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(54) **HOT-WATER SUPPLY HEAT EXCHANGER PROVIDED WITH A MIXING VALVE, AND ADAPTOR HAVING A BUILT-IN MIXING VALVE**

(57) A hot-water supply heat exchanger having a mixing valve and a mixing valve integrated adapter are provided to facilitate control of hot water temperature with a simplified pipe structure. A hot-water supply heat exchanger comprises a heat exchange part (100), a heating water inlet (212), a heating water outlet (214), a cold water inlet (222), a hot water outlet (224), and a mixing valve (230). The heat exchange part allows heat exchange between hot water provided from a main heat exchanger (20) with cold water. The heating water inlet draws hot water into the heat exchanger. The heating water outlet discharges the hot water heat-exchanged by the heat exchanger. The cold water inlet draws the cold water into the heat exchange part. The hot water outlet discharges the cold water that is heat-exchanged with heating water in the heat exchange part. The mixing valve mixes the hot water discharged through the hot water outlet with cold water provided from the cold water inlet.

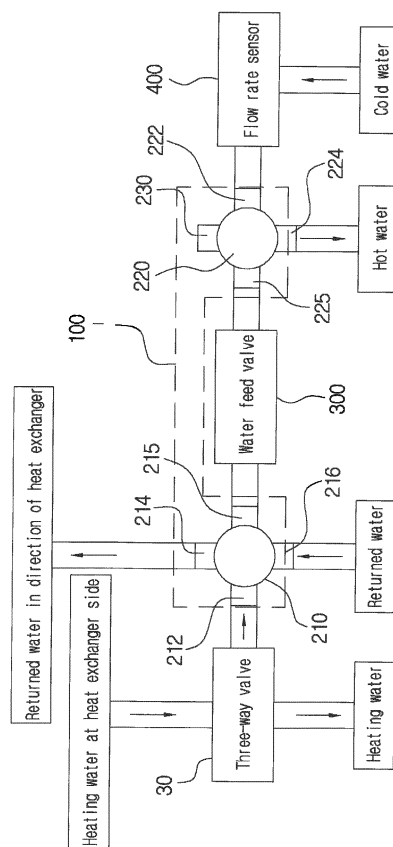


Fig. 3

Description

Technical Field

5 **[0001]** The present invention relates to a hot-water supply heat exchanger provided with a mixing valve and an adapter having a built-in mixing valve, and more particularly, to a hot-water supply heat exchanger having a mixing valve and an adapter integrated with a mixing valve capable of facilitating control of a temperature of hot water with a simplified structure.

10 *Background Art*

[0002] FIG. 1 is a diagram schematically showing a conventional heating/hot water-combined instant boiler, and FIG. 2 is a perspective view schematically showing an appearance of a conventional hot-water supply heat exchanger.

15 **[0003]** First, when a heating mode is performed, a circulation pump 10 is operated to convey heating water. The heating water is heated in a main heat exchanger 20 by combustion heat of a burner 21, and then conveyed to a place to be heated via a three-way valve 30, performing heating. Returned heating water, which is heat exchanged and cooled at the place to be heated, is conveyed to the main heat exchanger 20 via an expansion tank 50 and the circulation pump 10 to be re-heated. Reference numeral 22 represents a blower.

20 **[0004]** Meanwhile, when a hot water mode is performed, the three-way valve 30 blocks a path connected to the place to be heated and opens a path connected to a hot-water supply heat exchanger 40 to convey heating water heated in the main heat exchanger 20 to the hot-water supply heat exchanger 40. The hot-water supply heat exchanger 40 heat-exchanges cold water with the heating water to supply hot water to a place where hot water is to be used.

25 **[0005]** Referring to FIG. 2, the hot-water supply heat exchanger 40 has a structure in which a plurality of thin plates are coupled to each other in a stacked structure and heat exchange is performed between heating water and cold water in an inner space of the stacked structure.

[0006] A pipe 41 connected to the three-way valve 30 is connected to one side of the hot-water supply heat exchanger 40, i.e., an inlet side into which the heating water is introduced, and a pipe 42 connected to a heating pipe 45 through which returned heating water flows is coupled to an outlet side through which the heating water is discharged after heat exchange with the cold water.

30 **[0007]** In addition, a pipe 43 is coupled to an inlet side of the hot-water supply heat exchanger 40 into which cold water is introduced, and a pipe 44 is coupled to an outlet side through which hot water generated by heating the cold water is discharged.

35 **[0008]** The hot water heated by the hot-water supply heat exchanger is supplied to a user at a place where hot water is to be used. Here, since the hot water is directly supplied to the user immediately after being heated by the hot-water supply heat exchanger 40, it is difficult to control a temperature of the hot water.

Technical Problem

40 **[0009]** In order to solve the foregoing and/or other problems, it is an aspect of the present invention to provide hot-water supply heat exchanger provided with a mixing valve and an adapter having a built-in mixing valve capable of facilitating control of a temperature of hot water with a simplified structure.

Technical Solution

45 **[0010]** The foregoing and/or other aspects of the present invention may be achieved by providing a hot-water supply heat exchanger including a heat exchange part 100 configured to heat-exchange heating water supplied from a main heat exchanger 20 with cold water; a heating water inlet 212 configured to introduce the heating water into the heat exchange part 100; a heating water outlet 214 configured to discharge the heating water after heat exchange with the cold water in the heat exchange part 100; a cold water inlet 222 configured to introduce the cold water into the heat exchange part 100; a hot water outlet 224 configured to discharge hot water generated by heat-exchanging the cold water with the heating water in the heat exchange part 100; and a mixing valve 230 configured to mix cold water introduced from the cold water inlet 222 with the hot water discharged through the hot water outlet 224.

50 **[0011]** In addition, another aspect of the present invention may be achieved by providing an adapter integrated with a mixing valve including: an adapter 220 integrated with a cold water inlet 222 configured to introduce cold water into a heat exchange part 100, in which heating water supplied from a main heat exchanger 20 is heat-exchanged with the cold water, and a hot water outlet 224 configured to discharge hot water generated by heat-exchanging the cold water with the heating water in the heat exchange part 100; and a mixing valve 230 integrated with the adapter 220 to mix cold water introduced from the cold water inlet 222 with the hot water discharged through the hot water outlet 224.

Advantageous Effects

[0012] According to the present invention, a mixing valve is provided to mix cold water introduced from a cold water inlet with hot water discharged through a hot water outlet, enabling easy temperature control of the hot water.

[0013] In addition, since the cold water inlet and the hot water outlet are integrally formed with a second adapter connected to a heat exchange part and the mixing valve is integrally formed with the second adapter, a pipe connecting structure becomes very simple.

Description of Drawings

[0014] The above and other aspects and advantages of the present invention will become apparent and more readily appreciated from the following description of exemplary embodiments, taken in conjunction with the accompanying drawings of which:

FIG. 1 is a diagram schematically showing a conventional heating/hot water-combined instant boiler;
 FIG. 2 is a perspective view schematically showing appearance of a conventional hot-water supply heat exchanger;
 FIG. 3 is a view schematically showing a structure of a hot-water supply system including a hot-water supply heat exchanger of the present invention;
 FIG. 4 is a perspective view showing a connecting structure of the hot-water supply heat exchanger and an adapter in accordance with an exemplary embodiment of the present invention;
 FIG. 5 is a perspective view showing a first adapter;
 FIG. 6 is a cross-sectional view taken along line C-C of the first adapter shown in FIG. 5;
 FIG. 7 is a cross-sectional view taken along line D-D of the first adapter shown in FIG. 5;
 FIG. 8 is a perspective view showing a second adapter;
 FIG. 9 is a cross-sectional view taken along line E-E of the second adapter shown in FIG. 8;
 FIG. 10 is a cross-sectional view taken along line F-F of the second adapter shown in FIG. 8;
 FIG. 11 is a schematic cross-sectional view showing the second adapter integrated with a mixing valve of the present invention;
 FIG. 12 is a cross-sectional view taken along line A-A of a heat exchange part shown in FIG. 4;
 FIG. 13 is a cross-sectional view taken along line B-B of the heat exchange part shown in FIG. 4;
 FIG. 14 is a schematic cross-sectional view showing a state in which the first adapter is coupled to the heat exchange part;
 FIG. 15 is a schematic cross-sectional view showing a state in which the second adapter is coupled to the heat exchange part;
 FIG. 16 is a schematic cross-sectional view showing flows of heating water and cold water in a state in which a structure of the heat exchanger shown in FIG. 14 and a structure of the heat exchanger shown in FIG. 15 are coupled to each other.

