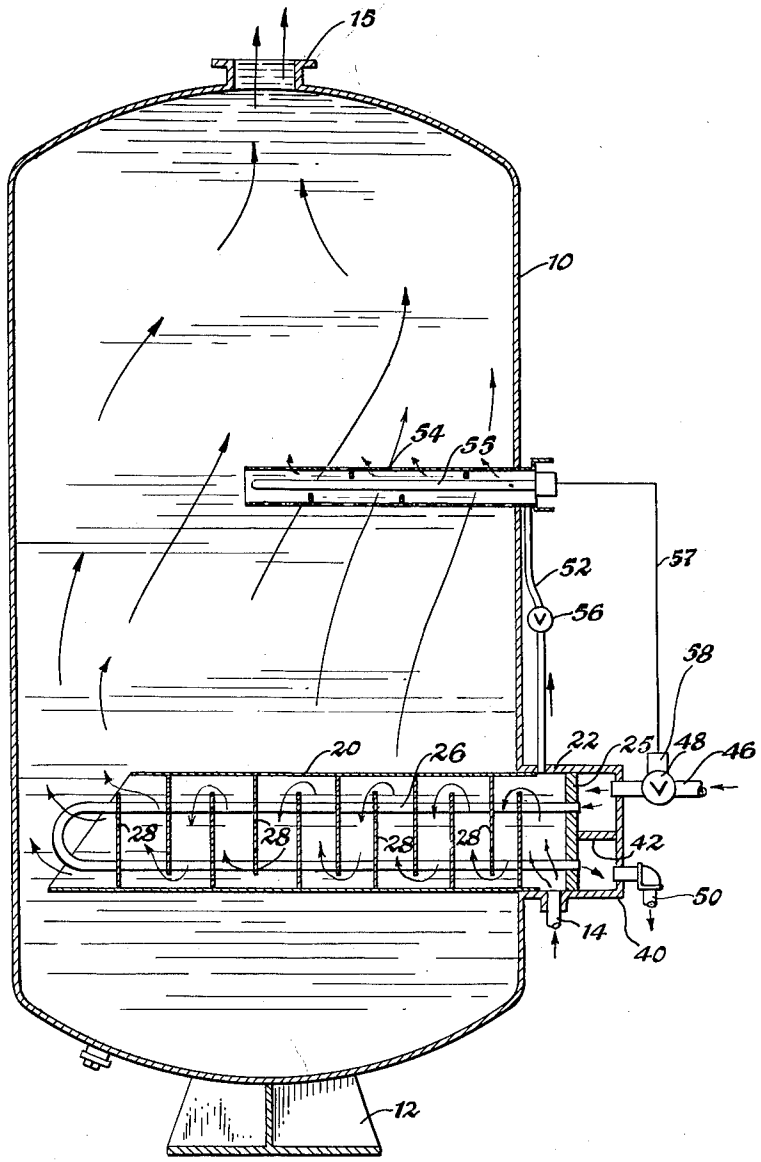
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TEMPERATURE CONTROLLING FLUID STORAGE SYSTEM

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TEMPERATURE CONTROLLING FLUID STORAGE SYSTEM

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This invention relates to storage water heaters, and more particularly to an improved unitized water storage tank and heater arrangement adapted to be installed wherever there is available a supply of steam or other hot fluid for heating purposes. The invention is particularly applicable to advantage where the demand for hot water is sometimes sudden and erratic and disproportional to normal operational requirements.

Thus, one object of the invention is to provide in a device as aforesaid means whereby the heating fluid is utilized normally at a substantially constant and efficient rate, while erratic demands for hot water are automatically met with instantaneously.

Another object of the invention is to provide an improved water storage and heating device as aforesaid which is adapted for automatically maintaining the storage water at the desired temperature while drawing upon the heat source only as needed to maintain the supply water at a specified temperature.

