Aug. 13, 1957 M. H. HOFMEISTER 2,802,629

HEAT EXCHANGER

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Fig. 1.

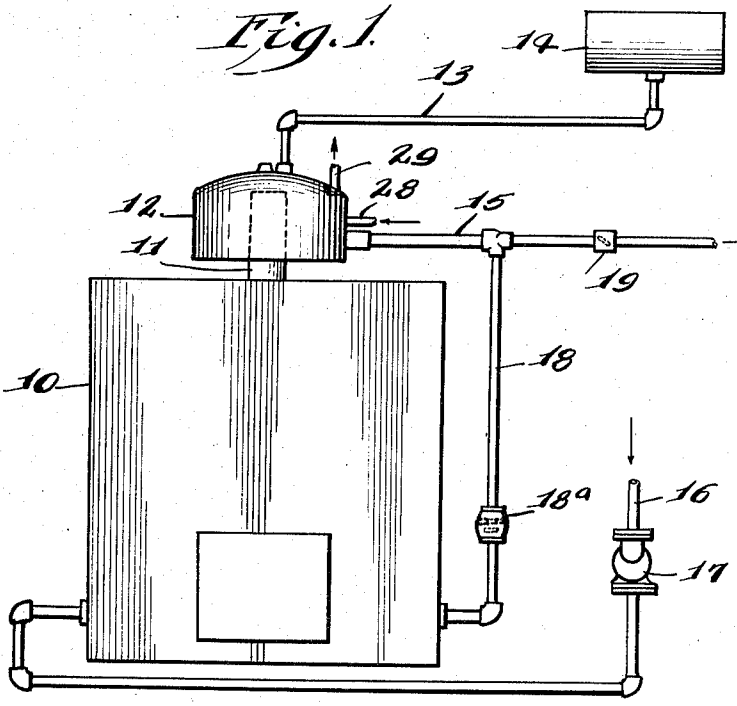
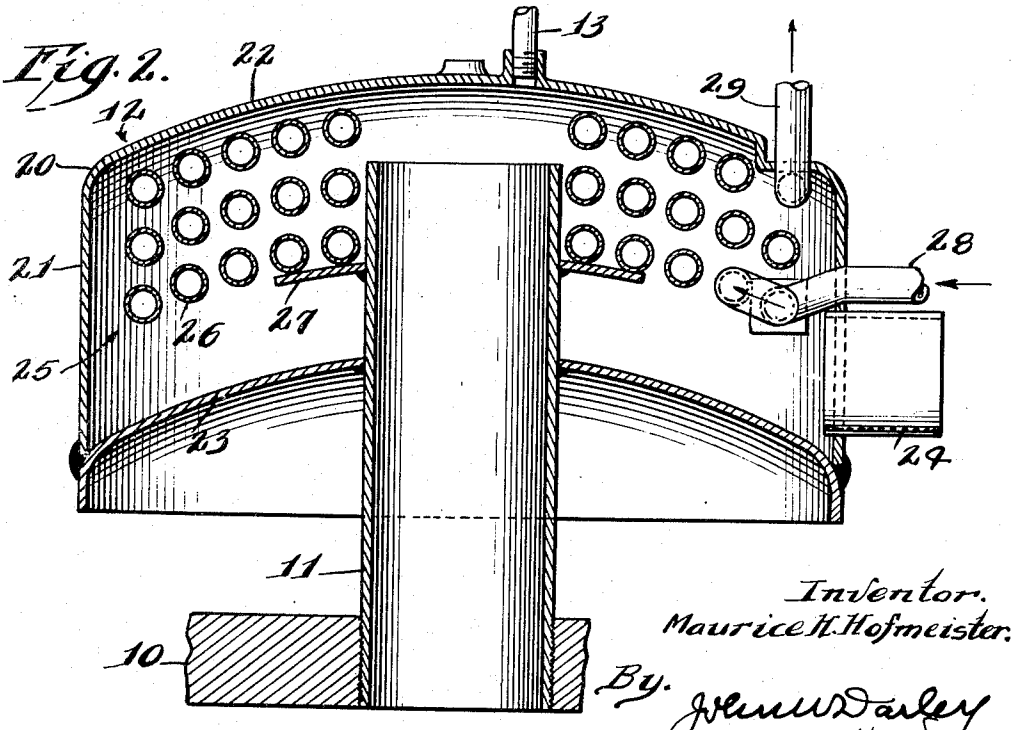


Fig. 2.



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Fig. 3.

