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HOT WATER DISTRIBUTION SYSTEM

5 The invention relates to a hot water distribution system for example a domestic hot water system, with a pump for secondary circulation.

10 In order to provide the immediate flow of hot water at all hot water outlets, hot water from a hot water supply (i.e. a hot water tank), is circulated at a slow speed by a circulation pump. The cooled return flow must re-enter the tank. Hitherto, this has required a special opening in the wall of the tank in its lower region. Most tanks do not have such an opening.

15 Therefore, a disadvantage of conventional circulation systems is that installation is difficult and can be done only if the tank has connectors for return flow. In addition, the installation of a circulation loop requires a check valve between the tank and the

20 pressure side of the pump. This check valve prevents the backflow of cold water to the hot water pipe, and protects the pump from a current flowing in the opposite direction opposite to the liquid conveyed by

the pump. This check valve requires a considerable initial pressure in order to open. This pressure must be provided by the pump which therefore requires a considerably larger motor than is necessary for the circulation mode itself.

An object of the present invention is to provide a hot water distribution system which includes a secondary circulation but does not require a hot water tank with specially configured openings.

Broadly stated, the invention provides a hot water distribution system including a hot water distribution line with an outlet for selectively discharging hot water; a hot water tank; means for heating water in the tank for discharge from said outlet through the distribution line; a circulation pump; a circulation line coupled to the distribution line to return water therefrom to the tank; and a coupling including at least three openings, a first of said openings being coupled to a port in the hot water tank, a second of the openings being coupled so that water from the circulation line is returned by the pump through said

port to the tank, and a third of the opening being arranged in water flow communication with the tank through said port.

5 In a first embodiment of the invention, the coupling comprises a T-fitting that forms a unit with the pump, and is connected to the hot water outlet of the tank. The connection is preferably made through a thermally insulating tube which is connected to a thin tube
10 mounted onto the inside of the main leg of the T-fitting, and its open end produces a jet directed downwardly. This jet of return flow, being cooler and therefore heavier than the hot water in the upper region of the tank, penetrates the highest hot water
15 layer, before it blends with the rest of the water in the tank. It is known that conventional check valves hinder initial filling of the system with water. The expulsion of the enclosed air is only possible, if a powerful stream of water drives the air out. For this
20 reason, the circulation lines used to date, have a significantly larger cross-section than required for the circulation of water. In this embodiment of the invention, a flooding device ensures suitable expulsion

of the air in the circulation line, because as the circulation line is initially filled with water, the air will be displaced without high water velocity. This flooding device allows reduction of the cross- section
5 of the circulation line to about 10 percent of that of the hot water distribution line. This makes it possible to use thin, manually bendable copper or plastic tubing, which can be laid parallel to the distribution line. Because of its very small diameter,
10 the tubing can be installed within the same insulating wrap.

A second embodiment of the invention places the coupling for secondary circulation on a dip tube for
15 the hot water tank. In this case, the cool return flow is guided to the lower part of the tank. This arrangement allows the installation of two pumps, one for hot water circulation, and one for cold water circulation to prevent ice build up in the coldwater
20 system.

In order that the invention may be more fully understood, the aforesaid embodiments of the invention will be described in detail by way of example with reference to the accompanying drawings in which:

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Figure 1 shows the circulation pump mounted on a T-fitting which is fixed on the hot water outlet on top of the tank,

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Figure 2 shows a unit consisting of a first pump for hot water circulation and a second for cold water circulation, fixed on a dip tube for the tank,

Figure 3 diagrammatically shows a piping system for the pump shown in Figure 2,

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Figure 4 shows an electrical circuit for the pumps shown in Figure 2, for off-periods such as night time,

Figure 5 shows the same circuit during the short period in which cold water is circulated in order to test the temperature of the water, and

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Figure 6 shows the same circuit during the period in which any ice build up is melted.

Figure 1 depicts a circulation pump and a cross-section of a vertical plane through the T-fitting. The pump comprises the pump motor 1 and the pump housing 2 with impeller 3. This pump is connected by means of tube 4 to the vertical tube 5 of the T-fitting. The T-fitting has a threaded opening 6 on top, for connection of the hot water distribution pipe. At its bottom end, the tube 5 has a union 7. This union 7 is screwed onto the outlet nipple 9 of the hot water tank 10. The circulation tube 12, made from plastic or copper, and having a considerably smaller diameter than the hot water distribution pipe, leads into the suction side of the pump housing 2. The tube 4, preferably made of stainless steel, is brazed into the outlet opening 20 of the pump 1, 2. The tube 4 extends into the tube 5 and is connected to tube 23. A ring 25 is located at the open end of the tube 4 and has a nonconcentric hole 26. The tube 4 contains a valve ball 27, whose diameter is somewhat larger than that of the hole 26. The tube 4 also contains a horizontal separating wall 28 that restricts the movement of the ball 27. In contrast to check valves, this ball 27 permits water to flow, without any pressure drop, through the tube 4,

