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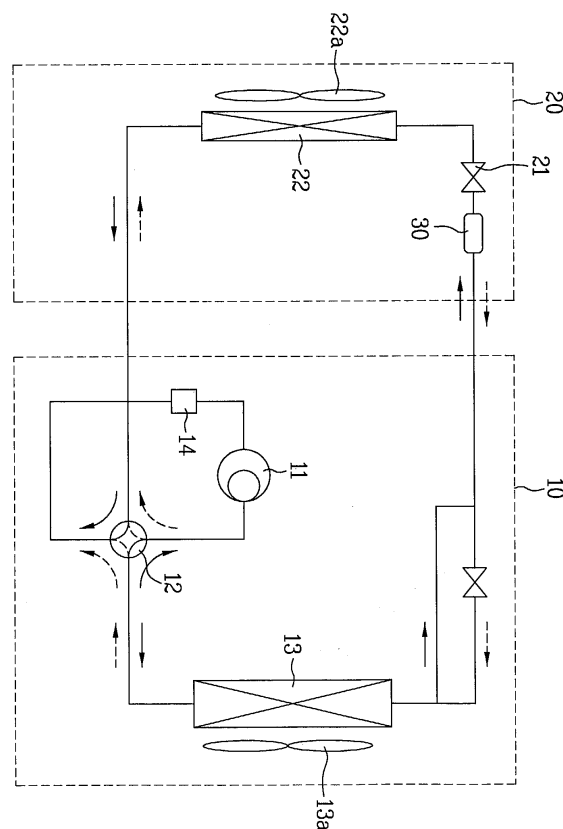
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(54) **Heating/cooling system used in air conditioner**

(57) A cooling/heating system used in an air conditioner is disclosed. The cooling/heating system comprises at least one silencer (30) coupled in series to a refrigerant pipe which is coupled to an expansion device (21) of an indoor unit (20), for eliminating a local pressure difference of a refrigerant flowing therein and for making a mixed state of gas and liquid uniform. The silencer (30) comprises a body direct coupled to the refrigerant pipe for making the refrigerant flow through therein, and a porous tube provided in the body, with a buffer space being formed between an outer periphery thereof and an inner periphery of the body, the porous tube having a plurality of passing holes for communicating an interior thereof with the buffer space.

FIG.1



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Description

[0001] This application claims the benefit of the Korean Application No. P2002-32915 filed on June 12, 2002, which is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to an air conditioner, and more particularly, to a heating/cooling system used in an air conditioner capable of reducing a noise caused by refrigerant flow.

Discussion of the Related Art

[0003] Generally, air conditioner is an apparatus to cool/heat room air by use of a phenomenon of absorbing or radiating heat from or into the surroundings when a refrigerant is carried out a phase change.

[0004] The air conditioner generally comprises an outdoor unit and an indoor unit, and is classified into a common air conditioner comprising one outdoor unit equipped with one indoor unit, and a multiple-unit type air conditioner comprising one outdoor unit equipped with a number of indoor units. Regardless of the kind of the above-mentioned common or multiple-unit type air conditioner, an operating principle of a cooling/heating system used in the air conditioner is substantially similar to each other, except for the number of the indoor units.

[0005] According to the cooling/heating system of the air conditioner, the outdoor unit is generally equipped with a compressor and an outdoor heat exchanger, while the indoor unit is generally equipped with an indoor heat exchanger and an expansion device.

[0006] With the cooling/heating system of the air conditioner constituted as described above, the phase change occurs in a refrigerant while the refrigerant flows in either direction by the control of a control unit. The heat exchanger in which the phase change occurs lets the refrigerant absorb or emit the heat, thereby enabling the air-conditioned room to be cooled or heated.

[0007] Specifically, if the air conditioner is operated in a cooling mode, the refrigerant compressed by a compressor is heat-exchanged with the atmosphere to exhaust the heat from the air-conditioned room to the outside and then condense. After the condensed refrigerant is fed to the expansion device so as to be expanded, it is heat-exchanged with the room air to absorb the surrounding heat. Such heat-exchanged cooled air is discharged into the air-conditioned room, thereby enabling the air-conditioned room to be cooled. And then, the refrigerant heat-exchanged by the indoor heat exchanger is again fed to the compressor, and the above-mentioned cycle is repeated to continuously cool the outdoor air-conditioned room. In the cooling operation mode, the heat exchanger serves as a condenser, while the indoor

heat exchanger serves as an evaporator.

[0008] Meanwhile, in the heating operation mode, the flow direction of the refrigerant is oriented contrary to that of the cooling operation mode, but the operating principle is substantially similar to each other. Therefore, the description on the heating cycle will be omitted herein. In the heating operation, however, the indoor heat exchanger serves as the condenser, while the outdoor heat exchanger serves as the evaporator. The indoor heat exchanger operating as the condenser exhausts the heat radiated at the condensing operation to the air-conditioned room, thereby enabling the air-conditioned room to be heated.

