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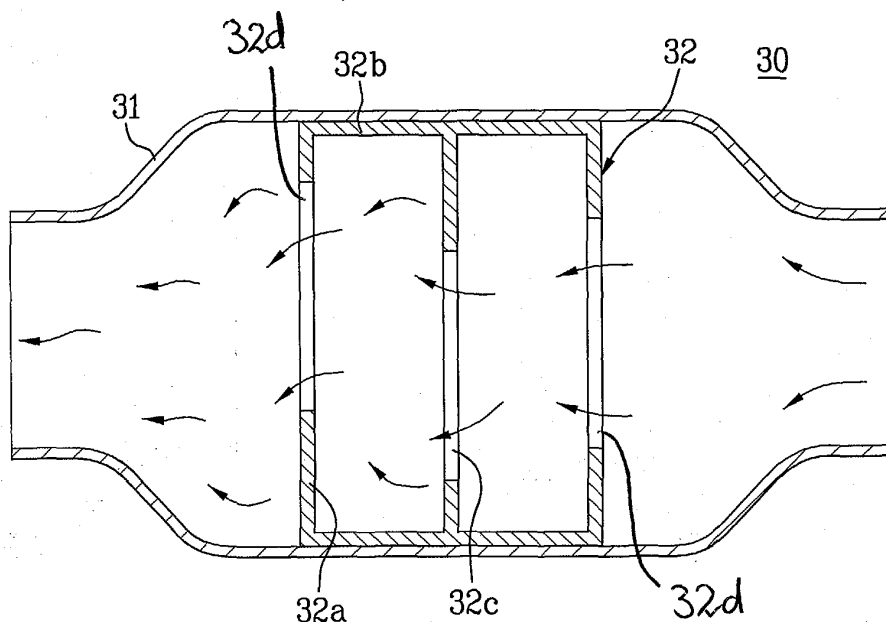
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(54) **Heating/cooling system used in air conditioner**

(57) A cooling/heating system used in an air conditioner comprises a silencer (30) comprising at least one body (31) coupled in series to a refrigerant pipe which is coupled to an expansion device (21) of an indoor unit (20), and a spatial comparting member (32) provided in such a way that an inner space of the body (31) is com-

parted across a flowing direction of a refrigerant, the spatial comparting member (32) being perforated with a refrigerant passing hole (32c), through which the refrigerant flows. The silencer (30) further comprises a screen (33) formed of a mesh type, and positioned in an inside of the body (31) such that the refrigerant flows through the screen (33).

FIG. 4



Description

[0001] The present invention relates to an air conditioner, and more particularly, to a heating/cooling system used in an air conditioner capable of reducing noise caused by refrigerant flow.

[0002] Generally, air conditioner is an apparatus to cool/heat air in a space by absorbing or radiating heat from or into the surroundings when a working fluid undergoes a phase change.

[0003] The air conditioner generally comprises an outdoor unit and an indoor unit. They are often classified as common air conditioners, comprising one outdoor unit and one indoor unit; and multiple-type air conditioners, comprising one outdoor unit coupled with a number of indoor units. Regardless of the kind of the above-mentioned common or multiple-type air conditioner, the operating principle of the cooling/heating system used in the air conditioner is substantially similar, except for the number of indoor units.

[0004] 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.

[0005] 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 enables the refrigerant to absorb or emit the heat, thereby cooling or heating the space to be air-conditioned.

[0006] 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.

[0007] 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. 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.

[0008] In particular, in the heating mode, the refrigerant passed through the outdoor heat exchanger flows into the expansion device in a dual phase state comprising a liquid phase and gas phase. Also, in the cooling mode, the refrigerant passed through the indoor heat exchanger flows into the expansion device in a dual phase state.

[0009] 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 noise to be produced and the evaporating efficiency to be reduced, thereby lowering the heat exchange capacity.

