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LIQUID HEATER AND CONTROL

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FIG. 1.

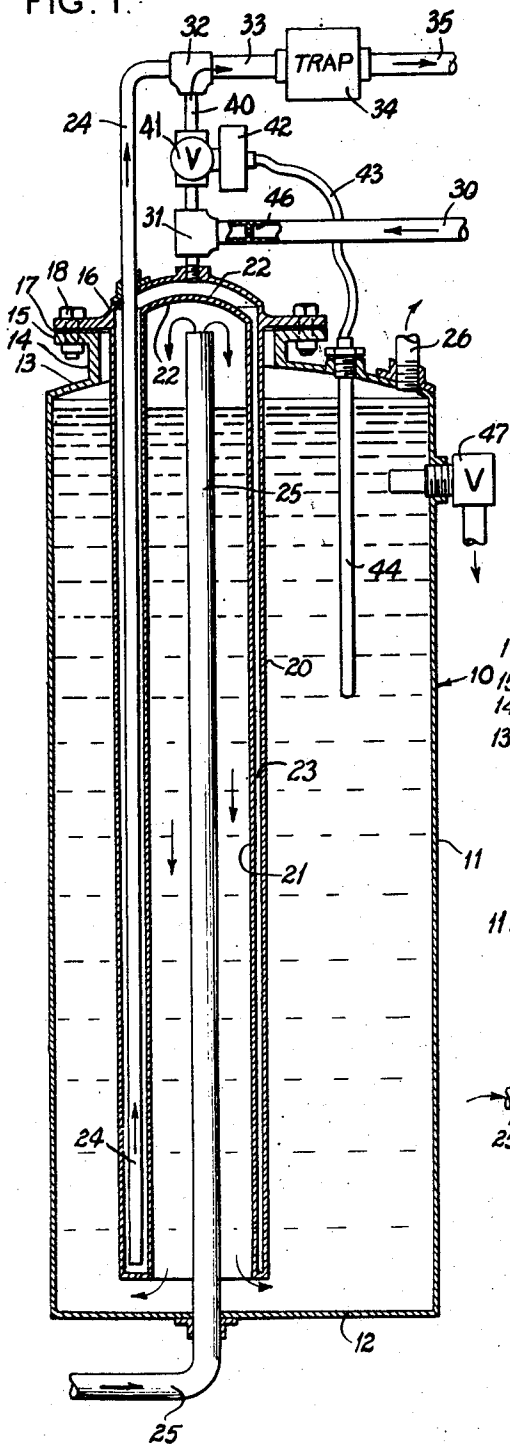


FIG. 3.

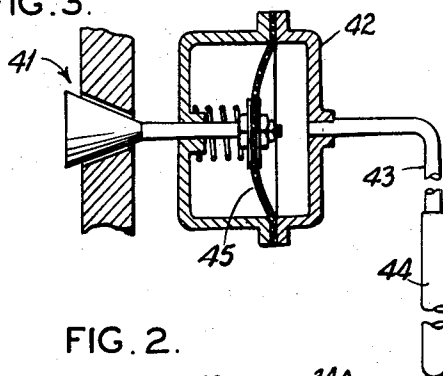
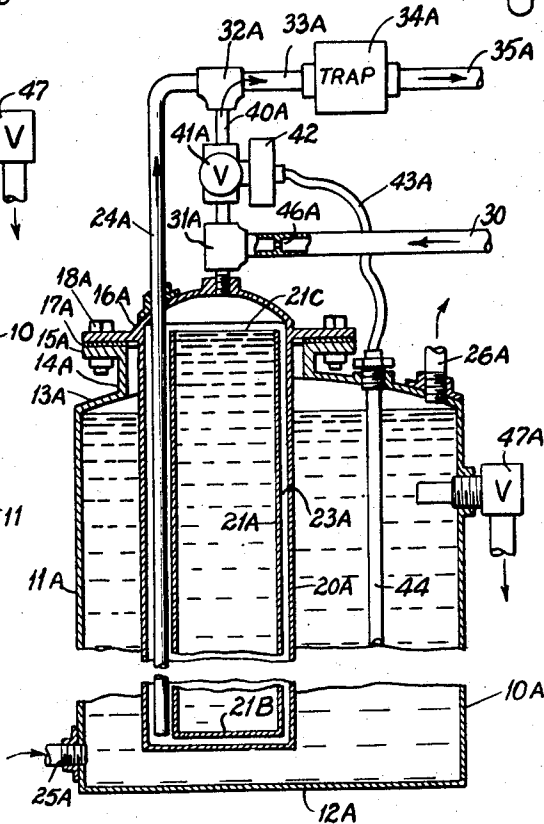


FIG. 2.



