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ELECTRODE TYPE WATER HEATER

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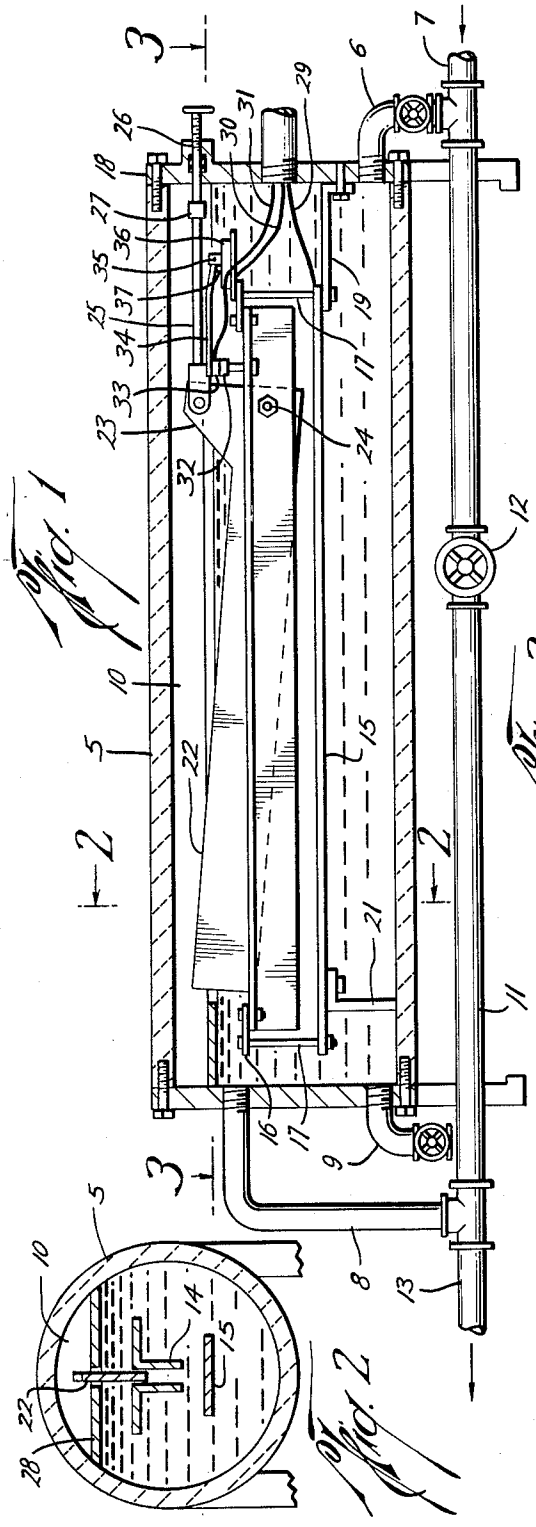

