



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
09.03.2005 Bulletin 2005/10

(51) Int Cl.7: **F25B 13/00, F25B 40/00**

(21) Application number: **04077404.4**

(22) Date of filing: **25.08.2004**

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IT LI LU MC NL PL PT RO SE SI SK TR**
Designated Extension States:
AL HR LT LV MK

(30) Priority: **05.09.2003 KR 2003062111
15.09.2003 KR 2003063664
05.11.2003 KR 2003077857**

(71) Applicant: **LG Electronics Inc.
Seoul 150-875 (KR)**

(72) Inventors:
• **Ki Soo Hong, 2-615 Jeongwoo APT.
Anyang-si, Gyeonggi-do (KR)**

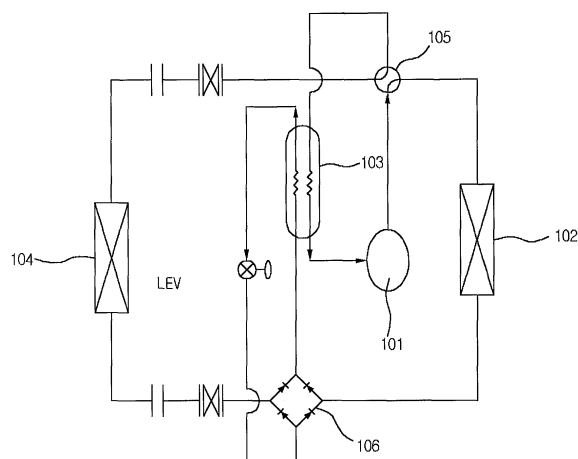
• **Sim Won Chin
Gwangmyeong-si, Gyeonggi-do (KR)**
• **Dong Su Moon
Seoul (KR)**
• **Jung Woo LEE
Seoul (KR)**
• **In Hwa Jung
Seoul (KR)**

(74) Representative: **Schlossman, Ulf
Albihns Göteborg AB
P.O. Box 142
401 22 Göteborg (SE)**

(54) **Air conditioner comprising heat exchanger and means for switching cooling cycle**

(57) The present invention relates to an air conditioner capable of performing heat exchange of refrigerant and cooling and heating operations. According to the invention, a dual-tube heat exchanger is disposed at the entrance of a compressor and a means for switching a cooling cycle is installed between an outdoor heat exchanger including a condenser and an indoor heat exchanger including an evaporator so that in an air conditioning mode, heat change between mid-temperature, high-pressure liquid refrigerant at the exit of the condenser and low-temperature, low-pressure superheated refrigerant at the exit of the evaporator is performed more effectively and as a result of this, super heating of the liquid refrigerant at the exit of the condenser is increased, refrigerant flow characteristics of an expansion unit are improved, and enthalpy at the entrance side of the evaporator is reduced, causing a greater enthalpy difference at the entrance and exit of the evaporator and improving air conditioning capacity overall. Moreover, the heat exchanger of the present invention has a dual tube structure and uses a counter flow or parallel flow for performing heat exchange. In the dual tube structure, a tube and a core of the heat exchanger form a line or surface contact and heating capacity is therefore enhanced.

Fig.10



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates in general to an air conditioner capable of performing heat exchange of refrigerant and cooling and heating operations. More particularly, the present invention relates to an air conditioner in which a dual-tube heat exchanger is disposed at the entrance of a compressor and a means for switching a cooling cycle is installed between an outdoor heat exchanger including a condenser and an indoor heat exchanger including an evaporator so that in an air conditioning mode, heat change between mid-temperature, high-pressure liquid refrigerant at the exit of the condenser and low-temperature, low-pressure superheated refrigerant at the exit of the evaporator is performed more effectively and as a result of this, super heating of the liquid refrigerant at the exit of the condenser is increased, refrigerant flow characteristics of an expansion unit are improved, and enthalpy at the entrance side of the evaporator is reduced, causing a greater enthalpy difference at the entrance and exit of the evaporator and improving air conditioning capacity overall.

[0002] In addition, the heat exchanger of the present invention has a dual tube structure and uses a counter flow or parallel flow for performing heat exchange. In the dual tube structure, a tube and a core of the heat exchanger form a line or surface contact and heating capacity is therefore enhanced.

2. Discussion of the Background Art

[0003] In general, the main function of an indoor air conditioning/heating machine, for example an air conditioner or a heat pump, is to maintain a desired indoor temperature regardless of the outside temperature.

[0004] Since the indoor temperature is set up as desired, a comfortable dwelling environment is created.

[0005] Fig. 1 illustrates a refrigeration cycle according to a related art.

[0006] As shown in Fig. 1, a refrigeration unit includes a compressor 1 for changing low-temperature, low-pressure vapor refrigerant to high-temperature, high-pressure vapor refrigerant; a condenser 2 for changing the high-temperature, high-pressure vapor refrigerant from the compressor 1 to mid-temperature, high-pressure liquid refrigerant; and an expansion valve 13 for changing the mid-temperature, high-pressure liquid refrigerant from the condenser 12 to low-temperature, low-pressure liquid refrigerant; and an evaporator 4 for changing the phase of the low-temperature, low-pressure liquid refrigerant to vapor and absorbing heat of the outside. Here, each component is connected to each other through a refrigerant tube.

[0007] The refrigeration unit absorbs heat of the out-

side through the evaporator and extracts heat outdoors through the condenser. Because of this, the refrigeration unit is often applied to a refrigerator or an air conditioner for purpose of keeping food fresh or providing cool (warm) comfort by air conditioning/heating indoor.

[0008] Fig. 2 illustrates a cooling cycle of an air conditioner according to a related art.

[0009] As shown in Fig. 2, low-temperature, low-pressure vapor refrigerant flown in a compressor 1 from an indoor heat exchanger 4 is compressed to high-temperature, high-pressure vapor refrigerant through the operation of the compressor 1, and at the same time, is discharged to an outdoor heat exchanger 2 through a four-way valve 5 that is switched for activating the cooling cycle. The refrigerant discharged to the outdoor heat exchanger 2 circulates inside the outdoor heat exchanger 2 and experiences heat exchange with outdoor air sucked in the outdoor heat exchanger through an outdoor fan 7. As a result of this, the refrigerant undergoes a phase change and becomes mid-temperature, high-pressure liquid refrigerant.

[0010] The phase-changed refrigerant is discharged to an expansion valve 3 and simultaneously circulates inside of the expansion valve 3 where the refrigerant is compressed to low-temperature, low-pressure liquid refrigerant to be more easily evaporated, and is discharged to the indoor heat exchanger 4. The refrigerant discharged to the indoor exchanger 4 experiences heat exchange with ambient air of the indoor heat exchanger and undergoes again a phase change to become low-temperature, low-pressure vapor state and then flows back into the compressor 1 through the four-way valve 5.

[0011] Therefore, the ambient air that underwent heat exchange in the indoor heat exchanger 4 with the compressed refrigerant through the expansion valve 3 loses its heat to the refrigerant and becomes noticeably chilly. This cold air is sucked in to the inside through the indoor fan 6 and thus, the cooling cycle of the air conditioner ends.

[0012] Fig. 3 illustrates a heating cycle of an air conditioner according to a related art.

[0013] As shown in Fig. 3, the heating cycle is opposite to the cooling cycle described before. That is, low-temperature, low-pressure vapor refrigerant flown in a compressor 1 from an outdoor heat exchanger 2 is compressed to high-temperature, high-pressure vapor refrigerant through the operation of the compressor 1 and at the same time, is discharged to an indoor heat exchanger 4 through a switched four-way valve 5. In the indoor heat exchanger 4, the vapor refrigerant experiences heat exchange with ambient air of the indoor heat exchanger 4 and undergoes a phase change and becomes mid-temperature, high-pressure liquid state and is charged to an expansion valve 3. At this time, the ambient air that experienced heat exchange with the high-temperature, high-pressure refrigerant changes to hot air by taking heat from the refrigerant and is sucked into

the inside through an indoor fan 6, resultantly raising the indoor temperature.

[0014] Further, the refrigerant discharged to the expansion valve 14 is compressed to low-temperature, low-pressure liquid state to be evaporated better in the outdoor heat exchanger 2 and then is discharged to the outdoor heat exchanger 2. In the outdoor heat exchanger 2 the refrigerant experiences heat exchange with outdoor air flown in the outdoor heat exchanger and undergoes a phase change and becomes low-temperature, low-pressure vapor state. At the end, this phase changed refrigerant flows back into the compressor 1 through the four-way valve.

[0015] Fig. 4 is a schematic diagram illustrating an air conditioning/heating device according to a related art.

[0016] As illustrated in Fig. 4, in operation of the air conditioning device, a refrigerant gas discharged from a compressor 1 is separated from oil through an oil separator 8, and this oil-free refrigerant gas flows in an outdoor heat exchanger 2 via a four-way valve 5 and becomes low-temperature, low-pressure refrigerant while passing through an expansion valve and then flows in an indoor heat exchanger 4.

[0017] The refrigerant gas evaporated in the indoor heat exchanger 4 experiences heat exchange with indoor air and flows in an accumulator 9 through the four-way valve 5. This refrigerant gas in the accumulator 9 is sucked in the compressor 1 and circulates therein continuously.

[0018] On the other hand, in operation of the heating device, a refrigerant gas discharged from the compressor 1 is separated from oil through the oil separator 8. This oil-free refrigerant gas flows in the indoor heat exchanger 4 via the four-way valve 5 and is condensed, experiencing heat exchange with indoor air. Later, the refrigerant travels in the expansion valve and changes to low-temperature, low-pressure state and is evaporated while passing through the outdoor heat exchanger 2.

[0019] The evaporated refrigerant gas flows in the accumulator 9 via the four-way valve 5. Then the refrigerant is sucked in the compressor 1 and circulates therein.

[0020] Fig. 5 illustrates a dual-tube heat exchanger of an air conditioner according to a related art.

[0021] The air conditioner of Fig. 5 is characterized of having a dual-tube heat exchanger 10 between a condenser 1 (outdoor heat exchanger) and an expansion unit 3.

[0022] A compressed refrigerant through a compressor 1 is transferred to the outdoor heat exchanger 2 and experiences heat exchange with outdoor air in the outdoor heat exchanger 2 and also in the dual-tube heat exchanger 10. Then the refrigerant flows in an evaporator 4 (indoor heat exchanger) via an expansion unit 3.

[0023] Through heat exchange with indoor air, the indoor temperature maintains a pre-set low temperature and later, the refrigerant experiences heat exchange while traveling in the dual-tube heat exchanger 10. Then, the refrigerant flows back into the compressor 1

and recirculates therein.

[0024] In the dual-tube heat exchanger, the refrigerant flow of the expansion unit changes depending on how to increase sub cooling of the outdoor heat exchanger and characteristics of the refrigerant flow are also subject to enthalpy difference at the entrance and exit of the evaporator, which in turn affects the entire system efficiency, e.g., the coefficient of performance (COP) of the air conditioner. Also, for this type of heat exchanger, preventing liquid from entering the compressor is influenced by a method for increasing super heating at the entrance of the compressor, and the temperature increase at the entrance of the compressor has a great impact on the performance of the heat exchanger at high speed.

