and dissolved oxygen to protect the metal tank and fixtures from galvanic corrosion. The voltage of the impressed current is dependent upon, among other things, the quality and characteristics of the lining, the electrical conductivity of the water within the tank, and the configuration of the anode in relation to the tank walls and other metal elements.

Non-sacrificial anodes are deficient in at least two significant aspects. Since the protective current follows the path of least resistance, it will frequently flow directly from the anode to a nearby metal projection, such as the heating elements, leaving the tank walls and remaining fixtures unprotected. It is possible to compensate for this by using a higher voltage so that the protective current is applied to all areas of the tank walls and fixtures notwithstanding a relatively greater current drain in some localised area. However, the materials,

methods of construction and operating conditions commonly associated with the anode and the tank are expensive and inherently limited so as to make operation of the tank and non-sacrificial anode system dangerous, especially in certain conditions. The higher voltages associated with certain systems increase the danger.

One conventional type of anode includes a filament of titanium coated with platinum. Use of this type is limited to low voltage systems because the platinum/titanium interfaces break down at voltages above 13 volts. The construction of this type of anode generally includes installing the anode as a plurality of short discreet filaments interspaced within the tank in order to avoid proximity between the anode and metal projections within the tank; this requires more materials and labour than single filament systems.

Single filament non-sacrificial anodes are high voltage types of conventional anodes and generally use a tantalum wire coated with platinum as the platinum/tantalum interface will withstand 85 to 100 volts. However, tantalum is more expensive than titanium and the higher voltage increases the dangers associated with non-sacrificial anodes.

The danger associated with non-sacrificial anodes results from an accumulation of hydrogen and oxygen gas generated through the electrolysis of water by the protective current flowing from the anode to the tank and fixtures. The presence of hydrogen and oxygen gas in an enclosed space creates a very real threat of explosion. In normal operating conditions, much of the hydrogen and oxygen gases are dissolved in the water flowing through and out of the tank. But when the heater stands idle, for example when a homeowner goes on vacation, the static conditions in the tank produce a serious explosion hazard — so serious that no hot water heater, now commercially available and known to us, has received the safety approval of either governmental or non-governmental consumer safety organisations. It can also be seen that the rate

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of accumulation of the gases depends primarily upon the magnitude of the protective current. Thus the larger the protective current, the more dangerous the explosion potential. We have sought to provide an improved hot water heater.

Accordingly, the present invention provides a hot water heater which comprises a substantially hollow metal tank having an interior surface, the tank being formed at least in part from a galvanically active material, heating means for heating water in the tank and a non-sacrificial anode adapted to direct an electrically positive current from within the tank to the interior surface when the tank is filled with water, a catalyst for catalyzing hydrogen gas and oxygen gas formed within the tank due to electrolysis of water resulting from operation of the non-sacrificial anode means to form water molecules within the tank, the catalyst being disposed near the top of tank and being chemically stable, inert, substantially water insoluble, non-toxic and harmless in contact with food stuffs.

Preferably, in the improved hot water heater of the present invention, the non-sacrificial anode comprises an elongated wire electrode within the tank having a plurality of discrete anode elements attached thereto along the length of the wire electrode, the elongated wire being formed from a titanium material and being electrically insulated from the contents of the tank, the anode elements being platinum coated tantalum members which are affixed to the wire electrode. The anode elements are electrically conductive, chemically stable, galvanically inert, substantially water insoluble and non-toxic. The wire is projected or positioned within the interior of the heater and the anode elements are connected to the electrically conductive wire at pre-selected locations. The anode elements thus cooperate with the tank to direct a protective positive electrical current from the interior of the tank to the entire area of the tank walls interior surface.

The hot water tank is of a substantially conventional construction comprising a hollow metal tank or shell with at least one opening and an interior wall surface defining an interior therein. The tank is generally formed, at least in part, of a galvanically active material and is lined with an electrically non-conductive galvanically inert material. The hot water heater also includes a conventional heating element, generally disposed within the interior of the tank.

The present invention is further illustrated in the accompanying Drawings wherein:

Figure 1 is a cross-sectional view of a hot water heater showing a preferred form

of the improved non-sacrificial anode assembly described herein;

Figure 2 is a cross-sectional view of a non-sacrificial anode assembly described herein;

Figure 3 is a perspective view of a portion of a non-sacrificial anode assembly;

Figure 4 is a cross-sectional view of a non-sacrificial anode assembly at line 4-4 of Figure 2;

Figure 5 is a cross-sectional view of a first embodiment of the catalyst and sacrificial anode assembly described herein; and

Figure 6 is a cross-sectional view of a second embodiment of the catalyst and sacrificial anode assembly described herein.