[0010] Furthermore, when the refrigerant of mixed gas and liquid phases flows along a refrigerant pipe, the pressure of the refrigerant is unevenly distributed in the refrigerant pipe which causes the flow to be noisy and the flow capability thereof to be reduced, thereby lowering the thermal efficiency of the air conditioner.

[0011] 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.

[0012] 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.

[0013] Another object of the present invention is to provide a heating/cooling system used in an air conditioner capable of improving flow capacity of refrigerant through a refrigerant pipe and thus improving its evaporating efficiency, thereby increasing the thermal efficiency of the air conditioner.

[0014] 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.

[0015] The present invention is defined in the accompanying independent claims. Some preferred features are recited in the dependent claims.

[0016] According to one embodiment of the invention, there is provided a cooling/heating system used in an air conditioner, the cooling/heating system comprising: a silencer comprising at least one body coupled in series to a refrigerant pipe which is coupled to an expansion device of an indoor unit, and a partition provided in such a way that an inner space of the body is partitioned across a flowing direction of a refrigerant, the partition being perforated with a refrigerant passing hole, through which the refrigerant flows.

[0017] The silencer is provided at a refrigerant inlet side of the expansion device, at a refrigerant outlet side of the expansion device, or at the refrigerant inlet and

outlet sides of the expansion device, respectively.

[0018] The body has a middle portion having a diameter larger than that of both ends. Alternatively, the body has a middle portion of a uniform diameter along its longitudinal direction, the diameter of each end being gradually expanded toward the middle portion.

[0019] The partition comprises at least two plates provided vertically to the flow direction of the refrigerant. The refrigerant passing hole each formed at the comparing plates is not opposite to each other.

[0020] A plurality of comparing plates are vertically protruded from an inside of a cylindrical tube. At that time, the outer periphery of the tube is closely contacted with the inner periphery of the body.

[0021] The spatial comparing member is provided in such a way that an outer periphery of the tube is closely contacted with an inner periphery of the body. Alternatively, the comparing plate is integrally and vertically protruded an inner periphery of the body.

[0022] The silencer may further comprise a screen formed, for example, of a mesh, positioned inside the body such that the refrigerant flows through the screen. The screen may be vertically arranged in the body, and at an end of the body toward the expansion device.

[0023] 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:

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

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

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;

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

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

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

[0024] Reference will now be made in detail to the preferred 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.

[0025] Referring to FIGs. 1 to 3, a cooling/heating system used in an air conditioner according to one embodiment of the present invention generally comprises an indoor unit 10 and an outdoor unit 20.

[0026] The outdoor unit 10 is equipped with a compressor 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.

[0027] 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.

[0028] Specifically, the silencer 30 may be provided at a refrigerant inlet side of the expansion device 21, as shown in FIG. 1.

[0029] Alternatively, the silencer 30 may be provided at a refrigerant outlet side of the expansion device 21, as shown in FIG. 2.

[0030] Furthermore, the silencer 30 may be provided at both the refrigerant inlet and outlet sides of the expansion device 21, respectively. In this case, the silencer 30 comprises 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.

[0031] The silencer 30 provided as described above comprises a body 31 and a partition 32 which eliminates any localised pressure difference in the refrigerant as it flows through, based on a principle similar to an expansion-type muffler or partition-type muffler, such that the refrigerant uniformly flows in the silencer 30 to reduce the flow/expansion noise of the refrigerant. The construction of the silencer may be realized in various embodiments, as shown in FIGs. 4 to 6.

[0032] Referring to FIG. 4 showing one embodiment of the silencer, it comprises the body 31 and the spatial comparing member 33 provided in the body 31. The body 31 is directly coupled to the refrigerant pipe by inlet and outlet apertures so as to pass the refrigerant. 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 ends each has a diameter gradually expanding from the corresponding aperture to the middle portion.

