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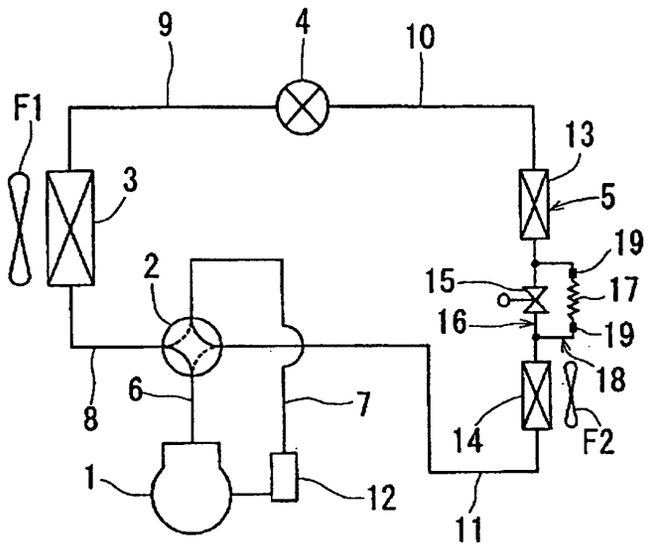
(54) AIR CONDITIONER

(57) A first heat exchanger (13) and a second heat exchanger (14) are connected to each other by a main passageway (16) having an on-off valve (15). The on-off valve (15) is bypassed by using a throttle passageway (18) having a capillary tube (17) . In a closed state of the on-off valve (15), the first heat exchanger (13) functions as a condenser and the second heat exchanger (14) functions as an evaporator, so that the air conditioner performs a reheat dehumidifying operation by which air of a room is cooled for moisture removal and then reheated and returned into the room. The throttle passageway (18) is provided with a flow-regulating member (19) . In this manner, an air conditioner with reduced vibration and capable of performing a stable reheat dehumidifying operation is provided.

FIG. 1



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Description

TECHNICAL FIELD

[0001] The present invention relates to an air conditioner.

BACKGROUND ART

[0002] An air conditioner is known, which has, as shown in Fig. 15, a compressor 51, a four-way valve 52, an outdoor heat exchanger 53, a pressure-reducing mechanism 54, and an indoor heat exchanger 55 and is capable of performing a reheat dehumidifying operation.

[0003] That is, the indoor heat exchanger 55 has a first heat exchanger 57 and a second heat exchanger 58. The first heat exchanger 57 and the secondheat exchanger 58 are connected to each other by a main passageway 60 having an on-off valve 59, and the on-off valve 59 is bypassed by using a throttle passageway 62 having a capillary tube 61. A discharge passageway and a sucking passageway of the compressor 51 are connected to primary ports of the four-way valve 52 respectively, and a refrigerant circuit from one secondary port of the four-way valve 52 to the other secondary port of the four-way valve 52 via the outdoor heat exchanger 53, the pressure-reducing mechanism 54, the indoor heat exchanger 55, etc. is constructed. In the air conditioner shown in Fig. 15, an accumulator 56 is installed on a sucking pipe of the compressor 51.

[0004] Therefore when the compressor 51 is driven with the four-way valve 52 switched to a state shown with a solid line, with the on-off valve 59 placed in an open state, and with an electric motor-driven valve constructing the pressure-reducing mechanism 54 set to a controlled opening, the outdoor heat exchanger 53 functions as a condenser and the indoor heat exchanger 55 functions as an evaporator. As a result, a cooling operation is performed. When the compressor 51 is driven with the four-way valve 52 switched to a state shown with a broken line, with the on-off valve 59 placed in the open state, and with the electric motor-driven valve constructing the pressure-reducing mechanism 54 set to a controlled valve opening, the indoor heat exchanger 55 functions as the condenser and the outdoor heat exchanger 53 functions as the evaporator. As a result, a heating operation is performed.

[0005] When the compressor 51 is driven with the four-way valve 52 switched to the state shown with a solid line, with the pressure-reducing mechanism 54 placed in a fully open state, and with the on-off valve 59 placed in a closed state, a refrigerant flows through a throttle passageway 62, and the first heat exchanger 57 functions as the condenser and the second heat exchanger 58 functions as the evaporator. Thereby a reheat dehumidifying operation is performed. The reheat dehumidifying operation is an operation of cooling indoor air by the second heat exchanger 58 serving as the evaporator to dehumidify the air and thereafter reheating the air by the first heat exchanger 57 functioning as the condenser and returning it to a room. In the reheat dehumidifying operation, by mixing the air dehumidified by cooling with air heated by a heater (in this case, the first heat exchanger), it is possible to generate a refreshing air having a proper temperature.

