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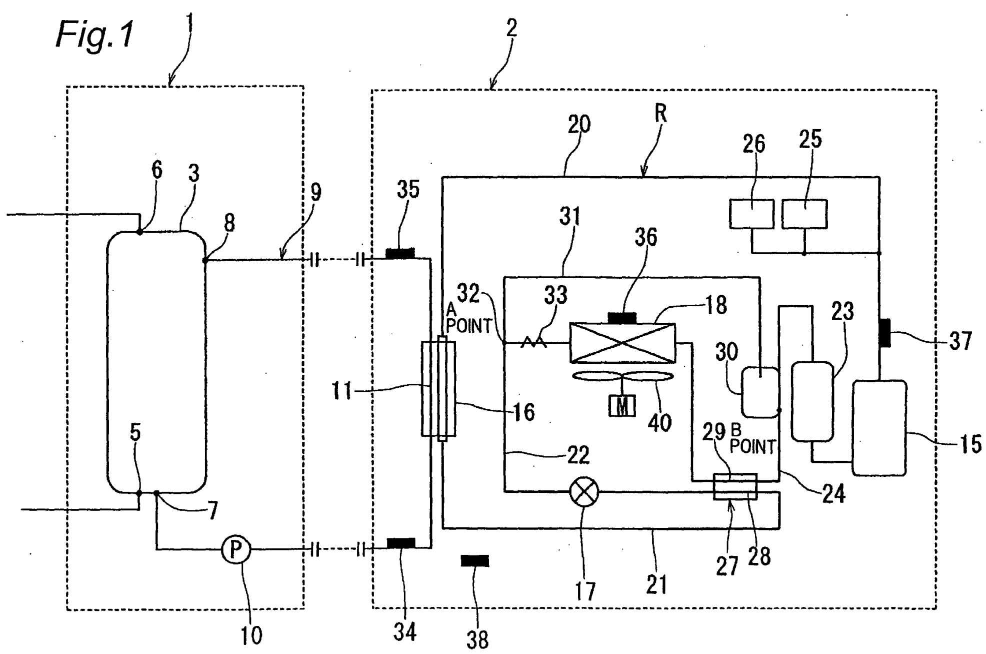
(54) REFRIGERATING CYCLE

(57) A refrigerating cycle which provides refrigerant circulation quantities corresponding to seasons, which can avoid overheat operation or wet operation, which does not require the use of a flow adjusting valve or the like, and which can be constructed at low costs. In this refrigerating cycle, a refrigerant delivered from a compressor (15) is caused to flow back to the compressor (15) successively through a gas cooler (16), a pressure reducing mechanism (17), and an evaporator (18). A refrigerant passage (22) and a refrigerant regulation vessel (30) which are disposed between the pressure reducing mechanism (17) and the evaporator (18) are interconnected through a connection passage (31). The refrigerant regulation vessel (30) is disposed in a temperature environment which changes dependent on the outside air temperature.

Fig.1



EP 1 541 939 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to refrigerating cycles, for example, to a refrigerating cycle which can be used in a heat source unit for heat-pump type water heaters.

BACKGROUND ART

[0002] Generally, as shown in Fig. 6, a heat-pump type water heater includes a tank unit 51 having a hot water storage tank 50, and a heat source unit 53 having a refrigerating cycle 52. Also, the refrigerating cycle 52 is constructed by connecting a compressor 54, a water-heat exchanger (condenser) 55, an expansion valve 57 and an evaporator 58 to one another in order. Then, the tank unit 51 includes the hot water storage tank 50 and a circulation passage 59, where a water circulating pump 60 and a heat exchange passage 61 are provided on the circulation passage 59. In this case, the heat exchange passage 61 is formed by a water-heat exchanger 55.

[0003] In this equipment, as the compressor 54 is driven and simultaneously the pump 60 is driven (actuated), stored water (hot water) flows out to the circulation passage 59 through a water intake hole provided at a bottom portion of the hot water storage tank 50, and flows through the heat exchange passage 61. During this time, the hot water is heated (boiled up) by the water-heat exchanger 55, and returned back to a top portion of the hot water storage tank 50 through a hot water entrance. Thus, high-temperature hot water is stored in the hot water storage tank 50.

[0004] Also, whereas a refrigerant such as dichlorodifluoromethane (R-12) or chlorodifluoromethane (R-22) has hitherto been used as the refrigerant of the refrigerating cycle, such an alternative refrigerant as 1,1,1,2-tetrafluoroethane (R-134a) has been coming to be used in terms of such issues as destruction of the ozone layer and environmental pollution. However, with this R-134a also, there is a problem, for example, that its global warming potency is still high, it has been increasingly recommended in recent years to use natural-based refrigerants that involve no such problems. It is publicly known that supercritical refrigerants such as carbonic acid gas are useful as the natural-based refrigerant.

[0005] However, in the above-described equipment, changes in outside air temperature would cause load changes on both water-heat exchanger (gas cooler) side and evaporator side, so that the refrigerant circulation quantity would differ among seasons. That is, as shown in Fig. 3, a cycle as indicated by I results with the outside air temperature high (in high outside air temperature), and such a cycle as indicated by II results with the outside air temperature low (in low outside air temperature), so that the refrigerant density within the evaporator 58 becomes larger in summer time (in high outside air temperature) than in winter time (in low outside air temperature). Therefore, the device would be difficult to operate at optimum refrigerant quantities among individual seasons so that the circulation quantity would tend to lack in summer time, resulting in excessive overheat operation, while the circulation quantity tends to be excessive in winter time, resulting in wet operation. Thus, there has been a fear that the compressor would lower in reliability.

[0006] On account of this, it is conceivable to provide a refrigerant regulation vessel 65 on the high pressure side, as shown in Fig. 5, to adjust a flow adjusting valve 66 so that the refrigerant quantity within the refrigerant regulation vessel (receiver) 65 is increased or decreased to set the refrigerant circulation quantity to one corresponding to the outside air temperature. In this case, there is provided a bypass circuit 67 which branches on the high pressure side and merges at a position downstream of the branch portion, while the receiver 65 is provided on the bypass circuit 67 and the flow adjusting valve 66 is provided on the outlet side of the receiver 65. That is, the bypass circuit 67 includes a first passage 68 which is branched from the upstream side of the water-heat exchanger 55 and connected to the receiver 65, and a second passage 69 which is led out from the receiver 65 and merged with the gas cooler 55 in the downstream of the branch portion of the first passage 68, with the flow adjusting valve 66 provided on the second passage 69. Also, a refrigerant passage 70 by which the expansion valve 57 and the evaporator 58 are connected to each other runs through the receiver 65.

[0007] Accordingly, in the refrigerating cycle shown in Fig. 5, heat exchange is performed between a high-pressure refrigerant brought into the receiver 65 via the bypass circuit 67 and a low-pressure refrigerant that flows through the refrigerant passage 70. Then, the flow rate of refrigerant that passes through the receiver 65 is regulated by regulating the opening of the adjusting valve 66, by which the refrigerant temperature in the receiver 65 is adjusted. That is, performing opening control of the flow adjusting valve 66 makes it possible to hold a required refrigerant temperature, an appropriate refrigerant storage quantity within the receiver 65, and an optimum level of refrigerant circulation quantity within the circuit.