[0025] The following will now explain relevant techniques for the heat exchanger.

[0026] Fig. 6 illustrates a related art liquid-vapor heat exchanger.

[0027] Referring to Fig. 6, the liquid/vapor heat exchanger 2 includes a first tube 11 inside and a second tube 12 outside, two being connected as a dual-tube type. One end of the first tube 11 is connected to an entrance P1 of an evaporator 13 and the other end is connected to an entrance P2 of a compressor 14. Thus low-temperature, low-pressure vapor is sucked in the heat exchanger 2 and experiences heat exchange with liquid flowing into the second tube 12 and then is transferred to the compressor 14.

[0028] That is, the first tube 11 is connected to the entrance P1 of the evaporator and the entrance P2 of the compressor and low-temperature, low-pressure vapor runs therein. The second tube 12, on the other hand, is connected to an entrance P3 of a condenser 15 and an entrance P4 of an expansion valve 16 and the refrigerant flowing inside the first tube 12 and mid-temperature, high-pressure liquid as counter flow (or parallel flow) runs therein, consequently changing the low-temperature vapor in the first tube to mid-temperature liquid.

[0029] Fig. 7 and Fig. 8 illustrate a related art liquid-vapor heat exchanger 2.

[0030] As shown in Figs. 7 and 8, a radial shaped core 17 is inserted in an inner space 11a of a first tube 11 to perform heat exchange on a refrigerant flowing inside the first tube 11.

[0031] As the name implies, the core 17 inserted into the first tube 11 has a radial shape, that is, a plurality of pins is separated by a constant angle from the center and each pin is protruded perpendicularly.

[0032] However, each of the pins of the core 17 is in line contact with the internal circumferential surface of the first tube 11, so heating efficiency thereof is pretty low and it is difficult to manufacture the core itself.

[0033] Meanwhile, inside surface 12a of the second tube 12 runs mid-temperature, high-pressure liquid.

[0034] Fig. 9 illustrates another embodiment of a related art liquid-vapor heat exchanger 2.

[0035] As shown in Fig. 9, there is a wave-shaped

("~" shape) tube 18 between a first tube 11 and a second tube 12, to improve heat exchange between liquid flowing into the second tube and a refrigerant flowing into the first tube 11. Other reference numerals shown in Fig. 9 correspond to those in Fig. 6.

[0036] Unfortunately this type of heat exchanger also poses a problem like low heating performance.

SUMMARY OF THE INVENTION

[0037] An object of the invention is to solve at least the above problems and/or disadvantages and to provide at least the advantages described hereinafter.

[0038] Accordingly, one object of the present invention is to solve the foregoing problems by providing a structure, in which a dual-tube heat exchanger is disposed at an entrance of a compressor and a refrigerant flow switching unit is disposed between an indoor heat exchanger and an outdoor heat exchanger, thereby improving refrigerant flow of an expansion unit by increasing super heating of the outdoor heat exchanger and by increasing enthalpy increase at an entrance of an evaporator.

[0039] Another object of the present invention is to prevent liquid from entering a compressor by increasing super heating at the entrance of the compressor and prevent temperature increase at the entrance of the compressor.

[0040] Another object of the invention is to provide a liquid-vapor heat exchanger including a core that is in surface contact with the internal circumferential surface of an inner or outer tube of the liquid-vapor heat exchanger.

[0041] Another object of the invention is to provide a dual-tube liquid-vapor heat exchanger, in which a vapor refrigerant flows in an inside or outside tube and liquid flows in an outside or inside tube as counter flow or parallel flow for heat conversion between the vapor refrigerant and the liquid and heating performance is greatly improved by a radial shaped or sector-shaped core inserted into the inside or outside tube.

[0042] Another object of the invention is to provide to a liquid-vapor heat exchanger capable of enhancing heating performance by employing a sector-shaped to be expanded by expansion tube to the center of a sector-shaped core, thereby causing the core to be in surface contact with a tube.

[0043] Another object of the invention is to provide to a liquid-vapor heat exchanger, in which an inside or outside tube is split in a longitudinal direction into at least one area and a section-shaped core is connected to each area in zigzags.

[0044] Another object of the invention is to provide a liquid-vapor heat exchanger with an improved heating capacity, in which a spiral-shaped internal core with folded surfaces is installed in the tube and fluid vortex generated by the folded surfaces of the internal core inside the first tube activates heat exchange between the out-

side surface of the internal core and the internal circumferential surface of the first tube.

[0045] The foregoing and other objects and advantages are realized by providing an air conditioner including a condenser; an evaporator; a compressor; a means for switching a flow line of refrigerant discharged from the compressor; and a heat exchange means for performing heat exchange disposed before the compressor.

[0046] According to another aspect of the invention, an air conditioner includes: a condenser; an evaporator; a compressor; a means for switching a refrigerant line; a heat exchange means for performing heat exchange disposed before the compressor; and check valve or four-side as a separate means for switching a flow line of refrigerant discharge from the condenser or evaporator and making the flow line pass through the heat exchanger.

[0047] According to another aspect of the invention, an air conditioner includes: a condenser; an evaporator; a compressor; and a heat exchange means for performing heat exchange disposed before the compressor, wherein at least two refrigerant flow lines are formed in the heat exchanger and a means for heat transfer between refrigerants flowing in the refrigerant flow lines forms a certain area of surface contact.

[0048] According to another aspect of the invention, a refrigerant flow line includes: a first tube where a first refrigerant flows in; a second tube where a second refrigerant flows in; and a means connected to the first tube or the second tube and forming a certain area of surface contact with the first tube or the second tube.

[0049] According to another aspect of the invention, an expansion tube is connected in the longitudinal direction to the center of the core in order to expand the surface contact between the first tube or the second tube and the sector-shaped tube.

[0050] According to another aspect of the invention, a spiral-shaped core is connected to a first tube where a first refrigerant flows in and to a second tube where a second refrigerant flows in, and forms a line or surface contact with the internal circumferential surface of the first tube or the second tube.

[0051] According to the present invention, increasing sub cooling of the outdoor heat exchanger increases refrigerant flow of the expansion unit, improves refrigerant flow characteristics in dependence of enthalpy difference at the entrance and exit of the evaporator and thus, enhances the total efficiency of the system. Increasing super heating at the entrance of the compressor prevents liquid (or fluid) from entering into the compressor, prevents temperature increase at the entrance of the compressor and thus, ensures excellent performance even at high speed operation.

[0052] Also, by connecting the easy-to-manufacture, sector-shaped core to the inside of the tube where vapor refrigerant flows, surface contact is formed between the core and the tube surface and this in turn improves heating performance of the refrigerant that is changed to liq-

uid-vapor phase through the surface contact with the tube surface.

[0053] Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objects and advantages of the invention may be realized and attained as particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0054] The invention will be described in detail with reference to the following drawings in which like reference numerals refer to like elements wherein:

[0055] Fig. 1 illustrates a refrigeration cycle according to a related art;

[0056] Fig. 2 illustrates a cooling cycle of an air conditioner according to a related art;

[0057] Fig. 3 illustrates a heating cycle of an air conditioner according to a related art;

[0058] Fig. 4 is a schematic diagram illustrating an air conditioning/heating device according to a related art;

[0059] Fig. 5 illustrates a dual-tube heat exchanger in an air conditioner according to a related art;

[0060] Fig. 6 illustrates a related art liquid-vapor heat exchanger;

[0061] Fig. 7 and Fig. 8 illustrate one embodiment of a related art liquid-vapor heat exchanger;

[0062] Fig. 9 illustrates another embodiment of a related art liquid-vapor heat exchanger;

[0063] Fig. 10 is a schematic diagram of a heat exchanger of the present invention, in which a check valve is used as a cooling cycle switch unit;

[0064] Fig. 11 is a schematic diagram of a heat exchanger of Fig. 10 of the present invention, in which a four-way valve is used as a cooling cycle switch unit;

[0065] Fig. 12 is a schematic diagram of a heat exchanger of Figs. 10 and 11, in which neither check valve nor four-way valve is mounted;

[0066] Fig. 13 is a perspective view of a liquid-vapor heat exchanger according to one embodiment of the present invention;

[0067] Fig. 14 is an exploded view of a liquid-vapor heat exchanger according to one embodiment of the present invention;

[0068] Fig. 15 illustrates a complete form of a liquid-vapor heat exchanger according to one embodiment of the present invention;

[0069] Fig. 16 is a cross-sectional view of a liquid-vapor heat exchanger according to one embodiment of the present invention;

[0070] Figs. 17, 18, 19, and 20 illustrate a liquid-vapor heat exchanger, respectively, according to another embodiment of the present invention;

[0071] Fig. 21 and Fig. 22 are perspective exploded views of a liquid-vapor heat exchanger of Fig. 20; and

[0072] Fig. 23 illustrates a ph diagram.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0073] The following detailed description will present an air conditioner comprising a heat exchanger and a means for switching a cooling cycle according to a preferred embodiment of the invention in reference to the accompanying drawings.

[0074] Fig. 10 is a schematic diagram of a heat exchanger of the present invention, in which a check valve is used as a cooling cycle switch unit; Fig. 11 is a schematic diagram of the heat exchanger of Fig. 10 of the present invention, in which a four-way valve instead of the check valve is used as a cooling cycle switch unit; and Fig. 12 is a schematic diagram of the heat exchanger of Figs. 10 and 11, in which neither check valve nor four-way valve is mounted.

[0075] Referring to the Figs. 10, 11 and 12, the air conditioning/heating device includes an indoor heat exchanger, an outdoor heat exchanger, a four-way valve and a compressor for compressing refrigerant. More specifically, a dual-tube heat exchanger 103 is disposed at the entrance of the compressor 101 and refrigerant flow switch units 105, 106 are connected between the indoor heat exchanger 104 and the outdoor heat exchanger 102 to perform more effective heat exchange during the air conditioning/heating operation. Also, when the cooling and heating cycles are switched, the refrigerant flows to a fixed direction at the entrance and exit of the dual-tube heat exchanger 103.

[0076] Particularly, the air conditioning/heating device of Fig. 10 is characterized of having a check valve 106 with a plurality of valves as the refrigerant flow switch unit, while the air conditioning/heating device of Fig. 11 is characterized of having a four-way valve 107 instead of the check valve as the refrigerant flow switch unit.

[0077] The following will not discuss the operation of the air conditioning/heating device mounted with the dual-tube heat exchanger 103 and the refrigerant flow switch unit.

[0078] During the air conditioning operation, mid-temperature, high-pressure liquid refrigerant at the exit of a condenser experiences heat exchange with low-temperature, low-pressure super heated refrigerant at the exit of an evaporator, and as a result of this, sub cooling of the liquid refrigerant at the exit of the condenser is increased and a refrigerant flow characteristic of an expansion unit is improved.

[0079] In other words, the greater sub cooling is, the more refrigerant flow increases, and the lower the enthalpy at the entrance of the evaporator becomes, making a bigger difference with the enthalpy at the entrance and exit of the evaporator, which consequently enhances air conditioning performance.