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LIQUID HEATER AND CONTROL

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7 Claims. (Cl. 257—2)

1

2

This invention relates to improvements in liquid heaters and controls, and more particularly to heaters of those types utilizing a condensible fluid such as steam, for the heating of a liquid, such as water. The present improvements being directed more particularly, but not exclusively, to automatically controlled storage type heaters.

There have heretofore been offered to the trade numerous types of automatic storage heaters; also many other types of elaborate steam systems for the heating of water and other liquids, among the many examples of the service to which these are adapted, being the automatic supply of hot water to railway vehicles, industrial establishments, and even for domestic hot water supply where a suitable source of steam under pressure is available. Particularly in the case of a high pressure steam supply, numerous difficulties are presented in the usual systems employing a powered valve assembly for steam shutoff purposes, there being many types of such valves. Invariably, as far as is known to this applicant, such valves when closed, act against a pressure differential across the valve which amounts to substantially the full steam supply pressure. Thus, control valves for these purposes present considerable service difficulties in the requirement of frequent replacement, packing, and renewal, besides being characterized by a high first cost. The present invention accordingly has as its prime objectives, the elimination of the difficulties aforesaid, by an improved design and arrangement of steam circuits and valves.

Yet another object of importance is attained in an arrangement enabling a much smaller and less expensive steam control valve, than is required in existing types of water heaters utilizing steam as the heating medium.

A still further object of the invention is attained in an improved structural arrangement of the heating elements and piping, together with controls of a simplified nature, such that a unitary assembly of such elements may be easily inserted in or removed from a water storage tank of the assembly, in a minimum of time and a low expense for service attention when required.

A still further object is attained in an improved arrangement of elements earlier referred to, in a combination with a condensate relief unit such as a trap, so located as to enable the steam coil to flood up at the termination of the heating cycle, thus enabling utilization of the heat of the condensate, or a substantial part thereof, to augment the water heating effect of the steam.

An additional valuable objective is attained in

a unique arrangement of steam flow passages and controls, in combination with a particularly advantageous arrangement of elements forming at times a steam heating chamber, and at other times a chamber of relatively restricted capacity which may quickly be flooded by condensate, whereby better to realize on water heating effect of the condensate.

The foregoing and numerous other objectives and advantages of the present improvements will more fully appear from the following detailed description of certain preferred examples and embodiments, particularly when considered in connection with the accompanying drawing, in which:

Fig. 1 is a vertical sectional elevation through an assembly of preferred form embodying present improvements, certain of the control elements being indicated diagrammatically;

Fig. 2 is a view similar to Fig. 1, of a somewhat modified form of the assembly, in which the tanks and certain elements are foreshortened, and

Fig. 3 is a diagram to show the valve actuating means including the heating control valve, and a temperature and/or pressure responsive instrument shown as of hydraulic-column type and subjected to the heated liquid such as water.

Referring now by characters of reference to the drawing, in a preferred stationary assembly there is provided an assembly of three tanks, each of which may be of a generally cylindrical form, the tanks being of graduated diameter, as will appear. The outermost tank, generally indicated at 10, includes a cylindrical body 11, a bottom 12 and a head 13; the head is characterized by a large opening or port at its top from which extends a cylindrical flange 14 surmounted by a horizontal flange 15, the latter serving to carry a detachable top closure 16. A gasket 17 and head bolts 18 complete this portion of the assembly. Depending from, and if desired formed integrally with the closure 16, is a tank 20 of intermediate diameter, serving as a steam tank as will appear, and within the tank 20 is a smallest or third tank used as a water container 21, provided with a convex top closure 22 somewhat below a correspondingly formed portion of the head 16. It will appear that there is thus formed between the cylindrical walls of tanks 20 and 21, a somewhat annular space 23. Some deviation from a true annular shaping may be desirable to provide for the location of a steam discharge pipe 24 which extends substantially the full length of the space 23, opening into the lower region of such space, and extending outwardly through the head 16.

A water supply pipe 25 connected, for example, to city mains or other suitable source of water under pressure, is shown as extending upwardly through the bottom 12 of tank 10 and substantially through the full height of the innermost or water tank 21, the upper end of the pipe 25 being open. As will appear, the innermost tank 21 is open fully across its lowermost end, so that the liquid within tank 21 may circulate freely from such open end into the tank 10 for storage. Discharge from tank 10 to the place of utilization is provided for by a connection or fitting 26.

