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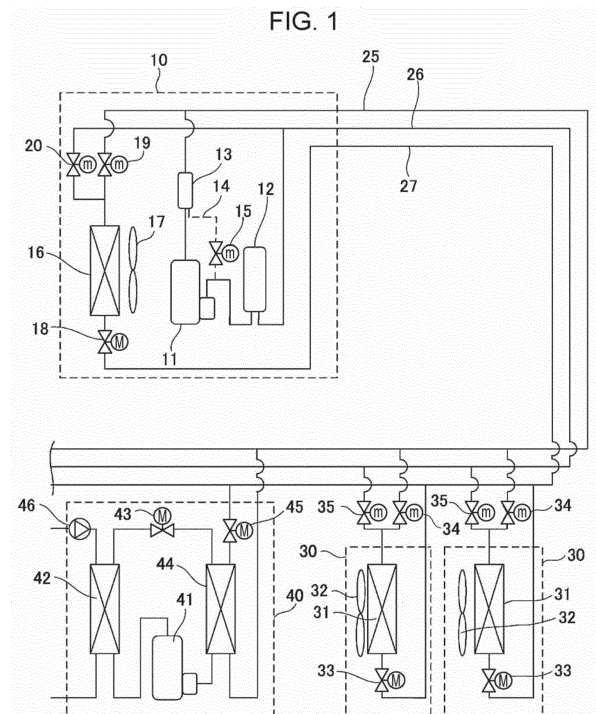
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(54)

HEAT-GENERATING UNIT

(57)

A heat-generating unit includes a hot-water-supply compressor that compresses a hot-water-supply refrigerant; a hot-water-supply heat exchanger that exchanges heat between the hot-water-supply refrigerant and a hot-water-supply heat medium; a cascade heat exchanger that exchanges heat between the hot-water-supply refrigerant and an air-conditioning refrigerant; and a casing that houses the hot-water-supply compressor, the hot-water-supply heat exchanger, and the cascade heat exchanger. The hot-water-supply heat exchanger is disposed on a bottom plate member of the casing, and the hot-water-supply compressor and the cascade heat exchanger are disposed above the bottom plate member of the casing.



Description

BACKGROUND

1. Technical Field

[0001] The present disclosure relates to heat-generating units, and more particularly, to a heat-generating unit which is used in an air-conditioning hot-water-supply system capable of simultaneously supplying high-temperature heat and low-temperature heat for cooling, heating, and hot water supply and which includes a refrigeration cycle that generates hot water to be supplied.

2. Description of the Related Art

[0002] Air-conditioning hot-water-supply systems capable of simultaneously supplying high-temperature heat and low-temperature heat for cooling, heating, and hot water supply generally include a heat-generating unit including a refrigeration cycle that generates hot water to be supplied.

[0003] The heat-generating unit includes a hot-water-supply heat exchanger (heat medium-refrigerant heat exchanger), a hot-water-supply compressor, and a cascade heat exchanger (refrigerant-refrigerant heat exchanger).

[0004] A technology for arranging the hot-water-supply heat exchanger and the cascade heat exchanger in the heat-generating unit is disclosed in, for example, WO2010/109620. According to this technology, the hot-water-supply heat exchanger and the cascade heat exchanger are arranged on a bottom plate member such that bonding portions of pipes that connect the hot-water-supply heat exchanger and the cascade heat exchanger face each other. Accordingly, piping installation is simplified in the manufacturing process, and the heat-generating unit can be reduced in size.

SUMMARY

[0005] In one general aspect, the techniques disclosed here feature a heat-generating unit including a hot-water-supply compressor that compresses a hot-water-supply refrigerant; a hot-water-supply heat exchanger that exchanges heat between the hot-water-supply refrigerant and a hot-water-supply heat medium; a cascade heat exchanger that exchanges heat between the hot-water-supply refrigerant and an air-conditioning refrigerant; and a casing that includes a bottom plate member and that houses the hot-water-supply compressor, the hot-water-supply heat exchanger, and the cascade heat exchanger, wherein the hot-water-supply heat exchanger is disposed on the bottom plate member of the casing, and the hot-water-supply compressor and the cascade heat exchanger are disposed above the bottom plate member of the casing.

[0006] Additional benefits and advantages of the dis-

closed embodiments will become apparent from the specification and drawings. The benefits and/or advantages may be individually obtained by the various embodiments and features of the specification and drawings, which need not all be provided in order to obtain one or more of such benefits and/or advantages.

BRIEF DESCRIPTION OF THE DRAWINGS

10 **[0007]**

Fig. 1 is a block diagram of a refrigeration cycle of an air-conditioning hot-water-supply system according to a first embodiment of the present disclosure; Fig. 2 is a front view of the inner structure of a heat-generating unit according to the first embodiment; Fig. 3 is a plan view of the inner structure of the heat-generating unit according to the first embodiment; Fig. 4 is a front view of the inner structure of a heat-generating unit according to a second embodiment; and

Fig. 5 is a plan view of the inner structure of the heat-generating unit according to the second embodiment.

DETAILED DESCRIPTION

[0008] In the heat-generating unit according to the related art, the hot-water-supply heat exchanger and the cascade heat exchanger, as well as the hot-water-supply compressor, are heavy objects. Therefore, when the heat exchangers are arranged as described in WO2010/109620, the hot-water-supply heat exchanger and the cascade heat exchanger are disposed next to the hot-water-supply compressor on the bottom plate member. The hot-water-supply compressor vibrates significantly during operation, in particular, when the operation is started and stopped. Therefore, in general, the hot-water-supply compressor is fixed to the bottom plate member with vibration isolation members interposed therebetween by using three or more fixing members.

[0009] There is a constant risk that water will be generated at the hot-water-supply heat exchanger and at heat medium pipes that extend from the outside of the heat-generating unit to the hot-water-supply heat exchanger and through which a heat medium, which contains water as the main component, flows. A low temperature heat medium at a temperature of 10°C to 20°C may flow through the hot-water-supply heat exchanger and the heat medium pipes even in summer, and dew forms on the surfaces of the hot-water-supply heat exchanger and the heat medium pipes. The dew may fall directly from the surfaces of the hot-water-supply heat exchanger and the heat medium pipes to the bottom plate member, which is part of a casing of the heat-generating unit. Alternatively, the dew may move along the surfaces of the heat medium pipes and fall onto the bottom plate member from the bottom surfaces of the hot-water-supply heat

exchanger and a heat medium pump.

[0010] The hot-water-supply heat exchanger is made of copper, which is highly conductive, and is connected to the heat medium pipes with connecting portions that are also made of copper. In contrast, connecting portions of the heat medium pump are not made of copper, and are generally made of a highly workable resin. Thus, the heat medium pipes included in the heat-generating unit are connected such that components made of different materials are connected together with a sealing member provided therebetween to prevent leakage of the heat medium.

[0011] However, since a refrigerant pipe of the hot-water-supply heat exchanger is directly connected to the hot-water-supply compressor, the vibration of the hot-water-supply compressor during operation is transmitted to the hot-water-supply heat exchanger and the heat medium pipes through the refrigerant pipe. The vibration causes loosening of the connecting portions provided with the sealing member, and the heat medium containing water as the main component may leak from the connecting portions. The leakage of the heat medium is more likely to occur when the operation is started or stopped and when a large vibration occurs than in a steady operation. Similarly to the dew, the heat medium that has leaked moves along the surfaces of the heat medium pipes and falls onto the bottom plate member from the bottom surfaces of the hot-water-supply heat exchanger and the heat medium pump.

[0012] As a result, the cascade heat exchanger disposed on the bottom plate member and the fixing members that fix the hot-water-supply compressor to the bottom plate member may become soaked with the water generated at the hot-water-supply heat exchanger and the heat medium pipes. This may cause rusting and corrosion of the soaked components, and the durability of the heat-generating unit is affected.

[0013] To prevent the cascade heat exchanger and the hot-water-supply compressor from becoming soaked with the water generated at the hot-water-supply heat exchanger, a drain pan or the like needs to be provided to receive the water, as described in WO2010/109620. Therefore, the cost will be increased.

[0014] The present disclosure has been made in light of the above-described circumstances, and one non-limiting and exemplary embodiment provides a heat-generating unit capable of preventing rusting and corrosion due to water generated at the hot-water-supply heat exchanger and the heat medium pipes and increasing the durability thereof.

[0015] A first aspect of the present disclosure provides a heat-generating unit including:

- a hot-water-supply compressor that compresses a hot-water-supply refrigerant;
- a hot-water-supply heat exchanger that exchanges heat between the hot-water-supply refrigerant and a hot-water-supply heat medium;

a cascade heat exchanger that exchanges heat between the hot-water-supply refrigerant and an air-conditioning refrigerant; and

a casing that includes a bottom plate member and that houses the hot-water-supply compressor, the hot-water-supply heat exchanger, and the cascade heat exchanger, wherein

the hot-water-supply heat exchanger is disposed on the bottom plate member of the casing, and the hot-water-supply compressor and the cascade heat exchanger are disposed above the bottom plate member of the casing.

[0016] In other words, the first aspect of the present disclosure provides a heat-generating unit including:

a hot-water-supply compressor that compresses a hot-water-supply refrigerant;

a hot-water-supply heat exchanger that exchanges heat between the hot-water-supply refrigerant and a hot-water-supply heat medium;

a cascade heat exchanger that exchanges heat between the hot-water-supply refrigerant and an air-conditioning refrigerant; and

a casing that includes a bottom plate member and that houses the hot-water-supply compressor, the hot-water-supply heat exchanger, and the cascade heat exchanger, wherein

the hot-water-supply heat exchanger is disposed on the bottom plate member of the casing, and

a lower end surface of the hot-water-supply compressor is disposed above a lower end surface of the hot-water-supply heat exchanger in a gravity direction, and a lower end surface of the cascade heat exchanger is disposed above the lower end surface of the hot-water-supply heat exchanger in the gravity direction.

[0017] With this structure, dew or the like formed in the heat-generating unit does not easily adhere to the hot-water-supply compressor and the cascade heat exchanger, so that rusting and corrosion of the hot-water-supply compressor and the cascade heat exchanger can be prevented and the durability of the heat-generating unit can be increased.

[0018] A second aspect of the present disclosure provides the heat-generating unit according to the first aspect, wherein at least one of a lower end surface of the hot-water-supply compressor and a lower end surface of the cascade heat exchanger is disposed above an upper end surface of the hot-water-supply heat exchanger.

[0019] Accordingly, even when a drainage hole or a drainage pipe is clogged, rusting and corrosion of at least one of the hot-water-supply compressor and the cascade heat exchanger can be prevented as long as the hot-water-supply heat exchanger is not completely immersed in the water, and the durability of the heat-generating unit can be increased.

[0020] A third aspect of the present disclosure provides the heat-generating unit according to the first or second aspect, wherein the casing further houses a heat medium pump that discharges the hot-water-supply heat medium, and the lower end surface of the hot-water-supply compressor and the lower end surface of the cascade heat exchanger are disposed above a lower end surface of the heat medium pump.