[0080] During the heating operation, mid-temperature, high-pressure liquid refrigerant at the exit of a con-

denser experiences heat exchange with low-temperature, low-pressure super heated refrigerant at the exit of an evaporator, and as a result of this, super heating at the entrance of the compressor is increased and there is less possibility for liquid to enter the compressor. Therefore, driving reliability of the compressor is improved.

[0081] More specifically, refrigerant at the entrance of the evaporator experiences heat exchange with super heated refrigerant at the exit of the evaporator, and as a result of this, super heating at the entrance of the compressor, namely the exit of the evaporator, is reduced and compression characteristics of the compressor are enhanced. Particularly, by reducing super heating at the entrance of the compressor during high frequency (Hz) operation, it becomes possible to prevent super heating of the exit of the compressor.

[0082] Fig. 12 is a schematic diagram of the heat exchanger of Figs. 10 and 11, in which neither check valve nor four-way valve is mounted.

[0083] As depicted in Fig. 12, a dual-tube heat exchanger 103 is installed between a four-way valve and the entrance of a compressor 101 so that mid-temperature, high-pressure liquid refrigerant at the exit of a condenser experiences heat exchange with low-temperature, low-pressure super heated refrigerant at the exit of an evaporator. In consequence, sub cooling of the liquid refrigerant at the exit of the condenser is increased and thus, the refrigerant flow characteristic of an expansion unit is improved.

[0084] In other words, the greater sub cooling is, the more refrigerant flow increases, and the lower the enthalpy at the entrance of the evaporator becomes, making a bigger difference with the enthalpy at the entrance and exit of the evaporator, which consequently enhances air conditioning performance.

[0085] Although the structure of Fig. 12 is simple, heat exchange effect in heating mode is extremely low, compared to the one in air conditioning mode.

[0086] Fig. 13 is a perspective view of a liquid-vapor heat exchanger according to one embodiment of the present invention; Fig. 14 is an exploded view of the liquid-vapor heat exchanger of the present invention; Fig. 15 illustrates a complete form of a liquid-vapor heat exchanger of the present invention; Fig. 16 is a cross-sectional view of the liquid-vapor heat exchanger of the present invention; and Figs. 17, 18, 19, and 20 illustrates a liquid-vapor heat exchanger, respectively, according to another embodiment of the present invention.

[0087] Referring to Figs. 13 through 16, the liquid-vapor heat exchanger includes a first tube 108 having an entrance and an exit 111, 110, wherein low-temperature, low-pressure vapor refrigerant flows; a second tube 109 having an entrance and an exit 113, 112 and disposed outside of the first tube 108, wherein mid-temperature, high-pressure liquid refrigerant flows as counter flow to heat the vapor refrigerant flowing inside the first tube 108; a sector-shaped core 130 housed in the first tube

108; and an expansion tube 114 inserted into the center of the core 130 to ensure that outside of the end portion of the core 130 is tightly fitted to outside surface of the first tube 108.

[0088] Here, the expansion tube 114 has jaws 119 on both ends, respectively, each with an inward nose projection as shown in Fig. 16, and is connected to the core 130 as one body.

[0089] The operation of the liquid-vapor heat exchanger with the above constitution will be now explained with reference to drawings.

[0090] Referring to Figs. 13, 14 and 15, the internal first tube 108 and the external second tube 109 form a dual tube in the longitudinal direction. The first tube 108 is connected to the exit P1 of the evaporator 110 and performs heat exchange on the low-temperature, low-pressure vapor refrigerant from the evaporator and sends it to the entrance P2 of the compressor 111.

[0091] At this time, the mid-temperature, high-pressure liquid flowing in the second tube 109 as counter flow or parallel flow heats up the vapor refrigerant through the core formed inside the first tube 108, thereby raising the vapor temperature inside of the first tube 108 and increasing the pressure of the vapor.

[0092] Therefore, to improve heating performance of the first tube 108, there sits a heating means at the internal space of the first tube 110 in a manner that the heating means makes a partial surface contact in the longitudinal direction. The sector-shaped core 130 is a good example of the heating means.

[0093] As illustrated in Figs. 14, 15 and 16, the core has a sector shape, that is, a vertical side and a horizontal side 118, 119 are connected to each other in an equilateral triangle shape, forming a sector shape.

[0094] More specifically, to connect neighboring vertical sides 118, an upper horizontal long side 117 and a lower short horizontal side 116 are successively connected to the vertical side 118 in zigzags. Also, by applying the short horizontal side 116 at the center as an origin, the long horizontal side 117 at the end is spread out in a sector shape.

[0095] Here, the long horizontal side 117 at the end of the core forms surface contact with the internal circumferential surface of the first tube 108, thereby improving the heating performance of the vapor refrigerant.

[0096] Also, to make the long horizontal side 117 at the end be closely adhered to the internal circumferential surface of the first tube 108, the expansion tube 114 passing through the inside of the short horizontal side 116 at the center of the core is connected in the longitudinal direction.

[0097] Referring to Figs. 14 through 16, the expansion tube 114 is longitudinally inserted into the center of the sector-shaped core 130 that is connected to the internal space 110 of the first tube 108.

[0098] Since the expansion tube 118 is inserted into the core, the center of the core is expanded so that the

entire core is pushed to the outside of the first tube 108 and the long horizontal side 117 is closely adhered to the inner surface of the tube.

[0099] Inside of the expansion tube 114 is opened, and its radius is preferably larger than the radius (or distance) from the center of the core to the short horizontal side 116.

[0100] Therefore, the expansion tube 114, the sector-shaped core 130, and the first tube 108 are adhered in sequence to the inner surface of the first tube 108.

[0101] In the above embodiment, the expansion tube 114 can be a longitudinal tube or have another structure in which its inside is opened and the core is expanded outward.

[0102] Both ends of the expansion tube 114, as shown in Fig. 16, are the jaws 119, and each jaw is hooked on both ends of the short horizontal side 116 of the core 130 to ensure that the core 130 and the expansion tube 114 are tied up together.

[0103] The jaws 119 on the both ends of the expansion tube 114 are protruded to connect the cores.

[0104] According to another embodiment, a plurality of expansion tubes, each with a screw at the center, can be connected to the jaws and they are hammered later, or the jaws are spaced apart for the core to be inserted into grooves between the jaws and the short horizontal side.

[0105] Fig. 17 illustrates a liquid-vapor heat exchanger 200 according to another embodiment of the present invention.

[0106] As shown in Fig. 17, a first tube 109 is divided into three areas d1, d2, d3, and sector-shaped cores 130, 120, 121 are inserted thereto, respectively, according to their sizes.

[0107] The above method is effective especially when it is difficult to insert a single core in the longitudinal direction.

[0108] In this embodiment, those three cores 130, 120, 121 are connected in zigzags to the direction where refrigerant flows. Hence, the contact area, namely resistance, between the vertical side of the core and the refrigerant, is increased.

[0109] At the center of those three cores 130, 120, 121 is connected to at least one expansion tube 114 based on the above-described method, and the sector-shaped cores 130, 120, 121 are expanded to the outside to form surface contact with the internal circumferential surface of the first tube 108.

[0110] As for one embodiment, the first core 121, the second core 120, and the third core 130 are connected in zigzags inside of the first tube 108, and one single expansion tube 114 is inserted into the inside.

[0111] Accordingly, vapor refrigerant passing through the first tube 121 is heated up and compressed by liquid inside of the second tube 120, the first core 130, the second core 120, the third core 121, and the expansion tube 114.

[0112] Another embodiment suggests that a variety of

shapes and structures are possible so that at least one sector-shaped core can be connected to the inside of the first tube to have at least one tube or no tube at all.

[0113] Fig. 18 illustrates a radial wave shaped core 122 as a modification of the radial core of Fig. 14.

[0114] As shown in Fig. 18, low-temperature, low-pressure liquid flowing in a first tube is faced with the wave shaped core and as a result of this, resistance and fluid vortex are created, whereby heat conductivity with high-temperature, high-pressure liquid in a second tube can be increased.

[0115] Fig. 19 illustrates that a core 123 is housed in a second tube, different from the structure shown in Fig. 14 where a core 130 is housed in a first tube for heat transfer. Whether the core is in the first tube or second tube, its operational characteristics are same.

[0116] Fig. 20 is a side cross-sectional view of a liquid-vapor heat exchanger according to another embodiment of the present invention, and Figs. 21 and 22 are exploded perspective view of the liquid-vapor heat exchanger shown in Fig. 20.

[0117] As shown in Fig. 20, a dual-tube liquid-vapor heat exchanger 102 is provided, a first tube 108 being inside and a second tube 109 being outside. One side of the first tube 108 in the second tube 109 is connected to the exit 110 of an evaporator and the other side thereof is connected to the entrance 111 of a compressor, thereby sucking in low-temperature, low-pressure vapor and changing heat with liquid flowing in the second tube 109 before sending it to the compressor.

[0118] As described above, the first tube 108 is connected to the exit of the evaporator and to the entrance of the compressor, and the low-temperature, low-pressure vapor refrigerant flows therein. On the other hand, the second tube 109 outside of the first tube 108 is connected to the exit of a condenser and to the entrance of an expansion valve. Inside the second tube is mid-temperature, high-pressure liquid as counter flow or parallel flow of the refrigerant flowing in the first tube 108 so that the temperature of the vapor inside the first tube 108 is raised. In this case, more fluid vortex is created by a spiral inner core 124 with a plurality of folded surfaces forming line or surface contact with a certain surface of the internal circumferential surface of the first tube 108. Thus, working fluid itself collides with the tube wall and activates heat transfer for more heat exchange.

[0119] The above operation will be explained with reference to Figs. 21 and 22.

[0120] To form the spiral shaped core 124 with a plurality of folded surfaces, a rectangular board is bent, and then installed in a manner that the core 124 forms line or surface contact with the internal circumferential surface of the first tube 108. When the low-temperature refrigerant flows in the first tube 108, it flows between the internal circumferential surface of the first tube 108 and the outside of the spiral core 124, and is heated up through heat exchange with mid-temperature refrigerant inside the second tube 109. This mid-temperature

refrigerant collides with the plural folded surfaces formed on the spiral core 124 and fluid vortex is created. Through this vortex, the low-temperature refrigerant inside the first tube 108 is easily mixed with the refrigerant inside the second tube 109.

[0121] Therefore, the refrigerant inside the first tube 108 quickly changes to mid-temperature refrigerant within a short period of time.

[0122] Fig. 23 illustrates a ph diagram.

[0123] As shown in Fig. 23, in a compression cooling cycle, enthalpy at a compressor ② increases but decreases at an expansion valve ① and evaporator ①. On the whole, heating performance is noticeably improved.

[0124] According to the present invention, for more effective heat exchange and air conditioning/heating the dual-tube heat exchange is installed at the entrance of the compressor and a means for switching a cooling cycle is disposed between the outdoor heat exchanger including the condenser and the indoor heat exchanger including the evaporator. Therefore, during the air conditioning operation, since mid-temperature, high-pressure liquid refrigerant at the exit of the condenser and low-temperature, low-pressure superheated refrigerant at the exit of the evaporator undergo heat exchange more effectively. Accordingly, super heating of the liquid refrigerant at the exit of the condenser is increased, refrigerant flow characteristics of the expansion unit are improved, and difference between the enthalpy at the entrance of the evaporator and the enthalpy at the entrance/exit of the evaporator becomes great, resulting in the enhanced air conditioning capacity.

