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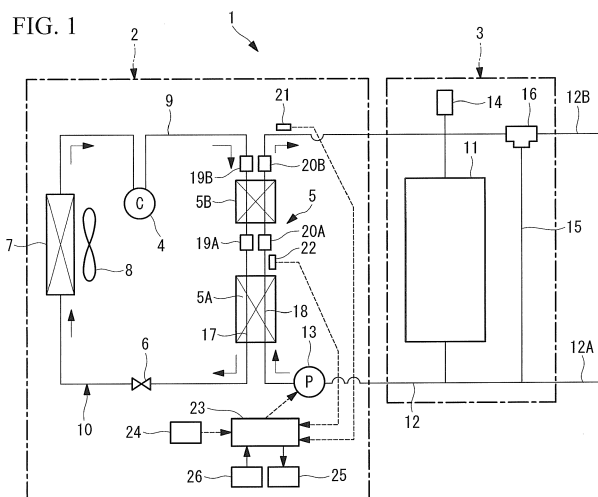
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(54) **Heat pump hot water supply system**

(57) The present invention provides a heat pump hot water supply system which can continue the operation even when scale builds up while maintaining the hot water outlet temperature at a target temperature, and can confine the scale buildup to the high temperature-side water heat exchanger so as to prevent it from spreading to the low temperature-side water heat exchanger. In a heat pump hot water supply system (1) of a type which controls the rotation speed of a water pump (13) and thereby the amount of water so that the hot water outlet temperature becomes equal to a target temperature, a water heat exchanger (5) is divided into a high temperature-side water heat exchanger (5B) and a low temperature-side water heat exchanger (5A), and a hot water outlet temperature sensor (21) is provided on a hot water

outlet side of the high temperature-side water heat exchanger (5B), and a hot water temperature sensor (22) is provided on an outlet side of the low temperature-side water heat exchanger (5A), and the heat pump hot water supply system includes a control part (23) which, if a detection value of the outlet hot water temperature sensor (22) of the low temperature-side water heat exchanger (5A) exceeds a set value when the performance of the high temperature-side water heat exchanger (5B) is degraded due to scale buildup, controls so that the hot water outlet temperature is kept equal to or lower than the set value, and outputs information on the decrease in the hot water outlet temperature and information on maintenance of the high temperature-side water heat exchanger (5B).



Description

{Technical Field}

5 **[0001]** The present invention relates to a heat pump hot water supply system of a type which includes a water heat exchanger and controls the rotation speed of a water pump and thereby the amount of water so that the hot water outlet temperature becomes equal to a target temperature.

{Background Art}

10 **[0002]** In a heat pump hot water supply system which heats water in a water heat exchanger by using a heat pump and delivers hot water, depending on the water quality, scale can build up on a water passage side of the water heat exchanger and degrade the heat exchange performance, which in some cases causes problems such as insufficient system capability, increased power consumption, or shutdown by protective control. Especially in a system of a type
 15 which controls the rotation speed of a water pump and thereby the amount of water so that the hot water outlet temperature becomes equal to a target temperature set by a remote controller, etc., it is difficult to recognize degradation of the heat exchange performance due to scale buildup since the hot water outlet temperature is maintained even when the performance is degraded.

20 **[0003]** In order to deal with these problems, PTLs 1 and 2 disclose heat pump water heaters which detect scale buildup and allow cleaning or replacement of a water heat exchanger. Those disclosed in PTL 1 include a heat pump water heater which is provided with a flow sensor on a water circuit side to detect scale buildup from a decrease in the flow due to scale buildup and issue an alert to the scale buildup by an alert means, and which allows removal of scale by a scale removal means, and another heat pump water heater in which a water heat exchanger is divided into a low
 25 temperature-side water heat exchanger and a high temperature-side water heat exchanger, and the scale removal means and a joint part which enables replacement of the heat exchanger are provided in the high temperature-side water heat exchanger which is prone to scale buildup.

30 **[0004]** On the other hand, PTL 2 discloses a heat pump water heater which is provided with temperature sensors on an outlet side and at an intermediate position of a water heat exchanger, or on an outlet side and an inlet side of a high temperature-side water heat exchanger which is divided into a low temperature-side water heat exchanger and the high temperature-side water heat exchanger, and determines scale buildup from a difference in detection values of the temperature sensors; if the difference is equal to or lower than a set value, the water heater continues the operation while decreasing the hot water outlet temperature, and when the hot water outlet temperature has been decreased to or below the set temperature, displays the decrease in the hot water outlet temperature and a maintenance call.

35 {Citation List}

{Patent Literature}

[0005]

40 {PTL 1}
 Japanese Unexamined Patent Application, Publication No. 2004-144445
 {PTL 2}
 Japanese Unexamined Patent Application, Publication No. 2011-252676

45 {Summary of Invention}

{Technical Problem}

50 **[0006]** However, PTLs 1 and 2 do not disclose how to continue the operation while maintaining the target temperature without lowering the hot water outlet temperature when the heat exchange performance is degraded due to scale buildup, or how to prevent scale buildup in the low temperature-side water heat exchanger. Therefore, these inventions are not capable of continuing the operation while maintaining the hot water outlet temperature at the target temperature as far as possible. Even if they can detect scale buildup and issue an alert to it, unfortunately, scale buildup can expand to the
 55 low temperature-side water heat exchanger if the operation is continued until maintenance is actually performed.

[0007] The present invention has been made in view of these situations, and aims to provide a heat pump hot water supply system which can continue the operation, even when scale builds up, while maintaining the hot water outlet temperature at a target temperature as far as possible, and can confine the scale buildup to the high temperature-side

water heat exchanger so as to prevent it from spreading to the low temperature-side water heat exchanger.

{Solution to Problem}

[0008] In order to solve the above problems, the heat pump hot water supply system of the present invention has adopted the following solutions:

A heat pump hot water supply system according to the present invention is a type of a heat pump hot water supply system which is provided with a water heat exchanger for producing hot water by heating the water with a refrigerant gas discharged from a heat pump or with a heat medium undergoing heat exchange with the refrigerant gas and circulating inside a closed cycle, and which controls a rotation speed of a water pump and thereby an amount of water so that a hot water outlet temperature becomes equal to a target temperature, wherein the water heat exchanger is divided into a high temperature-side water heat exchanger and a low temperature-side water heat exchanger, and a hot water outlet temperature sensor is provided on a hot water outlet side of the high temperature-side water heat exchanger, and a hot water temperature sensor is provided on an outlet side of the low temperature-side water heat exchanger; and the heat pump hot water supply system includes a control part which, if a detection value of the outlet hot water temperature sensor of the low temperature-side water heat exchanger exceeds a set value when performance of the high temperature-side water heat exchanger is degraded due to scale buildup, controls so that the hot water outlet temperature is kept equal to or lower than the set value, and outputs information on decrease in the hot water outlet temperature and information on maintenance of the high temperature-side water heat exchanger.