[0021] Accordingly, also when the heat medium pump is mounted in the heat-generating unit, rusting and corrosion of the hot-water-supply compressor and the cascade heat exchanger can be prevented and the durability of the heat-generating unit can be increased.

[0022] A fourth aspect of the present disclosure provides the heat-generating unit according to any one of the first to third aspects, wherein the hot-water-supply heat exchanger is a double pipe heat exchanger.

[0023] Since a double pipe heat exchanger is used, even though the installation space is limited, the heat exchanging performance and the heat exchange efficiency can be increased, and the manufacturing cost can be reduced. In addition, the pressures of the hot-water-supply refrigerant and the hot-water-supply heat medium can be increased.

[0024] A fifth aspect of the present disclosure provides the heat-generating unit according to any one of the first to fourth aspects, wherein the cascade heat exchanger is a plate heat exchanger.

[0025] Since a plate heat exchanger is used, the heat transfer efficiency is increased. In addition, the heat exchanger can be reduced in size and maintenance thereof can be facilitated.

[0026] A sixth aspect of the present disclosure provides the heat-generating unit according to any one of the first to fifth aspects, further including:

a first passage through which the hot-water-supply refrigerant flows;
a second passage through which the air-conditioning refrigerant flows; and
a third passage through which the hot-water-supply heat medium flows, wherein
the hot-water-supply compressor is disposed on the first passage,
the cascade heat exchanger is disposed on the first passage and the second passage, and
the hot-water-supply heat exchanger is disposed on the first passage and the third passage.

[0027] A seventh aspect of the present disclosure provides the heat-generating unit according to any one of the first to sixth aspects, further including:

the heat medium pump that is disposed on the third passage and that discharges the hot-water-supply heat medium, wherein
the casing houses the heat medium pump, and
the lower end surface of the heat medium pump is

disposed above the lower end surface of the hot-water-supply heat exchanger in the gravity direction.

[0028] An eighth aspect of the present disclosure provides the heat-generating unit according to any one of the first to seventh aspects, further including:

an air-conditioning compressor that is disposed on the second passage and that compresses the air-conditioning refrigerant;
an indoor heat exchanger that is disposed on the second passage; and
an outdoor heat exchanger that is disposed on the second passage.

[0029] A ninth aspect of the present disclosure provides the heat-generating unit according to any one of the first to eighth aspects, further including:

a hot water tank that is connected to the third passage.

[0030] A tenth aspect of the present disclosure provides the heat-generating unit according to any one of the first to ninth aspects, wherein the first passage constitutes a loop.

[0031] An eleventh aspect of the present disclosure provides the heat-generating unit according to any one of the first to tenth aspects, wherein the hot-water-supply heat exchanger includes copper.

[0032] Another first aspect of the present disclosure provides a heat-generating unit including:

a first passage through which a hot-water-supply refrigerant flows;
a second passage through which an air-conditioning refrigerant flows;
a third passage through which a hot-water-supply heat medium flows;
a hot-water-supply compressor that is disposed on the first passage and that compresses the hot-water-supply refrigerant;
an air-conditioning compressor that is disposed on the second passage and that compresses the air-conditioning refrigerant;
an indoor heat exchanger that is disposed on the second passage;
an outdoor heat exchanger that is disposed on the second passage;
a cascade heat exchanger that is disposed on the first passage and the second passage;
a hot-water-supply heat exchanger that is disposed on the first passage and the third passage; and
a casing that includes a bottom plate member and that houses the hot-water-supply compressor, the hot-water-supply heat exchanger, and the cascade heat exchanger, wherein
the hot-water-supply heat exchanger is disposed on

the bottom plate member of the casing,
 a lower end surface of the hot-water-supply compressor is disposed above a lower end surface of the hot-water-supply heat exchanger in a gravity direction, and
 a lower end surface of the cascade heat exchanger is disposed above the lower end surface of the hot-water-supply heat exchanger in the gravity direction.

[0033] Another second aspect of the present disclosure provides the heat-generating unit according to the other first aspect, further including:

a heat medium pump that is disposed on the third passage, wherein
 the casing houses the heat medium pump, which discharges the hot-water-supply heat medium, and
 a lower end surface of the heat medium pump is above the lower end surface of the hot-water-supply heat exchanger in a gravity direction.

[0034] Another third aspect of the present disclosure provides the heat-generating unit according to the other first or second aspect, wherein
 the lower end surface of the hot-water-supply compressor and the lower end surface of the cascade heat exchanger are disposed above a lower end surface of the heat medium pump.

[0035] Another fourth aspect of the present disclosure provides the heat-generating unit according to any one of the other first to third aspects, wherein the first passage constitutes a loop.

[0036] Another fifth aspect of the present disclosure provides the heat-generating unit according to any one of the other first to fourth aspects, further including:

an air-conditioning compressor that is disposed on the second passage;
 an indoor heat exchanger that is disposed on the second passage; and
 an outdoor heat exchanger that is disposed on the second passage.

[0037] Another sixth aspect of the present disclosure provides the heat-generating unit according to any one of the other first to fifth aspects, further including:

a hot water tank that is connected to the third passage.

[0038] Another seventh aspect of the present disclosure provides the heat-generating unit according to any one of the other first to sixth aspects, wherein
 the cascade heat exchanger transfers heat of the air-conditioning refrigerant that flows through the second passage to the hot-water-supply refrigerant that flows through the first passage, and
 the hot-water-supply heat exchanger transfers heat of

the hot-water-supply refrigerant that flows through the first passage to the hot-water-supply heat medium that flows through the third passage.

[0039] According to the heat-generating unit of the present disclosure, the hot-water-supply heat exchanger is disposed on the bottom plate member of the casing, and the hot-water-supply compressor and the cascade heat exchanger are disposed above the bottom plate member. Therefore, dew or the like formed in the heat-generating unit does not easily adhere to the hot-water-supply compressor and the cascade heat exchanger, so that rusting and corrosion of the hot-water-supply compressor and the cascade heat exchanger can be prevented and the durability of the heat-generating unit can be increased.

[0040] Embodiments of the present disclosure will be described with reference to the drawings.

[0041] Fig. 1 is a cycle block diagram of an air-conditioning hot-water-supply system according to a first embodiment of the present disclosure.

[0042] The air-conditioning hot-water-supply system illustrated in Fig. 1 includes an outdoor unit 10, indoor devices 30, and a heat-generating unit 40. In the present embodiment, two indoor devices 30 and a single heat-generating unit 40 are connected to a single outdoor unit 10. The structure of the refrigeration cycle is not limited to that illustrated in Fig. 1. For example, two or more outdoor units 10, one or three or more indoor devices 30, and two or more heat-generating units 40 may be connected in parallel.

[0043] The outdoor unit 10, the indoor devices 30, and the heat-generating unit 40 are connected with pipes through which an air-conditioning refrigerant flows.

[0044] The outdoor unit 10 is connected to each indoor device 30 with a gas pipe 25 through which a high-temperature, high-pressure air-conditioning refrigerant in the gas state flows; a suction pipe 26 through which a low-pressure air-conditioning refrigerant flows; and a liquid pipe 27 through which a high-pressure air-conditioning refrigerant in the liquid state flows. In the case where two indoor devices 30 are provided, as illustrated in Fig. 1, the indoor devices 30 are connected to the three pipes in parallel. Similar to the indoor devices 30, the outdoor unit 10 and the heat-generating unit 40 are connected to the pipes in parallel. The outdoor unit 10 is connected to the heat-generating unit 40 with the gas pipe 25 and the liquid pipe 27.

[0045] A refrigerant that is commonly used in home use air conditioners or building air conditioners, such as R22, R410A, and R32, is used as the air-conditioning refrigerant.

[0046] The outdoor unit 10 includes an air-conditioning compressor 11 that compresses the air-conditioning refrigerant. An accumulator 12 that supplies a gas refrigerant to the air-conditioning compressor 11 is connected to the suction side of the air-conditioning compressor 11. An oil separator 13 that removes refrigeration oil from the gaseous air-conditioning refrigerant discharged from

the air-conditioning compressor 11 is connected to the discharge side of the air-conditioning compressor 11. The refrigeration oil removed by the oil separator 13 is returned to the air-conditioning compressor 11 through an oil returning pipe 14. The flow of the refrigeration oil through the oil returning pipe 14 is controlled by opening or closing an oil-returning-pipe on-off valve 15.

[0047] The outdoor unit 10 also includes an outdoor heat exchanger 16. An outdoor blowing fan 17 that supplies the air around the outdoor unit 10 to the outdoor heat exchanger 16 is disposed near the outdoor heat exchanger 16. The outdoor heat exchanger 16 is configured to exchange heat between the air supplied by the outdoor blowing fan 17 and the air-conditioning refrigerant. In general, a fin tube heat exchanger or a micro tube heat exchanger may be used.

[0048] The outdoor unit 10 also includes an outdoor refrigerant flow regulating valve 18 that regulates the flow of the air-conditioning refrigerant supplied to the outdoor heat exchanger 16; an outdoor gas-pipe on-off valve 19 that regulates the flow of the air-conditioning refrigerant through the gas pipe 25; and an outdoor suction-pipe on-off valve 20 that regulates the flow of the air-conditioning refrigerant through the suction pipe 26.

[0049] Each indoor device 30 includes an indoor heat exchanger 31; an indoor blowing fan 32 that supplies the air around the indoor device 30 to the indoor heat exchanger 31; and an indoor refrigerant flow regulating valve 33 that regulates the flow of the air-conditioning refrigerant supplied to the indoor heat exchanger 31. The indoor heat exchanger 31 is configured to exchange heat between the air supplied by the indoor blowing fan 32 and the air-conditioning refrigerant. In general, a fin tube heat exchanger or a micro tube heat exchanger may be used.

[0050] Each indoor device 30 also includes an indoor gas-pipe on-off valve 34 that controls the presence/absence of flow of the air-conditioning refrigerant to/from the gas pipe 25, and an indoor suction-pipe on-off valve 35 that controls the presence/absence of flow of the air-conditioning refrigerant to/from the suction pipe 26.

[0051] The air-conditioning compressor 11, the accumulator 12, the oil separator 13, the outdoor heat exchanger 16, the outdoor refrigerant flow regulating valve 18, the outdoor gas-pipe on-off valve 19, the outdoor suction-pipe on-off valve 20, the indoor heat exchangers 31, the indoor refrigerant flow regulating valves 33, the indoor gas-pipe on-off valves 34, and the indoor suction-pipe on-off valves 35 form a second refrigeration cycle.

[0052] The heat-generating unit 40 includes a hot-water-supply compressor 41 that compresses a hot-water-supply refrigerant; a hot-water-supply heat exchanger 42 that exchanges heat between the hot-water-supply refrigerant and a heat medium that contains water as the main component; and a hot-water-supply refrigerant flow regulating valve 43 that regulates the flow of the hot-water-supply refrigerant.