Fig. 1

Fig. 2

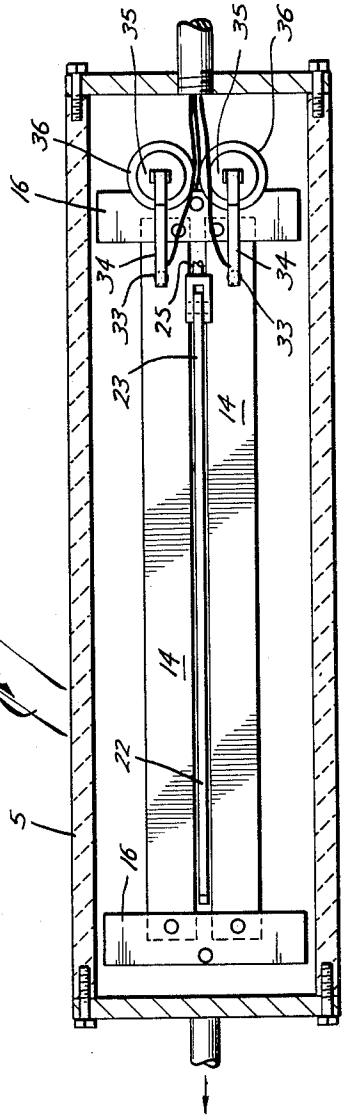

Fig. 3

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ELECTRODE TYPE WATER HEATER

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This invention is an improved fluid heater of the type in which the electrodes are immersed in a conductive fluid to be heated and the resistance of the fluid itself in the electric circuit is utilized for producing heat. In one aspect it relates to improved water heaters, and in other aspects it relates to improvements of regulation of such heaters and to improved systems for regulating the resistance supplied by the fluid heated, and to improvements in control of temperature in such heaters.

A great many heaters for fluid, in which fluid is connected into the circuit are known; in fact, an entire sub class of patents is devoted to heaters of this type. A principal disadvantage of such heaters large enough to supply water for the usual household uses results from the necessity for controlling flow of current both to prevent overheating, and to prevent large surges of electricity on the feed lines when the current is switched on and off. In the past rheostats have been suggested as a suitable means for control of current surges in the feed lines, but heaters equipped with rheostats are too expensive to be competitive in the household water heating field.

Variations in salt content of water, especially in waters from different locations, have made a standard spacing for electrodes impractical. This disadvantage has been met in the past by making one or more of the electrodes movable and providing means for varying the spacing of electrodes in the liquid or otherwise controlling effective resistance of liquid between electrodes. Devices of prior types, however, are fairly complicated and easily get out of adjustment.

When the temperature of water in an "instantaneous" household water heater of immersed electrode type is controlled by intermittent application of electric current, variations in demand on the power supply lines have been so large and instantaneous as to require a rheostat for their control to prevent undesirable variations in voltage in the supply lines.

It is an object of the present invention to provide a small compact electric heater of the immersed electrode type having capacity sufficient for ordinary household uses in which the need for rheostats and other outside controls has been eliminated.

Another object is to provide a heater of this type in which large instantaneous surges in power requirement are avoided.

Another object is to provide a heater of this type in which adjustment to compensate for variations in electrolyte content of water are easily made without moving an electrode.

Another object is to provide a highly efficient rapid heating device of this type which has high capacity suitable for an "instantaneous" hot water supply system.

Another object is to provide a heater of this type which is safe in operation and in which positive make and break in electrical connections occur at predetermined temperatures.

Another object is to provide a heater of this type which is inherently small in size in comparison to the volume of water heated, which is simple, rugged and dependable, cheap and easy to construct and which is very easily disassembled for replacement, repair or adjustment of parts.

These objects are accomplished in the present invention

by the provision of a heater of submerged electrode type in which the water or other conductive fluid to be heated provides not only the heating resistance, but resistance in gradually applying and discontinuing the supply of electric energy, thus performing a function formerly requiring outside controls, such as a rheostat, in water heaters of similar type. The gradual application and discontinuance of the electric current is accomplished by means of a pair of electric contact points, one of which is stationary in the water at a substantial distance below normal water level in the heater and is in electrical connection with one electrode; the other contact of the pair is movable between a position below the surface of the water in contact with the first mentioned point and a second position in an air pocket or pocket of other non-conductive gas maintained in the housing of the heater above the surface of the liquid.

When the movable contact point is in the air pocket, the current is positively cut off. The heater is thus safe and cannot overheat. As the movable contact point enters the water, an electric current is set up which gradually increases in intensity as the movable contact approaches the stationary one until the movable contact point makes contact with the stationary contact point and applies full voltage to the electrode.

Temperature responsive means for moving the movable contact points between their first and second positions are provided. These means preferably include a pivoted arm for each movable contact point and a device such as a thermostat for rotating the arm about its pivot.

At least two electrodes are necessary and these are spaced from each other and are at least partially immersed in water. In a three-wire system corresponding to the usual 220 volt house wiring system, three electrodes, or a multiple of three electrodes, are used. In a system of this type, all electrodes may be equipped with pairs of contact points, such as described above; but it is preferred to equip only two of each three with this type contact and to make a permanent stationary electrical connection to one of the trio of electrodes.

