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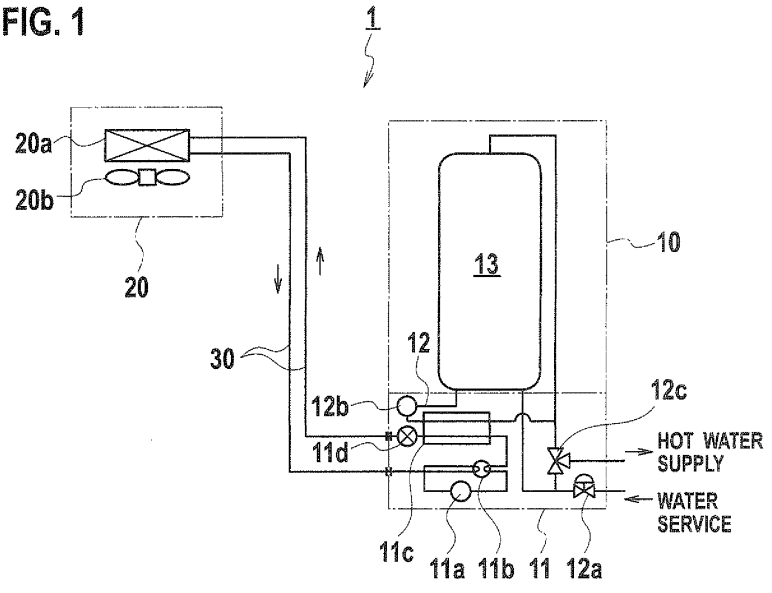
(54) **HEAT PUMP HOT WATER SUPPLY SYSTEM**

(57) In a heat pump water heating system (1) including a refrigerant circuit (30) having a compressor (11a), a four-way valve (11b), a water heat exchanger (11c), an expansion valve (11d), and a heat source end heat exchanger (20a) being piping-connected in series, and a hot water storage tank (13) connected to a water circuit (12) of the water heat exchanger (11c) for supply and storage of hot water generated at the water heat exchanger (11c), at least the compressor (11a), the four-way valve (11b), and the water heat exchanger (11c) constituting the refrigerant circuit (30), and the hot water storage tank with water circuitry connected to the water heat exchanger (11c) are accommodated together in a single casing to constitute a main unit (10), and the heat source end heat exchanger (20a) is configured to separate from the main unit (10) by a piping connection.

FIG. 1



EP 2 034 248 A1

Description

Technical Field

[0001] The present invention relates to a heat pump water heating system.

Background Art

[0002] Typically, the heat pump water heating system is configured as a combination of a refrigeration cycle including a compression machine (as a compressor), a four-way valve, a water heat exchanger (as a condenser), an expansion valve, and a heat source end heat exchanger (as an evaporator) being connected in series, and a water cycle including a hot water storage tank and a pump being connected to the water heat exchanger. As illustrated in a cycle diagram of Fig. 6, in configuration of a heat pump water heating system 100, a heat pump heat source unit 110 that constitutes a refrigeration cycle and a hot water storage tank unit 120 that constitutes a water cycle are interconnected by water lines 130.

[0003] For this heat pump water heating system, the refrigeration cycle will be described briefly. First, as shown by solid-line arrows, a refrigerant in a gaseous state is rendered high-temperature high-pressure by exertion of pressures at a compressor 111, and supplied through a four-way valve 112 to a water heat exchanger 113. On the other hand, water is supplied from a water service, and as shown by a broken-line arrow, is sent from a combination of a pressure reducing valve 121 and a hot water storage tank 122 constituting a hot water storage tank unit 120, to the water heat exchanger 113, by a pump 123. In the water heat exchanger 113, heat exchange is performed between refrigerant and water. That is, heat of refrigerant heats water supplied to the water heat exchanger 113 by the pump 123, and the refrigerant is cooled with this water, changing from gas to liquid. Heated water becomes hot water, which is stored in the hot water storage tank 122. Further, this hot water is supplied through a mixing valve 124 to a bathroom, for instance. The refrigerant having been deprived of heat by the water heat exchanger 113 and changed to liquid is let through an expansion valve 115 and a heat source end heat exchanger, where it is changed again to gas, to repeat the foregoing cycle.