[0009] According to this configuration, even when the heat exchange performance is degraded due to scale buildup in the high temperature-side water heat exchanger, it is possible to continue the operation while maintaining the hot water outlet temperature at a target temperature by controlling the amount of water with the water pump. Meanwhile, if the outlet hot water temperature of the low temperature-side water heat exchanger gradually increases and exceeds the set value, scale can deposit also in the low temperature-side water heat exchanger; therefore, the system continues the operation while suppressing scale deposition by controlling the heat pump capacity so that the outlet hot water temperature of the low temperature-side water heat exchanger is kept equal to or lower than the set value, and outputs the decrease in the hot water outlet temperature and the necessity for maintenance of the high temperature-side water heat exchanger, etc. as information. Thus, it is possible to continue the operation, without immediately lowering the hot water outlet temperature even when scale deposits, while maintaining the hot water outlet temperature at a target temperature as far as possible and preventing scale deposition in the low temperature-side water heat exchanger, as well as to accurately output information to the user on the decrease in the hot water outlet temperature due to scale buildup or on maintenance of the high temperature-side water heat exchanger, etc.

[0010] In the above-described heat pump hot water supply system, the control part may include a display part which displays the information on decrease in the hot water outlet temperature and the information on maintenance of the high temperature-side water heat exchanger when the performance of the high temperature-side water heat exchanger is degraded due to scale buildup.

[0011] According to this configuration, it is possible to provide the user with necessary information in a timely manner by outputting the information on the decrease in the hot water outlet temperature due to scale buildup or the information on the necessity for maintenance of the high temperature-side water heat exchanger, etc. to the display part and displaying the information. Thus, the user can take necessary measures on the basis of such information.

[0012] In any one of the above-described heat pump hot water supply systems, the control part may include a temperature setting switch for varying the set value of the outlet hot water temperature of the low temperature-side water heat exchanger according to the quality of the water supplied to the water heat exchanger.

[0013] According to this configuration, it is possible to determine the quality of the water supplied to the water heat exchanger, for example, by checking the hardness of tap water, and set the set value of the outlet hot water temperature of the low temperature-side water heat exchanger to a value suitable to the water quality based on the check result; for example, in the case of hard water which is prone to scale deposition, the set value can be set to a lower value by using the temperature setting switch, whereas in the case of soft water, the set value can be set to a higher value. Thus, the hot water supply system can be properly operated according to the water quality even if it varies from region to region.

[0014] In any one of the above-described heat pump hot water supply systems, the high temperature-side water heat exchanger may include a cleaning means for removing scale and/or a detaching means for replacing the heat exchanger.

[0015] According to this configuration, when the information on maintenance of the high temperature-side water heat exchanger is output due to scale buildup, it is possible to clean and remove the scale by supplying high-pressure cleaning water or ultrasonic cleaning water, etc. to the high temperature-side water heat exchanger through the cleaning means, or to detach the high temperature-side water heat exchanger as necessary from a refrigerant circuit and a water circuit

through the detaching means and replace it with a new heat exchanger. Thus, it is possible to easily and quickly maintain the high temperature-side water heat exchanger on which scale has built up and to recover the heat exchange performance.

[0016] In any one of the above-described heat pump hot water supply systems, the volume ratio of the high temperature-side water heat exchanger to the water heat exchanger may be 0.3 to 0.4.

[0017] According to this configuration, the high temperature-side water heat exchanger is divided from the low temperature-side water heat exchanger at a position of roughly 60 to 70% of the volume ratio (capacity ratio) of the water heat exchanger where the water temperature reaches approximately 60°C regardless of whether the water temperature at the inlet of the water heat exchanger is high or low. Thus, scale deposition can be confined to the high temperature-side water heat exchanger even under high hardness and high temperature conditions where the area of scale deposition is likely to expand. Thus, it is possible to facilitate the maintenance as well as to reduce the size and the cost of the high temperature-side water heat exchanger which requires replacement.

{Advantageous Effects of Invention}

[0018] According to the present invention, even when the heat exchange performance is degraded due to scale buildup in the high temperature-side water heat exchanger, it is possible to continue the operation while maintaining the hot water outlet temperature at a target temperature by controlling the amount of water with the water pump. Meanwhile, if the outlet hot water temperature of the low temperature-side water heat exchanger gradually increases and exceeds a set value, scale can deposit also in the low temperature-side water heat exchanger; therefore, the system continues the operation while suppressing scale deposition by controlling the heat pump capacity so that the outlet hot water temperature of the low temperature-side water heat exchanger is kept equal to or lower than the set value, and outputs the decrease in the hot water outlet temperature, the necessity for maintenance of the high temperature-side water heat exchanger, etc., as information. Thus, it is possible to continue the operation, without immediately lowering the hot water outlet temperature even when scale deposits, while maintaining the hot water outlet temperature at a target temperature as far as possible and preventing scale deposition in the low temperature-side water heat exchanger, as well as to accurately output the information to the user on the decrease in the hot water outlet temperature due to scale buildup or on maintenance of the high temperature-side water heat exchanger, etc.

{Brief Description of Drawings}

[0019]

{Fig. 1}

Fig. 1 is a configuration diagram of a heat pump hot water supply system according to a first embodiment of the present invention.

{Fig. 2}

Fig. 2 is a flow diagram of control when scale deposits in the heat pump hot water supply system.

{Fig. 3}

Figs. 3(A) to 3(C) are maps showing scale occurrence in a water heat exchanger of the heat pump hot water supply system.

{Fig. 4}

Fig. 4 is a configuration diagram of a heat pump hot water supply system according to a second embodiment of the present invention.

{Description of Embodiments}

[0020] In the following, embodiments of the present invention will be described with reference to the drawings.

(First Embodiment)

[0021] A first embodiment of the present invention will be described below by using Fig. 1 to Fig. 3.

[0022] Fig. 1 is a configuration diagram of a heat pump hot water supply system according to the first embodiment of the present invention, and Fig. 2 is a flow diagram of control performed by a control part of the heat pump hot water supply system when scale deposits.

[0023] A heat pump hot water supply system 1 of this embodiment includes: a supercritical-cycle heat pump 2 which uses a CO₂ refrigerant; and a hot water storage tank unit 3 which is provided with a hot water storage tank 11 for storing the hot water produced by the heat pump 2.