[0053] The heat-generating unit 40 also includes a cas-

cade heat exchanger 44 that exchanges heat between the air-conditioning refrigerant supplied from the gas pipe 25 and the hot-water-supply refrigerant; a heat-generating-unit refrigerant flow regulating valve 45 that regulates the flow of the air-conditioning refrigerant supplied to the cascade heat exchanger 44; and a heat medium pump 46 that supplies the heat medium to the hot-water-supply heat exchanger 42.

[0054] The hot-water-supply compressor 41, the hot-water-supply heat exchanger 42, the hot-water-supply refrigerant flow regulating valve 43, the cascade heat exchanger 44, the heat-generating-unit refrigerant flow regulating valve 45, and the heat medium pump 46 form a first refrigeration cycle.

[0055] The hot-water-supply refrigerant may be, for example, R134a, CO₂, R1234yf, or R1234ze. When the hot-water-supply refrigerant is R134a, R1234yf, or R1234ze, the heat medium can be boiled at 60°C to 80°C by the hot-water-supply heat exchanger 42. When the hot-water-supply refrigerant is CO₂, the heat medium can be boiled at 60°C to 90°C by the hot-water-supply heat exchanger 42.

[0056] Service water is generally used as the heat medium; however, an antifreeze obtained by dissolving ethylene glycol or alcohol in water may instead be used in cold areas.

[0057] The heat medium that has been boiled at 70°C to 90°C by the hot-water-supply heat exchanger 42 is stored in a hot water tank (not shown). The heat medium is directly supplied when the heat medium is drinking water. When the heat medium is an antifreeze or the like and is not drinking water, the heat medium is supplied to a radiator or the like placed indoors and used for heating purposes. Alternatively, heat is transferred to drinking water at the hot water tank, and the drinking water is supplied.

[0058] The inner structure of the heat-generating unit 40 according to the first embodiment will now be described.

[0059] Fig. 2 is a front view of the inner structure of the heat-generating unit 40 according to the first embodiment. Fig. 3 is a plan view of the inner structure of the heat-generating unit 40 according to the first embodiment.

[0060] As illustrated in Figs. 2 and 3, the heat-generating unit 40 includes a casing 50 that houses the refrigeration cycle formed of the hot-water-supply compressor 41, the hot-water-supply heat exchanger 42, the hot-water-supply refrigerant flow regulating valve 43 (see Fig. 1), and the cascade heat exchanger 44; the heat-generating-unit refrigerant flow regulating valve 45 (see Fig. 1); and the heat medium pump 46.

[0061] The casing 50 includes a bottom plate member 51 disposed at the bottom; a pair of side plate members 52 that stand on the bottom plate member 51 at both sides thereof so as to face each other; and a side plate member 53 that stands on the bottom plate member 51 at the rear end thereof and extends between the rear

ends of the side plate members 52.

[0062] In the present embodiment, a double pipe heat exchanger, for example, is used as the hot-water-supply heat exchanger 42. The double pipe heat exchanger is a heat exchanger in which one or more pipes (inner pipes) are inserted into a pipe (outer pipe) having a substantially circular cross section. In the case where a plurality of inner pipes are provided, the inner pipes are inserted into the outer pipe in a helically twisted state. In the case where a carbon dioxide refrigerant is used as the hot-water-supply refrigerant, the carbon dioxide refrigerant flows through the inner pipes of the hot-water-supply heat exchanger 42, and the heat medium flows through the space between the outer pipe and the inner pipes.

[0063] The double pipe heat exchanger is generally composed of copper pipes with a high thermal conductivity. When the entirety of the hot-water-supply heat exchanger 42 is made of copper, an oxidation film is formed on the surface of the copper and corrosion due to adhesion of water or the like can be prevented.

[0064] The hot-water-supply heat exchanger 42 may instead be composed of, for example, a plate heat exchanger or a shell and tube heat exchanger. The cascade heat exchanger 44 is composed of, for example, a plate heat exchanger or a shell and tube heat exchanger.

[0065] The heat exchanging performance of the double pipe heat exchanger is proportional to the length of the double pipes. Therefore, to maximize the heat exchanging performance in the limited installation space, the double pipes are formed in a wound shape. When the double pipe heat exchanger is installed, the double pipes are made as horizontal as possible to prevent a significant reduction in the heat exchanging performance due to accumulation of air in a portion of the double pipes through which the heat medium flows.

[0066] The hot-water-supply compressor 41 is fixed to a compressor fixing base 57, which is fixed to the top of the bottom plate member 51, with vibration isolation members 60, such as rubber, interposed therebetween. Reference numeral 67 denotes fixing members used to fix the hot-water-supply compressor 41 to the compressor fixing base 57.

[0067] The hot-water-supply heat exchanger 42 is also fixed to the top of the bottom plate member 51, and the cascade heat exchanger 44 is fixed to the top surface (upper end surface 42b) of the hot-water-supply heat exchanger 42.

[0068] More specifically, at least one of a lower end surface 41 a of the hot-water-supply compressor 41 and a lower end surface 44a of the cascade heat exchanger 44 (lower end surface 44a of the cascade heat exchanger 44 in this case) is disposed above the upper end surface 42b of the hot-water-supply heat exchanger 42.

[0069] Namely, the hot-water-supply compressor 41 and the cascade heat exchanger 44 are disposed above the bottom plate member 51 so as not to be in contact with the bottom plate member 51, and at least one of the hot-water-supply compressor 41 and the cascade heat

exchanger 44 is disposed above the hot-water-supply heat exchanger 42.

[0070] As described above, since the hot-water-supply heat exchanger 42 is made of copper, corrosion can be prevented even when dew is formed on the hot-water-supply heat exchanger 42. However, since a material other than copper is used to form the cascade heat exchanger 44, there is a possibility that rusting and corrosion of the cascade heat exchanger 44 will occur when dew is formed thereon. Similarly, a material that may cause rusting and corrosion is used to form the hot-water-supply compressor 41. Therefore, the hot-water-supply compressor 41 and the cascade heat exchanger 44 are arranged in the above-described manner so that formation of dew or the like on the hot-water-supply compressor 41 and the cascade heat exchanger 44 can be suppressed. As a result, rusting and corrosion can be prevented, and the durability of the heat-generating unit 40 can be increased.

[0071] The hot-water-supply heat exchanger 42 and the cascade heat exchanger 44 each include a heat insulator, such as Styrofoam or thick felt, and a structural member that covers the heat insulator. In particular, in the hot-water-supply heat exchanger 42, a strong iron plate is provided to cover and protect the surface of the heat insulator to prevent the heat insulator from being deformed by the weight of the cascade heat exchanger 44 placed on the hot-water-supply heat exchanger 42.

[0072] The cascade heat exchanger 44 is not necessarily in contact with the structural member that surrounds the hot-water-supply heat exchanger 42. In this case, the cascade heat exchanger 44 and the heat insulator around the cascade heat exchanger 44 may be fixed to one of the side plate members 52 of the heat-generating unit 40 in such a state that they are surrounded by a structural member that is strong enough to support the weight thereof.

[0073] As illustrated in Fig. 3, the heat medium pump 46 is fixed to the side plate member 53 at the rear of the casing 50. As illustrated in Fig. 2, a lower end surface 46a of the heat medium pump 46 is disposed below the lower end surface 41 a of the hot-water-supply compressor 41 and the lower end surface 44a of the cascade heat exchanger 44.

[0074] The heat medium pump 46 may be arranged such that an upper end surface 46b thereof is below the lower end surface 41 a of the hot-water-supply compressor 41. In other words, the heat medium pump 46 may be disposed below the hot-water-supply compressor 41. In this case, the heat medium pump 46 may be disposed in the compressor fixing base 57.

[0075] When the heat medium pump 46 is arranged in this way, even when the heat medium pump 46 is mounted in the heat-generating unit 40, rusting and corrosion of the hot-water-supply compressor 41 and the cascade heat exchanger 44 can be prevented and the durability of the heat-generating unit 40 can be increased.

[0076] As illustrated in Fig. 3, the bottom plate member

51 has a drainage hole 62 in the region where the hot-water-supply heat exchanger 42 and the heat medium pump 46 are present when they are projected onto the bottom plate member 51 vertically from above. The top surface of the bottom plate member 51 is appropriately inclined toward the drainage hole 62 so that water can be quickly discharged out of the heat-generating unit 40 through the drainage hole 62.

[0077] Referring to Figs. 2 and 3, the hot-water-supply heat exchanger 42 and the cascade heat exchanger 44 each include a heat insulator, such as Styrofoam or thick felt, and a structural member that covers the heat insulator. In particular, in the hot-water-supply heat exchanger 42, a strong iron plate is provided to cover and protect the surface of the heat insulator thereof to prevent the heat insulator from being deformed by the weight of the cascade heat exchanger 44 placed on the hot-water-supply heat exchanger 42.

[0078] The cascade heat exchanger 44 is not necessarily in contact with the structural member that surrounds the hot-water-supply heat exchanger 42. In this case, the cascade heat exchanger 44 and the heat insulator around the cascade heat exchanger 44 may be fixed to a side surface of the heat-generating unit 40 in such a state that they are surrounded by a structural member that is strong enough to support the weight thereof.

[0079] Reference numerals 63, 64, and 65 denote heat medium pipes through which the heat medium flows. The flow of the heat medium through the heat medium pipes 63, 64, and 65 is generated by the operation of the heat medium pump 46. The heat medium that has flowed into the heat-generating unit 40 flows into the heat medium pump 46 through the heat medium pipe 63, and is discharged to the heat medium pipe 64. Then, the heat medium enters the hot-water-supply heat exchanger 42, where the heat medium is heated to a temperature of 70°C to 90°C by the hot-water-supply refrigerant, and is discharged out of the heat-generating unit 40 through the heat medium pipe 65.

[0080] Although the heat medium pipes 63, 64, and 65 are mostly composed of copper pipes with high workability, a resin material is also used. A heat-medium suction portion and a heat-medium discharge portion of the heat medium pump 46 are generally made of a resin material. The hot-water-supply heat exchanger 42, which is a double pipe heat exchanger, is generally made of copper as described above, and connecting portions thereof are also made of copper pipes.

[0081] Thus, the passage through which the heat medium flows (the heat medium pipe 63, the heat medium pump 46, the heat medium pipe 64, the hot-water-supply heat exchanger 42, and the heat medium pipe 65 in that order) is formed of both the resin material and copper, and includes sections where connecting portions made of different materials are connected together. The connecting portions are fixed together with a sealing member (not shown) interposed therebetween to prevent leakage of the heat medium.

[0082] A refrigerant that is commonly used in home use air conditioners or building air conditioners, such as R410A, R32, and R407C, is used as the air-conditioning refrigerant, and a carbon dioxide refrigerant is used as the hot-water-supply refrigerant.

[0083] The operation of the outdoor unit 10, the indoor devices 30, and the heat-generating unit 40 will be described with reference to the refrigeration cycle diagram of Fig. 1.

[0084] In the case where only a cooling operation is performed, the outdoor gas-pipe on-off valve 19 is opened and the outdoor suction-pipe on-off valve 20 is closed in the outdoor unit 10, the indoor gas-pipe on-off valve 34 is closed and the indoor suction-pipe on-off valve 35 is opened in each indoor device 30, and the heat-generating-unit refrigerant flow regulating valve 45 is fully closed in the heat-generating unit 40.

