

Description

Technical field

[0001] The present invention relates to a hot water supply apparatus in which a heat pump is used as a heat source.

Background art

[0002] A hot water supply apparatus of this type includes a heat pump having a compressor, a water heating heat-exchanger, an expansion valve and an evaporator; a hot water storage tank; and a pipe line, in which a pump is interposed, for connecting the water passage of the water heating heat-exchanger to the hot water storage tank.

[0003] When the heat pump is operated, low-temperature water in the lower layer in the hot water storage tank is sent into the water passage of the water heating heat-exchanger by the operation of the pump, and the low-temperature water sent into the water passage of the water heating heat-exchanger is heated into high-temperature water by heat exchange with a refrigerant, and the high-temperature water is sent into the upper layer in the hot water storage tank.

Patent Document 1: Japanese Patent Publication 2004-211986

Disclosure of the invention

Problems to be solved by the invention

[0004] Since the above hot water supply apparatus uses the heat pump as a heat source, the operation efficiency of the heat pump changes according to the installation environment including open-air temperature or the like. In particular, in the winter season or the like in which the open-air temperature is low, even if air blow is utilized, it is difficult to accomplish anticipated heat recovery (refrigerant evaporation) by using the evaporator. Therefore, the evaporation capacity decreases as compared with the summer season or the like in which the open-air temperature is high, and therefore the operation efficiency of heat pump decreases.

[0005] An object of the present invention is to provide a hot water supply apparatus capable of improving the operation efficiency of a heat pump in the winter season or the like in which the open-air temperature is low.

Means for solving the problems

[0006] To achieve the above object, a hot water supply apparatus involved with the present invention comprises: a heat pump having a compressor, a water heating heat-exchanger, an expansion valve, and an evaporator; a hot water storage tank; a pipe line in which a pump is inter-

posed for connecting the water passage of the water heating heat-exchanger and the hot water storage tank to each other; a heating heat-exchanger a water passage of which is connected to the hot water storage tank through a pipe line in which a pump is interposed and a heating water passage of which is connected to a hot water heating system through a pipe line in which a pump is interposed; a heat releasing heat-exchanger capable of carrying out heat exchange with the evaporator of the heat pump; and a flow path changeover circuit for sending heat-exchanged water sent out of the water passage of the heating heat-exchanger to the heat releasing heat-exchanger when a predetermined condition is met.

[0007] According to this hot water supply apparatus, by sending the heat-exchanged water sent out of the water passage of the heating heat-exchanger to the heat releasing heat-exchanger during the time when the heat pump is operated and the heating operation is also performed, the evaporation (heat recovery) of the refrigerant flowing in the evaporator is promoted by the heat of the heat-exchanged water, and the frosting on the evaporator is restrained. Thereby, the operation efficiency of the heat pump can be improved especially in the winter season or the like in which the open-air temperature is low.

[0008] Also, a hot water supply apparatus involved with the present invention comprises: a heat pump having a compressor, a water heating heat-exchanger, an expansion valve, and an evaporator; a hot water storage tank; a pipe line in which a pump is interposed for connecting the water passage of the water heating heat-exchanger and the hot water storage tank to each other; a heating heat-exchanger a water passage of which is connected to the hot water storage tank through a pipe line in which a pump is interposed and a heating water passage of which is connected to a hot water heating system through a pipe line in which a pump is interposed; a heat releasing heat-exchanger capable of carrying out heat exchange with the evaporator of the heat pump; and a flow path changeover circuit for sending heating water returned from the hot water heating system to the heat releasing heat-exchanger when a predetermined condition is met.

[0009] According to this hot water supply apparatus, by sending the heating water returned from the hot water heating system to the heat releasing heat-exchanger during the time when the heat pump is operated and the heating operation is also performed, the evaporation (heat recovery) of the refrigerant flowing in the evaporator is promoted by the heat of the returned heating water, and the frosting on the evaporator is restrained. Thereby, the operation efficiency of the heat pump can be improved especially in the winter season or the like in which the open-air temperature is low.

Advantages of the invention

[0010] According to the present invention, under favor of the heat of the heat-exchanged water sent from the heating heat-exchanger or the returned heating water,

the evaporation (heat recovery) of the refrigerant flowing in the evaporator is promoted, and the frosting on the evaporator is restrained. Thereby, the operation efficiency of the heat pump can be improved especially in the winter season in which the open-air temperature is low.

[0011] The above object and other objects, features, and operations and advantages of the present invention will become apparent by referring to the following description and the accompanying drawings.

Brief description of the drawings

[0012]

Figure 1 is a general configuration diagram of a hot water supply apparatus showing a first embodiment of the present invention;
 Figure 2 is a block diagram showing a control system for the hot water supply apparatus shown in Figure 1;
 Figure 3 is a flowchart for flow path changeover of the hot water supply apparatus shown in Figure 1;
 Figure 4 is a general configuration diagram of a hot water supply apparatus showing a second embodiment of the present invention;
 Figure 5 is a modified flowchart for flow path changeover shown in Figure 3; and
 Figure 6 is another modified flowchart for flow path changeover shown in Figure 3.

Description of symbols

[0013] 10 ... heat pump unit, HP ... heat pump, 11 ... compressor, 12 ... water heating heat-exchanger, 13 ... expansion valve, 14 ... evaporator, 20 ... tank unit, 21 ... hot water storage tank, 22 ... first pump, 30, 30' ... heating unit, 31 ... heating heat-exchanger, 32 ... second pump, 33 ... third pump, 34 ... three-way selector valve, 35 ... heat releasing heat-exchanger, P11 to P24 ... pipe line.

Best mode for carrying out the invention

[First embodiment]

[0014] Figures 1 to 3 show a first embodiment of the present invention (hot water supply apparatus). Figure 1 is a general configuration diagram of a hot water supply apparatus, Figure 2 is a block diagram showing a control system for the hot water supply apparatus shown in Figure 1, and Figure 3 is a flowchart for flow path changeover of the hot water supply apparatus shown in Figure 1.

[0015] First, the general configuration of the hot water supply apparatus is explained with reference to Figure 1.

[0016] The hot water supply apparatus shown in Figure 1 has a heat pump unit 10, a tank unit 20, and a heating unit 30.

[0017] The heat pump unit 10 includes a heat pump HP configured by a compressor 11, a water heating heat-exchanger 12, an expansion valve 13, an evapora-

tor 14, and refrigerant pipe lines for connecting these devices to each other; and a fan 15 for evaporator. The water heating heat-exchanger 12 has a refrigerant passage and a water passage separated from each other therein in the state in which heat can be transferred from one to the other, and refrigerant pipe lines are connected to the inlet and the outlet of the refrigerant passage. As the compressor 11, a capacity variable compressor the number of revolutions of which can be controlled is preferably used. As the expansion valve 13, an electronic expansion valve the opening of which can be controlled is preferably used. As the refrigerant of the heat pump HP, carbon dioxide (CO₂) is preferably used.

