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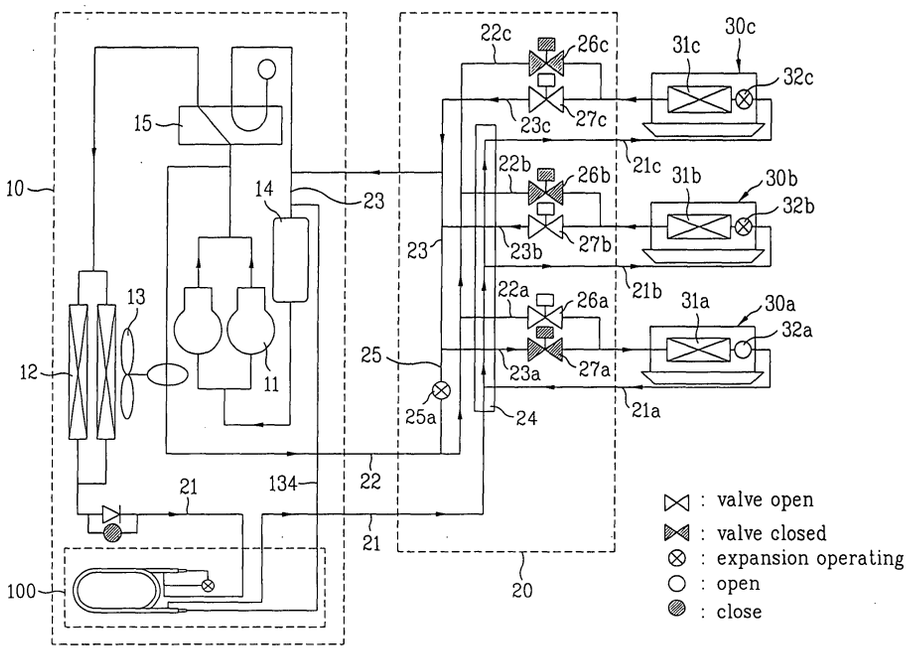
(54) Air conditioner

(57) Air conditioner including an outdoor unit (10) installed in outdoor having a compressor (11), an outdoor heat exchanger (12), an indoor unit (30) installed in indoor having an indoor heat exchanger (31), a distributor (20) for guiding refrigerant from the outdoor unit to the indoor unit proper to an operation condition, and refrigerant passed through the indoor unit to the outdoor unit, again, and a subcooling device (100) for subcooling the refrigerant passed through a heat exchange process at the outdoor heat exchanger under an isobaric condition, and guiding the subcooled refrigerant to the distributor, thereby improving an air conditioning capability.

FIG.1



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Description

[0001] This application claims the benefit of the Korean Application No. P2004-0005045 filed on January 27, 2004, which is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to air conditioners, and more particularly, to an air conditioner of an improved air conditioning capability.

Background of the Related Art

[0003] In general, the air conditioner cools or heats a room space, such as a residential space, a restaurant, a library, or an office, is provided with a compressor, and a heat exchanger to circulate refrigerant for cooling/heating the room space.

[0004] The air conditioner is developed to a multi-type air conditioner which can cools and heats at the same time enabling to cool or heat all rooms in the same operation mode, for maintaining a more comfortable room environment without being influenced from external weather or environment.

[0005] Such a related art multi-type air conditioner has a plurality of indoor units each installed in each room and connected to one outdoor unit, for cooling or heating all rooms in a cooling or heating mode.

[0006] However, in a case the related art multi-type air conditioner is applied to one, such as a high building having a complicate structure, and varieties of positions and purposes of rooms therein, pipelines from the outdoor unit to the indoor units become lengthy, to cause a pressure drop of the refrigerant introduced into the indoor unit, and drop of an air conditioning efficiency of the multi-type air conditioner.

SUMMARY OF THE INVENTION

[0007] Accordingly, the present invention is directed to an air conditioner that substantially obviates one or more of the problems due to limitations and disadvantages of the related art.

[0008] An object of the present invention is to provide an air conditioner having an improved air conditioning capability.

[0009] Other object of the present invention is to provide an air conditioner which can minimize a pressure loss of refrigerant flowing in a refrigerant pipe caused by lengthy refrigerant pipeline for guiding the refrigerant, and secure a subcooling state of refrigerant introduced into an expansion device.

[0010] Additional features and advantages of the invention will be set forth in the description which follows, and in part will be apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0011] To achieve these objects and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described herein, the air conditioner includes an outdoor unit installed in outdoor having a compressor, an outdoor heat exchanger, an indoor unit installed in indoor having an indoor heat exchanger, a distributor for guiding refrigerant from the outdoor unit to the indoor unit proper to an operation condition, and refrigerant passed through the indoor unit to the outdoor unit, again, and a subcooling device for subcooling the refrigerant passed through a heat exchange process at the outdoor heat exchanger under an isobaric condition, and guiding the subcooled refrigerant to the distributor.

[0012] The subcooling device makes a portion of the refrigerant passed through the heat exchange process at the outdoor heat exchanger to expand, and the expanded portion of the refrigerant to heat exchange with rest unexpanded refrigerant.

[0013] The subcooling device includes a subcooling heat exchanger for making an expanded portion of the refrigerant to heat exchange with rest unexpanded refrigerant, a first connection pipeline haying an expansion device for expanding a portion of the refrigerant passed through a heat exchange process at the outdoor heat exchanger, for guiding expanded refrigerant to the subcooling heat exchanger, a second connection pipeline for guiding unexpanded refrigerant to the subcooling heat exchanger, a third connection pipeline for guiding unexpanded refrigerant passed through the subcooling heat exchanger to the distributor, and a fourth connection pipeline for guiding the expanded refrigerant passed through the subcooling heat exchanger to the refrigerant pipeline connected to a suction end of the compressor.

[0014] The subcooling heat exchanger includes a first flow pipeline having one end connected to the second connection pipeline, and the other end connected to the third connection pipeline for flow of unexpanded refrigerant, and a second flow pipeline having one end connected to the first connection pipeline, and the other end connected to the fourth connection pipeline for making heat exchange with the first flow pipeline, and flow of the expanded refrigerant.

[0015] The subcooling heat exchanger has a double pipe structure. The second flow pipeline is provided in an inside of the first flow pipeline in a longitudinal direction.