Disclosure of Invention

[0004] However, for employment of a configuration separated into the heat pump heat source unit 110 and the hot water storage tank unit 120 being interconnected by water lines, as disclosed in Japanese Patent Application Laid-Open Publication No. 2001-82818, for instance, installation of the heat pump water heating system 100 needs a considerably wide installation space, whether indoor or outdoor. In particular, in a complex housing such as a condominium, although the hot water storage tank unit 120 may also be installed in an instrument panel in which a gas meter and the like are provided, there arises the problem of installation place for the heat pump heat source unit 110 in that case. In most cases, the heat pump heat source unit 110 is installed in a balcony, though there is a small area left available if the installation is on a floor of the balcony. On the other hand, if the installation is on a ceiling of the balcony, the installation construction includes a lot of work depending on the heat pump heat source unit 110's weight, scale, or such, in addition to an unappealing appearance.

[0005] For resolution of such difficulties in installation of the heat pump heat source unit 110, the heat pump heat source unit 110 might have been integrated with the hot water storage tank unit 120 to install together in an instrument panel. However, in that case, the heat source end heat exchanger would have a deteriorated performance due to insufficient ventilation of air in the instrument panel, with a reduced efficiency of the heat pump heat source unit 110.

[0006] Further, for interconnection of the heat pump heat source unit 110 and the hot water storage tank unit 120, if the water lines 130 had their piping installed outdoor, there would be the need for prevention of, among others, freeze and radiation loss at that part.

[0007] The present invention has been devised to solve the problems described, and it is an object of the present invention to provide a heat pump water heating system including rearranged combinations of constituent components of heat pump water heating system, thereby permitting the freedom of installation to be secured and enhanced, allowing for installation free of performance deterioration of components, without causing disfigurement.

[0008] For solution of the problems, according to aspects of the present invention, a heat pump water heating system includes a refrigerant circuit having a compression machine, a four-way valve, a water heat exchanger, an expansion valve, and a heat source end heat exchanger being piping-connected in series, and a hot water storage tank connected to a water circuit of the water heat exchanger for supply and storage of hot water generated at the water heat exchanger, and comprises a main unit configured with a heat source unit having at least the compression machine, the four-way valve, and the water heat exchanger constituting the refrigerant circuit, and the hot water storage tank with water circuitry connected to the water heat exchanger, and the heat source end heat exchanger configured for separation from the heat source unit in connection.

Brief Description of Drawings

[0009]

[Fig. 1] Fig. 1 is a configuration diagram illustrating a heat pump water heating system according to a first embodiment of the present invention.

[Fig. 2] Fig. 2 is a schematic diagram illustrating an exemplary installation in an apartment of a complex housing of the heat pump water heating system according to the first embodiment of the present invention.

[Fig. 3] Fig. 3 is a configuration diagram illustrating a heat pump water heating system according to an embodiment at a heat source end of the present invention.

[Fig. 4] Fig. 4 is a configuration diagram illustrating a heat pump water heating system according to a third embodiment of the present invention.

[Fig. 5] Fig. 5 is a configuration diagram illustrating a heat pump water heating system according to a fifth embodiment of the present invention.

[Fig. 6] Fig. 6 is a configuration diagram illustrating a conventional heat pump water heating system.

Best Mode for Carrying Out the Invention

[0010] There will be described into details embodiments of the present invention, with reference to the drawings.

(First embodiment)

[0011] According to the first embodiment of the present invention, as illustrated in Fig. 1, a heat pump water heating system 1 is configured mainly with a main unit 10, a heat source end heat exchanger unit 20, and a set of refrigerant lines 30 for interconnection between the main unit 10 and the heat source end heat exchanger unit 20.

[0012] The main unit 10 includes a heat source unit 11, water circuitry 12, and a hot water storage tank 13. In the first embodiment, they are accommodated together in a single casing. The heat source unit 11 has incorporated therein, for a refrigeration cycle: a compressor 11a for compressing a refrigerant circulating in the cycle; a four-way valve 11b for controlling flow directions of refrigerant; a water heat exchanger 11c for heating water by using heat of refrigerant; and an expansion valve 11d.

[0013] The water circuitry 12 is a set of flow passages (circuits) of (hot) water circulating in the main unit 10. Water is supplied from a water service, and once led from a pressure reducing valve 12a into the hot water storage tank 13, and after that, it is supplied through a pump 12b to the water heat exchanger 11c. Here is performed heat exchange between water and heated refrigerant, whereby water is changed to hot water, which is stored in the hot water storage tank 13. And, this hot water is supplied, through a mixing valve 12c, to a bathroom or kitchen, for instance.

