May 14, 1968 W. J. DARM 3,383,040

HEAT EXCHANGER WITH THERMOSENSITIVE CONTROL

Filed Aug. 2, 1966

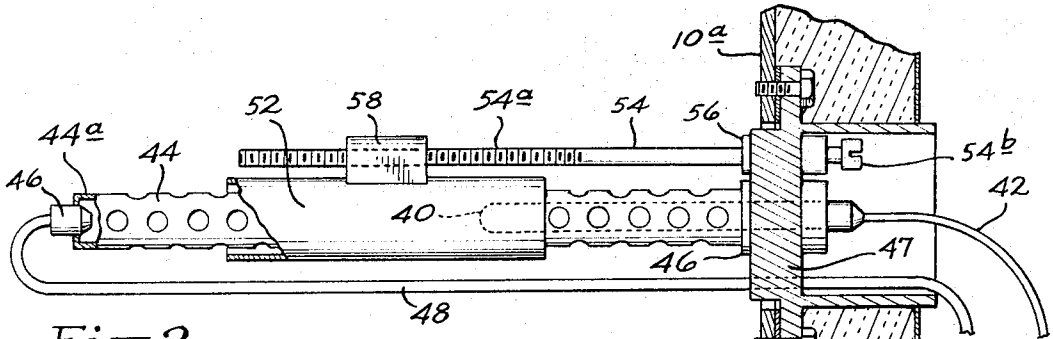


Fig. 2.