[0006] As described above, by performing the reheat dehumidifying operation, it is possible to generate refreshing air having a proper temperature. However, when the refrigerant (gas-liquid two-phase flow) flows through the throttle passageway 62 having the capillary tube 61, vibrations of piping are generated owing to nonuniformity of the refrigerant. Thus a refrigerant sound or noise (flow sound) is generated. As described above, the capillary tube 61 is provided between the first heat exchanger 57 and the second heat exchanger 58 of the indoor heat exchanger 55. This means that the refrigerant sound is emitted from an indoor unit installed in the room. Therefore the room cannot be maintained quiet, which is a cause of giving an unpleasant feeling to a user.

DISCLOSURE OF THE INVENTION

[0007] The present invention has been made to solve the above-described disadvantages of the conventional art. Therefore, it is an object of the present invention to provide an air conditioner making low vibrations and noises and capable of performing a reliable reheat dehumidifying operation.

[0008] The present invention provides an air conditioner in which a first heat exchanger and a second heat exchanger are connected to each other by a main passageway having an on-off valve, the on-off valve is bypassed by using a throttle passageway having a capillary tube, and in a closed state of the on-off valve, the first heat exchanger functions as a condenser and the second heat exchanger functions as an evaporator such that the air conditioner performs a reheat dehumidifying operation by which air of a room is cooled for moisture removal and then reheated and returned into the room, the air conditioner being characterized in that the throttle passageway is provided with a flow-regulating member.

[0009] In the air conditioner having the above-described construction, when the air conditioner is actuated (operated) with the on-off valve placed in the closed state, a refrigerant flows through the throttle passageway and the first heat exchanger functions as the condenser, while the second heat exchanger functions as the evaporator. Thus, the air conditioner is allowed to perform a reheat dehumidifying operation in which the indoor air is cooled for dehumidification and then reheated and returned into the room. By the reheat humidifying operation, air dehumidified by cooling is mixed with air heated by a reheater, so that refreshing air having a proper temperature can be generated. Therefore it is

possible to keep the interior of the room as a refreshing space having a proper temperature and humidity.

[0010] Because the flow-regulating member is installed on the throttle passageway, the refrigerant (gas-liquid two-phase flow) flowing through the throttle passageway is made uniform and it is possible to reduce the sound of the refrigerant and vibrations of piping. Thus, it is possible to construct a stable refrigerant circuit and allow the interior of the room to be a quiet and calm space.

[0011] In one embodiment, the flow-regulating member is provided upstream and/or downstream of the capillary tube.

[0012] When the flow-regulating member is provided upstream of the capillary tube, the gas-liquid two-phase flow of the refrigerant is made uniform before the refrigerant passes the capillary tube, so that the refrigerant passes the capillary tube in the uniformalized state and is reduced in its pressure. Thereby a muffling effect is displayed. Particularly because the refrigerant is reduced in its pressure while it is flowing, a pulsating flow of the refrigerant in the capillary tube becomes continuous and vibration of the piping is reduced.

[0013] When the flow-regulating member is disposed downstream of the capillary tube, the refrigerant is reduced in its pressure by the capillary tube and then uniformalized in its flow. In this case, it is also possible to obtain a vibration-reducing effect and hence a muffling effect.

[0014] When the flow-regulating member is disposed both at the upstream side and at the downstream side, the flow regulation, the pressure reduction, and the flow regulation are performed in this order, whereby vibration reduction or suppression can be accomplished more reliably.

[0015] In one embodiment, the throttle passageway is connected to the main passageway at a position where a gas-rich refrigerant flows preferentially. The "gas-rich refrigerant" means a refrigerant composed mostly of a gas.

[0016] That is, the gaseous refrigerant flows preferentially through the throttle passageway. Therefore it is possible to prevent pulsations from being generated, which would occur if a gaseous refrigerant is mixed into a liquid refrigerant that is flowing preferentially. Thus, it is possible to achieve formation of a quieter refrigerant circuit.

[0017] In one embodiment, the throttle passageway is provided with a muffler, and the flow-regulating member is accommodated inside the muffler.

[0018] Owing to a pulsation suppression action by the muffler combined with a refrigerant-uniformalizing action by the flow-regulating member, it is possible to display a more effective vibration-reducing effect.

[0019] When the flow-regulating member is constructed of a netted or meshy material, it is possible to provide the flow-regulating member having a simple construction at a low cost. Further the netted material displays a superior function as the flow-regulating member.