[0014] The heat source end heat exchanger unit 20 includes a heat source end heat exchanger 20a, and an air fan 20b. The heat source end heat exchanger 20a, as equipment separated from the main unit 10, is connected via refrigerant lines 30 to the four-way valve 11b and the expansion valve 11d. Refrigerant is changed to liquid at the water heat exchanger 11c, which is let through the expansion valve 11d to the heat source end heat exchanger 20a, where it is changed to a gaseous state. This refrigerant circulates, as shown by arrows in Fig. 1, through the compressor 11a, four-way valve 11b, water heat exchanger 11c, expansion valve 11d, heat source end heat exchanger 20a, four-way valve 11b, and compressor 11a, in this order, constituting a refrigeration cycle.

[0015] Fig. 2 is a schematic diagram illustrating an exemplary installation in an apartment of a complex housing of the heat pump water heating system according to the first embodiment of the present invention. In Fig. 2, walls, joists, floors, and the like are hatched. The complex housing 60 includes a balcony 61, a living room 62, a bathroom 63, and a common pathway 64, for instance. The main unit 10 is installed in a space between the bathroom 63 and the common pathway 64, main. From the main unit 10, hot water can be supplied through a water circuit 12 to the bathroom 63, for instance. Further, above the common pathway 64, there is installed the heat source end heat exchanger unit 20. The heat source end heat exchanger unit 20 is connected to the main unit 10 through the refrigerant lines 30.

[0016] In the first embodiment, the heat source end heat exchanger 20a is separated from the heat source unit 11 in the main unit 10, as separate equipment relative to the main unit 10, to be installed outside the main unit 10. Hence, for installation of the heat source end heat exchanger unit 20 only, its casing can also be compact and light-weighted, without needing a space to be secured for installation of an entirety of heat source unit 11 as ever. Further, with an enhanced freedom of installation, it also is enabled to employ such an installation method as suspending the heat source end heat exchanger unit 20 from a ceiling, embedding in a ceiling, or mounting on a wall. The heat source end heat exchanger 20a can have a secured performance as ever, thus permitting the heat source unit 11 provided in the main unit 10 to have a maintained efficiency, as well. Further, as described, the interconnection between the heat source end heat exchanger 20a and the main unit 10 is not made by any water circuits 12, but by the refrigerant lines 30, thus eliminating the needs for, among others, provision of measures for freeze prevention and prevention of radiation loss at the water circuits 12.

[0017] Such being the case, it is enabled to provide a heat pump water heating system including rearranged combinations of constituent components of heat pump water heating system, thereby permitting the freedom of installation to be secured, allowing for installation free of performance deterioration of components, without causing disfigurement.

(Second embodiment)

[0018] Description is now made of the second embodiment of the present invention. It is noted that in the fol-

lowing embodiments, like components to those components described in the first embodiment are designated by like reference characters, eliminating redundant description of like components.

[0019] In the second embodiment, a main unit 10 is distinctive over configuration disclosed in the first embodiment in that a hot water storage tank 13 is separated for installation from a heat source unit 11. The heat source unit 11 and the hot water storage tank 13 are connected to each other via water circuits 12.

[0020] By such the configuration, besides effects described in conjunction with the first embodiment, it is possible to install the hot water storage tank 13 as separated from the heat source unit 11. Therefore, a heat pump water heating system 1 can be installed with an enhanced installation freedom, in particular in respect of the height dimension, allowing for carry-in and construction upon installation of the heat source unit 11, and the maintainability to be improved, as well.

(Third embodiment)

[0021] Description is now made of the third embodiment of the present invention.

[0022] The third embodiment is distinctive over the foregoing embodiments in that the heat source end heat exchanger unit 20 is substituted with a solar heat collector 40 connected to a main unit 10.

[0023] The heat source end heat exchanger 20a is configured to change refrigerant incoming thereto as having passed the expansion valve 11d, from liquid to a gaseous state. At the heat source end heat exchanger 20a, the air fan 20b is then driven for revolutions to have ambient air strike on the refrigerant lines 30, thereby rendering refrigerant low-temperature low-pressure. For revolutions of this fan, various electric components are required, needing electric power also for driving the electric components.

