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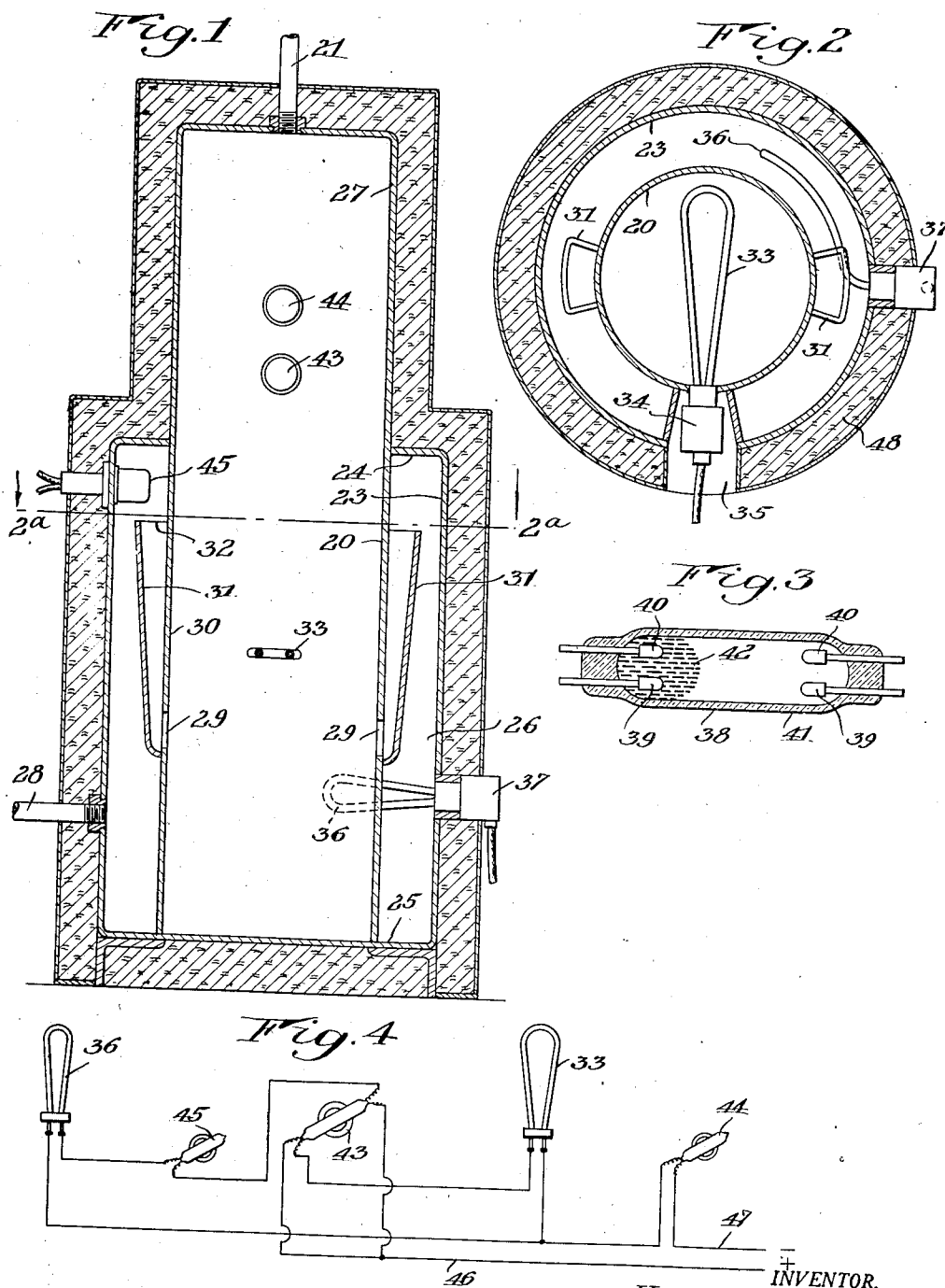
H. W. HAYWARD