A means for controlling effective fluid resistance between at least two of the electrodes also is provided. This means preferably is a pivoted blade or strip of insulating material which is manually adjustable from outside the heater. The blade rotates about its pivot from a position in which the blade is between the electrodes for substantially its full length to a position in which a large part of the blade is not blocking direct flow between the electrodes.

No fine adjustment in the position of the blade is necessary. It is merely set in a position approximating that at which a desired quantity of current will flow between the electrodes. Control of the total power input and temperature is provided by make and break of electrical connections by the contact points and by the thermostat controlling the movable points.

In the drawings, wherein like reference characters are used throughout to designate like parts:

FIG. 1 illustrates one preferred heater of the present invention in longitudinal vertical section;

FIG. 2 is a vertical section through the device of FIG. 1 on the line 2—2 perpendicular to the section of FIG. 1;

FIG. 3 is a horizontal section through the device of FIG. 1 on the line 3—3.

This heater will be described in the particular modification shown as a 220 volt heater having three electrodes, each attached to a wire of a common three-wire wiring system; but it is to be understood that other voltages and two-electrode systems may be used if desired. A three phase system utilizing four electrodes is within the purview of this invention.

In the device illustrated the reference numeral 5 indicates a housing. This housing preferably is cylindrical and is arranged horizontally although other shapes of cross section and a vertical arrangement may be used if desired. An inlet line 6 for cold water, preferably valved, is connected to the housing and to a line 7 communicating with a source of cold water (not shown). An outlet line 8 for hot water is attached to the housing, preferably at an end of the housing opposite line 6. A drain line 9 also is provided to drain out any accumulations of scale, or to empty housing 5 when repairs or replacement of parts may be necessary.

The outlet 8 is located at a distance below the top of housing 5 to maintain an air pocket 10 in the housing above and in contact with water therein. line 7 and line 8 preferably communicate through a line 11 containing a valve 12 in order to permit delivery of hot water through line 13 to a spigot or other point of utilization at a temperature below that reached in the housing 5.

In the modification illustrated, the heater comprises three electrodes immersed in water in the housing. Two electrodes 14 are identical and preferably are made of stainless steel angle iron or similar corrosion and electrolysis resistant material while the third electrode 15 preferably is a strip of the same type material. The electrodes 14 are spaced from each other by distances which are roughly approximated to give the desired degree of resistance in the water between electrodes. For example, the space between electrodes 14 should be widened a bit in localities where hard water containing a considerable proportion of electrolytes is to be encountered and should be narrowed to approximately the position shown in FIG. 3 when a water containing little electrolyte is to be heated.

Electrodes 14 are disposed parallel to each other and are rigidly mounted on supporting members 16, made of insulating material. Electrode 15 also is parallel to the two upper electrodes 14 and is suspended from the insulating members 16 in any suitable manner as by bolts 17.

The electrode assembly is attached to the end 18 of the housing and preferably is carried by an insulating supporting member 19. The opposite end of the electrode assembly is supported by a suitable bracket 21, preferably attached to electrode 15 and freely movable on the bottom of housing 5. Alternatively, the end of the electrode assembly opposite to end 18 of the housing may be supported upon a suitable shelf or bracket rigidly attached either to the bottom of the housing or to the adjacent end wall and freely movable against the underside of electrode 15. This method of assembly and support of electrodes is preferred so that detachment of the end wall 18 from the housing permits the entire electrode and control assembly to be withdrawn from the interior of the housing, thus making the heater very easy and simple to assemble and disassemble.

A pivoted blade 22 of insulating material is disposed between opposing surfaces of electrodes 14. Blade 22 is disposed to pivot around a suitably insulated pivot 24 in electrodes 14 and serves as means for controlling the effective resistance of water between the electrodes. Blade 22 has an offset portion 23 pivotally attached to a longitudinally movable rod 25. Rod 25 is positioned by a threaded shaft 26 attached to rod 25 through a suitable connection 27 permitting revolution of shaft 26 relative to rod 25. Before the heater is placed in use, the rod 25 is positioned by adjusting shaft 26 to allow for the expected concentration of electrolytes in the water to be heated. If the hardness of the water changes markedly, the blade 22 can be shifted in position by suitably manipulating shaft 26, although this adjustment will seldom be necessary.

