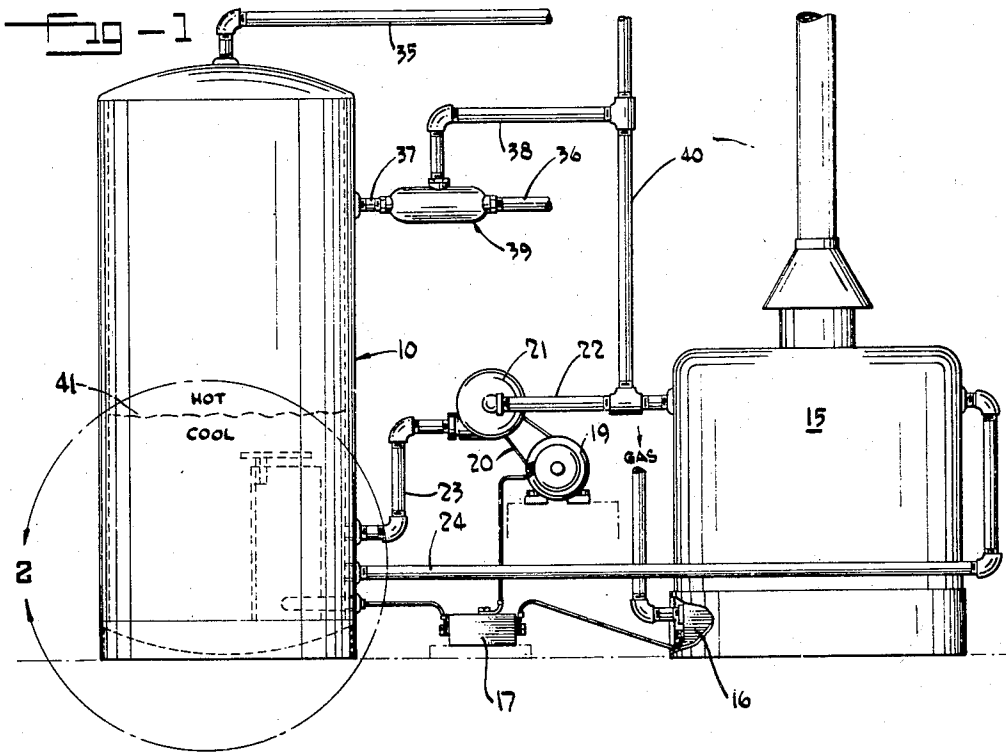
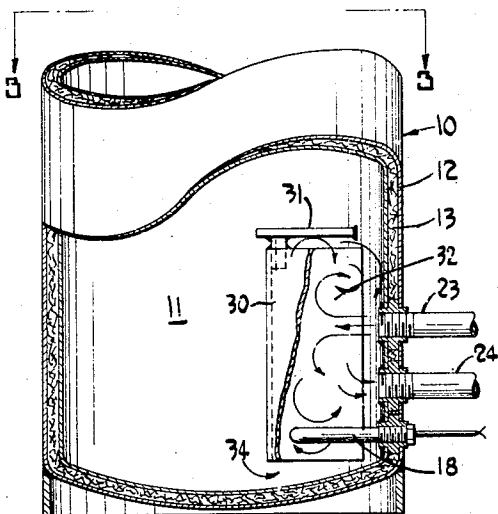
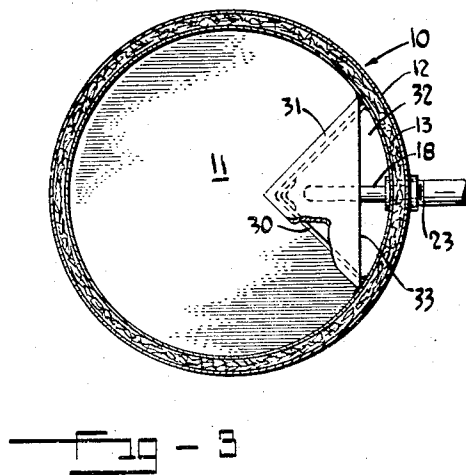