[0008] However, the refrigerating cycle such as shown in Fig. 5 would involve the use of the flow adjusting valve 66 as described above, leading to higher cost. Also, since the bypass circuit 67 is provided midway on the gas cooler 55 on the high pressure side, the circuit construction becomes complicated, causing a difficulty in manufacture, with the cost even more increased. Still more, since part of the refrigerant that circulates through the gas cooler 55 is bypassed, there would arise a heat loss, causing another fear that heating performance may be impaired.

DISCLOSURE OF THE INVENTION

[0009] The present invention having been accomplished to solve the above drawbacks of the prior art, an object thereof is to provide a refrigerating cycle which provides refrigerant circulation quantities corresponding to individual seasons, capable of avoiding overheat operation or wet operation, and yet which does not require the use of a flow adjusting valve or the like, thus capable of being constructed at low costs.

[0010] In order to achieve the above object, there is provided a refrigerating cycle for circulating a refrigerant, which is discharged from a compressor, via a gas cooler, a pressure reducing mechanism and an evaporator successively in order so as to be turned back to the compressor, comprising:

> a refrigerant regulation vessel which is connected via a connection passage to a refrigerant passage defined between the pressure reducing mechanism and the evaporator, wherein
> the refrigerant regulation vessel is placed under a temperature environment that changes depending on outside air temperature.

[0011] In this refrigerating cycle, since the refrigerant passage defined between the pressure reducing mechanism and the evaporator and the refrigerant regulation vessel are connected to each other via a connection passage, the refrigerant (gas refrigerant) is introduced from between the pressure reducing mechanism and the evaporator into the refrigerant regulation vessel. Then, the refrigerant regulation vessel is placed under a temperature environment that changes depending on outside air temperature. Therefore, for example, in summer time, in which the outside air temperature is high, the refrigerant regulation vessel is held on the high temperature side so that the storage quantity of the refrigerant in the refrigerant regulation vessel decreases, allowing the refrigerant circulation quantity within the circulation passage of the refrigerating cycle to be increased. Also, in winter time, in which the outside air temperature is low, the refrigerant regulation vessel is held on the low temperature side so that the storage quantity of the refrigerant in the refrigerant regulation vessel increases, allowing the refrigerant circulation quantity within the circulation passage of the refrigerating cycle to be decreased. That is, by placing the refrigerant regulation vessel under a temperature environment that changes depending on outside air temperature, the storage quantity of the refrigerant in the refrigerant regulation vessel can be increased or decreased, by which a refrigerant circulation quantity corresponding to an outside air temperature can be attained.

[0012] As a result, the refrigerant can be circulated with refrigerant quantities corresponding to individual seasons, so that excessive overheat operation or wet operation can be prevented. Still, the refrigerant circulation quantity can be controlled by the temperature environment that changes depending on outside air temperature, without providing any bypass circuit or the like on which a regulator valve is provided.

[0013] In one embodiment of the present invention, the temperature environment that changes depending on outside air temperature is formed by the refrigerant ranging from an outlet of the evaporator to an inlet of the compressor.

[0014] In the refrigerating cycle of this embodiment, the temperature of the refrigerant ranging from the evaporator outlet to the compressor inlet changes depending on outside air temperature. As a result, the refrigerant makes it possible to stably form a temperature environment that changes depending on outside air temperature, so that a refrigerant circulation quantity corresponding to an outside air temperature can reliably be attained.

[0015] In one embodiment of the present invention, the refrigerant regulation vessel is provided on a refrigerant piping ranging from the evaporator outlet to the compressor inlet, and a refrigerant within the refrigerant piping and a refrigerant within the refrigerant regulation vessel are heat exchanged.

[0016] In the refrigerating cycle of this embodiment, since the refrigerant regulation vessel is provided on the refrigerant piping ranging from the evaporator outlet to the compressor inlet, the heat exchange between the refrigerant within the refrigerant piping and the refrigerant within the refrigerant regulation vessel is of high reliability, so that a refrigerant circulation quantity corresponding to an outside air temperature can be attained stably.

[0017] In one embodiment of the present invention, a throttle is provided on the refrigerant passage between the pressure reducing mechanism and the evaporator and at a position which is closer to the evaporator than a connecting portion of the connection passage.

[0018] In the refrigerating cycle of this embodiment, providing the throttle allows an optimum degree of inlet superheat to be attained.

[0019] In one embodiment of the present invention, the refrigerant regulation vessel is placed so as to be exposed to outside air.

[0020] In the refrigerating cycle of this embodiment, since the refrigerant regulation vessel is exposed to outside air, the refrigerant in the refrigerant regulation vessel is warmed or cooled by the outside air. That is, with a simple construction, the refrigerant in the refrigerant regulation vessel is increased or decreased in response to an outside air temperature, so that refrigerant circulation quantities corresponding to the individual seasons can be attained.

[0021] In one embodiment of the present invention, the refrigerant regulation vessel is placed within a wind passage generated by a fan provided on the evaporator.

[0022] In the refrigerating cycle of this embodiment, since the refrigerant regulation vessel is placed within a wind passage generated by a fan provided on the evaporator, the temperature of the refrigerant regulation vessel can be controlled by this wind.

[0023] In one embodiment of the present invention, the refrigerant regulation vessel is placed leeward of a downstream of the evaporator.

[0024] In the refrigerating cycle of this embodiment, the refrigerant regulation vessel is placed leeward of a downstream of the evaporator, the refrigerating cycle becomes a preferred one in terms of heat exchange and the temperature control of the refrigerant regulation vessel can reliably be performed.

[0025] In one embodiment of the present invention, the temperature environment that changes depending on outside air temperature is implemented by heating cooling the refrigerant regulation vessel with a Peltier element or the like.

[0026] In the refrigerating cycle of this embodiment, since the refrigerant regulation vessel can be heated or cooled by a Peltier element or the like, the refrigerant in the refrigerant regulation vessel can reliably be increased or decreased in response to an outside air temperature. Thus, the refrigerant circulation quantity can stably be controlled to those corresponding to the individual seasons.

[0027] In one embodiment of the present invention, the refrigerant regulation vessel is placed so as to be heat exchanged with water that changes in temperature depending on outside air temperature.

[0028] In the refrigerating cycle of this embodiment, the refrigerant regulation vessel is temperature controlled by water of which the temperature depends on outside air. That is, the refrigerant in the refrigerant regulation vessel is increased or decreased in response to an outside air temperature, so that refrigerant circulation quantities corresponding to the individual seasons can be attained.

[0029] In one embodiment of the present invention, a throttle is provided on the refrigerant passage between the pressure reducing mechanism and the evaporator and at a position which is closer to the evaporator than a connecting portion of the connection passage, a refrigerant within the refrigerant regulation vessel and a refrigerant in proximity to the inlet of the evaporator located downstream of the throttle are heat exchanged with each other, and a heater for use of refrigerant quantity regulation is provided on the refrigerant regulation vessel.

[0030] In the refrigerating cycle of this embodiment, since the refrigerant in the refrigerant regulation vessel can be heat exchanged with the low-temperature refrigerant that has just passed through the throttle, heat exchange can reliably be performed. Moreover, since the refrigerant regulation vessel is equipped with the heater for use of regulation of refrigerant quantity, the temperature of the refrigerant regulation vessel can be controlled by the heater in response to an outside air temperature.

