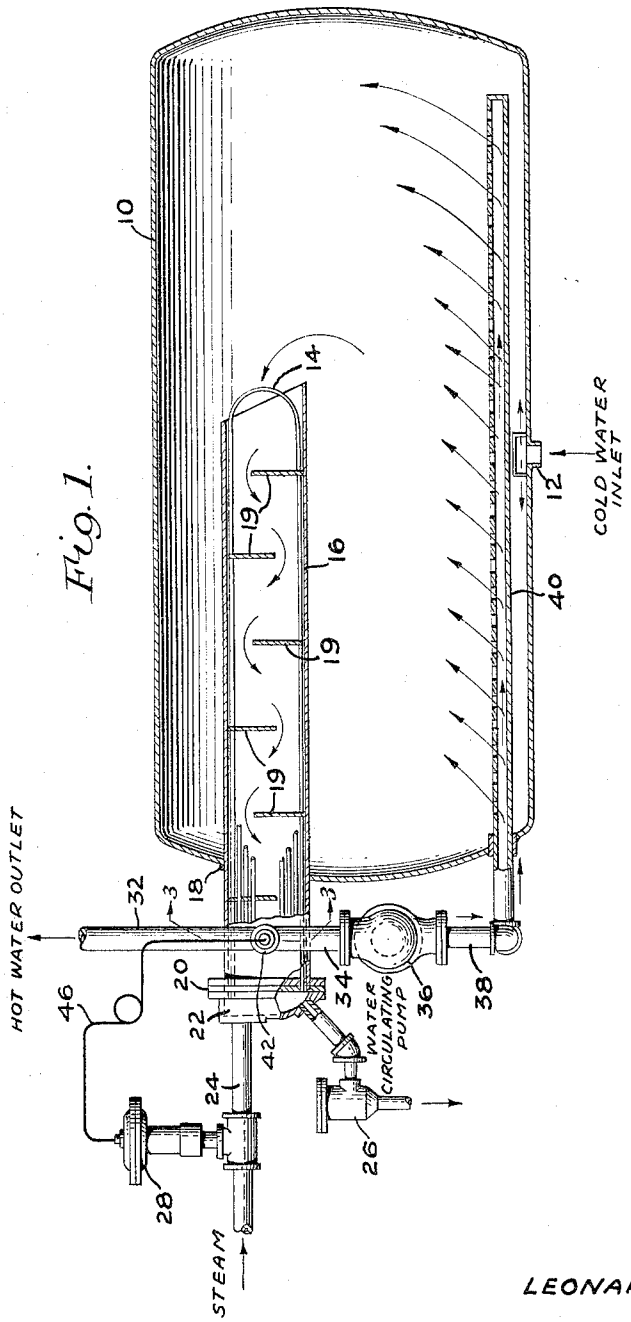
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WATER HEATER

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Fig. 1.



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Fig. 2.

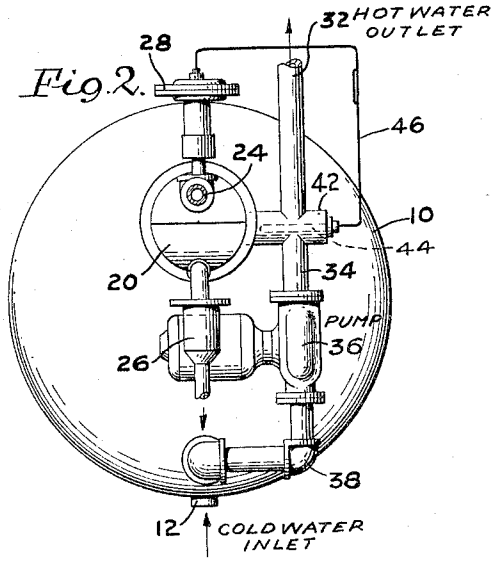
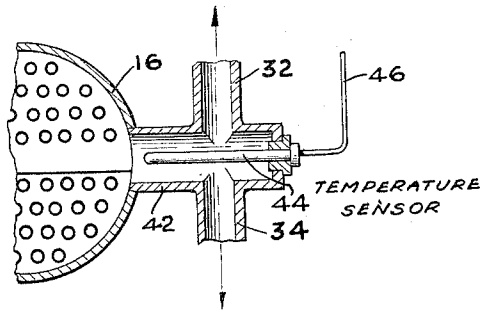


Fig. 3.



