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Kirschner

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[45] ***Oct. 23, 1973**

[54] **WATER HEATING AND SUPPLY SYSTEM**

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[*] Notice: The portion of the term of this patent subsequent to Dec. 21, 1988, has been disclaimed.

[22] Filed: **Aug. 23, 1971**

[21] Appl. No.: **174,090**

[52] **U.S. Cl.** **165/39**, 126/362, 165/108

[51] **Int. Cl.** **F24h 01/18**

[58] **Field of Search** 126/361, 362; 236/24.5; 137/114, 526; 165/39, 108

[56] **References Cited**

UNITED STATES PATENTS

3,688,839	9/1972	Kirschner	165/108
3,666,918	5/1972	Clark, Jr. et al.	219/314
3,666,003	5/1972	Clark, Jr. et al.	165/39
3,447,560	6/1969	Dodson et al.	126/362
2,756,739	7/1956	Schaub	126/362
3,276,517	10/1966	Lowe	165/108 X
3,383,040	5/1968	Darm	126/362 X
3,195,555	7/1965	Schaub	137/114
2,308,583	1/1943	Berges	137/526
2,481,018	9/1949	Johnson	137/526

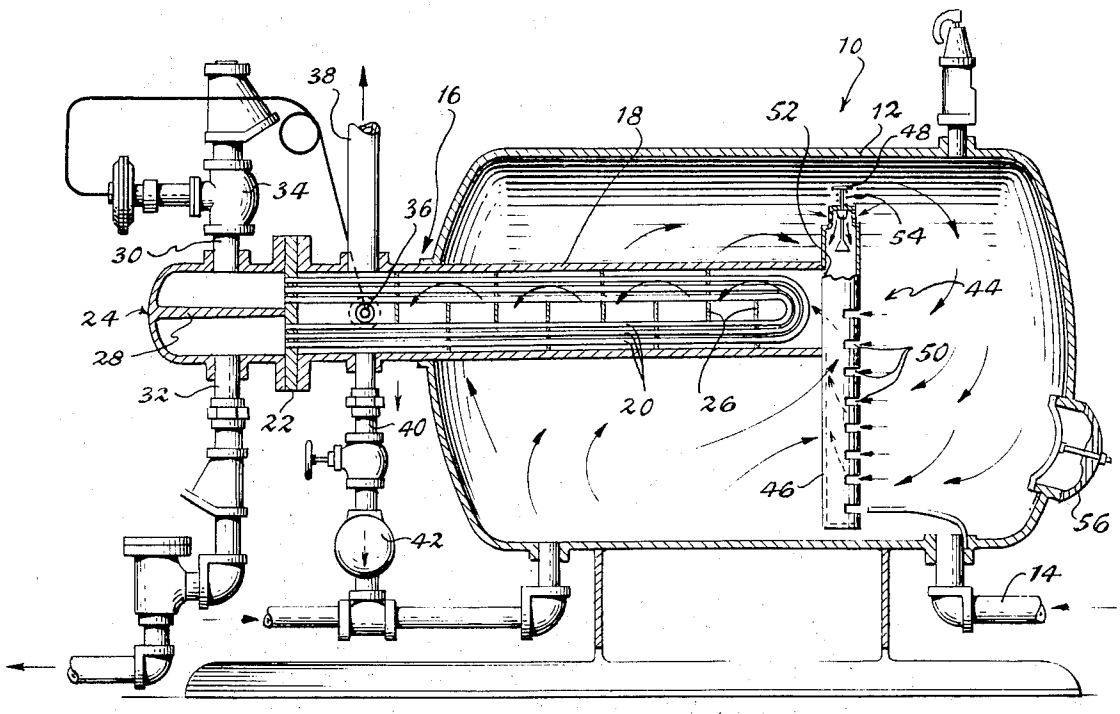
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[57] **ABSTRACT**

A water heating and storage system accommodating occasional peak demands for hot water, characterized by the utilization of a relatively small sized heated water storage tank and means to maximize efficiencies of the heat exchanger associated therewith and to insure delivery of properly heated water during both peak and normal demand periods.