[0125] The heat exchanger of the invention is characterized of dual tubes and improved heating performance, which is realized by forming line or surface contact between the tube and the core of the heat exchanger for performing heat exchange by counter flow or parallel flow.

[0126] Therefore, according to the present invention, increasing sub cooling of the outdoor heat exchanger increases refrigerant flow of the expansion unit, improves refrigerant flow characteristics in dependence of enthalpy difference at the entrance and exit of the evaporator and thus, enhances the total efficiency of the system. Increasing super heating at the entrance of the compressor prevents liquid (or fluid) from entering into the compressor, prevents temperature increase at the entrance of the compressor and thus, ensures excellent performance even at high speed operation.

[0127] Also, by connecting the easy-to-manufacture, sector-shaped core to the inside of the tube where vapor refrigerant flows, surface contact is formed between the core and the tube surface and this in turn improves heating performance of the refrigerant that is changed to liquid-vapor phase through the surface contact with the tube surface.

[0128] In addition, the expansion tube is inserted into the center of the core to ensure that the core is closely

adhered to the tube surface. In so doing, the heating performance by the core expansion and expansion tube is greatly improved.

[0129] Also, the internal core used to form folded surfaces activates the generation of vortex. Thus, the working fluid itself collides with the tube wall more often and heat transfer is activated.

[0130] While the invention has been shown and described with reference to certain preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

[0131] The foregoing embodiments and advantages are merely exemplary and are not to be construed as limiting the present invention. The present teaching can be readily applied to other types of apparatuses. The description of the present invention is intended to be illustrative, and not to limit the scope of the claims. Many alternatives, modifications, and variations will be apparent to those skilled in the art. In the claims, means-plus-function clauses are intended to cover the structures described herein as performing the recited function and not only structural equivalents but also equivalent structures.

Claims

1. An air conditioner comprising:

a condenser;
an evaporator;
a compressor;
a means for switching a flow line of refrigerant discharged from the compressor; and
a heat exchange means for performing heat exchange disposed before the compressor.

2. The air conditioner according to claim 1, wherein the heat exchanger is a dual-tube heat exchanger.

3. An air conditioner comprising:

a condenser;
an evaporator;
a compressor;
a means for switching a refrigerant line;
a heat exchange means for performing heat exchange disposed before the compressor; and
a means for changing a flow line of refrigerant discharge from the condenser or evaporator and making the flow line pass through the heat exchanger.

4. The air conditioner according to claim 3, wherein the means for changing the flow line of the refrigerant is a check valve.

5. The air conditioner according to claim 4, wherein the check valve is comprised of four combined valves.
6. The air conditioner according to claim 3, wherein the means for switching the flow line of the refrigerant is four sides.
7. An air conditioner comprising:
 - a condenser;
 - an evaporator;
 - a compressor; and
 - a heat exchange means for performing heat exchange disposed before the compressor, wherein at least two refrigerant flow lines are formed in the heat exchanger and a means for heat transfer between refrigerants flowing in the refrigerant flow lines forms a certain area of surface contact.
8. The air conditioner according to claim 7, wherein at least two refrigerant flow lines comprises:
 - a first tube where a first refrigerant flows in;
 - a second tube where a second refrigerant flows in; and
 - a means connected to the first tube or the second tube and forming a certain area of surface contact with the first tube or the second tube.
9. The air conditioner according to claim 8, wherein the means forming the certain area of surface contact with the first tube or the second tube is connected to the first tube or the second tube in the longitudinal direction and comprises a sector-shaped core forming a surface contact with an internal circumferential surface of the first tube or the second tube.
10. The air conditioner according to claim 8, wherein the sector-shaped core is formed by connecting vertical side and horizontal side of the core in an equilateral triangle structure.
11. The air conditioner according to claim 10, wherein to connect neighboring vertical sides, an upper horizontal long side and a lower short horizontal side of the core are successively connected to the vertical side in zigzags, and by applying the short horizontal side at the center as an origin, the long horizontal side at the end is spread out in a sector shape.
12. The air conditioner according to claim 9, wherein the first tube or the second tube is split into at least one area and the sector-shaped core is installed therein, respectively.
13. The air conditioner according to claim 8, wherein the means for forming the surface contact with the first tube or the second tube is connected to the first tube or the second tube in the longitudinal direction, and comprises a wave-shaped core forming a partial surface contact with the internal circumferential surface of the first tube or the second tube.
14. The air conditioner according to claim 13, wherein resistance and fluid vortex are generated by the wave-shaped core and thus, heat conductivity is improved.
15. The air conditioner according to claim 9, wherein an expansion tube is connected in the longitudinal direction to the center of the core in order to expand the surface contact between the first tube or the second tube and the sector-shaped tube.
16. The air conditioner according to claim 15, wherein jaws are formed at both ends of the expansion tube so that both ends of the core are suspended thereby.
17. The air conditioner according to claim 9, wherein at least two cores are inside the first tube or the second tube.
18. The air conditioner according to claim 17, wherein the cores inside the first tube or the second tube are connected in zigzags.
19. The air conditioner according to claim 8, wherein the means for forming the surface contact with the first tube or the second tube is connected to the first tube or the second tube in the longitudinal direction, and comprises a spiral-shaped core forming a line or surface contact with the internal circumferential surface of the first tube or the second tube.
20. The air conditioner according to claim 19, wherein the internal core is formed of a plurality of folded surfaces.
21. The air conditioner according to claim 20, wherein the plurality of folded surfaces is formed by bending or folding.
22. The air conditioner according to claim 20, wherein resistance and fluid vortex are generated by the folded core into the plural surfaces and thus, heat conductivity is improved.