[0085] The high-temperature, high-pressure air-conditioning refrigerant compressed by the air-conditioning compressor 11 flows into the outdoor heat exchanger 16 through the outdoor gas-pipe on-off valve 19, and is cooled and liquefied by the air around the outdoor unit 10. The liquefied air-conditioning refrigerant flows into the liquid pipe 27 through the outdoor refrigerant flow regulating valve 18 in the fully open state, and reaches the indoor devices 30.

[0086] The air-conditioning refrigerant that has reached each indoor device 30 is decompressed by the indoor refrigerant flow regulating valve 33 so that the state thereof is changed to a low-temperature, low-pressure gas-liquid two phase state. Then, the air-conditioning refrigerant flows into the indoor heat exchanger 31, and absorbs heat from the indoor air to perform cooling. During this process, the air-conditioning refrigerant evaporates. Then, the air-conditioning refrigerant flows into the suction pipe 26 through the indoor suction-pipe on-off valve 35, and returns to the outdoor unit 10. The air-conditioning refrigerant that has returned to the outdoor unit 10 flows through the accumulator 12 and returns to the air-conditioning compressor 11.

[0087] In the case where only a heating operation is performed, the outdoor gas-pipe on-off valve 19 is closed and the outdoor suction-pipe on-off valve 20 is opened in the outdoor unit 10, the indoor gas-pipe on-off valve 34 is opened and the indoor suction-pipe on-off valve 35 is closed in each indoor device 30, and the heat-generating-unit refrigerant flow regulating valve 45 is fully closed in the heat-generating unit 40.

[0088] The high-temperature, high-pressure air-conditioning refrigerant compressed by the air-conditioning compressor 11 flows into the gas pipe 25, and reaches the indoor devices 30. The air-conditioning refrigerant that has reached each indoor device 30 flows into the indoor heat exchanger 31 through the indoor gas-pipe on-off valve 34, and radiates heat into the indoor air to perform heating. During this process, the air-conditioning refrigerant is condensed and liquefied. Then, the air-conditioning refrigerant flows into the liquid pipe 27 through

the indoor refrigerant flow regulating valve 33 in the fully open state, and returns to the outdoor unit 10.

[0089] The air-conditioning refrigerant that has returned to the outdoor unit 10 is decompressed by the outdoor refrigerant flow regulating valve 18 so that the state thereof is changed to a low-temperature low-pressure gas-liquid two phase state. Then, the air-conditioning refrigerant enters the outdoor heat exchanger 16, where the air-conditioning refrigerant is heated by the air around the outdoor unit 10 and is evaporated. The evaporated and gasified air-conditioning refrigerant returns to the air-conditioning compressor 11 through the outdoor suction-pipe on-off valve 20 and the accumulator 12.

[0090] In the case where only a hot-water-supply operation is performed, the outdoor gas-pipe on-off valve 19 is closed and the outdoor suction-pipe on-off valve 20 is opened in the outdoor unit 10, the indoor gas-pipe on-off valve 34 and the indoor suction-pipe on-off valve 35 are both closed in each indoor device 30, and the heat-generating-unit refrigerant flow regulating valve 45 is opened in the heat-generating unit 40.

[0091] The high-temperature, high-pressure air-conditioning refrigerant compressed by the air-conditioning compressor 11 flows into the gas pipe 25, and reaches the heat-generating unit 40. The hot-water-supply compressor 41 of the heat-generating unit 40 is operated so that the hot-water-supply refrigerant circulates through the hot-water-supply compressor 41, the hot-water-supply heat exchanger 42, the hot-water-supply refrigerant flow regulating valve 43, and the cascade heat exchanger 44 in that order.

[0092] The air-conditioning refrigerant that has reached the heat-generating unit 40 heats the hot-water-supply refrigerant in the cascade heat exchanger 44, and is cooled and liquefied. Then, the air-conditioning refrigerant flows into the liquid pipe 27 through the heat-generating-unit refrigerant flow regulating valve 45, and returns to the outdoor unit 10.

[0093] The air-conditioning refrigerant that has returned to the outdoor unit 10 is decompressed by the outdoor refrigerant flow regulating valve 18 so that the state thereof is changed to a low-temperature low-pressure gas-liquid two phase state. Then, the air-conditioning refrigerant enters the outdoor heat exchanger 16, where the air-conditioning refrigerant is heated by the air around the outdoor unit 10 and is evaporated. The evaporated and gasified air-conditioning refrigerant returns to the air-conditioning compressor 11 through the outdoor suction-pipe on-off valve 20 and the accumulator 12.

[0094] The hot-water-supply refrigerant heated by the air-conditioning refrigerant in the cascade heat exchanger 44 is gasified and enters the hot-water-supply compressor 41. The hot-water-supply refrigerant is compressed by the hot-water-supply compressor 41 so that the temperature and pressure thereof are increased, enters the hot-water-supply heat exchanger 42, and heats the heat medium to a temperature of 70°C to 90°C. During this process, the hot-water-supply refrigerant is cooled

and liquefied. Then, the hot-water-supply refrigerant is decompressed by the hot-water-supply refrigerant flow regulating valve 43, and returns to the cascade heat exchanger 44.

[0095] In the case where a cooling operation and a heating operation are simultaneously performed, when the cooling load and the heating load are substantially equal, the outdoor gas-pipe on-off valve 19 and the outdoor suction-pipe on-off valve 20 are both closed in the outdoor unit 10. The indoor gas-pipe on-off valve 34 is closed and the indoor suction-pipe on-off valve 35 is opened in the indoor device 30 that performs a cooling operation, and the indoor gas-pipe on-off valve 34 is opened and the indoor suction-pipe on-off valve 35 is closed in the indoor device 30 that performs a heating operation. The heat-generating-unit refrigerant flow regulating valve 45 is fully closed in the heat-generating unit 40.

[0096] The high-temperature, high-pressure air-conditioning refrigerant that has been compressed by the air-conditioning compressor 11 flows into the gas pipe 25 and reaches the indoor device 30 that performs a heating operation. The air-conditioning refrigerant that has reached the indoor device 30 that performs a heating operation flows into the indoor heat exchanger 31 through the indoor gas-pipe on-off valve 34, and radiates heat into the indoor air to perform heating. During this process, the air-conditioning refrigerant is condensed and liquefied. Then, the air-conditioning refrigerant flows into the liquid pipe 27 through the indoor refrigerant flow regulating valve 33 in the fully open state.

[0097] The air-conditioning refrigerant in the liquid state that has flowed into the liquid pipe 27 reaches the indoor device 30 that performs a cooling operation. The air-conditioning refrigerant that has reached the indoor device 30 that performs a cooling operation is decompressed by the indoor refrigerant flow regulating valve 33 so that the state thereof is changed to a low-temperature, low-pressure gas-liquid two phase state. Then, the air-conditioning refrigerant flows into the indoor heat exchanger 31, and absorbs heat from the indoor air to perform cooling. During this process, the air-conditioning refrigerant evaporates. Then, the air-conditioning refrigerant flows into the suction pipe 26 through the indoor suction-pipe on-off valve 35, and returns to the outdoor unit 10. The air-conditioning refrigerant that has returned to the outdoor unit 10 flows through the accumulator 12 and returns to the air-conditioning compressor 11.

[0098] When the cooling load is greater than the heating load, the liquid refrigerant supplied from the indoor device 30 that performs a heating operation to the indoor device 30 that performs a cooling operation is insufficient. Therefore, additional liquid refrigerant is generated by the outdoor heat exchanger 16 of the outdoor unit 10. More specifically, the outdoor gas-pipe on-off valve 19 is opened while the outdoor suction-pipe on-off valve 20 is closed, and part of the refrigerant discharged from the air-conditioning compressor 11 is supplied to the outdoor

heat exchanger 16 and liquefied. Then, the liquefied refrigerant is supplied to the indoor device 30 that performs a cooling operation through the outdoor refrigerant flow regulating valve 18 and the liquid pipe 27.

[0099] Conversely, when the heating load is greater than the cooling load, the liquid refrigerant supplied from the indoor device 30 that performs a heating operation cannot be fully evaporated in the indoor device 30 that performs a cooling operation. Therefore, part of the liquid refrigerant is evaporated by the outdoor heat exchanger 16 of the outdoor unit 10. More specifically, the outdoor suction-pipe on-off valve 20 is opened while the outdoor gas-pipe on-off valve 19 is closed, and the liquid refrigerant that has flowed out of the indoor device 30 that performs a heating operation is returned to the outdoor unit 10 through the liquid pipe 27.

[0100] The liquid refrigerant that has returned to the outdoor unit 10 is decompressed by the outdoor refrigerant flow regulating valve 18, and is evaporated by the outdoor heat exchanger 16. The evaporated air-conditioning refrigerant returns to the accumulator 12 and the air-conditioning compressor 11 through the outdoor suction-pipe on-off valve 20.

[0101] In the case where a cooling operation and a hot-water-supply operation are simultaneously performed, when the cooling load and the hot-water-supply load are substantially equal, the outdoor gas-pipe on-off valve 19 and the outdoor suction-pipe on-off valve 20 are both closed in the outdoor unit 10. The indoor gas-pipe on-off valve 34 is closed and the indoor suction-pipe on-off valve 35 is opened in the indoor device 30 that performs a cooling operation, and the heat-generating-unit refrigerant flow regulating valve 45 is opened in the heat-generating unit 40.

[0102] The high-temperature, high-pressure air-conditioning refrigerant compressed by the air-conditioning compressor 11 flows into the gas pipe 25, and reaches the heat-generating unit 40. The hot-water-supply compressor 41 of the heat-generating unit 40 is operated so that the hot-water-supply refrigerant circulates through the hot-water-supply compressor 41, the hot-water-supply heat exchanger 42, the hot-water-supply refrigerant flow regulating valve 43, and the cascade heat exchanger 44 in that order.

[0103] The air-conditioning refrigerant that has reached the heat-generating unit 40 heats the hot-water-supply refrigerant in the cascade heat exchanger 44, and is cooled and liquefied. Then, the air-conditioning refrigerant flows into the liquid pipe 27 through the heat-generating-unit refrigerant flow regulating valve 45.

[0104] The air-conditioning refrigerant in the liquid state that has flowed into the liquid pipe 27 reaches the indoor device 30 that performs a cooling operation. The air-conditioning refrigerant that has reached the indoor device 30 that performs a cooling operation is decompressed by the indoor refrigerant flow regulating valve 33 so that the state thereof is changed to a low-temperature, low-pressure gas-liquid two phase state. Then, the

air-conditioning refrigerant flows into the indoor heat exchanger 31, and absorbs heat from the indoor air to perform cooling. During this process, the air-conditioning refrigerant evaporates. Then, the air-conditioning refrigerant flows into the suction pipe 26 through the indoor suction-pipe on-off valve 35, and returns to the outdoor unit 10. The air-conditioning refrigerant that has returned to the outdoor unit 10 flows through the accumulator 12 and returns to the air-conditioning compressor 11.