[0009] In particular, in the heating operation mode, the refrigerant passed through the outdoor heat exchanger flows into the expansion device in state of two phases containing a liquid phase and gas phase. Also, in the cooling operation mode, the refrigerant passed through the indoor heat exchanger flows into the expansion device in state of two phases containing the liquid phase and the gas phase.

[0010] When the refrigerant mixed with gas and liquid phases flows into the expansion device, and it expands by the expansion device, an uneven pressure difference of the refrigerant causes a noise to be produced and an evaporating efficiency to be reduced, thereby lowering a heat exchanging capacity.

[0011] Furthermore, when the refrigerant mixed with gas and liquid phases flows along a refrigerant pipe, the pressure of the refrigerant unevenly distributed in the refrigerant pipe causes the flow noise to be produced and flow capability thereof to be reduced, thereby lowering a thermal efficiency of the air conditioner.

SUMMARY OF THE INVENTION

[0012] Accordingly, the present invention is directed to a heating/cooling system used in an air conditioner that substantially obviates one or more problems due to limitations and disadvantages of the related art.

[0013] An object of the present invention is to provide a heating/cooling system used in an air conditioner capable of reducing flow noise and expansion noise of a refrigerant flowing through a refrigerant pipe.

[0014] Another object of the present invention is to provide a heating/cooling system used in an air conditioner capable of improving a flow capability of a refrigerant flowing through a refrigerant pipe and thus improving an evaporating efficiency thereof, thereby increasing a thermal efficiency of the air conditioner.

[0015] 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 objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims

hereof as well as the appended drawings.

[0016] To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, there is provided a cooling/heating system used in an air conditioner, the cooling/heating system comprising: at least one silencer coupled in series to a refrigerant pipe which is coupled to an expansion device of an indoor unit, for eliminating a local pressure difference of a refrigerant flowing therein and for making a mixed state of gas and liquid uniform.

[0017] The silencer may be provided at a refrigerant inlet side of the expansion device, at a refrigerant outlet side of the expansion device, or at refrigerant inlet side and refrigerant outlet side of the expansion device, respectively.

[0018] The silencer comprises a body direct coupled to the refrigerant pipe for making the refrigerant flow through therein, and a porous tube provided in the body, with a buffer space being formed between an outer periphery thereof and an inner periphery of the body, the porous tube having a plurality of passing holes for communicating an interior thereof with the buffer space.

[0019] The body has a middle portion having a diameter larger than that of both ends, or has a middle portion of a uniform diameter along its longitudinal direction, and diameters of both ends being gradually expanded facing the middle portion.

[0020] The porous tube is provided in such a way that both ends thereof having a diameter larger than a middle portion thereof are fitted to an inner periphery of the body, otherwise the porous tube is provided in such a way that both ends thereof having an enlarged diameter larger than a middle portion having a constant diameter along its longitudinal direction are fitted to an inner periphery of the body.

[0021] The silencer further comprises a screen formed of a mesh type, and positioned in an inside of the body such that the refrigerant flows through it. The screen is vertically provided in the inside of the body. Alternatively, the screen is provided at an end side of the body which is in close to the expansion device.

[0022] The silencer comprises a body direct coupled to the refrigerant pipe for making the refrigerant flow through therein; and a screen formed of a mesh type, and positioned in an inside of the body such that the refrigerant flows through it.

[0023] The body has a middle portion having a diameter larger than that of both ends, or has a middle portion of a uniform diameter along its longitudinal direction, and diameters of both ends being gradually expanded facing the middle portion.

[0024] The screen is vertically provided in the inside of the body, and is provided at an end side of the body which is in close to the expansion device.

[0025] The silencer further comprises a porous tube provided in the body, with a buffer space being formed between an outer periphery thereof and an inner periph-

ery of the body, the porous tube having a plurality of passing holes for communicating an interior thereof with the buffer space. The porous tube is provided in such a way that both ends thereof having a diameter larger than a middle portion thereof are fitted to an inner periphery of the body.

[0026] It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] 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. In the drawings:

[0028] FIG. 1 is a schematic view of a heating/cooling system used in an air conditioner according to one embodiment of the present invention;

[0029] FIG. 2 is a schematic view of a heating/cooling system used in an air conditioner according to another embodiment of the present invention;

[0030] FIG. 3 is a schematic view of a heating/cooling system used in an air conditioner according to still another embodiment of the present invention;

[0031] FIG. 4 is a cross-sectional view of an interior structure of a silencer according to one embodiment of the silencer in the present invention, employed in a schematic view of a heating/cooling system used in an air conditioner;

[0032] FIG. 5 is a cross-sectional view of an interior structure of a silencer according to another embodiment of the silencer in the present invention, employed in a schematic view of a heating/cooling system used in an air conditioner; and

[0033] FIG. 6 is a cross-sectional view of an interior structure of a silencer according to still another embodiment of the silencer in the present invention, employed in a schematic view of a heating/cooling system used in an air conditioner.