Fig.1
Related Art

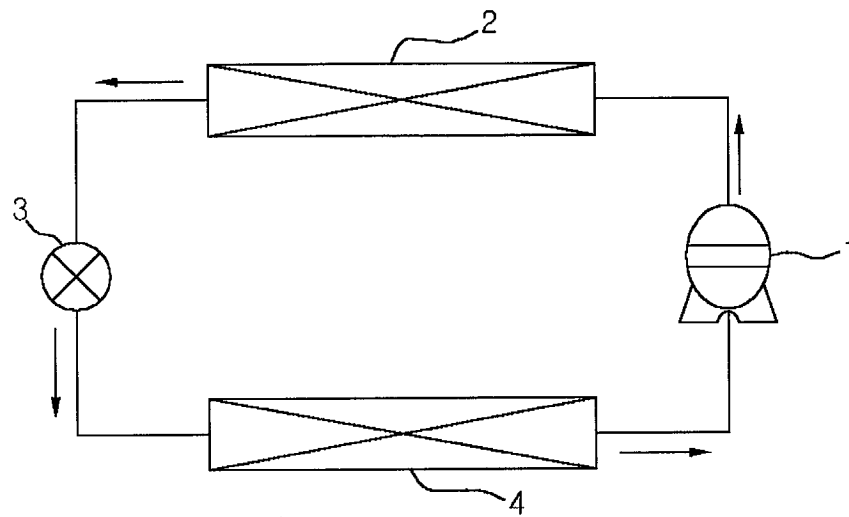


Fig.2
Related Art

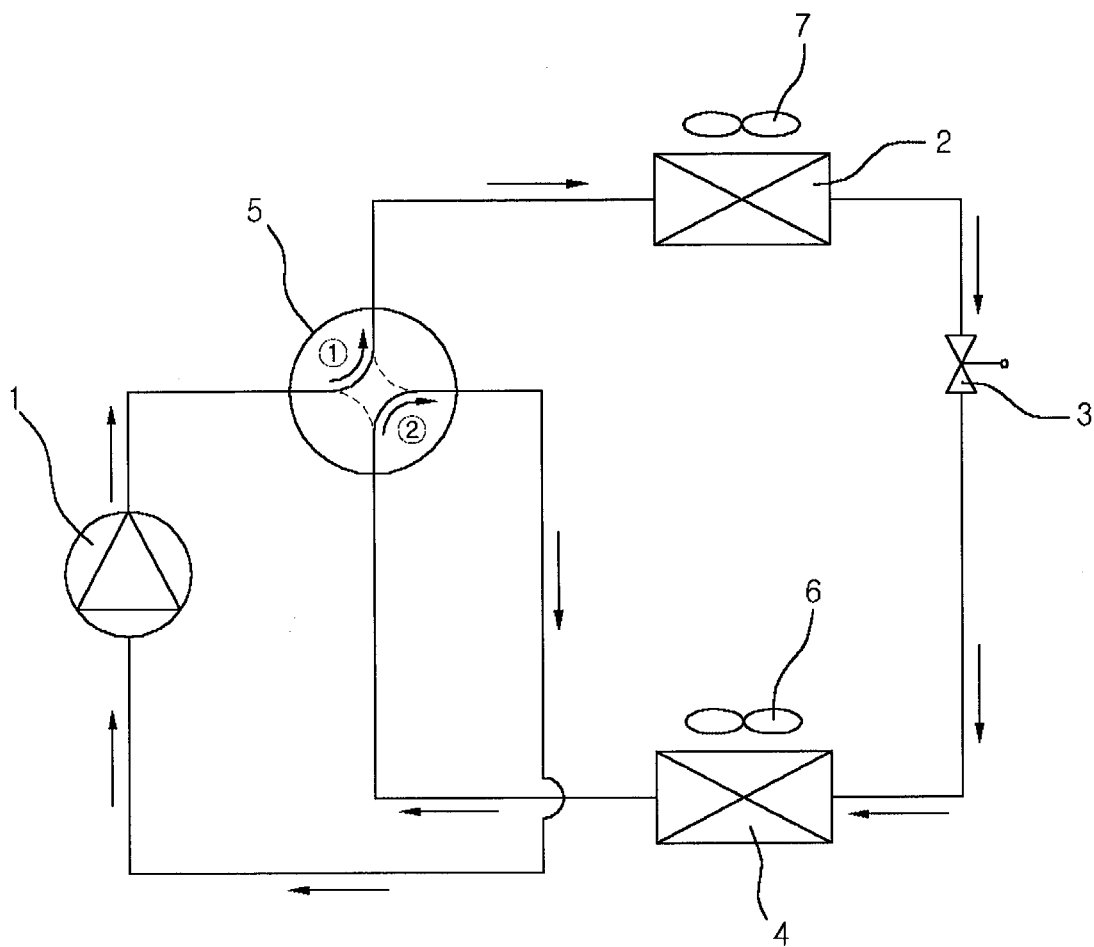


Fig.3
Related Art

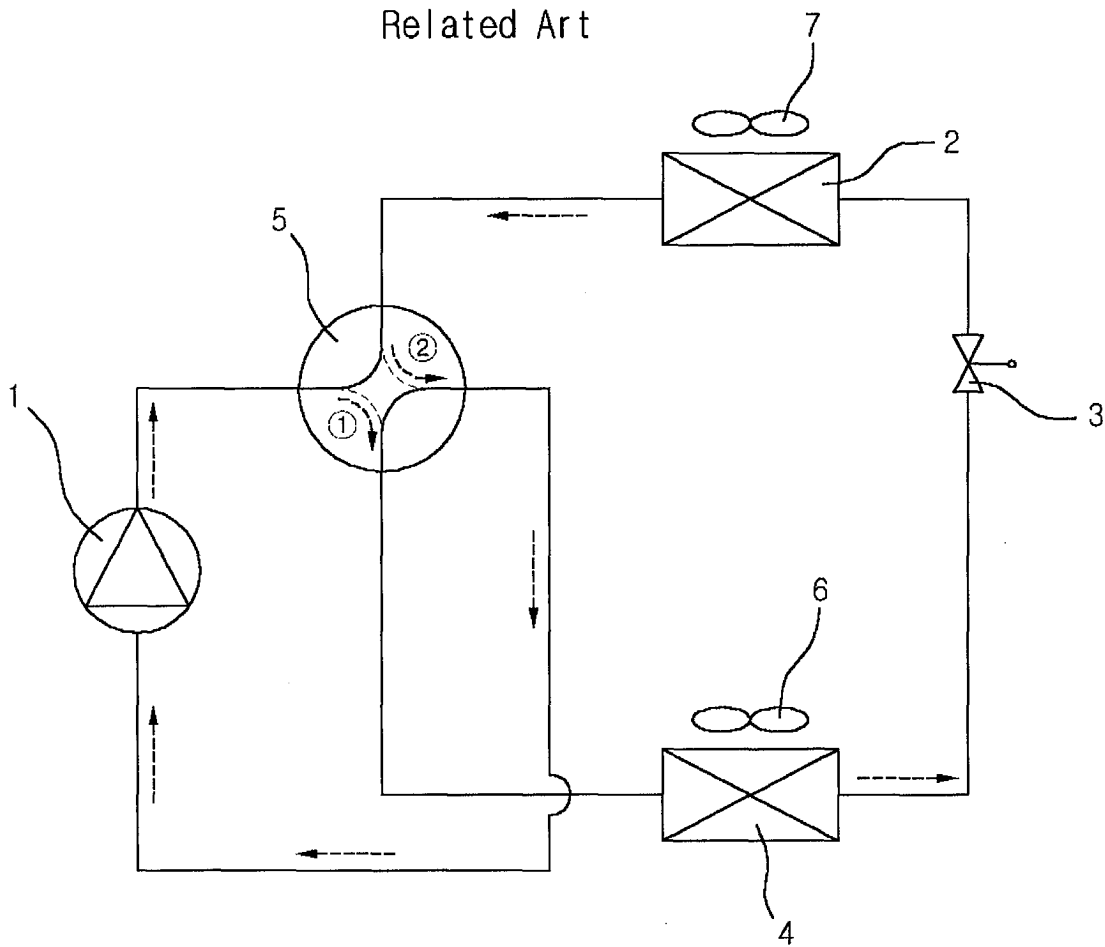


Fig.4
Related Art

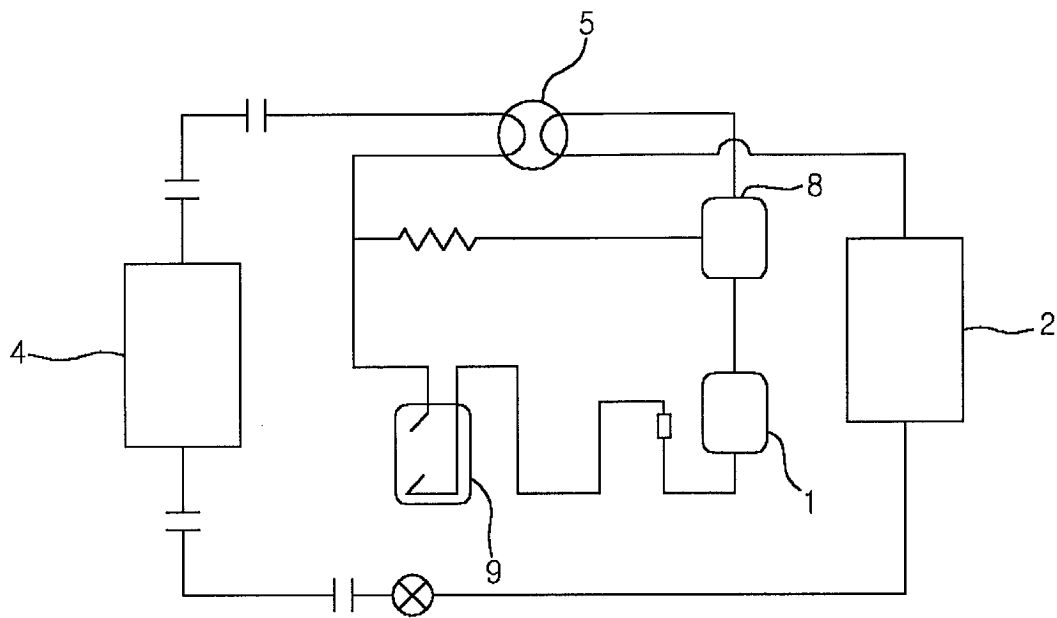


Fig.5
Related Art

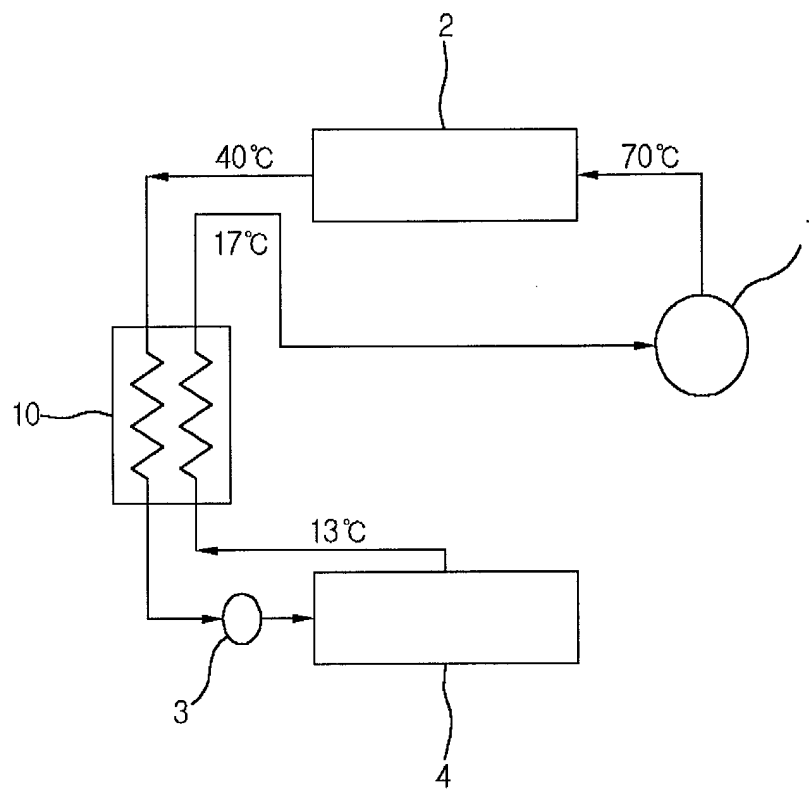