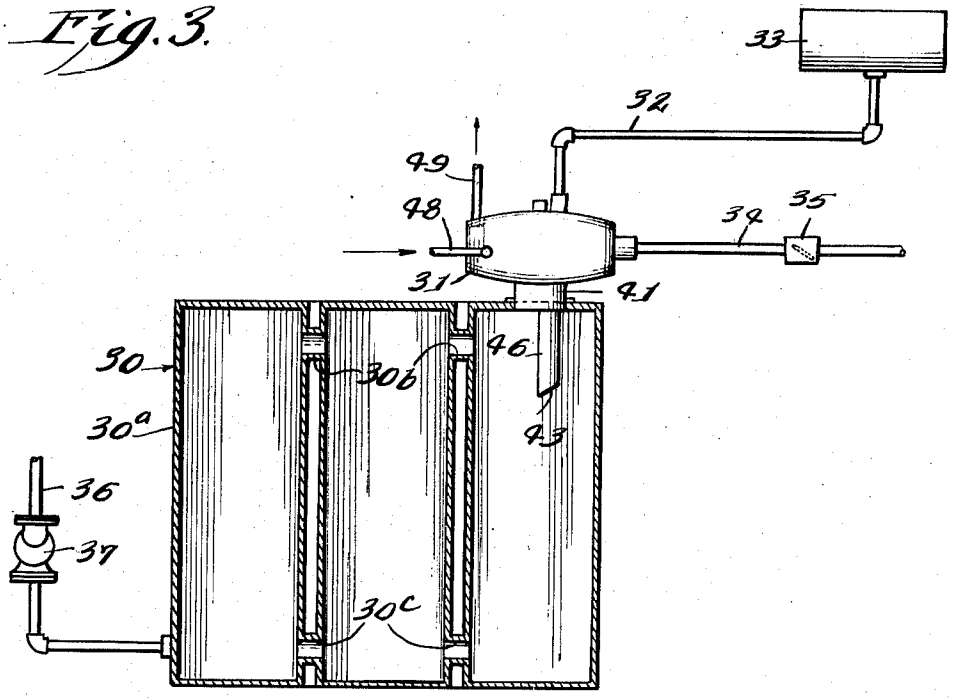


Fig. 4.

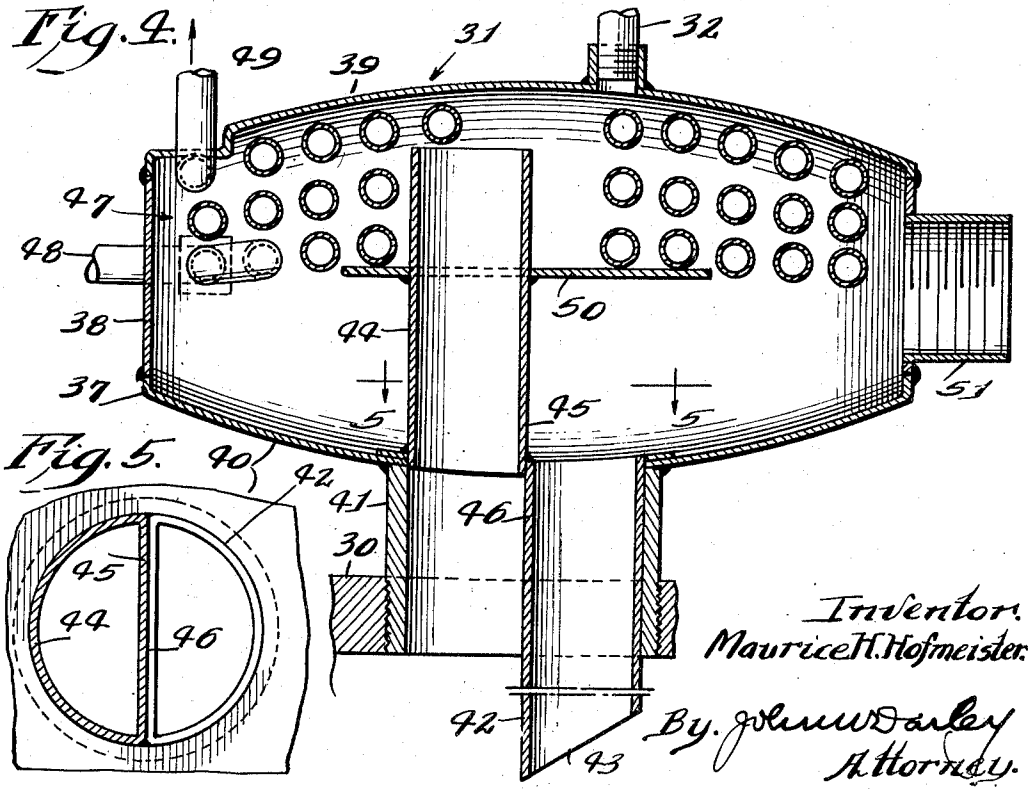


Fig. 5.