[0018] The tank unit 20 includes a hot water storage tank 21 capable of storing a predetermined amount of hot water or hot water and water in a filled state; and a first pump 22 for sending low-temperature water in the lower layer in the hot water storage tank 21 into the water heating heat-exchanger 12. The lower part of the hot water storage tank 21 and the inlet of water passage of the water heating heat-exchanger 12 are connected to each other by a first pipe line P11 in which the first pump 22 is interposed. The upper part of the hot water storage tank 21 and the outlet of water passage of the water heating heat-exchanger 12 are connected to each other by a second pipe line P12. Also, to the upper part of the hot water storage tank 21, one end of a third pipe line P13 for sending out high-temperature water in the upper layer in the hot water storage tank 21 to a kitchen, a washroom, a bathroom, and the like is connected. To the lower part of the hot water storage tank 21, one end of a fourth pipe line P14 such as a water service pipe for taking a consumed amount of water into the hot water storage tank 21 is connected. As the first pump 22, a pump the rotation of which can be controlled is preferably used.

[0019] The heating unit 30 includes a heating heat-exchanger 31 having a water passage and a heating water passage separated from each other therein in the state in which heat can be transferred from one to the other; a second pump 32 for sending the high-temperature water in the upper layer in the hot water storage tank 21 into the water passage of the heating heat-exchanger 31; a third pump 33 for circulating heating water between the heating water passage of the heating heat-exchanger 31 and a hot water heating system (not shown) such as a floor heating system or the like; an electromagnetic three-way selector valve 34 for changing over the flow path of return heating water; and a heat releasing heat-exchanger 35.

[0020] The heat releasing heat-exchanger 35 can carry out heat exchange with the evaporator 14 of the heat pump HP. Specifically, a mode can be employed in which a heat-exchanger is thermally connected to the evaporator 14 to use that heat-exchanger as the heat releasing heat-exchanger 35. In addition to a mode can be employed in which one pipe line side of one heat-exchanger having two pipe lines and common fins arranged so as to be in contact with both the pipe lines is used as the

evaporator 14, and the other pipe line side thereof is used as the heat releasing heat-exchanger 35.

[0021] The inlet of the water passage of the heating heat-exchanger 31 and the upper part of the hot water storage tank 21 are connected to each other by a fifth pipe line P15, and the outlet of the water passage thereof and one port of the three-way selector valve 34 are connected to each other by a sixth pipe line P16. Also, the inlet of the heating water passage of the heating heat-exchanger 31 is connected to the outlet side of the hot water heating system (not shown) such as a floor heating system through an eighth pipe line P18 in which the third pump 33 is interposed, and the outlet of the heating water passage thereof is connected to the inlet side of the hot water heating system (not shown) such as a floor heating system through a ninth pipe line P19.

[0022] Another port of the three-way selector valve 34 and the inlet of the heat releasing heat-exchanger 35 are connected to each other by a tenth pipe line P20, and the outlet of the heat releasing heat-exchanger 35 and the remaining one port of the three-way selector valve 34 are connected to each other by an eleventh pipe line P21.

[0023] The second pump 32 is interposed in a seventh pipe line P17. One end of the seventh pipe line P17 is connected to an intermediate portion of the eleventh pipe line P21, and the other end thereof is connected to a position slightly lower than the middle portion of the hot water storage tank 21. Also, as the second pump 32 and the third pump 33, pumps the rotation of which can be controlled is preferably used.

[0024] In the hot water supply apparatus shown in Figure 1, the three-way selector valve 34, the tenth pipe line P20, and the eleventh pipe line P21 correspond to a "flow path changeover circuit" described in claim 1.

[0025] Next, a control system for the hot water supply apparatus shown in Figure 1 is explained with reference to Figure 2.

[0026] The system shown in Figure 2 includes a controller 51 incorporating a microcomputer; a heat pump driver 52; a pump driver 53; a three-way selector valve driver 54; and an operation setting device 55. The memory of the controller 51 stores a program for accomplishing hot water storage and hot water heating based on the items set through the operation setting device 55, a program for accomplishing the changeover of the three-way selector valve shown in Figure 3, and so on together with data necessary for these programs.

[0027] To the heat pump driver 52, the compressor 11, the expansion valve 13, and the fan 15 are connected, so that the driver 52 sends out a drive signal to each of the compressor 11, the expansion valve 13, and the fan 15 based on a control signal sent from the controller 51.

[0028] To the pump driver 53, the first pump 22, the second pump 32, and the third pump 33 are connected, so that the driver 53 sends out a drive signal to each of the first pump 22, the second pump 32, and the third pump 33 based on a control signal sent from the controller

51.

[0029] To the three-way selector valve driver 54, the three-way selector valve 34 is connected, so that the driver 54 sends out a drive signal to the three-way selector valve 34 based on a control signal sent from the controller 51.

[0030] Next, the operating method of the hot water supply apparatus shown in Figure 1 is explained with reference to Figure 3.

[0031] At the time of heat pump operation, the low-temperature water in the lower layer in the hot water storage tank 21 is sent into the water passage of the water heating heat-exchanger 12 through the first pipe line P11 by the operation of the first pump 22. The low-temperature water sent into the water passage of the water heating heat-exchanger 12 is heated into high-temperature water by heat exchange with the refrigerant, and the high-temperature water is sent into the upper layer in the hot water storage tank 21 through the second pipe line P12. Basically, the heat pump HP temporarily stops the operation thereof when a preset amount of high-temperature water is stored in the hot water storage tank 21, and also temporarily stops the operation thereof during the defrosting operation.

[0032] Also, at the time of heating operation, the high-temperature water in the upper layer in the hot water storage tank 21 is sent into the water passage of the heating heat-exchanger 31 through the fifth pipe line P15 by the operation of the second pump 32, and the heating water returned from the hot water heating system is sent into the heating water passage of the heating heat-exchanger 31 by the operation of the third pump 33. Therefore, the returned heating water is heated into high-temperature heating water by heat exchange with the high-temperature water, and the high-temperature heating water is sent to the hot water heating system through the ninth pipe line P19.

[0033] The three-way selector valve 34 is usually at a position at which the sixth pipe line P16 and the eleventh pipe line P21 (the seventh pipe line P17) communicate with each other. However, during the time when the heat pump is operated and the heating operation is also performed or during the time when the defrosting operation is performed and the heating operation is also performed, the three-way selector valve 34 is changed over to a position at which the sixth pipe line P16 and the tenth pipe line P20 communicate with each other (refer to Steps SP1 to SP5 in Figure 3).