[0016] The refrigerant flowing through the second flow pipeline has a flow direction opposite to a flow direction of the refrigerant flowing through the first flow pipeline, or a flow direction the same with a flow direction

of the refrigerant flowing through the first flow pipeline.

[0017] The first flow pipeline is provided inside of the second flow pipeline in a longitudinal direction.

[0018] The subcooling heat exchanger has a length of 1m ~ 2.5m.

[0019] The subcooling heat exchanger further includes a heat exchange part on an inside wall for making a heat exchange area larger.

[0020] The heat exchange part is projected inward from an inside wall of the inner flow pipe. In more detail, the heat exchange part is provided on an inside wall of the inner flow pipe in a circumferential direction.

[0021] The heat exchange part is provided on an inside wall of the inner flow pipe in a longitudinal direction, or in a helix.

[0022] The expansion device is an electronic expansion valve.

[0023] The air conditioner further includes an accumulator on a refrigerant pipeline connected to the suction end of the compressor for separating gaseous refrigerant from liquid refrigerant.

[0024] The fourth connection pipeline is connected to a refrigerant pipeline connected to a refrigerant inlet to the accumulator.

[0025] The subcooling device is provided to a predetermined position of an inside of the outdoor unit.

[0026] The outdoor unit further includes a switching device for switching a flow direction of the refrigerant from the compressor to the outdoor heat exchanger or the distributor selectively proper to an operation condition.

[0027] The present invention provides a multi-type air conditioner which enables some of rooms operative in a cooling mode, while other rooms are operative in a heating mode according to room environments, improves degrees of freedom of installation of the multi-type air conditioner, and maintains a subcooling state of the refrigerant.

[0028] It is to be understood that both the foregoing description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention claimed.

BRIEF DESCRITPION OF THE DRAWINGS

[0029] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention.

[0030] In the drawings;

FIG. 1 illustrates a system diagram of an air conditioner in accordance with one preferred embodiment of the present invention;

FIG. 2 illustrates a system diagram of an air conditioner in accordance with another preferred embodiment of the present invention;

FIG 3 illustrates a system diagram of one preferred embodiment of a subcooling device provided to the air conditioner in FIG. 1 or 2;

FIG 4 illustrates a perspective view of one preferred embodiment of a subcooling heat exchanger in the subcooling device in FIG. 3;

FIG 5 illustrates a perspective view of another preferred embodiment of a subcooling heat exchanger in the subcooling device in FIG. 3; and

FIG 6 illustrates a P-h diagram of a refrigerating cycle of a multi-type air conditioner of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0031] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. In describing the embodiments, identical parts will be given the same names and reference symbols, and repetitive description of which will be omitted.

[0032] For better understanding of the present invention, functions of the air conditioner will be described. The air conditioner controls temperature, humidity, motion, and cleanliness of air so as to be suitable to a purpose of use for a particular area, for an example, room spaces, such as residential space, office, restaurant, and the like.

[0033] In a cooling operation, the air conditioner cools a room by compressing low pressure refrigerant having absorbed heat from the room and discharging the heat to an outdoor air, and, in a heating operation, heats the room by an opposite operation of the above process.

[0034] FIG. 1 illustrates a system diagram of an air conditioner in accordance with one preferred embodiment of the present invention, of a concurrent heating/cooling multi-type air conditioner that cools /heats rooms at the same time.

[0035] Referring to FIG. 1, the concurrent heating/cooling multi-type air conditioner includes an outdoor unit 10, a distributor 20, and a plurality of indoor units 30a, 30b, and 30c in each of rooms.

[0036] The outdoor unit 10 includes a compressor 11, an outdoor heat exchanger 12, an outdoor fan 13 on one side of the outdoor heat exchanger, a switching device 15 for switching a compressed refrigerant flow from the compressor 11 to the outdoor heat exchanger or the distributor selectively proper to operation modes, and accumulator 14 on a refrigerant pipeline connected to a suction end of the compressor for separating vapor phase refrigerant from liquid phase refrigerant.

[0037] The outer unit 10 is connected to the distributor 20 by the switching device through a first pipeline 21 for guiding high pressure refrigerant from the compressor 11 to the distributor through the outdoor heat exchanger

12, a second refrigerant pipeline 22 for guiding the refrigerant from the compressor 11 to the distributor 20 directly, and a third refrigerant pipeline 23 connected between the distributor 20 and the suction end of the compressor 11.

[0038] Each of the indoor units 30a, 30b, and 30c includes an indoor heat exchanger 31a, 31b, or 31c, and an expansion device 32a, 32b, or 32c for expanding refrigerant introduced into the indoor heat exchanger to a preset state in a cooling mode.

[0039] The distributor 20 is designed such that the refrigerant is guided from the outdoor unit 10 to the expansion device 32a, 32b, or 32c of the indoor unit directly if the indoor unit is operated in the cooling mode, and the refrigerant is guided from the outdoor unit 10 to the indoor heat exchanger 31a, 31 b, or 31c of the indoor unit directly if the indoor unit is operated in the heating mode.

[0040] For this, the distributor 20 includes first refrigerant branch pipelines 21a, 21b, and 21c branched from the first refrigerant pipeline 21 as many as a number of the indoor units, and connected to the indoor unit expansion devices 32a, 32b, and 32c respectively, second refrigerant branch pipelines 22a, 22b, and 22c branched from the second refrigerant pipeline and connected to the indoor heat exchangers 31a, 31b, and 31c respectively, and third refrigerant branch pipelines 23a, 23b, and 23c branched from the third refrigerant pipeline 23, and connected to the indoor heat exchangers 31 a, 31b, and 31c, respectively. The second refrigerant branch pipelines 22a, 22b, and 22c have first electronic shut off valves 26a, 26b, and 26c, respectively, and the third refrigerant branch pipeline 23a, 23b, and 23c have second electronic shut off valves 27a, 27b, and 27c, respectively.

[0041] According to above system, in a case the indoor unit is operated in the heating mode, the first electronic shut off valve on the second refrigerant branch pipeline connected to the indoor unit is opened, and the second electronic shut off valve on the third refrigerant branch pipeline connected to the indoor unit is closed, such that the refrigerant flows from the compressor 11 to the indoor heat exchanger through the second refrigerant pipeline 22, and the second refrigerant branch pipeline connected to the indoor unit. In a case of the indoor unit operated in the cooling mode, the first electronic shut off valve on the second refrigerant branch pipeline connected to the indoor unit operated in the cooling mode is closed, and the second electronic shut off valve on the third refrigerant branch pipeline connected to the indoor unit is opened, such that the refrigerant having introduced through the first refrigerant branch pipeline connected to the indoor unit, and expanded at the indoor unit expansion device is introduced into the third refrigerant pipeline 23 through the indoor heat exchanger of the indoor unit and the third refrigerant branch pipeline connected to the indoor unit.