[0020] For example, the flow-regulating member may be composed of a roll of the netted material that is formed in a thin-plate shape. Thus, the flow-regulating member is easy to manufacture and assemble. Further because the axial direction of the flow-regulating member is aligned with the flow direction of the refrigerant, it is possible to suppress a pressure loss. Thereby the reheat dehumidifying operation can be accomplished stably.

[0021] As the netted material, a disk-shaped netted material can be used instead of the rolled material. The disk-shaped netted material is also disposed with an axial direction thereof aligned with a flow direction of a refrigerant.

[0022] In one embodiment, the flow-regulating member is disposed near an outlet and/or an inlet of the throttle passageway. Therefore a work of disposing the flow-regulating member on the throttle passageway can be performed easily. Thereby it is possible to perform the work of assembling the air conditioner simply and achieve improvement of productivity and reduction of the cost.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023]

Fig. 1 is a schematic view showing an embodiment of the air conditioner of the present invention;
Fig. 2 is a schematic view showing a throttle passageway of the air conditioner;
Fig. 3 is an enlarged perspective view of a flow-regulating member of the air conditioner;
Fig. 4 is a schematic view showing a first modificationof the throttlepassagewayof the air conditioner;
Fig. 5 is a schematic view showing a second modificationof the throttlepassagewayof the air conditioner;
Fig. 6 is a schematic view showing a third modificationof the throttle passageway of the air conditioner;
Fig. 7 is a schematic view showing a fourth modificationof the throttlepassagewayof the air conditioner;
Fig. 8 is an enlarged perspective view of another flow-regulating member of the air conditioner;
Fig. 9 is a schematic view showing a fifth modificationof the throttle passageway of the air conditioner;
Fig. 10 is a schematic view showing a sixth modification of the throttle passageway of the air conditioner;
Fig. 11 is a schematic view showing a seventh modification of the throttle passageway of the air conditioner;
Fig. 12 is a schematic view showing an eighth modificationof the throttle passageway of the air conditioner;
Fig. 13 is a schematic view showing a ninth modifi-

cation of the throttle passage way of the air conditioner;

Fig. 14 is a schematic view showing a tenth modificationof the throttle passage way of the air conditioner; and

Fig. 15 is a schematic view showing a conventional air conditioner.

BEST MODE FOR CARRYING OUT THE INVENTION

[0024] The embodiments of the air conditioner of the present invention will be described in detail below with reference to the drawings. Fig. 1 is a schematic view of the air conditioner. The air conditioner has a compressor 1, a four-way valve 2, an outdoor heat exchanger 3, an expansion valve 4, and an indoor heat exchanger 5.

[0025] In this case, a discharge pipe 6 and a sucking pipe 7 of the compressor 1 are connected to respective primary ports of the four-way valve 2. One secondary port of the four-way valve 2 and the outdoor heat exchanger 3 are connected to each other by a first gas pipe 8. The outdoor heat exchanger 3 and the expansion valve 4 are connected to each other by a first liquid pipe 9, and the expansion valve 4 and the indoor heat exchanger 5 are connected to each other by a second liquid pipe 10, and the indoor heat exchanger 5 and the other secondary port of the four-way valve 2 are connected to each other by a second gas pipe 11. An accumulator 12 is mounted on the sucking pipe 7, and fans F1, F2 are provided for the outdoor heat exchanger 3 and the indoor heat exchanger 5, respectively.

[0026] The indoor heat exchanger 5 has a first heat exchanger 13 and a second heat exchanger 14 disposed in series with the first heat exchanger 13. The first heat exchanger 13 and the second heat exchanger 14 are connected to each other by a main passageway 16 having an on-off valve 15. The on-off valve 15 is bypassed by using a throttle passageway 18 having a capillary tube 17. In this case, flow-regulating members 19, 19 are installed on the throttle passageway 18.

[0027] That is, as shown in Fig. 2, the main passageway 16 has branch portions 20, 21 at its upstream side (inlet side) and downstream side (outlet side) respectively. An upstream-side branch pipe 22 branched from the upstream-side branch portion 20 is connected to an upstream end of the capillary tube 17. A downstream-side branch pipe 23 branched from the downstream-side branch portion 21 is connected to a downstream end of the capillary tube 17. The flow-regulating member 19 is inserted into each of the branch pipes 22, 23. As shown in Fig. 3, the flow-regulatingmember 19 is constructed of a rolled material 25 formed by rolling a thin-plate like netted material (so-called mesh). The rolled material 25 formed in this way is disposed such that its axial direction matches the flow direction of a refrigerant flowing through the throttle passageway 18. When forming the rolled material 25, a thin netted material is rolled either clockwise or counterclockwise. Although it is possible to select various degrees of coarseness of the mesh to be used, as will be described later, it is necessary that the mesh has such a degree of coarseness that the formed rolled material 25 allows the flowing refrigerant to form a uniform flow so that sounds are muffled.