[0031] In one embodiment of the present invention, the refrigerating cycle is operated on its high-pressure side with a supercritical pressure.

[0032] In the refrigerating cycle of this embodiment, since the refrigerating cycle is operated on its high-pressure side with a supercritical pressure, employing a supercritical refrigerant for supercritical use as the refrigerant allows the refrigerating cycle to become one which is friendly to the global environment. Also, with the refrigerating cycle employing a supercritical refrigerant, since the pressure on the high pressure side becomes a high one, the advantage by the provision of the refrigerant regulation vessel on the low pressure side can be fully exerted, the working effects of the above embodiments can particularly be fulfilled effectively.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033]

Fig. 1 is a simplified diagram showing an embodiment of a refrigerating cycle according to the present invention;
Fig. 2 is a Mollier chart of the refrigerating cycle;
Fig. 3 is a Mollier chart of the conventional refrigerating cycle;
Fig. 4 is a main part simplified diagram showing another embodiment of the refrigerating cycle of the invention;
Fig. 5 is a simplified diagram showing a comparative example of a refrigerating cycle; and
Fig. 6 is a simplified diagram of a refrigerating cycle according to the prior art.

BEST MODE FOR CARRYING OUT THE INVENTION

[0034] A specific embodiment of the refrigerating cycle of the present invention is described in detail with reference to the accompanying drawings. Fig. 1 shows a simplified diagram of a heat-pump water heater employing the refrigerating cycle. This heat-pump type water heater, including a tank unit 1 and a heat source unit 2, heats water (hot water) of the tank unit 1 by the heat source unit 2.

[0035] The tank unit 1 has a hot water storage tank 3, and hot water stored in the hot water storage tank 3 is supplied to an unshown tub or the like. That is, in the hot water storage tank 3, a water feed hole 5 is provided at its bottom wall and a hot water tap hole 6 is provided at its top wall. Then, city water (tap water) is fed from the water feed hole 5 to the hot water storage tank 3, and high temperature hot water is delivered out through the hot water tap hole 6. Also in the hot water storage tank 3, a water intake hole 7 is opened at its bottom wall, and a hot water entrance 8 is opened at a top portion of its side wall (peripheral wall), where the water intake hole 7 and the hot water entrance 8 are coupled to each other by a circulation passage 9. Then, a water circulating pump 10 and a heat exchange passage 11 are provided on the circulation passage 9.

[0036] Next, the heat source unit 2 includes a refrigerating cycle R according to this embodiment, and the refrigerating cycle R is constructed by connecting a compressor 15, a water-heat exchanger (gas cooler) 16 forming the heat exchange passage 11, a pressure reducing mechanism (electrically-operated expansion valve) 17 and an air-heat exchanger (evaporator) 18 to one another in order. That is, a discharge hole of the compressor 15 and the gas cooler 16 are connected to each other by a refrigerant passage 20, the gas cooler 16 and the electrically-operated expansion valve 17 are connected to each other by a refrigerant passage 21, the electrically-operated expansion valve 17 and the air-heat exchanger 18 are connected to each other by a refrigerant passage 22, and the air-heat exchanger 18 and the compressor 15 are connected to each other by a refrigerant passage 24 on which an accumulator 23 is provided. Then, as the refrigerant, for example, carbonic acid gas (CO_2) is used for use with supercritical pressure on the high pressure side. It is noted that the gas cooler as the water-heat exchanger 16 is one which has a function of cooling a high-temperature, high-pressure supercritical refrigerant compressed by the compressor 15.

[0037] Also, an HPS 25 as a pressure protection switch and a pressure sensor 26 are provided on the refrigerant passage 20. Further, a fan 40 for use of power regulation is provided on the evaporator 18.

[0038] Also, the refrigerating cycle R includes a liquid-gas heat exchanger 27 for cooling the high-pressure refrigerant that has flowed out from the gas cooler 16. In this case, the liquid-gas heat exchanger 27, which is of a double-tube structure, has a first passage 28 through which the refrigerant derived from the gas cooler 16 passes, and a second passage 29 through which the refrigerant derived from the evaporator 18 passes. That is, the first passage 28 forms part of the refrigerant passage 21 that connects the gas cooler 16 and the electrically-operated expansion valve 17 to each other, and the second passage 29 forms part of the refrigerant passage 24 that connects the evaporator 18 and the compressor 15 to each other. Therefore, heat exchange is performed between the high-pressure, high-temperature refrigerant that passes through the first passage 28 and the low-pressure, low-temperature refrigerant that passes through the second passage 29, so that the refrigerant derived from the gas cooler 16 is supercooled and the refrigerant flowing into the accumulator 23 is heated, thus making it possible to prevent wet compression of the compressor 15.

[0039] Further, the refrigerating cycle R has a refrigerant regulation vessel 30 provided on the refrigerant passage 24 (which is a refrigerant piping running from evaporator outlet to compressor inlet, more specifically, between the second passage 29 of the liquid-gas heat exchanger 27 and the accumulator 23). As a result of this, the refrigerant regulation vessel 30 is in contact with the refrigerant passage 24, enabling heat exchange between the refrigerant within the refrigerant regulation vessel 30 and the refrigerant within the refrigerant passage 24. Further, a connection passage 31 is connected to the refrigerant regulation vessel 30. That is, the connection passage 31 connects the refrigerant passage 22 (a refrigerant passage between the pressure reducing mechanism 17 and the evaporator 18) and the refrigerant regulation vessel 30 to each other. Therefore, the refrigerant of the refrigerating cycle R (gas refrigerant) is led out from between the pressure reducing mechanism 17 and the evaporator 18 and stored in the refrigerant regulation vessel 30 as a liquid refrigerant. Preferably, the capacity of the refrigerant regulation vessel 30 is set to about 1/10 (e.g., about 300 to 400cc) of the total capacity of the cycle (the circulation passage through which the refrigerant circulates from compressor 15 via gas cooler 16, pressure reducing mechanism 17 and evaporator 18 to compressor 15).

[0040] Further, a throttle 33 is provided on the refrigerant passage 22 between the pressure reducing mechanism 17 and the evaporator 18 at a place closer to the evaporator 18 than a connecting portion 32 (A point) of the connection passage 31. As this throttle 33, a fixed throttle such as a capillary tube is usable, but of course, it may be provided by an electrically-operated expansion valve or the like. Also, the throttle 33 is preferably selected as one which results in an inlet overheat degree of 3 to 5°C under the conditions that the outside air temperature is 7°C and the refrigerating cycle has a heating capacity of 4500 W, as an example.

[0041] This heat-pump water heater is equipped with a temperature sensor (invading water thermistor) 34 for detecting a temperature of the circulation passage 9 on its upstream side of the heat exchange passage 11, a temperature sensor (tapped hot water thermistor) 35 for detecting a temperature of the circulation passage 9 on its downstream side of the heat exchange passage 11, a temperature sensor (air-heat exchange thermistor) 36 for detecting temperature of the evaporator 18, a temperature sensor (discharge tube thermistor) 37 for detecting discharge gas temperature of the compressor 15, a temperature sensor (outside air temperature thermistor) 38 for detecting the outside air temperature, and the like. Then, data (detected temperatures) from these sensors are inputted to an unshown control section (e.g., implemented by a microcomputer or the like) of the heat-pump water heater, so that various types of control are performed based on these data.