[0024] The heat pump 2 includes a closed-cycle refrigerant circuit 10 which is constituted of the following components sequentially connected by a refrigerant pipe 9: a compressor 4 for compressing a refrigerant; a water heat exchanger (gas cooler) 5 functioning as a gas cooler and producing hot water by means of heat exchange between the refrigerant and water; a pressure reducing means 6 constituted of an electronic expansion valve, etc., for reducing the pressure of the refrigerant; and an evaporator 7 for evaporating the refrigerant by means of heat exchange with outside air circulated through a fan 8. The heat pump 2 is a supercritical-cycle heat pump filled with a CO₂ refrigerant as a working medium, and the pump itself may be a publicly-known one.

[0025] The hot water storage tank unit 3 includes: the hot water storage tank 11 which has a capacity required for storing the hot water produced on the heat pump 2 side; a water circuit 12 which allows the water to circulate to the water heat exchanger 5 of the heat pump 2 through the hot water storage tank 11; a water pump 13 provided inside the water circuit 12; an air vent 14 which, when air is included into the water circuit 12, functions to discharge the air to the outside by operation of the water pump 13; a bypass circuit 15 which is provided between a water supply pipe 12A and a hot water delivery pipe 12B of the water circuit 12; and a temperature-sensitive mixing valve 16 which mixes the water from the bypass circuit 15 and supply hot water from the hot water storage tank 11 to produce hot water at a predetermined temperature, and supplies the hot water to the load side.

[0026] The water heat exchanger (gas cooler) 5 of the heat pump 2 is a heat exchanger which performs heat exchange between the refrigerant flowing on a refrigerant passage 17 side which is connected with the refrigerant circuit 10 and the water flowing on a water passage 18 side which is connected with the water circuit 12, and functions to heat the water using radiation from the high-temperature, high-pressure refrigerant gas to produce hot water. The water heat exchanger 5 is configured such that the flow direction of the refrigerant flowing through the refrigerant passage 17 and the flow direction of the water flowing through the water passage 18 are opposite to each other. This water heat exchanger 5 is divided into a low temperature-side water heat exchanger 5A on the water inlet side and a high temperature-side water heat exchanger 5B on the hot water outlet side.

[0027] The divided high temperature-side water heat exchanger 5B is detachable from the refrigerant circuit 10 and the water circuit 12 through refrigerant-side detaching means (a joint and a fastener) 19A and 19B and water-side detaching means (a joint and a fastener) 20A and 20B, and can be easily replaced when scale builds up. The water-side detaching means 20A and 20B may be provided with a valve for cleaning and removing scale by circulating high-pressure cleaning water or ultrasonic cleaning water, and may be connectable with the cleaning means.

[0028] The volume ratio (capacity ratio) between the two divisions, the low temperature-side water heat exchanger 5A and the high temperature-side water heat exchanger 5B, is roughly as follows: low temperature-side water heat exchanger 5A:high temperature-side water heat exchanger 5B = 6:4 to 7:3. This is based on the finding that when, for example, hot water of 90°C is to be taken out, the water temperature reaches about 60°C, regardless of whether the water temperature at the inlet of the water heat exchanger 5 is high or low, at a position of roughly 60 to 70% of the volume ratio (capacity ratio) of the water heat exchanger 5.

[0029] The above-described heat pump hot water supply system 1 adopts a system in which the rotation speed of the water pump 13 and thereby the amount of water are controlled while the constant capacity of the heat pump 2 is maintained so that the temperature of the hot water delivered from the water heat exchanger 5 (hereinafter called a "hot water outlet temperature") becomes equal to a temperature set by the user with a remote controller, etc. (a target temperature). On the other hand, city water (tap water) is normally circulated on the water passage 18 side of the water heat exchanger (gas cooler) 5, and depending on the water quality, scale builds up on the water passage 18 side over a long period of operation, which can degrade the heat exchange performance so that the initial capability is no longer available.

[0030] Other than the pH and the M-alkalinity (as CaCO₃), the hardness and the temperature, etc. of the water have influence on scale deposition. Figs. 3(A), 3(B), and 3(C) are maps of scale occurrence when the hot water outlet temperature is at a low temperature, a medium temperature, and a high temperature, respectively. As can be seen from these figures, in the case of waters having the same pH, scale is more likely to deposit as the water temperature increases and as the hardness increases, even with a low M-alkalinity. That is, it can be seen that under high hardness and high temperature conditions, the area of scale deposition expands to a greater degree.

[0031] In this embodiment, therefore, a hot water outlet temperature sensor 21 for detecting the hot water outlet temperature is provided on the hot water outlet side of the high temperature-side water heat exchanger 5B of the divided water heat exchanger 5, and a hot water temperature sensor 22 for detecting the outlet hot water temperature is provided on the hot water outlet side of the low temperature-side water heat exchanger 5A, and a control part 23 is provided which, when the scale builds up in the high temperature-side water heat exchanger 5B and degrades the heat exchange performance, operates the heat pump hot water supply system 1 in the following manner on the basis of the detection values of the temperature sensors 21 and 22.

[0032] The control part 23 functions to control the rotation speed of the water pump 13 and thereby the amount of water so that the temperature of the hot water produced in the water heat exchanger 5 detected by the hot water outlet temperature sensor 21 becomes equal to a target temperature (e.g., 90°C) set by the user through a setting means such

as a remote controller 24. When the heat exchange performance of the high temperature-side water heat exchanger 5B is degraded due to scale buildup, the outlet hot water temperature of the low temperature-side water heat exchanger 5A gradually increases due to the control of the amount of water by the water pump 13. Therefore, the control part 23 also functions to monitor the detection value of the hot water temperature sensor 22, and when the outlet hot water temperature exceeds the set value, controls so that the outlet hot water temperature of the low temperature-side water heat exchanger 5A is kept equal to or lower than the set value, and outputs information on the resulting decrease in the hot water outlet temperature or maintenance information for the high temperature-side water heat exchanger 5B.

[0033] Furthermore, the control part 23 includes a temperature setting switch 26 for varying, according to the water quality, the set value for outputting the information on the control of the hot water temperature, the decrease in the hot water outlet temperature, and the maintenance information for the high temperature-side water heat exchanger on the basis of the detection value of the outlet hot water temperature of the low temperature-side water heat exchanger 5A. This switch makes it possible to set a set value which is suitable to the water quality by checking the hardness of the tap water, etc. circulating through the water heat exchanger 5; for example, in the case of high-hardness water which is prone to scale deposition, the set value can be set to a lower value, whereas in the case of low-hardness soft water, the set value can be set to a higher value. For example, in the case of high-hardness hard water, the set value may be 60°C, and the set value can be made higher as the hardness decreases.