Description of Major Reference Numerals

[0015]

100:	Heat exchange part		
101, 102, 103, 104, 111, 112, 113,	Partition plate		
114:			
102a, 103a, 114a, 102b, 103b, 112b,	Heating water passage hole		
113b:			
103c, 104c, 113c, 114c, 103d, 104d,	Cold water passage hole		
111 d, 112d:			
121:	First connecting member	122:	Second connecting member
123:	Third connecting member	124:	Fourth connecting member
131:	First heating water circulation path		
132:	Second heating water circulation path		
133:	First cold water circulation path		
134:	Second cold water circulation path		
210:	First adapter	220:	Second adapter

(continued)

	211, 221:	Body	212:	Heating water inlet
	213, 223:	Inlet extension	214:	Heating water outlet
5	215, 225:	Water feed valve connecting port		
	216:	Returned heating water connecting port		
	222:	Cold water inlet	224:	Hot water outlet
	230:	Mixing valve	231:	Valve unit
	232:	Drive unit	300:	Water feed valve
10	400:	Flow rate sensor		

Mode for Invention

15 **[0016]** Reference will now be made in detail to the embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

[0017] FIG. 3 is a view schematically showing a structure of a hot-water supply system including a hot-water supply heat exchanger of the present invention, and FIG. 4 is a perspective view showing a connecting structure of the hot-water supply heat exchanger and an adapter in accordance with an exemplary embodiment of the present invention. Reference numerals of like elements of the conventional art will be described with reference to FIGS. 1 and 2.

20 **[0018]** A hot-water supply heat exchanger 1 of the present invention includes a heat exchange part 100 configured to heat-exchange heating water supplied from a main heat exchanger 20 with cold water, a heating water inlet 212 configured to introduce the heating water into the heat exchange part 100, a heating water outlet 214 configured to discharge the heating water after heat exchange with the cold water in the heat exchange part 100, a cold water inlet 222 configured to introduce the cold water into the heat exchange part 100, a hot water outlet 224 configured to discharge hot water generated by heat-exchanging the cold water with the heating water in the heat exchange part 100, and a mixing valve 230 configured to mix cold water introduced from the cold water inlet 222 with the hot water discharged through the hot water outlet 224.

25 **[0019]** The heat exchange part 100 has a path through which heating water flows and a path through which cold water flows, which are isolated from each other with a plurality of partition plates interposed therebetween. Hot heating water and cold water are heat-exchanged with each other through the partition plates.

30 **[0020]** A first adapter 210 and a second adapter 220 are coupled to the heat exchange part 100.

[0021] The heating water inlet 212 and the heating water outlet 214 are integrally formed with the first adapter 210, and a water feed valve connecting port 215 and a returned heating water connecting port 216 are also formed at the first adapter 210.

35 **[0022]** The heating water inlet 212 is connected to a three-way valve 30 to introduce heating water supplied from the main heat exchanger 20 into the heat exchange part 100 in a hot water mode.

[0023] The heating water is heat-exchanged with the cold water in the heat exchange part 100, discharged through the heating water outlet 214, and then joined with returned heating water to flow toward a circulation pump 10.

40 **[0024]** The water feed valve connecting port 215 is connected to a water feed valve 300 configured to supply supplement water into a heating pipe. The water feed valve 300 is coupled both to the first adapter 210 and the second adapter 220 and arranged between them.

[0025] The returned heating water connecting port 216 is configured to introduce the returned heating water heat-exchanged and cooled at a place to be heated, and the returned heating water introduced into the first adapter 210 through the returned heating water connecting port 216 is discharged to the heating water outlet 214 to flow toward the circulation pump 10.

45 **[0026]** The cold water inlet 222, the hot water outlet 224 and a water feed valve connecting port 225 are integrally formed with the second adapter 220.

[0027] The cold water inlet 222 is configured to introduce cold water, and the cold water introduced through the cold water inlet 222 is introduced into the heat exchange part 100 to exchange heat with the heating water.

50 **[0028]** The cold water introduced into the heat exchange part 100 is heat-exchanged with the heating water in the heat exchange part 100 to become hot water, and the hot water is discharged to a place where the hot water is used through the hot water outlet 224.

[0029] A flow rate sensor 400 is installed on a path through which the cold water is introduced, and the flow rate sensor 400 detects a flow of the cold water to determine whether it is the hot water mode.

55 **[0030]** The water feed valve connecting port 225 is connected to the water feed valve 300. When the water feed valve 300 is opened to supply supplement water into the heating pipe, the hot water heated in the heat exchange part 100 sequentially passes through the water feed valve connecting port 225 of the second adapter 220 and the water feed

valve 300, is introduced into the water feed valve connecting port 215 of the first adapter 210 to be mixed with the returned heating water in the first adapter 210, and then flows to the heating water outlet 214.

[0031] The water feed valve 300 is configured to additionally supply heating water when the heating water is insufficient in the heating pipe. While the conventional art has a separate pipe structure configured to connect a water feed valve to a heating pipe, in the present invention, the water feed valve connecting ports 215 and 225 integrated with the first adapter 210 and the second adapter 220 are provided to simplify a pipe structure.

[0032] A mixing valve 230 configured to mix the cold water introduced from the cold water inlet 222 with the hot water discharged through the hot water outlet 224 is provided. When the mixing valve 230 is opened, the cold water is mixed with the hot water discharged through the hot water outlet 224 to enable easy temperature control of the hot water.

[0033] FIG. 5 is a perspective view showing the first adapter, FIG. 6 is a cross-sectional view taken along line C-C of the first adapter shown in FIG. 5, and FIG. 7 is a cross-sectional view taken along line D-D of the first adapter shown in FIG. 5.

[0034] The first adapter 210 has a cylindrical body 211. The heating water inlet 212, the heating water outlet 214, the water feed valve connecting port 215 and the returned heating water connecting port 216 project from an outer circumference of the body 211 at predetermined intervals in a circumferential direction thereof.

[0035] An inlet extension 213 having one end connected to the heating water inlet 212 and the other end connected to a first connecting member 121 (see FIG. 10) is formed in the body 211.

[0036] The end of the inlet extension 213 is coupled to the first connecting member 121 to be connected to a heating water circulation path in the heat exchange part 100. A space 211a through which the heating water circulated in the heat exchange part 100 flows is formed between the inlet extension 213 and an inner circumference of the body 211.

[0037] Accordingly, a path (the inlet extension 213) through which the heating water is introduced and a path (the space 211a) through which the heating water is discharged are disposed in parallel and concentrically in the body 211.

[0038] The returned heating water connecting port 216 is connected to the heating pipe through which the returned heating water flows. The returned heating water introduced through the returned heating water connecting port 216 is supplied to the circulation pump 10 through the heating water outlet 214.