Fig.6
Related Art

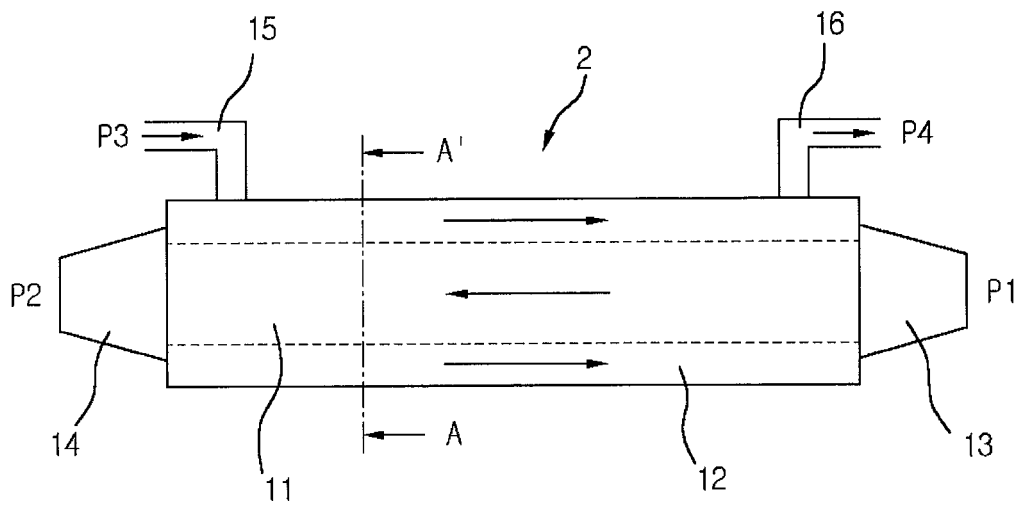


Fig.7
Related Art

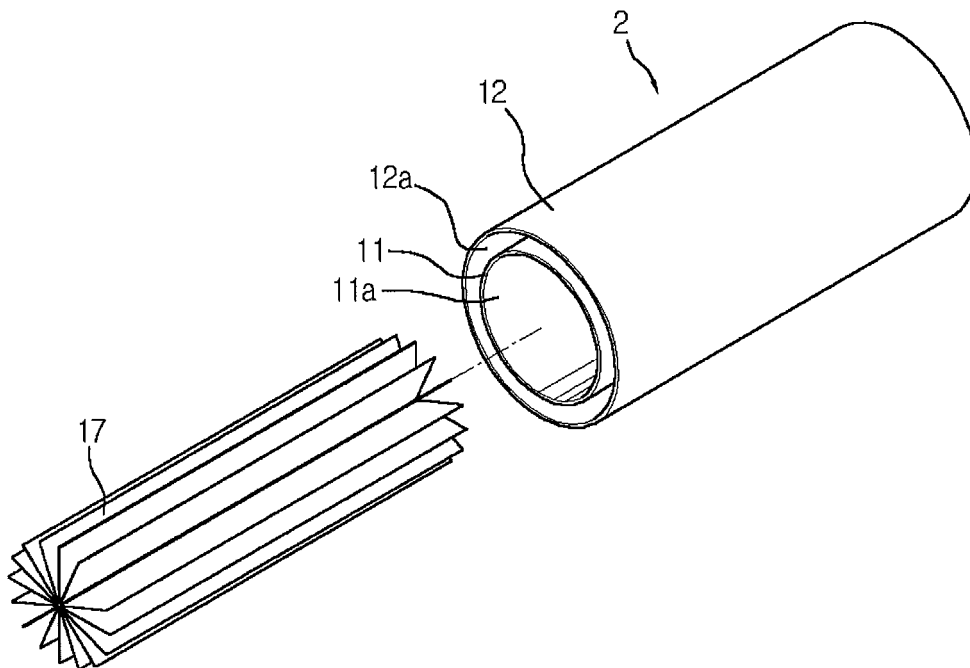


Fig.8
Related Art

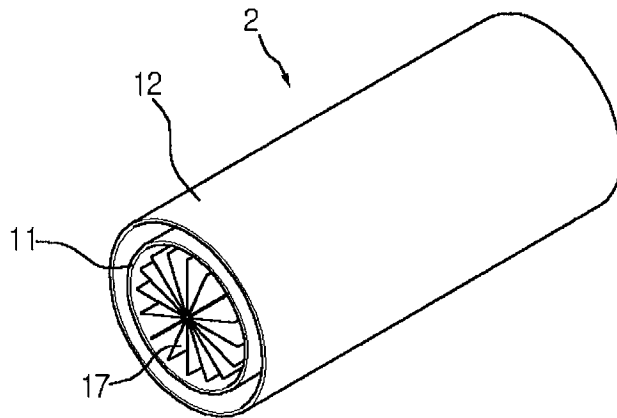


Fig.9
Related Art

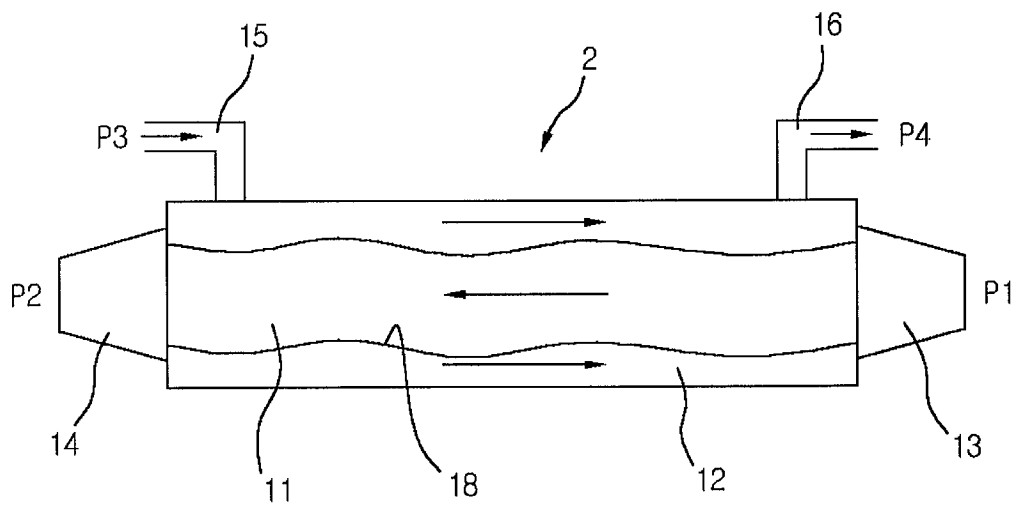


Fig.10

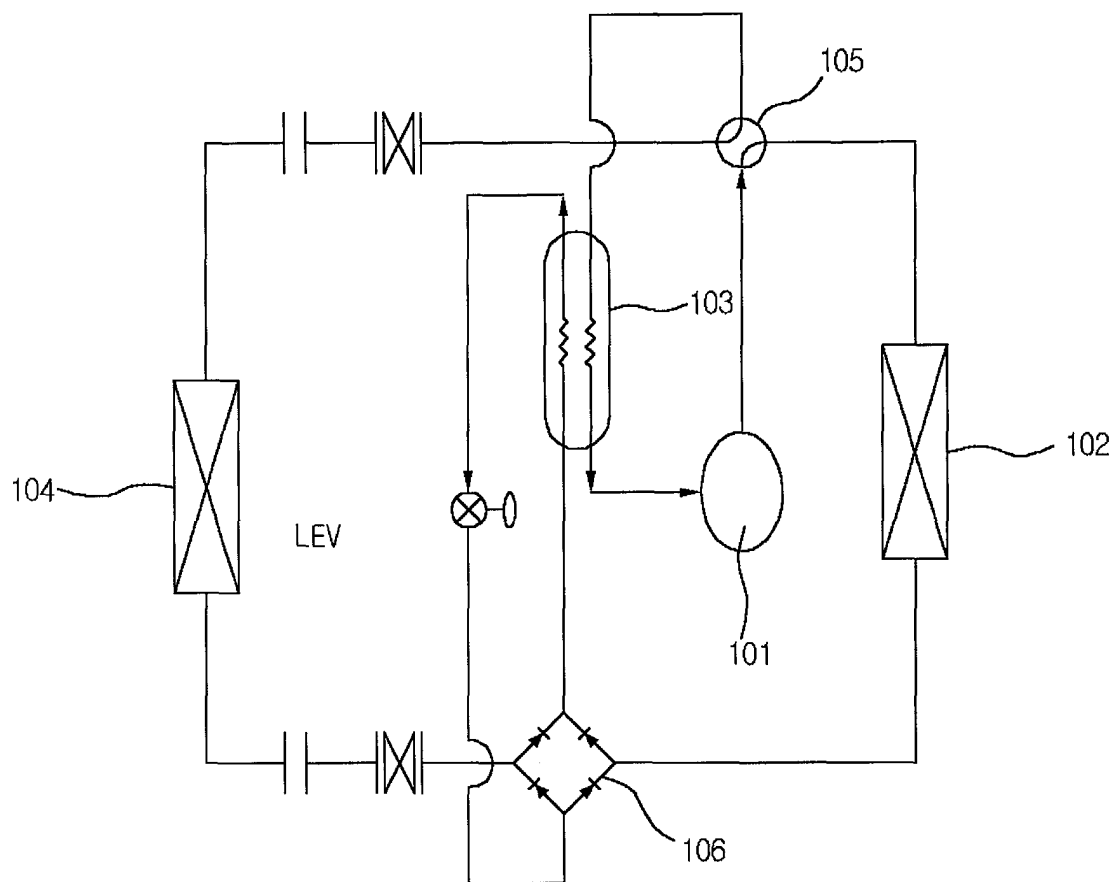


Fig.11