[0042] More specifically, in operation of the heat-pump type water heater, for example, a temperature of the discharge tube is detected by the discharge tube thermistor 37, and the opening of the electrically-operated expansion valve 17 can be adjusted (controlled) so that the discharge tube temperature becomes a target discharge tube temperature. Also, if the temperature of the invading water thermistor 34 is not less than a specified temperature (e.g., 60°C), then the water heating capacity (boil-up capacity) or the like can be adjusted by stopping the operation based on an assumption that the hot water in the hot water storage tank 3 has been boiled up, or by controlling the operating frequency of the compressor 15 based on the temperature of the outside air temperature thermistor 38.

[0043] Next, running operation (water boiling operation) of this heat-pump type water heater is explained. As the compressor 15 is driven, the water circulating pump 10 is driven (actuated). Then, stored water (hot water) flows out through the water intake hole 7 provided at a bottom portion of the hot water storage tank 3, and flows through the heat exchange passage 11 of the circulation passage 9. Also, the refrigerant discharged from the compressor 15 flows back through the gas cooler 16 to the pressure reducing mechanism 17 to the evaporator 18, successively, and to the compressor 15. As a result of this, the water circulating through the heat exchange passage 11 of the circulation passage 9 is heated (boiled up) by a water-heat exchanger, which is the gas cooler 16, and turned back through the hot water entrance 8 to the top portion of the hot water storage tank 3. By continuous execution of such an operation, hot water is stored in the hot water storage tank 3. It is noted that since the nighttime unit price of electric power charge is set lower than the daytime one in the existing electric power rate system, the above operation is preferably performed in midnight time periods of low cost so that a cost reduction can be achieved.

[0044] A Mollier chart for this operation is as shown in Fig. 2. More specifically, in this refrigerating cycle, a high-pressure refrigerant of state 1 is discharged from the compressor 15, and the high-pressure refrigerant is introduced to the gas cooler 16 (water-heat exchanger). In this gas cooler 16, heat exchange is done with water that passes through the heat exchange passage 11. As a result of this, the water that passes through the heat exchange passage 11 is heated (boiled up). Then, by this heat exchange, the high-pressure refrigerant yields heat radiation to the water, so that its enthalpy lowers from state 1 to 2. The high-pressure refrigerant in this state 2 is fed to the pressure reducing mechanism 17 (expansion valve). The high-pressure refrigerant is reduced in pressure to A point by the pressure reducing mechanism 17, and further lowered to state 3 by the throttle 33. Then, the resulting low-pressure refrigerant is introduced to the evaporator 18. In the evaporator 18, the low-pressure refrigerant is subject to heat exchange with air. As a result of this heat exchange, the low-pressure refrigerant absorbs heat so as to be evaporated, coming to state 4 at B point. That is, its enthalpy increases from state 3 to 4, and the low-pressure refrigerant of this state 4 is fed to the compressor 15.

[0045] In this case, the refrigerant in the state at the connecting portion 32 (A point) with the connection passage 31 on the refrigerant passage 22 between the pressure reducing mechanism 17 and the evaporator 18 is subject to heat exchange with the refrigerant that is located on the piping from evaporator outlet to compressor inlet and between the second passage 29 of the liquid-gas heat exchanger 27 and the accumulator 23 (B point). Therefore, as the temperature at the B point increases according to outside air, the temperature of the refrigerant regulation vessel 30 also increases so that the refrigerant storage quantity decreases. Also, as the temperature at the B point decreases according to outside air, the temperature of the refrigerant regulation vessel 30 also decreases so that the refrigerant storage quantity increases. Then, when the temperature difference between A point and B point has vanished as shown by broken line (isothermal line) in Fig. 2, changes in the refrigerant storage quantity in the refrigerant regulation vessel 30 vanish, so that the refrigerant circulates at a constant refrigerant circulation quantity. Thus, in this refrigerating cycle R, the temperature of A point and the temperature of B point become nearly equal to each other. Meanwhile, by the provision of the throttle 33, the temperature of B point becomes one in which a temperature corresponding to a pressure drop of the throttle 33 is added to the evaporating temperature as shown in Fig. 2 (a temperature at A point), so that a certain degree of superheat (S) corresponding to the pressure drop can be obtained, hence a high-efficiency operation being implementable.

[0046] In this connection, the refrigerant piping (refrigerant passage 24) running from evaporator outlet to compressor inlet, which is subject to influences of outside air temperature, is higher in temperature in summer time, in which the outside air temperature is higher, than in winter time, in which the outside air temperature is lower. Therefore, as shown in Fig. 3, such a cycle as indicated by I results when the outside air temperature is high (i.e., in high outside air temperature), and such a cycle as indicated by II results when the outside air temperature is low (i.e., in low outside air temperature), so that the refrigerant density within the evaporator 18 becomes larger in summer time (at high outside air temperature) than in winter time (at low outside air temperature). Therefore, the refrigerant quantity in the evaporator 18 largely differs between high outside air temperature and low outside air temperature. Thus, in spite of a necessity for a large refrigerating circulation quantity at the high outside air temperature, this refrigerant circulation quantity could not be ensured. At the low outside air temperature, on the other hand, the refrigerant circulation quantity would become larger than necessary quantity in spite of a need for only a less refrigerant circulation quantity.

[0047] However, with the provision of the refrigerant regulation vessel 30 and the connection passage 31, the refrigerant regulation vessel 30 is held on the higher temperature side in summer time because of high outside air temperature, so that the storage quantity of the refrigerant in the refrigerant regulation vessel 30 decreases, allowing the refrigerant circulation quantity within the circulation passage of the refrigerating cycle to be increased. Also, the refrigerant regulation vessel 30 is held on the low temperature side in winter time because of low outside air temperature, so that the storage quantity of the refrigerant in the refrigerant regulation vessel 30 increases, allowing the refrigerant circulation quantity within the circulation passage of the refrigerating cycle to be decreased. That is, by placing the refrigerant regulation vessel 30 under a temperature environment that changes depending on outside air temperature, the refrigerant quantity in the refrigerant regulation vessel 30 is increased or decreased so that a refrigerant circulation quantity corresponding to the outside air temperature can be attained. Therefore, the refrigerant can be circulated with refrigerant circulation quantities corresponding to the individual seasons, making it possible to prevent any excessive overheat operation or wet operation.

[0048] By virtue of the placement of the refrigerant regulation vessel 30 under a temperature environment that changes depending on outside air temperature, a circulation quantity corresponding to an outside air temperature is naturally attained as described above, so that the operation can be carried out at circulation quantities corresponding to outside air temperatures of the individual seasons, thus making it possible to prevent overheat operation or wet operation. Accordingly, only if the refrigerant regulation vessel 30, without being provided on the refrigerant passage 24 or the like, can be placed under other temperature environments that change depending on the outside air temperature, the operation can be performed at a circulation quantity corresponding to an outside air temperature.