[0024] In the third embodiment, the heat source end heat exchanger unit 20 is substituted with the solar heat collector 40, whereby a heat collector panel is heated by solar energy, permitting refrigerant flowing in the heat collector panel to be heated to cause evaporation. As a result, the air fan 20b, which has been provided in the heat source end heat exchanger unit 20 for sending air for heat exchange to the heat exchanger, is turned unnecessary, thus eliminating the need for electric components to drive the fan, as well. Further, along with the reduction in number of components, it is allowed to eliminate also the need for electric power to drive such electric components.

[0025] Such being the case, it is enabled to provide a heat pump water heating system including rearranged combinations of constituent components of heat pump water heating system, thereby permitting the freedom of installation to be secured and the number of components to be reduced, allowing for installation free of performance deterioration of components, without causing disfigurement.

(Fourth embodiment)

[0026] Description is now made of the fourth embodiment of the present invention.

[0027] In the first embodiment, the expansion valve 11d has been provided inside the heat source unit 11 in the main unit 10. In the fourth embodiment, as illustrated in Fig. 5 for instance, main, such an expansion valve 11d is separated from a heat source unit 11, and provided at the same unit end as a heat source end heat exchanger unit 20.

[0028] Provision of the expansion valve 11d in such a position permits a shortened distance between the expansion valve 11d and a heat source end heat exchanger 20a, thus allowing for an enhanced response of the heat source end heat exchanger 20a depending on open-close actions of the expansion valve 11d.

[0029] Further, the freedom of installation can be secured even with implementation of the expansion valve 11d in the same unit as the heat source end heat exchanger unit 20, permitting provision of a heat pump water heating system allowing for installation free of performance deterioration of components, without causing disfigurement.

[0030] It is noted that the present invention is in no way restricted to the foregoing embodiments as they are, and will be implemented with specifically modified components within a range not departing from the subject matter. Further, components disclosed in the foregoing embodiments may be adequately combined to provide various inventions. For instance, some of whole components disclosed in an embodiment may well be eliminated. In addition, components in different embodiments may be adequately combined.

Industrial Applicability

[0031] The present invention is applicable to a variety of heat pump water heating systems.

Claims

1. A heat pump water heating system including a refrigerant circuit having a compression machine, a four-way valve, a water heat exchanger, an expansion valve, and a heat source end heat exchanger being piping-connected in series, and a hot water storage tank connected to a water circuit of the water heat exchanger for supply and storage of hot water generated at the water heat exchanger, wherein the heat pump water heating system comprises a main unit in which at least the compression machine, the four-way valve, and the water heat exchanger constituting the refrigerant circuit, and the hot water storage tank with water circuitry connected to the water

heat exchanger are accommodated together in a single casing, and
the heat source end heat exchanger configured to separate from the main unit by a piping connection.

2. The heat pump water heating system according to claim 1, wherein the main unit is configured to be separable for installation into the hot water storage tank, and a heat source unit comprising the compression machine, the four-way valve, the water heat exchanger, and the expansion valve.

3. The heat pump water heating system according to claim 1 or 2, comprising a solar heat collector employed as the heat source end heat exchanger.