[0028] The air conditioner constructed as described above is capable of performing a cooling operation, a heating operation, and a reheat dehumidifying operation. In the cooling operation and the heating operation, each of the fans F1, F2 is driven with the on-off valve 15 of the main passageway 16 placed in a fully open state and with the expansion valve 4 controlled to have a specifiedvalve opening. In the cooling operation, with the four-way valve 2 switched to a state shown with a solid line, the compressor 1 is driven; thereby the refrigerant flows in the order of the compressor 1, the four-way valve 2, the outdoor heat exchanger 3, the expansion valve 4, the indoor heat exchanger 5 (the first heat exchanger 13 and the second heat exchanger 14), the four-way valve 2, and the accumulator 12. The outdoor heat exchanger 3 functions as a condenser, while the indoor heat exchanger 5 (the first heat exchanger 13 and the second heat exchanger 14) functions as an evaporator. In this way, the cooling operation is performed.

[0029] In the heating operation, with the four-way valve 2 switched to a state shown with a broken line, the compressor 1 is driven. Then, the refrigerant flows in the order of the compressor 1, the four-way valve 2, the indoor heat exchanger 5 (the first heat exchanger 13 and the second heat exchanger 14), the expansion valve 4, the outdoor heat exchanger 3, the four-way valve 2, and the accumulator 12. The indoor heat exchanger 5 (the first heat exchanger 13 and the second heat exchanger 14) functions as the condenser, while the outdoor heat exchanger 3 functions as the evaporator. In this way, the heating operation is performed.

[0030] In the reheat dehumidifying operation, with the expansion valve placed in a fully open state and the on-off valve 15 of the main passageway placed in a closed state, the four-way valve 2 is switched to the state shown with the solid line. Also, the outdoor fan F1 is stopped and the indoor fan F2 is driven. Then, the compressor 1 is driven. When the compressor 1 is driven in this state, the refrigerant flows to the throttle passageway 18. The first heat exchanger 13 of the indoor heat exchanger 5 functions as the condenser, while the second heat exchanger 14 functions as the evaporator. Thereby indoor air is cooled and dehumidified by the second heat exchanger 14 functioning as the evaporator, and thereafter heated by the first heat exchanger 13 functioning as the condenser and returned to a room. That is, air cooled and dehumidified is mixed with air heated by a reheater (i.e., the first heat exchanger 13), whereby refreshing air having a proper temperature is generated. In the reheat dehumidifying operation, the outdoor heat exchanger 3 is capable of functioning as the condenser.

But by stopping the fan F1 as described above, circulation of air around the periphery of the outdoor heat exchanger 3 is prevented to thereby perform as little heat exchange as possible by the outdoor heat exchanger 3.

[0031] In this case, as described above, because the flow-regulating members 19, 19 are installed on the throttle passageway 18, a damping, or vibration-reducing effect is displayed. This is because the refrigerant (gas-liquid two-phase flow) flowing through the throttle passageway 18 is made uniform by the flow-regulating members 19, 19, so that pulsations of the refrigerant and vibrations of pipes are reduced. Before the gas-liquid two-phase flow passes the capillary tube 17, this flow is made uniform by the flow-regulating member 19 disposed upstream of the capillary tube 17. Thus, the gas-liquid two-phase flow in the uniformalized state passes the capillary tube 17 and is depressurized there. Therefore discontinuous sound is reduced, and a superior vibration-suppressing effect is obtained. Furthermore, the flow of the pressure-reduced refrigerant is regulated (uniformalized) by the other flow-regulating member 19 disposed downstream of the capillary tube 17, which contributes to further reduction of vibration. Vibration reduction, or damping can be achieved more effectively by disposing the flow-regulating members 19, 19 both upstream and downstream of the capillary tube 17 than by disposing one flow-regulating member 19 only upstream or downstream of the capillary tube 17, so that it is possible to make the interior of the room quieter and more refreshing and keep the temperature thereof at a proper temperature.