[0105] The hot-water-supply refrigerant heated by the air-conditioning refrigerant in the cascade heat exchanger 44 is gasified and enters the hot-water-supply compressor 41. The hot-water-supply refrigerant is compressed by the hot-water-supply compressor 41 so that the temperature and pressure thereof are increased, enters the hot-water-supply heat exchanger 42, and heats the heat medium to a temperature of 70°C to 90°C. During this process, the hot-water-supply refrigerant is cooled and liquefied. Then, the hot-water-supply refrigerant is decompressed by the hot-water-supply refrigerant flow regulating valve 43, and returns to the cascade heat exchanger 44.

[0106] When the cooling load is greater than the hot-water-supply load, the liquid refrigerant supplied from the heat-generating unit 40 to the indoor device 30 that performs a cooling operation is insufficient. Therefore, additional liquid refrigerant is generated by the outdoor heat exchanger 16 of the outdoor unit 10. More specifically, the outdoor gas-pipe on-off valve 19 is opened while the outdoor suction-pipe on-off valve 20 is closed, and part of the refrigerant discharged from the air-conditioning compressor 11 is supplied to the outdoor heat exchanger 16 and liquefied. Then, the liquefied refrigerant is supplied to the indoor device 30 that performs a cooling operation through the outdoor refrigerant flow regulating valve 18 and the liquid pipe 27.

[0107] Conversely, when the hot-water-supply load is greater than the cooling load, the liquid refrigerant supplied from the heat-generating unit 40 cannot be fully evaporated in the indoor device 30 that performs a cooling operation. Therefore, part of the liquid refrigerant is evaporated by the outdoor heat exchanger 16 of the outdoor unit 10. More specifically, the outdoor suction-pipe on-off valve 20 is opened while the outdoor gas-pipe on-off valve 19 is closed, and part of the liquid refrigerant that has flowed out of the heat-generating unit 40 is returned to the outdoor unit 10 through the liquid pipe 27.

[0108] The liquid refrigerant that has returned to the outdoor unit 10 is decompressed by the outdoor refrigerant flow regulating valve 18, and is evaporated by the outdoor heat exchanger 16. The evaporated air-conditioning refrigerant returns to the accumulator 12 and the air-conditioning compressor 11 through the outdoor suction-pipe on-off valve 20.

[0109] In the case where a heating operation and a hot-water-supply operation are simultaneously performed, the outdoor gas-pipe on-off valve 19 is closed and the outdoor suction-pipe on-off valve 20 is opened

in the outdoor unit 10, the indoor gas-pipe on-off valve 34 is opened and the indoor suction-pipe on-off valve 35 is closed in each indoor device 30, and the heat-generating-unit refrigerant flow regulating valve 45 is opened in the heat-generating unit 40.

[0110] The high-temperature, high-pressure air-conditioning refrigerant compressed by the air-conditioning compressor 11 flows into the gas pipe 25, and reaches the indoor devices 30 and the heat-generating unit 40. The air-conditioning refrigerant that has reached each indoor device 30 flows into the indoor heat exchanger 31 through the indoor gas-pipe on-off valve 34, and radiates heat into the indoor air to perform heating. During this process, the air-conditioning refrigerant is condensed and liquefied. Then, the air-conditioning refrigerant flows into the liquid pipe 27 through the indoor refrigerant flow regulating valve 33 in the fully open state.

[0111] The air-conditioning refrigerant that has reached the heat-generating unit 40 heats the hot-water-supply refrigerant in the cascade heat exchanger 44, and is cooled and liquefied. Then, the air-conditioning refrigerant flows into the liquid pipe 27 through the heat-generating-unit refrigerant flow regulating valve 45. The liquid refrigerant merges with the liquid refrigerant that has flowed out of the indoor devices 30, which perform a heating operation, and returns to the outdoor unit 10. The liquid refrigerant that has returned to the outdoor unit 10 is decompressed by the outdoor refrigerant flow regulating valve 18, and is evaporated by the outdoor heat exchanger 16. The evaporated air-conditioning refrigerant returns to the accumulator 12 and the air-conditioning compressor 11 through the outdoor suction-pipe on-off valve 20.

[0112] The hot-water-supply refrigerant heated by the air-conditioning refrigerant in the cascade heat exchanger 44 is gasified and enters the hot-water-supply compressor 41. The hot-water-supply refrigerant is compressed by the hot-water-supply compressor 41 so that the temperature and pressure thereof are increased, enters the hot-water-supply heat exchanger 42, and heats the heat medium to a temperature of 70°C to 90°C. During this process, the hot-water-supply refrigerant is cooled and liquefied. Then, the hot-water-supply refrigerant is decompressed by the hot-water-supply refrigerant flow regulating valve 43, and returns to the cascade heat exchanger 44.

[0113] In the case where a cooling operation, a heating operation, and a hot-water-supply operation are simultaneously performed, in the case where the cooling load is substantially equal to the sum of the heating load and the hot-water-supply load, the outdoor gas-pipe on-off valve 19 and the outdoor suction-pipe on-off valve 20 are both closed in the outdoor unit 10. The indoor gas-pipe on-off valve 34 is closed and the indoor suction-pipe on-off valve 35 is opened in the indoor device 30 that performs a cooling operation, and the indoor gas-pipe on-off valve 34 is opened and the indoor suction-pipe on-off valve 35 is closed in the indoor device 30 that performs

a heating operation. The heat-generating-unit refrigerant flow regulating valve 45 is opened in the heat-generating unit 40.

[0114] The high-temperature, high-pressure air-conditioning refrigerant compressed by the air-conditioning compressor 11 flows into the gas pipe 25, and reaches the indoor device 30 that performs a heating operation and the heat-generating unit 40. The hot-water-supply compressor 41 of the heat-generating unit 40 is operated so that the hot-water-supply refrigerant circulates through the hot-water-supply compressor 41, the hot-water-supply heat exchanger 42, the hot-water-supply refrigerant flow regulating valve 43, and the cascade heat exchanger 44 in that order.

[0115] The air-conditioning refrigerant that has reached the indoor device 30 that performs a heating operation flows into the indoor heat exchanger 31 through the indoor gas-pipe on-off valve 34, and radiates heat into the indoor air to perform heating. During this process, the air-conditioning refrigerant is condensed and liquefied. Then, the air-conditioning refrigerant flows into the liquid pipe 27 through the indoor refrigerant flow regulating valve 33 in the fully open state.

[0116] The air-conditioning refrigerant that has reached the heat-generating unit 40 heats the hot-water-supply refrigerant in the cascade heat exchanger 44, and is cooled and liquefied. Then, the air-conditioning refrigerant flows into the liquid pipe 27 through the heat-generating-unit refrigerant flow regulating valve 45.

[0117] The liquefied air-conditioning refrigerant that has flowed into the liquid pipe 27 from the indoor device 30 that performs a heating operation and the liquefied air-conditioning refrigerant that has flowed into the liquid pipe 27 from the heat-generating unit 40 merge and reach the indoor device 30 that performs a cooling operation. The air-conditioning refrigerant that has reached the indoor device 30 that performs a cooling operation is decompressed by the indoor refrigerant flow regulating valve 33 so that the state thereof is changed to a low-temperature, low-pressure gas-liquid two phase state. Then, the air-conditioning refrigerant flows into the indoor heat exchanger 31, and absorbs heat from the indoor air to perform cooling. During this process, the air-conditioning refrigerant evaporates. Then, the air-conditioning refrigerant flows into the suction pipe 26 through the indoor suction-pipe on-off valve 35, and returns to the outdoor unit 10. The air-conditioning refrigerant that has returned to the outdoor unit 10 flows through the accumulator 12 and returns to the air-conditioning compressor 11.

[0118] The hot-water-supply refrigerant heated by the air-conditioning refrigerant in the cascade heat exchanger 44 is gasified and enters the hot-water-supply compressor 41. The hot-water-supply refrigerant is compressed by the hot-water-supply compressor 41 so that the temperature and pressure thereof are increased, enters the hot-water-supply heat exchanger 42, and heats the heat medium to a temperature of 70°C to 90°C. During this process, the hot-water-supply refrigerant is cooled

and liquefied. Then, the hot-water-supply refrigerant is decompressed by the hot-water-supply refrigerant flow regulating valve 43, and returns to the cascade heat exchanger 44.

[0119] When the cooling load is greater than the sum of the heating load and the hot-water-supply load, the liquid refrigerant supplied from the heat-generating unit 40 and the indoor device 30 that performs a heating operation to the indoor device 30 that performs a cooling operation is insufficient. Therefore, additional liquid refrigerant is generated by the outdoor heat exchanger 16 of the outdoor unit 10. More specifically, the outdoor gas-pipe on-off valve 19 is opened while the outdoor suction-pipe on-off valve 20 is closed, and part of the refrigerant discharged from the air-conditioning compressor 11 is supplied to the outdoor heat exchanger 16 and liquefied. Then, the liquefied refrigerant is supplied to the indoor device 30 that performs a cooling operation through the outdoor refrigerant flow regulating valve 18 and the liquid pipe 27.

[0120] When the sum of the heating load and the hot-water-supply load is greater than the cooling load, the liquid refrigerant supplied from the indoor device 30 that performs a heating operation and the heat-generating unit 40 cannot be fully evaporated in the indoor device 30 that performs a cooling operation. Therefore, part of the liquid refrigerant is evaporated by the outdoor heat exchanger 16 of the outdoor unit 10. More specifically, the outdoor suction-pipe on-off valve 20 is opened while the outdoor gas-pipe on-off valve 19 is closed, and part of the liquid refrigerant that has flowed out of the indoor device 30 that performs a heating operation and the heat-generating unit 40 is returned to the outdoor unit 10 through the liquid pipe 27.

[0121] The liquid refrigerant that has returned to the outdoor unit 10 is decompressed by the outdoor refrigerant flow regulating valve 18, and is evaporated by the outdoor heat exchanger 16. The evaporated air-conditioning refrigerant returns to the accumulator 12 and the air-conditioning compressor 11 through the outdoor suction-pipe on-off valve 20.

[0122] The movement of the heat medium in the heat-generating unit 40 will now be described with reference to Figs. 2 and 3.

[0123] The hot-water-supply compressor 41 and the heat medium pump 46 are operated when only a hot-water-supply operation is performed, when a cooling operation and a hot-water-supply operation are performed simultaneously, when a heating operation and a hot-water-supply operation are performed simultaneously, and when a cooling operation, a heating operation, and a hot-water-supply operation are performed simultaneously. When the heat medium pump is operated, the heat medium flows into the heat-generating unit 40 from, for example, a water supply pipe that is outside the heat-generating unit 40, and enters the heat medium pump 46 through the heat medium pipe 63.