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HEAT EXCHANGER

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Fig. 6

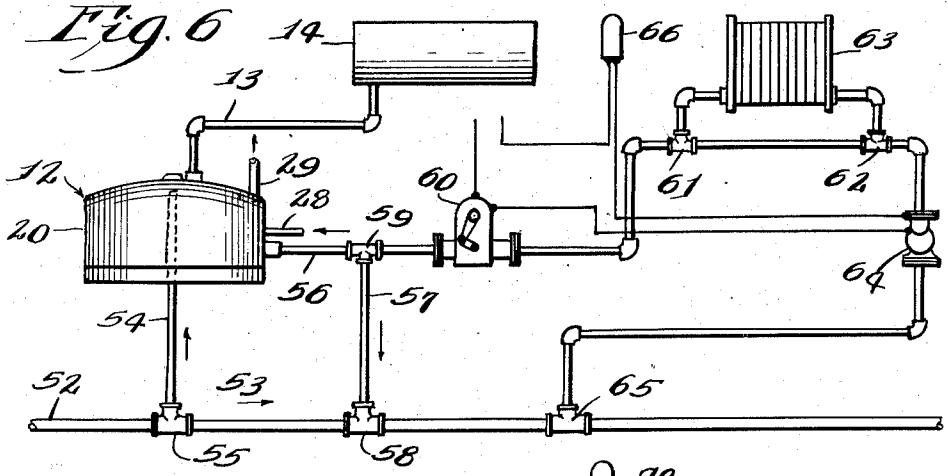
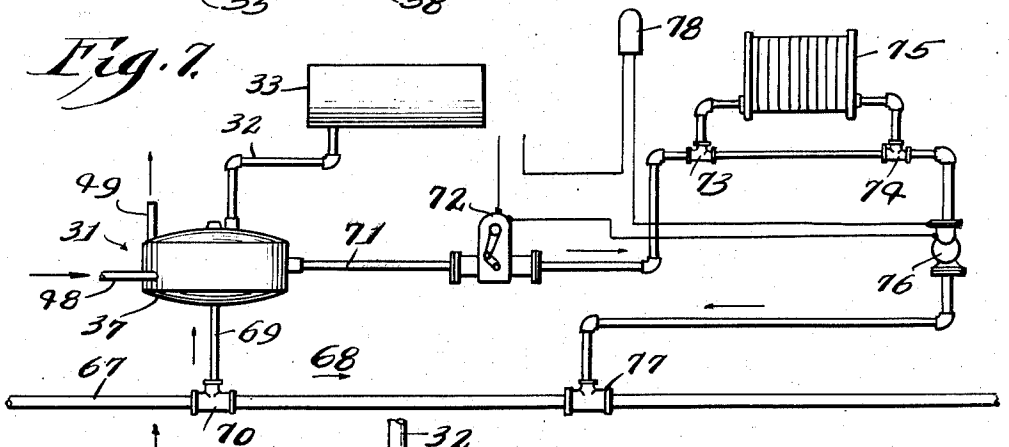


Fig. 7.



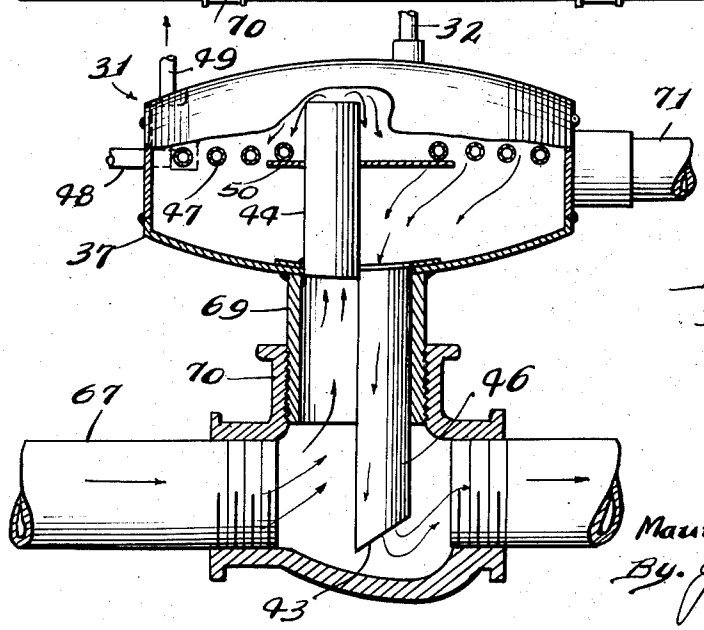


Fig. 8.