As shown in the Drawings, a hot water heater assembly 10, includes an outer casing 12 and a tank 14. The outer casing 12 may be made of metal, ceramic coated metal or plastic, using conventional construction techniques so as to form a shell over the tank 14. The tank 14 is shaped as a cylindrical tube and is formed at least in part from a galvanically active metal using conventional construction techniques. The casing 12 and tank 14 have a drain valve opening 16 in the lower portion of the tank 14 in which a drain valve 18 is fixed. The valve 18 has a handle 20 so that any water in the tank 14 can be drained manually. Tank interior 22 is closed by a top 24 having a filler pipe opening 26 positioned substantially centrally. A fixture 28 and filler pipe 30 are fixed to the tank 14 within the opening 26 so that water can be introduced into the tank 14. A first and second heating element 32, 34 of substantially conventional construction are also fixed to the tank 14 and project within the interior 22.

As shown in Figure 2, a non-sacrificial anode 40 comprises a single elongated wire 42 which is preferably attached to the top 24. In use the wire 42 projects within the interior 22, generally extending from the top 24 towards the lower portion of the interior of the tank 14. The wire 42 also extends out of the heater assembly 10 for connection with an external source of positive direct current potential. A post 44 projects from the anode 40 and is attached to a second wire 46 forming an electrical earth.

As best shown in Figure 2, wire 42 includes an electrically conductive core 50 and an electrically non-conductive, water impermeable covering 52. The material used to make core 50 is advantageously titanium. Tantalum or other electrically conductive materials which form electrically non-conductive, protective films in contact with water, may be used. The covering 52 is preferably a conventionally plastic material such as polyvinylchloride. The cover-

ing should be chemically stable, galvanically inert, substantially water insoluble, non-toxic and harmless when in contact with food stuffs. The covering 52 acts to protect the core material 50 particularly during the initial usage or break-in period of the hot water heated assembly 10.

A plurality of anode distribution points 54 are attached to wire 42, generally by spot welding the anode distribution point directly to the core material 50. The covering 52 is generally removed from the point of attachment prior to welding. As shown in Figure 4, the anode distribution point includes a flat, rectangular shaped base member 56 covered with a thin coating 58 and spot welded to core 50 at location 60. The base member 56 is preferably made of tantalum or other electrically conductive material which forms an interface with the coating metal capable of withstanding relatively high voltages. The coating 58 is preferably platinum, but may be any other electrically conductive material which is chemically stable, galvanically inert and which does not form an electrically non-conductive film in contact with water.

In use, the elongated wire 42 extends from top 24 towards the lower central portion of interior 22. The anode distribution points 54 are generally located at pre-selected locations so that the sum of the electrical resistances between any given localized area of tank 14 and the plurality of anode distribution points 54 is substantially constant. That is, the anode distribution points 54 are located at positions which are spaced substantially equally between the heating elements 32, 34 of the tank 14 and any other conductive projections within the interior 22. The protective current distribution from the points 54 is directed to each localized area of the tank 14 as well as to conductive projections such as heating elements 32, 34. It is known through measurements with a calomel reference cell that the requisite d.c. potential of the protective current at the protective coating surface should be at least +0.78 volts with respect to the tank. We have found that the single filament non-sacrificial anode of this invention will provide a protective current having the requisite potential at the coating or interior surface 62 while operating with a total current of from 8 to 40 milliamperes, preferably from 8 to 16 milliamperes and a total voltage potential from 1 to 85 volts, preferably 20 volts, depending upon the design of the water heater, the anode points, the resistivity of the water, and the placement of the anode distribution points.

A porous basket 70 adapted to be suspended within the interior 22 from the top 24 contains a catalyst 72 which permits

hydrogen and oxygen gas at standard atmospheric temperatures and pressures to form water molecules. The porous basket is preferably made of a water insoluble, non-corrosive, solid material. The catalyst should be chemically stable, inert, substantially water insoluble, non-toxic and harmless in contact with food stuffs. The catalyst is preferably a mixture of pulverized palladium or platinum and alumina or carbon. The carbon is advantageously activated carbon. The basket 70 is suspended by attaching it to a steel cap 74 having a threaded surface which screws into the top 24. Wire 42 projects through the centre of the steel cap 74 and the basket 70 into the interior 22. A plastic insert 76 and a rubber seal 78 are generally fitted within the steel cap 74 to position and electrically insulate the wire 42 with respect to the steel cap 74 and the basket 70. An insulating paper 80 is positioned around the wire 44 between the steel cap 74 and the top 24.