FIG. 1

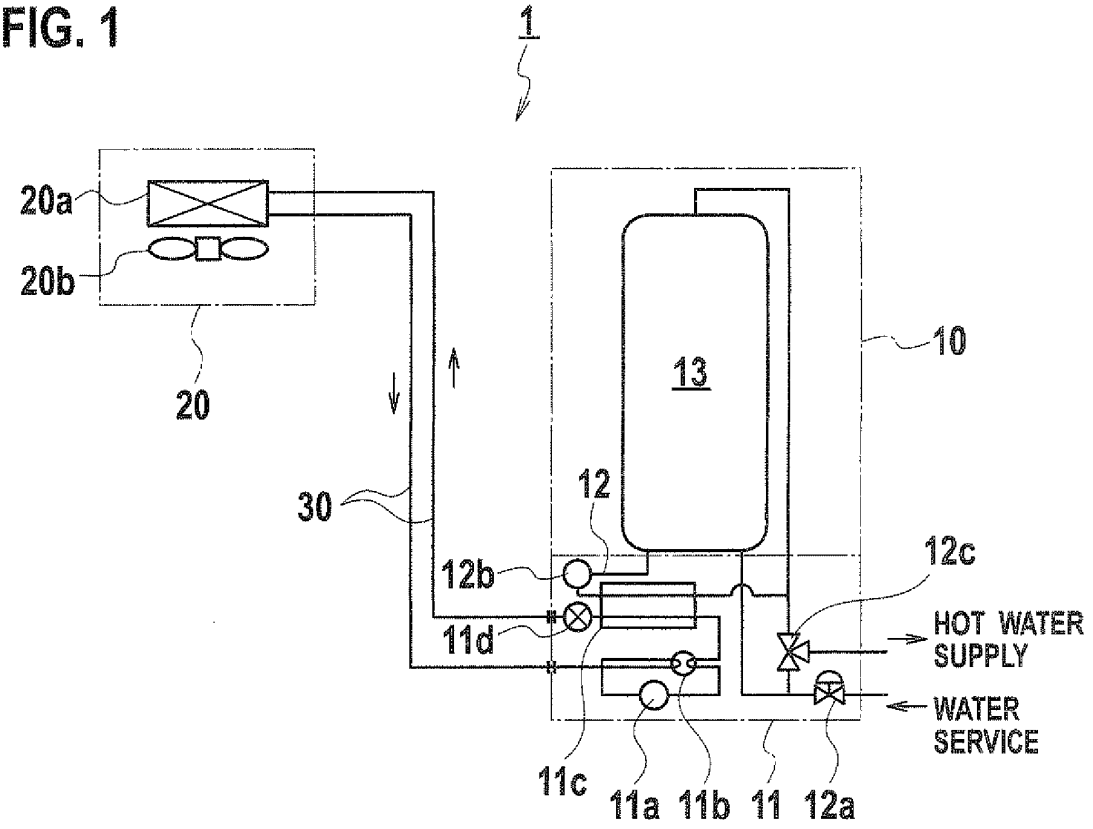

1
20a
20b
20
30
13
10
12
12b
12c
11d
HOT WATER SUPPLY
WATER SERVICE
11c
11a
11b
11
12a