[0034] In the following, a flow of control performed by the control part 23 when scale deposits will be described in detail on the basis of the control flow diagram shown in Fig. 2.

[0035] During operation of the heat pump hot water supply system 1, the user sets an arbitrary hot water outlet temperature (e.g., 90°C) through the setting means such as the remote controller 24 (step S1). This causes the hot water supply system 1 to operate, with the hot water outlet temperature set by the remote controller 24 as the target temperature, while controlling the amount of water so that the temperature of the hot water delivered from the water heat exchanger 5 (high temperature-side water heat exchanger 5B) detected by the hot water outlet temperature sensor 21 becomes equal to the target temperature by controlling the rotation speed of the water pump 13 with a constant capacity of the heat pump 2.

[0036] When the hot water outlet temperature is set in step S1, the control part proceeds to step S2, where a set value of the outlet hot water temperature of the low temperature-side water heat exchanger 5A is set. This set value to be input is a value which is obtained by checking the quality (hardness) of tap water, etc., which is supplied to the water heat exchanger 5, during installation, etc. of the heat pump hot water supply system 1, and is previously set by the temperature setting switch 26 as an appropriate temperature for the water hardness. When the set value of the outlet hot water temperature of the low temperature-side water heat exchanger 5A is set in step S2, the control part proceeds to step S3. In step S3, the hot water outlet temperature and the outlet hot water temperature of the low temperature-side water heat exchanger 5A are read as detection values of the temperature sensors 20 and 21 to be used as operation data.

[0037] Then, in step S4, it is determined whether or not the hot water outlet temperature detected by the temperature sensor 20 is equal to the target temperature set in step S1. If YES, the control part returns to step S1 and repeats the same actions. If NO, the control part proceeds to step S5, and while maintaining the constant capacity of the heat pump, controls the rotation speed of the water pump 13 so that the hot water outlet temperature becomes equal to the target temperature, before proceeding to step S6. In step S6, it is determined whether or not the outlet hot water temperature of the low temperature-side water heat exchanger 5A detected by the temperature sensor 21 is equal to or lower than the set value.

[0038] When scale deposits in the high temperature-side water heat exchanger 5B during hot water supply operation and builds up on the inner circumferential surface of the water passage 18, pressure loss increases and heat exchange with the refrigerant is inhibited, resulting in degradation of the heat exchange performance and a decrease in the hot water outlet temperature. Here, the rotation speed of the water pump 13 and thereby the amount of water are controlled so as to maintain the hot water outlet temperature at the target temperature. If the operation is continued in this state, the outlet hot water temperature of the low temperature-side water heat exchanger 5A gradually increases. Scale buildup can be detected by detecting and monitoring this hot water temperature by the temperature sensor 21. When the outlet hot water temperature of the low temperature-side water heat exchanger 5A is equal to or lower than the set value in step S6, YES is determined and the control part returns to step S1 to repeat the same actions.

[0039] On the other hand, if the outlet hot water temperature of the low temperature-side water heat exchanger 5A increases due to scale buildup and exceeds the set value, NO is determined and the control part proceeds to step S7. In this step, the control part controls the capacity of the heat pump 2 (e.g., controls the rotation speed of the compressor 4) in order to keep the outlet hot water temperature of the low temperature-side water heat exchanger 5A equal to or lower than the set value, and thereafter proceeds to step S8. In step S8, as it becomes difficult to maintain the hot water outlet temperature at the target temperature due to scale buildup and the control of the outlet hot water temperature of the low temperature-side water heat exchanger 5A, the control part outputs information on the decreasing hot water outlet temperature and information such as a maintenance alarm (cleaning/replacement) for removal of the scale in the

high temperature-side water heat exchanger 5B to a display part 25, and returns to step S1. Subsequently, the same actions are repeated.

[0040] Thus, in addition to the function of controlling the rotation speed of the water pump 13 so that the hot water outlet temperature becomes equal to the target temperature set by the remote controller 24, etc., the control part 23 also functions to continue the operation while maintaining the target temperature when the performance of the high temperature-side water heat exchanger 5B is degraded due to scale buildup, and when scale deposition in the low temperature-side water heat exchanger 5A becomes likely due to the increasing outlet hot water temperature of the low temperature-side water heat exchanger 5A as the operation continues, namely, when the detection value of the hot water temperature sensor 22 exceeds the set value, to continue the operation while controlling the capacity of the heat pump 2 (e.g., controlling the rotation speed of the compressor 4) and keeping the outlet hot water temperature of the low temperature-side water heat exchanger 5A equal to or lower than the set value, and to output the information on the decrease in the hot water outlet temperature and the maintenance information for the high temperature-side water heat exchanger 5B to the display part 25 to display the information.

[0041] Being configured as described above, this embodiment provides the following advantages:

When the supercritical-cycle heat pump 2 using a CO₂ refrigerant is operated in the heat pump system 1, a high-temperature, high-pressure refrigerant gas compressed in the compressor 4 is introduced into the water heat exchanger 5 through the refrigerant circuit 10. In the water heat exchanger, the refrigerant flowing through the refrigerant passage 17 of the high temperature-side water heat exchanger 5B and the low temperature-side water heat exchanger 5A and the water circulating to the water passage 18 through the water circuit 12 undergo heat exchange with each other. The water is thereby heated and increased in temperature due to the radiation from the high-temperature, high-pressure refrigerant gas, and delivered as hot water at a temperature set by the setting means such as the remote controller 24.

[0042] This hot water is delivered through the water circuit 12 to the hot water storage tank 11, and stored in the hot water storage tank 11. Meanwhile, the refrigerant having radiated heat to the water and been cooled in the water heat exchanger 5 is reduced in pressure by the pressure reducing means 6, and introduced as a gas-liquid two-phase, low-pressure and low-temperature refrigerant into the evaporator 7, where the refrigerant is evaporated through heat exchange with the outside air blown by the fan 8, and is suctioned into the compressor 4 to be recompressed. Subsequently, the same actions are repeated and the refrigerant serves the production of hot water.

[0043] The hot water stored in the hot water storage tank 11 is delivered, at the time of need, from the hot water storage tank 11 through the hot water delivery-side pipe 12B to the load side for consumption. At this time, the water around 20°C supplied from the water supply-side pipe 12A through the bypass circuit 15 to the mixing valve 16 and the high-temperature water of approximately 90°C having been stored inside the hot water storage tank 11 are mixed in the mixing valve 16, and adjusted to be hot water of approximately 60°C, for example, before being supplied to the load side.