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WATER HEATER

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Filed July 21, 1965, Ser. No. 473,795
12 Claims. (Cl. 165—39)

This application is a continuation-in-part of my abandoned application Serial No. 348,710, filed March 2, 1964.

This invention relates to storage water heaters, and more particularly to improvements in hot water storage and heating tank arrangements employing steam or other "hot" fluids for the heat source.

It is a primary object of the present invention to provide an improved water circulation system in conjunction with a water storage tank and the cold water inlet and "immersion" type heating component thereof, whereby an improved water temperature control response is attained under peak demand conditions.

Another object is to provide an improved system as aforesaid wherein the heater component is of the shrouded heat-exchange tube bundle type, and whereby an improved degree of water temperature uniformity throughout all levels of the storage facility is attained.

Other objects and advantages of the invention will be apparent from the specification hereinafter and the accompanying drawings wherein:

FIG. 1 is a longitudinal sectional view through a water storage heater system of the invention;

FIG. 2 is a front elevational view of the apparatus of FIG. 1; and

FIG. 3 is an enlarged vertical section taken through the hot water outlet region.

As shown in the drawing herewith, the invention may be embodied in a system including a water storage tank **10** having a cold water inlet at the bottom level thereof as shown at **12**. A tube "bundle" for heating the water, as indicated at **14** is housed within a cylindrical shaped shroud **16**, which extends into the interior of the tank **10** and is welded thereto as indicated at **18**. The shroud **16** is open at its inner end and a series of staggered baffles are preferably carried by the tubes as shown at **19** to force the circulating water to traverse a zig-zag path through the tube bundle, as will be explained more fully hereinafter.

At its outer end the shroud **16** is flanged and carries a tube sheet **20** through which the open ends of the tubes extend into open communication with the interior chambers of a horizontally partitioned bonnet **22** which is similarly flanged and bolted in cooperation with the tube sheet to the end of the shroud **16**. Thus, steam or other heating fluid may be introduced as by means of a conduit **24** into the upper portion of the bonnet, from whence it flows through the return bent tubes and then into the lower portion of the bonnet for discharge through a condensate trap or the like as indicated at **26**. Passage of steam through the conduit **24** and into the system is controlled as by means of a flow regulator which is indicated at **28**. The regular **28** is in turn controlled by a temperature sensing "bulb" or the like, such as is shown at **44** in FIGURES 2 and 3, located in the hot water withdrawal area provided by the hot water outlet manifold **42** and connected to the flow regulator **28** by the control line **46**. The hot water outlet conduit **32** and the hot water insulating conduit **34** lead away from the manifold **42**, as is best shown in FIGURE 3, so that the temperature-sensitive element **44** is positioned to be contacted by hot water flowing through the manifold **42** into either of the conduits **32** or **34**. A constant flow of water passes through the conduit **34**, as will hereinafter appear, while

flow through the conduit **32** takes place in response to the demand of the external load.

It should be noted that the hot water take-off conduit **32** draws from the outer end of the shroud **16**, and thus delivers only water which is freshly heated by the tube bundle regardless of from which portion of the storage tank it may have been drawn. Also leading away from the outer end of the tube shroud, a water circulating conduit **34** connected to a constantly running pump **36** delivering through conduit **38** to a hot water "spreader" or manifold **40** such as may comprise a conduit having an apertured top wall portion which extends into and substantially throughout the lower length of the storage tank in close proximity to the tank bottom and to the cold water inlet **12**. Hence, operation of the pump **36** draws water through the heating tube bundle and delivers it, as indicated by the flow directional arrows of FIGURE 1, in the form of a widely spread-out dispersion of heated water throughout the bottom level of the tank where it intimately mixes with the colder water occupying the upper levels of the tank.