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HOT WATER STORAGE TANK AND WATER HEATER
SYSTEM EMBODYING THE SAME
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HOT WATER STORAGE TANK AND WATER HEATER SYSTEM EMBODYING THE SAME

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The present invention relates generally to water heaters and more particularly to commercial installations such as in restaurants and the like, where large volume demands of relatively hot water are required from time to time at fairly wide spaced intervals, while at the same time a relatively steady supply of warm water at a somewhat lower temperature is also required.

Requirements of the type just described arise from the use of automatic dishwashers wherein the water temperature is quite high, usually on the order of 180° F. Other requirements such as warm water for washing hands and the like is preferably somewhat lower in temperature say on the order of 140°. Thus, it will be seen that if a single storage tank is employed in which to store hot water, it is necessary that the water be at the highest desired temperature and that other means be provided for mixing the high temperature water with cold water to produce the lower temperature water herein designated as "warm" water.

In restaurants and other establishments employing automatic dishwashing equipment and other types of equipment which have intermittent demands for hot (180°) water there is a further problem in that unless an excessively high capacity boiler is provided for heating the water, each withdrawal of a large volume of hot water causes an influx of relatively cold water into the storage tank wherein it mixes with the hot water therein (in the conventional system) thus reducing the temperature of the mixture below that desired. While recirculation of this mixture through the heater will ultimately bring it to the desired temperature, in the interim, it is impossible to obtain water at the desired high temperature.

Modern health department requirements call for water at not less than 180° in dishwashing and rinsing operations whereby to minimize pathological organisms on dishes and cooking utensils. This requirement has often made necessary the installation of completely separate water heating systems in restaurants in order to satisfy the intermittent demands of the dishwashers and similar equipment.

One solution in the past has been to heat the water to somewhat above 180° so that the cooling due to the influx of cold water will not bring the temperature below 180°. This gives rise to other problems, however, such as the formation of excessive lime deposits and the danger of producing live steam.

Bearing in mind the difficulties above described it is a major object of the present invention to provide in a single storage tank and associated water heater system, means for providing intermittent relatively high volume demands of hot water (180° F. or above) while at the same time supplying a more or less continuous demand of warm water at a lower temperature.

Another object of the present invention is to provide a system of the class described wherein an inordinately large storage tank is not required.

The foregoing and additional objects and advantages of the invention will be apparent from the following descrip-

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tion thereof, consideration being given also to the accompanying drawings wherein

Figure 1 is an elevation view of a water heating system embodying the present invention;

5 Figure 2 is an enlarged partially sectioned portion of Figure 1 as shown by the circle 2 thereon and showing the internal construction of the storage tank; and

Figure 3 is a horizontal section taken on the line 3—3 in Figure 2.

10 In the drawings the reference character 10 indicates generally a storage tank having an inner liner 11 and an outer housing 12 the space between the liner 11 and the housing 12 being filled with insulating material 13 for example rock wool. Water stored in the tank 10 is heated in a conventional gas fired water boiler 15, having a thermostatically controlled burner 16 of conventional design, electrically connected to be controlled by a thermostat relay 17 which in turn is actuated by a temperature sensing element 18 of the conventional immersion type located in the tank 10 as will hereinafter be explained in more detail.

It will be understood that the heating capacity of the boiler 15 is substantially less than the rate at which hot water may be withdrawn through the conduit 35 and that the maximum output temperature of the boiler starting with cold water is about 180°.

The thermostat relay 17 is supplied with electric power (connection not shown) and electrically connected to control a pump motor 19. The latter is mechanically connected through a V belt 20 or other suitable means to drive a centrifugal pump 21.

25 The pump 21 is connected by a conduit 22 to receive water from the boiler 15 and deliver the same through a conduit 23 to the tank 10 whence it is returned through a conduit 24 for recirculation through the boiler 15.