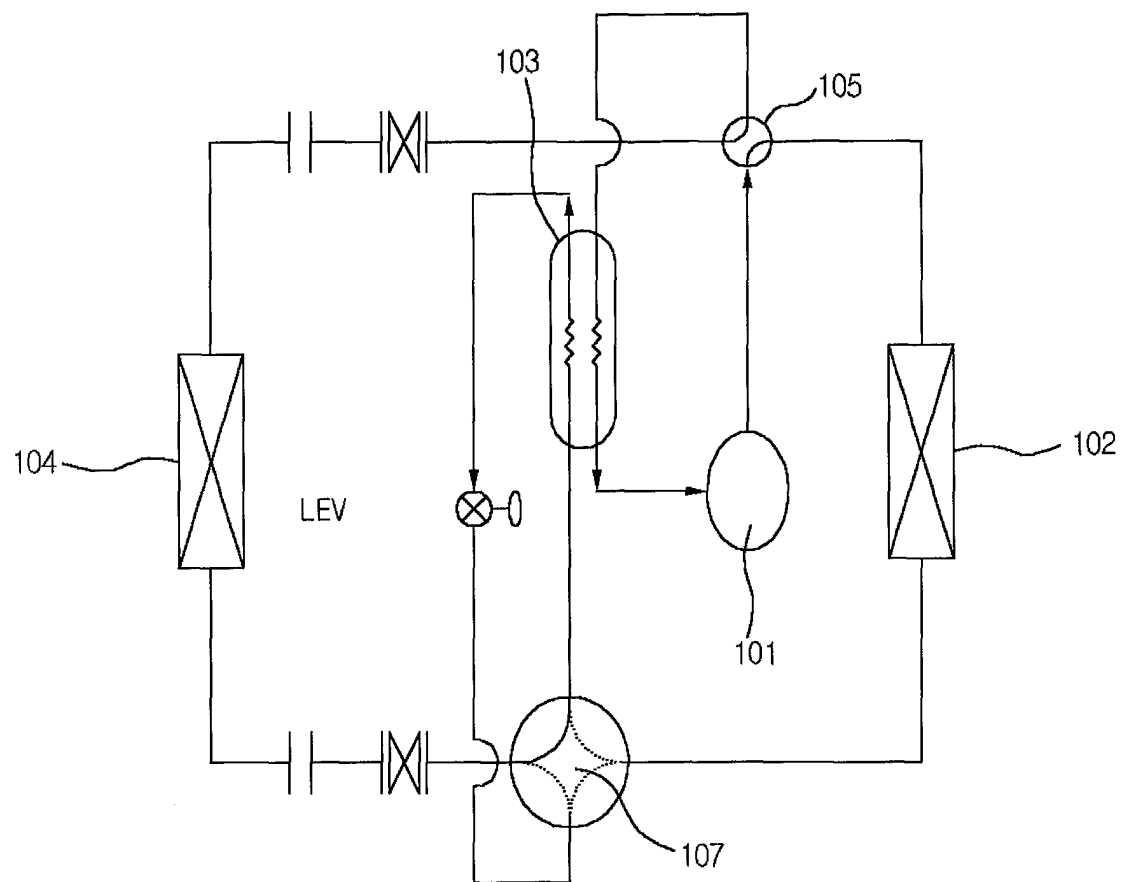


Fig.12

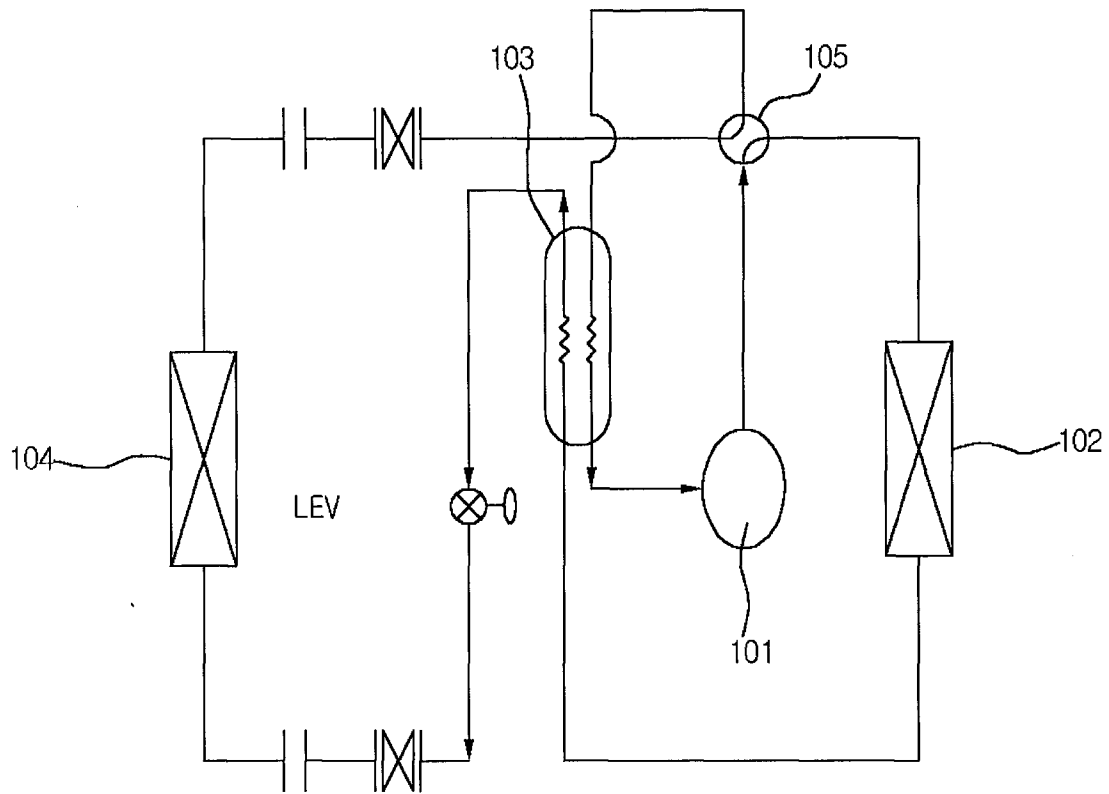


Fig.13

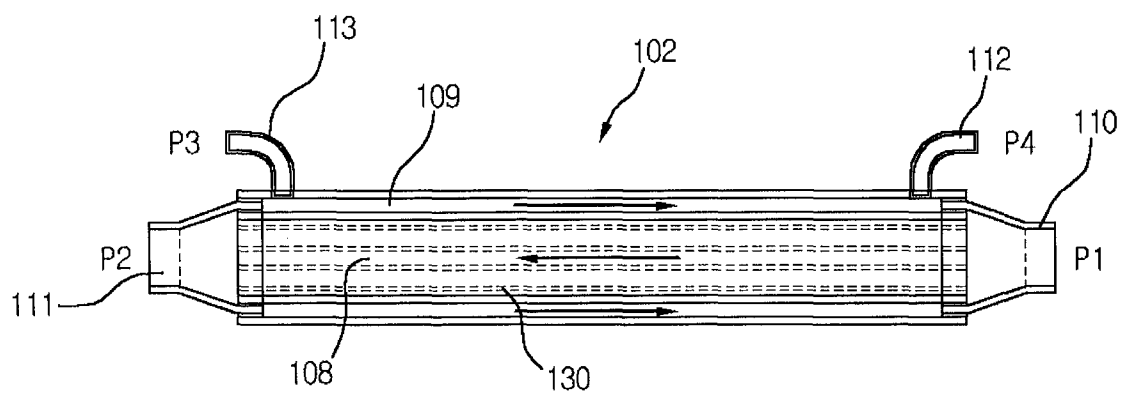


Fig.14

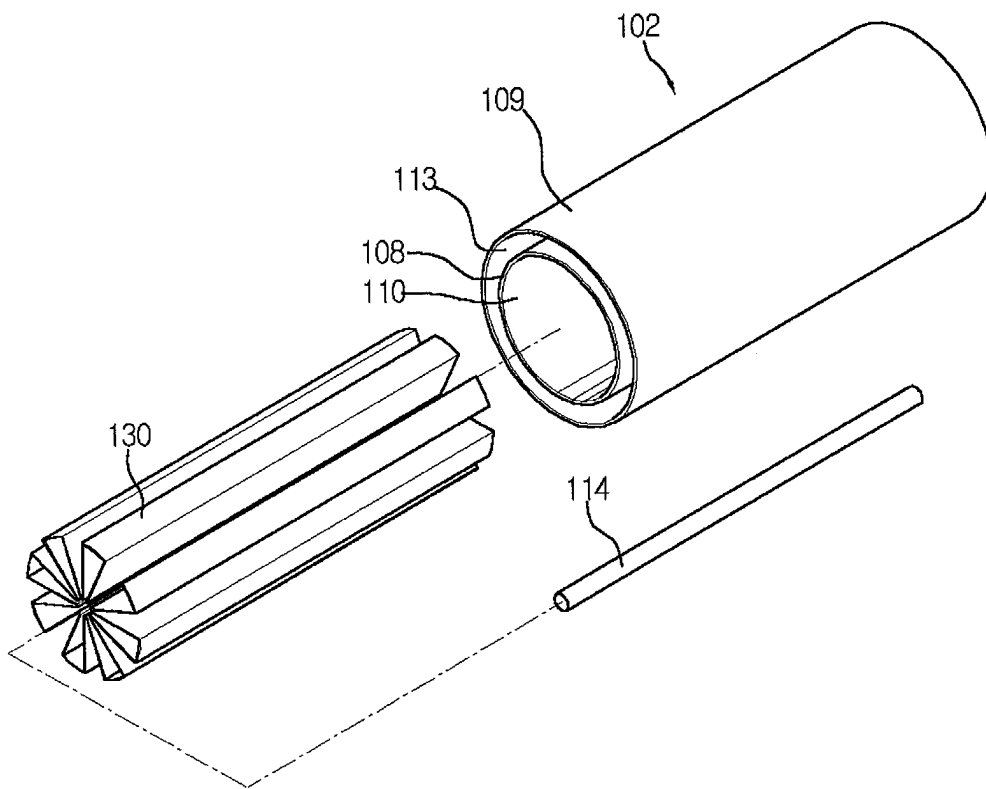


Fig.15

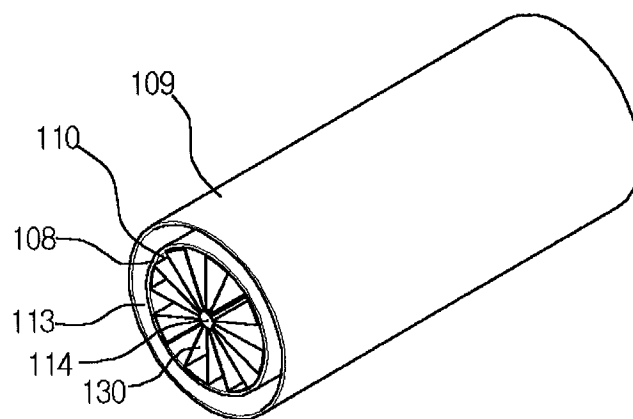


Fig.16

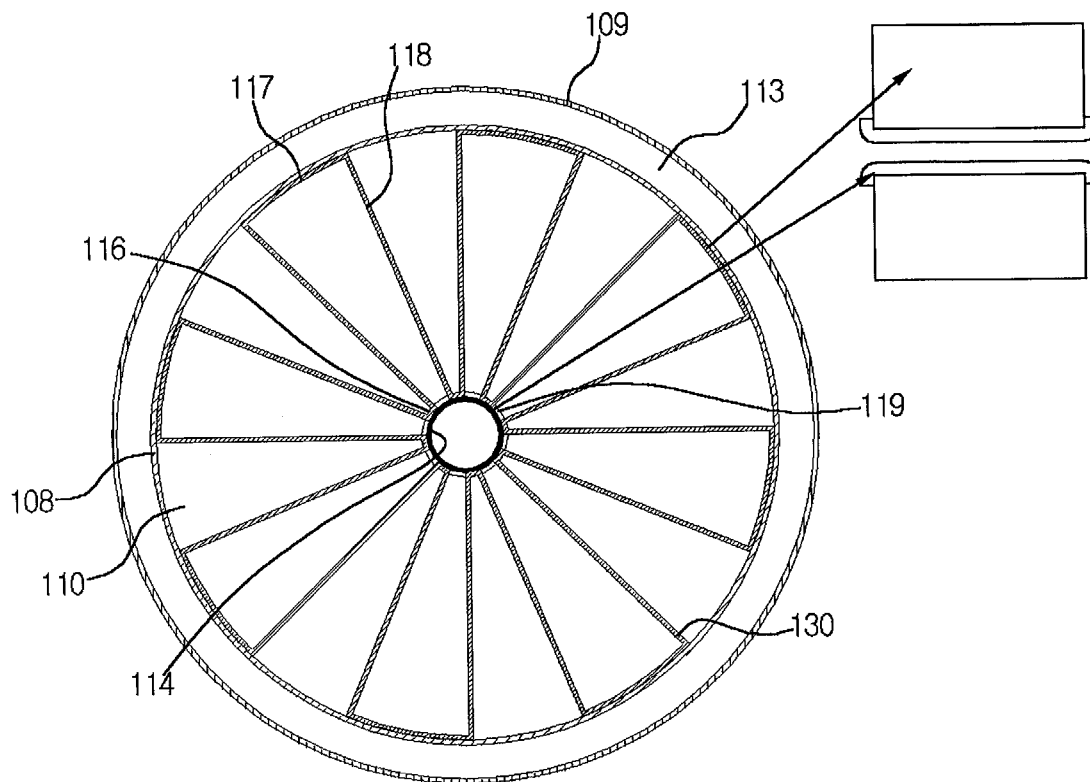


Fig.17