[0044] In the above-described hot water production process, water such as tap water is circulated to the water passage 18 of the water heat exchanger 5. Depending on the water quality, scale deposits on the water passage 18 side, and as the scale accumulates, heat exchange is inhibited and the heat exchange performance (capability) is degraded, which can result in insufficient capability of the system 1, increased power consumption, or shutdown by protective control, etc.

[0045] Hence in this embodiment, the water heat exchanger 5 is divided into the high temperature-side water heat exchanger 5B and the low temperature-side water heat exchanger 5A, and the hot water outlet temperature sensor 21 is provided on the hot water outlet side of the high temperature-side water heat exchanger 5B and the hot water temperature sensor 22 is provided on the outlet side of the low temperature-side water heat exchanger 5A, and the control part 23 is provided, which, if the detection value of the outlet hot water temperature sensor 22 of the low temperature-side water heat exchanger 5A exceeds the set value when the performance of the high temperature-side water heat exchanger 5B is degraded due to scale buildup, controls so that the hot water outlet temperature is kept equal to or lower than the set value, and outputs the information on the decrease in the hot water outlet temperature and the maintenance information for the high temperature-side water heat exchanger 5B.

[0046] Therefore, even when the heat exchange performance of the high temperature-side water heat exchanger 5B is degraded due to scale buildup, it is possible to continue the operation while maintaining the hot water outlet temperature at the target temperature by controlling the amount of water of the water pump 13. Meanwhile, scale can deposit also in the low temperature-side water heat exchanger 5A when the outlet hot water temperature of the low temperature-side water heat exchanger 5A gradually increases and exceeds the set value; therefore, the system continues the operation while suppressing scale deposition by controlling the capacity of the heat pump 2 and thereby keeping the outlet hot water temperature of the low temperature-side water heat exchanger 5A equal to or lower than the set value, and outputs the decrease in the hot water outlet temperature and the necessity for maintenance of the high temperature-side water heat exchanger 5B as information.

[0047] Thus, it is possible to continue the operation, without immediately lowering the hot water outlet temperature

even when scale deposits, while maintaining the hot water outlet temperature at a target temperature as far as possible and preventing scale deposition in the low temperature-side water heat exchanger 5A, as well as to accurately output the information to the user on the decrease in the hot water outlet temperature due to scale buildup or on maintenance of the high temperature-side water heat exchanger 5B, etc.

[0048] The control part 23 includes the display part 25 for displaying the information on the decrease in the hot water outlet temperature and the maintenance information for the high temperature-side water heat exchanger 5B when the performance of the high temperature-side water heat exchanger 5B is degraded due to scale buildup. Accordingly, it is possible to provide the user with necessary information in a timely manner by outputting the information on the decrease in the hot water outlet temperature due to scale buildup or the information on the necessity for maintenance of the high temperature-side water heat exchanger 5B, etc. to the display part 25 and displaying the information. Thus, the user can take necessary measures on the basis of such information.

[0049] Since the control part 23 includes the temperature setting switch 26 for varying the set value of the outlet hot water temperature of the low temperature-side water heat exchanger 5A according to the quality of the water supplied to the water heat exchanger 5, it is possible to determine the quality of the water supplied to the water heat exchanger 5, for example, by checking the hardness of tap water, and set the set value of the outlet hot water temperature of the low temperature-side water heat exchanger 5A to a value suitable to the water quality based on the check result; for example, in the case of hard water which is prone to scale deposition, the set value can be set to a lower value, whereas in the case of soft water, the set value can be set to a higher value, by the temperature setting switch 26. Thus, the hot water supply system 1 can be properly operated according to the water quality even if it varies from region to region.

[0050] In this embodiment, the high temperature-side water heat exchanger 5B includes the cleaning means for removing scale and/or the detaching means 19A, 19B, and 20A, 20B for replacing the heat exchanger. Thus, when the maintenance information for the high temperature-side water heat exchanger 5B is output due to scale buildup, it is possible to clean and remove the scale by supplying high-pressure cleaning water or ultrasonic cleaning water to the high temperature-side water heat exchanger 5B through the cleaning means, or to detach the high temperature-side water heat exchanger 5B as necessary from the refrigerant circuit 10 and the water circuit 12 through the detaching means 19A, 19B and 20A, 20B and replace it with a new heat exchanger. Thus, it is possible to easily and quickly maintain the high temperature-side water heat exchanger 5B on which scale has built up and to recover the heat exchange performance.

[0051] Moreover, in this embodiment, the volume ratio of the high temperature-side water heat exchanger 5B to the water heat exchanger 5 is 0.3 to 0.4. Thus, the high temperature-side water heat exchanger 5B is divided from the low temperature-side water heat exchanger at a position of roughly 60 to 70% of the volume ratio (capacity ratio) of the water heat exchanger 5 where the water temperature reaches approximately 60°C regardless of whether the water temperature at the inlet of the water heat exchanger 5 is high or low. Accordingly, the scale deposition can be confined to the high temperature-side water heat exchanger 5B even under high hardness and high temperature conditions where the area of scale deposition is likely to expand. Thus, it is possible to facilitate the maintenance as well as to reduce the size and the cost of the high temperature-side water heat exchanger 5B which requires replacement.

(Second Embodiment)

[0052] Next, a second embodiment of the present invention will be described by using Fig. 4.

[0053] This embodiment differs from the above-described first embodiment in that a closed-cycle heat medium circuit 30 is provided between the refrigerant circuit 10 and the water circuit 12 of the heat pump 2. Description of the other features, which are the same as those the first embodiment, will be omitted here.

[0054] In this embodiment, the closed-cycle heat medium circuit 30 which circulates a heat medium such as water or a coolant through a heat medium pump 31 is provided between the refrigerant circuit 10 and the water circuit 12, and the heat medium on the heat medium circuit 30 side and the refrigerant on the heat pump 2 side are subjected to heat exchange in a refrigerant/heat medium heat exchanger 32 to heat the heat medium, and the heat medium and the water circulating through the water circuit 12 are subjected to heat exchange in the high temperature-side water heat exchanger 5B and the low temperature-side water heat exchanger 5A to thereby produce hot water.

[0055] Thus, it is possible to solve the problem of scale buildup in the refrigerant/heat medium heat exchanger 32, which is specified for high-pressure refrigerants and hence expensive, by providing the closed-cycle heat medium circuit 30 between the refrigerant circuit 10 and the water circuit 12 of the heat pump 2 and heating the heat medium inside the closed-cycle heat medium circuit 30 by the refrigerant/heat medium heat exchanger 32 using the refrigerant on the heat pump 2 side, and heating the water on the water passage 12 side with this heat medium to produce hot water. The quality of the water supplied to the water passage 12 side varies from region to region. In the case of hard water which is prone to scale deposition, frequent replacement of the refrigerant/heat medium heat exchanger 32 may drive up the maintenance cost, but this embodiment can also solve this problem.