[0049] Also, in this embodiment, with the refrigerant regulation vessel 30 provided on the refrigerant passage 24, heat exchange is performed between the refrigerant in this refrigerant passage (refrigerant piping) 24 and the refrigerant in the refrigerant regulation vessel 30. However, the refrigerant regulation vessel 30 may also be set along the piping between the throttle 33 and the evaporator 18 as shown in Fig. 4. That is, it is enabled to fulfill the heat exchange between the refrigerant in the refrigerant regulation vessel 30 and the refrigerant in proximity to the entrance of the evaporator 18 located on the downstream side of the throttle 33. In this case, the refrigerant regulation vessel 30 is equipped with a heater H for use of regulation of refrigerant quantity.

[0050] With a constitution like this Fig. 4, since the refrigerant in the refrigerant regulation vessel 30 is heat exchanged with a low-temperature refrigerant that has just passed through the throttle 33, heat exchange can reliably be performed. Moreover, since the refrigerant regulation vessel 30 is equipped with the heater H for use of regulation of refrigerant quantity, the temperature of the refrigerant regulation vessel 30 can be controlled by this heater H. Therefore, the refrigerating cycle can reliably be operated at refrigerant circulation quantities corresponding to the individual seasons. That is, in this case, there is formed a temperature environment that changes depending on outside air temperature by virtue of the heat exchange with the low-temperature refrigerant as well as the heating by the heater H.

[0051] Another method for placing the refrigerant regulation vessel 30 under a temperature environment that changes depending on outside air temperature is as follows. For instance, the refrigerant regulation vessel 30 is set, merely, at a position where it is exposed to outside air (for example, outside the casing in which the refrigerating cycle is housed). In this case, the refrigerant regulation vessel 30, if exposed to outside air, will be heated or cooled in response to outside air temperatures. Also, since the fan 40 is provided on the evaporator 18, the refrigerant regulation vessel 30 is placed within a wind passage generated by the fan 40. In this case, the refrigerant regulation vessel 30 may be placed either windward or leeward of an upstream of the evaporator 18. This is because the temperature in this wind passage is dependent on the outside air in this case also. In particular, in terms of heat exchange, the refrigerant regulation vessel 30 is preferably placed leeward of a downstream of the evaporator 18. Further, Peltier element or the like may be used. It is noted here that the Peltier element refers to an element capable of fulfilling the Peltier effect, which is a phenomenon that when an electric current is passed through a contact between different kinds of conductors (or semiconductors), generation or absorption of heat other than Joule heat occurs at the contact. Accordingly, in this case, an outside air temperature is sensed (detected) by the outside air temperature thermistor 38, and the Peltier element is let to generate or absorb heat for the refrigerant regulation vessel 30 based on the outside air temperature. Further, the refrigerant regulation vessel 30 may also be set to perform heat exchange with water. In this case, the water for cooling use may be provided by city water (tap water) or water that has flowed out from the water intake hole 7 of the hot water storage tank 3 to the circulation passage 9, or the like. With city water (tap water) used, the refrigerant regulation vessel 30 may be provided on the water service pipe that supplies tap water to the hot water storage tank 3. With the use of the water of the circulation passage 9, the refrigerant regulation vessel 30 may be provided on the piping between the water intake hole 7 of the hot water storage tank 3 and the entrance of the gas cooler 16.

[0052] Although a concrete embodiment of the present invention has been described hereinabove, yet the present invention is not limited to the above embodiment and may be carried out in many variations within the scope of the invention. For example, when the refrigerant regulation vessel 30 is placed on the refrigerant passage 24 running from evaporator outlet to compressor inlet, it is also possible to place the refrigerant regulation vessel 30 on one side of the second passage 29 of the liquid-gas heat exchanger 27 closer to the evaporator 18. Further, the refrigerating cycle may be such that the throttle 33 is not provided or that the liquid-gas heat exchanger 27 is not disposed. In addition, the refrigerating cycle is usable for various types of refrigerators such as air conditioners or showcase other than heat-pump type water heaters. Also, the refrigerant may be ethylene, ethane, nitrogen oxide or other refrigerants for supercritical use other than carbonic acid gas, and moreover such refrigerants as dichlorodifluoromethane (R-12) and chlorodifluoromethane (R-22) other than those for supercritical use may be used.

Claims

1. A refrigerating cycle for circulating a refrigerant, which is discharged from a compressor (15), via a gas cooler (16), a pressure reducing mechanism (17) and an evaporator (18) successively in order so as to be turned back to the compressor (15), comprising:

    a refrigerant regulation vessel (30) which is connected via a connection passage (31) to a refrigerant passage (22) defined between the pressure reducing mechanism (17) and the evaporator (18), wherein
    the refrigerant regulation vessel is placed under a temperature environment that changes depending on outside air temperature.

2. The refrigerating cycle of Claim 1, wherein the temperature environment that changes depending on outside air temperature is formed by the refrigerant ranging from an outlet of the evaporator to an inlet of the compressor.

3. The refrigerating cycle of Claim 2, wherein the refrigerant regulation vessel (30) is provided on a refrigerant piping (24) ranging from the evaporator outlet to the compressor inlet, and a refrigerant within the refrigerant piping (24) and a refrigerant within the refrigerant regulation vessel (30) are heat exchanged.

4. The refrigerating cycle of any one of Claims 1 to 3, wherein a throttle (33) is provided on the refrigerant passage (22) between the pressure reducing mechanism (17) and the evaporator (18) and at a position which is closer to the evaporator (18) than a connecting portion (32) of the connection passage (31).

5. The refrigerating cycle of Claim 1, wherein the refrigerant regulation vessel (30) is placed so as to be exposed to outside air.

6. The refrigerating cycle of Claim 1, wherein the refrigerant regulation vessel (30) is placed within a wind passage generated by a fan (40) provided on the evaporator (18).