[0042] Moreover, the distributor 20 includes a bypass pipe 25 connected between the second refrigerant pipeline 22, and the third refrigerant pipeline 23, and an electronic conversion valve 25a on the bypass pipe for converting high pressure refrigerant stagnant at the second refrigerant pipeline 22 into a low pressure refrigerant, for preventing liquefaction of the refrigerant due to the stagnation of high pressure refrigerant in a case all the indoor units are operated in the cooling mode.

[0043] In the meantime, the concurrent heating/cooling multi-type air conditioner further includes a subcooling device 100 on the first refrigerant pipeline 21 connected between the outdoor heat exchanger 12 and the distributor 20.

[0044] The subcooling device 100 subcools the refrigerant passed through a heat exchange process at the outdoor heat exchanger under an isobaric condition, and guides to the distributor, i.e., expands a portion of the refrigerant from the outdoor heat exchanger 12, makes the expanded refrigerant to heat exchange with rest of the refrigerant discharged from the outdoor heat exchanger, and flowing toward the distributor 20 following the first refrigerant pipeline 21, and introduce into the third refrigerant pipeline 23 connected between the distributor 20 and the suction end of the compressor 11. The subcooling device 100 will be described in detail with reference to FIGS. 3 ~ 5, later.

[0045] In addition to above system, it is preferable that the distributor 20 further includes a supplementary subcooling device 24 of a coaxial tube fitted between the distributor 20 and the first refrigerant pipeline 21. The supplementary subcooling device 24 secures subcooling of the refrigerant introduced into the indoor heat exchangers 31a, 31b, and 31c by means of heat exchange between refrigerants.

[0046] As another embodiment of the air conditioner of the present invention, a cooling/heating selective multi-type air conditioner will be described with reference to FIG 2. FIG. 2 illustrates a system diagram of an air conditioner in accordance with another preferred embodiment of the present invention.

[0047] The cooling/heating selective multi-type air conditioner includes an outdoor unit 50, a distributor 60, and a plurality of indoor units 70a, 70b, and 70c in each room, for operating all the indoor units in a cooling mode, or heating mode.

[0048] The outdoor unit 50 includes a compressor 51, an outdoor heat exchanger 52, an outdoor fan 53 on one side of the outdoor heat exchanger, a switching device 55 for switching a compressed refrigerant flow from the compressor 51 to the outdoor heat exchanger or the distributor selectively proper to operation modes, and an accumulator 54 on a refrigerant pipeline connected to a suction end of the compressor 51 for separating vapor phase refrigerant from liquid phase refrigerant.

[0049] The outer unit 50 is connected to the distributor 60 by the switching device 55 through a first pipeline 61 for guiding high pressure refrigerant from the compressor 51 to the distributor through the outdoor heat exchanger 52, a second refrigerant pipeline 62 having one

end connected to a refrigerant pipeline connected to a discharge end of the compressor 51 for guiding the refrigerant from the compressor 51 to the distributor 60 directly, and a third refrigerant pipeline 63 connected between the distributor 60 and the suction end of the compressor 51.

[0050] Each of the indoor units includes an indoor heat exchanger 71a, 71b, or 71c, and an expansion device 72a, 72b, or 72c for expanding refrigerant introduced into the indoor heat exchanger to a preset state in a cooling mode.

[0051] The distributor 60 is designed such that the refrigerant is guided from the first connection pipeline 61 to the expansion device 72a, 72b, or 72c of the indoor unit directly if all the indoor units 70a, 70b, and 70c are operated in the cooling mode, and the refrigerant is guided from the first connection pipeline 62 to the indoor heat exchanger 71a, 71b, or 71c of the indoor unit directly if all the indoor units 70a, 70b, and 70c are operated in the heating mode.

[0052] For this, the distributor 60 includes first refrigerant branch pipelines 61a, 61b, and 61c branched from the first refrigerant pipeline 61 as many as a number of the indoor units 70a, 70b, and 70c, and connected to the indoor unit expansion devices 72a, 72b, and 72c respectively, second refrigerant branch pipelines 62a, 62b, and 62c branched from the second refrigerant pipeline 62 and connected to the indoor heat exchangers 71a, 71b, and 71c of the indoor units respectively, and an electronic shut off valves 64 at a position before the second refrigerant pipeline 62 is branched to the second refrigerant branch pipelines. The third refrigerant pipeline 63 is connected to the other end of the second refrigerant pipeline 62.

[0053] According to above system, in a case all the indoor units 70a, 70b, and 70c are operated in the cooling mode, the electronic shut off valve 64 on the second refrigerant branch pipeline 62 is closed, such that the refrigerant flows from the compressor 51 to the expansion devices 72a, 72b, and 72c through the first refrigerant branch pipelines 61a, 61b, and 61c connected to the first refrigerant pipeline 61 and the indoor units 70a, 70b, and 70c by the switching device 55, and expands at the expansion devices 72a, 72b, and 72c, and is drawn into the compressor 51 through the indoor heat exchanger 71 a, 71b, and 71c, the second refrigerant branch pipelines 62a, 62b, and 62c, and the third refrigerant pipeline 63.

[0054] In a case all the indoor units 70a, 70b, and 70c are operated in the heating mode, the electronic shut off valve 64 on the second refrigerant branch pipeline 62 is opened, such that the refrigerant flows from the compressor 51 to the indoor heat exchangers 71 a, 71 b, and 71c through the second refrigerant branch pipelines 61 a, 61b, and 61c connected to the second refrigerant pipeline 62 and the indoor units 70a, 70b, and 70c by the switching device 55, heat exchanges at the indoor heat exchangers 71a, 71b, and 71c, and is drawn into the compressor 51 through the expansion devices 72a, 72b, and 72c, the first refrigerant branch pipelines 61a, 61b, and 61c, and the first refrigerant pipeline 61.

[0055] In the meantime, the heating/cooling selective multi-type air conditioner further includes a subcooling device 100 on the first refrigerant pipeline 21 connected between the outdoor heat exchanger 12 and the distributor 20.