[0034] That is to say, during the time when the heat pump is operated and the heating operation is also performed or during the time when the defrosting operation is performed and the heating operation is also performed, the heat-exchanged water (hot water having a decreased temperature of, for example, about 40 to 50°C as the result of heat absorption due to heat exchange) sent out of the water passage of the heating heat-exchanger 31 is sent to the three-way selector valve 34 through the sixth pipe line P16, and is sent from the three-way selec-

tor valve 34 to the heat releasing heat-exchanger 35 through the tenth pipe line P20.

[0035] Since the heat releasing heat-exchanger 35 can carry out heat exchange with the evaporator 14 of the heat pump HP, during the heat pump operation, the evaporation (heat recovery) of the refrigerant flowing in the evaporator 14 is promoted by the heat of the heat-exchanged water sent to the heat releasing heat-exchanger 35, and the frosting on the evaporator 14 is restrained, so that the operation efficiency of the heat pump HP is improved. Also, during the defrosting operation, the defrosting of the evaporator 14 is promoted by the heat of the heat-exchanged water sent to the heat releasing heat-exchanger 35, so that the defrosting efficiency is increased by shortened defrosting time or the like.

[0036] The heat-exchanged water sent to the heat releasing heat-exchanger 35 through the tenth pipe line P20 is cooled into low-temperature water by the heat absorption due to the heat exchange, and the low-temperature water is sent into the hot water storage tank 21 through the seventh pipe line P17.

[0037] When the heat pump operation stops in the state where the heat pump is operated and the heating operation is also performed, or when the defrosting operation stops in the state where the defrosting operation is performed and the heating operation is also performed, the three-way selector valve 34 is changed over to a position at which the sixth pipe line P16 and the eleventh pipe line P21 (the seventh pipe line P17) communicate with each other (refer to Steps SP1 to SP4 and SP6 in Figure 3).

[0038] That is to say, during the time when the heat pump is not operated and the heating operation is performed, or during the time when the defrosting operation is not performed and the heating operation is performed, the heat-exchanged water sent out of the water passage of the heating heat-exchanger 31 is not sent to the heat releasing heat-exchanger 35, and is sent into the hot water storage tank 21 through the three-way selector valve 34, a part of the eleventh pipe line P21, and the seventh pipe line P17.

[0039] Thus, according to the first embodiment, during the time when the heat pump is operated and the heating operation is also performed, the heat-exchanged water sent out of the water passage of the heating heat-exchanger 31 is sent to the heat releasing heat-exchanger 35. Thereby, the evaporation (heat recovery) of the refrigerant flowing in the evaporator 14 is promoted by the heat of the heat-exchanged water, and the frosting on the evaporator 14 is restrained. Therefore, the operation efficiency of the heat pump HP can be improved especially in the winter season or the like in which the open-air temperature is low.

[0040] Also, during the time when the defrosting operation is performed and the heating operation is also performed, the heat-exchanged water sent out of the water passage of the heating heat-exchanger 31 is sent to the

heat releasing heat-exchanger 35. Thereby, the defrosting of the evaporator 14 is promoted by the heat of the heat-exchanged water, and the defrosting efficiency can be increased by shortened defrosting time or the like.

[0041] In the above first embodiment, the three-way selector valve 34 is used to selectively send the heat-exchanged water to the heat releasing heat-exchanger 35. However, a plurality of electromagnetic regulating valves may be used to accomplish the similar flow path changeover.

[Second embodiment]

[0042] Figure 4 is a general configuration diagram of a hot water supply apparatus showing a second embodiment of the present invention (hot water supply apparatus).

[0043] First, the points at which the second embodiment differs from the above first embodiment are explained.

[0044] The second embodiment differs from the above first embodiment in that the second pump 32 is interposed in the sixth pipe line P16 one end of which is connected to the outlet of the water passage of the heating heat-exchanger 31 in a heating unit 30' and the other end of the sixth pipe line P16 is connected to a position slightly lower than the middle portion of the hot water storage tank 21; in that the eighth pipe line P18 in which the third pump 33 is interposed is connected to one port of the three-way selector valve 34; in that another port of the three-way selector valve 34 and the inlet of the heating water passage of the heating heat-exchanger 31 are connected to each other by a twelfth pipe line P22; in that the remaining one port of the three-way selector valve 34 and the inlet of the heat releasing heat-exchanger 35 are connected to each other by a thirteenth pipe line P23; and in that the outlet of the heat releasing heat-exchanger 35 and the inlet of the heating water passage of the heating heat-exchanger 31 are connected to each other by a fourteenth pipe line P24. The connecting position of the fourteenth pipe line P24 to the heating heat-exchanger 31 need not necessarily be the inlet of the heating water passage, and the fourteenth pipe line P24 may be connected to another inlet provided near the aforementioned inlet.

[0045] Other configurations are the same as those of the above first embodiment, so that the same symbols are applied to elements that are the same as those in the first embodiment, and the explanation of these elements is omitted. In the hot water supply apparatus shown in Figure 4, the three-way selector valve 34, the twelfth pipe line P22, the thirteenth pipe line P23, and the fourteenth pipe line P24 correspond to a "flow path changeover circuit" described in claim 5.

[0046] Next, the operating method of the hot water supply apparatus shown in Figure 4 is explained with reference to Figure 3.

[0047] At the time of heat pump operation, the low-

temperature water in the lower layer in the hot water storage tank 21 is sent into the water passage of the water heating heat-exchanger 12 through the first pipe line P11 by the operation of the first pump 22. The low-temperature water sent into the water passage of the water heating heat-exchanger 12 is heated into high-temperature water by heat exchange with the refrigerant, and the high-temperature water is sent into the upper layer in the hot water storage tank 21 through the second pipe line P12. Basically, the heat pump HP temporarily stops the operation thereof when a preset amount of high-temperature water is stored in the hot water storage tank 21, and also temporarily stops the operation thereof during the defrosting operation.

[0048] Also, at the time of heating operation, the high-temperature water in the upper layer in the hot water storage tank 21 is sent into the water passage of the heating heat-exchanger 31 through the fifth pipe line P15 by the operation of the second pump 32, and the heating water returned from the hot water heating system is sent into the heating water passage of the heating heat-exchanger 31 by the operation of the third pump 33. Therefore, the returned heating water is heated into high-temperature heating water by heat exchange with the high-temperature water, and the high-temperature heating water is sent to the hot water heating system through the ninth pipe line P19.