14 Claims, 2 Drawing Figures



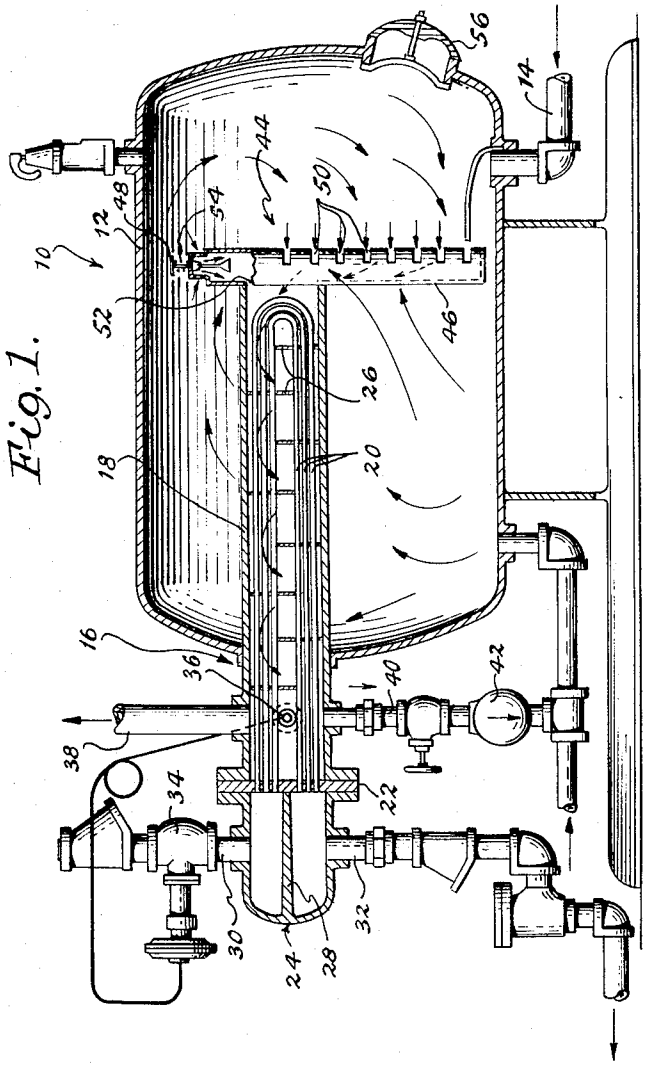


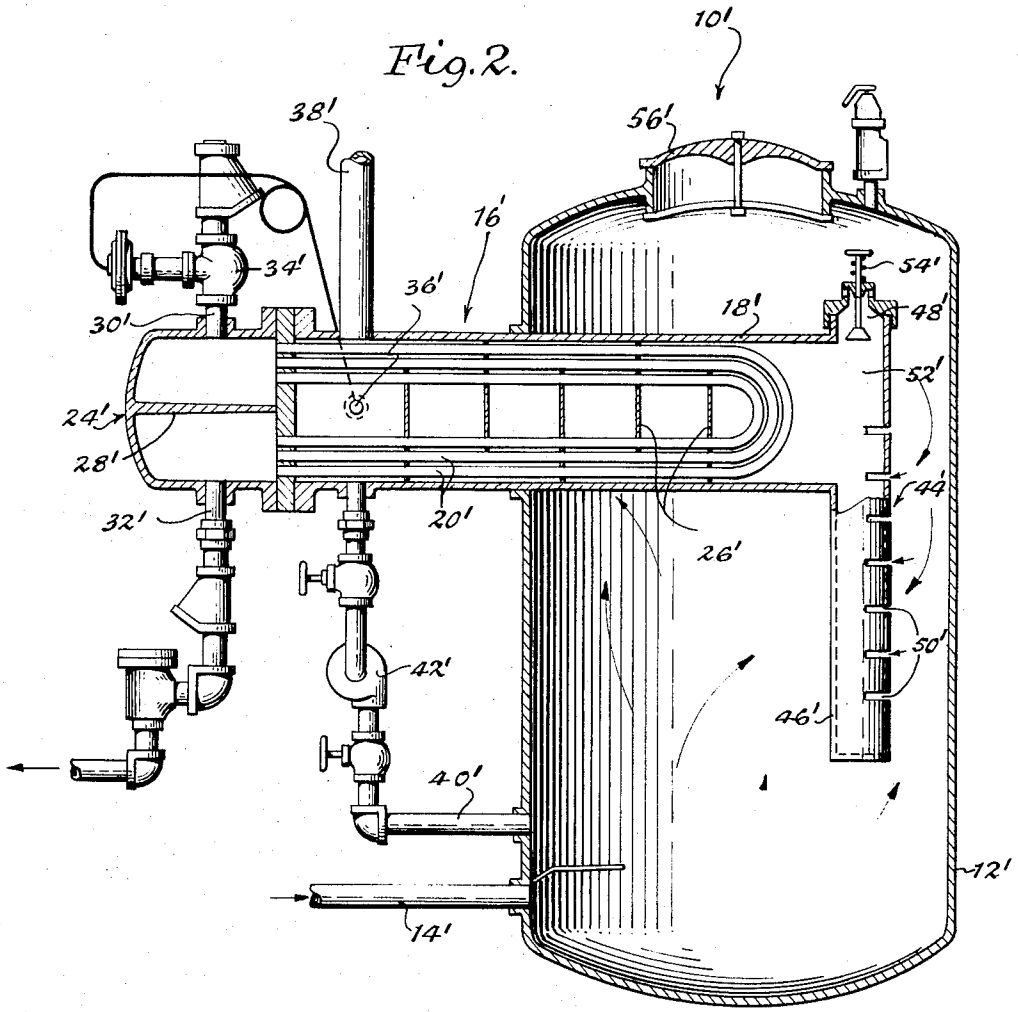
Fig. 1.