DETAILED DESCRIPTION OF THE INVENTION

[0034] Reference will now be made in detail to the embodiments of the present invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

[0035] Referring to FIGs. 1 to 3, a cooling/heating system used in an air conditioner according to the present invention generally comprises an indoor unit 10 and an outdoor unit 20.

[0036] The outdoor unit 10 is equipped with a com-

pressor 11, a four-way valve 12, an outdoor heat exchanger 13 and an accumulator 14, while the indoor unit 20 is equipped with an expansion device 21, an indoor heat exchanger 22 and a silencer 30. The outdoor heat exchanger 13 and the indoor heat exchanger 22 are provided with an outdoor fan 13a and an indoor fan 22a, respectively.

[0037] There is provided at least one silencer 30 coupled in series to a refrigerant pipe which is coupled to the expansion device 21 of the indoor unit 20. The silencer may be provided at various locations.

[0038] Specifically, the silencer 30 may be provided at a refrigerant inlet side of the expansion device 21, as shown in FIG. 1.

[0039] Alternatively, the silencer 30 may be provided at a refrigerant outlet side of the expansion device 21, as shown in FIG. 2.

[0040] Furthermore, the silencer 30 may be provided at the refrigerant inlet and outlet sides of the expansion device 21, respectively. In this case, the silencer 30 consists of a first silencer 30a provided between the outdoor heat exchanger 13 and the expansion device 21, and a second silencer 30b provided between the expansion device 21 and the indoor heat exchanger 22.

[0041] The silencer 30 provided as described above eliminates a local pressure difference of the refrigerant by making the refrigerant flow through therein, such that the refrigerant uniformly flows through the silencer 30 to reduce the flow/expansion noise of the refrigerant. The construction of the silencer 30 may be realized in various embodiments, as shown in FIGs. 4 to 6.

[0042] Referring to FIG. 4 showing one embodiment of the silencer, the silencer 30 comprises a body 31 and a porous tube 33 provided in the body 31.

[0043] The body 31 is directly coupled to the refrigerant pipe so as to make the refrigerant flow therein. The body 31 has a middle portion having a diameter larger than that of both ends. Preferably, the middle portion has a uniform diameter along its longitudinal direction, and the both ends have a diameter gradually increased facing the middle portion.

[0044] The porous tube 33 is provided in the body 31, with a buffer space 34 being formed between an outer periphery thereof and an inner periphery of the body 31. The porous tube 33 has a plurality of passing holes 33a for communicating the interior thereof with the buffer space 34. The porous tube 33 has both ends having a diameter larger than a middle portion thereof, and is provided in such a way that both ends are fitted to an inner periphery of the body 31. That is, the enlarged ends of the porous tube 33 are fitted to the inner periphery of the middle portion of the body 31.

[0045] Where the silencer 30 is constructed as the embodiment shown in FIG. 4, when the refrigerant flows through the body 31 of the silencer 30, it is diffused in the interior of the body 31. At that time, the refrigerant flows into the buffer space 34 and the interior of the porous tube 33 through the holes 33a. With the repeated

flow of the refrigerant, the liquid phase contained in the refrigerant may be uniformly mixed with the gas phase thereof, so that the flow noise of the refrigerant is reduced. The principle of the silencer is substantially similar to that of an expansion-type or resonance-type muffler.

[0046] Referring to FIG. 5 showing the silencer according to another embodiment, the silencer 30 comprises a body 31 and a screen 32.

[0047] The structure and position of the body 31 are substantially similar to those of the embodiment shown in FIG. 4, and so the description thereof will be omitted herein.

[0048] The screen 32 is formed of a mesh type, and is positioned in an inside of the body 31 such that the refrigerant flows through it. Preferably, the screen 32 is vertically provided in the inside of the body 31, and in particular, is provided at the end side of the body which is in close to the expansion device 21.

[0049] Where the silencer 30 is constructed as the embodiment shown in FIG. 5, when the refrigerant flows along the body 31 of the silencer 30, it is diffused in the interior of the body 31. At that time, the refrigerant passes through the mesh-type screen 32, such that impurities contained in the refrigerant are filtered, and simultaneously, the liquid phase contained in the refrigerant may be uniformly mixed with the gas phase thereof. Accordingly, the local pressure difference of the refrigerant is eliminated, and thus the flow noise of the refrigerant is reduced.

[0050] Referring to FIG. 6 showing the silencer according to still another embodiment, the silencer 30 comprises a body 31, a porous tube 33 and a screen 32.

[0051] The structure and position of the body 31, the porous tube 33 and the screen 32 are substantially similar to those of the embodiments shown in FIGs. 4 and 5, respectively, and so the description thereof will be omitted herein. Where the silencer 30 is constituted as the embodiment shown in FIG. 6, the apparatus exhibits the same operation and effects as those of the embodiments of FIGs. 4 and 5. Therefore, this embodiment is most preferable to the silencer of the present invention.