[0124] The heat medium that has flowed into the heat

medium pump 46 flows into the heat medium pipe 64 through a discharge hole, and enters the hot-water-supply heat exchanger 42. The heat medium exchanges heat with the high-temperature hot-water-supply refrigerant discharged from the hot-water-supply compressor 41 in the hot-water-supply heat exchanger 42, which is a double pipe heat exchanger, and is heated to a temperature of 70°C to 90°C. Then, the heat medium is discharged from the heat-generating unit 40 through the heat medium pipe 65.

[0125] As described above, there is a possibility that dew will form on the hot-water-supply heat exchanger 42 and the heat medium pipes 63, 64, and 65. A low temperature heat medium at a temperature of 10°C to 20°C may flow through the hot-water-supply heat exchanger 42 and the heat medium pipes 63, 64, and 65 even in summer, and this causes dew to form on the surfaces of the hot-water-supply heat exchanger 42 and the heat medium pipes 63, 64, and 65. The dew may fall directly from the surfaces of the hot-water-supply heat exchanger 42 and the heat medium pipes 63, 64, and 65 to the bottom plate member 51. The dew may also move along the surfaces of the heat medium pipes 63, 64, and 65 and fall onto the bottom plate member 51 from the bottom surfaces of the hot-water-supply heat exchanger 42 and the heat medium pump 46.

[0126] In addition, as described above, the passage through which the heat medium flows (the heat medium pipe 63, the heat medium pump 46, the heat medium pipe 64, the hot-water-supply heat exchanger 42, and the heat medium pipe 65 in that order) is formed of both the resin material and copper, and includes sections where connecting portions made of different materials are connected together.

[0127] Since the refrigerant pipe of the hot-water-supply heat exchanger 42 is directly connected to the hot-water-supply compressor 41, vibration of the hot-water-supply compressor 41 during operation is transmitted to the hot-water-supply heat exchanger 42 and the heat medium pipes through the refrigerant pipe. The vibration causes loosening of the connecting portions with the sealing member, and the heat medium, which contains water as the main component, may leak from the connecting portions. Similarly to the dew, the heat medium that has leaked moves along the surfaces of the heat medium pipes and falls onto the bottom plate member 51 from the hot-water-supply heat exchanger 42 and the lower end surface 46a of the heat medium pump 46.

[0128] According to the present embodiment, since the hot-water-supply compressor 41 and the cascade heat exchanger 44 are disposed above the hot-water-supply heat exchanger 42 and the heat medium pump 46, even when dew is formed or when the heat medium containing water as the main component leaks, the hot-water-supply compressor 41 and the cascade heat exchanger 44 will not be soaked with water. The dew and the heat medium that has leaked are quickly discharged out of the heat-generating unit 40 through the drainage hole 62 after

falling onto the bottom plate member 51.

[0129] As is clear from the above description, according to the present embodiment, water that causes rusting or corrosion of the cascade heat exchanger 44 and the hot-water-supply compressor 41 if the cascade heat exchanger 44 and the hot-water-supply compressor 41 are soaked therewith is quickly discharged out of the heat-generating unit 40. Therefore, the durability of the heat-generating unit 40 can be increased.

[0130] The hot-water-supply heat exchanger 42, which is a double pipe heat exchanger, is disposed on the bottom plate member 51, and the cascade heat exchanger 44, which is a plate heat exchanger, is disposed on the hot-water-supply heat exchanger 42. Therefore, the installation area of the heat-generating unit 40 is smaller than that in the case where the heat exchangers 42 and 44 are arranged such that the connection pipes thereof face each other.

[0131] As a modification of the present embodiment, the installation positions of the hot-water-supply compressor 41 and the cascade heat exchanger 44 illustrated in Fig. 2 may be switched. Namely, the hot-water-supply compressor 41 may be disposed on the hot-water-supply heat exchanger 42 placed on the bottom plate member 51, and the cascade heat exchanger 44 may be disposed on a cascade-heat-exchanger fixing base (not shown) provided in place of the compressor fixing base 57. In this case, the structural member that covers the heat insulator of the hot-water-supply heat exchanger 42 is a heavy object and sufficiently strong so that the hot-water-supply compressor 41, which vibrates during operation, can be reliably secured thereto.

[0132] Also in this modification, water that causes rusting or corrosion of the cascade heat exchanger 44 and the hot-water-supply compressor 41 if the cascade heat exchanger 44 and the hot-water-supply compressor 41 are soaked therewith is quickly discharged out of the heat-generating unit 40. Therefore, the durability of the heat-generating unit 40 can be increased. In addition, the installation area of the heat-generating unit 40 is smaller than that in the case where the heat exchangers 42 and 44 are arranged such that the connection pipes thereof face each other.

[0133] Fig. 4 is a front view of the inner structure of a heat-generating unit according to a second embodiment. Fig. 5 is a plan view of the inner structure of the heat-generating unit according to the second embodiment. In the second embodiment, components that are the same as those in the first embodiment are denoted by the same reference numerals, and detailed descriptions thereof are thus omitted.

[0134] As illustrated in Figs. 4 and 5, a heat-generating unit 80 included in an air-conditioning hot-water-supply system includes a hot-water-supply compressor 41, a hot-water-supply heat exchanger 81, a hot-water-supply refrigerant flow regulating valve 43 (see Fig. 1), a cascade heat exchanger 44, a heat-generating-unit refrigerant flow regulating valve 45 (see Fig. 1), and a heat me-

dium pump 46.

[0135] The hot-water-supply heat exchanger 81 exchanges heat between a hot-water-supply refrigerant and a heat medium that contains water as the main component, and basically has the same structure as that of the hot-water-supply heat exchanger 42 (see Fig. 2). The heat medium pump 46 supplies the heat medium to the hot-water-supply heat exchanger 81.

[0136] The hot-water-supply compressor 41, the hot-water-supply heat exchanger 81, the hot-water-supply refrigerant flow regulating valve 43, the cascade heat exchanger 44, the heat-generating-unit refrigerant flow regulating valve 45, and the heat medium pump 46 form a first refrigeration cycle.

[0137] The heat-generating unit 80 includes a casing 90 that houses the refrigeration cycle formed of the hot-water-supply compressor 41, the hot-water-supply heat exchanger 81, the hot-water-supply refrigerant flow regulating valve 43, and the cascade heat exchanger 44; the heat-generating-unit refrigerant flow regulating valve 45; and the heat medium pump 46.

[0138] The casing 90 includes a bottom plate member 91 disposed at the bottom; a pair of side plate members 52 that stand on the bottom plate member 91 at both sides thereof so as to face each other; and a side plate member 93 that stands on the bottom plate member 91 at the rear end thereof and extends between the rear ends of the side plate members 52.

[0139] The hot-water-supply compressor 41 is fixed to the top surface (upper end surface 81b) of the hot-water-supply heat exchanger 81 with vibration isolation members 60, such as rubber, interposed therebetween. The hot-water-supply compressor 41 is fixed to the top surface of the water-supply heat exchanger 81 with fixing members 67.

[0140] The cascade heat exchanger 44 is also fixed to the top surface of the hot-water-supply heat exchanger 81.

[0141] In other words, the hot-water-supply compressor 41 and the cascade heat exchanger 44 are both disposed on top of the hot-water-supply heat exchanger 81. A lower end surface 46a of the heat medium pump 46 is disposed below a lower end surface 41a of the hot-water-supply compressor 41 and a lower end surface 44a of the cascade heat exchanger 44, that is, below the top surface (upper end surface 81b) of the hot-water-supply heat exchanger 81.

[0142] The structure of the refrigeration cycle of the air-conditioning hot-water-supply system including the heat-generating unit 80 is the same as that in the first embodiment, and the description thereof is thus omitted.

[0143] As described in the first embodiment illustrated in Figs. 2 and 3, when the heat-generating unit 80 is operated, dew may be formed on the hot-water-supply heat exchanger 81 and heat medium pipes 63, 64, and 65, and the heat medium, which contains water as the main component, may leak from connecting portions of the heat medium pipes 63, 64, and 65.

[0144] According to the present embodiment, since the hot-water-supply compressor 41 and the cascade heat exchanger 44 are disposed on the top surface of the hot-water-supply heat exchanger 81 and above the heat medium pump 46, even when dew is formed on the hot-water-supply heat exchanger 81 and the heat medium pipes 63, 64, and 65 or when the heat medium containing water as the main component leaks, the hot-water-supply compressor 41 and the cascade heat exchanger 44 will not be soaked with water. The dew and the heat medium that has leaked are quickly discharged out of the heat-generating unit 80 through a drainage hole 62 after falling onto the bottom plate member 51.

[0145] Even when the drainage hole 62 is clogged and the dew and the heat medium that has leaked accumulate in the heat-generating unit 80, since the hot-water-supply compressor 41 and the cascade heat exchanger 44 are both disposed on top of the hot-water-supply heat exchanger 81, the hot-water-supply compressor 41 and the cascade heat exchanger 44 will not be soaked with water as long as the hot-water-supply heat exchanger 81 is not completely immersed in the water.

[0146] As is clear from the above description, according to the present embodiment, water that causes rusting or corrosion of the cascade heat exchanger 44 and the hot-water-supply compressor 41 if the cascade heat exchanger 44 and the hot-water-supply compressor 41 are soaked therewith is quickly discharged out of the heat-generating unit 80. Therefore, the durability of the heat-generating unit 80 can be increased.

[0147] Even when the drainage hole 62 is clogged, rusting and corrosion of the hot-water-supply compressor 41 and the cascade heat exchanger 44 can be prevented as long as the hot-water-supply heat exchanger 81 is not completely immersed in the water. Thus, the durability of the heat-generating unit 80 can be increased.

[0148] The hot-water-supply heat exchanger 81, which is a double pipe heat exchanger, is disposed on the bottom plate member 91, and the hot-water-supply compressor 41 and the cascade heat exchanger 44, which is a plate heat exchanger, are disposed on the hot-water-supply heat exchanger 81. Therefore, unlike the first embodiment, the bottom plate member 91 is not required to have an installation area for the hot-water-supply compressor 41. As a result, the installation area of the heat-generating unit 80 can be reduced.

[0149] As described above, the hot-water-supply compressor 41 and the cascade heat exchanger 44 are disposed above the bottom plate member 91 so as not to be in contact with the bottom plate member 91. Preferably, the hot-water-supply compressor 41 and the cascade heat exchanger 44 are both disposed above the hot-water-supply heat exchanger 81.

[0150] By arranging the hot-water-supply compressor 41 and the cascade heat exchanger 44 in this way, rusting and corrosion of the hot-water-supply compressor 41 and the cascade heat exchanger 44 can be prevented and the durability of the heat-generating unit 80 can be in-

creased.

[0151] As illustrated in Figs. 2 and 4, the heat-generating unit 40, 80 includes the casing 50, 90 that houses the hot-water-supply compressor 41 that compresses the hot-water-supply refrigerant, the hot-water-supply heat exchanger 42, 81 that exchanges heat between the hot-water-supply refrigerant and the hot-water-supply heat medium, and the cascade heat exchanger 44 that exchanges heat between the hot-water-supply refrigerant and the air-conditioning refrigerant. The hot-water-supply heat exchanger 42, 81 is disposed on the bottom plate member 51, 91 of the casing 50, 90, and the hot-water-supply compressor 41 and the cascade heat exchanger 44 are disposed above the bottom plate member 51, 91.