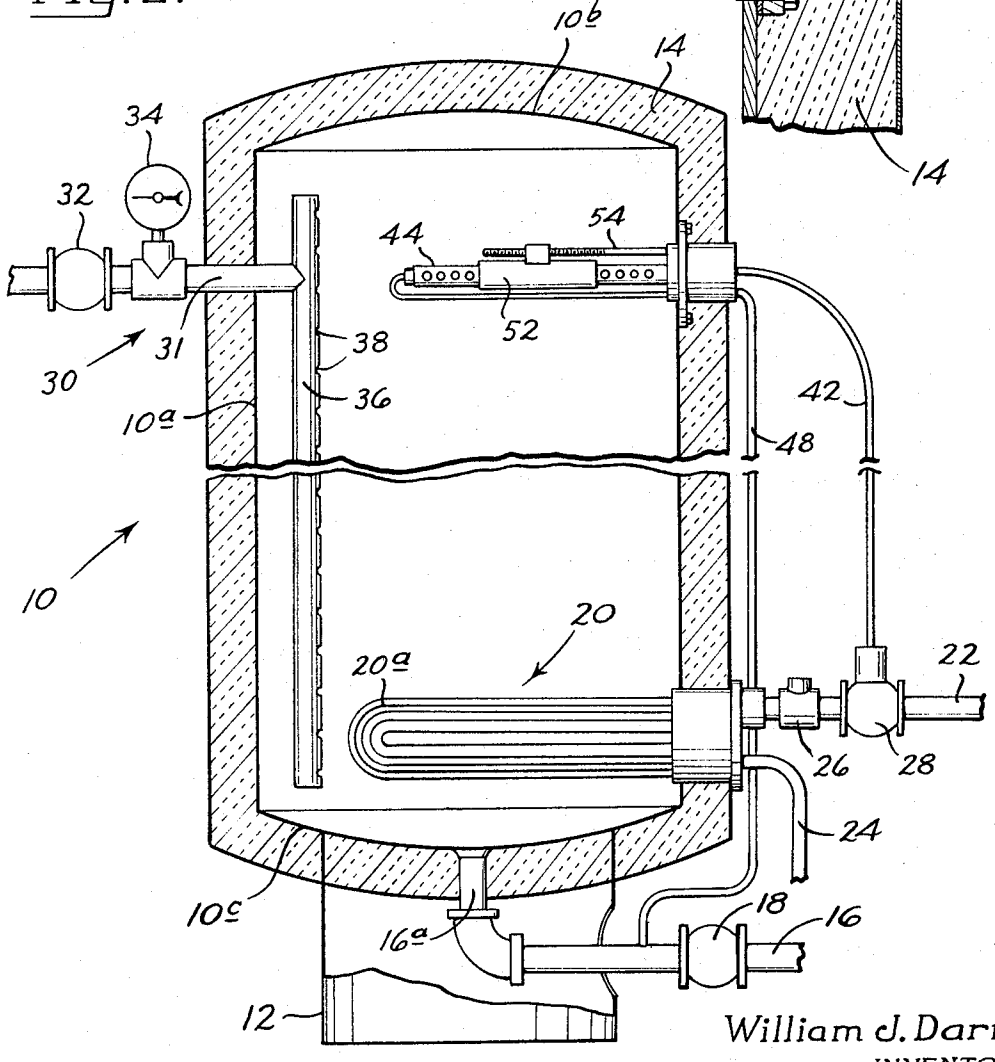


Fig. 1.

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United States Patent Office 3,383,040
Patented May 14, 1968

3,383,040

HEAT EXCHANGER WITH THERMOSENSITIVE CONTROL

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Filed Aug. 2, 1966, Ser. No. 569,719
9 Claims. (Cl. 236—18)

ABSTRACT OF THE DISCLOSURE

A hot water heat exchanger including a tank with a heating element adjacent the base of the tank for heating water. A bleed conduit bleeds a portion of the cold water being introduced to the tank and feeds such against a thermosensitive bulb controlling the heating element. Water is discharged from the bleed conduit through a nozzle spaced from the thermosensitive bulb, and a tubular part interposed between such nozzle and bulb is adjustable to produce a change in the mix of water which flows against the bulb. Hot water is withdrawn from the tank through an upright perforated pipe effective to stabilize the temperature of the water withdrawn.

This invention relates to heat exchangers, and more particularly to certain improvements in heat exchangers designed to heat a fluid whereby with intermittent drawing of heated fluid from the exchanger a substantially uniform temperature may be maintained in the heated fluid drawn off.

In a specific and preferred embodiment of the invention, the heat exchanger comprises a liquid heater, such as a water heater. Heating of cold water introduced to the exchanger is accomplished by intermittent energizing of a heating element in the exchanger. The objective is to maintain a uniform temperature in water drawn from the exchanger (approximately 100° F. in a typical domestic hot water system) even through such water be drawn from the exchanger intermittently.

Further explaining the operating conditions of an exchanger of the type contemplated, a fluid such as water tends to stratify in an exchanger with hot water tending to rise above the cold water. With water withdrawn from the upper hot water region, and if a thermostat or other thermosensitive device is placed in this upper hot water region for controlling the heating element for the exchanger, characteristically a relatively slow response results in energizing of the heating element since appreciable amounts of water must be withdrawn before the thermosensitive device will detect the draw of water. On the other hand, if the thermosensitive device is mounted in the lower cold water region, there is lack of control since temperatures in this region tend to vary between too wide a range with intermittent draw of hot water. The way in which hot water is withdrawn from the exchanger also is a factor affecting the uniformity of the temperature of the water which is withdrawn.

Generally, an object of this invention is to provide an improved heat exchanger for fluid, such as water and the like, featuring novel means resulting in substantially improved uniformity in the temperature of the water withdrawn from the exchanger.

More specifically, an object is to provide such a heat exchanger which includes novel means for anticipating a drop in water temperature upon withdrawal of fluid from the exchanger.

Yet a further object is to provide an extraction system for fluid held by an exchanger which, together with the anticipating means described, promotes greater uniformity in the temperature of fluid withdrawn.

With heat exchangers such as hot water heaters, and

with conventional temperature control systems, there is a close cooperative relationship between the various control elements, tank size, etc., whereby the temperature of the water withdrawn and heater response has a high degree of dependence upon the particular components used in the system. Thus, replacement of any control component with a component of different origin or type from the original tends to affect temperature level and heater response, and existing systems make little, if any, provision for taking care of this change which takes place. The apparatus contemplated features a unique construction which facilitates the making of temperature and response adjustments. The apparatus, therefore, can be readily incorporated with existing or new units regardless of their origin, and after installation may be easily adjusted to produce a uniform temperature in the withdrawn water at the exact temperature level desired.