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Fig. 2.



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WATER HEATING AND SUPPLY SYSTEM

SUMMARY OF THE INVENTION

The present invention relates to water heating and storage systems, and more particularly to improvements in systems adapted for installation in office, school or apartment buildings or the like, wherein space saving is an important consideration, and wherein peak demands for hot water are interspersed by pluralities of normal demands, which require water flow rates through the system substantially below that required by the peak demands.

Specifically, the system of the present invention features a relatively small heated water storage tank. The tank is provided with a cold water supply inlet for replenishing water withdrawn from the tank through a shrouded heat exchanger with heating capacity sufficient to increase the temperature of water passing therethrough during a peak demand up to a desired delivery temperature. A pump is also connected into the discharge end of the heat exchanger and employed to normally circulate water through the heat exchanger between different levels of the tank with a view to bring up and/or maintain water within the tank at the desired delivery temperature; the heat exchanger being regulatable by a suitable sensor arranged to sense the temperature of water passing from the heat exchanger.

In that heat exchangers must be designed to at least substantially accommodate peak hot water demands, they necessarily possess reduced heat exchange efficiencies during normal demand periods, which may require flow rates which are typically less than 50 percent of the flow rate experienced during a peak demand. Further, time delays are necessarily experienced between the sensing of the temperature of water passing from the heat exchanger and regulation of the heat exchanger in accordance therewith, as by adjustably controlling a flow control valve through which a suitable heating medium is admitted to the heat exchanger. As a result, a heat exchanger is ofttimes subject to wildly cycling or fluctuating operating conditions, thereby resulting in inefficient power consumption and substantial variances from the desired temperature of the delivery water.

The above problems are particularly acute when the heating medium is steam, but may be encountered in varying degrees when other heating mediums including boiler water are employed. In this respect, it has been recognized that when conventional flow control valves are operated from between about 0 and 50 percent capacity (which accommodates for normal hot water demands on the system) such valves are very inefficient and promote cycling of the temperature control system. However, as the control valve is operated from between about 50 and 100 percent capacity, the problem of cycling of the system is progressively reduced, because both the flow control valve and the heat exchanger approach their most efficient ranges of operation.

In accordance with the present invention, the problems heretofore described are substantially reduced by providing the heat exchanger with a pair of water inlets; a first of such inlets accommodating for system recovery and normal demand or withdrawal periods, and the second inlet accommodating for additional water intake requirements occasioned by peak demands.