[0033] The compartment member 32 is provided in such a way that the inner space of the body 31 is partitioned across the flow direction of the refrigerant. The compartment member 32 has a refrigerant passing aperture 32c. In this embodiment the compartment mem-

ber 32 comprises at least two partition plates 32a each positioned perpendicularly to the flow direction of the refrigerant. The respective plates 32a are also formed with refrigerant passing apertures 32d that are laterally offset with respect to in such a way that the refrigerant passing apertures 32c/d are not aligned. Where the refrigerant passing aperture 32c is arranged as described above, as shown in FIG. 4, the path of the refrigerant is not a straight path, but curved. In the embodiment, the compartment member 32 is constituted by a number of plates 32a inside a cylindrical sleeve 32b, as shown in FIG. 4. The sleeve 32b is closely contacted to the inner surface of the body 31.

[0034] With the silencer 30 constructed in accordance with the embodiment shown in FIG. 4, the refrigerant flowing along the body 31 of the silencer 30 is diffused in the interior of the body 31. The refrigerant flows along the curved path through the refrigerant passing apertures 32c/d in the plates 32a, such that local pressure differences in the refrigerant is eliminated so that it flows in the uniform state, thereby suppressing the flow noise of the refrigerant. The principle of the silencer is substantially similar to that of an expansion-type or partition-type muffler.

[0035] Referring to FIG. 5 showing the silencer according to another embodiment, the silencer 30 comprises a body 31, a spatial compartment member 32, and a screen 33.

[0036] The structure and position of the body 31 and the spatial compartment member 32 are substantially similar to those of the embodiment shown in FIG. 4, respectively, and so the description thereof will not be repeated.

[0037] The screen 33 is formed as a mesh, and is positioned inside the body 31 such that the refrigerant flows through it. Preferably, the screen 33 is laterally arranged in the body 31, and in particular, is provided at the end of the body on the expansion device 21 side.

[0038] Where the silencer 30 is constructed as the embodiment shown in FIG. 5, the refrigerant flows through the body 31 of the silencer 30, and is diffused in the interior of the body 31. The refrigerant follows the curved path within the compartment member 32 to eliminate the local pressure differences. In addition, the refrigerant passes through the mesh-type screen 33, such that impurities contained in the refrigerant are filtered, and simultaneously, the liquid phase contained in the refrigerant is mixed with the gas phase. Accordingly, the local pressure difference of the refrigerant is eliminated, and thus the flow noise of the refrigerant is further suppressed, compared with the embodiment shown in FIG. 4.

[0039] Referring to FIG. 6 showing the silencer according to another embodiment, the silencer 30 comprises a body 31, a compartment member 32 and a screen 33. The structure and position of the body 31, the compartment member 32 and the screen 33 are substantially similar to those of the embodiment shown in

FIG. 5, respectively, and so the description thereof will be omitted herein. However, the structure of the compartment member 32 is slightly different from that of the embodiment shown in FIG. 5. Specifically, the plate 32a is provided at the inside of the body 31 (see embodiment shown in FIG. 5), but the plates 32d are integral with and laterally extend across the inside of the body.

[0040] 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 5.

[0041] First of all, it will be described in a cooling mode, in which the flow of the refrigerant is as indicated by the solid line in the figures.

[0042] The refrigerant compressed by the compressor 11 is fed to the outdoor heat exchange 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 the dual phase state of mixed gas and liquid.

[0043] The refrigerant condensed in the dual 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 along the curved path within the spatial compartment member 32 to eliminate the local pressure difference and thus maintain the evenly mixed state. Then the uniformly mixed refrigerant passes through the mesh-type screen 33 for more uniform mixing of the gas and the liquid phases, before it flows into the expansion device 21.

[0044] The refrigerant of having no local pressure difference because of the uniform mixing of the gas phase and the liquid phase is expanded by the expansion device 21. At that time, the expansion pressure is evenly applied to the refrigerant, such that the flow noise of the refrigerant remarkably is suppressed relative to the conventional cooling/heating apparatus of expanding the non-uniformly mixed refrigerant.