The lower voltage requirements of the non-sacrificial anode of the present invention produce a lower build-up of hydrogen and oxygen gas than conventional non-sacrificial anodes. The catalyst further inhibits the build-up of hydrogen and oxygen gas, thus further increasing the safety factor of this non-sacrificial anode and hot water heater design.

Figures 5 and 6 show further embodiments for the arrangement of catalyst 72. Figure 5 shows the catalyst as cylindrical pellets with a central passageway. The pellets are strung on the elongated wire 42 near the steel cap 74. Figure 6 shows how the catalyst can be made in flat, planar members and mounted on wire 42 near the steel cap 74. The choice of configuration of the catalyst depends upon the active surface area of the catalyst and the diffusion paths for the oxygen and hydrogen gas and other characteristics conventionally known in the art.

The above description relates to a preferred embodiment of the invention. However, alternative configurations and modifications are possible within the scope of the invention. For example, the number of the distribution anode points 54 may be changed; the configuration of wire 42 may be altered although the wire may be retained as a single filament. The materials used in making the wire and the anode distribution points may be varied. The location of the catalyst may be isolated from the location of the wire 42; and the materials used to make the catalyst may be different.

WHAT WE CLAIM IS:—

1. A hot water heater which comprises a substantially hollow metal tank having an interior surface, the tank being formed at



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ing should be chemically stable, galvanically inert, substantially water insoluble, non-toxic and harmless when in contact with food stuffs. The covering 52 acts to protect the core material 50 particularly during the initial usage or break-in period of the hot water heated assembly 10.

A plurality of anode distribution points 54 are attached to wire 42, generally by spot welding the anode distribution point directly to the core material 50. The covering 52 is generally removed from the point of attachment prior to welding. As shown in Figure 4, the anode distribution point includes a flat, rectangular shaped base member 56 covered with a thin coating 58 and spot welded to core 50 at location 60. The base member 56 is preferably made of tantalum or other electrically conductive material which forms an interface with the coating metal capable of withstanding relatively high voltages. The coating 58 is preferably platinum, but may be any other electrically conductive material which is chemically stable, galvanically inert and which does not form an electrically non-conductive film in contact with water.

In use, the elongated wire 42 extends from top 24 towards the lower central portion of interior 22. The anode distribution points 54 are generally located at pre-selected locations so that the sum of the electrical resistances between any given localized area of tank 14 and the plurality of anode distribution points 54 is substantially constant. That is, the anode distribution points 54 are located at positions which are spaced substantially equally between the heating elements 32, 34 of the tank 14 and any other conductive projections within the interior 22. The protective current distribution from the points 54 is directed to each localized area of the tank 14 as well as to conductive projections such as heating elements 32, 34. It is known through measurements with a calomel reference cell that the requisite d.c. potential of the protective current at the protective coating surface should be at least +0.78 volts with respect to the tank. We have found that the single filament non-sacrificial anode of this invention will provide a protective current having the requisite potential at the coating or interior surface 62 while operating with a total current of from 8 to 40 milliamperes, preferably from 8 to 16 milliamperes and a total voltage potential from 1 to 85 volts, preferably 20 volts, depending upon the design of the water heater, the anode points, the resistivity of the water, and the placement of the anode distribution points.

A porous basket 70 adapted to be suspended within the interior 22 from the top 24 contains a catalyst 72 which permits

hydrogen and oxygen gas at standard atmospheric temperatures and pressures to form water molecules. The porous basket is preferably made of a water insoluble, non-corrosive, solid material. The catalyst should be chemically stable, inert, substantially water insoluble, non-toxic and harmless in contact with food stuffs. The catalyst is preferably a mixture of pulverized palladium or platinum and alumina or carbon. The carbon is advantageously activated carbon. The basket 70 is suspended by attaching it to a steel cap 74 having a threaded surface which screws into the top 24. Wire 42 projects through the centre of the steel cap 74 and the basket 70 into the interior 22. A plastic insert 76 and a rubber seal 78 are generally fitted within the steel cap 74 to position and electrically insulate the wire 42 with respect to the steel cap 74 and the basket 70. An insulating paper 80 is positioned around the wire 44 between the steel cap 74 and the top 24.