FIG. 2

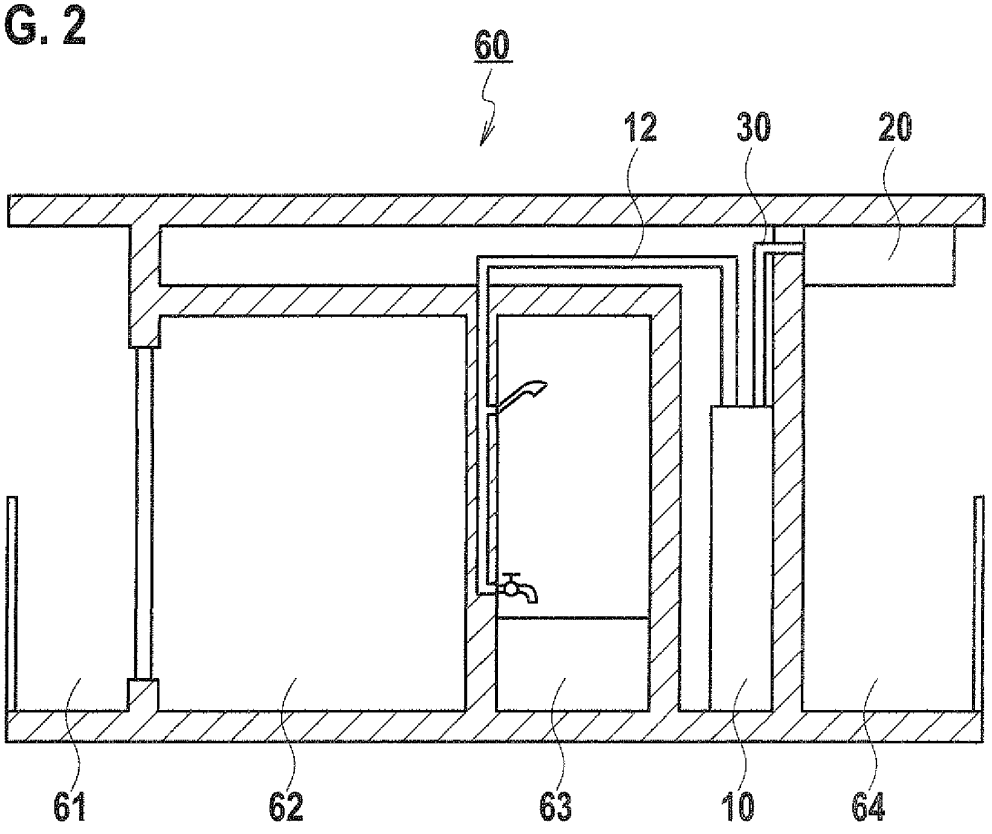

60
12
30
20
61
62
63
10
64

FIG. 3

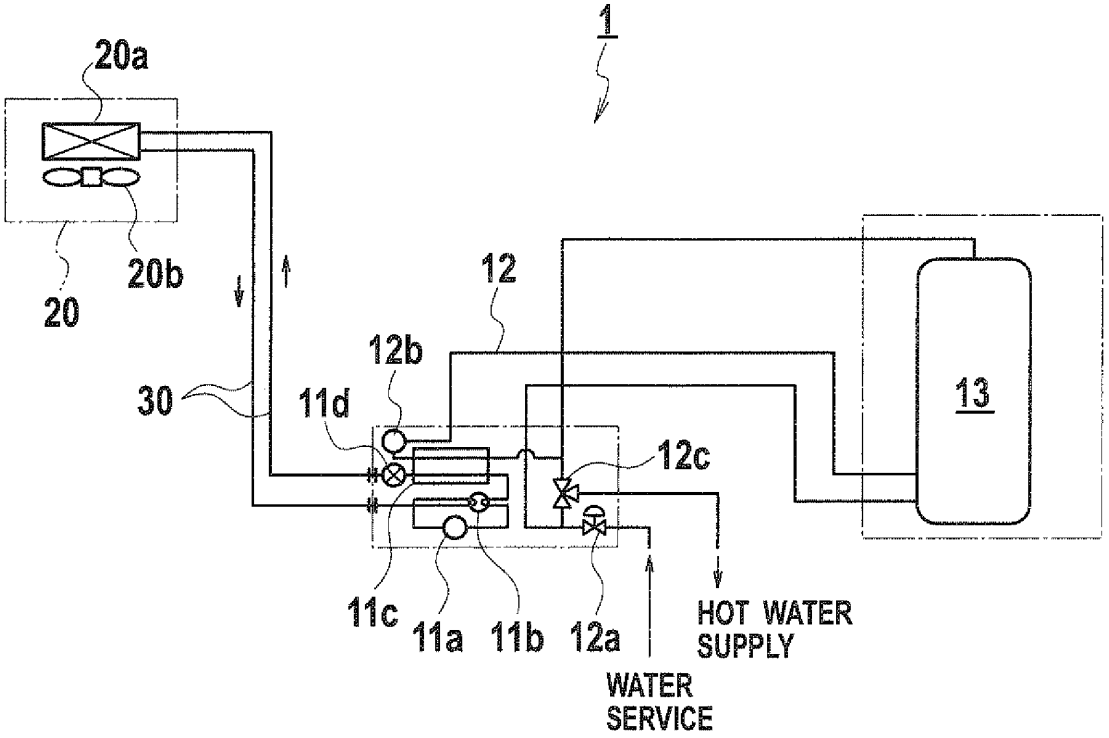

1
20a
20
20b
30
12
12b