By virtue of the functional features of the present invention a superior admixture of raw water and heated water at the time of raw water inlet, as well as an optimum uniformity of heated water temperatures throughout the various levels of the storage tank, are attained. The constant circulation of water by the pump **36** continuously assures that the water temperature throughout the tank is at the desired level inasmuch as the constant water circulation assures that no stagnation takes place, even during periods in which no external load demand exists. That is to say, the temperature-sensitive element is constantly exposed to the circulating hot water so that the flow regulator **28** is continuously updated to assure sufficient flow of steam as to maintain the required water temperature. Thus, as soon as a temperature drop is experienced, as when a sudden influx of cold water occurs by reason of a sudden increase in external demand, the temperature-sensitive element will immediately demand more steam to assure that steam flow is sufficient to maintain the water temperature in the manifold **42** at the proper level even though the water as it enters the flow channel provided by the shroud or conduit **16** may be cooler than the required temperature.

Also note that the direction of water flow through the shroud **16** is such as to first bring the relatively cool water from the tank into the inner end of the shroud and into heat-exchange contact with the relatively cooler inner end portions of the tube bundle. From thence the water travels in heat exchange relationship with progressively hotter portions of the tubes **14** until it reaches the hot water draw-off portion of the apparatus, thereby increasing the overall heat-exchange efficiency of the system, and at the same time providing for an "instantaneous" response of the steam supply regulating mechanism to hot water withdrawals. Hence, the system is particularly adapted to "sense" and compensate promptly for peak demands.

The invention is particularly applicable in situations where the storage and heating capacity requirements approach equality. For example, when the recovery rate is equal to half or more of the equivalent storage capacity, the possibility of a high sustained peak demand of short duration becomes apparent; and such situations usually provide relatively short periods of time for storage recovery. Typical examples of such situations can be found in the hot water demands of commercial laundries, textile mills, hotels, hospitals, etc. Also, high peak shock loads are often experienced in connection with field houses or wherever extra heavy demands for hot water are put on the system by large shower gangs or the like.

The heating component of the system must be sized to pass the highest peak load of water withdrawal rate expected on the system with a nominal pressure drop. Also, it must be sized for either the recovery capacity required or balanced out at a specific rate so that when matched with the amount of hot water held in reserve, it will be able to furnish the required amount of water through the duration of the peak load. In this situation no attempt is made to preserve a constant temperature in the tank, but rather to consider it as meeting the major part of the total peak demand with the balance to be taken care of by the heating elements as the water passes therethrough.

With a system of this type, at the start of a typical water withdrawal cycle, water of predetermined temperature is taken out through the shrouded tube bundle. As the draw continues, the water temperature drops slightly, at which point the thermostatic control valve **28** is actuated by the bulb **30** in the discharge line, thereby regulating the valve against the difference in temperature. As the draw continues and the temperature in the tank continues to drop, the regulator continues to open, thereby adding the required heat by appropriate degrees in order to maintain the previously determined desired temperature. As an example, assuming the desired outlet temperature of the hot water is set at 180°, at the start of a withdrawal the entire tank contents will be at approximately this temperature. When the bulb senses a temperature drop to approximately 172°, the control valve will open and will continue to supply steam to maintain a temperature of 180°. If the tank temperature falls say to 170°, the regulator valve modulates to a still further open position, thus maintaining the outgoing water temperature at 180°. This automatic control continues throughout the withdrawal cycle until the end of the peak demand has been reached; and by properly allocating the volume of water required in storage in any given case, a heater of proper size but including the minimum storage provision and with a heating section scheduled for a minimum of steam demand, can be designed into a compact sized and minimum cost unit.