When a heater of this type is to be installed in a position where there is likelihood of vibration, it is preferred to install a splash plate 28, having suitable openings therethrough for operation of blade 22 and switches to be described later; but inclusion of this feature is optional and it will seldom be necessary.

A principal feature of novelty in this invention lies in the elimination of outside rheostats and similar controls, formerly necessary on large capacity water heaters of the electrode type. In the modification illustrated, the electric leads 29, 30 and 31 are so connected that there is a voltage of 220 between electrodes 14 and a voltage of 110 between each of electrodes 14 and electrode 15. It is preferred to connect lead 29 permanently to electrode 15 as by attachment to bolt 17 since make and break of electric contacts in the circuits to electrodes 14 is sufficient to apply or shut off current from all electrodes. It is to be understood that leads 29, 30 and 31 will be covered with a water-resistant, heat-resistant insulation, although this insulation is omitted from the drawings for purposes of clarity.

A stationary electric contact point is electrically connected to each of electrodes 14 at a point below normal water level in housing 5. It is thus covered with water at all times. Leads 30 and 31 are each connected to a movable contact making up the pair of electric contacts supplying electricity to each electrode. Contact point 33 is movable between a first position in contact with contact point 32 and a second position out of contact with water in the air pocket above the surface of water in housing 5.

Contact point 33 preferably is carried on a pivoted arm 34 made of insulating material and disposed for angular movement around a pivot 35. A temperature responsive means 36 is disposed to move the arm 34 between its position in contact with contact point 32 and its second position in the air pocket above the surface of the liquid in response to selected temperatures. Means 36 may be of expansible fluid type in which expansion and contraction of fluid moves a pin 37 on which arm 34 rests. Many other types of temperature responsive means may be substituted for the one shown if desired. For example, an expansible fluid filled bellows, a coiled bi-metallic thermostat, a piston operated by an expansible fluid or a coil containing an expansible fluid may be substituted if desired. No particular type of temperature responsive means is essential to this invention, but any means which moves contact point 33 from its position beneath the level of water in housing 5 into the air pocket, and return, in response to selected temperature variations may be substituted for the particular device shown.

The leads 30 and 31 are connected to contact points 33 at a point adjacent the end of pivoted arm 34 so that the ends of the leads are also carried out of the water when the arm is raised to prevent stray current continuing to heat the water.

The two separate temperature responsive means 36 are used, and in use these will be adjusted to operate at slightly different temperatures. Thus, when both contacts are closed, there will be a flow of current not only between electrodes 14 but also between electrodes 14 and electrode 15. Since the voltage between electrodes 14 is 220 and the voltage between one electrode 14 and electrode 15 is 110, there will be very rapid heating of the water contained in the housing due principally to the 220 volt current flowing between electrodes 14. As the temperature approaches the maximum desired, for example 158° F., the temperature responsive means 36 connected in the 220 volt circuit will open and the contact point 33 in this circuit will be lifted out of contact with the water and held in open position, thus leaving the 110 volt circuit between electrode 14 and electrode 15 still in operation to complete heating for the next few degrees, for example up to 160° F. At this temperature the remaining contact 33 is raised by operation of its corresponding temperature responsive means 36 and arm 34

into the air pocket above the liquid and all current flow ceases.

As hot water is withdrawn from the housing and is replaced by cold water, the temperature falls and the contact points **33** are lowered into the water. Normally the change in temperature required to lower each of the contact points into circuit closing position is the same, and consequently the contact point **33** which was lifted out of the water first, breaking the 220 volt circuit, will be first to re-enter the water and move to closing position. However, since there is only a 110 volt potential between each of electrodes **14** and electrode **15**, only a 110 volt circuit is closed by the first contact point to reach circuit closing position. When only a little water is withdrawn, the 110 volt circuit will be sufficient to restore the water in the housing to the desired temperature and the 220 volt circuit need not operate. However, when larger quantities of water are withdrawn, both contact points **33** are lowered into the water and close both circuits.