Another object of this invention is to provide an improved heating system as aforesaid which will automatically furnish hot water at a substantially constant uniform temperature.

Another object is to provide a system as aforesaid which will furnish hot water in the quantities required, regardless of how sudden or erratic the demands may be or how quickly the hot water must be drawn.

Another object is to provide a system which will furnish the required hot water at minimum cost.

Other objects and advantages will appear from the specification hereinafter.

Generally stated, the invention contemplates an improved method of heating water and storing it in a reduced size accumulator tank to have it available to supply either constant or intermittent demands for either small or large quantities of hot water. The system consists of a heater unit and an automatically controlled heat flow control valve. Cold water enters the heater unit which is disposed interiorly of the tank and then moves into the main body of the tank. A temperature sensor is located in the main body of the tank and is connected to control the heat supply control valve. However, a by-pass conduit interconnects the volume of water in the area of the sensor and the cold water inlet, and is fitted with a one-way check valve opening in the direction of flow from the cold water inlet to the sensing area.

The invention may be practiced for example in combination with a storage water tank of any suitable shape with suitable outlet for delivery of hot water to the water-consuming equipment. Although any suitable type of heat supply may be employed, as shown herein, a tube bundle type heat exchange unit extends into the tank in the lower level thereof and is sheathed by a casing enclosing the tube bundle except at one end thereof. The tube bundle comprises banks of return-bent tubes arranged in spaced relation. Water flow pattern control baffles are associated with the tube sheath to cause the flow of water to zig-zag through the elongate housing enclosing the tubes; the housing being joined at one of its ends to the tube sheet and being open at its other end interiorly of the tank. Thus, the cold water travels in heat exchange relation around the tubes prior to discharge from the open end of the casing into the main section of the tank. The bank of tubes is arranged to be

fed with steam or other hot fluid delivered from any suitable source according to requirements for additional heat energy to maintain the hot water supply delivery at the prescribed temperature.

The device may be readily constructed in unit form, fully self-contained and requiring minimum floor space, and is suitable for installation in any out-of-way locations. It is readily connected to existing piping systems, and normally draws upon the associated steam generating boiler in such limited manner as to avoid interference with constant steam pressures at the other associated steam operated equipment, and evens out the boiler load thereby improving its efficiency and life span. The above and other objects of the apparatus of the invention will be apparent from detailed descriptions of exemplary embodiments of the invention in storage water heater units as illustrated in the accompanying drawings wherein:

The figure is a vertical sectional view through a typical upright type water storage heater of the invention.

As illustrated in the drawing herewith, the water storage supply tank is illustrated at **10** as being generally of cylindrical form and is supported to stand vertically as upon a standard **12**; but it is to be understood that the tank **10** may in lieu thereof be provided of any other preferred shape or form and may stand in any other attitude and be otherwise supported in any other manner if preferred. In any case, the tank **10** will include a cold water supply conduit connection as indicated at **14** and a heated water outlet connection as indicated at **15**.

The heat exchange device of the present invention is illustrated in the drawings herewith as comprising an elongated casing **20**, which is welded at its forward end to the throat portion **22** of an opening formed in a wall of the tank **10**. A tube sheet **25** into which are mounted the terminal ends of a bank of reverse bent tubes **26** is provided for attachment to the flanged tank opening. Baffle plates **28** disposed vertically and alternately occupying upper and lower portions of the casing **20**, function simultaneously as vertical supports for the tubes **26** and as liquid passageway guide devices so as to cause the water circulating through the casing **20** to pursue a zig-zag path through the casing and around the heat exchange tubes **26** as indicated by the directional arrows in the drawing.

A manifold cover or bonnet as indicated at **40** is fixed to the outer face of the tube sheet **25**, and is provided with an internal partition rib **42**; the rib being dimensioned to bear firmly against the tube sheet when the unit is in assembly so as to thereby internally divide the fluid chamber portion thereof into two sections, as shown in the drawing. Thus, it will be appreciated that the tubes **26** may be initially assembled upon the tube sheet **25**, and that this subassembly may then be slip-fitted into the throat portion **22** of the tank **10** and into the casing **20**, and the tube sheet and manifold assembly may then be firmly fixed in place to complete the mounting of the heat exchange unit in the tank.