[0049] The three-way selector valve 34 is usually at a position at which the eighth pipe line P18 and the twelfth pipe line P22 communicate with each other. However, during the time when the heat pump is operated and the heating operation is also performed or during the time when the defrosting operation is performed and the heating operation is also performed, the three-way selector valve 34 is changed over to a position at which the eighth pipe line P18 and the thirteenth pipe line P23 communicate with each other (refer to Steps SP1 to SP5 in Figure 3).

[0050] That is to say, during the time when the heat pump is operated and the heating operation is also performed or during the time when the defrosting operation is performed and the heating operation is also performed, the heating water returned from the hot water heating system is sent from the three-way selector valve 34 to the heat releasing heat-exchanger 35 through the thirteenth pipe line P23.

[0051] Since the heat releasing heat-exchanger 35 can carry out heat exchange with the evaporator 14 of the heat pump HP, during the heat pump operation, the evaporation (heat recovery) of the refrigerant flowing in the evaporator 14 is promoted by the heat of the returned heating water sent to the heat releasing heat-exchanger 35, and the frosting on the evaporator 14 is restrained, so that the operation efficiency of the heat pump HP is improved. Also, during the defrosting operation, the defrosting of the evaporator 14 is promoted by the heat of the returned heating water sent to the heat releasing heat-exchanger 35, so that the defrosting efficiency is

increased by shortened defrosting time or the like.

[0052] The returned heating water sent to the heat releasing heat-exchanger 35 through the thirteenth pipe line P23 is cooled by the heat absorption due to the heat exchange, and the returned heating water is sent into the hot water passage of the heating heat-exchanger 31 through the fourteenth pipe line P24.

[0053] When the heat pump operation stops in the state where the heat pump is operated and the heating operation is also performed, or when the defrosting operation stops in the state where the defrosting operation is performed and the heating operation is also performed, the three-way selector valve 34 is changed over to a position at which the eighth pipe line P18 and the twelfth pipe line P22 communicate with each other (refer to Steps SP1 to SP4 and SP6 in Figure 3).

[0054] That is to say, during the time when the heat pump is not operated and the heating operation is performed, or during the time when the defrosting operation is not performed and the heating operation is performed, the heating water returned from the hot water heating system through the eighth pipe line P18 is not sent to the heat releasing heat-exchanger 35, and is sent into the heating water passage of the heating heat-exchanger 31 through the three-way selector valve 34 and the twelfth pipe line P22.

[0055] Thus, according to the second embodiment, during the time when the heat pump is operated and the heating operation is also performed, the heating water returned from the hot water heating system is sent to the heat releasing heat-exchanger 35. Thereby, the evaporation (heat recovery) of the refrigerant flowing in the evaporator 14 is promoted by the heat of the returned heating water, and the frosting on the evaporator 14 is restrained. Therefore, the operation efficiency of the heat pump HP can be improved especially in the winter season or the like in which the open-air temperature is low.

[0056] Also, during the time when the defrosting operation is performed and the heating operation is also performed, the heating water returned from the hot water heating system is sent to the heat releasing heat-exchanger 35. Thereby, the defrosting of the evaporator 14 is promoted by the heat of the returned heating water, and the defrosting efficiency can be increased by shortened defrosting time or the like.

[0057] In the above second embodiment, the three-way selector valve 34 is used to selectively send the returned heating water to the heat releasing heat-exchanger 35. However, a plurality of electromagnetic regulating valves may be used to accomplish the similar flow path changeover.

[Other embodiments]

[0058] Figures 5 and 6 are modified flowcharts for flow path changeover shown in Figure 3.

[0059] The flowchart of Figure 5 differs from the flowchart of Figure 3 in that Step SP7 in which the open-air

temperature is judged is added before Step SP5. That is to say, during the time when the heat pump is operated and the heating operation is also performed or during the time when the defrosting operation is performed and the heating operation is also performed, it is judged whether or not the present open-air temperature T_o is lower than a preset reference temperature T_{os} . If the open-air temperature T_o is lower than the reference temperature T_{os} , the control goes to Step SP5, and if the open-air temperature T_o is not lower than the reference temperature T_{os} , the control goes to Step SP6.

[0060] The flowchart of Figure 5 can be applied to the hot water supply apparatus shown in Figure 1 and the hot water supply apparatus shown in Figure 4.

[0061] In the case where the flowchart of Figure 5 is applied to the hot water supply apparatus shown in Figure 1, even during the time when the heat pump is operated and the heating operation is also performed or during the time when the defrosting operation is performed and the heating operation is also performed, when the heat recovery (refrigerant evaporation) of the evaporator 14 can be accomplished satisfactorily to some degree or more by air blow only due to the relationship of the open-air temperature T_o (the open-air temperature T_o is not lower than the reference temperature T_{os}), the heat-exchanged water sent out of the water passage of the heating heat-exchanger 31 is not sent to the heat releasing heat-exchanger 35 even during the heating operation. That is to say, by adding the open-air temperature T_o as a judgment condition, the heat-exchanged water sent out of the water passage of the heating heat-exchanger 31 can be sent to the heat releasing heat-exchanger 35 properly.

[0062] Also, in the case where the flowchart of Figure 5 is applied to the hot water supply apparatus shown in Figure 4, even during the time when the heat pump is operated and the heating operation is also performed or during the time when the defrosting operation is performed and the heating operation is also performed, when the heat recovery (refrigerant evaporation) of the evaporator 14 can be accomplished satisfactorily to some degree or more by air blow only due to the relationship of the open-air temperature T_o (the open-air temperature T_o is not lower than the reference temperature T_{os}), the heating water returned from the hot water heating system is not sent to the heat releasing heat-exchanger 35 even during the heating operation. That is to say, by adding the open-air temperature T_o as a judgment condition, the heating water returned from the hot water heating system can be sent to the heat releasing heat-exchanger 35 properly.

[0063] On the other hand, the flowchart of Figure 6 differs from the flowchart of Figure 3 in that Step SP8 in which the returned heating water temperature (the temperature of the heating water returned from the hot water heating system) is judged is added before Step SP5. That is to say, during the time when the heat pump is operated and the heating operation is also performed or during the

time when the defrosting operation is performed and the heating operation is also performed, it is judged whether or not the returned heating water temperature T_{wi} is higher than a preset reference temperature T_{wis} . If the returned heating water temperature T_{wi} is higher than the reference temperature T_{wis} , the control goes to Step SP5, and if the returned heating water temperature T_{wi} is not higher than the reference temperature T_{wis} , the control goes to Step SP6.

[0064] The flowchart of Figure 6 can be applied to the hot water supply apparatus shown in Figure 4.