The temperature control system contemplated is relatively simple in construction and, as a consequence, is produceable at a relatively low cost. The flexibility of the system enables it to be utilized with a wide variety of exchangers.

These and other objects and advantages are attained by the invention, and the same is described hereinbelow in conjunction with the accompanying drawings, wherein:

FIG. 1 is a cross-sectional side elevation, illustrating a heat exchanger as contemplated herein; and

FIG. 2 is a view, drawn on a slightly larger scale, showing adjustable mechanism inside the exchanger forming part of the temperature control system for the unit.

Referring now to the drawings, in the heat exchanger shown a tank is illustrated at **10** comprising a conventional upstanding cylindrical shell **10***a* closed off at the top and bottom of the tank by end walls **10***b* and **10***c*. The tank is supported in a position elevated above the ground on a base **12**. Insulation **14** surrounds the tank in the conventional manner.

The heat exchanger illustrated is of the type that might be employed to heat water in a domestic hot water system. Cold water is introduced to the tank through a pipe or feed conduit means **16**, including at **16***a* an inlet end which communicates with the interior of the tank. Pipe **16** may be provided with the usual hand operated valve **18** for shutting off the flow of water through the pipe when desired.

Water within the tank is heated by operating a heater in the form of a conventional U-tube bundle or assembly, shown generally at **20**. The bundle includes the usual U-shaped tubes **20***a* heated by the passage of steam therethrough. Steam inlet pipe **22** feeds steam to the U-tube bundle. Shown at **24** is a condensate drain. A vacuum breaker, i.e. a check valve allowing flow of air into the steam pipe when vacuum conditions result in the U-tube bundle, is shown at **26**. Controlling the supply of steam to the U-tube bundle through pipe **22** is a valve **28**.

Hot water is drawn off from the tank through an outlet or discharge conduit means generally designated at **30**. This may include a pipe **31**, which extends from the inside to the outside of the tank, provided with a valve **32** for controlling the flow of hot water through the pipe. A thermometer sensing the temperature of water flowing through the pipe is designated at **34**.

As discussed earlier, with an exchanger such as a hot water heater where there is an intermittent draw of water from the tank, there tends to be stratification within the tank with hot water rising to the top and cold water settling to the bottom. Upon water being withdrawn from the tank through pipe **31**, cold water replenishing the tank is introduced through the inlet pipe **16**. At such times that the U-tube bundle is operating, there is heating of the water around the bundle with such water tending to rise

and displace colder water above. These various conditions produce a number of different water temperatures at different elevations in the tank. By this invention it is contemplated that when water is withdrawn from the tank, such will be withdrawn from multiple locations distributed at multiple elevation throughout the tank. With such an organization, water drawn off comprises a blend of water fractions drawn from various levels within the tank, having a temperature tending to remain constant over the span of the withdrawal period.

Thus, and referring to FIG. 1, discharge conduit means 30 further includes a vertical pipe 36 disposed within tank 10 extending from adjacent the base to adjacent the top. This pipe includes perforations, such as those shown at 38, distributed along the length thereof. These perforations communicate with the interior of the pipe, and the interior of the pipe in turn communicates with the interior of pipe 31. The ends of pipe 36 are closed. The perforations provide a restriction to flow into the pipe, with the result that during water withdrawal a pressure pattern is produced causing water to be forced into the pipe at levels distributed throughout its length.

Actuation of the heater means for heating the water is performed automatically, through actuation of a thermosensitive device, such as the gas operated, thermostatic bulb shown at 40. Bulb 40 through thermostat lead 42 is connected for control purposes to valve 28 earlier described, which is a gas pressure operated valve. The bulb and valve are conventional. Describing the operation of these elements, upon a drop in the temperature of the water surrounding the bulb, the pressure of gas within the bulb decreases, producing opening of valve 28, and on a rise in temperature in the water the pressure of the gas increases producing closing of the valve.