For example, as shown in the drawing herewith the first water intake to the heat exchanger is in the form of a vertically extending manifold arranged to take in water from different levels of the tank at which levels water at varying temperatures will exist, due to pump circulation or turbulence conditions occasioned by the introduction of cold supply water into the tank during a withdrawal. The manifold, in effect, serves to pass water to the heat exchanger at some "integrated" or "averaged" value, which increases or decreases in a relatively smooth or consistent manner. By thus dampening the variations in temperature of water passing to the heat exchanger, the magnitude and period of temperature variations in the water passing from the heat exchanger into association with the temperature sensor is of course reduced, thereby permitting the control valve to be smoothly operated to achieve optimum efficiency of the temperature control system during both recovery and withdrawal periods.

The manifold is designed to accommodate only recovery circulation and withdrawals at normal rates; thereafter effectively limiting the rate at which water may be withdrawn therethrough by creating an effective pressure drop, thereby establishing a pressure differential between the interiors of the tank and the heat exchanger. In accordance with the present invention this pressure differential is employed to control operation of the second inlet means, which is in the form of a valve automatically operable to permit appropriate amounts of water to be added to that taken in through the manifold whenever required by larger than normal withdrawal demands. Preferably, the valve when opened, would initially permit hot water from within the upper level of the tank to enter the heat exchanger; thereby dampening the temperature transition.

As will be appreciated, the admission of water through the second inlet means will not by itself, produce undesirable cycling of the control system, since the system design will be such that the heat exchanger and control valve will be operable in their most efficient operational ranges during above normal draws.

DRAWINGS

The nature and mode of the present invention will now be more fully described in the following detailed description taken with the accompanying drawings wherein:

FIG. **1** is a schematic sectional view illustrating one form of the water heating and storage system of the present invention; and

FIG. **2** is a schematic sectional view illustrating a modified form of the present invention.

DETAILED DESCRIPTION

Now referring more particularly to FIG. **1**, the water heating and storage system of the present invention is generally designated as **10** and shown as including a generally horizontally disposed water storage tank **12** having a cold water supply inlet connection **14** for replenishing water withdrawn from the tank.

A heat exchange unit, generally designated at **16**, includes a tubular shroud **18** housing a bundle of return bent heat-exchange tubes **20**. Tubes **20** extend through a tube sheet **22**, which closes the outer end of shroud **18**, and into a heating medium supply bonnet **24**. Alternately disposed baffle plates **26** are preferably arranged within shroud **18** to guide the flow of water there-

through along an undulating or zig-zag path relative to tubes **20** to insure maximum heat exchange efficiency.

Bonnet **24** is provided with an internal partition or rib **28**, which divides the fluid chamber portion thereof into multiple sections into which in turn are connected heating medium inlet and outlet conduits **30** and **32**, respectively. The heating medium may be steam, boiler water, etc. The admission of the heating medium through inlet conduit **30** may be varied by a flow control valve **34** whose operation is adjustably controlled by a suitable water temperature sensing device **36** arranged adjacent the outlet or delivery end portion of shroud **18**.

By referring to FIG. **1**, it will be apparent that heated water may be withdrawn from the delivery or outlet end portion of shroud **18** either for delivery to a point of use through a heated water delivery conduit **38** and/or for reintroduction into a lower level of tank **12** by a conduit **40** including a pump **42**, which preferably runs continuously.

At this point, it will be understood that heat exchange unit **16** is preferably designed to raise the temperature of water passing therethrough up to a desired withdrawal or delivery temperature, when such water is flowing at a given maximum rate determined by a peak demand required by fixtures, not shown, to which delivery conduit **38** is connected. However, for many installations, including multiple tenant dwellings, normal demands occurring periodically throughout any given **24** hour period are normally satisfied by the operations of the heat exchange unit at less than about 50 percent capacity.

The inlet end portion of shroud **18** is disposed interiorly of tank **12** and receives tank water to be heated from a novel selective flow source/rate feed system generally designated as **44**. System **44** includes a first water intake device in the form of a substantially vertically extending manifold **46**, which is arranged to take in water from throughout a relatively lower region of the tank, and a second water intake device in the form of a pressure-differential responsive valve **48**, which is arranged adjacent the upper end of manifold **46** in order to take in water from a relatively upper region of the tank.