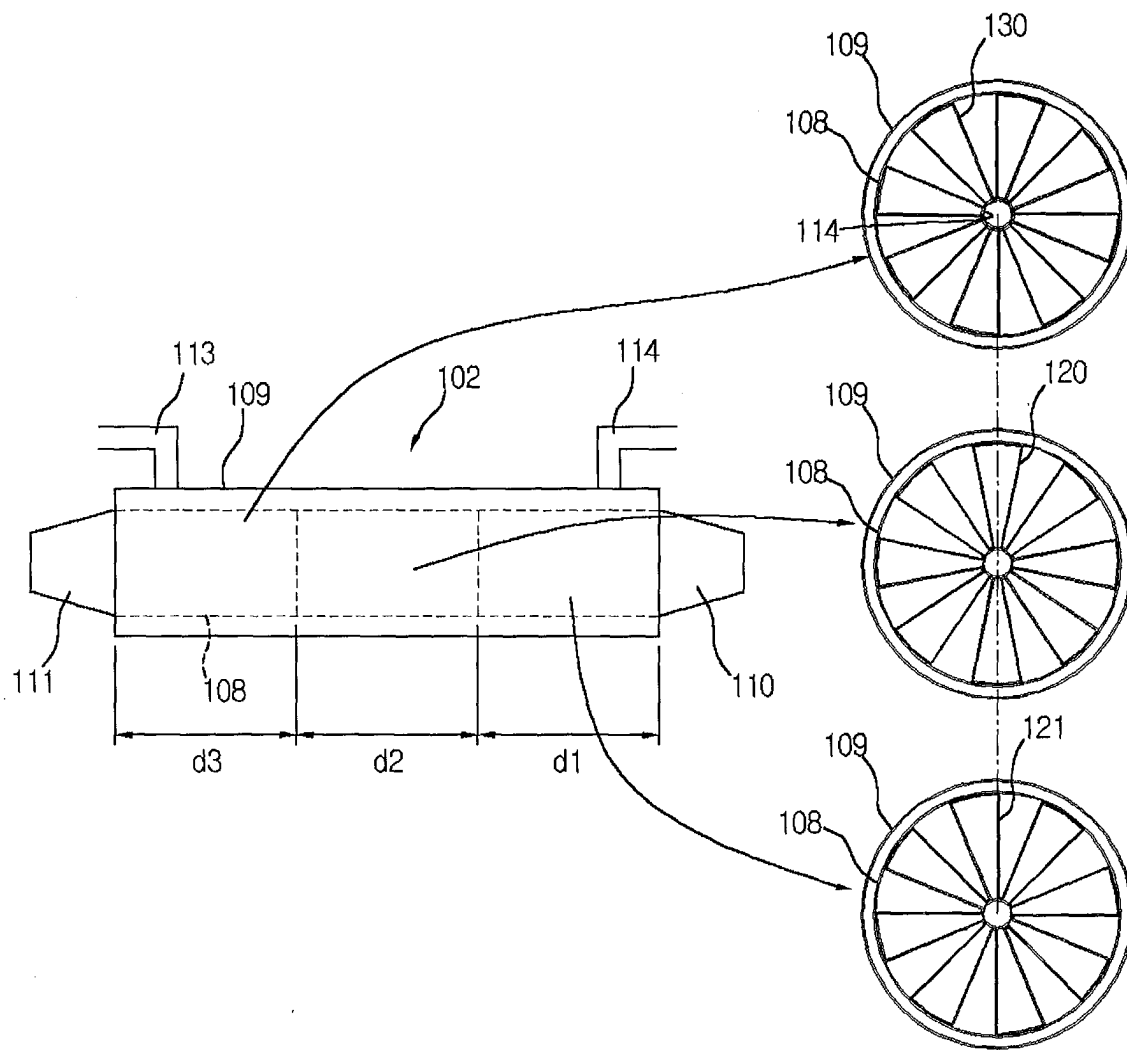


Fig.18

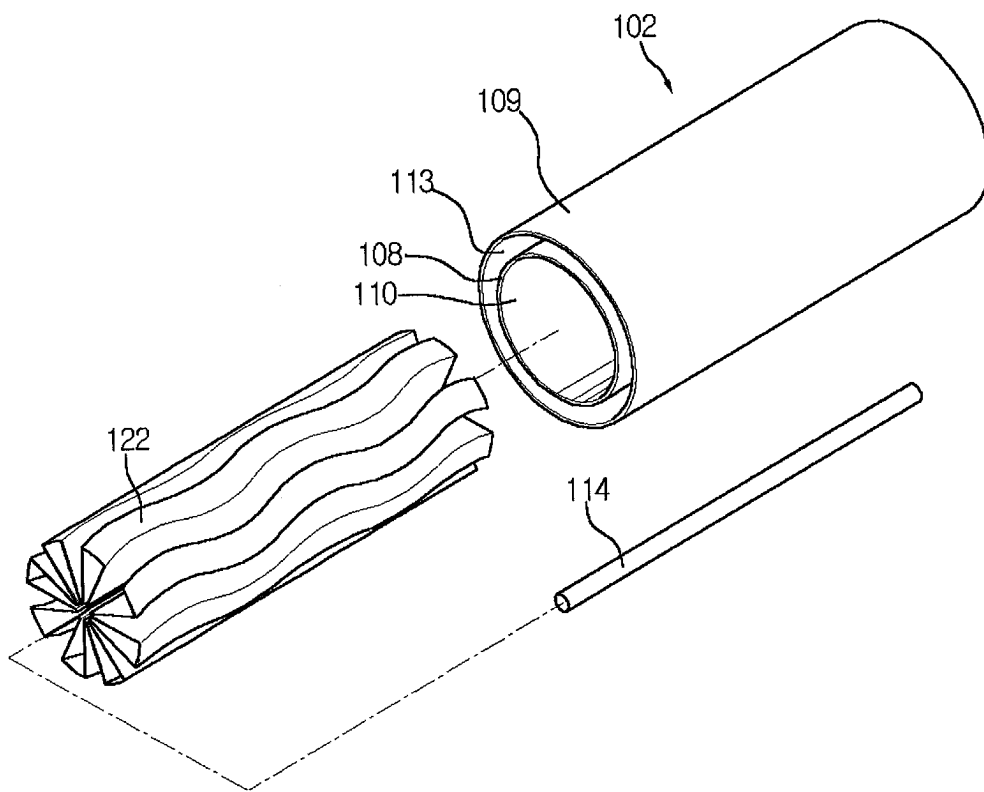


Fig.19

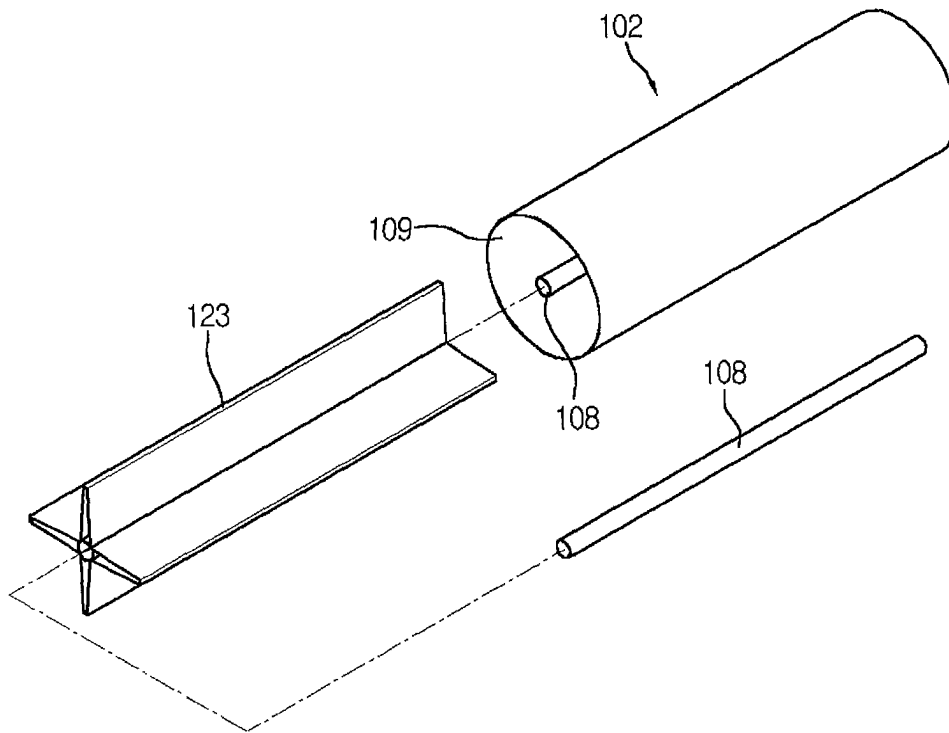


Fig.20

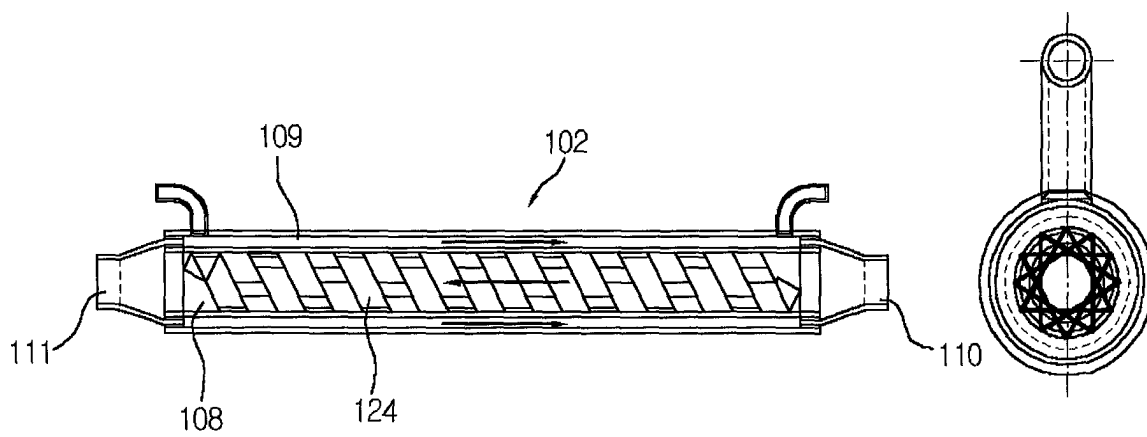


Fig.21

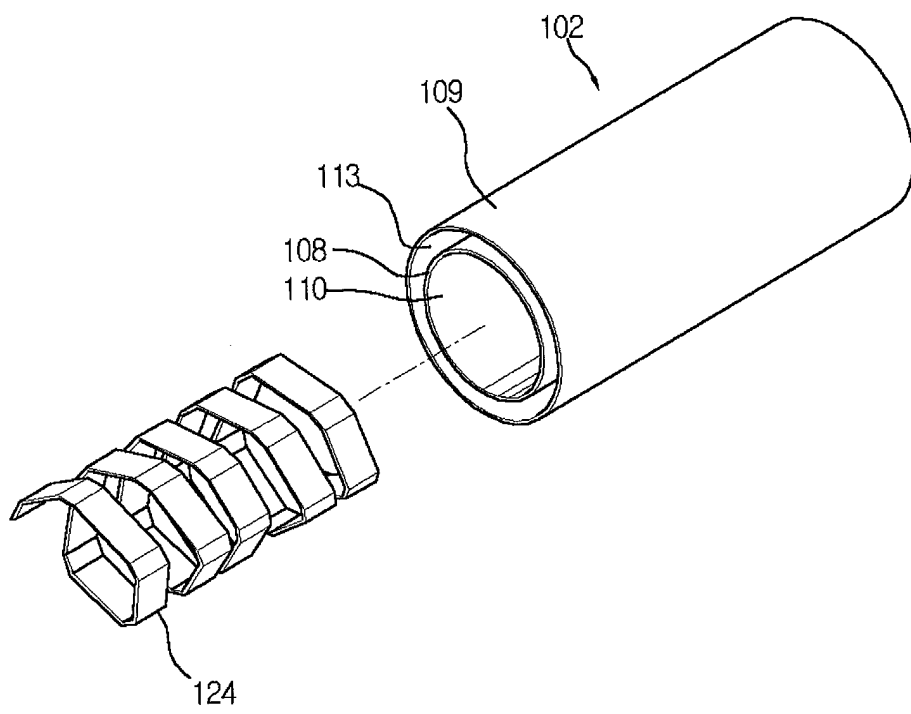


Fig.22

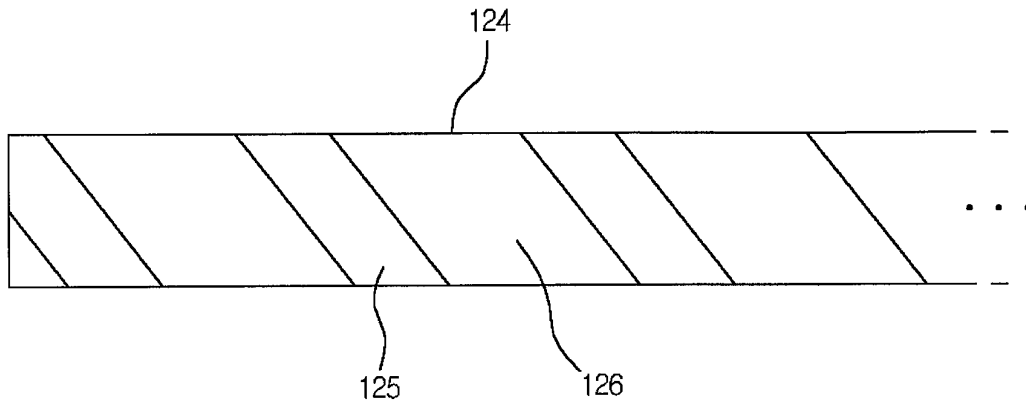


Fig.23