The movable contact points thus open and close their respective circuits one at a time, dividing the current surge into two separate surges occurring at different times. Each separate surge also is smoothed out by travel of the corresponding movable contact point through the water. The diminishing or increasing resistance of water between a moving contact point **33** and its corresponding stationary contact point **32** performs a function similar to that of a rheostat.

It will be seen that as a contact point **33** touches the surface of the water, a current is immediately established, and that this current slowly increases in intensity until contact point **33** touches its corresponding point **32** and completely closes the circuit. In the heater of the present type, there is no sudden surge of electric current at either make or break; and many heaters located on the same main feed line will not increase the peak demand of current from that line to an undesirable extent because of surges in power requirements.

It will further be seen that the device of the present invention provides a water heater which is almost 100 percent efficient in that there is substantially no heat lost from the heater providing that the heater walls be well lagged according to the usual construction of water heaters.

The small size of the present heater also enables it to be installed in motel units, in office building lavatories and other places where the demand for hot water is quite variable and for which the present systems require a pump for continuously circulating hot water through a building in order to have hot water available in all locations at a time when it is required. A heater of the type described is further advantageous in that it is extremly cheap in construction and simple and easy to service and may be installed at or very near to a point of hot water utilization, avoiding heat losses in long pipes.

Its capacity is remarkably high in proportion to its size. For example, 85 measured gallons of water per hour have been heated to a temperature increase of 60° F. in a heater constructed as shown in the drawings having a cylindrical body six inches in diameter and equipped with three electrodes eighteen inches in length, made from one inch angle bars of stainless steel. This heater drew a maximum electric current of 50 amperes and was operated from an ordinary three-wire 220 volt system using No. 8 lead wires without causing any overheating of conductors or undesirable current or voltage fluctuation.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the apparatus.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

The invention having been described, what is claimed is:

1. A fluid heater comprising in combination a housing; a conductive liquid in the housing; a body of non-conducting gas above the liquid in the housing; at least two electrodes in contact with said liquid and spaced apart; means for passing an electric current through the electrodes and liquid, including a pair of cooperable contact points, one of said pair of contact points being stationary, electrically connected to an electrode and located at a substantial distance below a normal fluid level in the fluid in the housing, and the other of the pair of contact points being movable between a first position in contact with said first mentioned contact point and a second position in said body of gas above said liquid, and means, responsive to temperature of the liquid, for moving the movable contact point between said first and second positions.

2. A water heater comprising in combination a housing; a body of water in the housing; a body of air above the water in the housing; at least two electrodes spaced apart and at least partially immersed in said body of water; means for passing an electric current through the electrodes and water, including a pair of contact points, one of said contact points being stationary, electrically connected to an electrode, and located at a substantial distance below a normal water level in water in the housing, and the other of said pair of contact points being movable between a first position in contact with said first mentioned contact point and a second position in said body of air above said water, and means, responsive to temperature of the liquid, for moving the second contact point between said first and second positions.

3. A water heater comprising in combination a housing; a body of water disposed in the housing; a body of air above the water in the housing; at least two electrodes in contact with said water and spaced apart therein; means for passing an electric current through the electrodes and water, including pairs of cooperable contact points, said pairs being one less in number than the number of electrodes, one of each pair of contact points being stationary, electrically connected to a single electrode and located at a substantial distance below a normal water level in water in the housing and the other of said pair of contact points being movable between a first position in contact with said first mentioned contact point of each pair and a second position in said body of air above said water, and temperature responsive means for moving the second contact point between said first and second positions; and means for controlling the effective resistance of water between at least two of said electrodes.