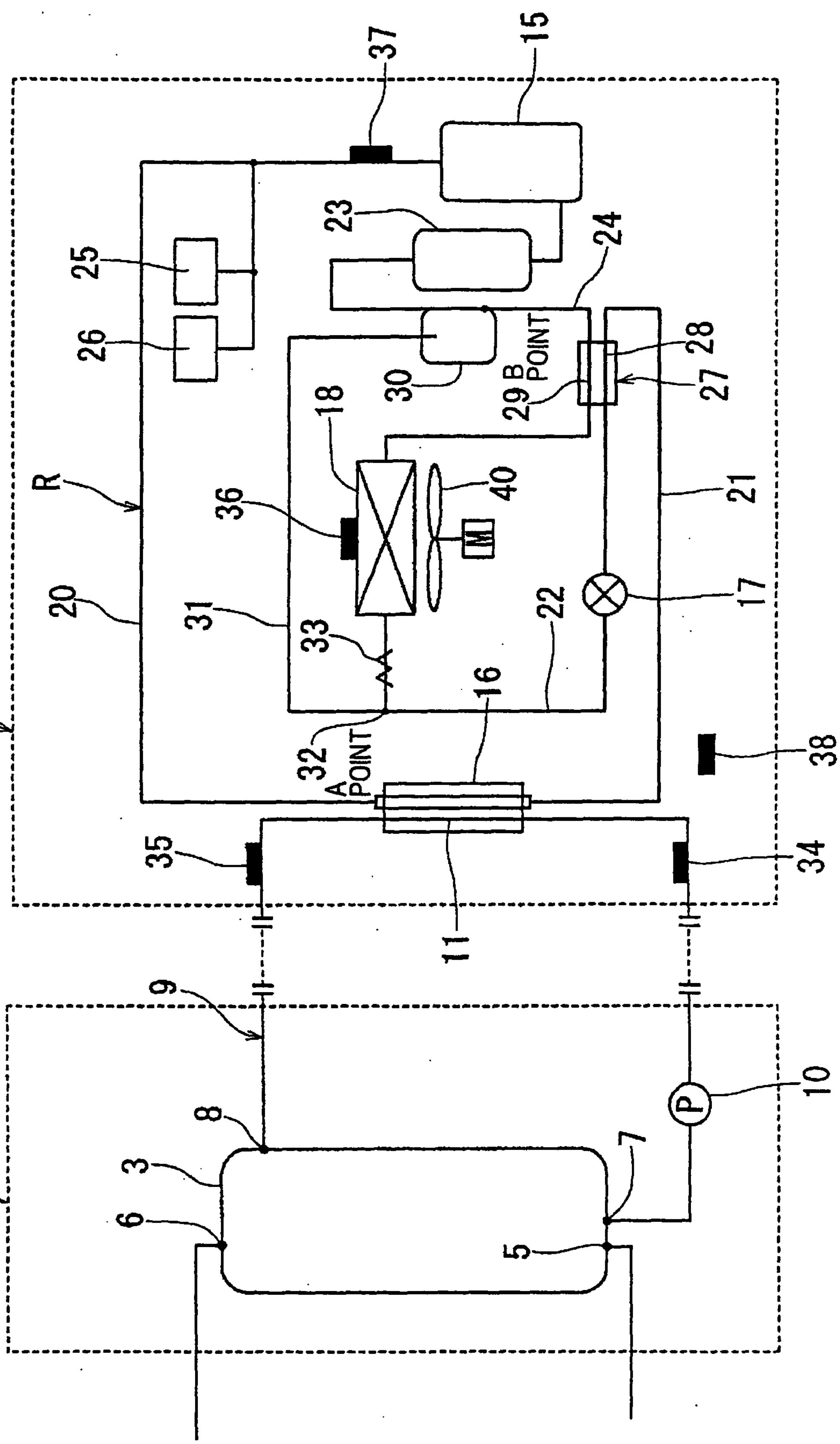
7. The refrigerating cycle of Claim 6, wherein the refrigerant regulation vessel (30) is placed leeward of a downstream of the evaporator (18).

8. The refrigerating cycle of Claim 1, wherein the temperature environment that changes depending on outside air temperature is implemented by heating cooling the refrigerant regulation vessel (30) with a Peltier element or the like.

9. The refrigerating cycle of Claim 1, wherein the refrigerant regulation vessel (30) is placed so as to be heat exchanged with water that changes in temperature depending on outside air temperature.

10. The refrigerating cycle of Claim 1, wherein a throttle (33) is provided on the refrigerant passage (22) between the pressure reducing mechanism (17) and the evaporator (18) and at a position which is closer to the evaporator (18) than a connecting portion (32) of the connection passage (31), a refrigerant within the refrigerant regulation vessel (30) and a refrigerant in proximity to the inlet of the evaporator 18 located downstream of the throttle (33) are heat exchanged with each other, and a heater (H) for use of refrigerant quantity regulation is provided on the refrigerant regulation vessel (30).

11. The refrigerating cycle of any one of Claims 1 to 10, wherein the refrigerating cycle is operated on its high-pressure side with a supercritical pressure.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R
A POINT
B POINT
M
P