11d
13
12c
11c
11a
11b
12a
HOT WATER SUPPLY
WATER SERVICE

FIG.4

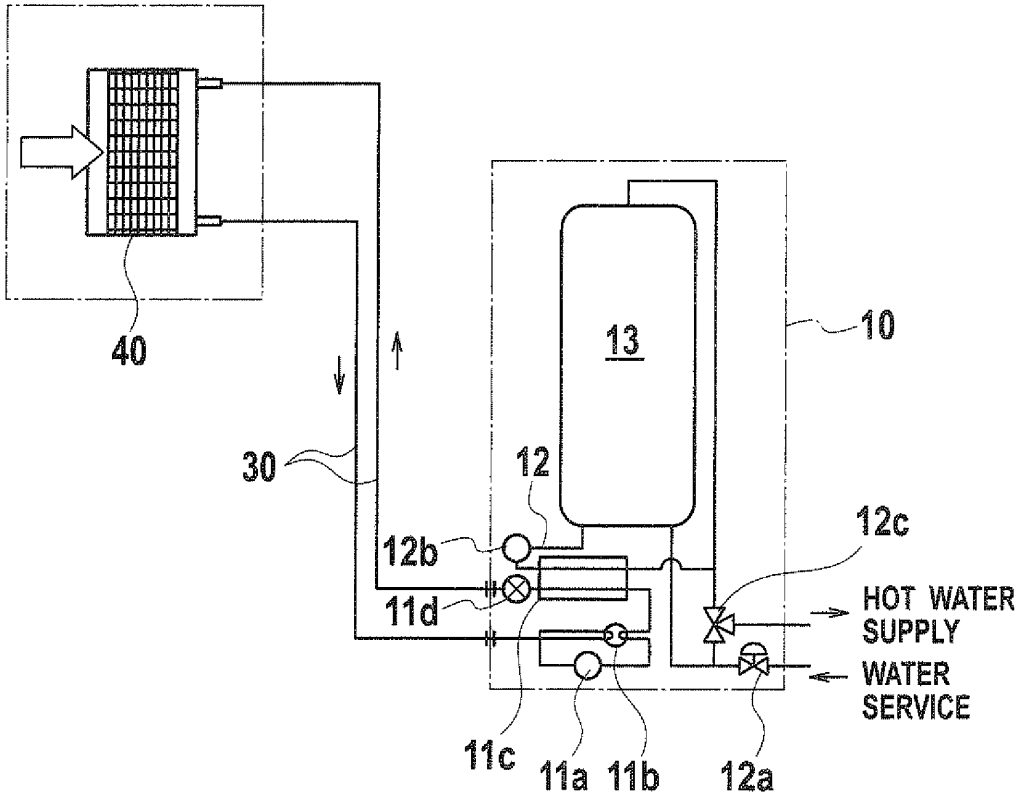
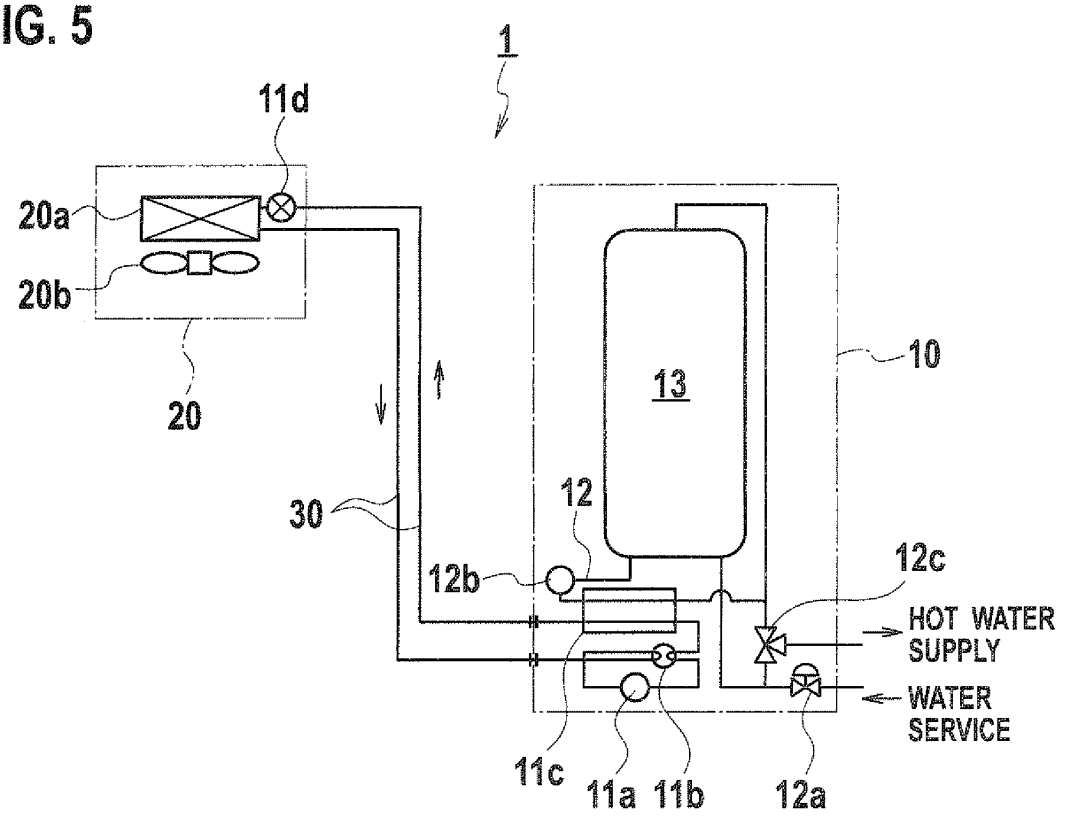