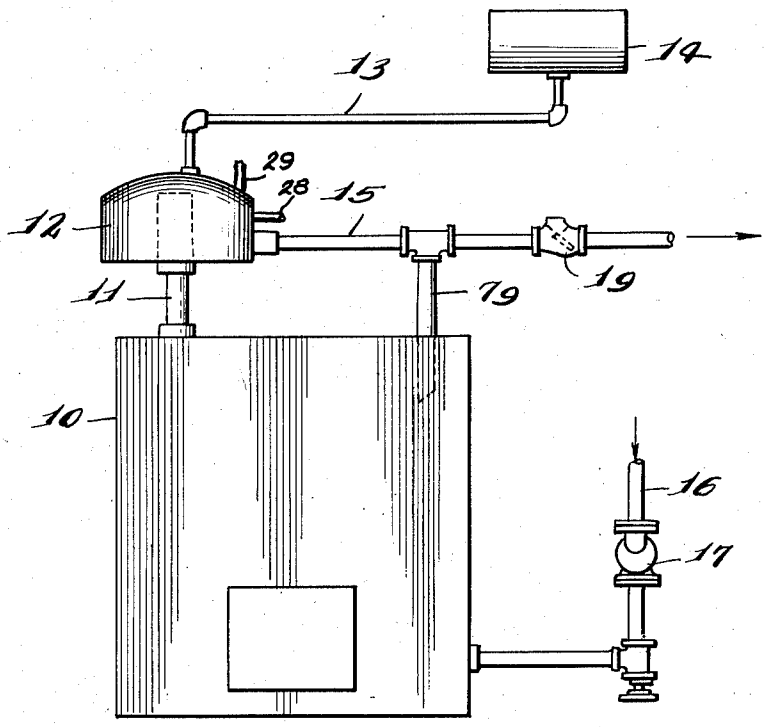
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HEAT EXCHANGER

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Fig. 9.



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United States Patent Office 2,802,629 Patented Aug. 13, 1957

2,802,629

HEAT EXCHANGER

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Application March 31, 1953, Serial No. 345,779

8 Claims. (Cl. 237—19)

My invention relates to a heat exchanger and more particularly to a unit that is specially adapted for association with a hot water source in a manner to mutually improve their respective efficiencies and of any heating system with which they may be connected.

One object of the invention is to provide a heat exchanger mounted above a hot water source, such as a boiler or a hot water supply pipe and connected thereto to improve the circulatory flow between the source and exchanger and therefore the rate of heat exchange between the exchanger coil and the water in the exchanger casing.

A further object is to provide an arrangement of the character indicated in which the exchanger casing constitutes a low velocity zone and which, due to the manner of its connection to the hot water source, facilitates separation of air bubbles from the hot water.

These and further objects of the invention will be set forth in the following specification, reference being had to the accompanying drawings, and the novel means by which said objects are effectuated will be definitely pointed out in the claims.

In the drawings:

Fig. 1 is a schematic view of a hot water boiler forming part of a heating system and showing one form of my improved heat exchanger connected thereto.

Fig. 2 is an enlarged, sectional elevation of the exchanger shown in Fig. 1.

Fig. 3 is a diagrammatic view, partly in section, of a hot water boiler showing a modified type of heat exchanger connected thereto.

Fig. 4 is an enlarged, sectional elevation of the exchanger shown in Fig. 3.

Fig. 5 is a section along the line 5—5 in Fig. 4.

Fig. 6 is a diagrammatic view of one zone of a heating system and incorporating for the particular zone the heat exchanger illustrated in Fig. 2.

Fig. 7 is also a diagrammatic view of one zone of a heating system including in the zone the heat exchanger shown in Fig. 4.

Fig. 8 is an enlarged, fragmentary and sectional view of the connection between the exchanger and hot water supply pipe in Fig. 7.

Fig. 9 is a variant form of the Fig. 1 arrangement.

Referring to Fig. 1, the numeral 10 designates a conventional hot water boiler which may be fired in any appropriate manner. The boiler is intended to be representative of any hot water reservoir and therefore inclusive of boilers as such, and also of a hot water pipe in the zone systems shown in Figs. 6 and 7. Mounted on the top of the boiler and communicating therewith by a vertical inlet pipe 11 is a heat exchanger 12 whose upper portion connects by a pipe 13 with an expansion tank 14 of standard type. Leading from the lower part of the exchanger 12 is a supply or outlet pipe 15 that connects with any desired number of radiators (not shown) forming a characteristic heating system. The return from the radiators flows through a pipe 16 which includes a conventional circulating pump 17 to the lower part of the boiler 10. Local, thermogravitational circulation between the boiler 10 and heat exchanger 12 when the pump is not operating is provided by a pipe 18 whose opposite ends are respectively connected to the lower part of the boiler 10 and to the supply pipe 15 which beyond the connection of the pipe 18 thereto in the direction of flow includes a flow control valve 19 that is gravity biased to closed and pump actuated to an open position.