Manifold **46** is shown as being provided with a plurality of water intake openings **50**, which are spaced vertically along the manifold and an outlet opening **52** arranged in flow communication with the inlet end portion of shroud **18**. As will be apparent from viewing FIG. **1**, intake openings **50** are arranged in flow communication with different levels within tank **12** at which levels water at different or varying temperatures may exist, due to pump circulation or turbulance occasioned by the introduction of cold supply water into the tank during a draw period.

Manifold **46** may be fabricated in any suitable manner, as from standard tubular stock, and inlet openings **50** may be suitably formed, as by a series of saw cuts or drilled or punched holes through the side wall of the tubular stock. Alternatively, manifold **46** may be inclined relative to its position shown in FIG. **1**, and/or the plural inlet openings may be replaced by a single elongated inlet opening arranged to take in water from desired levels within the tank.

Further, the inlet openings of manifold **46** are sized so as to permit up to about a "normal" rate of flow of water into shroud **18**, which is an amount equivalent to a selected rate of circulation determined by operation of pump **42** plus withdrawals from the system at "normal" rates through delivery conduit **38**. Thus, the operation of pump **42** and the initiation of a draw will cause water to be sucked into manifold **46** through openings **50** from all levels within the tank that are within the elevational reaches of the manifold, such water being mixed or integrated within the manifold for passage into heat exchange association with tubes **20**. The amounts of water withdrawn from each of the several levels within the tank may be equal or varied, depending upon the relative sizes and placements of the openings **50**. It will be understood that the term "lower" region is meant to include a substantial portion of the vertical extent of tank **10**, in that it is desirable to permit manifold **46** to take in water from levels at which widely differing water temperatures may exist. On the other hand, the term "upper" region is meant to include only a relatively small portion of the vertical extent of the tank in which is normally formed a "reservoir" of hot water, as a result of stratification phenomena.

Thus, it will be appreciated that the provision of manifold **46** serves to increase the recovery efficiencies of the system. In this respect, the mixing or integrating of water from the different temperature levels within the tank serves at least for a substantial portion of the recovery period to decrease the temperature of water supplied to shroud **18**, whose elevated position would otherwise result in only relatively hot water from the relatively upper region of tank **12** to be drawn thereinto; thereby forcing the heat exchange unit to initially operate in a more efficient range in order to quickly bring the circulated water up to the prescribed withdrawal temperature. The required output of the heat exchanger would of course be progressively reduced as all the water within the tank is brought up to the substantially desired withdrawal temperature.

When a normal draw is initiated and cold supply water enters the tank, manifold **46** serves to minimize sudden turbulence induced variations in the temperature of water passing into shroud **18** with the result that the "integrated" or averaged temperature of such water is progressively reduced. As a result, temperature sensor **36** serves to smoothly and progressively open the control valve **34** to permit heating of the water to be more efficiently accomplished.

Valve **48** is adjusted so as to remain closed when operating under pressure differentials such as are encountered under "normal" operations of the system. Thus, as indicated above, when operating under recovery and "normal" withdrawal conditions, pump **42** gently circulates water at a selected rate through manifold **46**, shroud **18**, and then into the lower level of the tank; thereby maintaining and/or gradually bringing the entire tank contents up to the desired withdrawal temperature. However, when withdrawals of hot water through conduit **38** increase above the "normal" withdrawal rate, the pressure drop across manifold **46** becomes sufficient to initiate opening of valve **48** so as to allow appropriate amounts of hot water to be drawn from the uppermost region or level of the tank and to be mixed with the relatively cool water being drawn in through manifold **46**. The withdrawal of relatively hot water from the upper level of the tank serves to initially meet the "excess" demand for water at the desired withdrawal temperatures without requiring an immedi-

ate surge of heater operation such as would otherwise be occasioned if valve **48** were to remain closed and cause the inflow of relatively cold supply water through the lower portion of the manifold in an amount sufficient to accommodate for the increased demand. The amount of hot water present in the upper level of tank **12** is sufficient to afford the heat exchanger time to obtain its most efficient operating condition. Also, the admission of water through valve **48** reduces the problem of undesirable control system cycling. As illustrated at FIG. **1**, the opening and closing of valve **48** may be controlled by a suitable spring device **54**; which is made accessible for purposes of adjustment and/or replacement by providing tank **12** with an access opening **56**.