[0052] The operation of the cooling/heating system used in the air conditioner according to the present invention constituted as described above will now be explained with reference to FIGs. 3 and 6.

[0053] First of all, it will now be described the case the air conditioner is operated in a cooling mode, in which a flow direction of the refrigerant is indicated by a solid line in the figures.

[0054] The refrigerant compressed by the compressor 11 is fed to the outdoor heat exchanger 13 by the control of the four-way valve 12, and then is heat-exchanged with the atmosphere ventilated by the outdoor fan 13a so as to condense in two-phase state mixed with gas and liquid.

[0055] The refrigerant condensed in the two-phase state is fed to the first silencer 30a so as to be uniformly

mixed thereby. Specifically, the refrigerant fed to the body 31 of the first silencer 30a is diffused in the interior of the body 31. At that time, the refrigerant flows into the buffer space 34 and the interior of the porous tube 33 through the holes 33a, such that the liquid phase contained in the refrigerant may be uniformly mixed with the gas phase thereof. And then, the uniformly mixed refrigerant passes through the mesh-type screen 32 to be more uniformly mixed with the gas and the liquid, before it flows into the expansion device 21.

[0056] The expansion device 21 expands the refrigerant of which its local pressure difference is absolutely eliminated by the uniform mixing of the gas phase and the liquid phase. At that time, the expansion pressure is evenly applied to the refrigerant, such that the flow noise of the refrigerant remarkably is reduced relative to the conventional cooling/heating apparatus of expanding the non-uniformly mixed refrigerant.

[0057] The refrigerant passing through the expansion device 21 is again fed to the second silencer 30b. The refrigerant flows into the body 31 through the porous tube 33, the buffer space 34 and the screen 32. Since the refrigerant flows in the uniform state, the flow noise of the refrigerant remarkably is remarkably suppressed relative to the case in which the local pressure difference is existed.

[0058] The refrigerant of uniform state discharged from the second silencer 30b is fed to the indoor heat exchanger 22, and is heat-exchanged with the room air circulated by the indoor fan 22a to absorb the surrounding heat of the air-conditioned room. At that time, the cooled air heat-exchanged by the indoor heat exchanger 22 is discharged into the air-conditioned room, thereby enabling the air-conditioned room to be cooled. Meanwhile, it improves the evaporate efficiency by discharging the refrigerant in the uniform state, thereby improving the heat exchanging capability, relative to the conventional apparatus by which the refrigerant is heat-exchanged in the non-uniform state.

[0059] And then, the refrigerant heat-exchanged by the indoor heat exchanger 22 is again fed to the compressor 11 through the accumulator 14, and the above-mentioned cycle is repeated to continuously cool the air-conditioned room.

[0060] Further, it will now be described the case the air conditioner is operated in a heating mode, in which a flow direction of the refrigerant is indicated by a dotted line in the figures.

[0061] The refrigerant compressed in high temperature and pressure by the compressor 11 is fed to the indoor heat exchange 13 by the control of the four-way valve 12, and then is heat-exchanged with the room air ventilated by the indoor fan 22a so as to condense in two-phase state mixed with gas and liquid. At that time, the room air heated by the heat radiated from the indoor heat exchanger 22 is discharged into the air-conditioned room, thereby enabling the room to be heated.

[0062] And then, the refrigerant condensed in the two-

phase state is fed to the expansion device 21 through the second silencer 30b in the uniformly mixed state. The expansion of the refrigerant in the expansion device 21 causes it to be converted into two-phase state or liquid phase state of low temperature and low pressure.

[0063] The refrigerant expanded by the expansion device 21 flows through the first silencer 30a. After the refrigerant is uniformly mixed, it is discharged into the outdoor heat exchanger 13. The refrigerant is heat-exchanged with the atmosphere ventilated by the outdoor fan 13a so as to evaporate the refrigerant. And then, the evaporated refrigerant is again fed to the compressor 11 through the accumulator 14, and the above-mentioned cycle is repeated to continuously heat the air-conditioned room. In the heating operation mode, the flow noise and expansion noise of the refrigerant are suppressed by the first and second silencers 30a and 30b, thereby improving the heat exchanging capability of the air conditioner, similar to the cooling operation mode.

[0064] The cooling/heating system used in the air conditioner according to the present invention has following advantages.

[0065] First, in addition to the filtering function, the screen serving as a strainer of noise suppressing type may reduce the noise produced when the refrigerant expands by the expansion device, because the flow of refrigerant having non-uniformed two-phase state is converted into the uniform two-phase state.

[0066] Second, since the refrigerant expanded by the expansion device is converted into the uniform two-phase state by the silencer, the local pressure difference is eliminated in the refrigerant tube, thereby preventing the flow noise from being produced due to the pressure difference.

[0067] Third, since the silencer has combined characteristics of the expansion-type muffler and the resonance-type muffler, the apparatus may eliminate or reduce the noise source of various frequencies.