[0039] According to the above-mentioned structure, since the heating water inlet 212, the heating water outlet 214, the water feed valve connecting port 215 and the returned heating water connecting port 216 are integrally formed with the adapter 210, a pipe structure connected thereto can be simplified.

[0040] FIG. 8 is a perspective view showing the second adapter, FIG. 9 is a cross-sectional view taken along line E-E of the second adapter shown in FIG. 8, and FIG. 10 is a cross-sectional view taken along line F-F of the second adapter shown in FIG. 8.

[0041] The second adapter 220 has a body 221, and the cold water inlet 222, an inlet extension 223, the hot water outlet 224, the water feed valve connecting port 225 and the mixing valve 230 project from an outer circumference of the body 221 at predetermined intervals in a circumferential direction thereof.

[0042] The inlet extension 223 is installed in the body 221 to be connected to the cold water inlet 222 at its one end and coupled to a second connecting member 122 (see FIG. 15) at the other end.

[0043] The body 221, the cold water inlet 222, the inlet extension 223 and the hot water outlet 224 have the same shapes as the first adapter 210.

[0044] A through-hole 222a is formed in the cold water inlet 222 to communicate with the inside of the hot water outlet 224. The mixing valve 230 includes a valve unit 231 configured to open and close the through-hole 222a, and a drive unit 232 configured to drive the opening and closing of the valve unit 231. Accordingly, when the valve unit 231 is opened by the drive unit 232, the cold water is mixed with the hot water through the through-hole 222a to enable temperature adjustment of the hot water.

[0045] FIG. 11 is a schematic cross-sectional view showing the second adapter integrated with the mixing valve of the present invention.

[0046] The cold water inlet 222, the hot water outlet 224 and the water feed valve connecting port 225 are integrally formed with the body 221 of the second adapter 220, and the mixing valve 230 is integrally coupled to the body 221 of the second adapter 220.

[0047] A through-hole 222a is formed in the cold water inlet 222, and the valve unit 231 of the mixing valve 230 configured to open and close the through-hole 222a is connected to the drive unit 232.

[0048] FIG. 12 is a cross-sectional view taken along line A-A of the heat exchange part shown in FIG. 4, FIG. 13 is a cross-sectional view taken along line B-B of the heat exchange part shown in FIG. 4, FIG. 14 is a schematic cross-sectional view showing a state in which the first adapter is coupled to the heat exchange part, FIG. 15 is a schematic cross-sectional view showing a state in which the second adapter is coupled to the heat exchange part, and FIG. 16 is a schematic cross-sectional view showing flows of heating water and cold water in a state in which a structure of the heat exchanger shown in FIG. 14 and a structure of the heat exchanger shown in FIG. 15 are coupled to each other.

[0049] The heat exchange part 100 has a structure in which a plurality of partition plates 101, 102, 103, 104, 111, 112, 113 and 114 are stacked. The partition plates 101, 102, 103, 104, 111, 112, 113 and 114 become a heat transfer surface

in which heat exchange between heating water and cold water is performed. The stacked structure is formed by bending edges of thin plates and welding the edges of the neighboring partition plates.

[0050] Spaces formed between the partition plates constitute heating water circulation paths 131 and 132 and cold water circulation paths 133 and 134.

[0051] The heating water circulation paths 131 and 132 through which the heating water flows and the cold water circulation paths 133 and 134 through which the cold water flows are blocked by the partition plates 101, 102, 103, 104, 111, 112, 113 and 114 so that the heating water and the cold water flow without mixing.

[0052] The heating water introduced into the heat exchange part 100 sequentially passes through the first heating water circulation path 131 and the second heating water circulation path 132 to exchange heat with the cold water passing through the first cold water circulation path 133 and the second cold water circulation path 134, and then is discharged towards the returned heating water through the first adapter 210.

[0053] In addition, the cold water introduced into the heat exchange part 100 sequentially passes through the first cold water circulation path 133 and the second cold water circulation path 134 to exchange heat with the heating water passing through the first heating water circulation path 131 and the second heating water circulation path 132, and then is supplied to the place where hot water is to be used through the second adapter 220.

[0054] A heating water passage hole 114a and a cold water passage hole 114c are formed in the partition plate 114, into which the first adapter 210 and the second adapter 220 are inserted and coupled, among the partition plates.

[0055] A cylindrical third connecting member 123, which the first adapter 210 is inserted into and coupled, is coupled to the heating water passage hole 114a. And a cylindrical fourth connecting member 124, which the second adapter 220 is inserted into and coupled, is coupled to the cold water passage hole 114c.

[0056] Paths of the heating water and the cold water will be described with reference to FIGS. 14 to 16.

[0057] When the three-way valve 30 is shifted to the hot water mode, the heating water heated in the main heat exchanger 20 is supplied toward a hot-water supply heat exchanger 1, while a flow to the place to be heated is blocked, and then introduced into the heating water inlet 212 and the inlet extension 213 of the first adapter 210.

[0058] The heating water introduced into the first adapter 210 sequentially passes through the first heating water circulation path 131 and the second heating water circulation path 132 of the heat exchange part 100 to exchange heat with the cold water flowing through the first cold water circulation path 133 and the second cold water circulation path 134 to be cooled, and then is discharged to an expansion tank 50 through the heating water outlet 214.

[0059] Simultaneously, the cold water is introduced into the cold water inlet 222 and the inlet extension 223 of the second adapter 220. The cold water introduced into the second adapter 220 sequentially passes through the first cold water circulation path 133 and the second cold water circulation path 134 of the heat exchange part 100 to exchange heat with the heating water flowing through the first heating water circulation path 131 and the second heating water circulation path 132 to become hot water, and then is discharged to the place where hot water is to be used through the hot water outlet 224.

[0060] In this case, in order to adjust a temperature of the hot water, the mixing valve 230 is operated. That is, when the valve unit 231 is operated by the drive unit 232 to open the through-hole 222a, the cold water is mixed with the hot water through the through-hole 222a. Here, when a moving amount of the valve unit 231 is controlled, an amount of the cold water mixed with the hot water is adjusted to enable temperature adjustment of the hot water.

[0061] Meanwhile, when the three-way valve 30 is shifted to a heating mode, the heating water supplied to the place to be heated performs a heat exchange process, and then is returned toward the circulation pump 10. In the present invention, the heating water returned toward the circulation pump 10 is introduced into the returned heating water connecting port 216 of the first adapter 210 to pass through the heating water outlet 214, and then returned toward the circulation pump 10 through the expansion tank 50.

[0062] If the heating water is insufficient in the heating pipe, the water feed valve 300 is opened to supplement heating water. The water feed valve 300 is installed between the water feed valve connecting port 215 of the first adapter 210 and the water feed valve connecting port 225 of the second adapter 220. Accordingly, when the water feed valve 300 is opened, some of the hot water in the body 221 of the second adapter 220 sequentially passes through the water feed valve connecting port 215 and the outlet 214 of the first adapter 210 via the water feed valve connecting port 225 to be supplied to the heating pipe at a returned water side.

[0063] The foregoing description concerns an exemplary embodiment of the invention, is intended to be illustrative, and should not be construed as limiting the invention. The present teachings can be readily applied to other types of devices and apparatuses. Many alternatives, modifications, and variations within the scope and spirit of the present invention will be apparent to those skilled in the art.