As described earlier, the invention contemplates novel means for anticipating a drop in water temperature upon the withdrawal of water thereby producing faster response in the operation of valve 28 than were the thermostat merely suspended in the tank. This means, also referred to as a temperature control system, includes adjustable mixer mechanism inside the tank effective to direct a current of water against the thermosensitive device, partially made up of cold water bled from pipe 16 and partially made up of water already in the tank. Adjustment of a movable device in the adjustable mechanism is effective to change the proportions of water from these sources making up the current which is directed against said thermosensitive device i.e., the mix of such current.

Further explaining, shown at 44 is a tubular part mounted within the tank as by securing it to fitting 46 supported on a plate 47, which fitting also mounts the thermostatic bulb. Tubular part 44, as best seen in FIG. 2, comprises a perforate wall, which may be cylindrical, with the perforations in such wall permitting a degree of water circulation through the wall into the interior of the tubular part.

End 44*a* of the tubular part is closed off by an end wall, and supported by this end wall centrally of the part is a nozzle part 46. Connecting the nozzle part with cold water feed pipe 16 is a bleed conduit or line 48. With hot water withdrawn from the tank, a drop of water pressure occurs therein, with cold water then flowing into the tank simultaneously through pipe 16 as well as through the bleed line 48. It should be understood, of course, that ordinarily the fraction of the water introduced into the tank through line 48 and the nozzle part is only a minor portion of the total inflow of water. Water discharged from the nozzle part is directed as a stream toward the thermostatic bulb. Such stream of water produces a current flow within the tubular part (which constitutes means defining a path of fluid flow between the nozzle part and thermostatic bulb). This current flow results in the production of a low pressure condition within the tubular part adjacent the nozzle part, whereby water already within the tank tends to be drawn in through the perforations of the tubular part and

become mixed with the cold stream emanating from the nozzle part. The current of water, therefore, which actually moves against bulb 40 comprises a mixture of cold water and hot water, having a temperature somewhat above the temperature of the water in pipe 16.

Encompassing the tubular part is a cylindrical shield 52. This shield is nonperforate, and has an inner diameter only slightly exceeding the outer diameter of part 44. Supporting the shield within the tank is an elongated threaded stud 54 journaled in a fitting 56 mounted on plate 47, which fitting permits rotation of the stud while inhibiting axial movement relative to plate 47. The stud has an inner threaded end 54*a* which is received within threaded nut 58 joined in a suitable manner to a side portion of shield 52.

Stud 54 also has an outer end 54*b* which is slotted or otherwise shaped to permit the stud to be turned by a tool to produce rotation of the stud. It should be apparent from this description that with rotation of the stud in one direction, the shield is advanced toward end 44*a* of the tubular part, and on rotation of the stud in the opposite direction this shield is moved toward the side of the tank, toward a position more fully encompassing the thermostatic bulb.

Explaining now the operation of the shield, as already described water on being discharged from nozzle part 46 produces a current of water flowing through the interior of the tubular part 44, made up partly of water already contained in the tank which through induction is drawn in through the perforation of the tubular part to travel against the thermostatic bulb. With the shield positioned close to end 44*a* of the tubular part, the shield is effective to produce a closing off of the perforations in the tubular part directly adjacent the nozzle. As a consequence, the stream of water emanating from the nozzle travels downwardly through the tubular part with minimum induction of tank water through the perforations. This water, therefore, which moves as a current against the thermostatic bulb, is relatively cold, and produces a relatively sharp temperature drop in the bulb. On the other hand, on movement of the tubular part toward the side of the tank, whereby it is retracted over the bulb, the perforations adjacent the nozzle part are opened up, which promotes the inflow of tank water through the perforations. As a consequence, the current moving against the bulb has a warmer temperature.

Explaining now how the apparatus as a whole operates, with water withdrawn from the tank as by opening of valve 32, cold water is introduced into the tank through pipe 16 and through bleed conduit 48. Cold water moving down through the tubular part produces a current of water made up of both the cold water and of water already contained within the tank at a higher temperature. The water on traveling through the tubular part moves against the bulb to produce actuation of the heater means anticipating the drop in water temperature resulting from the withdrawal of water. Water is withdrawn from the tank, through vertical pipe 38, at different elevations in the tank. The temperature of the water noted on thermometer 34, therefore, tends to remain uniform, whether a relatively small or a relatively large quantity of water is withdrawn.