40
30
13
10
12
12b
12c
11d
HOT WATER SUPPLY
WATER SERVICE
11c
11a
11b
12a

FIG. 5


1
11d
20a
20b
20
30
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10
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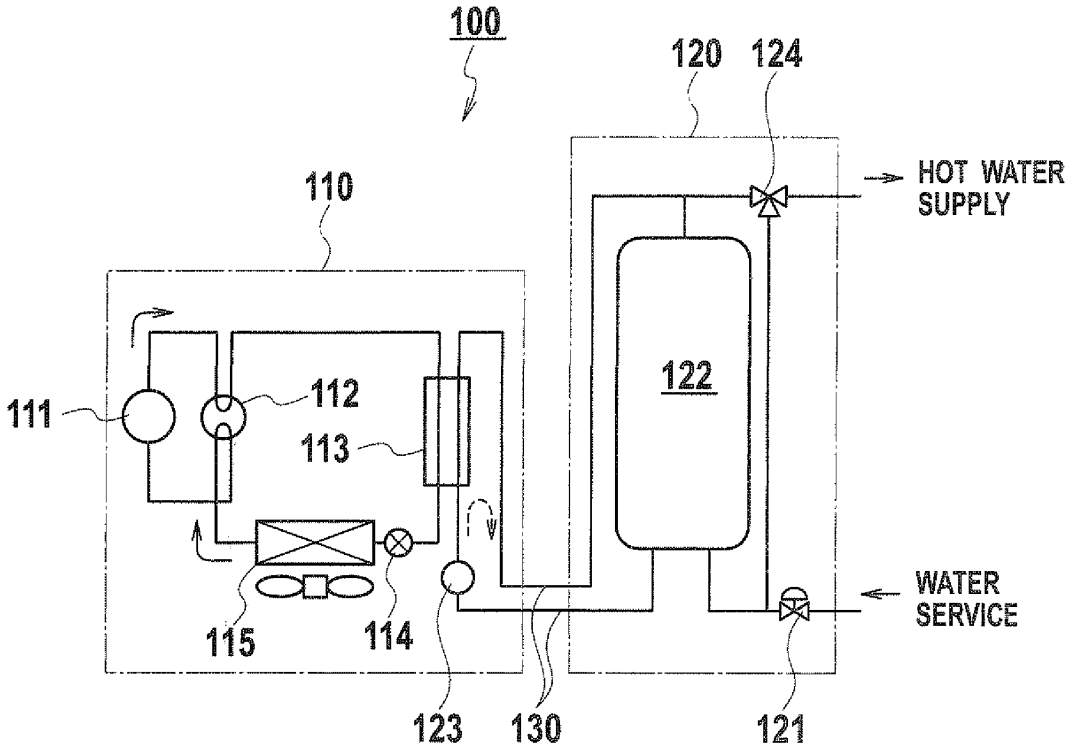
12b
12c
HOT WATER SUPPLY
WATER SERVICE
11c
11a
11b
12a

FIG. 6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110
HOT WATER SUPPLY
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111
112
113
115
114
WATER SERVICE
123
130
121

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/061200

A. CLASSIFICATION OF SUBJECT MATTER
F24H1/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F24H1/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2007
Kokai Jitsuyo Shinan Koho 1971-2007 Toroku Jitsuyo Shinan Koho 1994-2007

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2004-245466 A (Sanyo Electric Co., Ltd.), 02 September, 2004 (02.09.04), Par. Nos. [0007] to [0014]; Fig. 1 (Family: none)	1-3
Y	JP 2001-82818 A (Mitsubishi Electric Corp.), 30 March, 2001 (30.03.01), Par. Nos. [0020] to [0022], [0054] to [0055]; Figs. 1, 7 (Family: none)	1-3
Y	JP 2005-106333 A (Sanyo Electric Co., Ltd.), 21 April, 2005 (21.04.05), Par. Nos. [0047] to [0051]; Fig. 3 (Family: none)	2

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
02 July, 2007 (02.07.07)	17 July, 2007 (17.07.07)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/061200

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 61-3955 A (Matsushita Electric Industrial Co., Ltd.), 09 January, 1986 (09.01.86), Page 1, left column, line 14 to right column, line 10; Figs. 1, 2 (Family: none)	3

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2001082818 A **[0004]**