[0056] The subcooling device 100 subcools the refrigerant passed through a heat exchange process at the outdoor heat exchanger 52 under an isobaric condition, and guides to the distributor, i.e., expands a portion of the refrigerant from the outdoor heat exchanger 52, makes the expanded refrigerant to heat exchange with rest of the refrigerant discharged from the outdoor heat exchanger, and flowing toward the distributor 60 following the first refrigerant pipeline 61, and introduce into the third refrigerant pipeline 63 connected between the distributor 60 and the suction end of the compressor 51.

[0057] A system of the subcooling device 100 applied to the concurrent, or selective heating/cooling multi-type air conditioner will be described with reference to FIGS. 3 ~ 5.

[0058] The subcooling device 100 includes a subcooling heat exchanger 110, an expansion device 120, and connection pipes to the subcooling heat exchanger.

[0059] In more detail, the subcooling device 100 includes a subcooling heat exchanger 110 for heat exchange between a portion of refrigerant expanded and rest of refrigerant not expanded, a first connection pipeline 131 having the expansion device 120 for expanding the portion of refrigerant passed through a heat exchange process at the outdoor heat exchanger, and connected to the first refrigerant pipeline 21, or 61 for guiding expanded refrigerant to the subcooling heat exchanger 110, a second connection pipeline 132 for guiding the refrigerant not expanded to the subcooling heat exchanger 110, a third connection pipeline 133 for guiding the unexpanded refrigerant passed through, heat exchanged, and subcooled at the subcooling heat exchanger 110 to the distributor 20 or 60, and a fourth connection pipeline 134 for guiding the expanded refrigerant passed through, and heat exchanged at the subcooling heat exchanger to the third refrigerant pipeline connected to the suction end of the compressor 11 or 51.

[0060] The subcooling heat exchanger 110 has flow passages designed to introduce the refrigerant from the outdoor heat exchanger 12 or 52 in a plurality of paths. For this, it is preferable that the subcooling heat exchanger 110 includes a first flow pipeline 111 having one end connected to the second connection pipeline 132, and the other end connected to the third connection pipeline 133 for flow of the unexpanded high temperature refrigerant, and a second flow pipeline 112 having one end connected to the first connection pipeline 131, and the other end connected to the fourth connection pipeline 134, for heat exchange with the first flow pipeline 111, and flow of the low temperature expanded re-

frigerant.

[0061] It is preferable that the subcooling heat exchanger 110 has a double pipe structure with an inner flow pipe and an outer flow pipe on an outside of the inner flow pipe, for improving a heat exchange efficiency of the refrigerant.

[0062] In the present invention, it is preferable that the inner flow pipe is the second flow pipeline 112, and the outer flow pipe is the first flow pipeline 111, for flow of the expanded low temperature refrigerant in the inner flow pipe 112, and the high temperature refrigerant discharged from the outdoor heat exchanger 12 or 52 in the outer flow pipe 111, to prevent dew from forming on a surface of the subcooling heat exchanger 110. Of course, it is apparent that the outer flow pipe of the subcooling heat exchanger 110 can be connected to the first connection pipeline 131, and the second connection pipeline 132 can be connected to the second connection pipeline 132. However, in this instance, since the outer flow pipeline has the relatively low temperature refrigerant flowing therein, it is liable that dew is formed on the surface of the subcooling heat exchanger 110.

[0063] The subcooling heat exchanger 110 may have a variety of structures as far as the structure brings the two flow pipes 111, and 112 into contact. As one example, the subcooling heat exchanger may have a structure in which the second flow pipe winds the first flow pipe several times. Moreover, it is preferable that the two flow pipes 111, and 112 are formed of a material having a good thermal conductivity.

[0064] In order to prevent liquid refrigerant from entering into the compressor, it is preferable that the fourth connection pipeline 134 is connected to a predetermined position of the third refrigerant pipeline 23, and 63 which is connected to the inlet of the accumulator 14 or 54.

[0065] Of course, it is apparent that the fourth connection pipeline 134 can be connected to the third refrigerant pipeline 23 between the compressor 11, or 51, and the accumulator 14, or 54. Since the refrigerant is expanded to a substantially gas state, even though the refrigerant is introduced into the compressor 11, or 51, stability of the compressor 11, or 51 is not harmed much.

[0066] It is preferable that the first to fourth pipelines 131, 132, 133, and 134 are connected to the subcooling heat exchanger 110 such that the high temperature refrigerant flowing in the first flow pipeline 111 has a flow direction opposite to a flow direction of the low temperature expanded refrigerant, for enhancing a heat exchange efficiency. Of course, depending on a design condition of the subcooling heat exchanger 100, it is possible that the first to fourth pipelines 131, 132, 133, and 134 are connected to the subcooling heat exchanger 110 such that the high temperature refrigerant flowing in the first flow pipeline 111 has a flow direction opposite to a flow direction of the low temperature expanded refrigerant.

[0067] It is preferable that the inner flow pipe of the subcooling heat exchanger has a heat exchange part 113a, or 113b for making a heat exchange area larger.

[0068] In more detail, the heat exchange part 113a, or 113b are inward projections from the inner flow pipe, the second flow pipe 112, for preventing an increase of flow resistance of the refrigerant flowing along the first flow pipeline 111, and increasing a heat exchange area of the refrigerant flowing through the second flow pipeline 112.

[0069] Of course, the heat exchange part 113a, or 113b may be formed both on the inside/outside walls of the inner flow pipe, or both on the inside/outside of the inner flow pipe, and on an inside wall of the outer flow pipeline.

[0070] The heat exchange part 113a, or 113b may be formed on the inside wall surface of the inner flow pipe in a form of a ring along a circumferential direction, or as shown in FIG 4, in a form of a helix along the flow direction, or as shown in FIG 5, in a form thin, and extended along the flow direction of the refrigerant. Those structures enable to increase the thermal efficiency of the refrigerant, while decreasing a flow resistance of the expanded refrigerant.

[0071] Above forms of the heat exchange part 113a, or 113b are only a few embodiments, and it is apparent that there can be many variations of the heat exchange part 113a, or 113b.