[0152] With this structure, dew or the like formed in the heat-generating unit 40, 80 does not easily adhere to the hot-water-supply compressor 41 and the cascade heat exchanger 44, so that rusting and corrosion of the hot-water-supply compressor 41 and the cascade heat exchanger 44 can be prevented and the durability of the heat-generating unit 40, 80 can be increased.

[0153] At least one of the lower end surface 41 a of the hot-water-supply compressor 41 and the lower end surface 44a of the cascade heat exchanger 44 is disposed above the upper end surface 42b, 81 b of the hot-water-supply heat exchanger 42, 81. Therefore, even when the drainage hole 62 or a drainage pipe is clogged, rusting and corrosion of at least one of the hot-water-supply compressor 41 and the cascade heat exchanger 44 can be prevented as long as the hot-water-supply heat exchanger 42, 81 is not completely immersed in the water, and the durability of the heat-generating unit 40, 80 can be increased.

[0154] The casing 50, 90 houses the heat medium pump 46 that discharges the hot-water-supply heat medium, and the lower end surface 41 a of the hot-water-supply compressor 41 and the lower end surface 44a of the cascade heat exchanger 44 are disposed above the lower end surface 46a of the heat medium pump 46. Therefore, also when the heat medium pump 46 is mounted in the heat-generating unit 40, 80, rusting and corrosion of the hot-water-supply compressor 41 and the cascade heat exchanger 44 can be prevented and the durability of the heat-generating unit 40, 80 can be increased.

[0155] The hot-water-supply heat exchanger 42, 81 is a double pipe heat exchanger. Since a double pipe heat exchanger is used, even though the installation space is limited, the heat exchanging performance and the heat exchange efficiency can be increased, and the manufacturing cost can be reduced. In addition, the pressures of the hot-water-supply refrigerant and the hot-water-supply heat medium can be increased.

[0156] The cascade heat exchanger 44 is a plate heat exchanger. Since a plate heat exchanger is used, the heat transfer efficiency is increased. In addition, the heat exchanger can be reduced in size and maintenance thereof can be facilitated.

[0157] Although a plate heat exchanger is used as the cascade heat exchanger 44 in the above-described embodiments, the cascade heat exchanger 44 is not limited to this, and a double pipe heat exchanger, for example, may instead be used.

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[0158] The present disclosure is not limited to the above-described embodiments, and various modifications are possible without departing from the gist of the disclosure.

[0159] The present disclosure is suitable for a heat-generating unit of an air-conditioning hot-water-supply system capable of simultaneously supplying high-temperature heat and low-temperature heat for cooling, heating, and hot water supply.

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Claims

1. A heat-generating unit comprising:

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a hot-water-supply compressor that compresses a hot-water-supply refrigerant;

a hot-water-supply heat exchanger that exchanges heat between the hot-water-supply refrigerant and a hot-water-supply heat medium;

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a cascade heat exchanger that exchanges heat between the hot-water-supply refrigerant and an air-conditioning refrigerant; and

a casing that includes a bottom plate member and that houses the hot-water-supply compressor, the hot-water-supply heat exchanger, and the cascade heat exchanger, wherein the hot-water-supply heat exchanger is disposed on the bottom plate member of the casing, and

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the hot-water-supply compressor and the cascade heat exchanger are disposed above the bottom plate member of the casing.

2. The heat-generating unit according to Claim 1, wherein

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at least one of a lower end surface of the hot-water-supply compressor and a lower end surface of the cascade heat exchanger is disposed above an upper end surface of the hot-water-supply heat exchanger.

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3. The heat-generating unit according to Claim 1 or 2, wherein

the casing further houses a heat medium pump that discharges the hot-water-supply heat medium, and a lower end surface of the hot-water-supply compressor and a lower end surface of the cascade heat exchanger are disposed above a lower end surface of the heat medium pump.

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4. The heat-generating unit according to any one of Claims 1 to 3, wherein the hot-water-supply heat exchanger is a double pipe heat exchanger.

5. The heat-generating unit according to any one of Claims 1 to 4, wherein the cascade heat exchanger is a plate heat exchanger.

FIG. 1

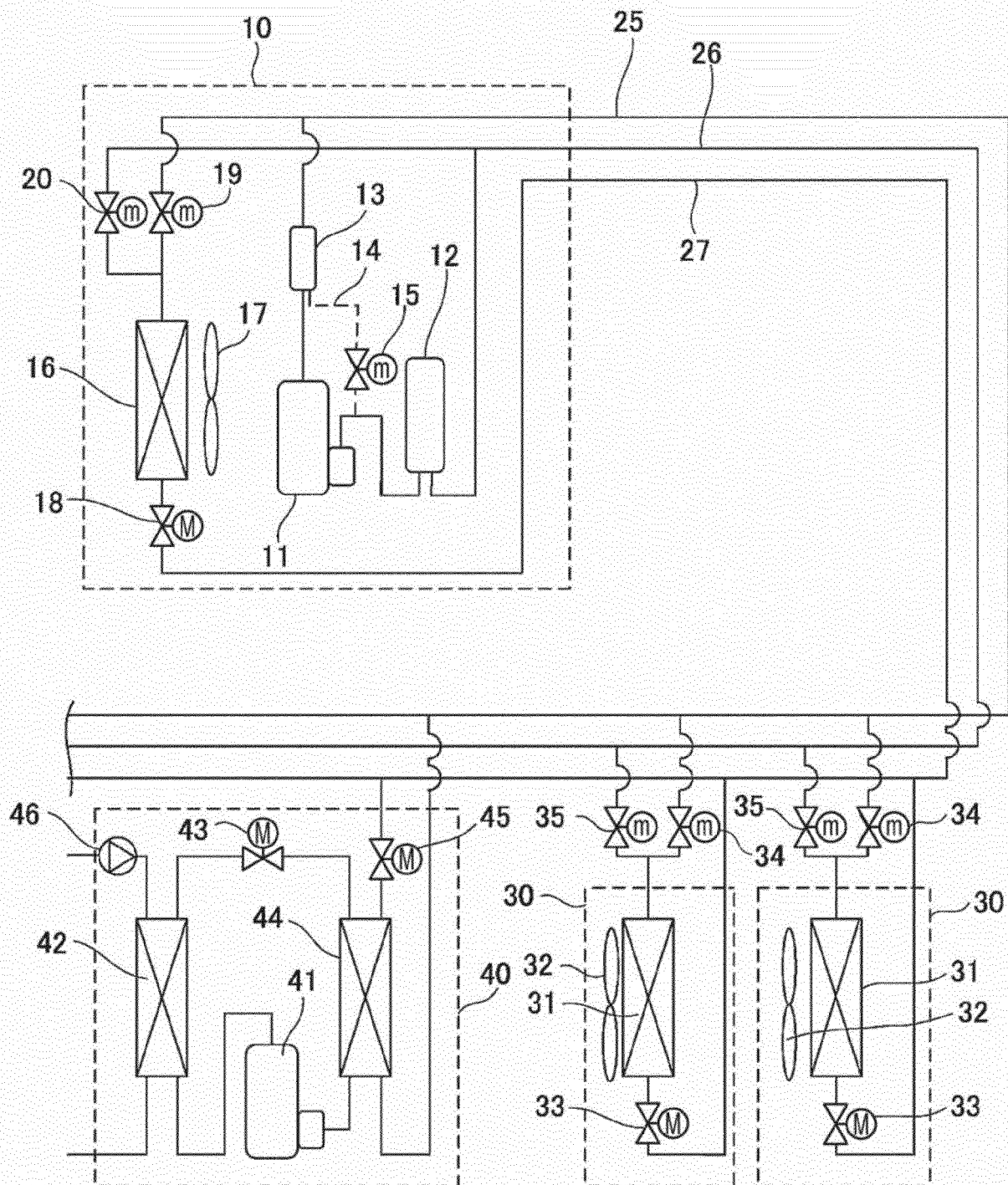


FIG. 2

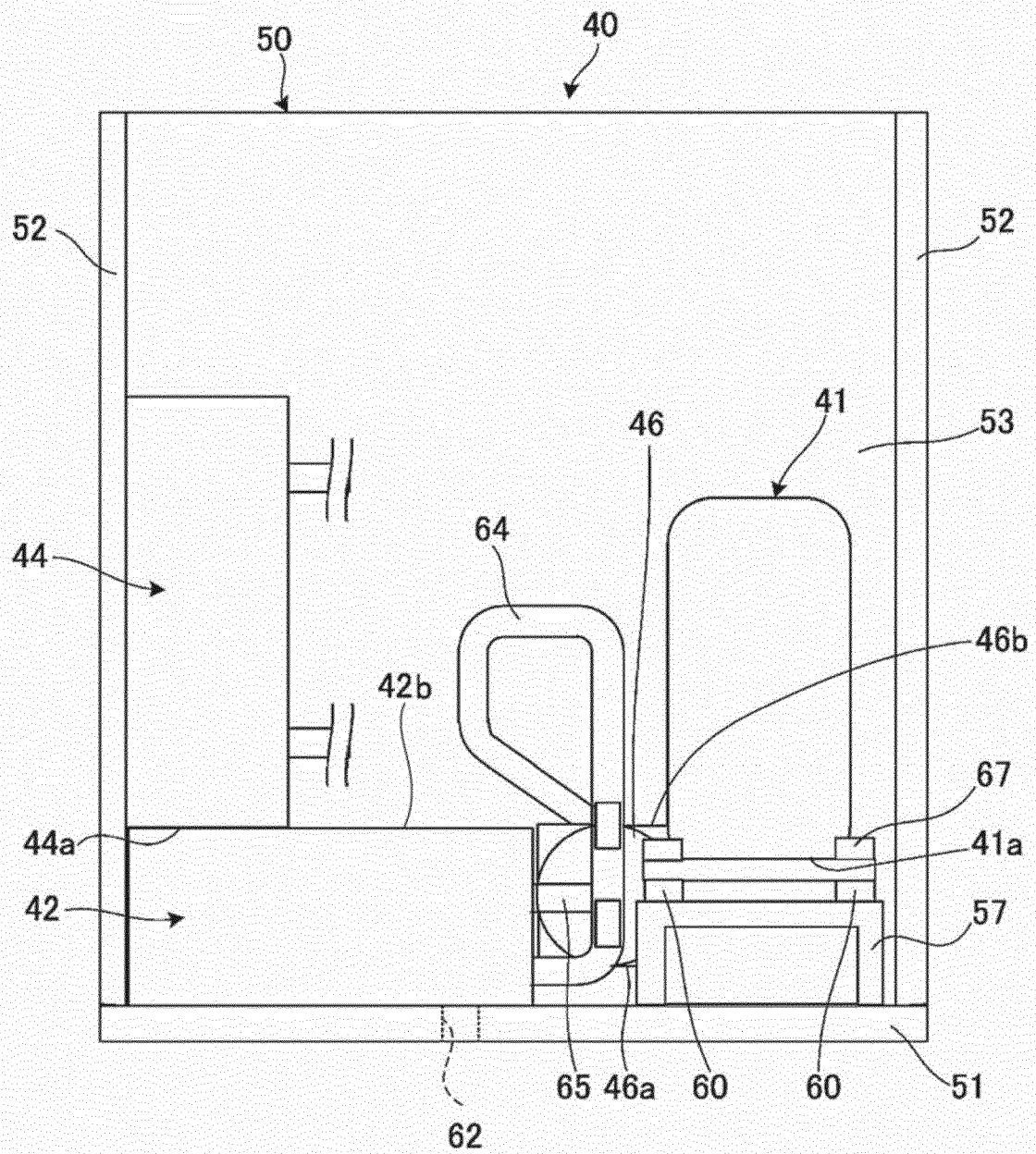


FIG. 3

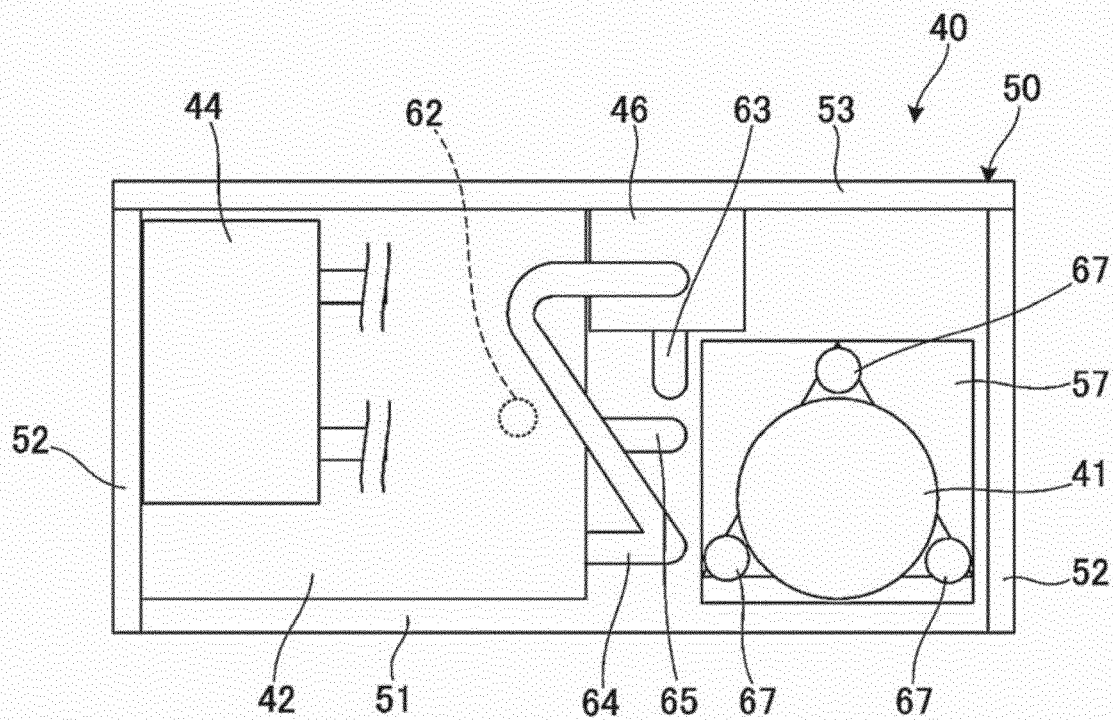


FIG. 4

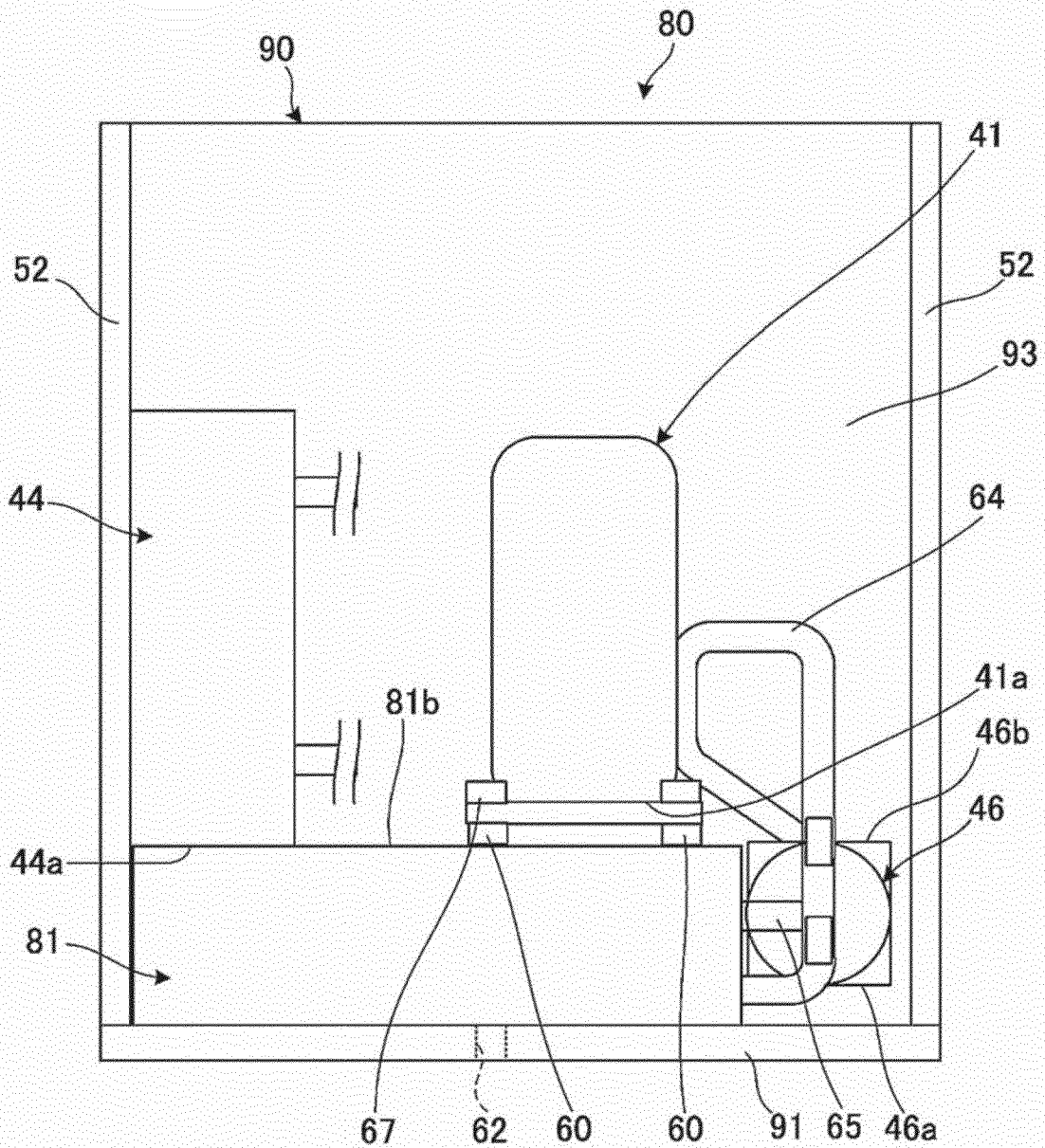
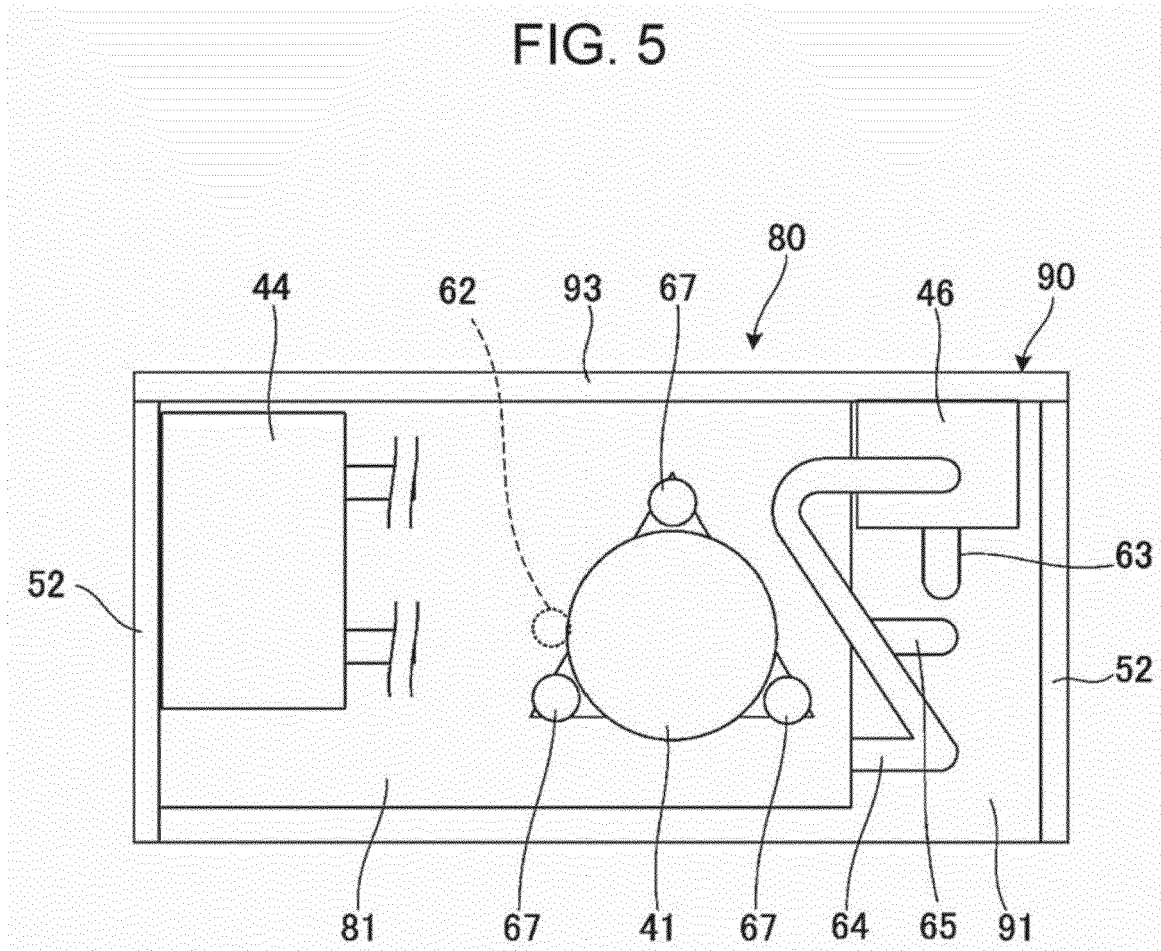


FIG. 5





EUROPEAN SEARCH REPORT

Application Number
EP 16 17 9998

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Place of search		Date of completion of the search	Examiner
Munich		2 December 2016	Schwaiger, Bernd
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