Piping connections are then made through the front wall of the manifold cover **40** into the chamber portions thereof, as will be explained more fully hereinafter; while the cold water inlet connection into the interior of the casing **20** at its forward end is effected by means of the inlet connection **14**. Thus, it will be appreciated that upon withdrawal of water from the interior of the tank **10** cold water will replace it through the conduit **14** and thence into the front end of the casing **20** wherefrom it will proceed rearwardly in a vertically zig-zag path as indicated by the directional arrows. When the water emerges from the rear end of the casing **20** it circulates upwardly into the main body of the storage tank **10**.

The heat exchange component of the device of the present invention embodies means for drawing upon any

suitable supply of heat such as a live steam, waste heat steam, or water source from any associated system. For this purpose, a live steam or other heated fluid inlet conduit as indicated at 46 is arranged to deliver heated fluid into the bonnet 40 as controlled by a valve 48; the return outlet for the heating fluid being indicated at 50. A by-pass conduit as indicated at 52 interconnects the cold water end of the casing 20 with a housing 54 which encloses a temperature responsive "bulb" as indicated at 55 disposed interiorly of the main body portion of the water supply within the tank 10; the mechanism being so arranged that a spring-biased one-way check valve 56 in the conduit 52 will be automatically opened only whenever the withdrawal of hot water at the outlet 15 is at a predetermined "excessive" rate.

When the rate of withdrawal of hot water from the outlet 15 is "normal" or relatively slow, the pressure drop in the tank between the interiors of the casing 54 and the housing 20, in the zones of their communications with opposite ends of the conduit 52, will be insufficient to unseat the check valve 56. Thus, under normal conditions the check valve will remain closed, and as heated water is slowly drawn out of the top of the tank cold water replaces it by flowing through the inlet 14 and through the housing 20 and then into the body of the tank. Here it gradually mixes and lowers the temperature of the water within the tank in the area of the bulb 55. The bulb 55, through a connection 57 operates a valve control 58 to automatically adjust the steam flow control valve 48 so as to call upon the supply of heating fluid as and whenever it may be required to maintain the temperature of the main body of water within the tank within the prescribed range of temperatures therefor. This type of "normal" automatic temperature control is of course quite conventional, and the present invention relates to the "heavy demand" condition automatic control feature including the check valve regulated by-pass conduit 52.

As explained hereinabove, whenever large quantities of hot water are rapidly withdrawn from the top of the tank, the baffling devices within the housing 20 operate to retard the rate of responsive replacement flow of water from the inlet 14 through the housing 20. Hence, a substantial hydrostatic pressure differential is immediately established between the interior of the casing 54 and the inlet end portion of the housing 20. This pressure differential functions to unseat the check valve 56 whereupon cold replacement water immediately starts to flow from the cold water inlet end portion of the housing 20 through the conduit 52 and into the bulb shroud 54. The advent of cold supply water directly into the shroud surrounding the sensing bulb 55 immediately causes the latter to call upon the steam control valve 48 for a corresponding flow of heating fluid.

Hence, the system of the present invention does not wait upon a general mixing of cold inlet water into the large volume of water occupying the main body of the tank and a consequent gradual lowering of the temperature thereof in the neighborhood of the sensing bulb, as in the case of conventional heating arrangements. Instead, in the case of the present invention any heavy withdrawal is immediately signaled to the check valve 56 which thereupon admits a supply of cold water directly to the sensing bulb. This responds instantly to call upon the heating supply for a commensurate flow of heating fluid.

Hence, in the same system, slow or "normal" withdrawals are matched by slow and correspondingly economical heat additions while heavy withdrawals are matched by rapid and commensurate heat additions.