[0065] In the case where the flowchart of Figure 6 is applied to the hot water supply apparatus shown in Figure 4, even during the time when the heat pump is operated and the heating operation is also performed or during the time when the defrosting operation is performed and the heating operation is also performed, when the heat recovery (refrigerant evaporation) of the evaporator 14 is not promoted or less liable to be promoted even if the returned heating water is sent to the heat releasing heat-exchanger 35 under the condition of the returned heating water temperature T_{wi} is not higher than the reference temperature T_{wis} , the heating water returned from the hot water heating system is not sent to the heat releasing heat-exchanger 35 even during the heating operation. That is to say, by adding the returned heating water temperature T_{wi} as a judgment condition, the heating water returned from the hot water heating system can be sent to the heat releasing heat-exchanger 35 properly.

[0066] In the flowchart of Figure 6, Step SP7 for judging the open-air temperature shown in Figure 5 can be added before or after Step SP8. In this case, by adding both of the returned heating water temperature T_{wi} and the open-air temperature T_o as judgment conditions, the heating water returned from the hot water heating system can be sent to the heat releasing heat-exchanger 35 more properly.

Claims

1. A hot water supply apparatus comprising:

a heat pump (HP) having a compressor (11), a water heating heat-exchanger (12), an expansion valve (13), and an evaporator (14);
a hot water storage tank (21) ;
a pipe line (P11) in which a pump (22) is interposed for connecting the water passage of the water heating heat-exchanger (12) and the hot water storage tank (21) to each other;
a heating heat-exchanger (31) a water passage of which is connected to the hot water storage tank through a pipe line (P17) in which a pump (32) is interposed and a heating water passage of which is connected to a hot water heating system through a pipe line (P18) in which a pump (33) is interposed;

- a heat releasing heat-exchanger (35) capable of carrying out heat exchange with the evaporator (14) of the heat pump (HP) ; and a flow path changeover circuit (34, P20, P21) for sending heat-exchanged water sent out of the water passage of the heating heat-exchanger (31) to the heat releasing heat-exchanger (35) when a predetermined condition is met. 5
2. The hot water supply apparatus according to claim 1, wherein: 10
- the flow path changeover circuit has a pipe line (P20, P21) for connecting the inlet and outlet of the heat releasing heat-exchanger (35) to an intermediate portion of the pipe line (P17) for connecting the water passage of the heating heat-exchanger (31) and the hot water storage tank (21) to each other; and a selector valve (34) which is interposed in the pipe line and sends the heat-exchanged water sent out of the water passage of the heating heat-exchanger (31) to either one of the hot water storage tank (21) and the heat releasing heat-exchanger (35) . 15 20 25
3. The hot water supply apparatus according to claim 1 or 2, wherein: 30
- the phrase of "when a predetermined condition is met" means during the time when the heat pump is operated and the heating operation is also performed; or during the time when the defrosting operation is performed and the heating operation is also performed. 35
4. The hot water supply apparatus according to claim 1 or 2, wherein 40
- the phrase of "when a predetermined condition is met" means during the time when the heat pump is operated and the heating operation is also performed and when the open-air temperature (To) is lower than the reference temperature (Tos); or during the time when the defrosting operation is performed and the heating operation is also performed and when the open-air temperature (To) is lower than the reference temperature (Tos). 45
5. A hot water supply apparatus comprising: 50
- a heat pump (HP) having a compressor (11), a water heating heat-exchanger (12), an expansion valve (13), and an evaporator (14); a hot water storage tank (21); a pipe line (P11) in which a pump (22) is interposed for connecting the water passage of the water heating heat-exchanger (12) and the hot water storage tank (21) to each other; 55
- a heating heat-exchanger (31) a water passage of which is connected to the hot water storage tank through a pipe line (P16) in which a pump (32) is interposed and a heating water passage of which is connected to a hot water heating system through a pipe line (P18) in which a pump (33) is interposed; a heat releasing heat-exchanger (35) capable of carrying out heat exchange with the evaporator (14) of the heat pump (HP) ; and a flow path changeover circuit (34, P22, P23, P24) for sending heating water returned from the hot water heating system to the heat releasing heat-exchanger (35) when a predetermined condition is met.
6. The hot water supply apparatus according to claim 5, wherein: 60
- the flow path changeover circuit has a pipe line (P22, P23, P24) for connecting the inlet and outlet of the heat releasing heat-exchanger (35) to the inlet side of the heating water passage of the heating heat-exchanger (31); and a selector valve (34) which is interposed in the pipe line and sends the heating water returned from the hot water heating system to either one of the heating water passage of the heating heat-exchanger (31) and the heat releasing heat-exchanger (35). 65
7. The hot water supply apparatus according to claim 5 or 6, wherein: 70
- the phrase of "when a predetermined condition is met" means during the time when the heat pump is operated and the heating operation is also performed; or during the time when the defrosting operation is performed and the heating operation is also performed. 75
8. The hot water supply apparatus according to claim 5 or 6, wherein: 80
- the phrase of "when a predetermined condition is met" means during the time when the heat pump is operated and the heating operation is also performed and when the open-air temperature (To) is lower than the reference temperature (Tos); or during the time when the defrosting operation is performed and the heating operation is also performed and when the open-air temperature (To) is lower than the reference temperature (Tos). 85
9. The hot water supply apparatus according to claim 5 or 6, wherein: 90
- the phrase of "when a predetermined condition is met" means during the time when the heat pump is operated and the heating operation is also performed and when the open-air temperature (To) is lower than the reference temperature (Tos); or during the time when the defrosting operation is performed and the heating operation is also performed and when the open-air temperature (To) is lower than the reference temperature (Tos). 95

is met" means during the time when the heat pump is operated and the heating operation is also performed and when the returned heating water temperature (T_{wi}) is higher than the reference temperature (T_{wis}); or during the time when the defrosting operation is performed and the heating operation is also performed and when the returned heating water temperature (T_{wi}) is higher than the reference temperature (T_{wis}).