[0072] It is preferable that the subcooling device 100 with the subcooling heat exchanger 110 is mounted on an inside of the outdoor unit 10 or 50. In more detail, a length of the first refrigerant pipeline 21 or 61 between the subcooling device 100 and the outdoor heat exchanger 12 or 52 is made shorter, to make the refrigerant from the outdoor heat exchanger 12 or 52 heat exchange, for preventing expansion of a portion of the refrigerant in the first refrigerant pipeline 21, and subcooled liquid refrigerant is supplied to the distributor 20, for minimizing pressure drop of the refrigerant at the first refrigerant pipeline 21, or 61.

[0073] It is preferable that the subcooling heat exchanger 110 has a length of 1 ~ 2.5m, for adequate heat exchange of the low temperature refrigerant expanded at the expansion device 120 on the first connection pipeline 131 and the unexpanded refrigerant flowing through the second connection pipeline at the subcooling heat exchanger 110.

[0074] Since operations of the subcooling devices 100 provided to the concurrent heating/cooling multi-type air conditioner, and the selective heating/cooling multi-type air conditioner are almost identical, the operation of the present invention will be described with reference to the concurrent heat/cooling multi-type air conditioner a majority of which indoor units 30b and 30c are in cooling mode, and a minority of which indoor units 30a are in a heating mode.

[0075] At first, when the concurrent heat/cooling multi-type air conditioner is put into operation, the refrigerant compressed to a high pressure at, and discharged

from the compressor 11 is introduced into the outdoor heat exchanger 12 by the switching device 15. The high pressure refrigerant heat exchanges with the outdoor air, and condenses as the outdoor fan 13 rotates, and discharged to the first refrigerant pipeline 21 connected to the subcooling device 100.

[0076] A portion of the refrigerant introduced into the subcooling device 100 following the first refrigerant pipeline 21 is expanded to a low temperature refrigerant by the expansion device 120 on the first connection pipeline 131, and flows through the second flow pipeline 112, rest of the refrigerant introduced into the subcooling device 100 following the first refrigerant pipeline 21 is introduced into the first flow pipeline 111 by the second connection pipeline 132, to heat transfer to each other, such that the refrigerant flowing through the first flow pipeline 111 is subcooled under an isobaric state.

[0077] Next, the refrigerant from the first flow pipeline 111 of the subcooling heat exchanger 110 is introduced into the distributor 20 through the third connection pipeline 133 and the first refrigerant pipeline 21 in an unexpanded state, guided to the indoor units 30b, and 30c through the first refrigerant branch pipelines 21b and 21c connected to the indoor units operative in the cooling mode, passes through an expansion process and heat exchange process to cool respective rooms, is drawn into the compressor 11 through the third refrigerant branch pipeline 23b, and 23c, the third refrigerant pipeline 23, and the accumulator 14.

[0078] The refrigerant from the second flow pipeline 112 of the subcooling heat exchanger 110 is introduced into the accumulator 14 guided by the fourth connection pipeline 134 and the third connection pipeline 23, separated into gaseous refrigerant and liquid refrigerant, and drawn into the compressor 11.

[0079] In the meantime, a portion of the refrigerant from the compressor 11 is introduced into the distributor 20 directly without passing through the outdoor heat exchanger 12, and introduced into the indoor unit 30a through the second refrigerant branch pipeline 22a connected to the indoor unit 30a operative in the heating mode, passes through a heat exchange process to heat the room, and joins with the refrigerant flowing through the first refrigerant pipeline following through the first refrigerant branch pipeline 21a connected to the indoor unit operative in the heating mode.

[0080] FIG 6 illustrates a P-h diagram of a refrigerating cycle of a multi-type air conditioner of the present invention.

[0081] The air conditioner of the present invention has the following advantages.

[0082] First, even if a length of the first refrigerant pipeline between the outdoor unit and the indoor unit is extensive, refrigerant pressure drop is minimized and refrigerant capability is improved owing to the subcooling device that provides subcooled refrigerant.

[0083] Second, the noise occurred at the time of expansion of the refrigerant at the expansion device of the indoor unit can be minimized owing to introduction of the subcooled high pressure refrigerant thereto.

[0084] Third, the minimized pressure drop of the refrigerant introduced into the indoor unit permits to minimize a capacity of the compressor provided to the air conditioner, enabling to save a production cost, and minimize a volume of the air conditioner.

[0085] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

Claims

1. An air conditioner comprising:

an outdoor unit installed in outdoor having a compressor, an outdoor heat exchanger;
an indoor unit installed in indoor having an indoor heat exchanger;
a distributor for guiding refrigerant from the outdoor unit to the indoor unit proper to an operation condition, and refrigerant passed through the indoor unit to the outdoor unit, again; and
a subcooling device for subcooling the refrigerant passed through a heat exchange process at the outdoor heat exchanger under an isobaric condition, and guiding the subcooled refrigerant to the distributor.

2. The air conditioner as claimed in claim 1, wherein the subcooling device makes a portion of the refrigerant passed through the heat exchange process at the outdoor heat exchanger to expand, and the expanded portion of the refrigerant to heat exchange with rest unexpanded refrigerant.

3. The air conditioner as claimed in claim 1, wherein the subcooling device includes;

a subcooling heat exchanger for making an expanded portion of the refrigerant to heat exchange with rest unexpanded refrigerant,

a first connection pipeline having an expansion device for expanding a portion of the refrigerant passed through a heat exchange process at the outdoor heat exchanger, for guiding expanded refrigerant to the subcooling heat exchanger,

a second connection pipeline for guiding unexpanded refrigerant to the subcooling heat exchanger,

a third connection pipeline for guiding unexpanded refrigerant passed through the subcooling heat exchanger to the distributor, and

a fourth connection pipeline for guiding the ex-

panded refrigerant passed through the subcooling heat exchanger to the refrigerant pipeline connected to a suction end of the compressor.

4. The air conditioner as claimed in claim 3, wherein the subcooling heat exchanger includes;

a first flow pipeline having one end connected to the second connection pipeline, and the other end connected to the third connection pipeline for flow of unexpanded refrigerant, and

a second flow pipeline having one end connected to the first connection pipeline, and the other end connected to the fourth connection pipeline for making heat exchange with the first flow pipeline, and flow of the expanded refrigerant.

5. The air conditioner as claimed in claim 4, wherein the subcooling heat exchanger has a double pipe structure.

6. The air conditioner as claimed in claim 5, wherein the second flow pipeline is provided in an inside of the first flow pipeline in a longitudinal direction.

7. The air conditioner as claimed in claim 6, wherein the refrigerant flowing through the second flow pipeline has a flow direction opposite to a flow direction of the refrigerant flowing through the first flow pipeline.