Fig.1

Fig.2

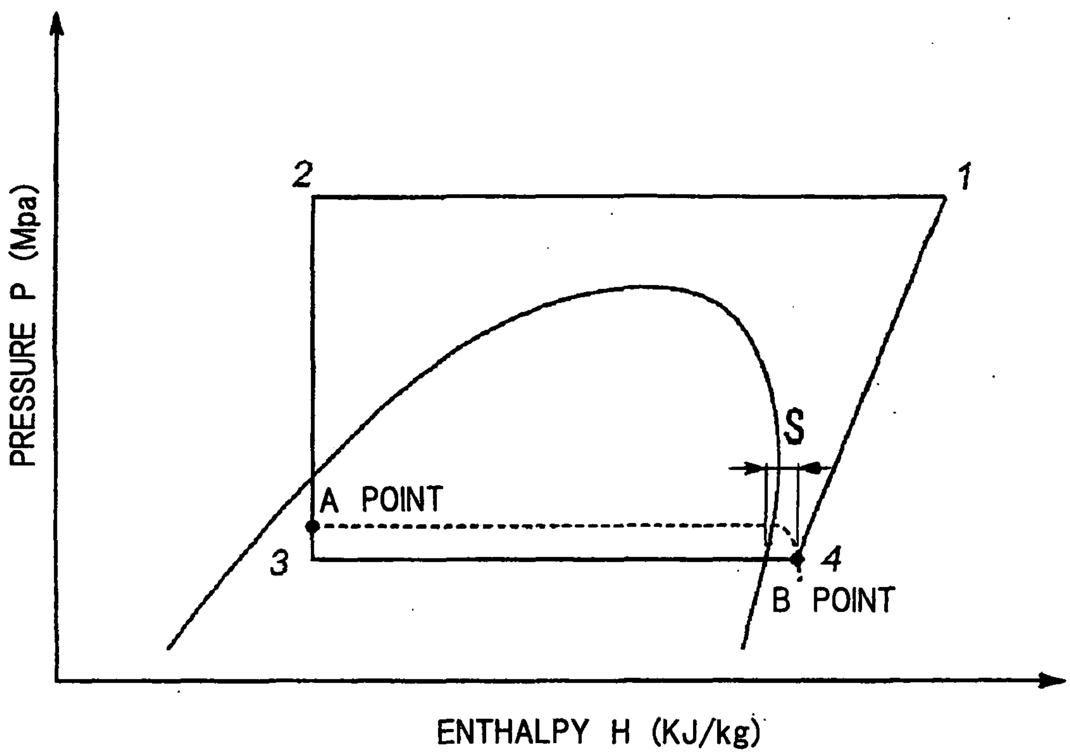


Fig.3

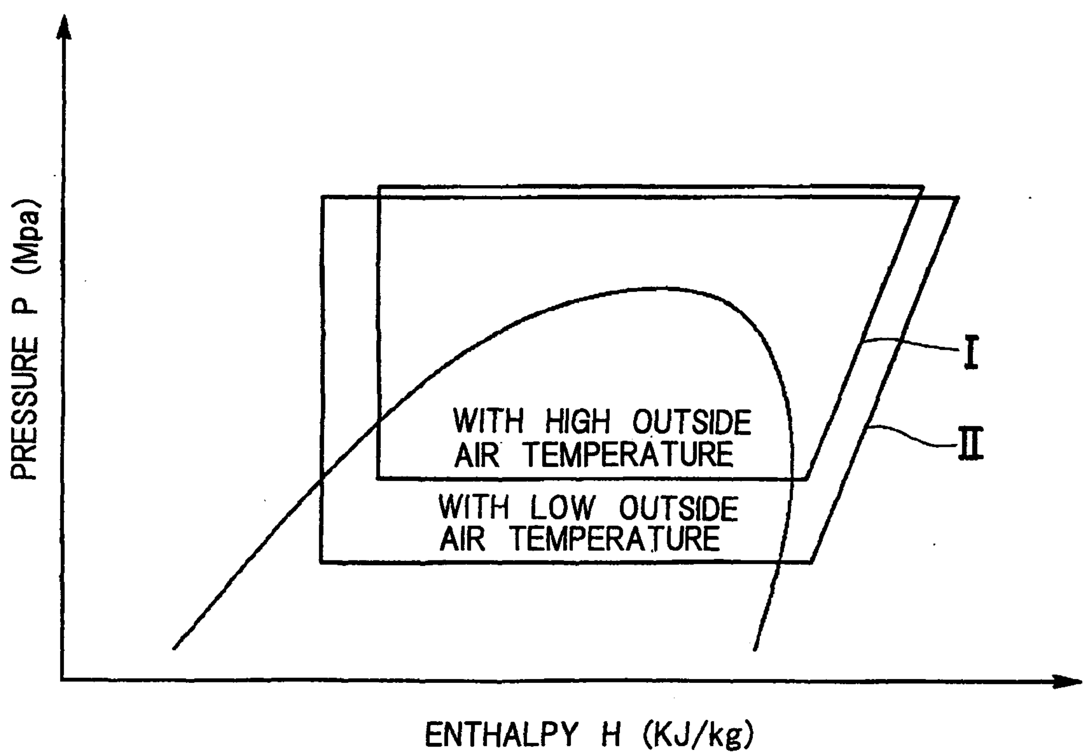

PRESSURE P (Mpa)
WITH HIGH OUTSIDE AIR TEMPERATURE
WITH LOW OUTSIDE AIR TEMPERATURE
I
II
ENTHALPY H (KJ/kg)

Fig.4

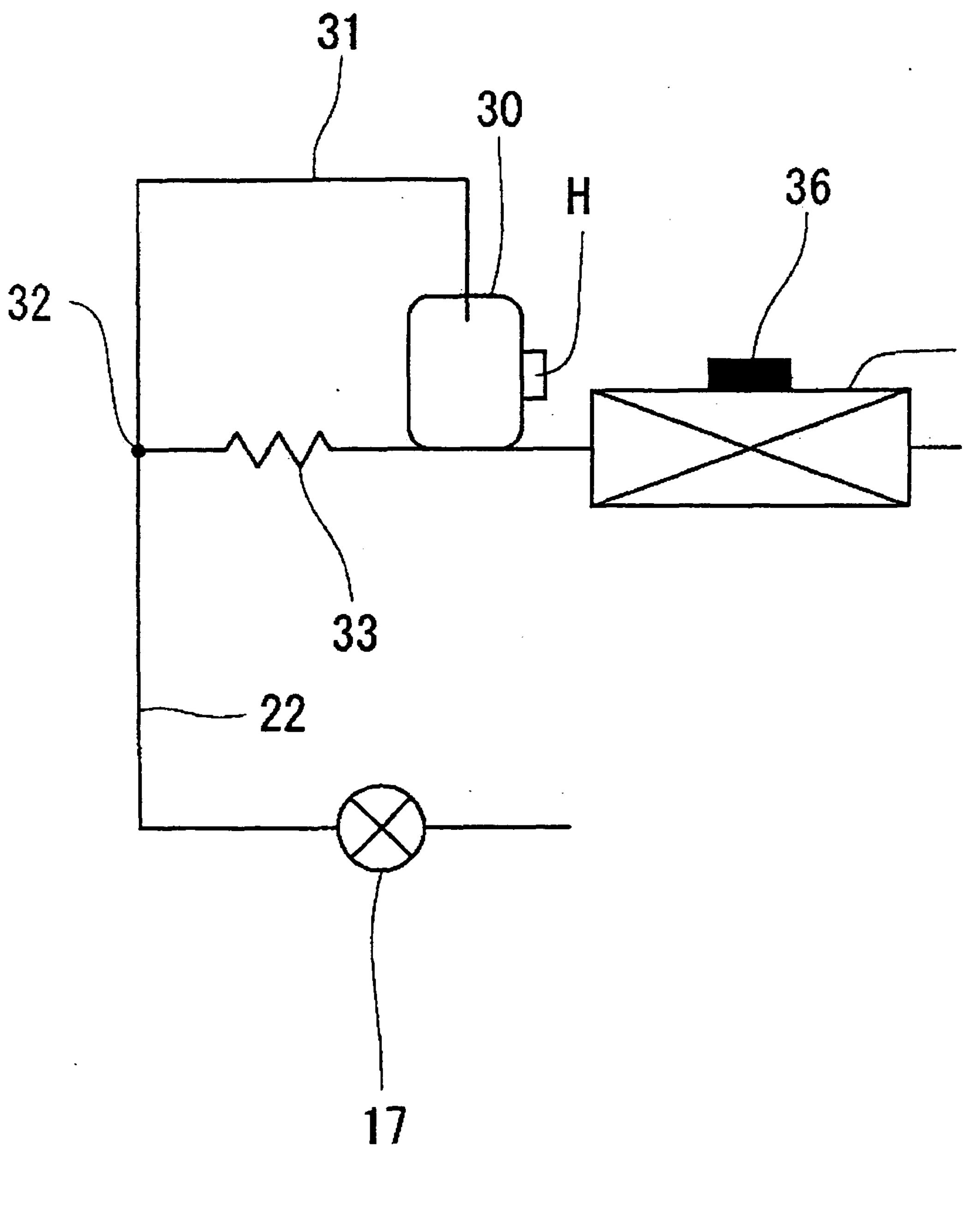


Fig.5

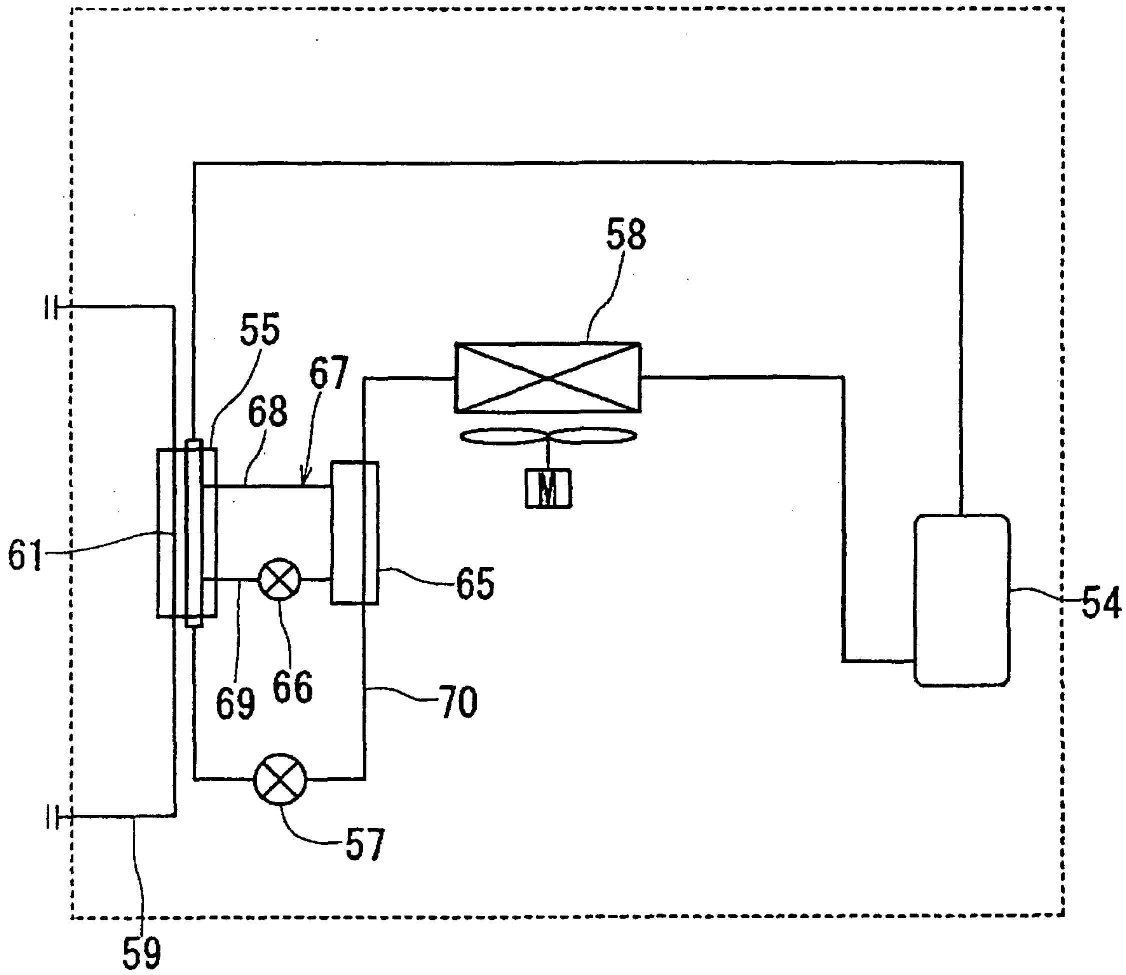
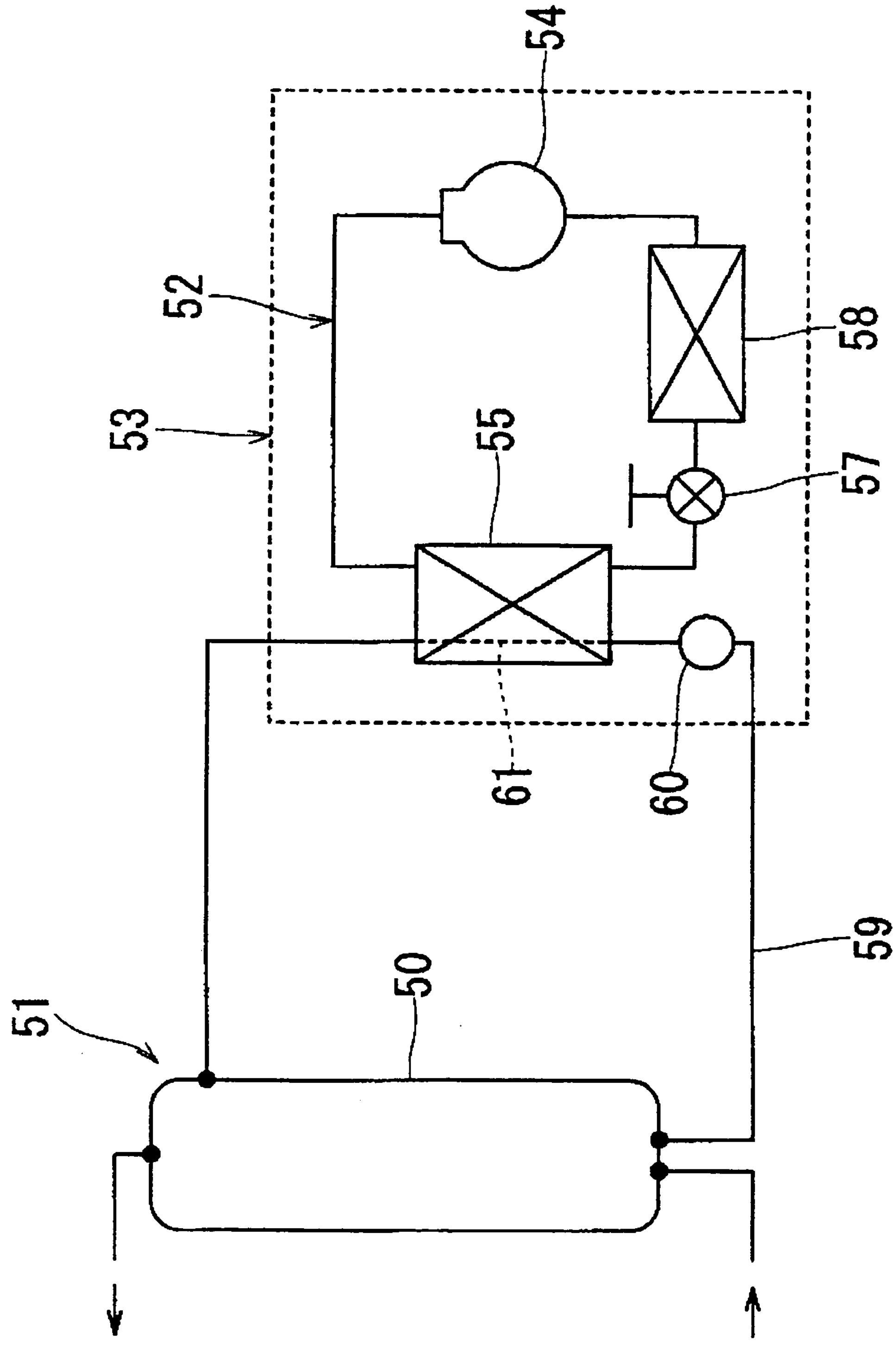


Fig.6 PRIOR ART



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP03/09319

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl^7 F25B1/00

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)
Int.Cl^7 F25B1/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1926-1996	Toroku Jitsuyo Shinan Koho	1994-2003
Kokai Jitsuyo Shinan Koho	1971-2003	Jitsuyo Shinan Toroku Koho	1996-2003

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
ECLA, F25B1/00

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2000-179958 A (Matsushita Electric Industrial Co., Ltd.), 30 June, 2000 (30.06.00), Full text; Figs. 1 to 3 (Family: none)	1-11
Y	JP 2002-115924 A (Daikin Industries, Ltd.), 19 April, 2002 (19.04.02), Full text; Figs. 1 to 7 (Family: none)	1-4,6,8,10

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

* Special categories of cited documents:
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"E" earlier document but published on or after the international filing date
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search 10 October, 2003 (10.10.03)	Date of mailing of the international search report 28 October, 2003 (28.10.03)
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/JP03/09319

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 55232/1990(Laid-open No. 14975/1992) (Daikin Industries, Ltd.), 06 February, 1992 (06.02.92), Full text; Figs. 1 to 5 (Family: none)	5,7
Y	JP 61-62757 A (Mitsubishi Electric Corp.), 31 March, 1986 (31.03.86), Full text; Figs. 1 to 4 (Family: none)	8,10
Y	WO 99/08053 A1 (ZEXEL CORP.), 18 February, 1999 (18.02.99), Full text; Figs. 1 to 3 & JP 11-63686 A Full text; Figs. 1 to 3	10,11

Form PCT/ISA/210 (continuation of second sheet) (July 1998)