[0068] Fourth, the pressure difference is eliminated in the refrigerant pipe, and the expansion device expands the refrigerant uniformly, thereby improving the evaporating efficiency and thus improving the thermal efficiency of the air conditioner.

[0069] And finally, since the silencer is designed to combine the filtering function and the noise suppressing function, the space occupied by the indoor unit may be reduced.

[0070] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention. For example, the silencer may be provided at the refrigerant pipe of the outdoor unit, as well as the indoor unit. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

[0071] Summarized, a cooling/heating system used in an air conditioner is disclosed. The cooling/heating system comprises at least one silencer coupled in series to

a refrigerant pipe which is coupled to an expansion device of an indoor unit, for eliminating a local pressure difference of a refrigerant flowing therein and for making a mixed state of gas and liquid uniform. The silencer comprises a body direct coupled to the refrigerant pipe for making the refrigerant flow through therein, and a porous tube provided in the body, with a buffer space being formed between an outer periphery thereof and an inner periphery of the body, the porous tube having a plurality of passing holes for communicating an interior thereof with the buffer space.

Claims

1. A cooling/heating system used in an air conditioner, the cooling/heating system comprising at least one silencer (30) coupled in series to a refrigerant pipe which is coupled to an expansion device (21) of an indoor unit (20), for eliminating a local pressure difference of a refrigerant flowing therein and for making a mixed state of gas and liquid uniform.
2. A cooling/heating system used in an air conditioner, the cooling/heating system comprising an outdoor unit (10) equipped with a compressor (11) and an outdoor heat exchanger (13); and at least one indoor unit (20) equipped with an indoor heat exchanger (22) and an expansion device (21) which are coupled to the compressor (11) and the outdoor heat exchanger (13) through a refrigerant pipe, and at least one silencer (30) coupled in series to a refrigerant pipe which is coupled to the expansion device (21) of the indoor unit (20), for eliminating a local pressure difference of a refrigerant flowing therein and for making a mixed state of gas and liquid uniform.
3. The cooling/heating system as claimed in claim 1 or 2, wherein the silencer (30) is provided at a refrigerant inlet side or/and a refrigerant outlet side of the expansion device (21).
4. The cooling/heating system as claimed in one of claims 1 to 3, wherein the silencer (30) comprises:
 - a body (31) direct coupled to the refrigerant pipe for making the refrigerant flow through therein; and
 - a porous tube (33) provided in the body (31), with a buffer space (34) being formed between an outer periphery thereof and an inner periphery of the body (31), the porous tube (33) having a plurality of passing holes (33a) for communicating an interior thereof with the buffer space (34).
5. The cooling/heating system as claimed in claim 4, wherein the porous tube (33) is provided in such a way that both ends thereof having a diameter larger than a middle portion thereof are fitted to an inner periphery of the body (31).
6. The cooling/heating system as claimed in claim 4 or 5, wherein the porous tube (33) is provided in such a way that both ends thereof having an enlarged diameter larger than a middle portion thereof having a constant diameter along its longitudinal direction are fitted to an inner periphery of the body (31).
7. The cooling/heating system as claimed in one of claims 4 to 6, wherein the silencer (30) further comprises a screen (32) formed of a mesh type, and positioned in an inside of the body (31) such that the refrigerant flows through the screen (32).
8. The cooling/heating system as claimed in one of claims 1 to 3, wherein the silencer comprises:
 - a body (31) direct coupled to the refrigerant pipe for making the refrigerant flow through therein; and
 - a screen (32) formed of a mesh type, and positioned in an inside of the body (31) such that the refrigerant flows through the screen (32).
9. The cooling/heating system as claimed in claim 7 or 8, wherein the screen (32) is vertically provided in the inside of the body (31).
10. The cooling/heating system as claimed in one of claims 7 to 9, wherein the screen (32) is provided at an end side of the body (31) which is in close to the expansion device (21).
11. The cooling/heating system as claimed in one of claims 4 to 10, wherein the body (31) has a middle portion having a diameter larger than that of both ends.
12. The cooling/heating system as claimed in one of claims 4 to 11, wherein the body (31) has a middle portion of a uniform diameter along its longitudinal direction, and diameters of both ends being gradually expanded facing the middle portion.