[0056] The present invention is not limited to the inventions according to the above-described embodiments, but can

be appropriately modified without departing from the scope of the present invention. For example, in the above-described embodiments, the supercritical-cycle heat pump 2 using a CO₂ refrigerant is used. However, the present invention is not limited to this example, and needless to say, a heat pump 2 using an HFC refrigerant can also be adopted. In addition, if a CO₂ refrigerant is used, the compressor 4 is preferably a two-stage compressor, which promises an even higher capability.

{Reference Signs List}

[0057]

1	Heat pump hot water supply system
2	Heat pump
3	Hot water storage tank unit
5	Water heat exchanger
5A	Low temperature-side water heat exchanger
5B	High temperature-side water heat exchanger
12	Water circuit
13	Water pump
19A, 19B, 20A, 20B	Detaching means
21	Hot water outlet temperature sensor
22	Hot water temperature sensor
23	Control part
24	Remote controller
25	Display part
26	Temperature setting switch
30	Closed-cycle heat medium circuit
31	Heat medium pump
32	Refrigerant/heat medium heat exchanger

Claims

1. A heat pump hot water supply system (1) of a type which is provided with a water heat exchanger (5) for producing hot water by heating water with a refrigerant gas discharged from a heat pump (2) or with a heat medium undergoing heat exchange with the refrigerant gas and circulating inside a closed cycle, and which controls a rotation speed of a water pump (13) and thereby an amount of water so that a hot water outlet temperature becomes equal to a target temperature, **characterized in that** the water heat exchanger (5) is divided into a high temperature-side water heat exchanger (5B) and a low temperature-side water heat exchanger (5A), and a hot water outlet temperature sensor (21) is provided on a hot water outlet side of the high temperature-side water heat exchanger (5B), and a hot water temperature sensor (22) is provided on an outlet side of the low temperature-side water heat exchanger (5A), and the heat pump hot water supply system (1) includes a control part (23) which, if a detection value of the outlet hot water temperature sensor (22) of the low temperature-side water heat exchanger (5A) exceeds a set value when performance of the high temperature-side water heat exchanger (5B) is degraded due to scale buildup, controls so that the hot water outlet temperature is kept equal to or lower than the set value, and outputs information on decrease in the hot water outlet temperature and information on maintenance of the high temperature-side water heat exchanger (5B).
2. The heat pump hot water supply system (1) according to claim 1, wherein the control part (23) includes a display part (25) which displays the information on decrease in the hot water outlet temperature and the information on maintenance of the high temperature-side water heat exchanger (5B) when the performance of the high temperature-side water heat exchanger (5B) is degraded due to scale buildup.
3. The heat pump hot water supply system (1) according to claim 1 or 2, wherein the control part (23) includes a temperature setting switch (26) for varying the set value of the outlet hot water temperature of the low temperature-side water heat exchanger (5A) according to quality of the water supplied to the water heat exchanger (5).
4. The heat pump hot water supply system (1) according to any one of claims 1 to 3, wherein the high temperature-

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side water heat exchanger (5B) includes a cleaning means for removing scale and/or a detaching means (19A, 19B, 20A, 20B) for replacing the heat exchanger (5).

5. The heat pump hot water supply system (1) according to any one of claims 1 to 4, wherein a volume ratio of the high temperature-side water heat exchanger (5B) to the water heat exchanger (5) is 0.3 to 0.4.