8. The air conditioner as claimed in claim 6, wherein the refrigerant flowing through the second flow pipeline has a flow direction the same with a flow direction of the refrigerant flowing through the first flow pipeline.

9. The air conditioner as claimed in claim 5, wherein the first flow pipeline is provided inside of the second flow pipeline in a longitudinal direction.

10. The air conditioner as claimed in claim 5, wherein the subcooling heat exchanger has a length of 1m ~ 2.5m.

11. The air conditioner as claimed in claim 5, wherein the subcooling heat exchanger further includes a heat exchange part on an inside wall for making a heat exchange area larger.

12. The air conditioner as claimed in claim 11, wherein the heat exchange part is projected inward from an inside wall of the inner flow pipe.

13. The air conditioner as claimed in claim 12, wherein the heat exchange part is provided on an inside wall of the inner flow pipe in a circumferential direction.

14. The air conditioner as claimed in claim 12, wherein the heat exchange part is provided on an inside wall of the inner flow pipe in a flow direction of the refrigerant.

15. The air conditioner as claimed in claim 12, wherein the heat exchange part is provided on an inside wall of the inner flow pipe in a helix.

16. The air conditioner as claimed in claim 3, wherein the expansion device is an electronic expansion valve.

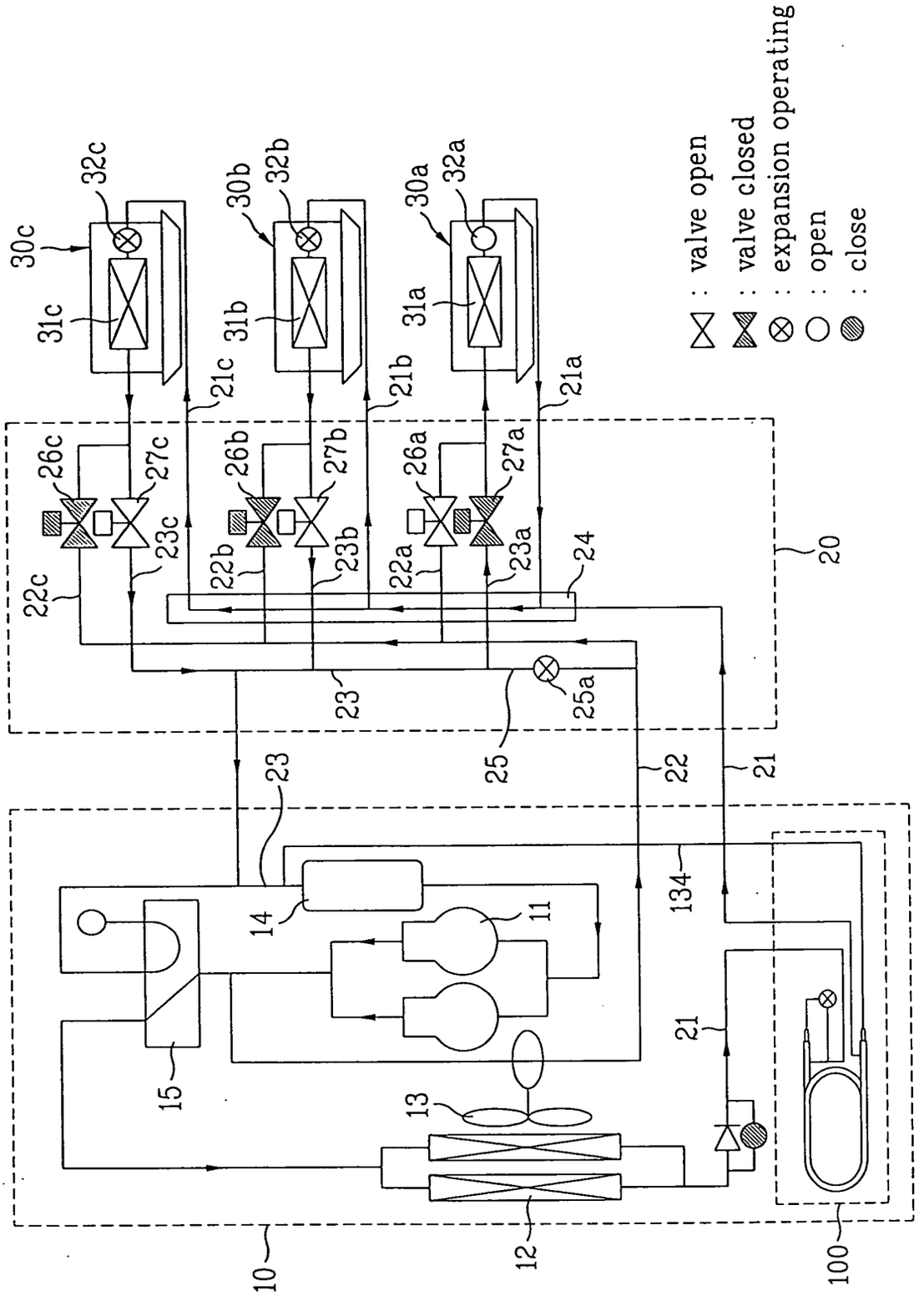
17. The air conditioner as claimed in claim 3, further comprising an accumulator on a refrigerant pipeline connected to the suction end of the compressor for separating gaseous refrigerant from liquid refrigerant.

18. The air conditioner as claimed in claim 12, wherein the fourth connection pipeline is connected to a refrigerant pipeline connected to a refrigerant inlet to the accumulator.

19. The air conditioner as claimed in claim 1, wherein the subcooling device is provided to a predetermined position of an inside of the outdoor unit.

20. The air conditioner as claimed in claim 1, wherein the outdoor unit further includes a switching device for switching a flow direction of the refrigerant from the compressor to the outdoor heat exchanger or the distributor selectively proper to an operation condition.