A steam supply pipe, connected for example to a suitable commercial steam line or boiler system (not shown), is indicated at 30, and in the example of Fig. 1, is threaded into a T fitting 31, whence the steam supply is directed as through an intervening nipple or connection, into the head space between elements 22 and 16, thence into the annular space 23 in heat exchange relation with the water in the innermost tank 21. It is here parenthetically noted that in the present description and claims, usage of the terms, "steam" and "water" is in an exemplifying sense without restriction to these fluids per se, condensable fluids other than steam, and heated liquids other than water, being also distinctly within the purview of the improvements.

Brief reference was heretofore made to the steam discharge line or pipe 24, directed from the bottom, or one end, of the annular space 23. This line, as noted, extends upwardly in the drawing, and connects into a T fitting 32 beyond which the line 24 is continued in a section 33 of suitable length, thence into a condensate evacuation unit such as a steam trap 34 which is vented as by a line 35 to atmosphere or otherwise as desired. The trap 34 may be of any suitable type or form, and since it constitutes of itself no part of the present improvements apart from combination, no detailed description thereof is felt necessary. It is greatly preferred in connection with the present improvements to locate trap 34 in an upper portion of the assembly, usually at the highest level of that portion of the system illustrated, being in a vertical assembly as disclosed, at the top of the unit substantially as shown, or in any case, distinctly above the steam drum, coil, jacket or the like.

Of importance in the present arrangement is the provision of a by-pass line 40 which is conveniently located as shown, between and interconnecting the T's 31 and 32. This provides under certain conditions, as will appear, an auxiliary path of steam flow directly from the supply line 30 to line 33, thence to trap 34, without however barring or obstructing the main steam heating line through and including fitting 31, space 23 and line 24.

Disposed by preference in the by-pass line 40 is a motor valve, which may be any suitable form of power-actuated valve, preferably subject to automatic controls to be described, the valve assembly proper being indicated at 41. Numerous types of such valves are well known and available to the trade, hence the specific structure of this valve forming of itself, no part of the present improvements, need not be described in detail. Such assemblies usually embody a reciprocal valve element which is actuated either directly by a diaphragm 45 or equivalent or responsively to movement of such an element, and includes a housing 42 for the dia-

phragm and spring. The valve assembly 41—42 is shown as connected through a suitable length of flexible tubing 43 to a feeler bulb, thermostat or similar unit 44, and which is detachably threaded into the top closure 13 of the structure of Fig. 1, the feeler portion of the unit preferably extending a substantial distance into the storage liquid in tank 10.

In contemplation of the usual installation of an assembly of the type shown by Fig. 1, into a commercial steam supply line, there is advantageously provided an element shown as an apertured insert 46, characterized by a relatively small opening or passage, or a plurality thereof, so as desirably to throttle the input volume of steam supplied to the unit and to restrict such supply to a rate of flow which, upon opening of a safety relief valve 47, will enable, in case of steam chamber rupture, the resulting flow of fluid to be safely disposed of. It is advisable that the passage in element 46 be adequate to supply maximum steam requirements.

The present assembly departs considerably from conventional practice in which a steam control valve is opened to admit steam to a coil, drum or the like, surrounded by or enclosing a volume of water. The converse is true, with advantages later appearing, in the present arrangement. The portion of the cycle during which the major heating effect occurs, is coincident with closing of the valve 41, thus obstructing the by-pass 40 and resulting in a flow of steam via line 30, fitting 31, space 23 and line 24—33, to the trap, with some pressure drop across the steam space 23.

Condensate accumulating in space 23 will be expelled, either currently or after some minor accumulation, through line 24 into the trap, hence out through drain line 35. In this heating portion of the cycle, there will occur a minor pressure drop between line 30 and line 33, for example. When, however, the water heated in the inner tank 21, having been displaced into the outer storage space in tank 10, attains a predetermined temperature, and the fluid in thermal element 44 and line 43 expands to a predetermined extent, movement of the diaphragm against the spring serves to open and steam is supplied at substantially equal pressures through the two branches at opposite ends of the coil or drum identified with space 23, at which time substantially a zero pressure differential exists across this steam heating space. It will now have appeared that steam is supplied at substantially equal pressures both to the head end of the space for steam between elements 22 and 16, and to the opposite end of the annular space, through the by-pass 40 and line 24. During this period condensate will accumulate in and flood the space 23, thus precluding entrance of further steam and the heat from such condensate continues for some time in thermal exchange relation with the water interiorly of tank 21. Thus the heated condensate is substantially utilized, in distinction from many other less efficient types of steam-liquid heaters in which it is blown from the heating space as soon as supply is cut off. Since such accumulation of condensate will remain in situ until such time as the element 44 again calls for heat, the thermal values of this body of condensate are substantially fully realized upon, and the body of condensate itself form a steam shut-off agency.