expelling the air out of the circulation tube 12, but acts as a non-return valve for water flowing in the opposite direction to that conveyed by pump 1, 2. A thermostatic switch 30, located in the pump motor 1, switches off the pump as soon as the temperature of the water entering via the circulation tube 12 has risen to a given value; and switches it on again as soon as the water temperature in the pump 1, 2 falls below a differential of about 15°F below the desired hot water temperature. A fin 8, made preferably of copper sheet metal, extracts heat from the tube 4 so that the pump 1, 2 cools down if it is not in action. As long as the motor 1 is running, the impeller 3 produces pressure in the pump housing 2. Suction is applied to circulation tube 12. Discharge is made through the hole 26 and the tubes 4 and 23, so that the cooled circulating stream 24 is sent back into the tank 10 as a jet pointing downward. In this way, a return opening in the tank 10 is not necessary. As soon as thermostatic switch 30 switches the pump 1, 2 off, the circulation stops and the hot water piping and pump housing 2 cool off. The cycle starts again as soon as the hot water has cooled down 15°F below that of the original hot water

temperature. Tube 4 is made from thin-walled stainless steel, which has 10 times less thermal conductivity than brass piping. Therefore, a minimal amount of heat is conducted by tube 4 from the hot water flowing through tube 5. Nevertheless, tube 4 can be made from any other metal. The separating wall 28 inhibits thermal convection in tube 4; as a result, the enclosed, motionless water transports almost no heat, and the remaining low heat flux through the metal wall of tube 4 is dissipated through heat exchange fin 8.

In case several outlets, (taps and faucets) are opened at the same time, the reverse flow forces valve ball 27 into hole 26 thus preventing flow of water into the pump housing 2 opposite to the pumping direction.

As the system is initially filled with water, the outlet located furthest away from the tank 10, must be opened slightly so that the air in tube 12 can escape, filling tube 12 with water. During this initial removal of air, the valve 26, 27 stays open, permitting the filling of tube 12. For this reason, the nonconcentric hole 26 is situated high enough, so that

the valve ball 27 rises only with high through-velocity of water, and remains stationary in the shown position permitting filling of tube 12 under low velocity.

5 Figure 2A shows a T-fitting 31 which is connected by
the union 37 to the end 34 of the dip tube, which runs
vertically through the entire tank. The two arms 31a
and 31b of the T-fitting hold the two circulation pumps
32, 38, 33, 39. The pump 32 with motor 38 and timer
10 40, circulates the water in the hot water piping
through tube 41. The pump 33 with motor 39 circulates
the water in the cold water piping with the circulation
pipe 42. The hot water pump 32, 38 is equipped with a
thermostatic switch 43; the cold water pump 33, 39 has
15 a timer 44 and a thermostatic switch 45 with a sensor
46.

Figure 2B shows the T-fitting 31, without pumps, from
its side view. If several taps are open at the same
20 time, causing a considerable pressure drop within the
distribution pipes, the valve ball 47, held in the
shown position below hole 49 by a wire strap 48, is
forced into said hole 49. The cold water main 55

(Figure 3) feeds the system through nipple 50, of T-fitting 31. A second nipple 51 is connected to the cold water distribution pipe 56 (Figure 3). The thermostatic switch 43, mounted in the hot water circulation pump 32, 38, shuts the pump 32, 38 off when a prescribed water temperature (e.g. 150°F) is reached as described in Figure 1. In order to save energy by preventing heat loss, a 24-hour timer 40 interrupts hot water circulation during the night.

The timer 44 switches on the cold water pump 33, 39 for a few minutes each hour, to check for any ice formation in the system. When the temperature of the cold water stream drops below a predetermined value slightly higher than freezing temperature (e.g. 37°F), the sensor 46 of the cold water circulation pump 33, 39 closes switch 45, located in the pump housing.

Figure 3 is a flow diagram of the system in a residential house. The content of tank 10 is heated by the heating element 52. The hot water flows through pipe 53 to the water outlet 54. Circulation tube 41 leads the suction side of pump 32, 38. When pump 32,

38 sucks hot water out of tank 10 through pipe 53, the same amount of cold water will be conveyed through T-fitting 31 into the dip tube 62 and from there into the bottom region of tank 10. The cold water distribution pipe 56 is also connected to T-fitting 31 via nipple 50 (Figure 2B) and leads to water faucets 57 and 58. The ends of pipe 55, 56, 59 are connected to the ends of the circulation pipe 42, 42a, 42b, bringing the circulation water stream back to the suction side of cold water circulation pump 33, 39. As long as the cold water pump 33, 39 is in operation, the content of the pipe 55, 56, 59 will be circulated. None of this water enters tank 10. If, on the other hand, both pumps 32, 38 and 33, 39 are in operation simultaneously, a portion of the hot water circulation stream blends into the water of pipes 55, 56, 59 along with the circulating cold water from the pump 33, 39.