Thus, it will be seen that whenever the temperature at the sensing element 18 is below a predetermined value, the burner 16 will be ignited heating water in the boiler 15 and at the same time the pump 21 will operate to circulate water through the tank 10 and the boiler 15. This operation continues until the temperature at the sensing element reaches the desired value whereupon the burner 16 is turned off through the operation of the thermostatic controls just described and at the same time the circulating pump 21 is stopped. As thus far described, the system embodying my invention is of more or less conventional design. It is the usual practice however to widely separate the water circulating connections to a water heater tank whereby to cause the entire contents of the tank to be mixed and gradually raised to the desired temperature as the recirculating heater operates. By reason of this arrangement, each time hot water is withdrawn from the storage tank the entire contents of the storage tank is substantially immediately reduced in temperature and thereafter gradually rises to the desired "shut-off" value. Thus, any substantial volume of water withdrawn from the tank has a temperature considerably below the "shut-off" temperature.

30 In order to prevent the just described reduction in temperature, I provide means in the tank embodying my invention for stratifying the tank contents so as to maintain a substantially large body of high temperature water in the upper portion of the tank where it may be withdrawn, such means also preventing any intermixing of the entire tank contents each time hot water is withdrawn therefrom.

35 In the preferred form of my invention the stratifying means comprises a generally triangular mixing chamber within the tank 10 which chamber is formed by welding an angle wall member 30 to the inner cylindrical wall of the liner 11 and covering the upper end of the chamber with a flat triangular baffle 31 so as to form a generally

sector-shaped compartment or chamber 32 adjacent the circulating conduits 23 and 24. The chamber 32 encompasses the temperature sensing element 18. The baffle 31 at the upper end of the chamber 32 is spaced slightly from the angular wall 30 and is also spaced from the cylindrical wall of the liner 11 as is shown at 33, whereby to permit a limited, low-velocity egress of heated water from the chamber 32 due to convection. The bottom edge of the wall 30 is spaced above the bottom of the tank liner 11 as indicated at 34 so as to permit relatively cool water to enter at the bottom of the chamber 32 to replace heated water which escapes upwardly at the upper spaces previously described.

In the present embodiment hot water at, for example 180° F., is withdrawn from the upper end of the storage tank 10 through a conduit 35. Warm water at for example 140°, is supplied by the system at a delivery conduit 36 and is produced by mixing hot water delivered from the tank through a conduit 37 and cold water from a supply main 40 delivered through a conduit 38. The just described mixing is accomplished in a thermostatic mixing valve 39 of conventional design adapted to proportion hot water from the tank 10 with cold water from the conduit 38 to produce the desired temperature at the delivery conduit 36.

The cold water supply main 40 is also connected to the recirculation conduit 22 so that cold water is fed into the output of the boiler 15 whenever hot or warm water is withdrawn from the delivery conduits 35 and 36 respectively.

The components of the system having been described, the operation will be apparent from the following description. Assuming a starting condition wherein the entire content of the tank 10 is at ambient temperature, that is the temperature of cold water supplied from the main 40, the device is set in operation by turning on the power to the thermostatic control relay 17 by conventional means (not shown). The thermostat is set in the illustrative example, to automatically turn off the gas burner 16 and the pump motor 19 when the temperature at the sensing element 18 reaches approximately 180° F. Initially the system will operate in more or less a conventional manner, the boiler 15 delivering hot water through the conduit 23 where it mixes with cold water in the mixing chamber 32, such mixture being recirculated through the conduit 24 to the boiler 15. As the temperature in the mixing chamber 32 rises, convection causes heated water to move upwardly past the baffle 31 drawing in relatively cold water at the under edge of the angular wall 30. This process continues until the entire content of the tank 10 has been raised to 180° F. at which time the thermostatic controls previously described will shut off the burner 16 and the pump motor 19.