2,386,949

LIQUID HEATER

Filed Nov. 9, 1943

3 Sheets-Sheet 1



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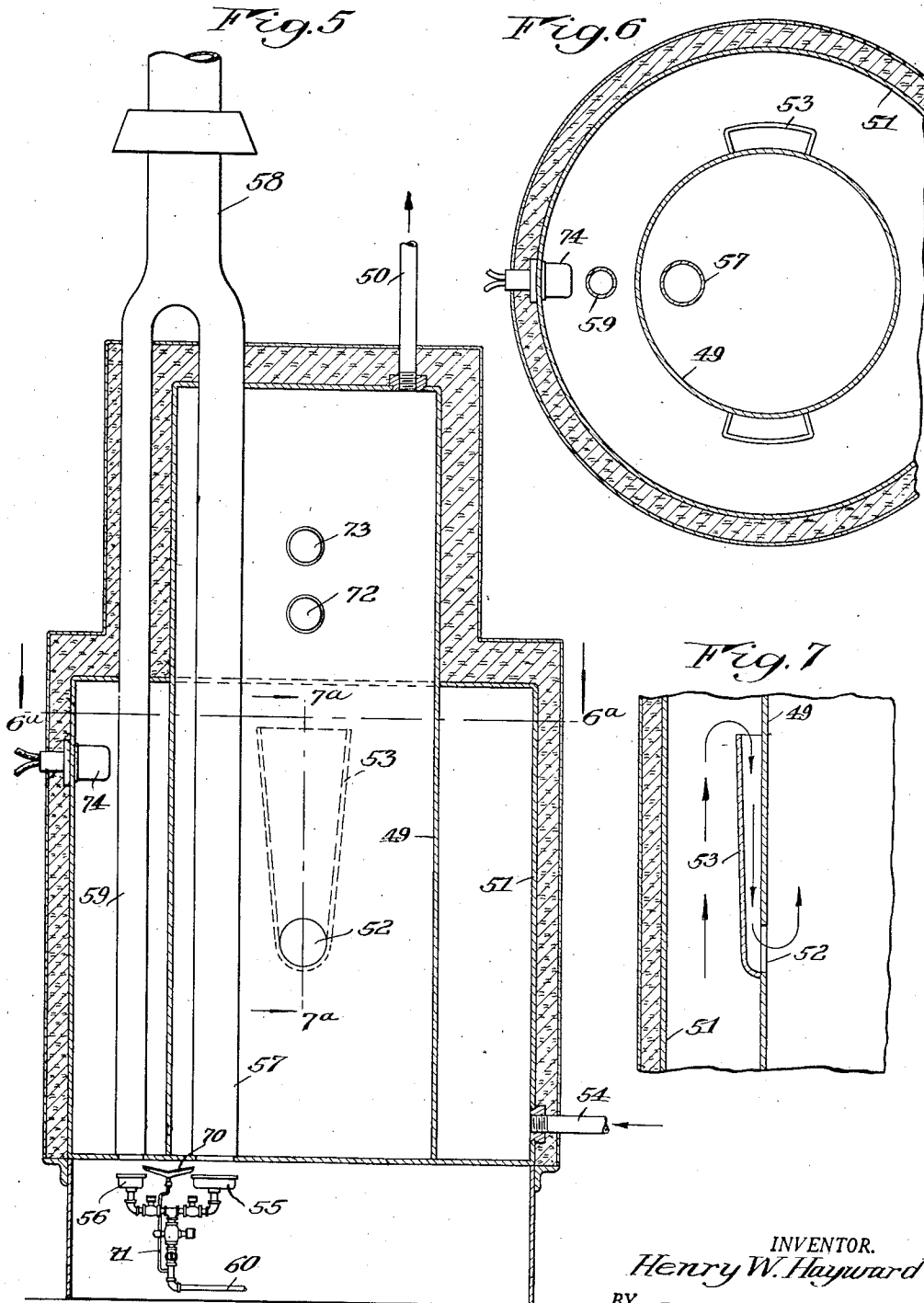
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3 Sheets-Sheet 2