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FIG. 1

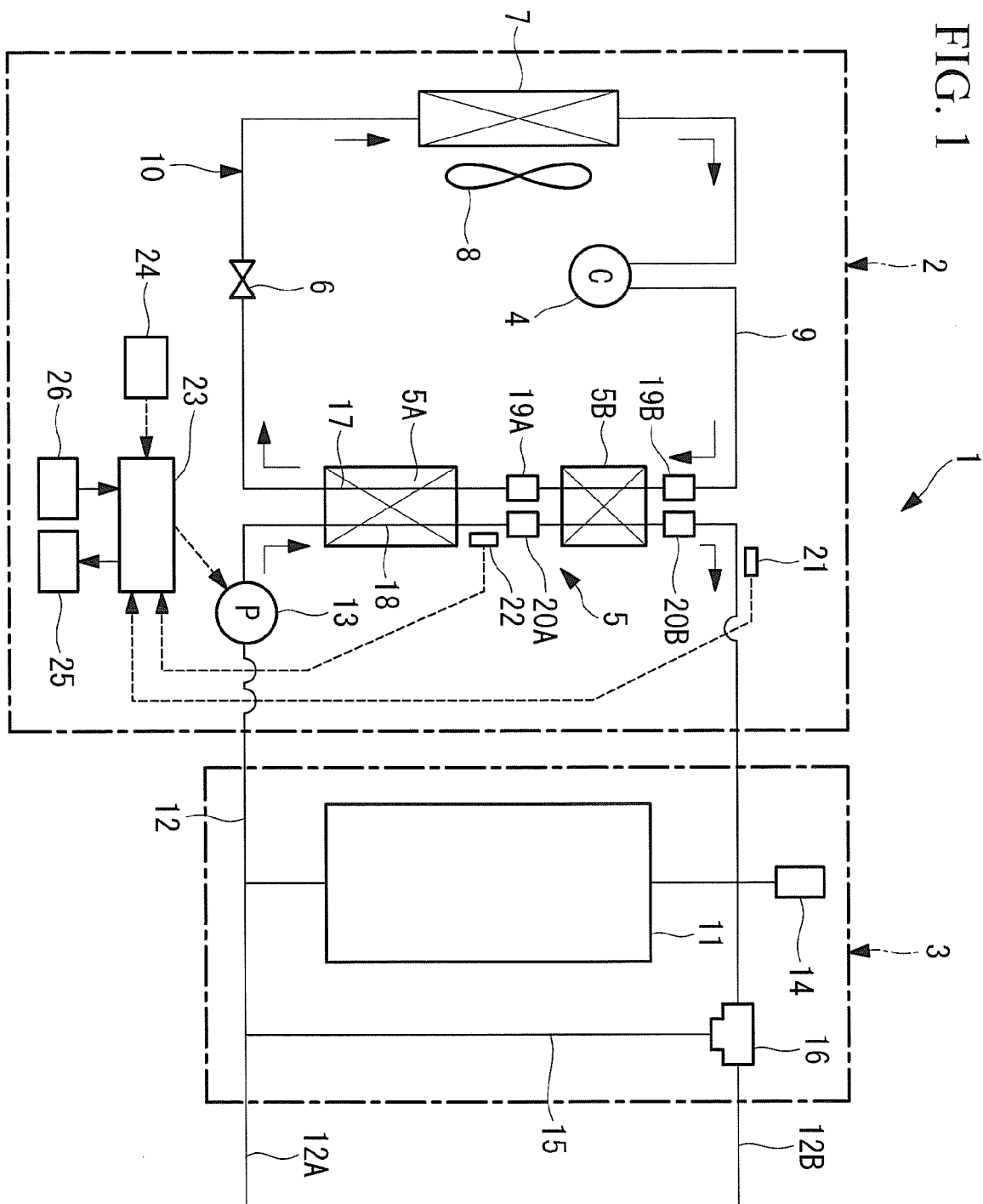


FIG. 2

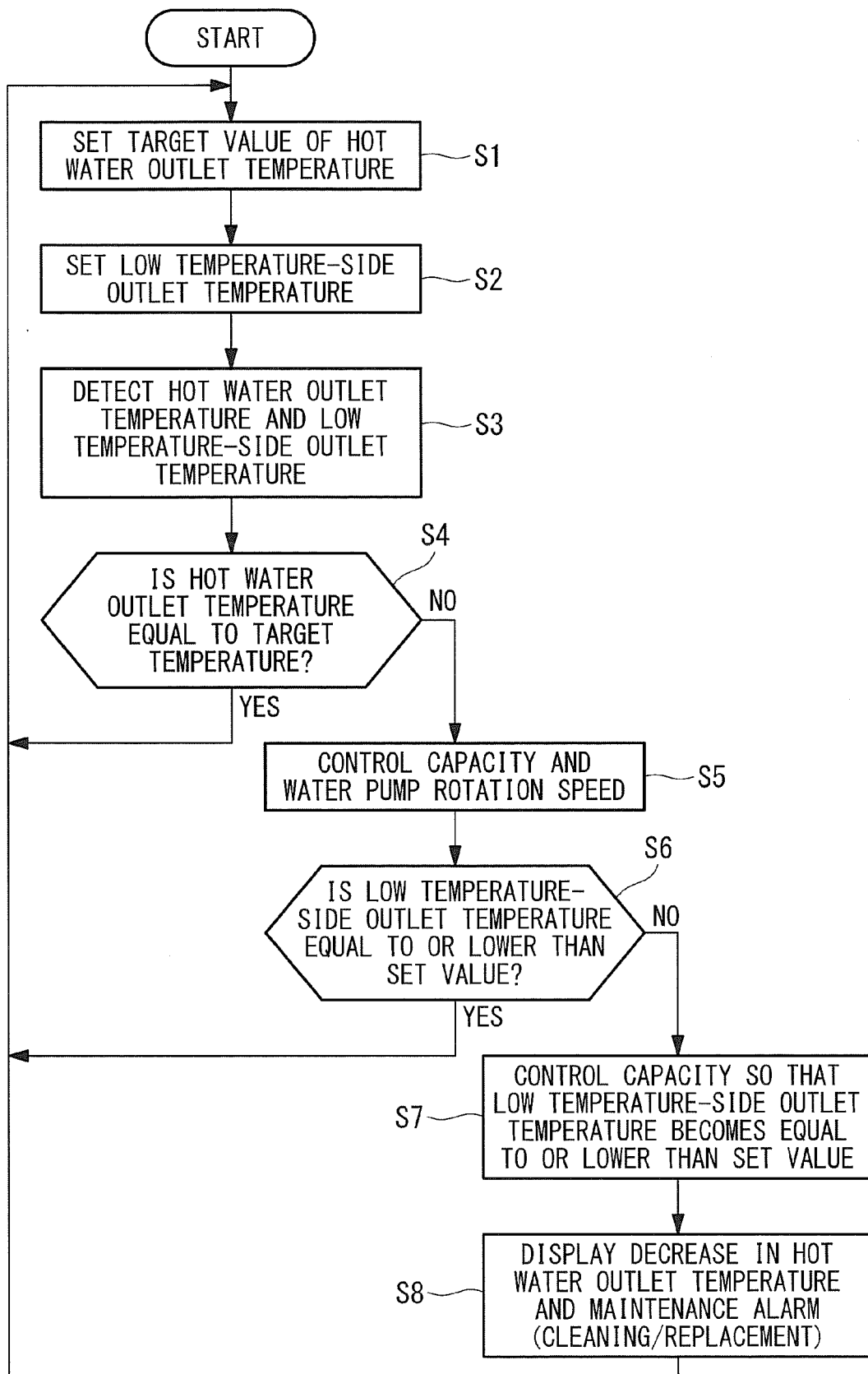


FIG. 3

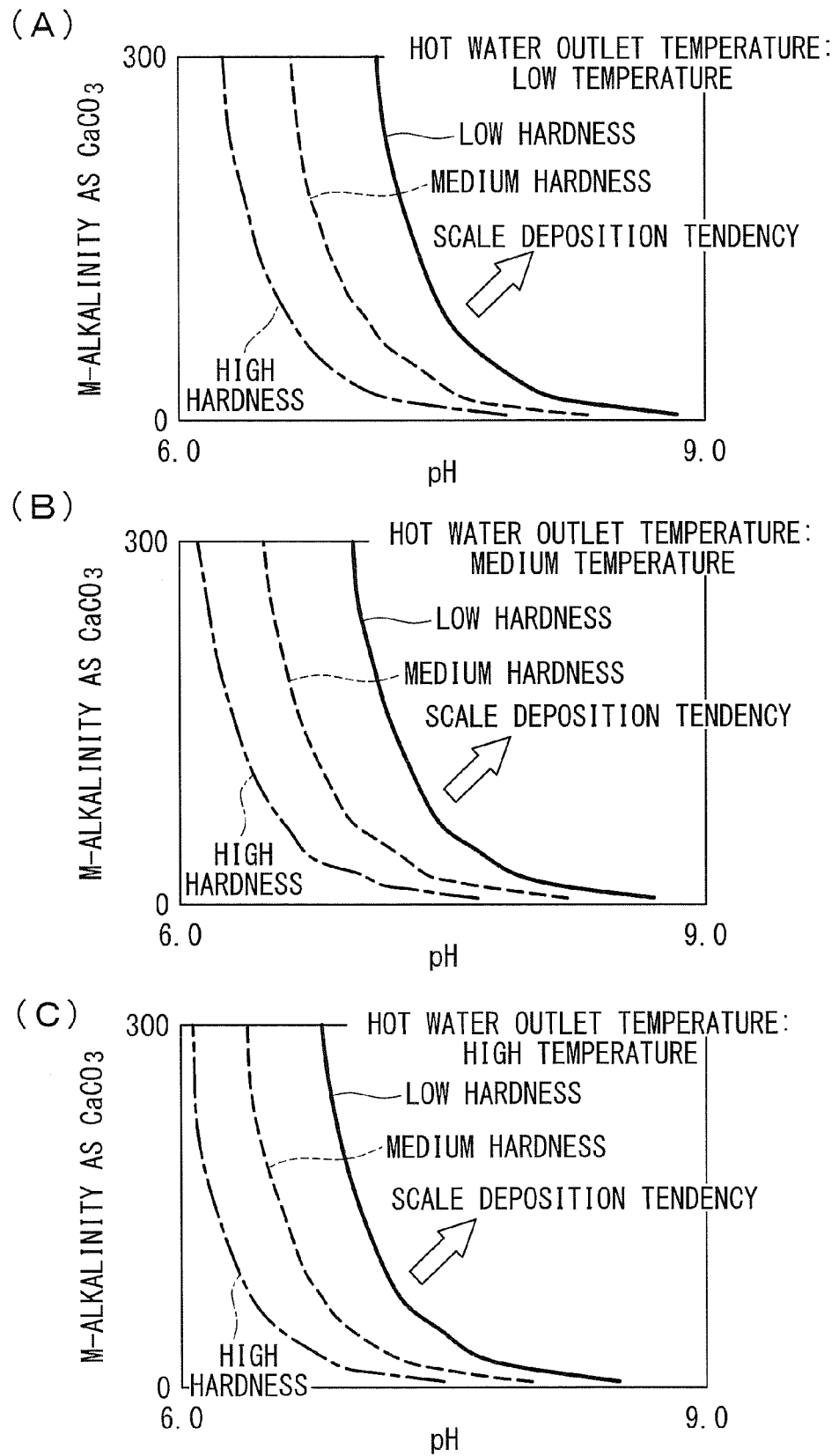
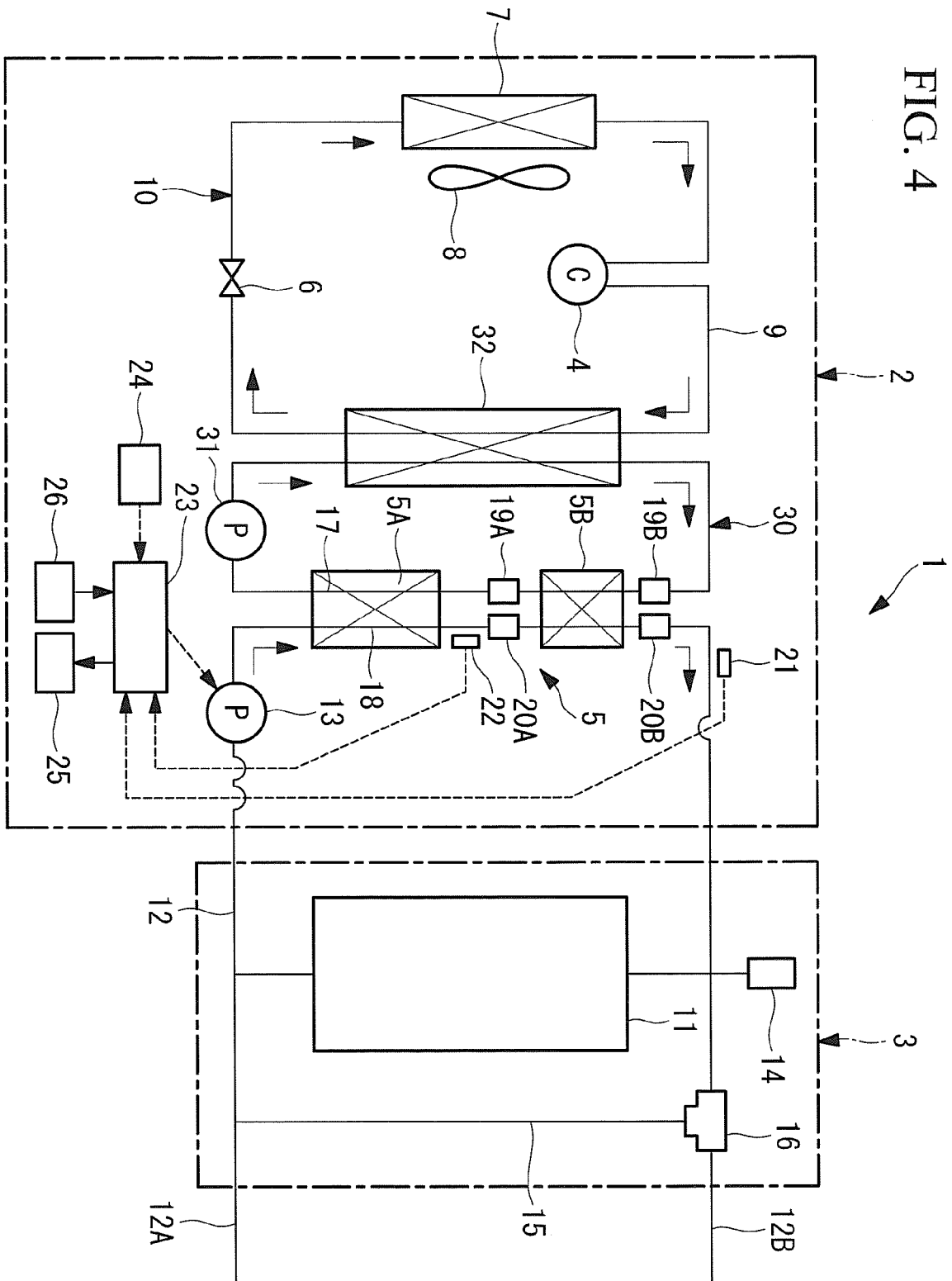


FIG. 4





EUROPEAN SEARCH REPORT

Application Number
EP 14 17 5502

DOCUMENTS CONSIDERED TO BE RELEVANT

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2011/151933 A1 (HITACHI APPLIANCES INC [JP]; ENOKIZU YUTAKA [JP]; SUGIYAMA KAZUICHI [J]) 8 December 2011 (2011-12-08) * the whole document * -----	1-5	INV. F24D17/02 F24D19/00 F24D19/10
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			TECHNICAL FIELDS SEARCHED (IPC)
			F24D
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Munich		14 November 2014	von Mittelstaedt, A
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X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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The members are as contained in the European Patent Office EDP file on
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14-11-2014

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