Assuming now that a substantial quantity of hot water is withdrawn through the conduit 35 for example an amount equal to one-third the capacity of the tank 10, it will be seen that this volume is immediately replaced with cold water entering through the conduits 40, 22, the pump 21, and the conduit 23. Because of the baffle effect of the angular wall 30 and the top baffle 31, the turbulence caused by the influx of cold water will be confined to the mixing chamber 32 and the cold water will, due to its relatively greater density, fill the lower one-third of the tank 10 leaving a relatively well defined interface between hot water at 180° and cool water at or near ambient temperature. This interface is indicated by the dotted line 41 in Figure 1.

The cool water reaching the sensing element 18 actuates the same turning on the burner 16 and the pump motor 19 causing the recirculation previously described. As the heating and recirculation operation continues the volume of water within the mixing chamber 32 will be highly turbulent but such turbulence will be confined within the chamber due to the baffle effect of the wall 30 in

the upper baffle 31. As the temperature of the water within the chamber 32 is increased due to the recirculation and heating, the heated water gradually moves upwardly out of the top of the chamber 32 as previously described and relatively cool water moves in as indicated at 34. This relatively slow circulation of water within the lower one-third of the volume of tank 10 does not materially disturb the interface indicated at 41 but the same moves down gradually as the contents of the lower one-third of the tank is heated, until the interface reaches the sensing element 18 at which point it will be realized the system is shut off through the operation of the thermostatic relay 17.

The foregoing arrangement produces an unusually uniform temperature of water withdrawn at the conduit 35 so long as the amount withdrawn is within the limits of the storage capacity of the tank 10. The following table of comparative temperatures illustrates the marked increase in uniformity of temperature achieved with the present invention.

In each of the tests I through V tabulated below the ambient temperature of the water supplied at the main 40 was 60° F. In each case, water was withdrawn at the conduit 35 at the rate of 5¼ gallons per minute. The system was started cold in each test and the thermostatic control was set at 180° F. Such operation was allowed to continue until the thermostat shut off the heater. The conduit 35 or the corresponding hot water output in the conventional systems tested, was then opened allowing hot water to be withdrawn at the aforesaid rate of 5¼ gallons per minute. Such withdrawal of hot water was allowed to continue in each case until a total of 400 gallons had been withdrawn from the tank. Measurements of the output temperature of the water were taken as follows: (1) at the time the withdrawal started, (2) after 100 gallons had been withdrawn, (3) after 200 gallons had been withdrawn, (4) after 300 gallons had been withdrawn, and (5) after 400 gallons had been withdrawn. In the table below test I was of the system illustrated in Figure 1 wherein the capacity of the tank 10 was 386 gallons and the heating capacity of the heater was 171,500 B. t. u. per hour.

Tests II through V were taken with a conventional system wherein the mixing of water during the heating cycle takes place through the entire contents of the tank.

In test II the capacity of the tank was 386 gallons and the same heater was used as in test I.

In test III a storage tank of 772 gallons was used with the same heater.

In test IV a 1,158 gallon tank was used with the same heater.

In test V a 386 gallon capacity tank was used with a 343,000 B. t. u. per hour heater.

Test	Start	100 Gallons With-drawn	200 Gallons With-drawn	300 Gallons With-drawn	400 Gallons With-drawn
I.....	Degrees 180	Degrees 180	Degrees 180	Degrees 180	Degrees 121
II.....	180	160	147	135	127
III.....	180	168	160	153	147
IV.....	180	171	165	159	157
V.....	180	170	163	159	158

Thus it will be seen that the system embodying my invention greatly enhances the effectiveness of the heater for installations of the type wherein substantial withdrawals of water are required intermittently. For example, note that in test V, in spite of the fact that the heater capacity is double that of the system in test I embodying the present invention, the temperature of the withdrawn water dropped immediately in test V and by the time 300 gallons had been withdrawn was far below the desired temperature of 180°. On the other hand in test I employing the present invention, the temperature after withdrawing 300 gallons was still 180° and it was not until

a total of 325 gallons had been withdrawn (not shown in table) that the temperature of the output water dropped appreciably below 180°.