FIG.1

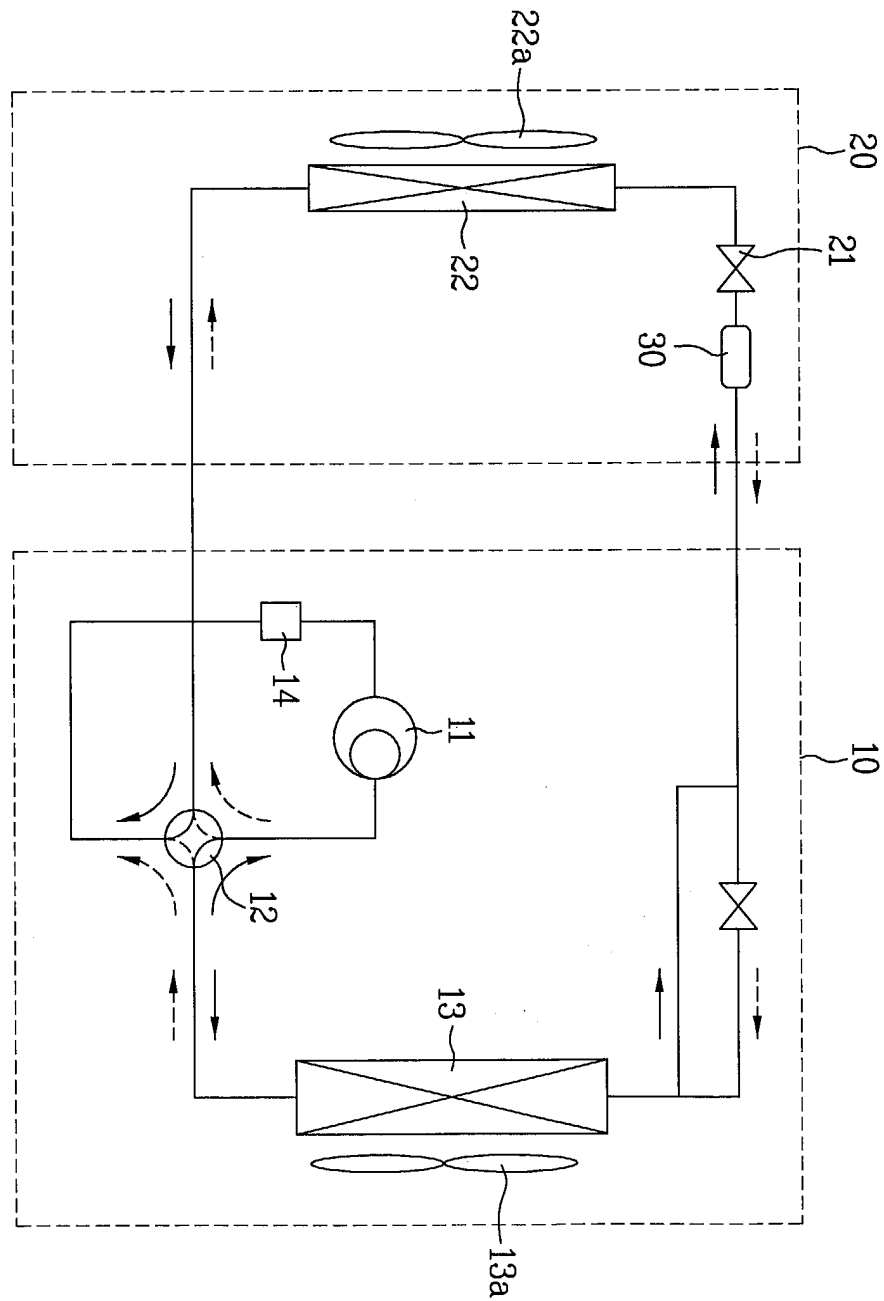


FIG. 2

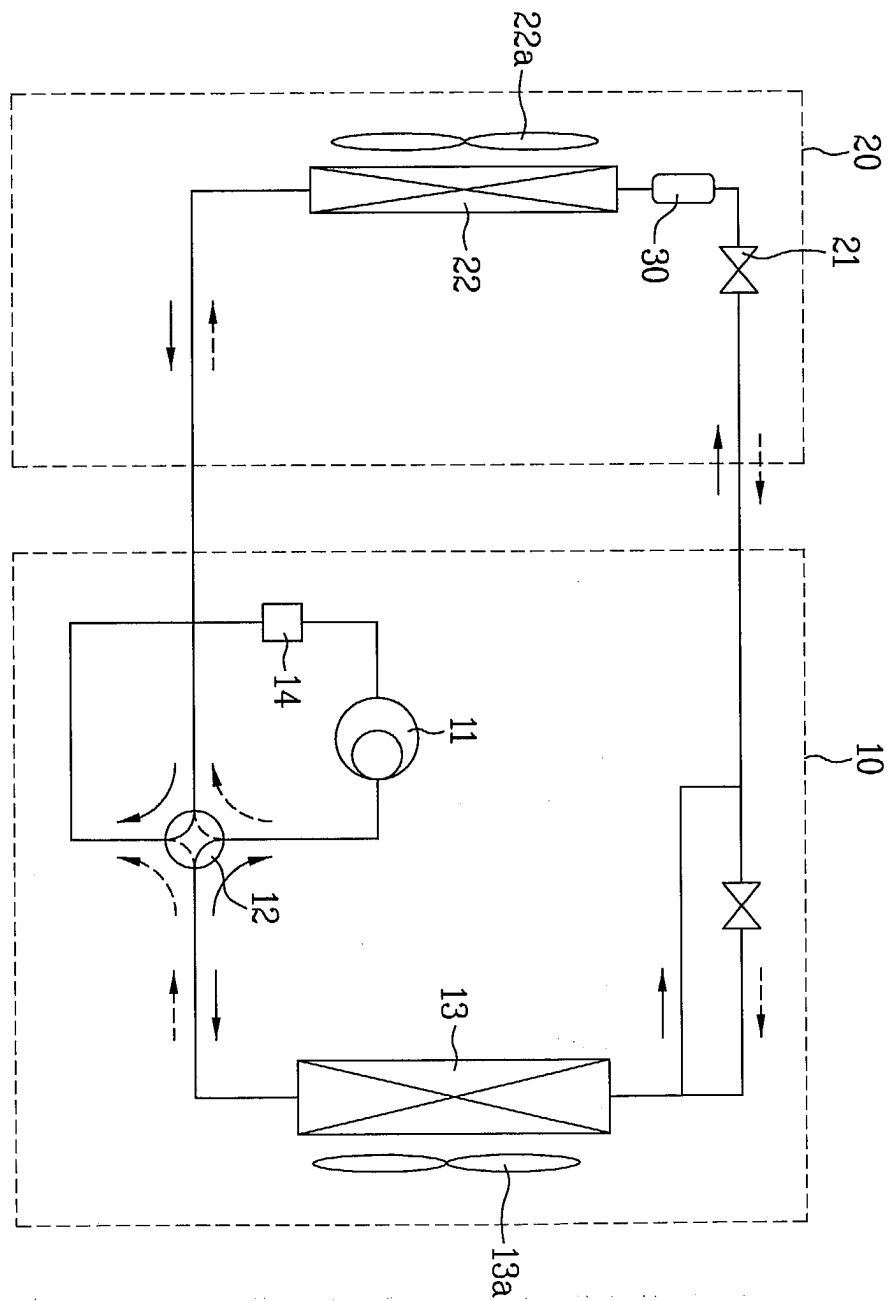