Claims

1. A hot-water supply heat exchanger comprising:

a heat exchange part (100) configured to heat-exchange heating water supplied from a main heat exchanger (20) with cold water;
a heating water inlet (212) configured to introduce the heating water into the heat exchange part (100);
a heating water outlet (214) configured to discharge the heating water after heat exchange with the cold water in the heat exchange part (100);
a cold water inlet (222) configured to introduce the cold water into the heat exchange part (100);
a hot water outlet (224) configured to discharge hot water generated by heat-exchanging the cold water with the heating water in the heat exchange part (100); and
a mixing valve (230) configured to mix cold water introduced from the cold water inlet (222) with the hot water discharged through the hot water outlet (224).

2. The hot-water supply heat exchanger according to claim 1, wherein the heating water inlet (212) and the heating water outlet (214) are integrally formed with a first adapter (210) coupled to one side of the heat exchange part (100), the cold water inlet (222) and the hot water outlet (224) are integrally formed with a second adapter (220) coupled to the other side of the heat exchange part (100), and the mixing valve (230) is integrally formed with the second adapter (220).

3. The hot-water supply heat exchanger according to claim 2, wherein a through-hole (222a) is formed in the cold water inlet (222) to communicate with the inside of the hot water outlet (224), and the mixing valve (230) is constituted by a valve unit (231) configured to open and close the through-hole (222a) and a drive unit (232) configured to drive the opening and closing of the valve unit (231).

4. The hot-water supply heat exchanger according to claim 2, wherein an inlet extension (213) connected to the heating water inlet (212) to pass through a side portion of a body (211) and connected to heating water circulation paths (131, 132) in the heat exchange part (100) through an inner space of the body (211) is formed at the first adapter (210), and the heating water heat-exchanged in the heat exchange part (100) is returned to a heating pipe through the heating water outlet (214) of the first adapter (210) via the inlet extension (213) of the first adapter (210).

5. The hot-water supply heat exchanger according to claim 2 or 4, wherein a returned heating water connecting port (216) into which returned heating water cooled after circulating a place to be heated is introduced is formed at the side portion of the body (211) of the first adapter (210), and the returned heating water introduced through the returned heating water connecting port (216) is discharged through the heating water outlet (214) of the first adapter (210).

6. The hot-water supply heat exchanger according to claim 2 or 4, wherein water feed valve connecting ports (215, 225) connected to a water feed valve (300) are formed at side portions of the bodies (211, 221) of the first adapter (210) and the second adapter (220), and when the water feed valve (300) is opened to supplement heating water into a heating pipe of a boiler, hot water passing through cold water circulation paths (133, 134) in the heat exchange part (100) sequentially passes the water feed valve connecting port (225) of the second adapter (220), the water feed valve (300), and the water feed valve connecting port (215) of the first adapter (210), and then, is supplied to the heating pipe.

7. An adapter integrated with a mixing valve comprising:

an adapter (220) integrated with a cold water inlet (222) configured to introduce cold water into a heat exchange part (100), in which heating water supplied from a main heat exchanger (20) is heat-exchanged with the cold water, and a hot water outlet (224) configured to discharge hot water generated by heat-exchanging the cold water with the heating water in the heat exchange part (100); and
a mixing valve (230) integrated with the adapter (220) to mix cold water introduced from the cold water inlet (222) with the hot water discharged through the hot water outlet (224).

8. The adapter integrated with a mixing valve according to claim 7, wherein a through-hole (222a) is formed in the cold water inlet (222) to communicate with the inside of the hot water outlet (224), and the mixing valve (230) is constituted by a valve unit (231) configured to open and close the through-hole (222a) and a drive unit (232) configured to drive the opening and closing of the valve unit (231).