I claim:

1. A water heating and storage device comprising the combination of a single container in which water is to be heated and stored, a cold water inlet adjacent the bottom of said container, a heated water outlet adjacent the top of said container, a water heating device disposed within the lower portion of said container and comprising an elongate housing of generally tubular form arranged in communication at one end with said cold water inlet and having a heated water discharge opening at its other end, a water heater disposed within said housing in heat exchange relation with water therewithin, water passage baffling means disposed within said housing to retard passage of water through said housing, a water temperature sensor disposed within the upper portion of said container, a heater energizing control device connected to said heating device for control of the latter, means operatively interconnecting said sensor and said heater control to regulate the operation of said heater in accord with water temperature variations in the region of said sensor, a by-pass conduit connected at one end to said housing adjacent said one end thereof and having a discharge end located in the region of said sensor, and check valve means in said by-pass conduit responsive only to a pressure differential of predetermined value existing between said one end of said housing and the region of said sensor.

2. A water heating and storage device comprising in combination, a single container in which water is to be heated and stored, a cold water inlet and a heated water outlet disposed at different positions of said container, a water heater disposed within said container adjacent said cold water inlet and comprising an elongate housing of generally tubular form arranged in communication at one end with said cold water inlet and having a heated water discharge opening at its other end, a water heating device disposed within said housing in heat exchange relation with water therewithin, water passage baffling means disposed within said housing to retard passage of water through said housing, a water temperature sensor disposed within said container, a heater energizing control device connected to said heating device for control of the latter, means operatively interconnecting said sensor and said heater control to regulate the operation of said heater in accord with water temperature variations in the region of said sensor, a by-pass conduit connected at one end to said housing adjacent said one end thereof and having a discharge end located in the region of said sensor, and check valve means in said by-pass conduit responsive only to a pressure differential of predetermined value existing between said one end of said housing and the region of said sensor.

3. A water heating and storage device comprising the combination of a single elongate container in which water is to be heated and stored, a cold water inlet adjacent one end of said container, a heated water outlet adjacent the other end of said container, a water heating device disposed intermediately of said inlet and outlet and comprising an elongate housing of generally tubular form arranged in communication at one end with said cold water inlet and having a heated water discharge opening at its other end, a water heater disposed within said housing in heat exchange relation with water therewithin, water passage baffling means disposed within said housing to restrict passage of water through said housing and create a substantial pressure differential between said one end and said other end of the housing in response to a rate of withdrawal from the tank which exceeds a predetermined value, a water temperature sensor disposed within the upper portion of said container, a heater energizing control device connected to said heating device for control of the latter, means operatively interconnecting said sensor and said heater control to regulate the operation of said heater in accord with water temperature variations in the region of said sensor, a by-pass conduit for cold water from said cold water inlet directly into the region of said sensor, and check valve means in said by-pass conduit opening only in response to the substantial pressure differential as aforesaid.

4. A water heating and storage device comprising the combination of a vertically elongate container in which water is to be heated and stored, a cold water inlet ad-

jacent the bottom of said container, a heated water outlet adjacent the top of said container, a water heating device disposed within the lower portion of said container and comprising an elongate housing arranged in communication at one end with said cold water inlet and having a heated water discharge opening at its other end, a water heater disposed within said housing in heat exchange relation with water therewithin, water passage baffling means disposed within said housing to restrict passage of water through said housing and create a substantial pressure differential between said one end and said other end of the housing in response to a rate of withdrawal from the tank which exceeds a predetermined value, a water temperature sensor disposed within the heated water storage portion of said container, a heater energizing control device connected to said heating device for control of the latter, means operatively interconnecting said sensor and said heater control to regulate the operation of said heater in accord with water temperature variations in the region of said sensor, a by-pass conduit for cold water from said inlet directly into the region of said sensor, and check valve means in said by-pass conduit opening only in response to the substantial pressure differential as aforesaid.