FIG. **2** illustrates a modified form of the heating system of the present invention, wherein similar components are designated by similar "prime" numerals. In this form, tank **12'** is of the stand up type in order to minimize the floor space required for installation; and inlet connection **14'**, conduit **40'** and manhole **56'** are arranged to permit tank **12'** to be installed within a room or room recess with minimum spacing between the room walls and three sides of the tank.

Thus, it will be appreciated that the present invention provides a novel water heating and storage system embodying various important features and advantages as set forth hereinabove. While the invention has been illustrated and described with reference to a heating system by steam or hot fluid energized type immersion heater, it will be understood that the invention may be embodied in other forms of heating systems.

We claim:

1. A system for supplying water within a desired temperature range to an installation characterized as having peak demands for such water at up to a given maximum rate of flow and normal demands for such water at normal rates of flow substantially less than said maximum rate of flow, said system comprising in combination:

a hot water storage tank having a capacity sufficient to accommodate for only relatively short demands of water within said temperature range at said maximum rate;

inlet means for delivering relatively cold supply water into a relatively lower region of said tank to replenish water withdrawn therefrom, whereby said tank tends to become filled with relatively cold water progressively upwardly throughout said lower region as water is withdrawn from said tank;

water temperature sensing means;

a conduit system including (**1**) heater means, having means responsive to said sensing means for regulating the heating output thereof, (**2**) intake means for delivering tank water to said heater means and (**3**) means downstream of said heater means for normally circulating water heated by said heater means into said tank at a selected rate thereby tending to add heat to the water contents of said tank and to establish a reservoir of tank water heated up to within said temperature range at least within a relatively upper region of said tank; and

outlet means connected into said conduit system downstream of said heater means for withdrawing water from said tank for delivery to said installation upon demand at rates up to said maximum rate;

said intake means including (**1**) first means for delivering tank water to said heater means from said lower region at flow rates accommodating for said selected flow rate and said normal flow rates and (**2**) normally-closed second means for delivering tank water to said heater means from said upper region whenever the rate of withdrawal of water through said outlet means is at a rate in excess of said normal flow rates.

2. A system according to claim **1**, wherein said heater means is characterized as having relatively maximum heating efficiency when operating at a heating output rate needed to heat the water to within said temperature range at said maximum withdrawal rate and being relatively inefficient when operating at a heating output rate needed to heat water to within said temperature range at flow rates below said normal rates.

3. A system according to claim **2**, wherein said heater means includes a steam powered heat exchanger and a steam flow control valve operable in response to said temperature sensing means.

4. A system according to claim **1**, wherein said first intake means includes means for inducing a pressure differential in said conduit system upstream of said heater means relative to said tank whenever the withdrawal demand exceeds said normal flow rates, and said second intake means includes normally-closed valve means operable in response to said pressure differential.

5. A system according to claim **1**, wherein said first intake means is arranged in flow communication with vertically different levels within said tank at which levels different water temperatures may exist, whereby the temperature of water passing through said first intake means into heat exchange relationship with said heater means is an integral of the temperatures of water withdrawn from said levels.

6. A system according to claim **5**, wherein said first intake means includes means for inducing a pressure differential in said conduit system upstream of said heater means relative to said tank whenever the withdrawal demand exceeds said normal flow rates, and said second intake means includes normally-closed valve means operable by said pressure differential to admit the additional flow of water to said heater means.

7. A system according to claim **6**, wherein said heater means includes a steam powered heat exchanger and a steam flow control valve operable in response to said temperature sensing means, and said control valve is characterized as having an efficiency of less than about 50 percent for heating tank water to within said temperature range when withdrawal flow rates are less than about said normal flow rates and as having progressively increasing efficiency as withdrawal flow rates increase above said normal flow rates towards said relatively maximum flow rate.

8. A system according to claim **1**, wherein said water circulating means includes a continuously driven pump.

9. A system according to claim **1**, wherein said conduit system includes a shroud having an inlet end portion disposed within said tank in flow communication with said intake means and an outlet end portion disposed exteriorly of said tank in flow communication with said outlet means and said water circulating means, said water circulating means includes a continuously driven pump and delivers circulated water into said lower region of said tank, said heater means is an immersion heater to which heating medium is supplied

under the control of a heating medium flow control valve, said sensing means is arranged within said outlet end portion, said first intake means is open to vertically spaced levels within said tank at which levels significantly different water temperatures may be expected to exist during operation, said first intake means includes means for inducing a pressure differential in said shroud inlet end portion relative to said tank whenever the withdrawal demand exceeds said normal flow rates, and said second intake means includes a normally-closed spring-biased valve operable by said pressure differential to admit additional water flow to said shroud inlet end portion.