[0045] The refrigerant passing through the expansion device 21 is then fed to the second silencer 30b. The refrigerant flows into the body 31 through the compartment member 32 and the screen 33. Since the refrigerant flows in the uniform state, the flow noise of the refrigerant is remarkably suppressed relative to the case in which a local pressure difference existed.

[0046] The uniformly mixed refrigerant 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 room to be cooled. It is also found that there is also an improved evaporation efficiency by discharging the refrigerant in the more 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.

[0047] Thereafter, 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.

[0048] It will now be described in a heating mode, in which a flow direction of the refrigerant is indicated by a dotted line in the figures.

[0049] The refrigerant compressed at 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 dual phase state of mixed 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.

[0050] The refrigerant condensed in the dual 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 dual phase state or liquid phase state at low temperature and low pressure.

[0051] 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 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, in a similar manner to the cooling mode.

[0052] The cooling/heating system used in the air conditioner according to the present invention has following advantages.

[0053] First, since the refrigerant converted into a uniform state by the silencer flows into the expansion device, the present invention reduces the noise produced when the refrigerant expands in the expansion device.

[0054] Second, since the refrigerant expanded by the expansion device is converted into the uniform dual phase state by the silencer, the local pressure difference is eliminated in the refrigerant tube, thereby preventing any flow noise from being produced due to the pressure difference.

[0055] Third, the pressure difference is eliminated in the refrigerant pipe, and the refrigerant is uniformly expanded by the expansion device, thereby improving the evaporating efficiency and thus improving the thermal efficiency of the air conditioner.

[0056] Finally, since the silencer serves as a filter and the body and compartment member serve as a noise

suppressor, the space occupied by the indoor unit may be reduced. In addition, the connection of piping may be simplified.

[0057] 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. Also, a number of partition plates may not be integrally formed with the body, but can separately inserted and fixed to the body. 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.

Claims

1. A heat exchange system for use in an air conditioner, the system comprising:

a silencer comprising at least one body coupled in series with an expansion device of an indoor unit, and a partition member provided in such a way that an inner space of the body is partitioned across a flow direction through the body, the partition member being apertured to allow fluid flow.

2. The system as claimed in claim 1, wherein the silencer is provided at an inlet side of the expansion device.
3. The system as claimed in claim 1, wherein the silencer is provided at an outlet side of the expansion device.
4. The system as claimed in claim 1, wherein the silencer is provided at both an inlet side and an outlet side of the expansion device, respectively.
5. The system as claimed in claim 1, wherein the body has a middle portion having a diameter larger than that of both ends.
6. The system as claimed in claim 1, wherein the body has a middle portion of uniform dimensions along its longitudinal direction, the dimensions of both ends being gradually expanded toward the middle portion.
7. The system as claimed in any preceding claim, wherein the partition member comprises at least two plates arranged across the flow direction through the body.
8. The system as claimed in claim 7, wherein the aperture formed in each plate are offset laterally with respect to each other.

9. The system as claimed in claim 7, wherein a plurality of plates are laterally arranged inside a sleeve.
10. The system as claimed in claim 9, wherein the partition member is arranged with an outer surface of the sleeve in close contact with an inner surface of the body. 5
11. The system as claimed in claim 7, wherein the partition plate is integral with and laterally arranged across an inner surface of the body. 10
12. The system as claimed in any preceding claim, wherein the silencer further comprises a screen in the form of a mesh positioned inside the body such that the refrigerant flows through the screen. 15
13. The system as claimed in claim 12, wherein the screen is laterally arranged across the inside of the body. 20
14. The system as claimed in claim 12, wherein the screen is arranged at an end of the body toward the expansion device. 25
15. The system of any preceding claim, including:
- an outdoor unit equipped with a compressor and a first heat exchanger, the silencer being coupled in series with a second heat exchanger and the expansion device of the indoor unit which are coupled to the compressor and the first heat exchanger. 30

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FIG.1

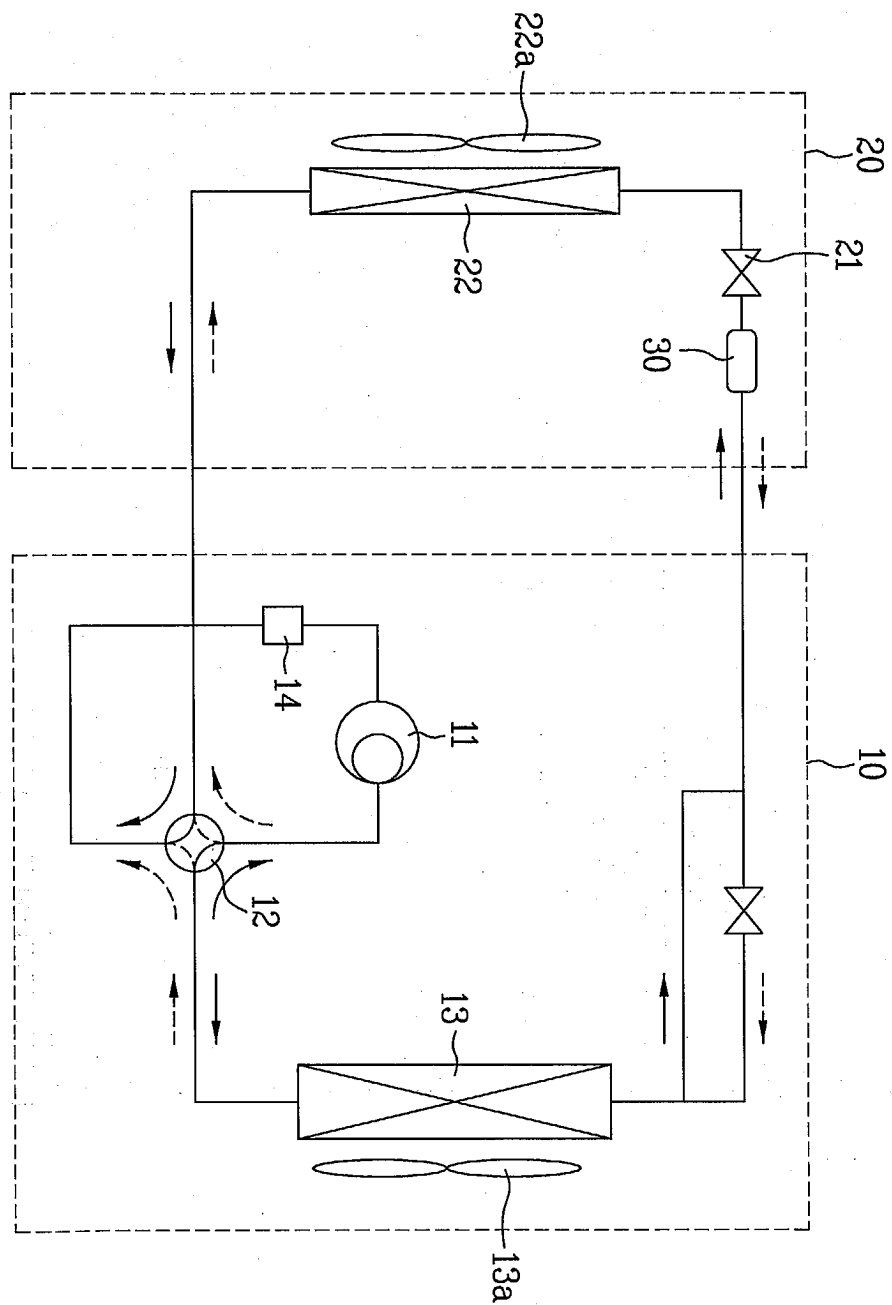


FIG.2

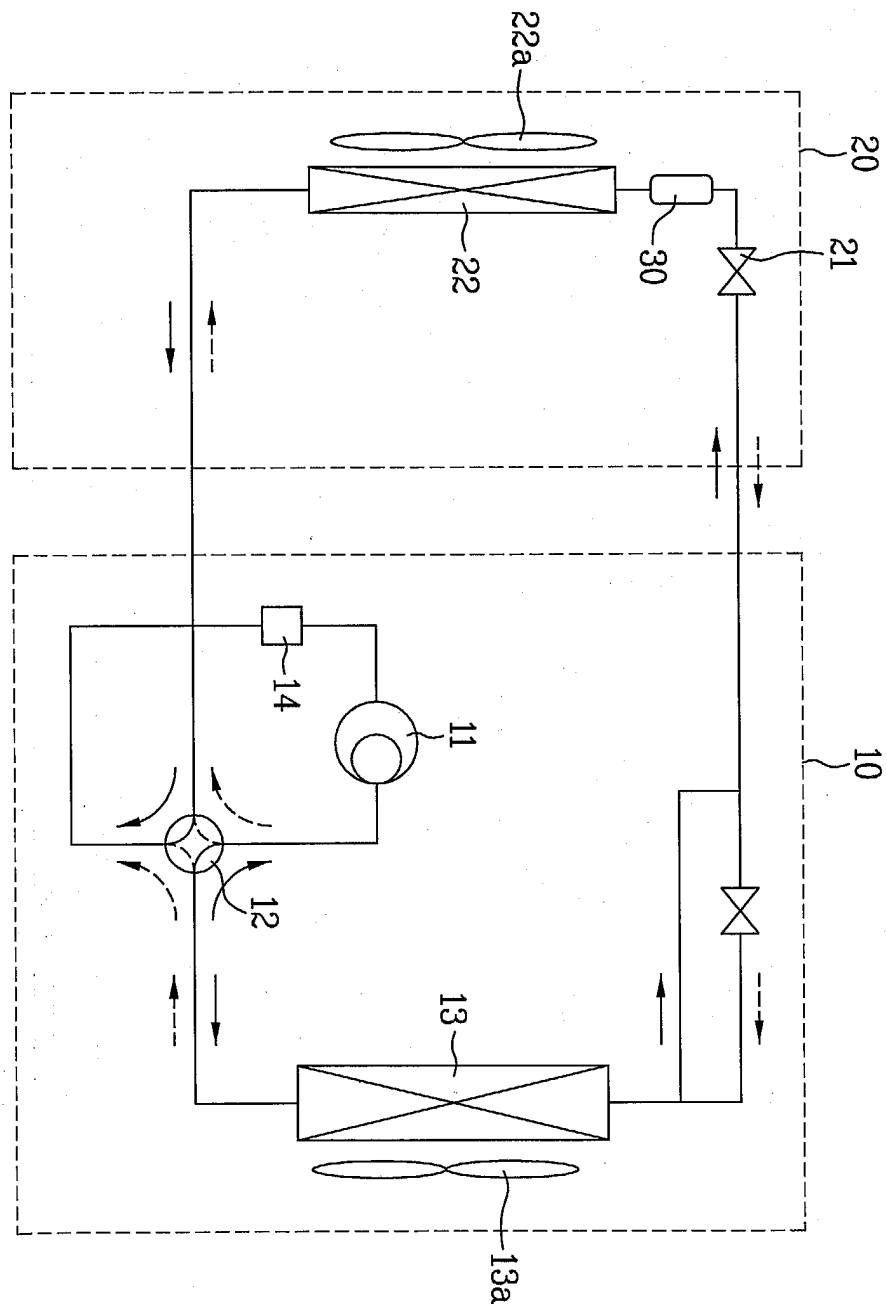


FIG. 3

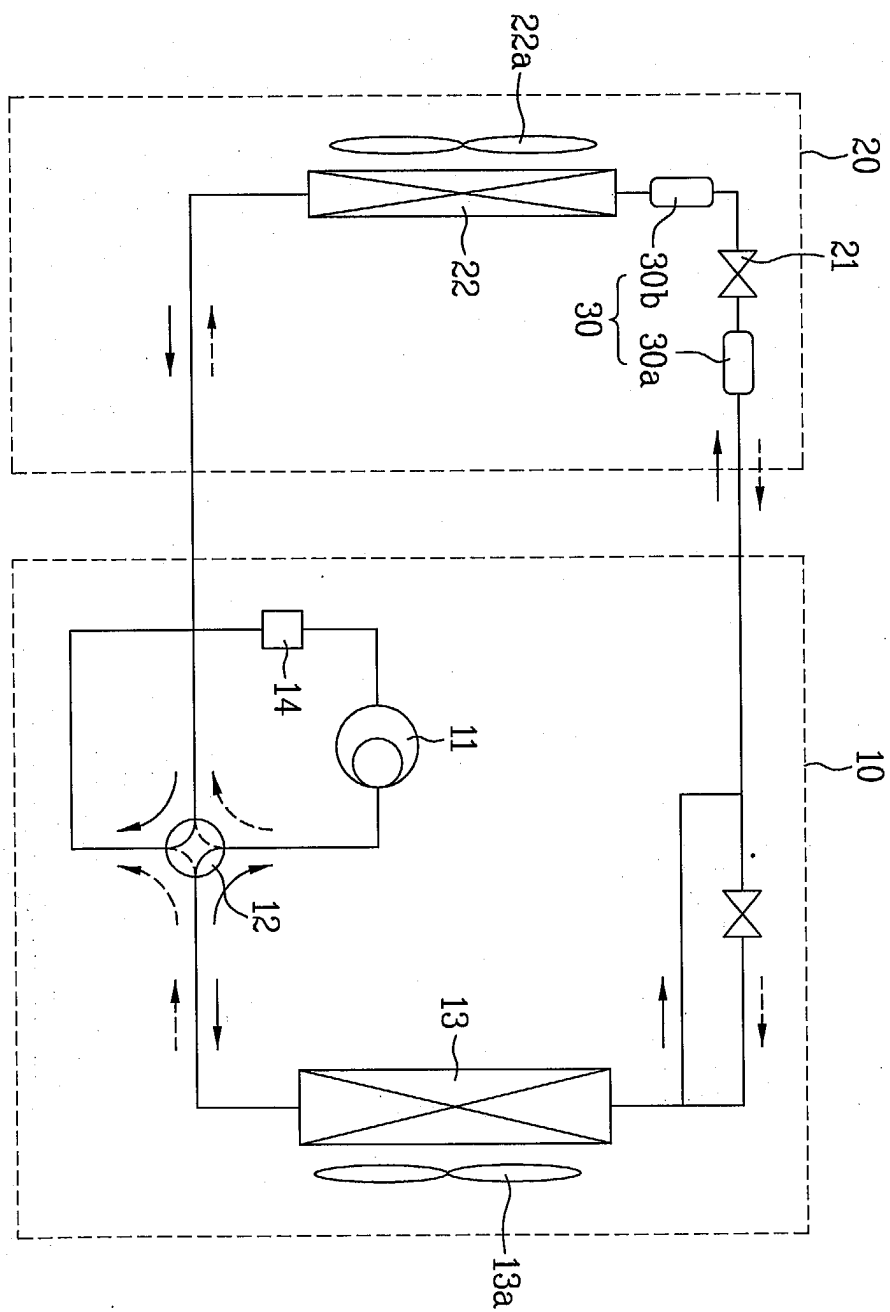


FIG. 4

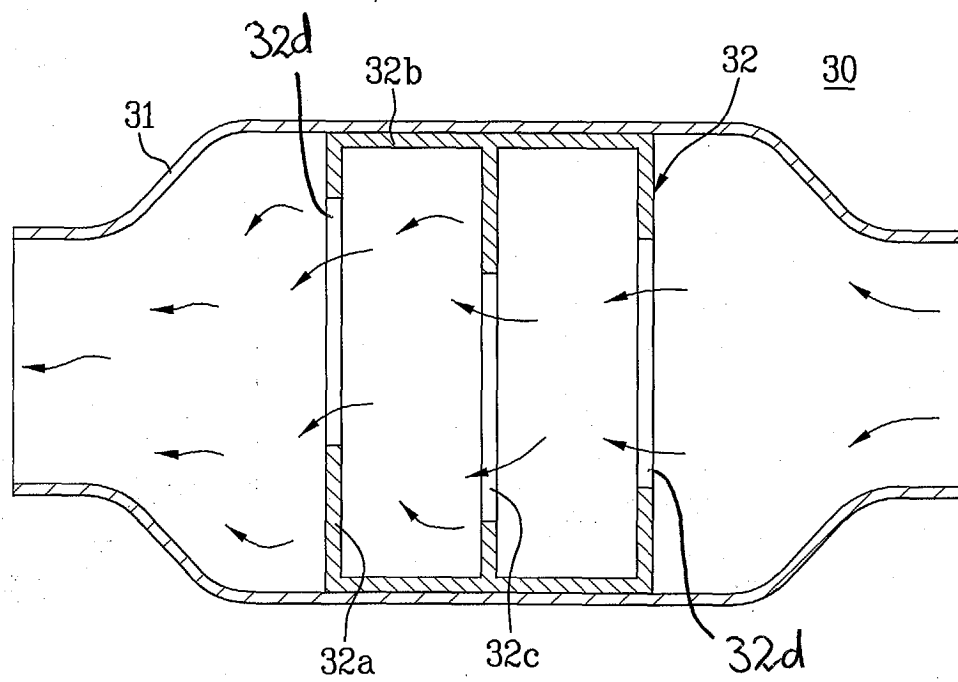