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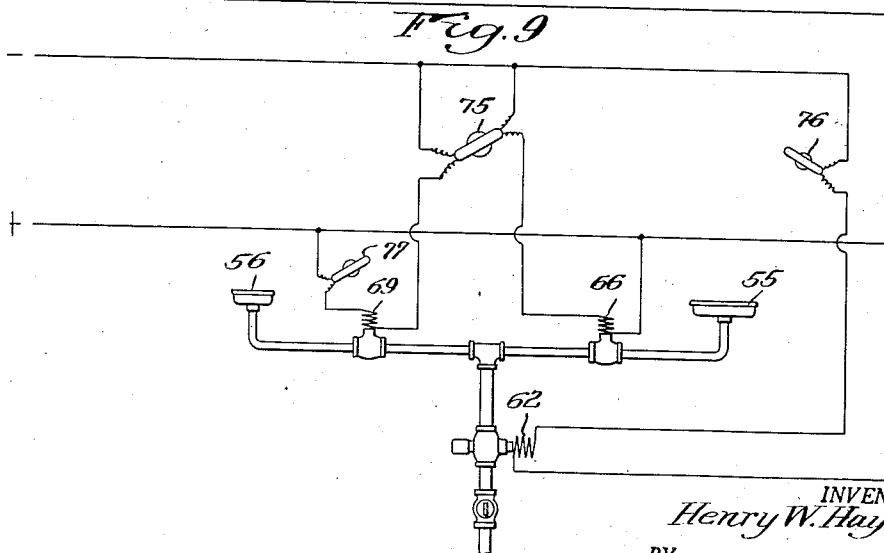
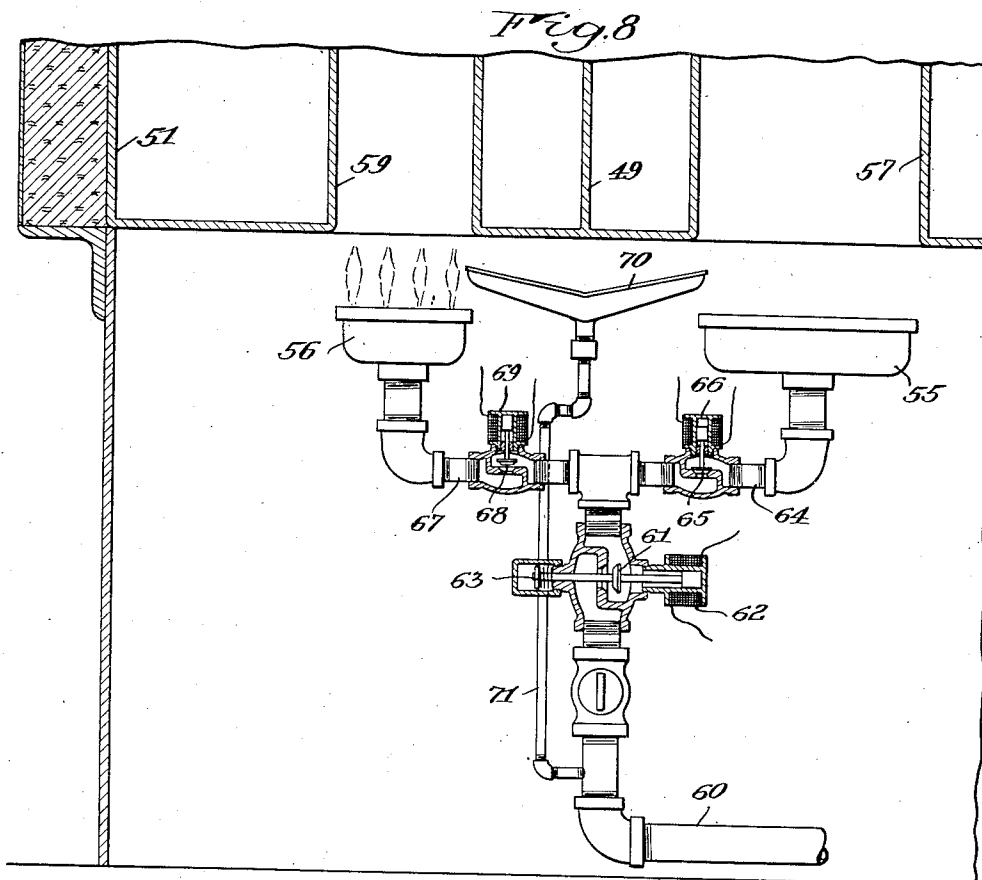
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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LIQUID HEATER

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16 Claims. (Cl. 219—39)

This invention relates to liquid heaters, such, for example, as water heaters for residential installations, one object of the invention being to provide an improved and more practical and economical heater of the character described, adapted to be heated by either gas burner means or electrical resistance elements, as desired.

Another object is to provide such a heater capable of furnishing an ample supply of hot water, or other liquid, with quick recovery of temperature after service demands thereon, while at the same time requiring heat input at a more constant rate.

A further object is to afford a heater of the character described capable of maintaining in storage at all times a substantial quantity of hot water sufficient for normal immediate needs, produced by a succession of heating periods so as to spread out over a relatively long time the total required heat input, thus combining the advantages of an instantaneous type heater with those of a slow recovery heater but without the known disadvantages of such prior heaters.

Still a further object is to provide such a heater having, in combination with the above features, an advantageous arrangement for reducing radiation losses and so additionally increasing the operating efficiency.

To these and other ends the invention resides in certain improvements and combinations of parts, all as will be hereinafter more fully described, the novel features being pointed out in the claims at the end of the specification.

In the drawings:

Fig. 1 is a central, vertical section of a heater of the electrical type embodying the present invention;

Fig. 2 is a horizontal section on the line 2a—2a in Fig. 1;

Fig. 3 is an enlarged, sectional view illustrating the "Mercoide" type switch employed in the present embodiment;

Fig. 4 is a diagram of the electrical circuit employed in a heater of the type shown in Fig. 1;

Fig. 5 is a view similar to Fig. 1 of a modified embodiment of the invention, comprising gas burner heating means;

Fig. 6 is a horizontal section on the line 6a—6a in Fig. 5;

Fig. 7 is a vertical, sectional view on the line 7a—7a in Fig. 5;

Fig. 8 is an enlarged, vertical view of the gas burner means shown in Fig. 5, and

Fig. 9 is a diagram of the electrical circuit for controlling the heating means shown in Fig. 5.

The preferred embodiment of the invention, herein disclosed by way of illustration, comprises a combination of liquid heating and storing chambers one of which, herein termed the "primary storage container" is employed to heat and hold a substantial body of hot water ready for immediate use, while the other termed the "secondary storage container" encompasses the primary container and serves as a preheating chamber, as well as a means of insulating the primary container against heat losses, the heat being preferably supplied directly to and also interchanged between the containers in such a way as to insure rapid recovery after service demands and operating at a substantially constant rate of heat input.

Referring more particularly to the drawings, the primary storage container is shown at 20 (Fig. 1) in the form of a vertically arranged, cylindrical, metal drum having at its top an outlet pipe 21 for supplying the heated water for use. The secondary storage container is shown at 23 in the form of an annular casing, the outer cylindrical walls of which are of substantially greater diameter than container 20, while the inner walls of container 23 are formed by the walls of container 20 with which container 23 is connected in a fluid-tight manner by means of top flange 24 and the bottom 25 of container 23. The secondary container thus encloses an annular space, 26, of substantial capacity but is of substantially less height than container 20, the upper portion 27 of which extends above the top of container 23, preferably as an extension of its cylindrical lower portion, although such upper portion 27 may have any other suitable shape. Container 23 has communicating therewith a water inlet pipe 28, as shown.

As indicated above, the water, or other liquid to be heated, is introduced to the unit through pipe 28 connected with the secondary or outer container 23, and is discharged from the top of the primary or inner container 27 through the pipe 21, and means are provided for the flow of the water from container 23 to container 20 to replace that withdrawn by service demands. Such means comprises, preferably, a suitable number of openings 29 in the lower portion of the common wall 30 between the containers, these openings being shrouded by conducting baffles or hoods 31, open at their tops 32 which are positioned for communication with the upper portion of the secondary container 23. By this means the preheated water collecting in the upper portion of secondary container 23 may flow

downwardly through the hoods 31 and openings 29 into the lower portion of the primary container 20, the openings 29 being located at approximately the level at which the water temperature corresponds with that of the preheated water supplied from container 23.

Means are provided for directly heating the water in the lower portion of the primary container, 20, from which the heat is transmitted through the common wall 30 to preheat the water in the secondary container 23. While such a heating arrangement may be sufficient for some installations, it is preferred to provide means also for supplying heat directly to the water in the secondary container 23, and such a heating system, of the electrical resistance type, will now be described.

The electrical heating means preferably comprises an electrical resistance heating element in the form of a horizontal loop 33 (Figs. 1, 2 and 4), supported by an outlet box 34 positioned in a recess 35 in the secondary container and having a liquid-tight fit in an opening in primary container 20, with the heating element projecting into the primary container, as shown in Fig. 2. A similar heating element is provided for the secondary container in the form of a vertically arranged and curved loop 36, carried by an outlet box 37 having a liquid-tight fit in an opening in the outer wall of the container, as shown, heating elements 33 and 36 being both connected with temperature responsive elements located in the containers.

Such temperature responsive elements preferably comprise a switch 38 of the "Mercoide" type, illustrated in Fig. 3, which is connected to and oscillated by temperature responsive means of any known or suitable variety, as well understood in the art, such devices being enclosed in liquid-tight housings projecting in liquid-tight arrangement through openings in the container walls. Each switch comprises a pair of electrical terminals 39 and 40, extending in pairs in sealed relation through the ends of the glass tube 41, in which is a body of mercury 42 for electrically connecting the terminals of each pair as the tube 41 is tipped to drive the mercury to one end or the other. One such temperature responsive device is located at 43 in the upper portion 27 of the primary container in which the hot water is stored for use. Another such device 44 is located in container 27 a short distance above device 43, while a third temperature responsive device 45 is located in the upper portion of secondary container 23.

These temperature responsive devices are connected in circuit with the heating elements 33 and 36, as shown in Fig. 4, from which it will be seen that temperature responsive device 43 operates to connect one side 46 of the power line alternately with one or the other of the heating elements, being shown in position in Fig. 4 for energizing the heating element 33 of the primary container. The circuit including the heating element 36 of the secondary container includes the temperature responsive device 45 located in the top of the secondary container, while the device 44 controls the connection of both heating elements with the opposite side 47 of the power line. It will be apparent from this arrangement that when a sufficient body of water in the upper portion of the primary container is heated down to the level of the temperature responsive element 43, the associated switch will be operated to disconnect the primary heating element 33 and

close the circuit including the heating means in the secondary container. When the temperature of the water reaches a predetermined high limit in the top of the secondary container, its temperature responsive element 45 and associated switch will then deenergize its heating element 36. When a demand on the unit reduces the temperature at the temperature responsive element 43, so as to result in closing of its associated switch and the energizing of its heating element 33, then the circuit through the heating means of the secondary container will be open, the separate heating means for the respective containers being thus operated in an alternating fashion which, with the continuous transfer of heat through the common wall between the containers, tends to produce a more uniform rate of heat input.

When the temperature at the responsive device 44 in the upper portion of the primary container reaches a predetermined high limit, it operates the associated switch to deenergize the heating means in both containers until the temperature drops again within the desired operating range. It will be seen that the secondary container is not only heated in part from the primary container through their common wall surfaces, but serves, in addition, to insulate the lower portion of the primary container, and conserve the heat which would otherwise be radiated from it and otherwise dissipated and lost. Such encompassing location of the secondary container, on the outside of the primary container, presents water of lower temperature at the outer surfaces of such portions of the unit to further reduce the dissipation of heat, and these features afford a greatly increased operating efficiency. The compact association and design of the two containers, furthermore, is such as to facilitate the encasement thereof in a substantial jacket of efficient insulating material of any known or suitable variety indicated at 48, as well understood in the art.

Starting with the inner or heating chamber full of water at, say 160° F., the thermostat 43 will deenergize the heat source. Heat transfer will immediately occur through the common wall between the containers into the water in the secondary or outer container so as to preheat it. This in time will cool the water in the primary or inner container to a degree below the setting of its thermostat, thus reenergizing its heat source until its water is again raised to the setting of its thermostat and its heat again shut off. The hottest water will collect, of course, in the upper portion of the primary container, from which it is withdrawn, as required, through pipe 21. On such withdrawal, makeup water which has been preheated and collected in the top of the secondary container, will be admitted to the primary container through the hoods 31 and openings 29. This will result in lowering the temperature of the water in the primary container and the reenergizing of its heating means, followed by reenergizing of the heating means in the secondary container, to supplement the heat supplied by transmission through the common wall. It will be noted, however, that the water admitted to the primary container will be preheated to a temperature of, say, 100° F., as controlled by the setting of thermostat 45 in the secondary container, so as to require further heating in the primary container through a range of only 60° F., thereby decreasing the heat input required in the primary container and its rate of recovery following a demand on its storage supply.

Thus the heating operation and maintenance of temperature in the primary container will proceed in a series of steps of alternate operation of its heat source and loss of temperature to the secondary container, with the result that the temperature of the water in the primary container will be maintained nearly constant, while intermittently transferring heat to the encompassing secondary container for additional storage in the form of preheated water. The secondary container may or may not be directly supplied with heat depending, for example, upon the application to it of the separate heating means described, or, when applied, upon the setting of its temperature responsive element. Such direct heating of the secondary container may be preferable, for example, in installations operated at a relatively high rate of duty.

In Figs. 5 to 9, inclusive, there is shown a modified construction comprising gas burner heating means for one or both containers. This embodiment employs a similar primary container 49, with an outlet connection 50, and an encompassing secondary container 51, which has the same construction and arrangement as described above, except for a somewhat larger diameter. Similar openings 52 are provided in the common wall between the containers, shrouded by conducting hoods 53, communicating with the upper portion of the secondary container, which is provided with an inlet connection 54.

In this modified embodiment, however, the electrical resistance heating elements are replaced by fuel gas burners 55 and 56, each of a size suitable for its associated container. The products of combustion from burner 55 pass into a flue 57, which rises through the water in the primary container 49, to heat the same and out through a stack 58. The products of combustion from burner 56 pass into a flue 59, which rises through the water in the secondary container and to the stack 58.

The fuel gas is supplied to burner 55 from a main connection 60 controlled by a valve 61 operated by a horizontal solenoid 62 and spring 63, as well understood in the art. A branch pipe 64, leading directly to burner 55, is similarly controlled by a valve 65 operated by a vertically arranged solenoid 66, as well understood in the art. Burner 56 is supplied through a branch line 67, similarly controlled by a valve 68, operated by a similar solenoid 69. At 70 is a pilot means for lighting each burner supplied through a pipe 71.

The temperature responsive elements 72, 73 and 74, associated respectively with "Mercoid" switches 75, 76 and 77, are of the same construction and arrangement as explained in connection with the embodiment first described, and are employed to control the solenoids 66, 68 and 62. Element 72, with its switch 75, controls solenoid 66 and the circuit of solenoid 69, for alternate operation of the valves 65 and 68. Element 74, with its switch 77, directly controls solenoid 69 and valve 68, while element 73, with its switch 76, controls solenoid 62 and main valve 61. The operation of this control system is the same as that of the electrical system of the embodiment first described, with corresponding operation of the containers and the unit as a whole.

It will be apparent from the description of the foregoing embodiments of the invention that they provide a unit having a heat storage chamber elevated above and protected from the cooling effect of the secondary chamber, so as to afford an ample reservoir of heated water held ready

for instant use. The concentric and encompassing preheating container, with its common wall surfaces, absorbs a large proportion of the heat dissipated from the primary container to provide preheating of the water supply, assisted by direct heating means, if desired, thus contributing to a rapid recovery rate and efficient operation. A further advantage resides in a more constant rate of heat and power input, which facilitates efficient service on the part of the electrical or gas power utility by which the unit is supplied.

It will thus be seen that the invention accomplishes its objects and while it has been described in preferred form and in detail, it is to be understood that such description is intended in an illustrative, rather than a limiting sense, as it is contemplated that various changes in the construction and arrangement of the parts will readily occur to those skilled in the art within the spirit of the invention and the scope of the appended claims.

I claim:

1. A liquid heater comprising a primary storage container having communicating upper and lower portions, said upper portion being adapted and arranged to store a supply of heated liquid ready for use and having a liquid outlet, a secondary storage container having a liquid inlet, means for heating the liquid in said primary container, said lower portion only of said primary container and said secondary container having common wall surfaces therebetween of substantial extent for transferring heat from the liquid in said lower portion only of said primary container to the liquid in said secondary container to preheat the same, and a connection from the upper portion of said secondary container to said lower portion of said primary container for transmitting thereto the liquid preheated in said secondary container.

2. A liquid heater comprising a primary storage container having a thermally insulated upper portion provided with a liquid outlet, a secondary storage container having a liquid inlet, means for heating the liquid in said primary container, said containers having wall surfaces common to substantially the full height of said secondary container but to the lower portion only of said primary container, for transferring heat from the liquid in the lower portion only of said primary container to the liquid in said secondary container to preheat the same, without substantially affecting the temperature of the supply of heated liquid contained in the upper portion of said primary container, and a connection from the said secondary container to said lower portion of said primary container for transmitting thereto the liquid preheated in said secondary container.

3. A liquid heater comprising a primary storage container having a liquid outlet, a secondary storage container having a liquid inlet, means for heating the liquid in said primary container, said primary container having an upper portion extending above said secondary container for storing heated liquid ready for use and said containers having common wall surfaces arranged therebetween for transferring heat from the liquid in the lower portion only of said primary container to the liquid in said secondary container to preheat the same, without substantially affecting the temperature of said heated liquid in said upper portion, and a connection from said secondary container to said lower portion of said

primary container for transmitting thereto the liquid preheated in said secondary container.

4. A liquid heater comprising a primary storage container having a liquid outlet, a secondary storage container having a liquid inlet, means for heating the liquid in said primary container, said primary container having an upper portion extending above said secondary container and provided with said outlet for storing and supplying heated liquid ready for use and said containers having common wall surfaces positioned therebetween below said upper portion of said primary container for transferring heat from the liquid in the lower portion of said primary container to the liquid in said secondary container to preheat the same, and a connection leading downwardly from the liquid in the upper portion of said secondary container to a region of liquid having substantially the same temperature in the lower portion of said primary container for transmitting thereto the liquid preheated in said secondary container.

5. A liquid heater comprising a primary storage container having communicating upper and lower portions, said upper portion being provided with a liquid outlet, a secondary storage container of substantially annular shape encircling said lower portion only of said primary container and having a liquid inlet, means for heating the liquid in said primary container, said lower portion only of said primary container and said secondary container having common wall surfaces therebetween of substantial extent for transferring heat from the liquid in said lower portion of said primary container to the liquid in said secondary container to preheat the same, without substantially affecting the temperature of said heated liquid in said upper portion, and a connection from the upper portion of said secondary container to said lower portion of said primary container for transmitting thereto the liquid preheated in said secondary container.

6. A liquid heater comprising a primary storage container having a liquid outlet, a secondary storage container of substantially annular shape encircling the lower portion only of said primary container and having a liquid inlet means immersed in and surrounded by the liquid of said primary container for heating the same, the wall of said primary container and the inner wall of said secondary container comprising common metal wall surfaces therebetween for transmitting heat from the liquid in said lower portion only of said primary container to the liquid in said secondary container to preheat the same, without substantially affecting the temperature of the supply of heated liquid contained in the upper portion of said primary container, and a connection from the upper portion of said secondary container to said lower portion of said primary container intermediate the top and bottom thereof for transmitting thereto the liquid preheated in said secondary container.

7. A liquid heater comprising a primary storage container having communicating upper and lower portions, said upper portion having a liquid outlet, a secondary storage container having a liquid inlet, separate means for heating said containers, respectively, temperature responsive means in said containers for controlling each of said heating means, said lower portion of said primary container and said secondary container having common metal wall surfaces therebetween of substantial extent for transferring heat from the liquid in said lower portion of said pri-

mary container to the liquid in said secondary container to additionally preheat the same, without substantially affecting the temperature of the supply of heated liquid contained in the upper portion of said primary container, and a connection from said upper portion of said secondary container to said lower portion of said primary container for transmitting thereto the liquid preheated in said secondary container.

8. A liquid heater comprising a primary storage container having a liquid outlet, a secondary storage container of substantially annular shape encircling the lower portion only of said primary container and having a liquid inlet, separate means for heating said containers, respectively, temperature responsive means in said containers for controlling each of said heating means, the wall of said lower portion of said primary container and the inner wall of said secondary container providing common wall surfaces therebetween for transferring heat from the liquid in said lower portion of said primary container to the liquid in said secondary container to additionally preheat the same, without substantially affecting the temperature of the supply of heated liquid contained in the upper portion of said primary container, and a connection from the upper portion of said secondary container to said lower portion of said primary container for transmitting thereto the liquid preheated in said secondary container.

9. A liquid heater comprising a primary storage container having communicating upper and lower portions, said upper portion being adapted and arranged to store a supply of heated liquid ready for use and provided with a liquid outlet, a secondary storage container having a liquid inlet, means including a separate gas burner for each of said containers having a flue extending through the liquid therein for heating the same, means in said containers for controlling said gas burners, said lower portion only of said primary container and said secondary container having common wall surfaces therebetween for transferring heat from the liquid in said lower portion only of said primary container to the liquid in said secondary container to additionally preheat the same, and a connection from the upper portion of said secondary container to said lower portion of said primary container for transmitting thereto the liquid preheated in said secondary container.

10. A liquid heater comprising a primary storage container having a liquid outlet, a secondary storage container having a liquid inlet, means including a separate gas burner for each of said containers having a flue extending through the liquid therein for heating the same, means in said containers for controlling said gas burners, said primary container having an upper portion extending above said secondary container for storing heated liquid ready for use and the lower portion of said primary container and said secondary container having common wall surfaces therebetween for transferring heat from the liquid in the lower portion of said primary container to the liquid in said secondary container to additionally preheat the same, and a connection from the upper portion of said secondary container to said lower portion of said primary container for transmitting thereto the liquid preheated in said secondary container.

11. A liquid heater comprising a primary storage container having communicating upper and lower portions, said upper portion being adapted

and arranged to store a supply of heated liquid ready for use and having a liquid outlet, a secondary storage container having a liquid inlet, means including a separate gas burner for each of said containers having a flue extending through the liquid therein for heating the same, temperature responsive means in said primary container arranged to effect the energizing of said heating means in alternation with each other, said lower portion of said primary container and said secondary container having common wall surfaces therebetween for transferring heat from the liquid in said lower portion of said primary container to the liquid in said secondary container to additionally preheat the same, and a connection from the upper portion of said secondary container to said lower portion of said primary container for transmitting thereto the liquid preheated in said secondary container.

12. A liquid heater comprising a primary storage container having a liquid outlet, a secondary storage container having a liquid inlet, means including an electrical heating element immersed in and surrounded by the liquid in each of said containers, for heating the same, temperature responsive means in said containers for controlling said elements, said primary container having an upper portion extending above said secondary container for storing heated liquid ready for use and the lower portion of said primary container and said secondary container having common wall surfaces therebetween for transferring heat from the liquid in the lower portion of said primary container to the liquid in said secondary container to additionally preheat the same, and a connection from said secondary container to said lower portion of said primary container for transmitting thereto the liquid preheated in said secondary container.

13. A liquid heater comprising a primary storage container having a liquid outlet, a secondary storage container having a liquid inlet, separate means for heating the liquid in said containers, respectively, temperature responsive means in said primary container arranged to effect the energizing of said heating means in alternation with each other, said containers having common wall surfaces therebetween of substantial extent for transferring heat from the liquid in said primary container to the liquid in said secondary container to additionally preheat the same, and a connection from said secondary container to said primary container for transmitting thereto the liquid preheated in said secondary container.

14. A liquid heater comprising a primary storage container having communicating upper and lower portions, said upper portion being adapted and arranged to store a supply of heated liquid and having a liquid outlet, a secondary storage container having a liquid inlet, separate means

for heating the liquid in said containers, respectively, temperature responsive means in said primary container arranged to effect the energizing of said heating means in alternation with each other, said lower portion only of said primary container and said secondary container having common wall surfaces therebetween for transferring heat from the liquid in said lower portion only of said primary container to the liquid in said secondary container to additionally preheat the same, and a connection from said secondary container to said lower portion of said primary container for transmitting thereto the liquid preheated in said secondary container.

15. A liquid heater comprising a primary storage container having a liquid outlet, a secondary storage container having a liquid inlet, separate means for heating the liquid in said containers, respectively, temperature responsive means in said primary container arranged to effect the energizing of said heating means in alternation with each other, temperature responsive means in each of said containers for deenergizing the heating means thereof at a predetermined maximum temperature, respectively, said containers having common wall surfaces therebetween of substantial extent for transferring heat from the liquid in said primary container to the liquid in said secondary container to additionally preheat the same, and a connection from said secondary container to said primary container for transmitting thereto the liquid preheated in said secondary container.

16. A liquid heater comprising a primary storage container having communicating upper and lower portions, said upper portion being adapted and arranged to store a supply of heated liquid and having a liquid outlet, a secondary storage container having a liquid inlet, separate means for heating the liquid in said containers, respectively, temperature responsive means in said primary container arranged to effect the energizing of said heating means in alternation with each other, temperature responsive means in each of said containers for deenergizing the heating means thereof at a predetermined maximum temperature, respectively, said lower portion only of said primary container and said secondary container having common wall surfaces therebetween for transferring heat from the liquid in said lower portion only of said primary container to the liquid in said secondary container to additionally preheat the same, without substantially affecting the temperature of said heated liquid in said upper portion of said primary container, and a connection from the upper portion of said secondary container to said lower portion of said primary container for transmitting thereto the liquid preheated in said secondary container.

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