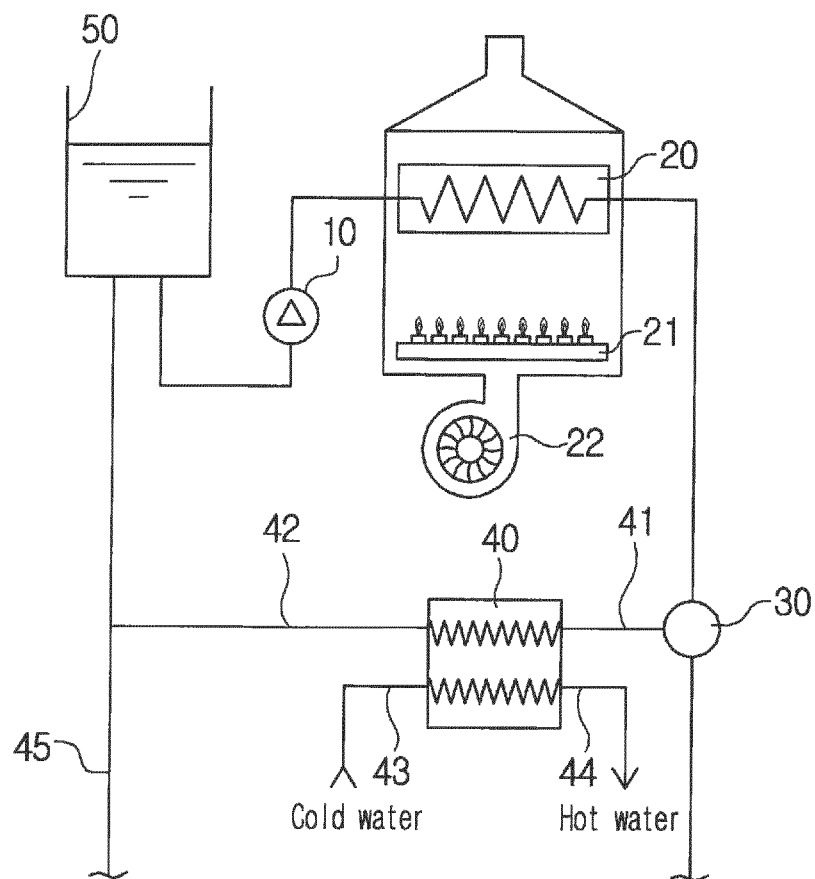


Fig. 1

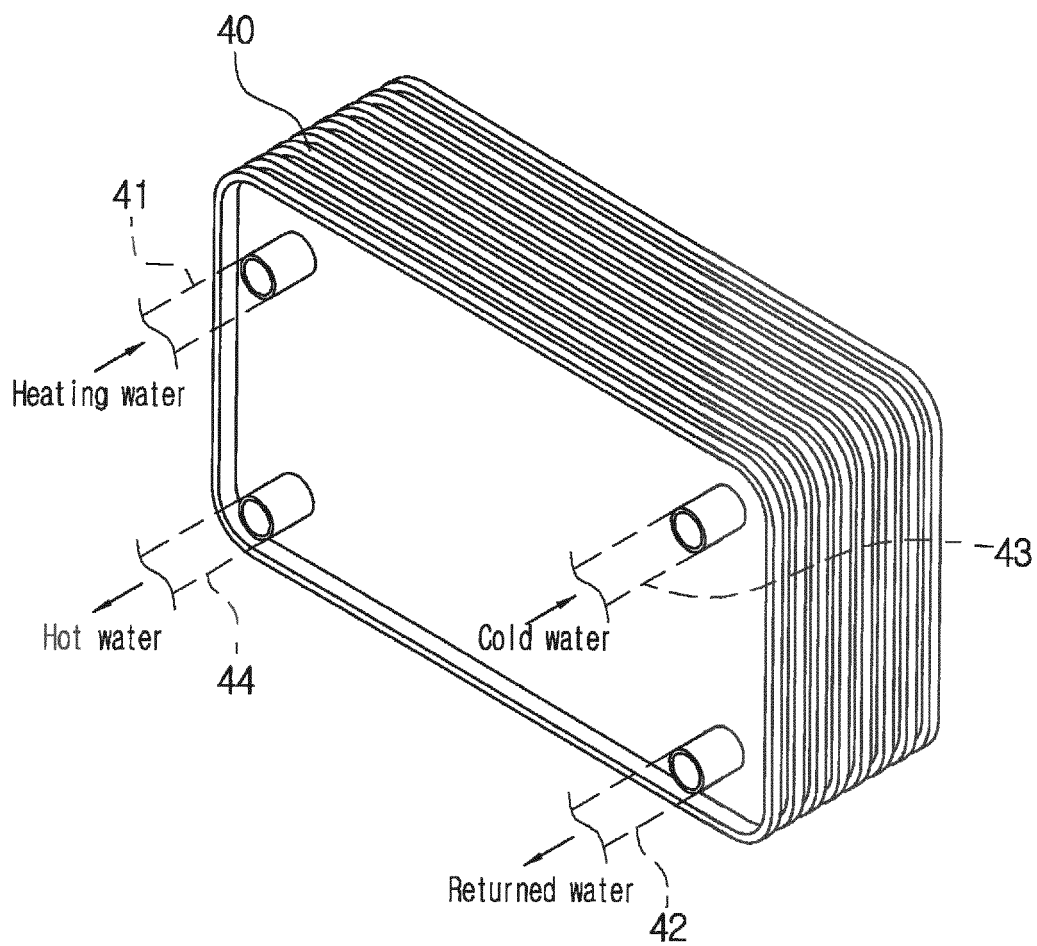


Fig. 2

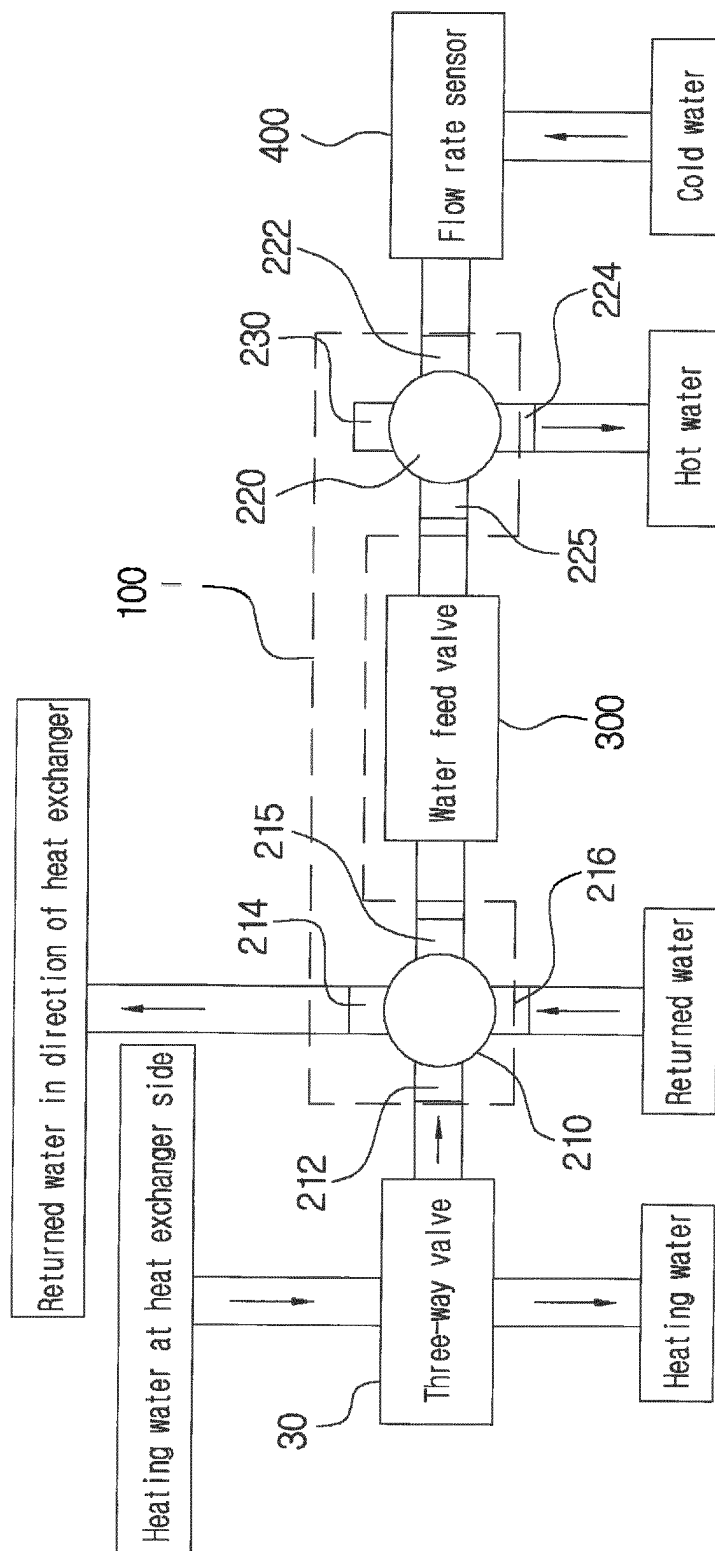


Fig. 3

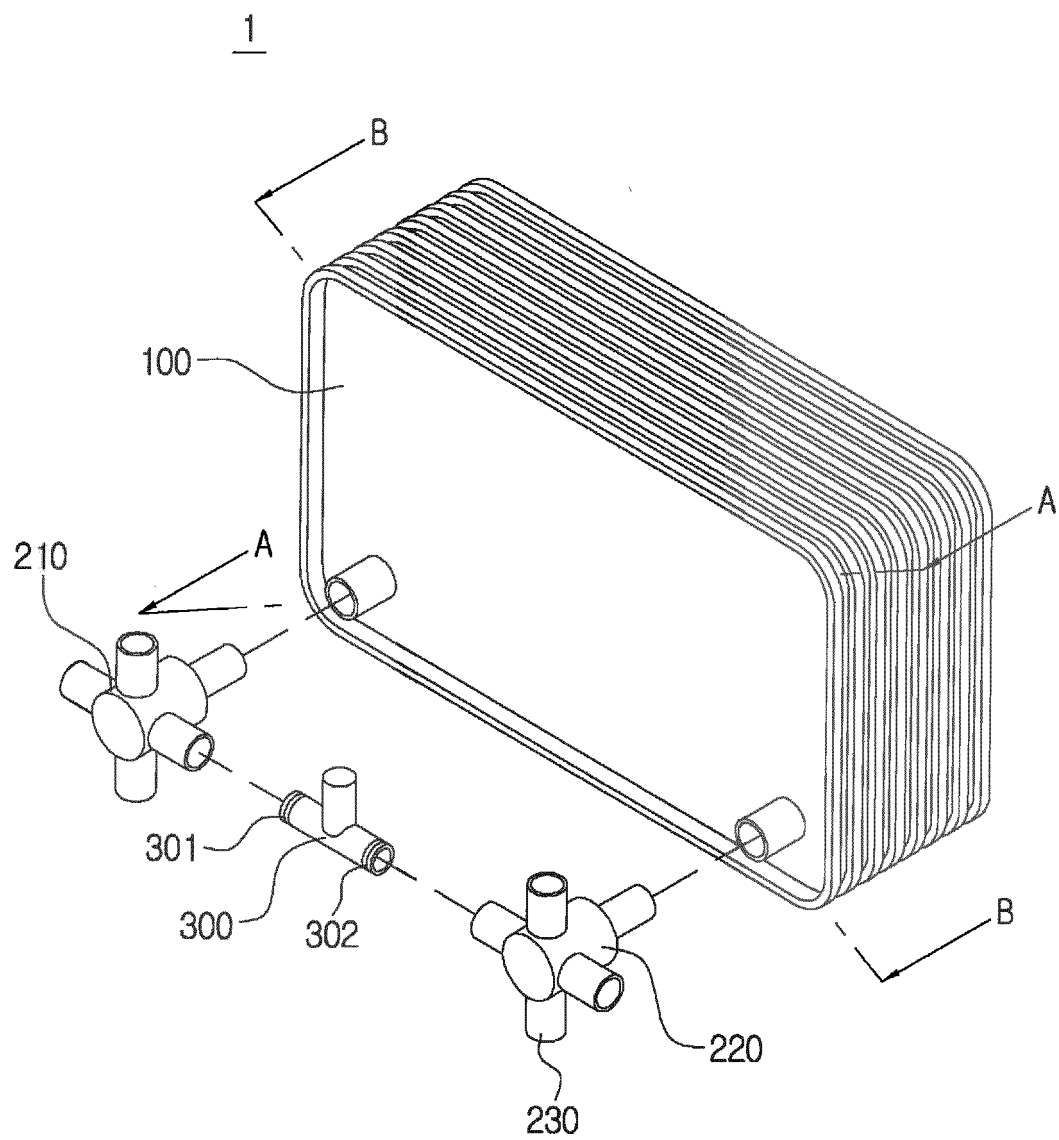


Fig. 4