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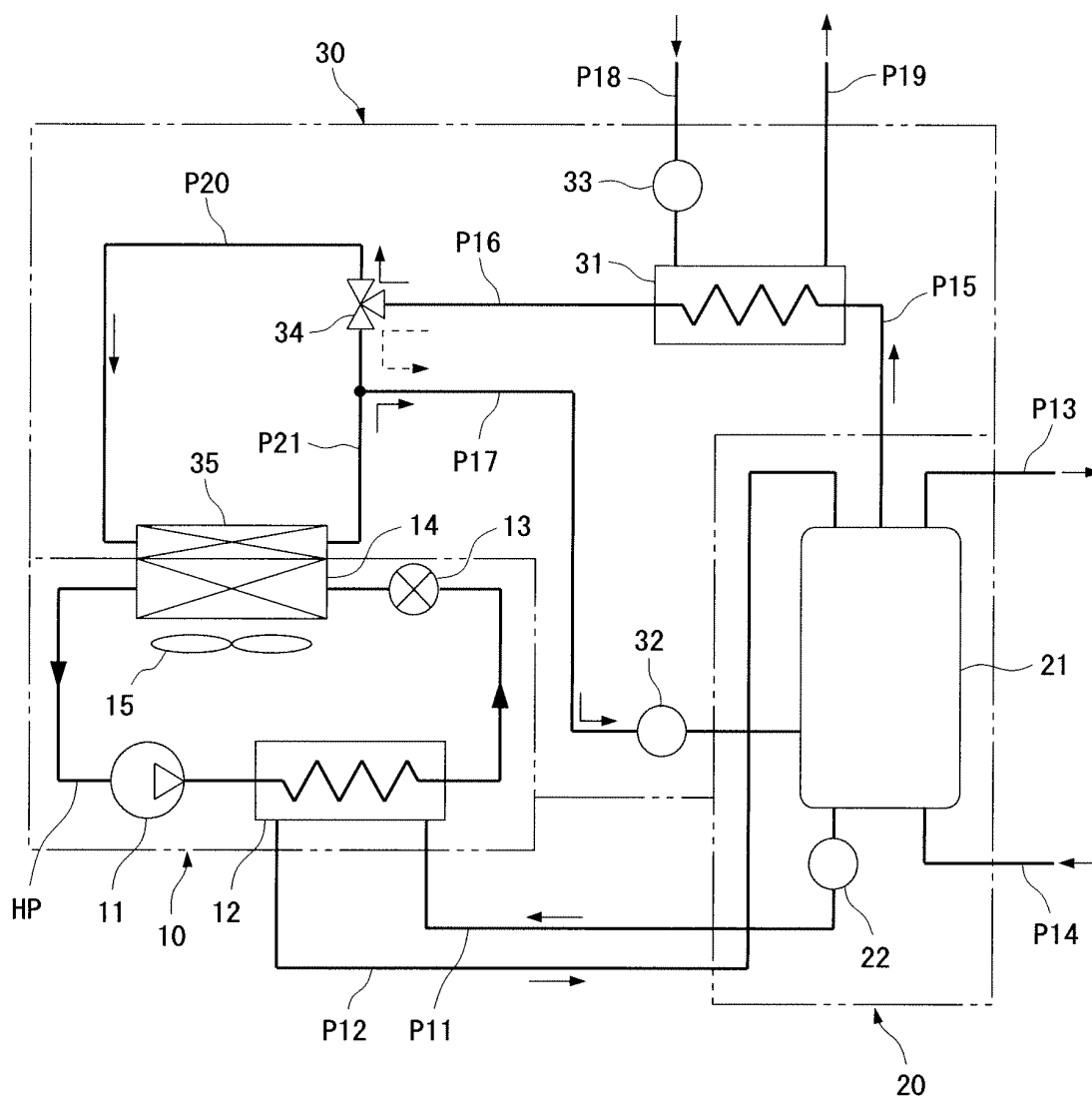
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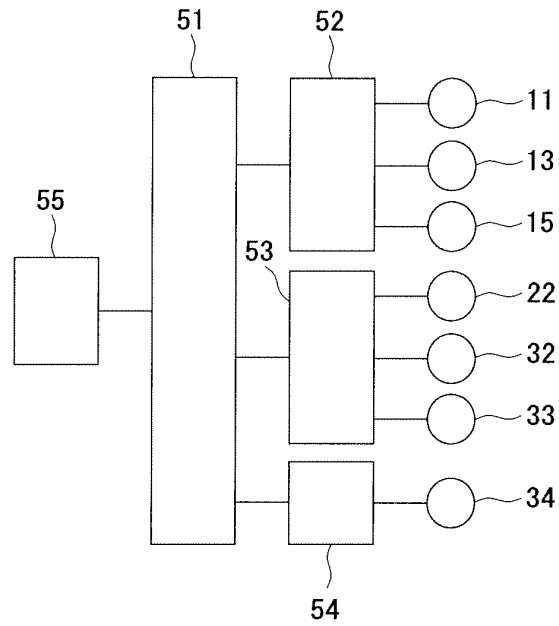
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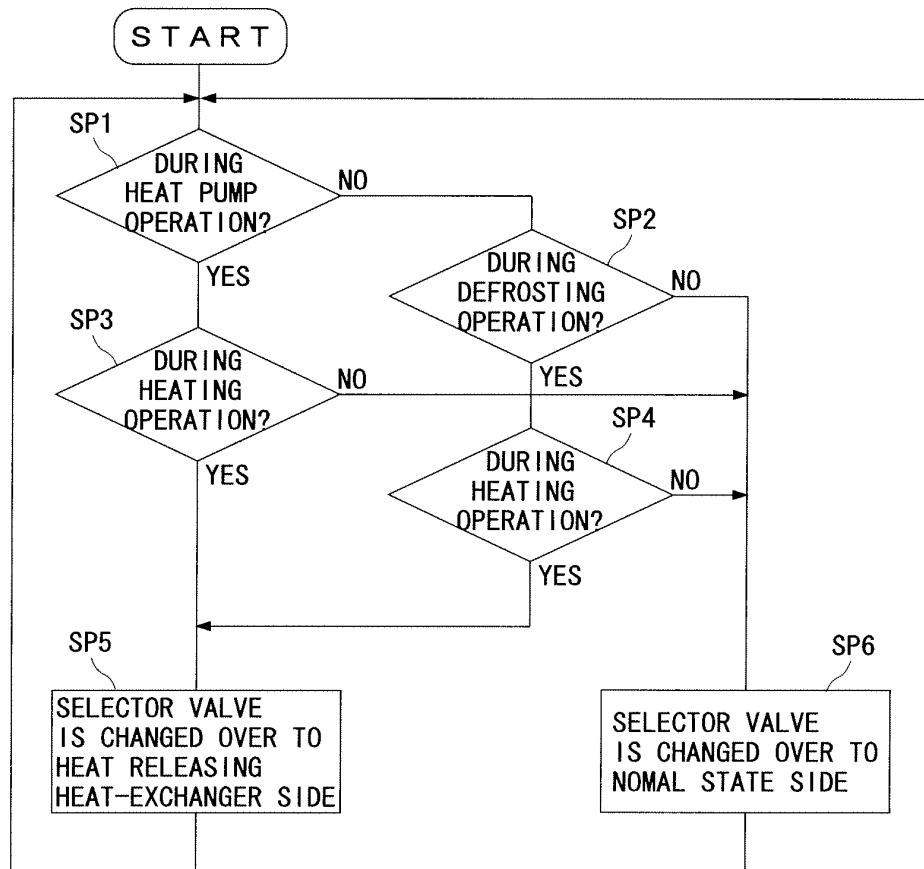
[Fig. 1]