An adjustment may be made to change the response of the heater means relatively easily and quickly. Thus, in the event that it is noted that there is some lag in the response, as evidenced by a significant drop in water temperature after the withdrawal of a certain quantity of water, the response may be speeded up by shifting the shield more closely adjacent the nozzle. Conversely, should a rise in the temperature of the water be noted, signifying too fast a response, then the shield may be retracted toward the thermostatic bulb.

While an embodiment of the invention has been described, obviously modifications and variations may be made without departing from the invention. It is de-

sired to cover all such variations as would be apparent to one skilled in the art, and that come within the scope of the appended claims.

It is claimed and desired to secure by Letters Patent:

1. In a heat exchanger including a tank for holding fluid and a heating element within the tank for heating such fluid, feed conduit means for introducing cold fluid to the tank including an inlet opening communicating with the interior of the tank, a thermosensitive device mounted within the tank responsive to fluid temperature therein and connected to the heating element for controlling its operation, bleed conduit means connecting with said feed conduit means for bleeding from the feed conduit means a flow of cold fluid and introducing such to the interior of the tank as a stream of fluid adjacent said thermosensitive means, and adjustable mixer mechanism inside the tank effective to direct a current of fluid comprising a mix of at least a portion of said stream of fluid mixed with other fluid already in the tank against said thermosensitive device, said mechanism including a movable device which is adjustable to effect for a given rate of flow in said stream of fluid a change in the proportions of the fluid in said stream and other fluid in the tank making up the mix of said current.

2. The heat exchanger of claim 1, wherein said adjustable mixer mechanism includes means within the tank defining a path for fluid flow toward said thermosensitive device and said means received fluid emanating from said bleed conduit means.

3. The heat exchanger of claim 2, wherein said means defining a path for fluid flow comprises a tubular part with perforate walls.

4. The heat exchanger of claim 3, wherein said tubular part partially surrounds said thermosensitive element.

5. The heat exchanger of claim 1, wherein said bleed conduit means includes a nozzle part spaced from said thermosensitive device for the discharge of fluid within the interior of the tank, and said movable device comprises a member located between said nozzle part and thermonsensitive device.

6. The heat exchanger of claim 5, wherein said adjustable mechanism includes a tubular part with perforate walls defining a path for fluid flow between said nozzle part and thermosensitive device.

7. The heat exchanger of claim 1, wherein said bleed conduit includes a nozzle part operable to discharge fluid into the tank and wherein said adjustable mechanism comprises a tubular part with perforate walls defining a path for fluid flow between said nozzle part and thermosensitive device and a movable sleeve encircling the tubular part operable to restrict flow of fluid in the tank into the sleeve, and adjustable axially of the sleeve to effect a change in the restriction offered by the sleeve.

8. The heat exchanger of claim 7, which further includes an adjuster mounted outside said tank, and means operatively interconnecting said adjuster and sleeve whereby manipulation of the adjuster results in a change in the position of the sleeve.

9. In a heat exchanger including a tank for holding fluid and a heating element within the tank adjacent its base for heating such fluid, feed conduit means for introducing cold water into the tank including an inlet opening adjacent the tank base communicating with the interior of the tank, a thermosensitive device mounted within the tank spaced above said inlet opening responsive to fluid temperature in the tank and connected to the heating element for controlling its operation, bleed conduit means connecting with said feed conduit means for bleeding from the feed conduit means a flow of cold fluid and introducing such to the interior of the tank as a stream of fluid adjacent said thermosensitive means, mechanism in the tank effective to direct a current of fluid comprising at least a portion of said stream of fluid against said thermosensitive device, and outlet conduit means for withdrawing fluid from the tank, said outlet conduit means including apparatus within the tank accommodating a restricted flow of fluid into the outlet conduit means from regions spaced at multiple elevations within the tank, said regions being distributed in a zone extending from adjacent said heating element upwardly to said thermosensitive bulb.

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