Also it will be seen that increasing the capacity of the storage tank is to no avail since as shown in tests III and IV, doubling or even tripling the capacity of the tank produced no appreciable improvement over the performance shown in II.

Statistical data compiled in restaurants discloses that the demand for hot water at 180° F. for dishwashing and rinsing purposes averages approximately one-half gallon per meal served. This water is not consumed at a uniform rate however, but is used in intermittent, relatively large volume increments each time the dishwashing cycle reaches the point at which hot water is required either for charging the washer or for rinsing. Thus it will be seen that by the use of the present invention wherein the heater itself may operate substantially continuously and the incremental demands can be met by a storage tank having a capacity on the order of each withdrawn increment, installation costs, efficiency of operation, and uniformity of output water temperature may be greatly improved.

While the form of the device shown and described herein is fully capable of achieving the objects and providing the advantages hereinbefore stated, it will be realized that the system is capable of modification without departure from the spirit of the invention. For this reason, I do not mean to be limited to the form shown and described but rather to the scope of the appended claims.

I claim:

1. A water heating and storage system comprising: a circulating water heater; a cylindrical storage tank positioned with its cylindrical axis vertical; a mixing chamber located within the lower portion of said tank and of generally triangular horizontal cross-section having a pair of side walls connected together along a common vertical edge and with their free vertical edges connected to the side wall of said tank, the bottom edges of said walls being spaced above the bottom of said tank and said chamber including a generally horizontal baffle spaced above the top edges of said side walls whereby to afford upper and lower limited communication between said chamber and the interior of said tank; conduit means connecting the input and the output respectively of said heater with spaced points in said mixing chamber; a delivery port formed in the upper portion of said tank; pump means in said conduit means to effect circulation through said heater and chamber; and thermostatic control means controlling the operation of said pump means and including a temperature sensing element located in the lower portion of said tank whereby so long as the temperature of water in the lower portion of said tank is less than a predetermined value, heated water will automatically be forced into said chamber through said conduit means, while cooler water is simultaneously

withdrawn from said chamber through said conduit means, said walls and baffle of said mixing chamber baffling the water entering said chamber so as to effect turbulent mixing thereof with cool water entering the lower end of said chamber from the lower portion of said tank and heated water rising by convection from the upper end of said chamber toward the upper portion of said tank and undergoing relative interchange with the contents of said tank at a sufficiently low rate that an interface is defined between water existing at said predetermined value and water existing at a lower value.

2. A water heating and storage system, comprising: a circulating water heater; a storage tank; a mixing chamber fixedly mounted within the lower portion of said tank adjacent the side wall thereof and including vertically extending side walls, the lower edges of which are spaced from the bottom of said tank and a substantially horizontal top baffle spaced above the top edges of said side walls to afford upper and lower limited communication between said chamber and the interior of said tank; conduit means connecting the input and output respectively of said heater with spaced points in said mixing chamber; a delivery port formed in the upper portion of said tank; pump means in said conduit means to effect circulation through said heater and chamber; and thermostatic control means controlling the operation of said pump means and including a temperature sensing element located in the lower portion of said tank whereby so long as the temperature of the water in the lower portion of said tank is less than the predetermined value, heated water will automatically be forced into said chamber through said conduit means, while cooler water is simultaneously withdrawn from said chamber through said conduit means, said vertical walls and baffle baffling the water entering said chamber so as to effect turbulent mixing thereof with cool water entering the lower end of said chamber from the lower portion of said tank and heated water rising by convection from the upper end of said chamber toward the upper portion of said tank and undergoing relative interchange with the contents of said tank at sufficiently low rate that an interface is defined between water existing at said predetermined value and water existing at a lower value.

3. The construction of claim 2 further characterized in that said temperature sensing element is located within said chamber.

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