The heat exchanger 12 is more particularly illustrated in Fig. 2 to which reference will now be made. The exchanger includes a casing 20 composed of an annular shell 21 whose upper end is closed by an upwardly convex, top wall 22, preferably integral with the wall 21, while the lower end is closed by a similarly shaped, bottom wall 23 which is welded to the shell 21. The lower end of the pipe 11 is threaded in the top wall of the boiler 10 while its upper end extends through the central portion of the wall 23, is welded thereto, and terminates short of the wall 22, the spacing therefrom being sufficient to insure free flow of the water from the pipe 11 into the casing 20. A nipple 24 is threaded in the shell 21 close to the bottom wall 23 for connection with the supply pipe 15.

A continuous, pan cake type and slightly dished coil 25 composed of a plurality of stacked, spirally wound, tubular components 26, three such being shown in Fig. 2, is located within the casing 20 and close to the top wall 22. The coil 25 is preferably composed of finned tubing and is concentric with the pipe 11 which extends partly through the stacked assembly, and carried by the pipe 11 is an annulus 27 which provides a support for the coil. One end of the coil extends through the shell 21 for connection to a cold water supply and the other end extends through the top wall 22 for connection with service outlets.

The temperature of the water in the boiler 10 is maintained as close to a determined value as possible and when the pump 17 is not operating, there is a free, thermogravitational flow in the circuit including the boiler 10, heat exchanger 12 and pipes 15 and 18, and when the pump is running, the flow through the foregoing circuit is maintained in addition to a flow through the main heating system, the valve 19 then being open. Preferably, the pipe 18 includes a check valve 18a of conventional type which is gravity biased to open position and closed by pump pressure so that when the pump 17 is running, all water flows through the boiler 10. Whatever the nature of the flow through the casing 20, it will be noted that water flowing out of the upper end of the pipe 11 is baffled by the support annulus 27 to spread laterally across the coil 25 in its descent to the bottom of the casing 20 and that the nipple 24 is disposed below the coil 25, thus insuring full heat exchange relation between the coil and the water in the casing.

Since the casing 20 is disposed immediately above the boiler, the coil 25 is continuously bathed by the hottest water flowing from the boiler. Sufficient heating surface is included in the coil to class the heat exchanger 12 as being of the instantaneous type, i. e., cold water entering the coil through the pipe 28 is discharged through the pipe 29 with a temperature sufficiently high for service purposes. In a typical design wherein the diameter of the casing 20 was 13" with a depth of 8" and the coil 25 comprised 33' of ½" inside diameter copper tubing, the heat exchanger delivered water with a temperature of about 150° F. at the rate of about five gallons per minute, the cold and boiler water temperatures being of the order of 50° F. and 200° F., respectively.

Referring to Figs. 3, 4 and 5 which illustrate a modified form of heat exchanger and its relation to a boiler and considering Fig. 3, the numeral 30 designates

a sectional type, hot water boiler including sections 30[a] which are flow connected by upper and lower nipples 30[b] and 30[c], although the precise boiler construction is unimportant, and which is fired in any desired manner. Mounted above the boiler is a heat exchanger 31 which is circulatingly connected to the boiler by means more particularly shown in Fig. 4 and which will be hereinafter described. Communicating with the upper portion of the exchanger 31 is a pipe 32 that is connected to a conventional expansion tank 33 and leading from the side of the exchanger is a supply or outlet pipe 34 that connects with radiators (not shown) and which preferably includes a flow control valve 35, similar to the valve 19. The return from the radiators is conducted through a pipe 36, which includes a circulating pump 37, to the lower portion of the boiler 10.

The heat exchanger detail is more particularly shown in Fig. 4 to which reference will now be made. It includes a casing 37 composed of an annular shell 38 and dome-shaped walls 39 and 40 which are convex in opposite directions and are respectively welded to and close the upper and lower ends of the shell 38. Depending from the central portion of the wall 40 and welded thereto is a short length of pipe 41 whose lower end is threaded in the top wall of the boiler 30 and serves as a support for the casing 37.

Mounted within the pipe 41 and suitably supported from the casing wall 40 is a semicylindrical, outlet pipe 42 which extends vertically downward within the boiler 30 for a distance that will depend upon the construction of the boiler, about six inches being an optimum figure. The lower end of the pipe 42 is preferably beveled as at 43 to insure that this end will not be closed by contact with any interior wall in the boiler, such as one that encloses a flue passage. A second, semicylindrical pipe 44 extends vertically upward from the wall 40 with the lower end of its flat side 45 in abutting relation to the upper end of the flat side 46 on the pipe 42. The pipe 44 functions as a continuation of that portion of the pipe 41 which is not occupied by the pipe 42 and the upper end of the pipe 44 terminates short of the casing wall 39 for the same reasons as expressed in connection with the pipe 11. Hence, the pipe 44 constitutes an inlet pipe leading from the boiler to the casing 37.

A continuous coil 47 composed of stacked, tubular components, similar to the coil 25, is mounted in the upper part of the casing 37 in concentric relation to the casing and connects externally thereof with a cold water supply pipe 48 and a hot water delivery pipe 49. To support the coil 47 in its upper position, an annulus 50 is welded to the inlet pipe 41 and on which the lower component of the coil 47 rests. A nipple 51 extends transversely from the shell 38 for connection with the supply pipe 34 and the lower component of the coil 47 is preferably disposed above the center line of this nipple.

When the pump 37 is not operating, there is a free, thermogravitational flow upwardly from the boiler 30 through the pipe 44 to the upper portion of the casing 37, and thence laterally and downwardly over the coil 47 to the outlet pipe 42 for return to the boiler well below its upper wall. With the pump 37 running, the above circulation is maintained in addition to a flow through the heating system including the supply or second outlet and return pipes 34 and 36, respectively, the flow control valve 35 then being open. During both kinds of flow, the annulus 50 exercises a baffling action in lateral directions so that the hot water flows in intimate heat exchange relation to the components of the coil 47. With the same sizes and temperatures as expressed for the heat exchanger 12, the exchanger 31 is characterized by slightly less capacity.

In either type of heat exchanger, the coil is located in the zone of highest water temperature so that it is possible to establish maximum heat exchange with the cold water flowing through the coil. Coupled with this aspect is the controlled directional flow between the exchanger casing and boiler which insures that the part of the flow circuit in the region of the coil is always active for heat transfer and that there are not any stationary or dead parts in this circuit. This improved circulation not only materially increases the efficiency of the boiler, but it has been ascertained that, compared to prior types of heat exchangers, the same results can be secured with as much as a 30% reduction in the heating surface of the coil.

Further, with both exchangers, it will be noted that each casing constitutes a low velocity zone, either in relation to local circulation with the boiler or as a part of the supply line leading to the radiators. Accordingly, air bubbles rising with the hot water from the boiler have an opportunity to freely separate in the exchanger casing for collection in the expansion tank.

Preferably, when the sectional boiler 30 is used as shown in Fig. 3, the heat exchanger 31 is mounted above the right section 30[a] so that water flowing through the adjacent upper nipple 30[b] can move directly to the pipe 41 without being baffled by the downwardly extending pipe 42.

In Figs. 6 to 8, there are illustrated suggested adaptations of the heat exchangers 12 and 31 to the zone type of heating system wherein a plurality of such zone systems, each being individually controlled, are connected to a hot water source, such as a supply pipe that is common to all of the systems. A characteristic use of zone systems is exemplified in apartment houses where each apartment is serviced by one of the zones. Parts in Figs. 6 to 8 which are identical in function with those shown in Figs. 1 to 4 are designated by like numerals.

Referring to Fig. 6, the numeral 52 indicates a hot water supply pipe which is connected to any heat reservoir, such as a hot water boiler, and through which it will be assumed that the hot water flows continuously in the direction of the arrow 53.

The lower end of a vertical inlet pipe 54 is connected by a fitting 55 to the pipe 52 and its opposite end extends upwardly and coaxially within the casing 20 of the heat exchanger 12, the pipe 54 therefore corresponding to the pipe 11 in Fig. 2. Also as in Fig. 1, the pipe 13 leads from the upper part of the casing 20 to the expansion tank 14 and cold water supply and hot water delivery pipes 28 and 29, respectively, connect with the coil 25 (not shown in Fig. 6). An outlet pipe 56, corresponding to the pipe 15 in Fig. 1, extends laterally from the casing 20 and a pipe 57 is bridged between the pipes 52 and 56 and connected thereto by fittings 58 and 59, respectively. The pipe 56 continues beyond the fitting 59 and includes in order a motor operated valve 60, spaced fittings 61 and 62 which provide connection between a radiator 63 and the pipe 56, a motor driven pump 64, and a fitting 65 which connects the pipe 56 with the pipe 52 beyond the fitting 58 in the direction of flow.