It is important to be noted that when the power

5

valve 41 is opened, its valve element is not subjected to adverse pressure effects. Similarly, when it is closed, because of the location of by-pass 40 in the steam circuit, the pressure differential across the valve is extremely low; in fact, there may under most conditions be no difference discernible by usual gauge tests. It now becomes fully clear that this facility enables the use of a smaller, less expensive valve unit, and minimizes the power requirement for its actuation.

The modified arrangement shown by Fig. 2 is very similar both in structure and function, to that shown by Fig. 1, minor differences however being noted in the provision of a water inlet line directly into the storage space of the outer tank, and in some differences in the innermost water container, the latter in the modification being provided with a bottom closure 21B and having a top opening 21C. The steam flow remains essentially the same as in Fig. 1, and in the showing of Fig. 2, all generally corresponding elements are numbered similarly to those of Fig. 1, but with the addition of the suffix letter A. In the modification, the description of steam flow applicable to Fig. 1, is adapted as to Fig. 2, without change. Something of a difference exists however in the function of the water circuit. As noted, direct flow, say from city mains, is introduced through the fitting 25A and upon being heated in the tank 10A, is directed to the point of utilization through the fitting 26A. In this arrangement the innermost tank 21A will remain virtually filled with condensate at all times, overflow from the top opening occasionally taking place into the annular space 23A, thence outward through the steam discharge line 24A. The space 23A will at times become filled, or partly so, with condensate, but will be cleared thereof or substantially so, during the next heating portion of the cycle. Virtually the same advantages noted in connection with Fig. 1, in general arrangement, prevail also as to Fig. 2. In either arrangement, the detachable head structure carrying the major circulating and control elements, is readily removed and replaced as an assembled unit.

To the end of minimized description, reference has been made to a vertical arrangement of tanks, and in some cases to "top" or "bottom" of containers or lines, without however any intended restriction to any specific space arrangement of the elements, since the essential advantages will prevail in a horizontal or other disposition of parts, but with preference in all cases that the trap 34 or 34A, be located above those portions of the system normally filling with condensate during the inactive portion of the cycle.

Further note should be made of particular advantages of the arrangement exemplified currently by the proportion and relation of the tank elements 20 and 21 forming the narrow annular steam-condensate space 23 therebetween. These elements are so proportioned as to provide only the minimum volume of space necessary to pass the requisite amount of steam. This arrangement presents an advantage of a substantial steam heating surface in proportion to volume of liquid to be heated; the minimization of the volume of this steam space reduces override, and results in a steam space which floods up quickly during less active or inactive portions of the cycle, and upon resumption of the more active working portions of the cycle, clears quickly of condensate.

Although illustrated as embodied in a storage type of heater, it should be noted that the gen-

6

eral arrangement may be employed without direct combination with specific storage facilities, and thus may be employed equally well, in heaters of so-called instantaneous type.

It should further be noted that, although the description of operation has heretofore referred principally to an "on" and "off" control, the arrangement lends itself without change, to a so-called modulating control operation, it now being obvious that the column of liquid in elements 42, 43 and 44 may actuate the valve through various intermediate positions between full-closed and full-open limits.

Although the improvements have thus far been embodied principally in installations for the heating of water by steam as the heating medium, it is of course now apparent that it is equally applicable, as in certain processing techniques, to the heating of fluids generally, not being solely restricted as to fields of usage, to water heaters.

Although the improvements have been described by making detailed reference to but a few possible embodiments, this detail of explanation is to be understood solely in an instructive, and not in a limiting sense, because of the numerous variants possible within the scope of the claims hereunto appended.