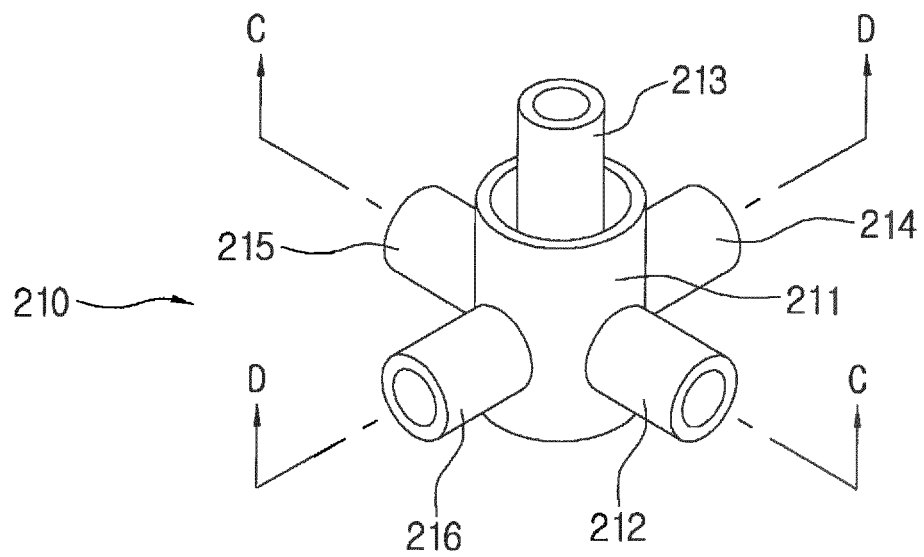


Fig. 5

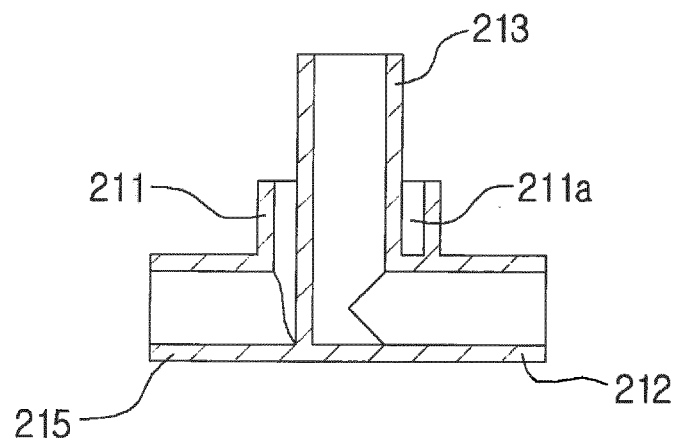


Fig. 6

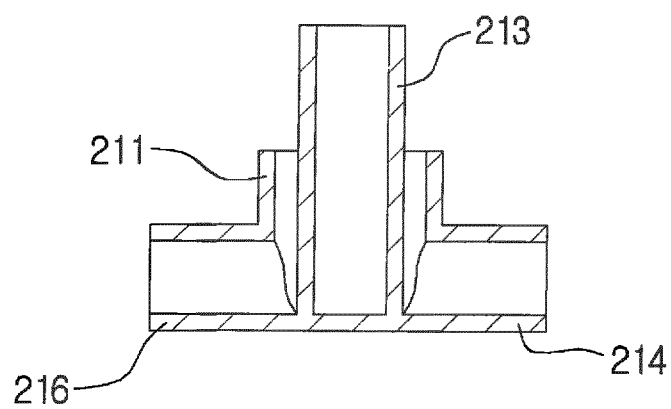


Fig. 7

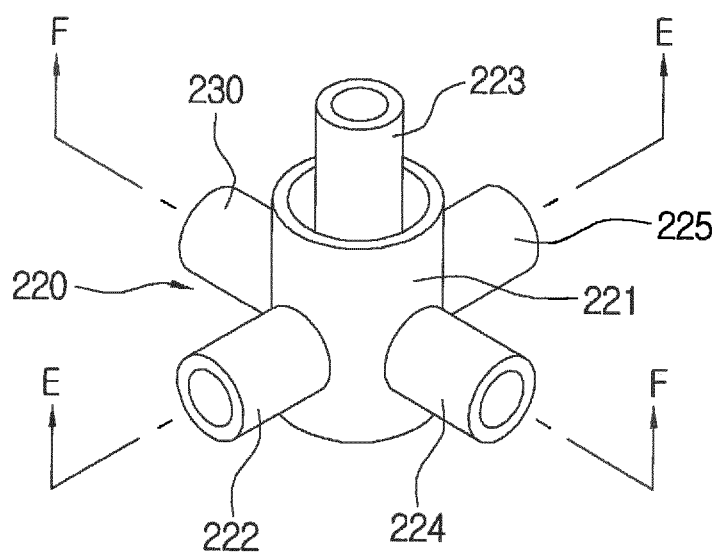


Fig. 8