10. A system according to claim **1**, wherein said water temperature sensing means senses the temperature of the heated water downstream of the heater means.

11. A system for supplying water within a desired temperature range to an installation characterized as having peak demands for such water at up to a given maximum rate of flow and normal demands for such water at normal rates of flow substatially less than said maximum rate of flow, said system comprising in combination:

a hot water storage tank having a capacity sufficient to accommodate for only relatively short demands of water within said temperature range at said maximum rate;

inlet means for delivering relatively cold supply water into a relatively lower region of said tank to replenish water withdrawn therefrom, whereby said tank tends to become filled with relatively cold water progressively upwardly from said lower region as water is withdrawn from said tank;

water temperature sensing means;

water heating means including (**1**) a heater having means responsive to said sensing means for regulating the heating output thereof to maintain the temperature of water passing downstream therefrom within said temperature range, (**2**) intake means for delivering tank water to said heater and (**3**) means for increasing the temperature of the tank water at least within an upper region of the tank to within said temperature range during periods of less than normal demands; and

outlet means for withdrawing water from said tank successively through said intake means and said heater for delivery to said installation at flow rates up to said maximum rate;

said intake means including (**1**) first means for concurrently delivering tank water to said heater from vertically different levels within said tank, at which levels significantly different water temperatures may be expected to exist during operation, at rates accommodating for said normal flow rates and (**2**) normally-closed second means for delivering additional tank water to said heater from said upper region of said tank to accommodate for withdrawal at rates in excess of said normal flow rates.

12. A system according to claim **11**, wherein:

said heater means includes a steam powered heat exchanger and a steam flow control valve operable in response to said temperature sensing means; and

said control valve is characterized as having an efficiency of less than about 50 percent for heating tank water to within said temperature range when withdrawal flow rates are less than said normal flow rates and as having progressively increasing efficiency as withdrawal flow rates increase above said normal rates towards said relatively maximum flow rate.

13. A system according to claim **12**, wherein:

said first intake means includes means for inducing a pressure differential in said intake means relative to said tank whenever the withdrawal demand on said outlet means exceeds said normal flow rates; and

said second intake means includes normally-closed valve means operable in response to said pressure differential to provide additional flow of water to said intake means.

14. A system for supplying water within a desired temperature range to an installation characterized as having peak demands for such water at up to a given maximum rate of flow and normal demands for such water at normal rates of flow substantially less than said maximum rate of flow, said system comprising in combination:

a hot water storage tank having a capacity sufficient to accommodate only relatively short demands for water within said temperature range at said maximum rate;

inlet means for supplying replacement water into the lower region of said tank upon withdrawals therefrom, whereby said tank remains filled with water at different temperatures, the water in the upper region of the tank being normally considerably hotter than that in the lower region of the tank;

a conduit system including (**1**) a regulatable heater for heating water passing therethrough, (**2**) a first water intake means disposed within the lower region of said tank and (**3**) a second water intake means in communication with the upper region of said tank;

outlet means for withdrawing water from said tank for delivery to said installation upon demand at rates up to said maximum rate, said outlet means being coupled into said conduit system downstream of said heater; and

water temperature sensor means in association with said conduit system for regulating the operation of said heater in response to changes in temperature of the water flowing through said conduit system;

said first water intake means including means for accommodating normal rate flow demands upon said system without substantial pressure drop between the interior of the tank and the interior of said conduit system, and said second water intake means having a pressure responsive control means operable to maintain said second water intake means closed under said normal rate flow conditions and to open said second water intake means in response to a flow demand above said normal flow rates.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,766,974 Dated October 23, 1973

Inventor(s) Robert F. Kirschner

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, line 27, after "ferential" insert --to provide additional flow of water to said heater means--.

Signed and sealed this 2nd day of April 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents