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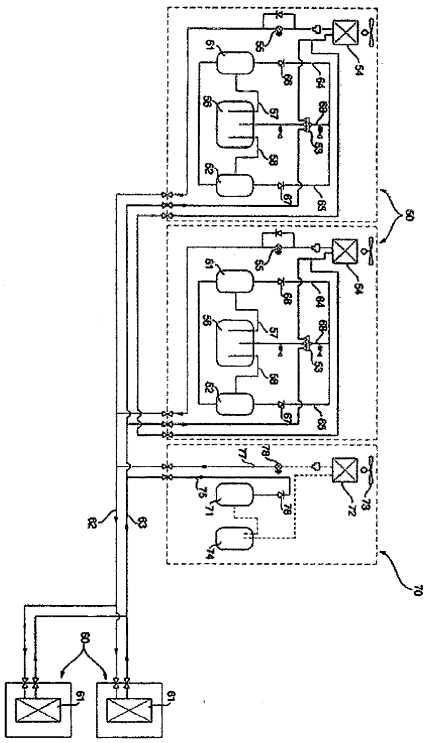
(54) Reversible cycle air conditioner

(57) A heat pump air conditioner includes an outdoor unit (70) for heating use only for supplementing heating capacity when additional heating capacity must be provided to the heating capacity of an outdoor unit (50) for heating and cooling in a heating mode. Since the outdoor unit (70) for heating use only is installed independent from the outdoor units (50) for heating and cooling use, such that the outdoor unit (70) for heating use only can supplement the heating capacity only when the additional heating capacity is required in addition to the heating capacity of the outdoor units (50) for heating and cooling use in the heating mode, in order to correspond to the heating load in cold climes, there is no need to install an outdoor unit having larger heating capacity than the required heating capacity. Thus, costs for installation and management are reduced.

FIG. 1



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Description

[0001] The present invention relates to a heat pump air conditioner.

[0002] Generally, an air conditioner is a device for cooling or heating in order to provide a comfortable indoor climate. Indoor air is drawn in, heated or cooled, and discharged into a confined space.

[0003] A conventional air conditioner includes a compressor for compressing low-temperature/low-pressure gas refrigerant into high-pressure gas refrigerant, a condenser (serving as an indoor heat exchanger in a heating mode, and an outdoor heat exchanger in a cooling mode) for condensing the gas refrigerant discharged from the compressor, an expansion device for expanding the gas refrigerant condensed by the condenser, an evaporator (serving as an outdoor heat exchanger in a cooling mode, and an indoor heat exchanger in a heating mode) for evaporating liquid refrigerant introduced from the expansion device, and a four-way valve for switching the direction of the refrigerant flow according to the heating mode and the cooling mode.

[0004] The compressor and the outdoor heat exchanger are installed in the outdoor unit, and the expansion device and the indoor heat exchanger are installed in the indoor unit.

[0005] Plural outdoor units and indoor units can be provided. The outdoor units are connected to a refrigerant tube by means of a service valve.

[0006] In the conventional air conditioner as described above, the refrigerant compressed by the compressor is fed to the outdoor units by the four-way valve in the cooling mode. The refrigerant passing through the outdoor heat exchangers is condensed due to heat exchange between the refrigerant and ambient air and is fed to the expansion device.

[0007] The refrigerant expanded by the expansion device enters the indoor units and is evaporated by absorbing heat from indoor air, thereby cooling the indoor air.

[0008] Meanwhile, in the heating mode, the four-way valve switches the refrigerant passage so that the refrigerant discharged from the compressor passes through the four-way valve, the indoor units, the expansion device, the outdoor units, and the four-way valve to heat a confined space.

[0009] However, in order to use the conventional air conditioner in cold climes, a large capacity outdoor unit suited to the cold climes of average winter temperature of about sub-zero 15 degrees centigrade must be installed. The cost of buying and installing such large outdoor units is considerable. Moreover, since only about 20 days in a year in such cold climes are reach minus 15 degrees centigrade, the large outdoor unit is unnecessary in remaining days so that the large outdoor has considerable over capacity.

[0010] Therefore, the present invention has been made in view of the above and/or other problems, and it is an object of embodiments of the present invention to provide a heat pump air conditioner in which an outdoor unit for heating use only is installed to add heating capacity to the heat pump air conditioner so that the cost of installing a large capacity outdoor unit can be reduced and the size of the large capacity outdoor unit is reduced.

[0011] The present invention is defined in the accompanying independent claims. Some preferred features are recited in the dependent claims.

[0012] A heat pump air conditioner in which costs for installing an outdoor unit of a larger capacity than required can be saved by additionally installing an outdoor unit for heating use only capable of supplementing heating capacity of a heating and cooling air conditioning system when additional heating capacity is required in addition to the heating capacity of an outdoor unit for heating and cooling in a heating mode.

[0013] In accordance with embodiments of the present invention, the above and other aspects can be accomplished by the provision of a heat pump air conditioner including at least one outdoor unit for heating and cooling use including compressors, a four-way valve, and an outdoor heat exchanger, at least one indoor unit for heating and cooling use connected to the outdoor unit by a refrigerant tube, and an outdoor unit for heating use only installed independently from the outdoor unit for heating and cooling use and supplementing heating capacity of the heat pump air conditioner when there is a need to provide additional heating capacity to the heating capacity of the outdoor unit for heating and cooling use in a heating mode.

[0014] Preferably, the outdoor unit for heating use only includes an additional compressor, and an additional outdoor heat exchanger.

[0015] The outdoor unit for heating use may only include a valve device for opening and closing a passage connected to the indoor unit.

[0016] The valve device may include an electronic expansion valve opened to expand refrigerant introduced from the indoor unit for heating and cooling use in the heating mode, and closed to prevent the refrigerant from being introduced from the indoor unit for heating and cooling use in the cooling mode.

[0017] Preferably, the valve device further includes a check valve installed in a discharge passage of the additional compressor to prevent the refrigerant from flowing in reverse to the additional compressor in the cooling mode.

[0018] The outdoor unit for heating use only further includes an accumulator installed to an inlet port of the additional compressor to accumulate liquid refrigerant from the refrigerant drawn into the additional compressor.

[0019] In accordance with embodiments of the present invention, the above and other aspects can be accomplished by the provision of a heat pump air conditioner including at least one outdoor unit for heating and cooling use having compressors, a four-way valve, and an outdoor heat exchanger, at least one indoor unit for heating and cooling use connected to the outdoor unit for heating

and cooling use by a refrigerant tube, and an outdoor unit for cooling use only installed independently from the outdoor unit and supplementing cooling capacity of the heat pump air conditioner when there is a need to provide additional cooling capacity to the cooling capacity of the outdoor unit for heating and cooling use in a cooling mode.

[0020] Preferably, the outdoor unit for cooling use only includes an additional compressor, an additional outdoor heat exchanger, and a valve device for opening and closing a passage connected to the indoor unit for heating and cooling use.

[0021] The valve device may include an electronic expansion valve opened to expand refrigerant introduced from the additional outdoor heat exchanger in the cooling mode, and closed to prevent the refrigerant from being introduced from the additional outdoor heat exchanger in the heating mode.

[0022] The outdoor unit for cooling use only further comprises an accumulator installed to an inlet port of the additional compressor to accumulate liquid refrigerant from the refrigerant sucked into the additional compressor.

[0023] These and/or other aspects and advantages of the present invention will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a systemic view illustrating a heat pump air conditioner according to a first preferred embodiment of the present invention in a cooling mode;

Fig. 2 is a systemic view illustrating the heat pump air conditioner according to the first preferred embodiment of the present invention in a heating mode; and

Fig. 3 is a systemic view illustrating a heat pump air conditioner according to a second preferred embodiment of the present invention in a cooling mode.

[0024] The heat pump air conditioner according to the first preferred embodiment of the present invention, as shown in Figs. 1 and 2, includes at least one outdoor unit 50 for heating and cooling use having compressors 51 and 52, a multi-way (in this case four-way) valve 53, and an outdoor heat exchanger 54, at least one indoor unit 60 for heating and cooling use connected to the outdoor unit 50 for heating and cooling use by a refrigerant tube, and an outdoor unit 70 for heating use only installed independently from the outdoor unit 50 and providing additional heating capacity for the heat pump air conditioner when there is a need to add the additional heating capacity to the heating capacity of the outdoor unit 50 for heating and cooling use in a heating mode.

[0025] Although the heat pump air conditioner may include plural outdoor units 50 for heating and cooling use, in this preferred embodiment of the present invention, only the heat pump air conditioner having two outdoor units 50 is described, and each of the outdoor units 50 further includes an expansion device 55.

[0026] The outdoor heat exchanger 54 serves as a condenser in the cooling mode and as an evaporator in the heating mode. The four-way valves 53 switch the direction of refrigerant flow according to the heating or cooling mode.

[0027] Each of the indoor units 60 includes an indoor heat exchanger 61 serving as an evaporator in the cooling mode and as a condenser in the heating mode.

[0028] The outdoor units 50 for heating and cooling use and the indoor units 60 for heating and cooling use are connected to each other by a refrigerant tubing. The refrigerant tube includes a first refrigerant tube 62 installed such that refrigerant flows to the outdoor units 50 for heating and cooling use from the indoor units 60 for heating and cooling use in the heating mode. A second refrigerant tube 63 installed such that refrigerant flows to the indoor units 60 for heating and cooling use from the outdoor units 50 for heating and cooling use.

[0029] Each of the outdoor units 50 includes two compressors, i.e. a first compressor 51 and a second compressor 52 connected to each other via a common accumulator 56. Each of the common accumulators 56 is connected to each of a first suction passage 57 and a second suction passage 58 provided in each of the first and second compressors 51 and 52.

[0030] Each of the first and second compressors 51 and 52 is connected to each of a first discharge passage 64 and a second discharge passage 65 from which gas refrigerant compressed at high temperature and high pressure by the first and second compressors 51 and 52 is discharged. Each of the first and second discharge passages 64 and 65 includes each of first check valves 66 and second check valves 67 for preventing the high-temperature/high-pressure gas refrigerant from flowing in reverse.

[0031] Each of the first and second discharge passages 64 and 65 is combined into each of third discharge passages 68 for guiding the discharged refrigerant into each of the four-way valves 53.

[0032] Meanwhile, the outdoor unit 70 for heating use includes an additional compressor 71, an additional outdoor heat exchanger 72, and a valve device for opening and closing a passage by which the refrigerant is introduced from the indoor units 60 for heating and cooling use.

[0033] The additional compressor 71 is a constant-speed compressor, and the additional outdoor heat exchanger 72 includes a fan 73 for blowing outdoor air for heat exchange to the additional outdoor heat exchanger 72.

[0034] The additional compressor 71 includes an accumulator 74 installed to an inlet port of the additional compressor 71 to accumulate liquid refrigerant from the refrigerant drawn into the additional compressor 71.

[0035] The additional compressor 71 includes an additional discharge passage 75 such that the refrigerant

compressed and discharged from the additional compressor 71 is guided to the indoor units 60 for heating and cooling use. The additional discharge passage 75 is connected to the second refrigerant tube 63.

[0036] The indoor units 60 for heating and cooling use and the outdoor unit 70 for heating use are connected by an additional suction passage 77 through which the refrigerant is drawn into the additional outdoor heat exchanger 72 from the indoor units 60 for heating and cooling use. The additional suction passage 77 is connected to the first refrigerant tube 62.

[0037] The valve device in this embodiment includes an electronic expansion valve 78, which is installed in the additional suction passage 77. It is opened in the heating mode to expand the refrigerant introducing from the indoor units 60 for heating and cooling use, and is closed in the cooling mode to block the passage of the refrigerant from the indoor units 60 for heating and cooling use.

[0038] Moreover, the valve device further includes a check valve 76 installed in the additional discharge passage 75 to prevent the refrigerant from flowing in reverse to the additional compressor 71 in the cooling mode.

[0039] Preferably, the outdoor units 50 for heating and cooling use having a capacity corresponding to heating and cooling load under the general standard temperature condition are selected and installed. In order to cope with the weather in very cold climes in winter, the outdoor unit 70 for heating use has a heating capacity which can be as much as the heating capacity of the outdoor unit 50 for heating and cooling use.

[0040] The heat pump air conditioner further includes a controller (not shown) for closing the electronic expansion valve 78 to prevent the outdoor units 50 for heating and cooling use from being used under the general standard temperature conditions or in the cooling mode, and for opening the electronic expansion valve 78 to enable the further outdoor unit 70 when the additional capacity of the outdoor unit 70 is required.

[0041] Operation of the heat pump air conditioner according to the first preferred embodiment of the present invention as described above will be described in detail.

[0042] First, in the cooling mode, the four-way valves 53 are switched to the cooling mode. The refrigerant compressed by each set of the first and second compressors 51 and 52 is discharged through the first and second discharge passages 64 and 65 and is mixed in the combined discharge passage 68. The refrigerant then passes through the four-way valve 53, the outdoor heat exchanger 54, the expansion devices 55, and to the indoor heat exchangers 61. The refrigerant returns through the four-way valve 53, the common accumulator 56, and the first and second compressors 51 and 62, again.

[0043] The refrigerant absorbs the heat drawn from the indoor air and is evaporated to cool indoor air during passage through the indoor units 61.

[0044] In the cooling mode, the electronic expansion valve 78 of the outdoor unit 70 for heating use only is closed so that the refrigerant is prevented from being drawn into the outdoor unit 70 for heating use only via the additional suction passage 77 from the indoor heat exchangers 61. Thus, the outdoor unit 70 for heating use only 70 is disabled.

[0045] In the heating mode, under the standard temperature condition, i.e. when the heating capacity of the outdoor units 50 for heating and cooling use can cope with the heating load, as in the cooling mode, the electronic expansion valve 78 is closed, and thus the outdoor unit 70 for heating use only is inactive.

[0046] However, when the temperature is lower than the standard temperature, i.e. when the additional heating capacity is required in addition to the heating capacity of the outdoor units 50 for heating and cooling use, the electronic expansion valve 78 is opened, and thus the refrigerant enters the outdoor unit 70 for heating use only.

[0047] The refrigerant drawn into the outdoor unit 70 for heating use only circulates through the electronic expansion valve 78, the additional outdoor heat exchanger 72, the accumulator 74, the additional compressor 71, and the indoor units 60 for heating and cooling use.

[0048] Therefore, by adding the outdoor unit 70 for heating use only when the heating capacity is insufficient, as in very cold regions, the heat pump air conditioner according to the first preferred embodiment of the present invention can cope with the required heating capacity as necessary.

[0049] Here, since the outdoor unit 70 for heating use only has a simple structure without various sensors, a four-way valve, or the like, and occupies a small installation space, costs for installation and management can be reduced.

[0050] Fig. 3 illustrates a heat pump air conditioner according to a second preferred embodiment of the present invention in a cooling mode.

[0051] The heat pump air conditioner according to the second preferred embodiment of the present invention includes at least one outdoor unit 50 for heating and cooling use having compressors 51 and 52, a four-way valve 53, and an outdoor heat exchanger 54, at least one indoor unit 60 for heating and cooling use connected to the outdoor unit 50 for heating and cooling use by a refrigerant tube, and an outdoor unit 80 for cooling use only installed independently from the outdoor unit 50 and supplementing the cooling capacity of the heat pump air conditioner when there is a need to add the additional cooling capacity to the cooling capacity of the outdoor unit 50 for heating and cooling use in a cooling mode.

[0052] Here, since the internal configuration and operations of the outdoor units 50 for heating and cooling use and the indoor units 60 for heating and cooling use are the same as those of the heat pump air conditioner according to the first preferred embodiment of the present invention, except that the outdoor unit 80 for cooling use only is used only in the cooling mode, the same reference numerals are assigned to the outdoor units 50 for heating and cooling use, the indoor units 60 for heating and cool-

ing use, and their elements, and their separate description is omitted.

[0053] The outdoor unit 80 for cooling use includes an additional compressor 81, an additional outdoor heat exchanger 82, a valve device for opening and closing a passage connected to the indoor units 60 for heating and cooling use, and an accumulator 84.

[0054] An additional suction passage 85, through which the refrigerant is drawn into the outdoor unit 80 for cooling use only, connects the first refrigerant tube 62 with a suction part of the accumulator 84. An additional discharge passage 86, through which the refrigerant is discharged from the outdoor unit 80 for cooling use only, connects the second refrigerant tube 63 to the additional outdoor heat exchanger 82.

[0055] The valve device is an electronic expansion valve 83, which is installed in the additional discharge passage 86. It is opened in the cooling mode to expand the refrigerant introduced from the_additional outdoor heat exchanger 82, and is closed in the heating mode to block the refrigerant introduced from the_additional outdoor heat exchanger 82.

[0056] The heat pump air conditioner according to the present invention configured as described above has the following advantages.

[0057] In the heat pump air conditioner according to the present invention, the outdoor unit for heating use only is installed independently of the outdoor units for heating and cooling use. Thus, the outdoor unit for heating use can be used to supplement the heating capacity when the additional heating capacity is actually required, there is no need to install a large outdoor unit having heating capacity greater than necessary to cope with cold weather in cold regions. Thus, costs for installation and management are saved.

[0058] Moreover, as the outdoor unit for heating use only includes an additional compressor, an additional outdoor heat exchanger, and a valve means, the configuration is simple so that space and cost of installation of the outdoor unit for heating use only are reduced.

[0059] The outdoor unit for heating use only is installed in the cold climes and places where the heating capacity of an air conditioning system is sometimes insufficient, so that the required heating capacity can be easily provided to the heating load on an occasional basis.

[0060] Although the preferred embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope of the invention as disclosed in the accompanying claims.

[0061] The following embodiments are disclosed

1. A heat pump air conditioner comprising:

at least one outdoor unit (50) for heating and cooling use including compressor means (51 and 52), a multi-way valve (53), and an outdoor heat exchanger (54);
at least one indoor unit (60) for heating and cooling use connected to the outdoor unit (50) by a refrigerant tube; and
a further outdoor unit (70) for heating use installed independently of the outdoor unit (50) and operable to supplement the heating capacity of the heat pump air conditioner to provide additional heating capacity to the heating capacity of the outdoor unit (50) in a heating mode.

2. The heat pump air conditioner as set forth in item 1, wherein the further outdoor unit (70) comprises:

an additional compressor (71); and
an additional outdoor heat exchanger (72).

3. The heat pump air conditioner as set forth in item 2, wherein the further outdoor unit (70) comprises a valve means for opening and closing a passage connected to the indoor unit (50) to enable the further outdoor unit (70).

4. The heat pump air conditioner as set forth in item 3, wherein the valve means comprises an electronic expansion valve (78) for expanding refrigerant introduced from the indoor unit (60) for heating and cooling use in the heating mode, which expansion valve is closable to prevent the refrigerant from being introduced from the indoor unit (60) in the cooling mode.

5. The heat pump air conditioner as set forth in item 4, wherein the valve means further comprises a check valve (76) installed in a discharge passage of the additional compressor (71) to prevent refrigerant from flowing in reverse to the additional compressor (71) in the cooling mode.

6. The heat pump air conditioner as set forth in item 5, wherein the outdoor unit (70) further comprises an accumulator (74) installed to an inlet port of the additional compressor (71) to accumulate liquid refrigerant from the refrigerant drawn into the additional compressor (71).

7. A heat pump air conditioner comprising:

at least one outdoor unit (50) for heating and cooling use having compressor means (51 and 52), a multi-way valve (53), and an outdoor heat exchanger (54);
at least one indoor unit (60) for heating and cooling use connected to the outdoor unit (50) for heating and cooling use by a refrigerant tube; and
a further outdoor unit (80) for cooling use installed independently of the outdoor unit (50)

and arranged to be enabled to supplement the cooling capacity of the heat pump air conditioner to provide additional cooling capacity to the cooling capacity of the outdoor unit (50) in a cooling mode.

8. The heat pump air conditioner as set forth in item 7, wherein the further outdoor unit (80) comprises:

an additional compressor (81);
an additional outdoor heat exchanger (82); and
a valve means for opening and closing a passage connected to the indoor unit (60).

9. The heat pump air conditioner as set forth in item 1, wherein the valve means comprises an electronic expansion valve (83) openable to expand refrigerant introduced from the additional outdoor heat exchanger (82) in the cooling mode, and closable to prevent the refrigerant from being introduced from the additional outdoor heat exchanger (82) in the heating mode.

10. The heat pump air conditioner as set forth in item 8, wherein the further outdoor unit (80) further comprises an accumulator (84) installed to an inlet port of the additional compressor (81) to accumulate liquid refrigerant from the refrigerant drawn into the additional compressor (81).

Claims

1. A heat pump air conditioner comprising:

at least one outdoor unit (50) for heating and cooling use including compressor means (51 and 52), a multi-way valve (53) , and an outdoor heat exchanger (54);
at least one indoor unit (60) for heating and cooling use connected to the outdoor unit (50) by a refrigerant tube; and
a further outdoor unit (70) for heating use installed independently of the outdoor unit (50) and operable to supplement the heating capacity of the heat pump air conditioner to provide additional heating capacity to the heating capacity of the outdoor unit (50) in a heating mode.

2. The heat pump air conditioner as set forth in claim 1, wherein the further outdoor unit (70) comprises:

an additional compressor (71); and
an additional outdoor heat exchanger (72).

3. The heat pump air conditioner as set forth in claim 2, wherein the further outdoor unit (70) comprises a valve means for opening and closing a passage connected to the indoor unit (50) to enable the further outdoor unit (70).

4. The heat pump air conditioner as set forth in claim 3, wherein the valve means comprises an electronic expansion valve (78) for expanding refrigerant introduced from the indoor unit (60) for heating and cooling use in the heating mode, which expansion valve is closable to prevent the refrigerant from being introduced from the indoor unit (60) in the cooling mode.

5. The heat pump air conditioner as set forth in claim 4, wherein the valve means further comprises a check valve (76) installed in a discharge passage of the additional compressor (71) to prevent refrigerant from flowing in reverse to the additional compressor (71) in the cooling mode.

6. The heat pump air conditioner as set forth in claim 5, wherein the outdoor unit (70) further comprises an accumulator (74) installed to an inlet port of the additional compressor (71) to accumulate liquid refrigerant from the refrigerant drawn into the additional compressor (71).

7. A heat pump air conditioner comprising:

at least one outdoor unit (50) for heating and cooling use having compressor means (51 and 52), a multi-way valve (53), and an outdoor heat exchanger (54);
at least one indoor unit (60) for heating and cooling use connected to the outdoor unit (50) for heating and cooling use by a refrigerant tube; and
a further outdoor unit (80) for cooling use installed independently of the outdoor unit (50) and arranged to be enabled to supplement the cooling capacity of the heat pump air conditioner to provide additional cooling capacity to the cooling capacity of the outdoor unit (50) in a cooling mode.

8. The heat pump air conditioner as set forth in claim 7, wherein the further outdoor unit (80) comprises:

an additional compressor (81);
an additional outdoor heat exchanger (82); and
a valve means for opening and closing a passage connected to the indoor unit (60).

9. The heat pump air conditioner as set forth in claim 1, wherein the valve means comprises an electronic expansion valve (83) openable to expand refrigerant introduced from the additional outdoor heat exchanger (82) in the cooling mode, and closable to prevent the refrigerant from being introduced from

the additional outdoor best exchanger (82) in the heating mode,

10. The heat pump air conditioner as set forth in claim 8, wherein the further outdoor unit (80) further comprises an accumulator (84) installed to an inlet port of the additional compressor (81) to accumulate liquid refrigerant from the refrigerant drawn into the additional compressor (81).

FIG. 1

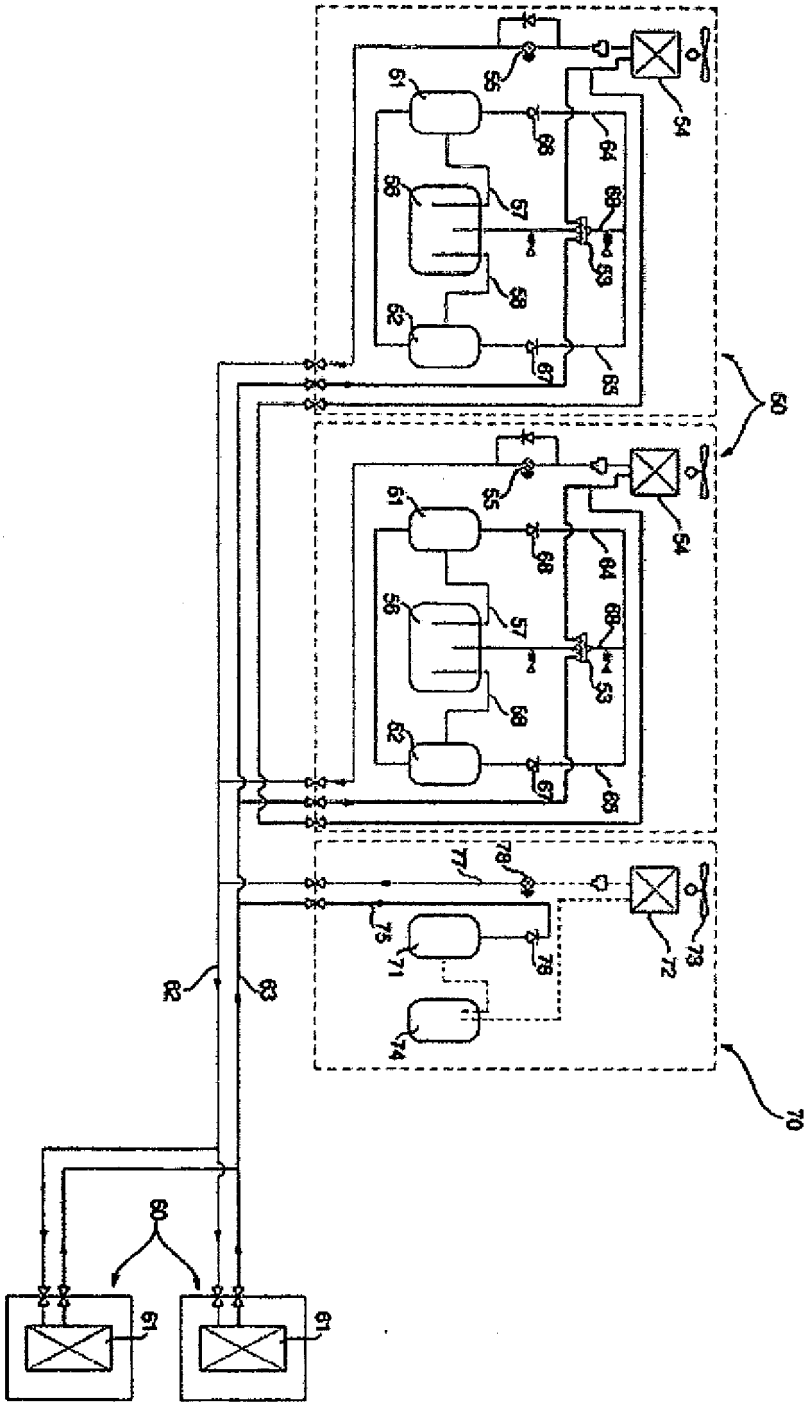
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FIG. 2

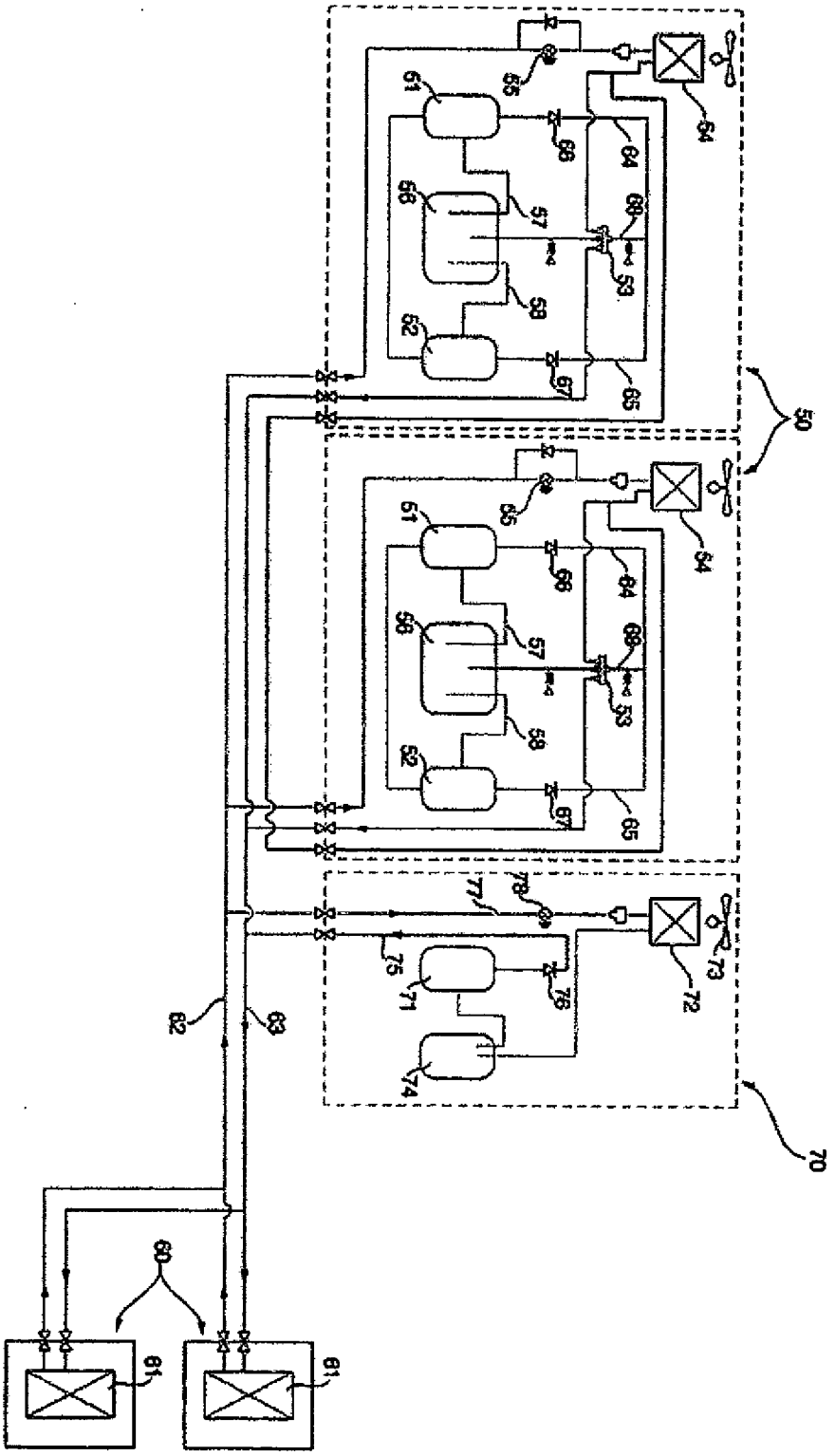
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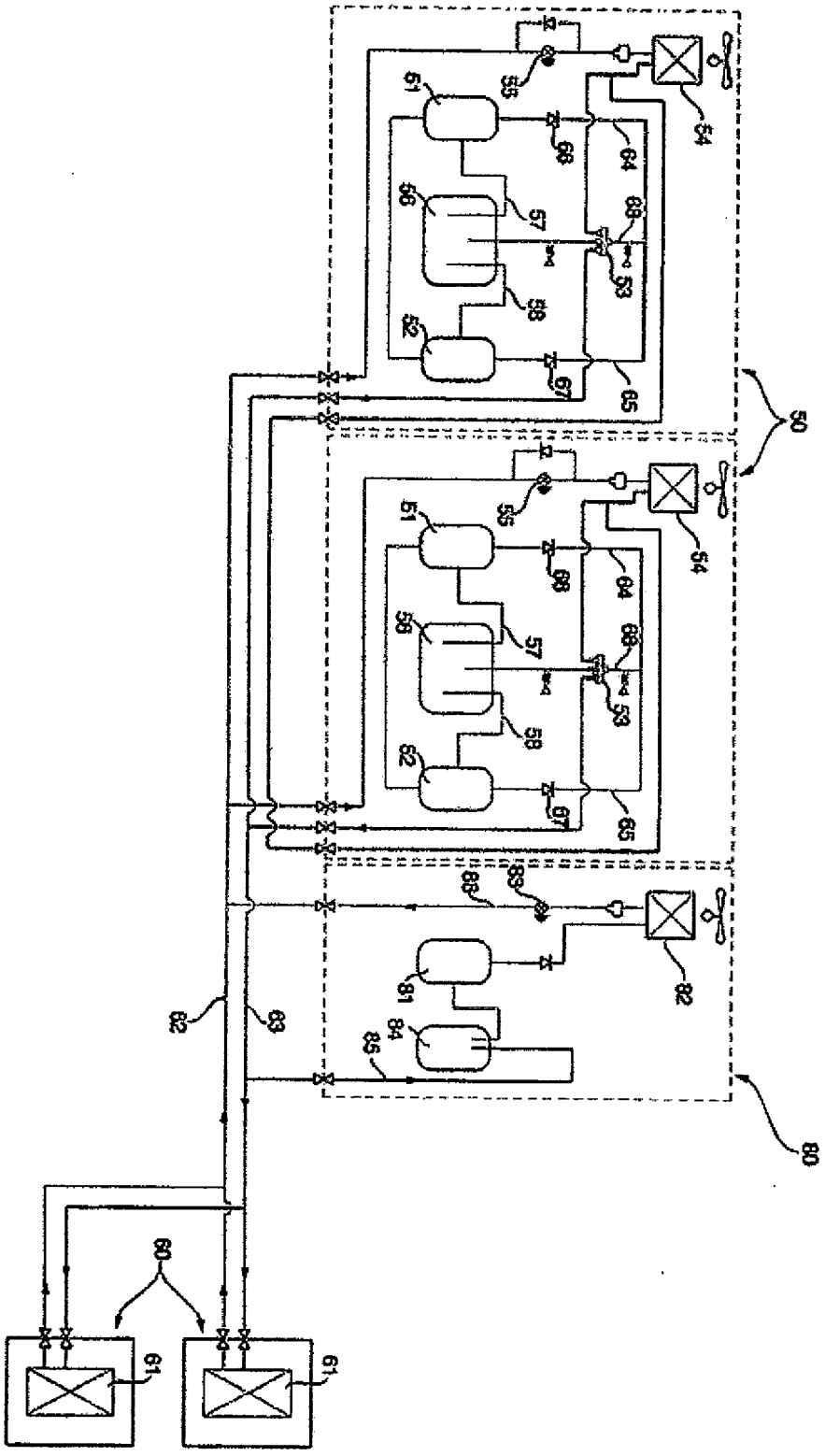
FIG. 3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EUROPEAN SEARCH REPORT

Application Number
EP 10 18 2046

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 0 638 777 A (DAIKIN IND LTD [JP]) 15 February 1995 (1995-02-15) * column 2, line 43 - column 30, line 46; figures 1-12 *	1-10	INV. F25B13/00
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TECHNICAL FIELDS SEARCHED (IPC)

F25B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	3 February 2011	Szilagyi, Barnabas

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 10 18 2046

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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