I claim as my invention:

1. In a water heater of the type utilizing steam as a heating medium, a steam supply line, a steam tank supplied from said line, an inner tank within the steam tank forming therewith a restricted, quickly flooded space for steam surrounding the inner tank, a steam discharge line extending substantially the length of the steam space, a trap in the steam discharge line, the trap being located at a distinctly higher level than the steam space, a by-pass connection between the steam supply line and the steam discharge line ahead of said trap, a power valve in said by-pass and beyond the steam supply line, and means for actuating the valve toward open position to reduce the rate of flow from the steam supply line through the steam discharge line into the trap.

2. In a water heater of a type utilizing steam as a heating medium, a water storage tank for the water after heating, a steam tank extending into the storage tank, a water heating tank within the steam tank; and spaced inwardly of the walls of the latter so as to form a restricted steam flow space therebetween, a steam discharge line extended substantially the full length of the steam tank, thence outwardly thereof, a trap into which the discharge line is connected, a by-pass connection between the steam supply line and steam discharge line ahead of the trap, a power valve in the by-pass connection, and thermal control means adapted to effect opening actuation of said valve, to create a by-pass flow of steam to the trap, responsively to attainment of a predetermined temperature of water in the storage tank.

3. The combination and arrangement of elements as recited by claim 2, but further characterized by the addition of means associated with the steam supply line, providing a steam throttling orifice therein, and a relief valve in the storage tank operable to relieve the storage tank of excessive pressures.

4. In a water heater utilizing steam as a heating medium, a water storage tank, a removable head portion forming a closure for said tank, a double tank unit supported by said head portion and detachably mounted thereby, in the storage

7

tank, one portion of the double tank unit constituting a steam container and a second portion of the double tank unit having its walls spaced from those of the first said portion of said unit providing an annular space therebetween, a water supply pipe adapted to deliver water to one end of the double tank unit, a steam discharge pipe providing a steam takeoff from the opposite end of the companion tank of the double tank unit, a by-pass connection between the steam supply line and the said steam discharge line, a power valve in the by-pass connection, and thermal responsive means adapted to cause opening movement of said valve, responsive to increase in water temperature, and a trap located at substantially the highest point of the assembly and in the steam discharge line, beyond said by-pass line.

5. In a water heater of steam heated type, an outer tank and intermediate and inner tanks substantially within the outer tank, a water supply line to one end of the inner tank, a steam inlet line directed to the intermediate tank, a steam discharge line from the opposite end of the intermediate tank, a short by-pass line between the steam supply line and said steam discharge line, a fluid-motor valve in the by-pass line, a closed fluid system communicating with and energizing the fluid motor valve, and including a feeler portion responsive to attainment of predetermined temperature conditions in a water space of one of the tanks, to cause an opening of the valve, with reduction of rate of steam supply for heating, and a trap located to relieve condensate from both the steam heating line and the by-pass line aforesaid, and being located at a higher level than said tanks.

6. In a water heater utilizing steam as a heating medium, a water storage tank, a pair of tanks one within the other, extended into the storage tank, the water supply line extended into the tanks and opening at one end of the innermost of said paired tanks, said innermost tank constituting a water heating structure, the outer tank of said paired tank elements being spaced from the inner to form a narrow elongate steam space between the walls of the paired tanks, the innermost of said paired tanks having a top closure element and being open at its bottom end into the water storage tank, a steam discharge line from said space between the paired tank

8

walls, a steam supply line provided with a throttling orifice and opening into the uppermost end of the steam space, a short by-pass pipe between the steam supply line and the said steam discharge line, a power valve in said by-pass, a trap at substantially the highest portion of the assembly and in the steam discharge line beyond said by-pass, thermal control means responsive to temperature of the heated water, and in communication with the power valve in such relation as to cause opening actuation of said valve responsively to attainment of higher water temperatures, a discharge connection for heated water and a safety relief valve in the water storage tank.

7. In a water heater of a type utilizing steam as a heating medium, an assembly of vertically disposed, substantially cylindrical tanks including a largest water storage tank, an intermediate tank forming a steam heating space, an innermost tank within the last said tank and spaced therefrom to form a substantially annular space for heating steam around the innermost tank, the innermost tank being open at its upper end to the steam heating space, a steam discharge line extended from the bottom of the steam heating space upwardly through the top of the assembly, a steam trap in the steam discharge line and disposed in an upper zone of the assembly, a by-pass line between the steam supply line and discharge line into the trap, a motor valve in the by-pass line, thermal control and energizing means communicating with the motor valve and acting responsively to the temperature of water in the outermost of said tanks, means providing a throttling orifice in the steam supply line, and a pressure relief valve located in the outermost or storage tank.

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