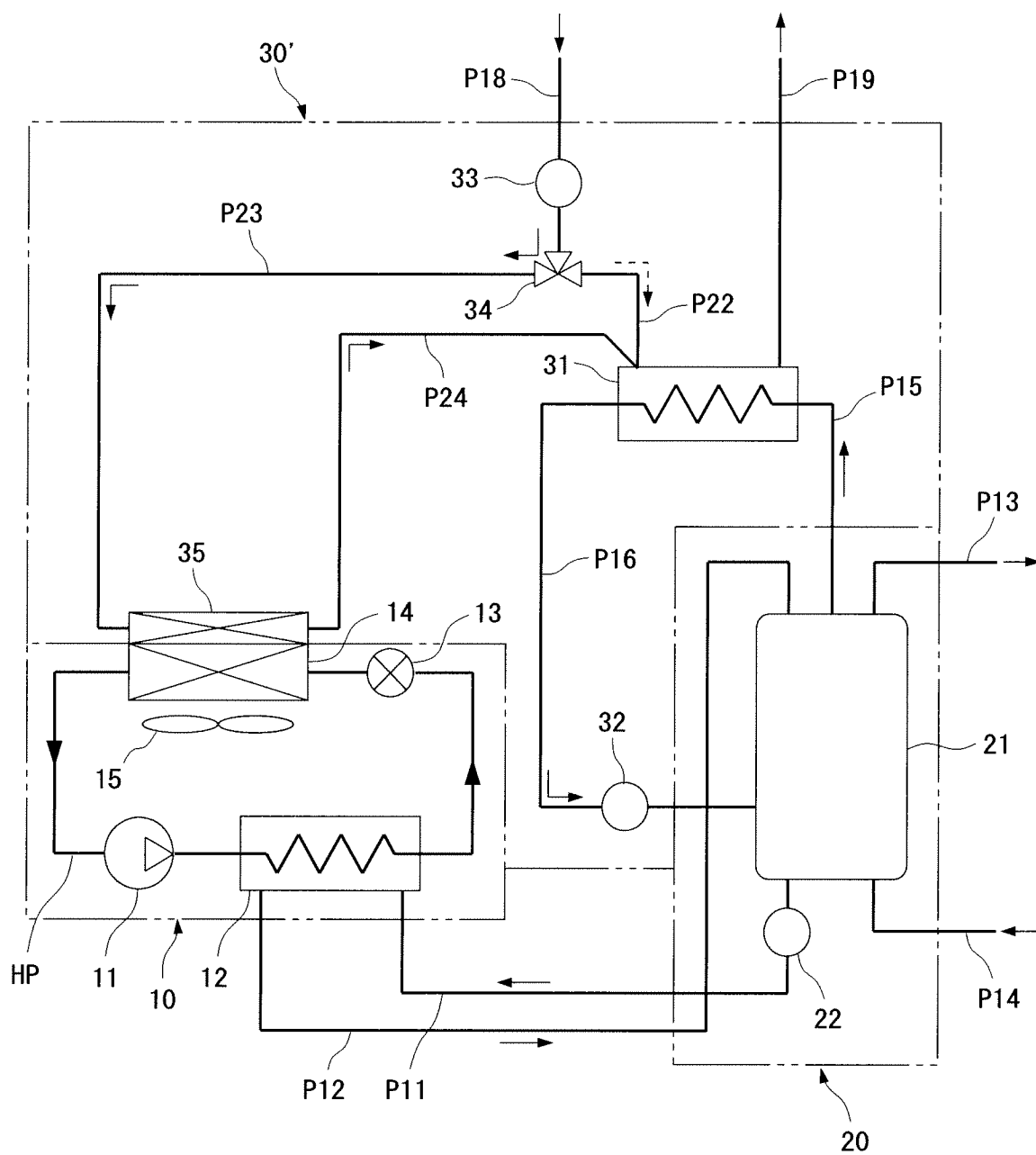
[Fig. 2]



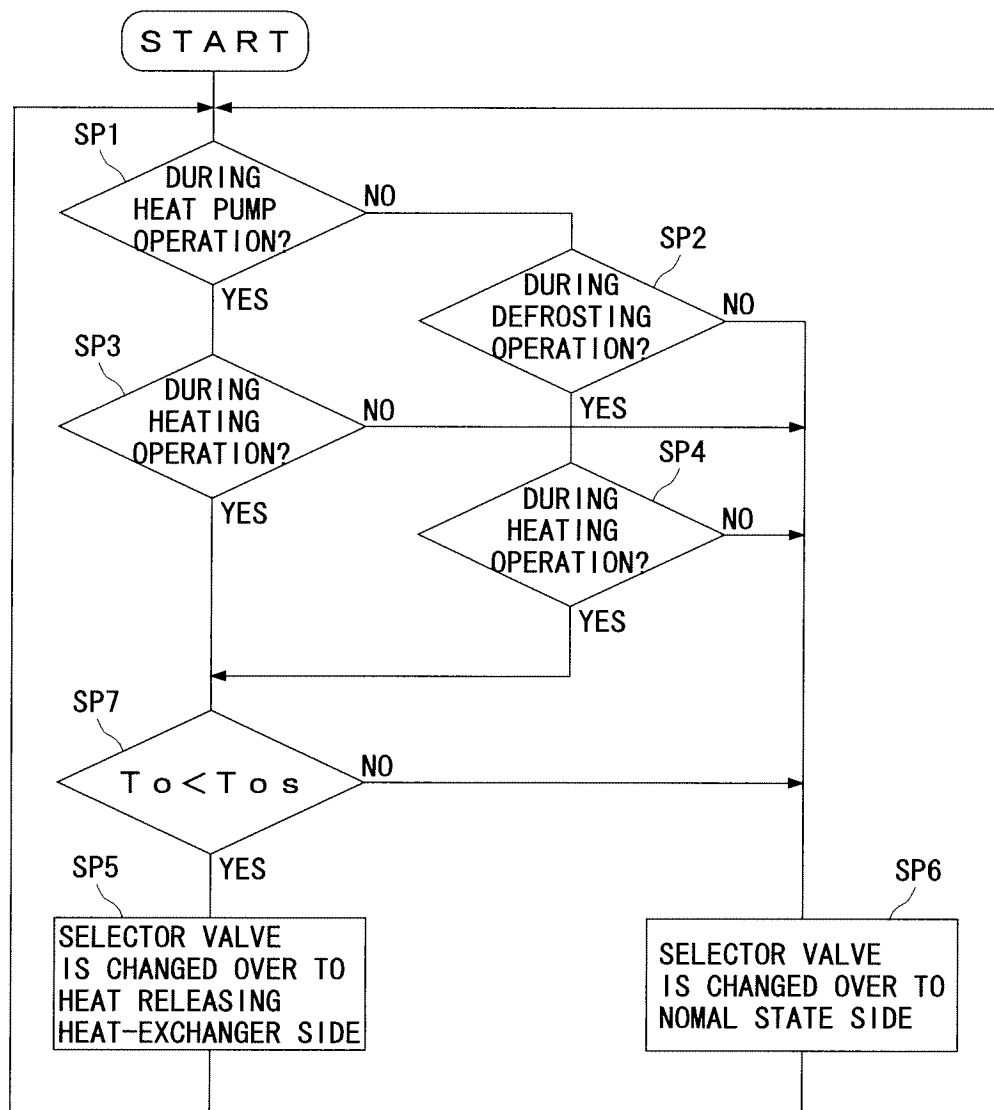
[Fig. 3]