The lower voltage requirements of the non-sacrificial anode of the present invention produce a lower build-up of hydrogen and oxygen gas than conventional non-sacrificial anodes. The catalyst further inhibits the build-up of hydrogen and oxygen gas, thus further increasing the safety factor of this non-sacrificial anode and hot water heater design.

Figures 5 and 6 show further embodiments for the arrangement of catalyst 72. Figure 5 shows the catalyst as cylindrical pellets with a central passageway. The pellets are strung on the elongated wire 42 near the steel cap 74. Figure 6 shows how the catalyst can be made in flat, planar members and mounted on wire 42 near the steel cap 74. The choice of configuration of the catalyst depends upon the active surface area of the catalyst and the diffusion paths for the oxygen and hydrogen gas and other characteristics conventionally known in the art.

The above description relates to a preferred embodiment of the invention. However, alternative configurations and modifications are possible within the scope of the invention. For example, the number of the distribution anode points 54 may be changed; the configuration of wire 42 may be altered although the wire may be retained as a single filament. The materials used in making the wire and the anode distribution points may be varied. The location of the catalyst may be isolated from the location of the wire 42; and the materials used to make the catalyst may be different.

WHAT WE CLAIM IS:—

1. A hot water heater which comprises a substantially hollow metal tank having an interior surface, the tank being formed at

- least in part from a galvanically active material, heating means for heating water in the tank and a non-sacrificial anode adapted to direct an electrically positive
- 5 current from within the tank to the interior surface when the tank is filled with water, a catalyst for catalyzing hydrogen gas and oxygen gas formed within the tank due to
- 10 electrolysis of water resulting from operation of the non-sacrificial anode means to form molecules within the tank, the catalyst being disposed near the top of the tank and being chemically stable, inert, substantially water insoluble, non-toxic and harm-
- 15 less in contact with food stuffs.
2. A hot water heater as claimed in Claim 1, wherein the catalyst comprises palladium or platinum mixed with alumina or carbon.
- 20 3. A hot water heater as claimed in Claim 2, wherein the palladium, platinum, alumina and/or carbon are pulverized.
4. A hot water heater as claimed in Claim 2, wherein the carbon is activated
- 25 carbon.
5. A hot water heater as claimed in any of claims 1 to 4, further comprising a porous basket made from a water insoluble, non-corrosive solid material in which the
- 30 catalyst is disposed as pellets.
6. A hot water heater as claimed in any of claims 1 to 4, wherein the catalyst is formed as pellets having central passageways and including a suspending member
- 35 projecting through the central passageways.
7. A hot water heater as claimed in any of claims 1 to 4, wherein the catalyst is formed as flat planar members mounted on a support member.
- 40 8. A hot water heater as claimed in any of claims 1 to 7, wherein the non-sacrificial anode comprises a wire electrode projecting into the tank, the wire electrode
- being generally insulated from the tank and including a plurality of separate anode 45 members attached thereto at intervals along the wire electrode for directing current discharge and thereby protecting the tank.
9. A hot water heater as claimed in any of claims 1 to 8, wherein the non-sacrifi- 50 cial anode comprises an elongated wire electrode within the tank having a plurality of discreet, spaced, anode elements attached thereto along the length of the wire electrode, the wire electrode being formed 55 from a titanium material and being electrically insulated from the contents of the tank, the anode elements being platinum coated tantalum members which are affixed to the wire electrode. 60
10. A hot water heater as claimed in Claim 9, wherein the wire electrode is insulated at least in part by an insulating material clad on the wire electrode.
11. A hot water heater as claimed in 65 Claim 9, wherein the wire electrode is insulated at least in part by an oxide layer formed on the wire electrode.
12. A hot water heater as claimed in any of claims 9 to 12, wherein the tantalum 70 members are arranged on the wire at pre-selected positions such that the sum of electrical resistances between the plurality of anode members and each one of a number of a separate localized areas on the interior surface of the tank is substantially 75 constant.
13. A hot water heater substantially as herein described and with reference to the 80 accompanying drawings.
- LLOYD WISE, TREGEAR & CO.
Norman House,
105-109 Strand,
London, WC2R 0AE.