FIG.1


: valve open
: valve closed
: expansion operating
: open
: close
10
11
12
13
14
15
20
21
21a
21b
21c
22
22a
22b
22c
23
23a
23b
23c
24
25
25a
26a
26b
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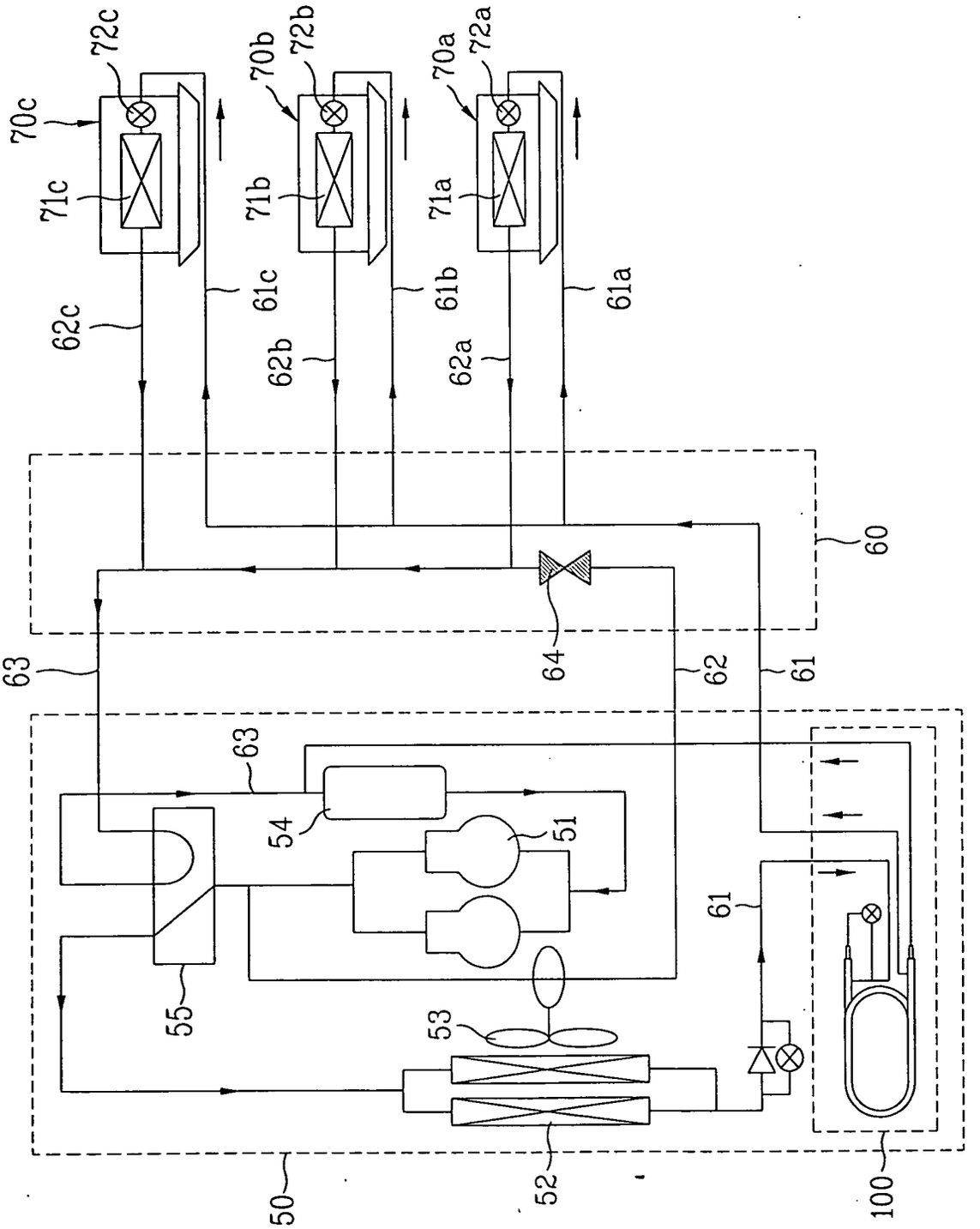
30b
30c
31a
31b
31c
32a
32b
32c
100
134


70c
72c
71c
70b
72b
71b
70a
72a
71a
62c
61c
62b
61b
62a
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51
55
53
52
50
100