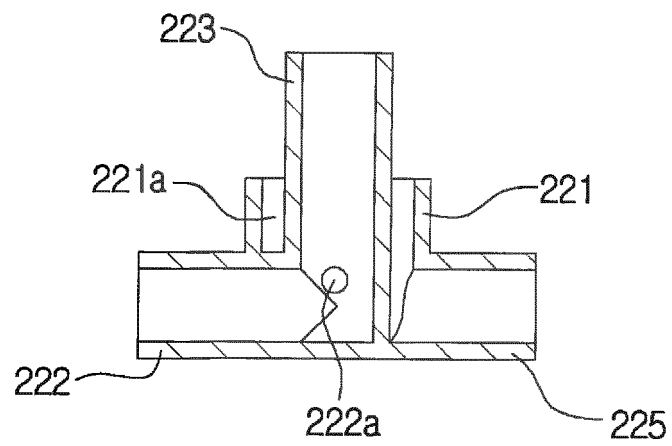


Fig. 9

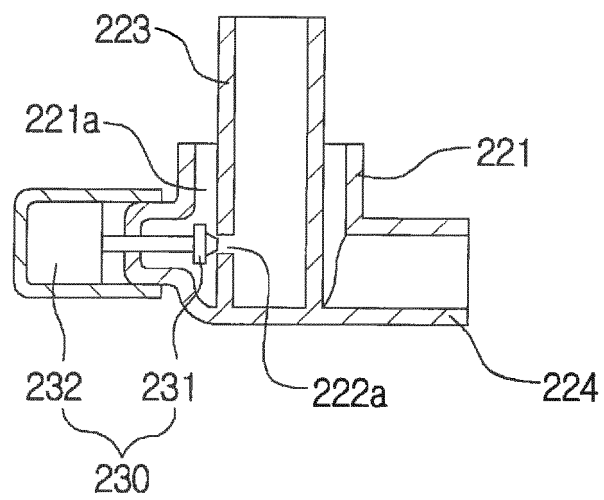


Fig. 10

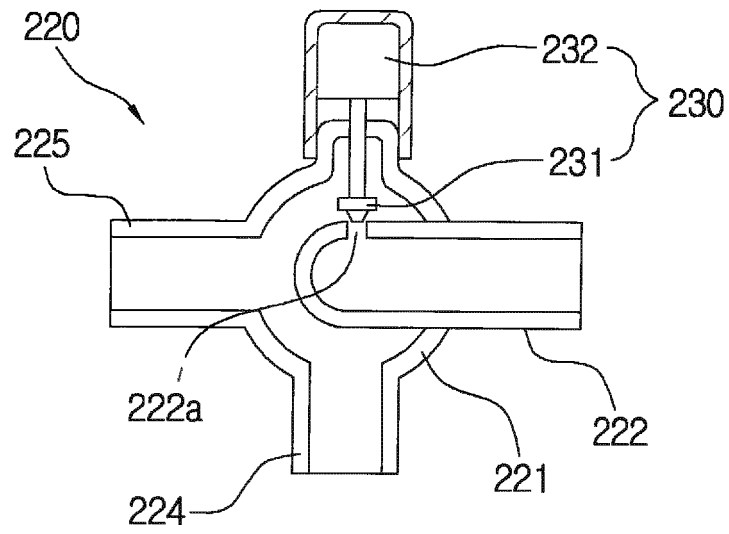


Fig. 11

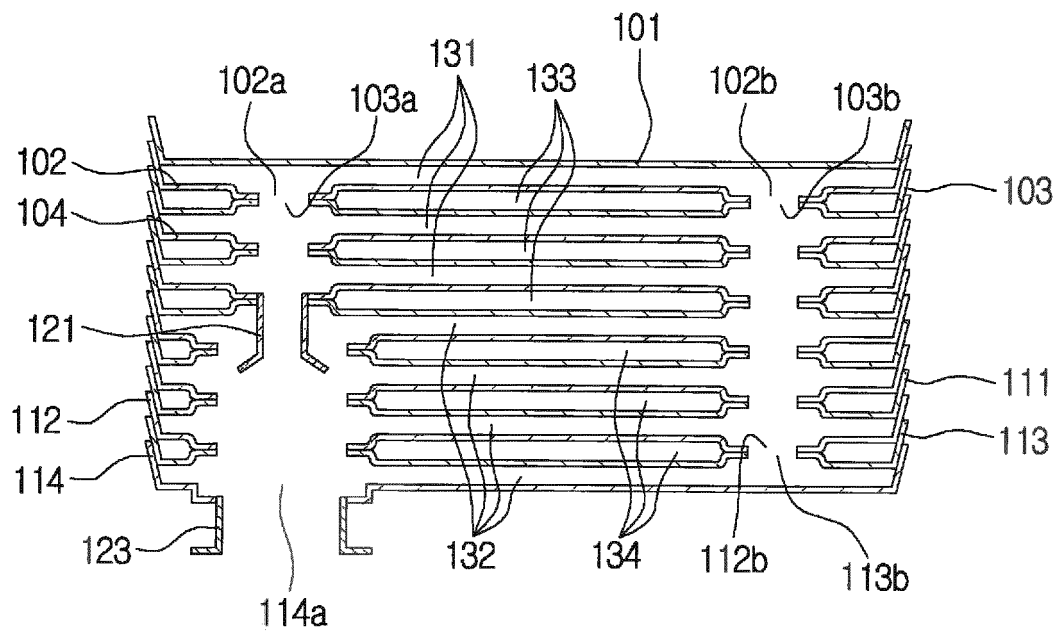


Fig. 12