It will of course be appreciated that although only one form of the invention has been illustrated and described in detail hereinabove, various changes may be made therein without departing from the spirit of the invention or the scope of the following claims.

I claim:

1. A water heating system of the immersion heater type comprising,
- a water carrying storage tank,
- an immersion heater extending into said tank,
- said immersion heater comprising an elongate shroud projecting through a wall portion of said tank and extending both inwardly and outwardly therefrom, and being open at its inner end portion,
- a hot water supply outlet connection in the outer extending end portion of said shroud,
- a tube sheet closing the extreme outer end of said shroud,
- a bundle of return-bent tubes mounted upon said tube sheet and disposed within said shroud substantially throughout the length thereof,
- means circulating heating fluid through said tubes,
- a cold water inlet connection in the bottom portion of said tank,
- and a storage water circulation device comprising a pump drawing water through an outlet connection in the outer end portion of said shroud and discharging said water through a conduit leading into the bottom portion of said tank,
- said conduit extending substantially throughout the lower level of said tank and being apertured substantially throughout its length to disperse the water being discharged therefrom into the relatively cold water substantially throughout the lower portion of said tank.

2. A water heating system comprising,
- a water storage tank,
- an immersion heater extending into said tank,
- said immersion heater comprising an elongate shroud projecting through a wall portion of said tank and extending both inwardly and outwardly therefrom, and being open at its inner end,
- a hot water supply outlet connection in the outer extending end portion of said shroud,
- a tube sheet closing the extreme outer end of said shroud,
- a plurality of heat exchange tubes mounted upon said tube sheet and disposed within said shroud substantially throughout the length thereof,
- means supplying heating fluid to said tubes,
- a cold water inlet connection in the bottom portion of said tank,
- and a storage water circulation device comprising a pump drawing water through an outlet connection in the outer end portion of said shroud and discharging said water through a conduit leading into the bottom portion of said tank,
- said conduit extending substantially throughout the lower level of said tank and being apertured substantially throughout its length to disperse the water being discharged therefrom into the relatively cold water disposed within the lower portion of said tank.

3. A water heating system of the immersion heater type comprising,
- a water storage tank,
- an immersion heater extending into said tank,
- said immersion heater comprising an elongate shroud projecting into said tank and being open at its innermost end portion,
- a hot water supply outlet connection in the outermost end portion of said shroud,
- heat-exchange tube means disposed within said shroud substantially throughout the length thereof,
- means supplying heating fluid to said tube means,
- a cold water inlet connection in the bottom portion of said tank,
- and a storage water circulation device comprising a pump drawing water through an outlet connection in the outermost end portion of said shroud and discharging said water through a conduit leading into the bottom portion of said tank,
- said conduit extending substantially throughout the lower level of said tank and being apertured substantially throughout its length to disperse the water being discharged therefrom into the relatively cold water in the lower portion of said tank.

4. A water heating assembly comprising in combination,
- a storage tank,
- a shroud projecting into the interior of said storage tank and having an opening communicating therewith,
- said storage tank having a cold water inlet remote from said shroud opening,
- a manifold disposed within said storage tank between said cold water inlet and said shroud opening for discharging hot water substantially throughout the region between said cold water inlet and said shroud opening,
- a circulating pump having an inlet connected to said shroud remote from said shroud opening and an outlet connected to said manifold,
- heater means within said shroud between said shroud opening and said pump inlet,
- and a hot water outlet communicating with said shroud adjacent said pump inlet.

5. The assembly as defined in claim **4** wherein said heater means is in the form of a tube bundle having a

connection to heat source fluid, said connection located adjacent to said pump inlet and said hot water outlet.

6. A hot water supply system comprising, in combination,

a hot water storage tank,

an elongate conduit extending into the interior of said tank and having an open inner end and having a hot water outlet adjacent its opposite end, to supply a variable-demand external load,

means for supplying cold water to said tank remote from said inner end of the conduit in response to hot water withdrawal from said hot water outlet,

means for selectively heating water passing from the inner end of said conduit toward the opposite end thereof and including a temperature-sensitive element adjacent said hot water outlet,

and means for constantly recirculating hot water from adjacent the hot water outlet to the region between said cold water inlet and the open inner end of said conduit.

7. The system according to claim 6 wherein the last-mentioned means includes a manifold having plural discharge outlets and located between said cold water inlet and said inner end of the conduit.

8. A hot water supply system comprising, in combination,

a water storage tank,

an elongate conduit extending into said tank and having an open inner end communicating with the interior of said tank,

a hot water discharge line connected to the other end of said conduit for withdrawing hot water from the interior of said tank at said open inner end of the conduit and through said conduit to said other end thereof for supplying an external load, through said discharge line,

a cold water inlet connected to said tank remote from said open inner end of the conduit for supplying cold water to the tank in response to hot water withdrawal therefrom,

heater means within said conduit for directly heating water passing through said conduit to said hot water discharge line,

means for supplying heating medium to said heater means,

a temperature-sensitive element disposed adjacent the point of communication between said discharge line and said conduit for selectively controlling the supply of heating medium to said heater means,

and means for continuously circulating hot water from a point adjacent said point of communication between the discharge line and the conduit to the interior of said tank for discharge into the region between said cold water inlet and the open inner end of said conduit.

9. A water heating assembly comprising, in combination,

a storage tank,

a shroud projecting into the interior of said storage tank and having an opening communicating therewith,

said storage tank having a cold water inlet remote from said shroud opening,

means disposed within said storage tank for discharging hot water substantially throughout the region between said cold water inlet and said shroud opening,

a circulating pump having an inlet connected to said shroud remote from said shroud opening and an outlet connected to said means,

heater means within said shroud between said shroud opening and said pump inlet,

and a hot water outlet communicating with said shroud adjacent said pump inlet.

10. The assembly as defined in claim 9 wherein said heater means is in the form of a tube bundle having a connection to heat source fluid, said connection located adjacent to said pump inlet and said hot water outlet.

11. A water heating assembly comprising, in combination,

a storage tank,

a shroud projecting into the interior of said storage tank and having an opening communicating therewith,

said storage tank having a cold water inlet remote from said shroud opening,

means disposed within said storage tank between said cold water inlet and said shroud opening for discharging hot water substantially throughout the region between said cold water inlet and said shroud opening,

a circulating pump having an inlet connected to said shroud remote from said shroud opening and an outlet connected to said means,

heater means within said shroud between said shroud opening and said pump inlet,

and a hot water outlet communicating with said shroud adjacent said pump inlet.

12. A hot water supply system comprising, in combination,

a hot water storage tank,

an elongate shroud projecting into the interior of said tank and having an open inner end communicating therewith,

conduit means for withdrawing hot water from said shroud remote from said open inner end of the shroud,

heater means within said shroud between said open inner end of the shroud and said conduit means,

a water temperature sensing element disposed in the region of said conduit means for controlling said heater means,

said conduit means having a first branch connected to an external load for withdrawing hot water from said tank through said shroud,

a cold water inlet connected to said tank remote from said open inner end of the shroud for replenishing water withdrawn from said tank through said first branch,

said conduit means also having a second branch,

pump means having an inlet connected to said second branch for withdrawing hot water from said shroud, said pump means having an outlet connected to said tank remote from said open inner end of the shroud so that water entering said open inner end of the shroud in response to hot water withdrawal from said shroud includes freshly heated water circulated by said pump means.

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Disclaimer

3,276,517.—*Leonard F. Lowe*, East Stroudsburg, Pa. WATER HEATER. Patent dated Oct. 4, 1966. Disclaimer filed May 22, 1970, by the assignee, *The Patterson-Kelley Co., Inc.*

Hereby enters this disclaimer to claim 12 of said patent.

[*Official Gazette Sept. 1, 1970.*]