The function of the two pumps 32 and 33, shall be described with the aid of the circuit diagrams in Figures 4, 5, and 6.

Figure 4 shows an electrical circuit diagram. The first conductor 60a of the power grid is connected to one lead of the motor pump 32 and 33, the cycling timer 44 and the 24-hour timer 40. The second conductor 60b is connected to the other leads of the cycling timers 40 and 44, the thermostatic switch 45, and the double through switch 61. This switch 61 feeds either the second lead of the motor of pump 33 or the switch 40a of timer 40 which feeds the second lead of the motor of pump 32. Thermostatic switch 43 interrupts the operation of the motor of pump 32, when a preset temperature has been reached.

When hot water circulation is scheduled to be discontinued during certain hours of the day the 24-hour timer 40 causes the switch 40a to interrupt power to the motor of pump 32. In this position, the double through switch 61 of cycling timer 44 feeds only the hot water circulation pump 32.

In Figure 5, the double through switch 61 interrupts the power of the hot water circulator pump 32, activating the cold water pump 33 for one to three

minutes. The time span depends on the length and diameter of the cold water pipe 56 and the circulation pipe 42 (see Figure 3). The water in the pipes must circulate at least once.

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Figure 6 shows the system in the de-icing mode. The sensor 46 kicks on the switch 45 if the water temperature of the systems drops considerably below the ambient temperature of the building, indicating that
10 somewhere in the pipes, ice is starting to form. Switch 45 overrules all other switches, and causes circulation in both the cold and hot water circuits. During this phase, both the circulated cold water, brought by cold water pump 33, and part of the warm
15 water, brought by hot water pump 32, flow through nipple 51 (Figure 3), into the cold water circuit. This mixture of cold and warm water melts away any ice formed in the cold water system. Once the ice has melted, the increase in water temperature causes the
20 sensor 46 to bring the circuit back to one of the modes in Figure 4 or Figure 5.



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CLAIMS

1. A hot water distribution system including a hot water distribution line with an outlet for selectively discharging hot water; a hot water tank; means for heating water in the tank for discharge from said outlet through the distribution line; a circulation pump; a circulation line coupled to the distribution line to return water therefrom to the tank; and a coupling including at least three openings, a first of said openings being coupled to a port in the hot water tank, a second of the openings being coupled so that water from the circulation line is returned by the pump through said port to the tank, and a third of the opening being arranged in water flow communication with the tank through said port.

2. A system according to claim 1 wherein the water distribution line is coupled to said third opening whereby hot water from the tank can flow by said water flow communication through the port to said distribution line, and said coupling includes a tube extending inside the first opening into the tank and providing a



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flow path for returned water from the second opening into the tank.

5 3. A system according to claim 1 or 2 wherein the pump is mounted with its outlet coupled to said second opening and with its inlet being coupled to said circulation line.

10 4. A system according to claim 3 including a check valve between said pump and the first opening to inhibit flow from said first opening to the second opening.

15 5. A system according to claim 4 wherein the check valve comprises an orifice and a ball, and during operation of the pump, the ball lies below the centre of the orifice .

20 6. A system according to any one of claims 3 to 5 including a fin adjacent the pump outlet for dissipating heat from the coupling.



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7. A system according to any one of claims 3 to 6 including a conduit made of stainless steel extending between the pump outlet and said second opening.

5 8. A system according to claim 1 wherein the tank includes an inlet port for cold water, and an outlet port for hot water, said distribution line being coupled to the outlet port, and said coupling having its first opening coupled to said inlet port whereby
10 cold water can flow by said water flow communication from said third opening into said inlet port of the tank.

9. A system according to claim 9 including a dip
15 tube mounted on said inlet port, extending into the tank.

10. A system according to any preceding claim wherein the coupling holds both a pump for circulation
20 of warm water and a second pump for circulation of cold water.



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11. A system according to claim 10 wherein the cold water pump is controlled by a timer.

5 12. A system according to claim 10 or 11 including a thermostatic switch which runs the cold water pump as long as the water temperature stays below a predetermined temperature which is above, but close to freezing temperature.

10 13. A system according to claim 12 including a thermostatic switch which runs the warm water pump as long as the water temperature in the cold water loop stays below a predetermined temperature which is above, but close to freezing.

15 14. A system for domestic water circulation substantially as hereinbefore described with reference to Figure 1 or Figures 2 to 6 of the accompanying drawings.