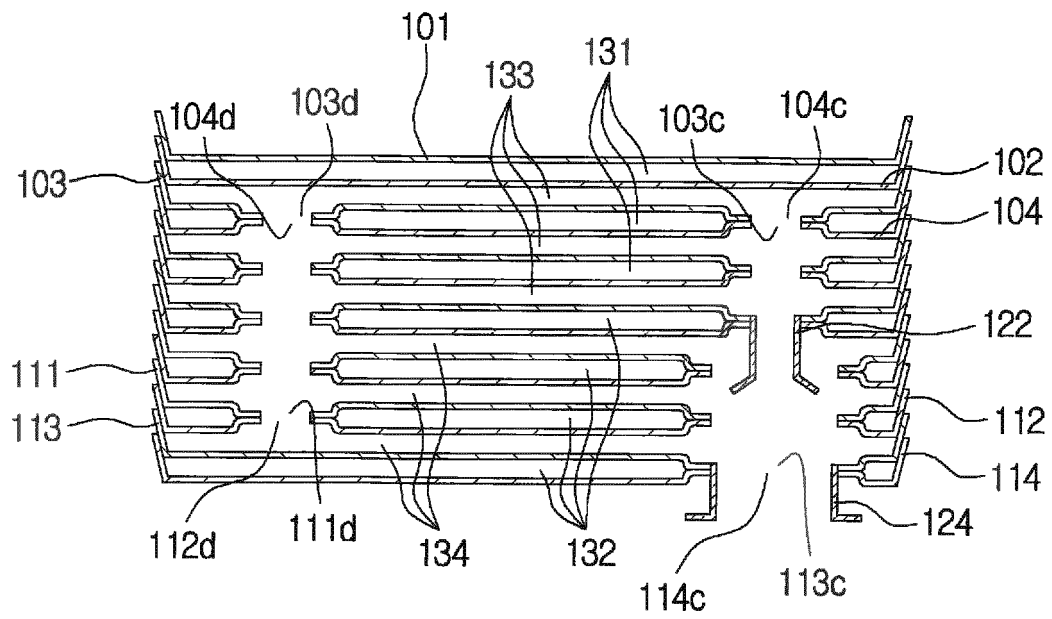


Fig. 13

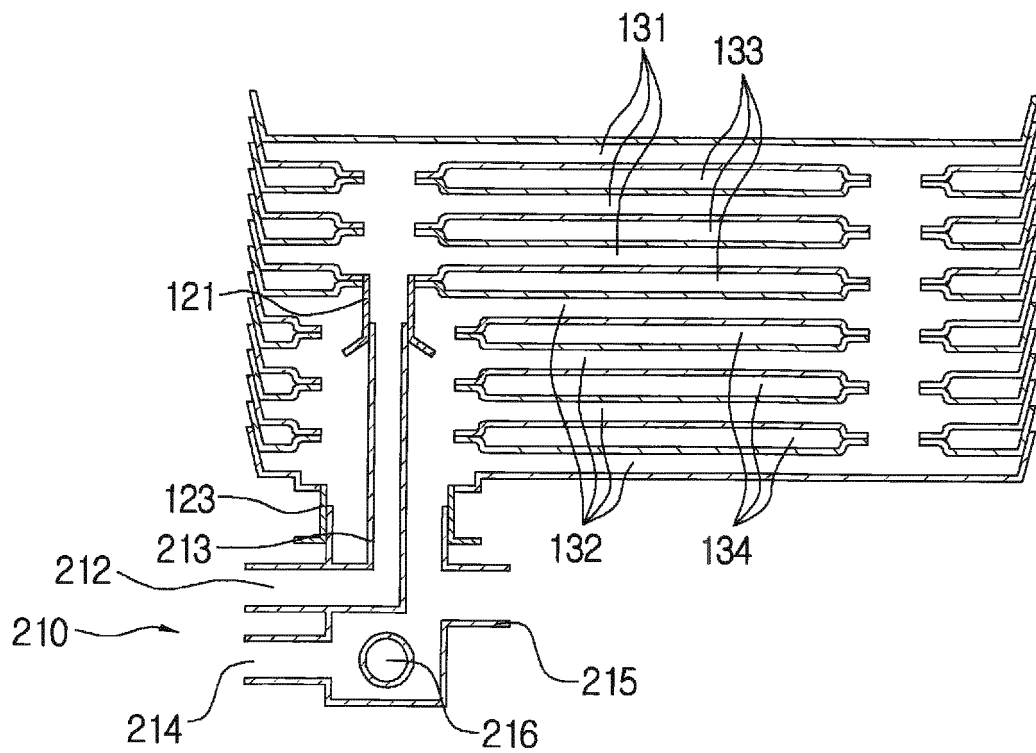


Fig. 14

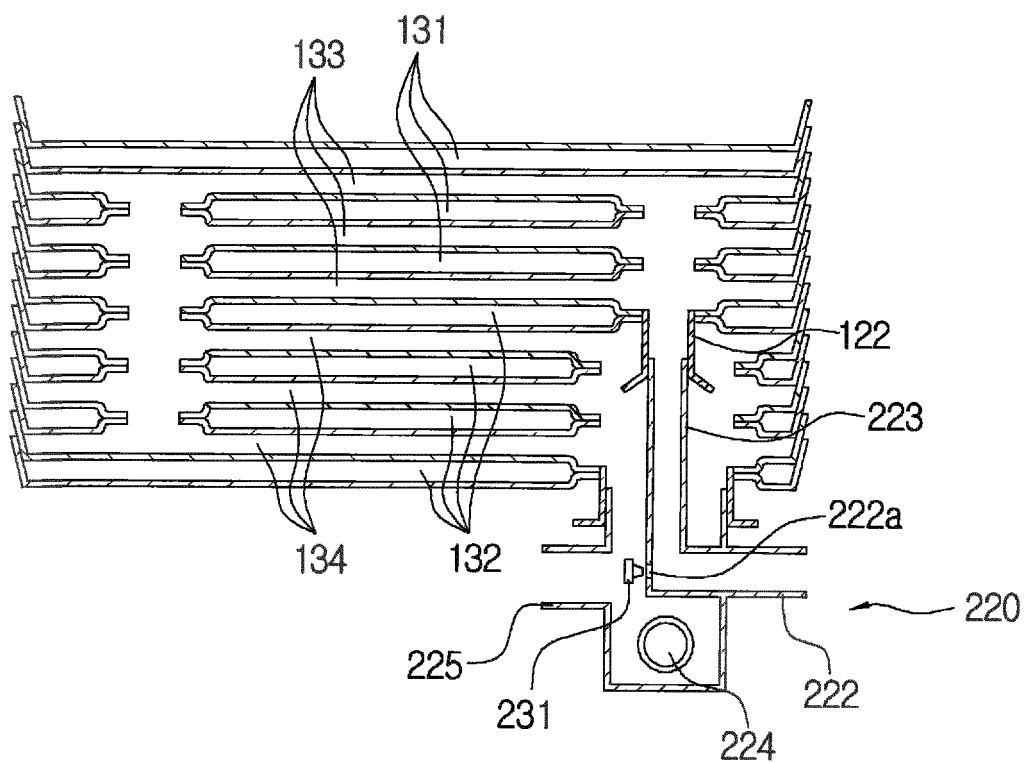


Fig. 15

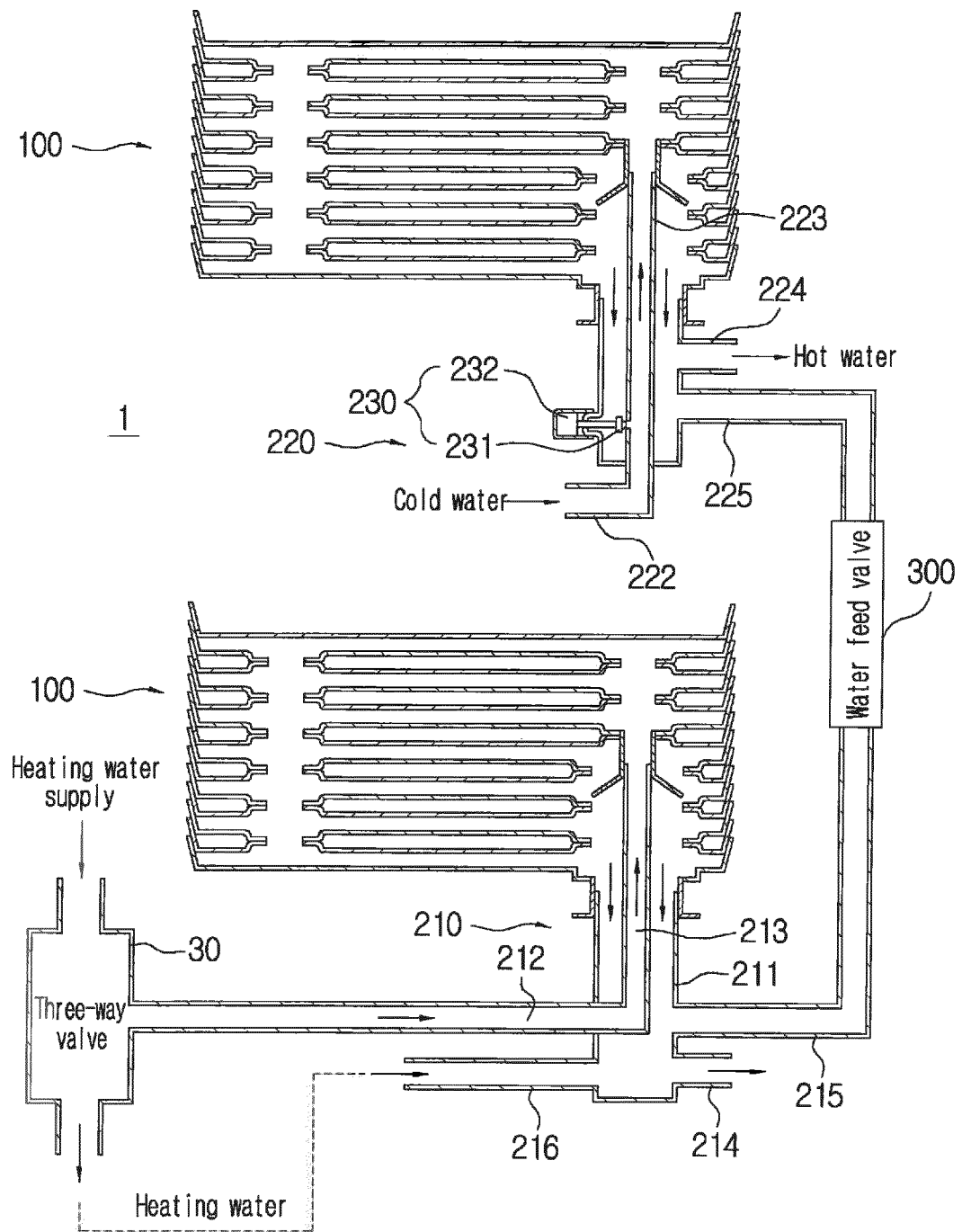


Fig. 16