5. A water heating and storage device comprising the combination of a container in which water is to be heated and stored, a cold water inlet into said container, a heated water outlet leading from said container, a water heating device disposed within said container and comprising a water passageway constricted to restrict flow of water therethrough and create a substantial pressure differential between the opposite ends of said passageway in response to a rate of withdrawal from said tank which exceeds a predetermined value, said passageway being arranged in communication at one end with said cold water inlet and having a heated water discharge opening at its other end, a heater disposed in heat exchange relation with water within said passageway, a water temperature sensor disposed within the water storage portion of said container, a heater energizing control device connected to said heater for control of the latter, means operatively interconnecting said sensor and said heater control to regulate the operation of said heater in accord with water temperature variations in the region of said sensor, a by-pass conduit for cold water from said cold water inlet directly into the region of said sensor, and check valve means in said by-pass conduit opening only in response to the substantial pressure differential as aforesaid.

6. A water heating and storage device comprising the combination of a single elongate container in which water is to be heated and stored, a cold water inlet adjacent one end of said container, a heated water outlet adjacent the other end of said container, a water heating device disposed intermediately of said inlet and outlet and including a constricted water passageway arranged in communication at one end with said cold water inlet and having a heated water discharge opening at its other end, a water heater disposed in heat exchange relation with water therewithin, said water passageway operating to restrict passage of water through said passageway and create a substantial pressure differential between the opposite ends of said passageway in response to a rate of withdrawal from said tank which exceeds a predetermined value, a water temperature sensor disposed within the storage portion of said container, a heater control device connected to said heating device for control of the latter, means operatively interconnecting said sensor and said heater control to regulate the operation of said heater

in accord with water temperature variations in the region of said sensor, a by-pass conduit for cold water from said cold water inlet directly into the region of said sensor, and check valve means in said by-pass conduit opening only in response to the substantial pressure differential as aforesaid.

7. A water heating and storage device comprising the combination of a single container in which water is to be heated and stored, a cold water inlet and a heated water outlet adjacent opposite ends of said container, a water heating device disposed intermediately of said inlet and said outlet and including a constricted water passageway arranged in association at one end with said cold water inlet and having a heated water discharge opening at its other end, a water heater disposed in heat exchange relation with water within said passageway, said water passageway operating to restrict passage of water through said passageway and create a substantial pressure differential between the opposite ends of said passageway in response to a rate of withdrawal from said tank which exceeds a predetermined value, a water temperature sensor disposed within the water storage portion of said container, a heater control device connected to said heating device for control of the latter, means operatively interconnecting said sensor and said heater control to regulate the operation of said heater in accord with water temperature variations in the region of said sensor, a by-pass conduit for cold water from said cold water inlet directly into the region of said sensor, and flow control means for said by-pass conduit permitting flow of water therethrough only in response to the substantial pressure differential as aforesaid.

8. A heated fluid supply system comprising, in combination,

a hot fluid storage tank having an outlet communicating with one region of the tank and from which heated fluid may be withdrawn at various rates,

fluid supply means communicating with the interior of said tank at a region thereof spaced from said region at which said outlet communicates,

temperature sensor means in said tank remote from both of said regions,

said fluid supply means including a conduit for conducting supply fluid into said tank to replenish that withdrawn from said outlet, said conduit having a discharge opening, a cold fluid supply connected to said conduit remote from said discharge opening, and mechanism for restricting flow of fluid through said conduit, said mechanism including heater means in said conduit,

control means connecting said sensor means with said heater means for control of the latter in accord with temperature variations detected by the sensor means,

and a cold fluid bypass connected to said conduit adjacent said cold fluid supply and discharging into said tank adjacent said sensor means, said bypass including a check valve responsive only to a differential pressure between the opposite ends of said bypass which exceeds a predetermined amount corresponding to an abnormally high fluid withdrawal rate from said tank.

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