FIG. 3

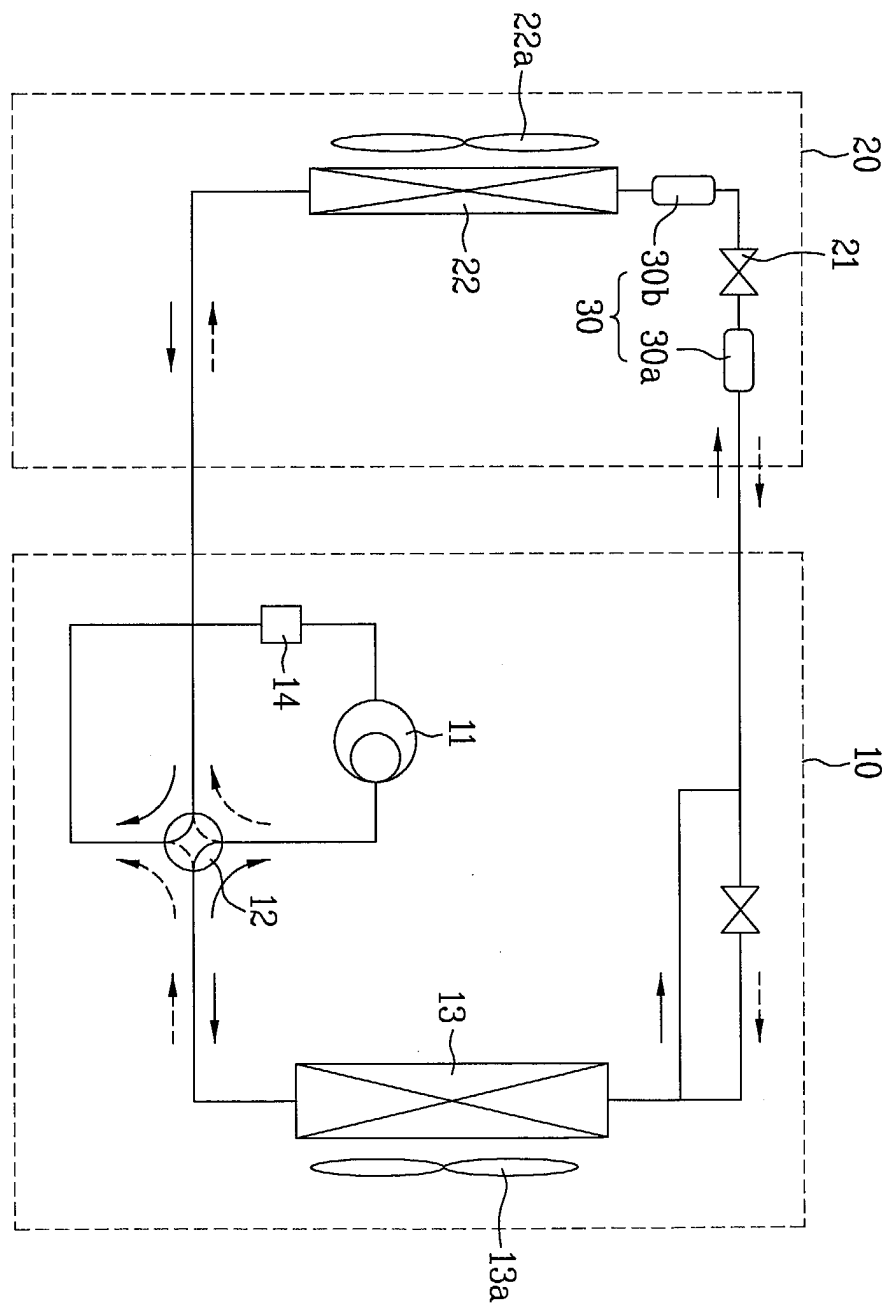


FIG. 4