FIG. 2

FIG. 3

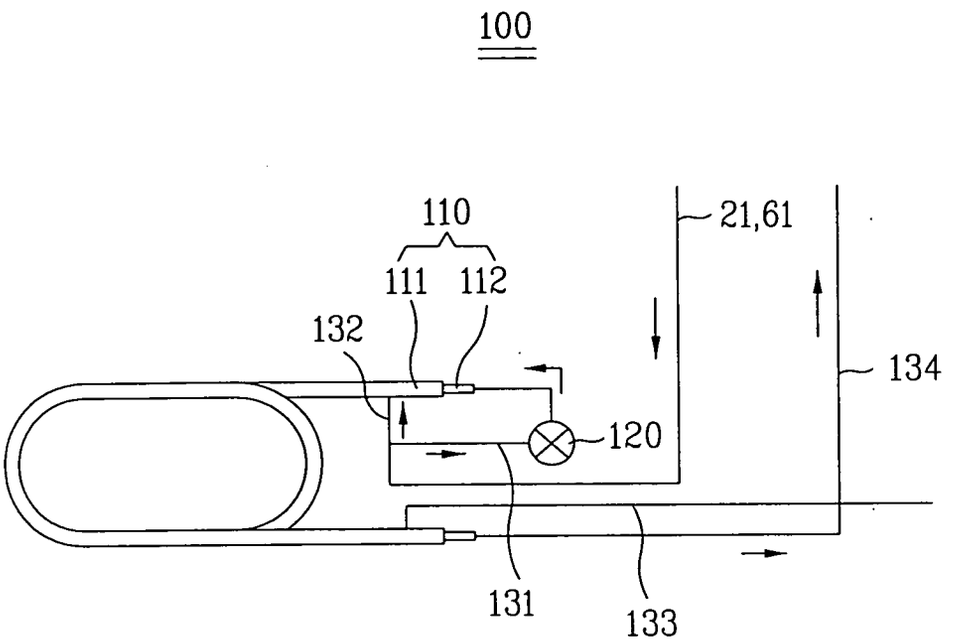


FIG. 4

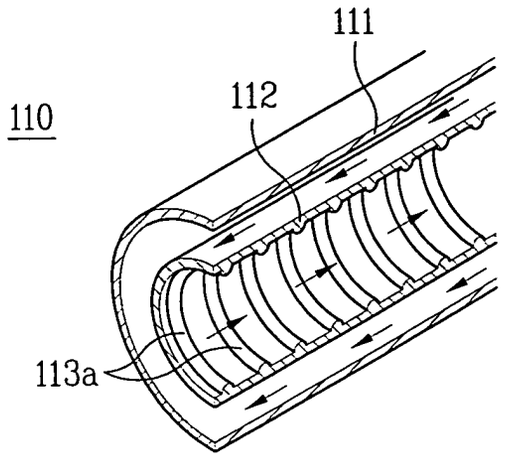


FIG. 5

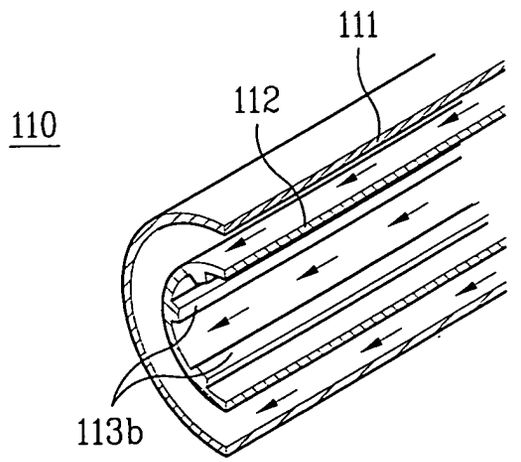
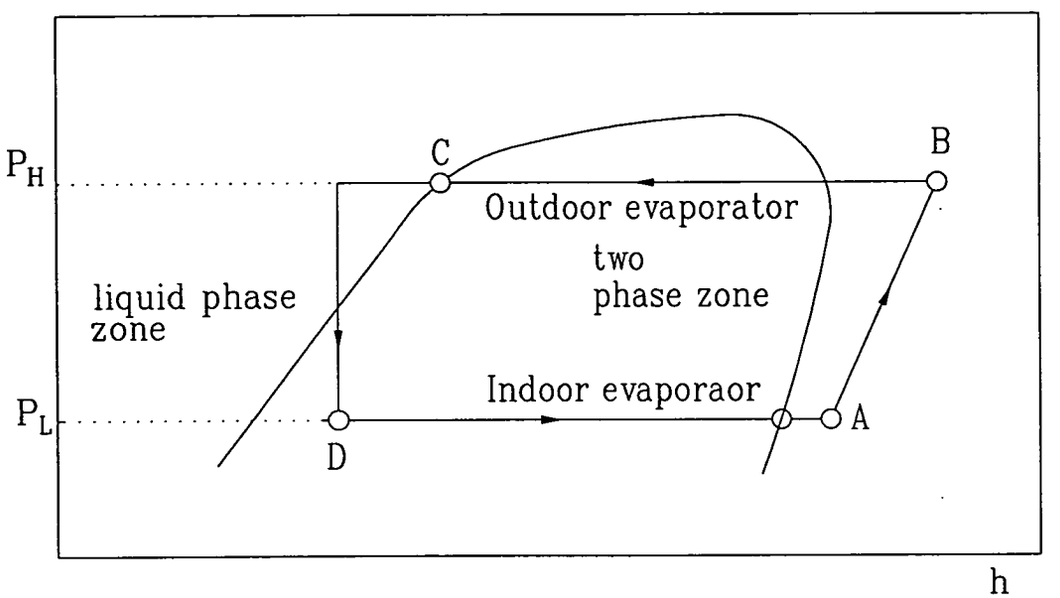


FIG. 6


P_H
P_L
C
B
A
D
Outdoor evaporator
two
phase zone
liquid phase
zone
Indoor evaporaor
h

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 01 8471

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X Y	EP 0 496 505 A (MITSUBISHI DENKI KABUSHIKI KAISHA) 29 July 1992 (1992-07-29)	1-4 5-7	F25B13/00 F25B40/02 F24F3/06
X	EP 1 162 414 A (YANMAR DIESEL ENGINE CO. LTD) 12 December 2001 (2001-12-12) * paragraphs [0025], [0026]; figures 1,12-18 *	1-4	
X	US 4 760 707 A (DENNIS ET AL) 2 August 1988 (1988-08-02) * column 6, line 52 - column 7, line 40; figure 2 *	1	
P,X	EP 1 437 555 A (LG ELECTRONICS INC) 14 July 2004 (2004-07-14) * claims 1-18; figures 2a,4a,4b *	1-6,8	
Y	EP 0 855 562 A (DAIKIN INDUSTRIES, LIMITED) 29 July 1998 (1998-07-29) * column 5, lines 3-51; figures 1,4a *	5-7	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

F25B
F24F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	9 May 2005	Lienhard, D

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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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09-05-2005

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0496505 A	29-07-1992	AU 634111 B2	11-02-1993
		AU 1004792 A	23-07-1992
		AU 656064 B2	19-01-1995
		AU 3680893 A	24-06-1993
		AU 656063 B2	19-01-1995
		AU 3680993 A	24-06-1993
		DE 69201968 D1	18-05-1995
		DE 69201968 T2	23-11-1995
		EP 0496505 A2	29-07-1992
		ES 2074817 T3	16-09-1995
		JP 2944507 B2	06-09-1999
		JP 8291951 A	05-11-1996
		JP 2875507 B2	31-03-1999
		JP 8291952 A	05-11-1996
		JP 2875665 B2	31-03-1999
		JP 5231749 A	07-09-1993
		US 5309733 A	10-05-1994
		US 5388422 A	14-02-1995
		US 5237833 A	24-08-1993
EP 1162414 A	12-12-2001	JP 2000234818 A	29-08-2000
		JP 2000283583 A	13-10-2000
		JP 2000283598 A	13-10-2000
		JP 2000304374 A	02-11-2000
		EP 1162414 A1	12-12-2001
		WO 0049346 A1	24-08-2000
US 4760707 A	02-08-1988	JP 62080457 A	13-04-1987
EP 1437555 A	14-07-2004	CN 1517609 A	04-08-2004
		EP 1437555 A2	14-07-2004
		JP 2004219046 A	05-08-2004
		US 2004134215 A1	15-07-2004
EP 0855562 A	29-07-1998	JP 10054616 A	24-02-1998
		AU 727320 B2	07-12-2000
		AU 3783297 A	06-03-1998
		DE 69726107 D1	18-12-2003
		DE 69726107 T2	26-08-2004
		EP 0855562 A1	29-07-1998
		HK 1009682 A1	04-06-2004
		US 6164086 A	26-12-2000
		ES 2210549 T3	01-07-2004
		WO 9806983 A1	19-02-1998
		PT 855562 T	31-03-2004

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82