Since the above circuit is of the one-pipe type, the fittings 55, 58, 61, 62 and 65 are preferably arranged in accordance with the disclosure in United States Letters Patent No. 1,663,271, dated March 20, 1928, to insure adequate flow. Further, the circuit constitutes a zone heating system, of which there may be several that are serviced by the supply pipe 52, and the motor operated valve 60 and the motor of the pump 64 are electrically connected in the manner well known with a room thermostat 66 that is responsive to the heat demands of the space with which the radiator 63 is associated. Accordingly, when the thermostat 66 demands heat, the valve 60 opens and the pump 64 begins operation so that hot water courses through the radiator 63. The intake of this flow

is at the fitting 55, and from thence the water flows through the heat exchanger 12 to thereby provide hot service water for the space associated with the radiator, and through the valve 60 and radiator 63 to the fitting 65. If desired, a flow control valve of the type which is gravity biased to closure and opened by pump pressure may be substituted for the valve 60.

When the pump 64 is not running and the valve 60 therefore closed, there is a local, thermogravitational circulation upwardly through the pipe 54 to the exchanger casing 20 and thence through the pipes 56 and 57 to the pipe 52, thus insuring hot service water under this condition. During either flow, air is tapped from the casing 20 to thereby free the zone system of air blockage.

Referring to Figs. 7 and 8, the numeral 67 designates a hot water supply pipe through which hot water flows continuously in the direction of the arrow 68. The lower end of a vertical pipe 69 is threaded in a T fitting 70 that is included in the pipe 67 and its upper end is secured to the lower end of the heat exchanger casing 37 (see Fig. 8). The vertical inlet and outlet pipes 44 and 46 are related to the casing 37, the coil 47, and the pipe 69 in the manner shown in Fig. 8 which is identical with that illustrated in Fig. 4, with the exception that the lower end of the outlet pipe 46 terminates just short of the bottom wall of the fitting 70 and is beveled at 43 for the reason noted above.

A second outlet pipe 71 extends laterally from the side wall of the casing 37 for connection to the zone heating system which includes in order a motor operated valve 72, spaced fittings 73 and 74 which connect with a radiator 75, a motor driven pump 76, and a fitting 77 providing a terminal connection of the pipe 71 with the pipe 67 beyond the fitting 70 in the direction of flow. The fittings 73, 74 and 77 are preferably of the type disclosed in the above noted patent and the valve 72 and the motor of the pump 76 are electrically connected in a circuit including a thermostat 78.

When the space serviced by the radiator 75 influences the thermostat 78 to demand heat, there is a pump induced flow through the circuit shown in Fig. 7 beginning at the fitting 70 and thence upwardly through the pipes 69 and 44, through the casing 37, pipe 71, the valve 72 being open, and through the radiator 75 to the fitting 77 and pipe 67. When the pump 76 is not running, there is a local, thermogravitational flow upwardly through the pipes 69 and 44 to the casing 37 and thence downwardly through the pipe 46 to the bottom portion of the fitting 70.

During either kind of flow, cold water entering the coil 47 through the pipe 48 is discharged as hot water through the pipe 49 and air freed in the casing 37 passes through the pipe 32 to the expansion tank 33.

From the foregoing, it will be understood that in a heating system including several zone heating circuits, there would be provided for each such circuit either the heat exchanger 12 or 31 connected as shown in Figs. 6 or 7, respectively.

In Fig. 9 is illustrated a variation of the boiler-heat exchanger structure shown in Fig. 1 and wherein parts in the former figure which are identical with those in the latter figure are identified by the same numerals.

The only difference between Figs. 1 and 9 resides in the manner of providing for local circulation when the pump 17 is not operating. A pipe 79 is bridged between the supply pipe 15 on the inlet side of the flow control valve 19 and the upper portion of the boiler 10, the boiler end of the pipe 79 extending below the top wall of the boiler a distance comparable to that indicated for the pipe 42 in Fig. 4.

Hence, when the pump 16 is not running, the thermogravitational circulation is upwardly through the pipe 11 to the heat exchanger 12 and thence through the pipes 15 and 79 to the boiler. During pump operation, the water moving upwardly in the boiler flows through the pipes 11 and 79 to the supply pipe 15.

I claim:

1. The combination of a hot water reservoir, and a heat exchanger including a casing positioned above the reservoir, first pipe means communicating the casing with the reservoir and extending upwardly within and terminating short of the upper part of the casing whereby the hotter water rises to the casing, a coil positioned within the casing around the first pipe means, baffle means carried by the first pipe means in encircling and transverse relation thereto for laterally directing across the coil fluid issuing from the upper end of the first pipe means and having support contact with the bottom portion of the coil around the first pipe means, and second pipe means providing return circulation from the casing to the reservoir.

2. The combination of a hot water reservoir, and a heat exchanger including a casing positioned above the reservoir, first pipe means communicating the casing with the reservoir and extending upwardly within and terminating short of the upper part of the casing whereby the hotter water rises to the casing, a coil positioned within the casing around the first pipe means, baffle means carried by the first pipe means in encircling and transverse relation thereto for laterally directing across the coil fluid issuing from the upper end of the first pipe means and having support contact with the bottom portion of the coil around the first pipe means, and second pipe means providing return circulation from the casing to the reservoir and having its casing connected end disposed below the coil.