4. A water heater comprising in combination a housing; a body of water in the housing; means for maintaining a body of air above the water in the housing; at least two electrodes at least partially immersed in said water and spaced apart therein; means for passing an electric current through the electrodes and water including a pair of cooperable contact points, one of said pair of contact points being stationary, electrically connected to a single electrode and located at a substantial distance below a normal water level in the water in the housing and the other of said pair of contact points being movable between a first position in contact with said first mentioned contact point and a second position in said body of air above said water, and temperature responsive means for moving the second contact point between said first and second positions, said temperature responsive means including a pivoted arm carrying said movable contact point and expansible means for moving the arm about its pivot.

5. A water heater comprising in combination a housing; a body of water in the housing; an outlet for hot water spaced from the top of the housing maintaining a

body of air above the water in the housing; at least two electrodes in contact with said water and spaced apart therein; means for passing an electric current through the electrodes and water, including a pair of cooperable contact points, one of said contact points being stationary, electrically connected to an electrode and located in the water at a substantial distance below normal water level in the housing and the other of said pair of contact points being movable between a first position in contact with said first mentioned contact point and a second position in said body of air above said water, and temperature responsive means for moving the second contact point between said first and second positions, said temperature responsive means including a pivoted arm carrying said movable contact point and an expansible means for moving said arm about its pivot; means for controlling the effective resistance of water between at least two of said electrodes; means for admitting cold water at controlled rate into a lower part of said housing; and means for mixing a controlled proportion of cold water with hot water issuing from said housing.

6. A water heater comprising in combination a housing having at least one removable end; a body of water in the housing; an outlet for hot water disposed at a level below the top of the housing together with the upper part of the housing defining a body of air in the housing above the water contained therein; at least two electrodes in contact with water in the housing and spaced apart therein, said electrodes and all electrical connections thereto being carried by a removable end of the housing; means for passing an electric current through the electrodes and liquid, including a pair of contact points, one of said contact points being stationary, electrically connected to an electrode and located in the water at a substantial distance below a normal water level in the housing and the other of the pair of contact points being movable between a first position in contact with said first mentioned contact point and a second position in the body of air above the water, and temperature responsive means for moving the second contact point between said first and second positions; and means for controlling the effective resistance of water between at least two of said electrodes; and an inlet for cold water communicating with said housing.

7. A hot water heater comprising in combination a housing having at least one removable end; means for introducing cold water into said housing at controlled rate; an outlet for hot water communicating with said housing at a point below the top of the housing and together with the upper part of the housing defining a body of air in the housing above and in contact with water

therein; three electrodes carried by a removable end of the housing and at least partially immersed in water therein; means for passing an electric current through the electrodes and water, including a permanent electrical connection to one of said electrodes, two pairs of contact points singly disposed in electric circuits to the other two electrodes, one of each pair of contact points being stationary, electrically connected to a single electrode and located in the water at a substantial distance below a normal water level in the housing and the other of each pair of contact points being movable between a first position in contact with said first mentioned contact point of each pair and a second position in said body of air above said water, and temperature responsive means for moving the second contact point between said first and second positions; and means for controlling the effective resistance of water between two of said electrodes.

8. The heater of claim 7 wherein the temperature responsive means comprises a pivoted arm carrying said movable contact point and means responsive to expansion and contraction of fluid, for moving said arm about its pivot.

9. The heater of claim 7 wherein the temperature responsive means for moving the movable contact points to and from their first and second positions is disposed to operate each of said movable contact points at a different temperature.

10. The heater of claim 3 wherein the temperature responsive means for moving the movable contact point includes a pivoted arm carrying the contact point and means responsive to expansion and contraction of fluid for moving said arm about the pivot.

11. The heater of claim 7 wherein the means for controlling the effective resistance of water between two electrodes comprises a movable strip of insulating material disposed between said electrodes and manually operable means for positioning said strip.

12. The heater of claim 11 wherein the movable strip is pivoted adjacent to one end thereof on a pivot carried by two electrodes and a longitudinally movable member is disposed through the removable end of the housing to move the strip about the pivot.

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