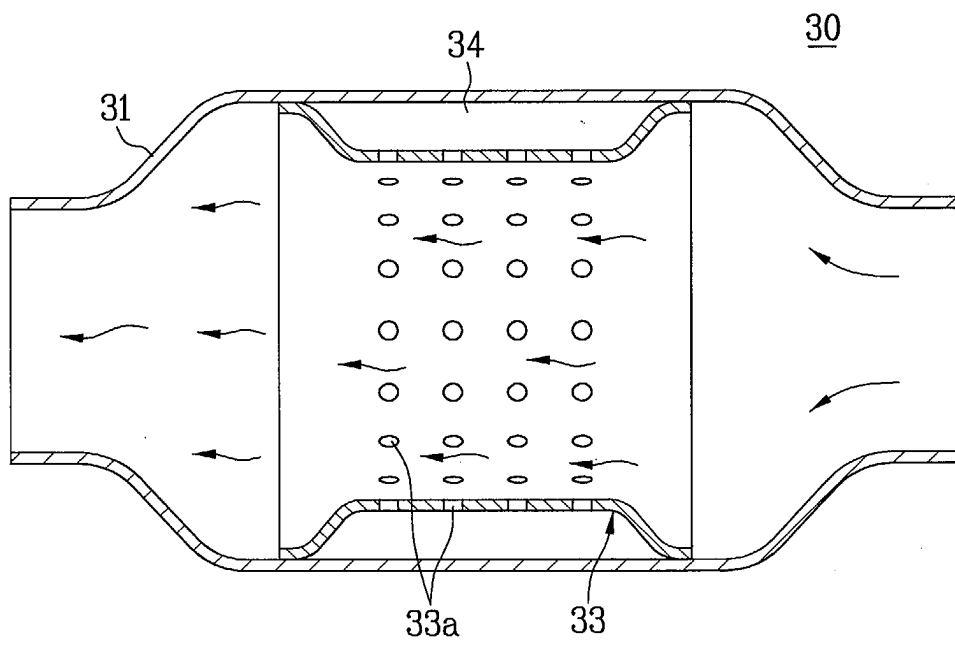


FIG. 5

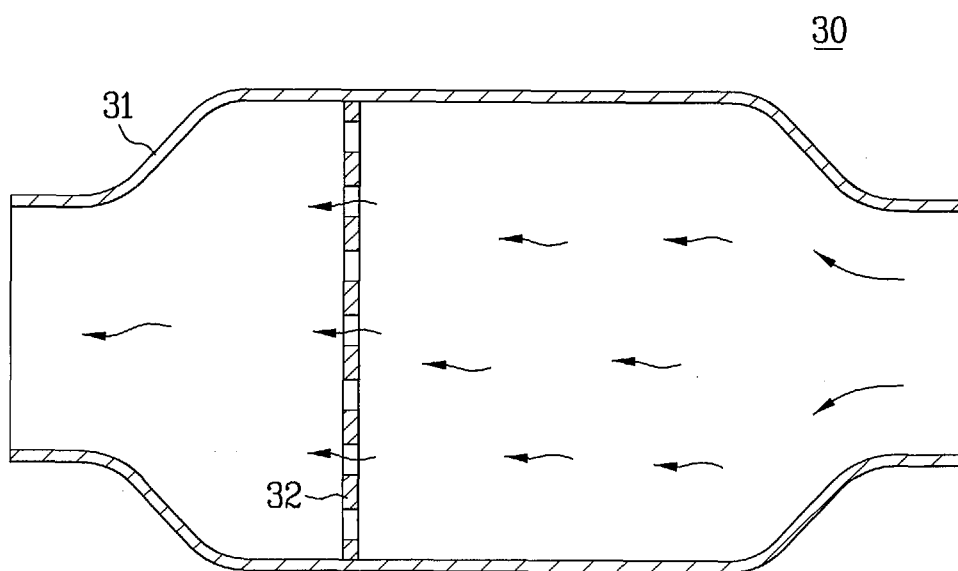


FIG. 6