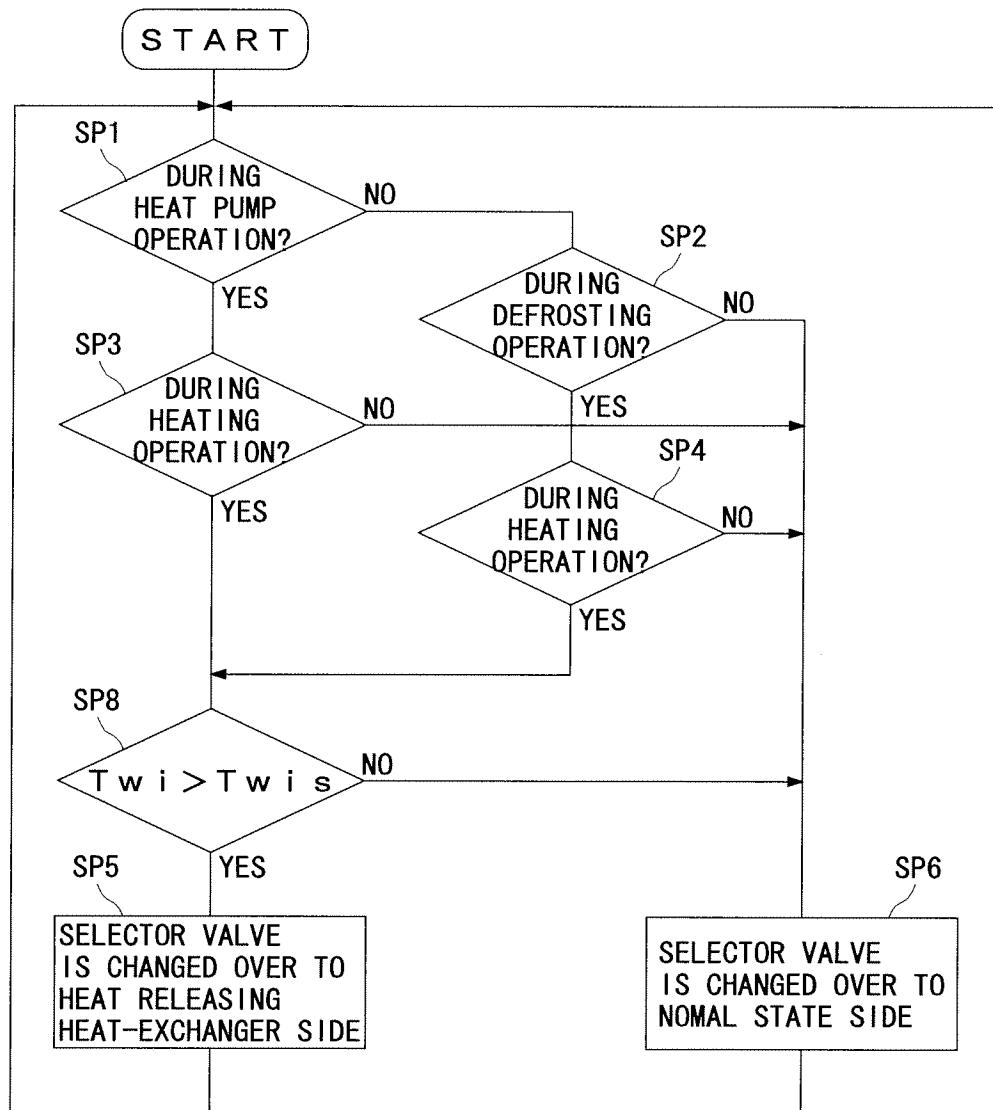
[Fig. 4]



[Fig. 5]



[Fig. 6]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2007/061802

A. CLASSIFICATION OF SUBJECT MATTER <i>F24H1/00</i> (2006.01)i, <i>F24D3/18</i> (2006.01)i, <i>F24H1/18</i> (2006.01)i, <i>F25B47/02</i> (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) <i>F24H1/00</i> , <i>F24D3/18</i> , <i>F24H1/18</i> , <i>F25B47/02</i> 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 <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>JP 2005-233444 A (Matsushita Electric Industrial Co., Ltd.), 02 September, 2005 (02.09.05), Full text; Figs. 1 to 3 (Family: none)</td> <td>1-9</td> </tr> <tr> <td>A</td> <td>JP 9-53846 A (Sanyo Electric Co., Ltd.), 25 February, 1997 (25.02.97), Par. Nos. [0030] to [0033]; Fig. 1 (Family: none)</td> <td>1-9</td> </tr> <tr> <td>A</td> <td>JP 2002-228258 A (Toshiba Carrier Corp.), 14 August, 2002 (14.08.02), Par. Nos. [0076] to [0078]; Fig. 5 (Family: none)</td> <td>1-9</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	A	JP 2005-233444 A (Matsushita Electric Industrial Co., Ltd.), 02 September, 2005 (02.09.05), Full text; Figs. 1 to 3 (Family: none)	1-9	A	JP 9-53846 A (Sanyo Electric Co., Ltd.), 25 February, 1997 (25.02.97), Par. Nos. [0030] to [0033]; Fig. 1 (Family: none)	1-9	A	JP 2002-228258 A (Toshiba Carrier Corp.), 14 August, 2002 (14.08.02), Par. Nos. [0076] to [0078]; Fig. 5 (Family: none)	1-9
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Date of the actual completion of the international search 05 September, 2007 (05.09.07)		Date of mailing of the international search report 18 September, 2007 (18.09.07)												
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Patent documents cited in the description

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