3. The combination of a hot water reservoir, and a heat exchanger including a casing positioned above the reservoir and having top and bottom walls, a vertical inlet pipe communicating at its lower end with the upper part of the reservoir and extending upwardly from the bottom wall and terminating close to the top wall whereby the hotter water rises to the casing, a vertical outlet pipe depending from the bottom wall for a substantial distance within the reservoir and providing for return circulation from the casing to the reservoir, a coil located in the upper part of the casing around the inlet pipe, and baffle means carried by the inlet pipe in encircling and transverse relation thereto for laterally directing across the coil fluid issuing from the upper end of the inlet pipe and having support contact with the bottom portion of the coil around the inlet pipe.

4. In a hot water heating system, the combination of a main hot water supply pipe, a heat exchanger including a casing positioned above the supply pipe, first pipe means communicating with the supply pipe and extending upwardly within and terminating short of the upper part of the casing whereby the hotter water rises to the casing, a coil positioned within the casing around the pipe and having a cold water inlet and a hot water outlet, baffle means carried by the first pipe means for supporting and laterally directing across the coil water issuing from the upper end of the first pipe means, an expansion tank connected to the upper part of the casing, a zone type heating system including second pipe means extending from the casing below the coil to the supply pipe beyond the connection of the first pipe means thereto in the direction of flow, a radiator, and a flow control valve and pump responsive to the demand for heat of the space associated with the radiator, and a pipe bridged between the supply pipe and second pipe means for providing local flow through the casing when the pump is not running.

5. In a hot water heating system, the combination of a main hot water supply pipe, a heat exchanger including a casing positioned above the supply pipe and having top and bottom walls, a vertical inlet pipe communicating at its lower end with the upper part of the supply pipe and extending upwardly from the bottom wall and terminating close to the top wall of the casing whereby the hotter water rises to the casing, a vertical outlet pipe depending from the bottom wall almost to the bottom of the supply

pipe, a coil positioned in the upper part of the casing around the inlet pipe and having a cold water inlet and a hot water outlet, baffle means carried by the inlet pipe for supporting and laterally directing across the coil water issuing from the upper end of the inlet pipe, an expansion tank connected to the top wall of the casing, and a zone type heating system including a second outlet pipe extending from the casing below the coil to the supply pipe beyond the connection of the inlet pipe thereto in the direction of flow and including a radiator, and a flow control valve and pump responsive to the demand for heat of the space associated with the radiator, the vertical inlet and outlet pipes providing local circulation through the casing when the pump is not running.

6. A heat exchanger comprising a casing including bottom and top walls, a vertical inlet pipe extending through the bottom wall and having its delivery end terminating within the casing short of the top wall, an outlet for the casing, a coil positioned within the casing around the inlet pipe, and a baffle carried by the inlet pipe in encircling and transverse relation thereto for laterally directing across the coil fluid issuing from the delivery end of the pipe and having support contact with the bottom portion of the coil around the inlet pipe.

7. A heat exchanger comprising a casing having bottom and top walls and a connecting wall, a vertical inlet pipe extending through the bottom wall and having its delivery end terminating within the casing short of the top wall, an outlet in the connecting wall, a coil positioned within the casing around the inlet pipe with its major portion disposed above the outlet, and a baffle carried by the inlet pipe in encircling and transverse relation thereto for laterally directing across the coil fluid issuing from the delivery end of the inlet pipe and having support contact with the bottom portion of the coil around the inlet pipe.

8. A heat exchanger comprising a casing including bottom and top walls, a vertical inlet pipe extending through the bottom wall and having its delivery end terminating within the casing short of the top wall, a vertical outlet pipe depending from the bottom wall and having its upper end in juxtaposed relation to the lower end of the inlet pipe at its junction with the bottom wall, a coil positioned within the casing around the inlet pipe, and a baffle carried by the inlet pipe in encircling and transverse relation thereto for laterally directing across the coil fluid issuing from the delivery end of the inlet pipe and having support contact with the bottom portion of the coil around the inlet pipe.

References Cited in the file of this patent

UNITED STATES PATENTS

404,512	Vail	June 4, 1889
1,328,259	Barbet	Jan. 20, 1920
1,344,381	Coen	June 22, 1920
1,649,482	Metzger et al.	Nov. 15, 1927
1,698,456	Schneible	Jan. 8, 1929
2,290,347	Moore et al.	July 21, 1942
2,408,605	Brookes	Oct. 1, 1946