FIG. 5

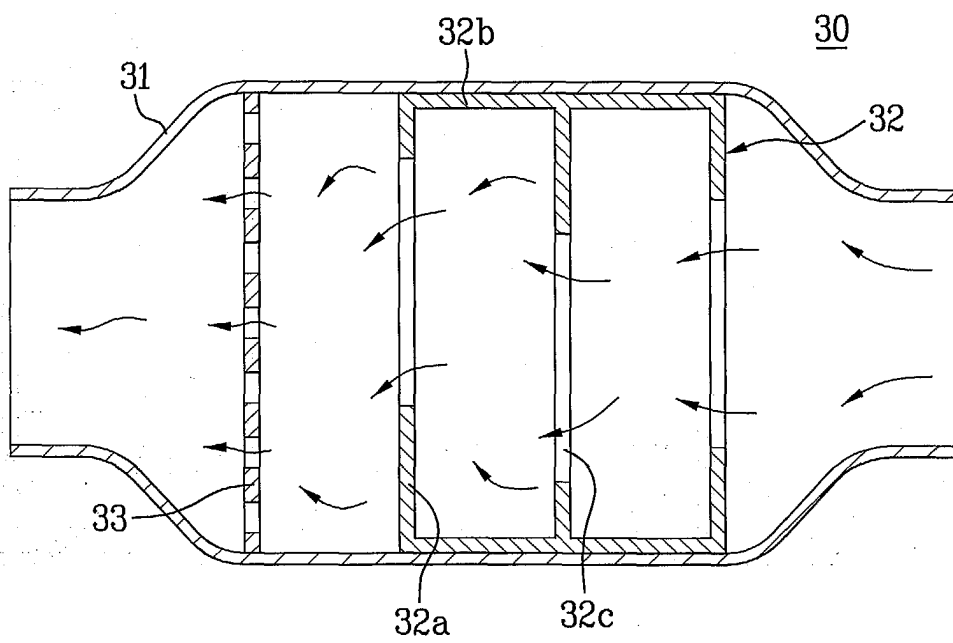


FIG. 6