[0032] Because the flow-regulating members 19, 19 are disposed near the inlet and outlet of the throttle passageway 18, the flow-regulating members 19 can be inserted easily into the throttle passageway 18, and the refrigerant circuit can be assembled simply. In Fig. 2, although the flow-regulating member 19 is shown disposed in the upstream-side branch pipe 22 and the downstream-side branch pipe 23, the flow-regulating member 19 may be disposed in only the upstream-side branch pipe 22 as shown in Fig. 4, or in only the downstream-side branch pipe 23 as shown in Fig. 5.

[0033] Referring now to Fig. 6, the throttle passageway 18 is connected to the main passageway 16 at a position where a gas-rich refrigerant flows preferentially. The gas-rich refrigerant means a refrigerant composed mostly of a gas. In this case, the upstream-side branch pipe 22 is disposed upward of the main passageway with respect to a gravity direction to thereby flow the gas-rich refrigerant preferentially (To the contrary, in the throttle passageways 18 shown in Figs. 2, 4, and 5, the upstream-side branch pipe 22 branches downward in the gravity direction) . The flow-regulating member 19 is placed within the upstream-side branch pipe 22. In this case, although the other flow-regulating member 19 is placed in the downstream-side branch pipe 23, the flow-regulating member 19 of the downstream-side branch pipe 23 may be omitted.

[0034] As described above, when the throttle passageway 18 is disposed at the position where the gas-rich refrigerant flows preferentially, the gaseous refrigerant flows through the throttle passageway 18 preferentially. Therefore it is possible to prevent pulsations from being generated owing to mixing of a gaseous refrigerant into a liquid refrigerant that flows preferentially, so that a more quiet refrigerant circuit is realized.

[0035] In Fig. 7, a muffler 27 is installed on the throttle passageway 18, and further the flow-regulating member 19 is inserted (accommodated) in the muffler 27. In this case, the muffler 27 is disposed at the upstream-side branch pipe 22. As shown in Fig. 8, the flow-regulating member 19 is composed of a disk-shaped material 28 formed from a netted material (mesh). The axial direction of the flow-regulating member 19 is aligned with the flow direction of the refrigerant. In Fig. 9, the downstream-side branch pipe 23 is provided with the muffler 27 accommodating the flow-regulating member 19. In Fig. 10, each of the upstream-side branch pipe 22 and the downstream-side branch pipe 23 is provided with the muffler 27 accommodating the flow-regulating member 19. Further in Fig. 11, the upstream-side branch pipe 22 is provided with the muffler 27 accommodating two flow-regulating members 19, 19.

[0036] Therefore, according to the throttle passageways 18 shown in Figs. 7, 9, 10, and 11, owing to the pulsation suppression action by the muffler 27 and, in addition, the liquid-uniformalizing action by the flow-regulating member (s) 19, it is possible to make the refrigerant circuit quieter.

[0037] In Fig. 12, similarly to the throttle passageway 18 shown in Fig. 6, the upstream-side branch pipe 22 is disposed at the position where the gas-rich refrigerant flows preferentially, and the muffler 27 accommodating the flow-regulating member 19 is installed at the upstream-side branch pipe 22. Further, in Fig. 13, the upstream-side branch pipe 22 is projected vertically from the branch portion 20, and further the muffler 27 accommodating the flow-regulating member 19 is installed to the upstream-side branch pipe 22 and the downstream-side branch pipe 23. Therefore in these refrigerant circuits, similarly to the refrigerant circuit shown in Fig. 6, it is possible to accomplish a stable operation (refrigerant circulation) with few pulsations.

[0038] In Fig. 14, the flow-regulatingmember 19 composed of a disk-shaped material (mesh) 28 shown in Fig. 7 is replaced with the flow-regulating member 19 composed of the rolled material 25 shown in Fig. 3. In this case as well, the axial direction of the flow-regulating member 19 matches, or is aligned with the flow direction of the refrigerant. Therefore owing to the pulsation suppression action by the muffler 27 and the liquid-uniformalizing action by the flow-regulating member 19, it is possible to make the refrigerant circuit quiet.

[0039] The present invention is not limited to the embodiments described above, but can be altered and modified within the scope of the present invention. For

example, the flow-regulating member 19 may have a honeycomb construction or made of a punching metal. Further in the throttle passageways 18 shown in Figs. 2, 4, 5, and 6, the disk-shaped material 28 shown in Fig. 8 may be used as the flow-regulating member 19. Also, in the throttle passageways 18 shown in Figs. 7, 9, 10, 11, 12, and 13, the rolled material 25 shown in Fig. 3 may be used as the flow-regulating member 19. Further when the flow-regulating member 19 is disposed at both of the branch pipes 22, 23, the flow-regulating member composed of the disk-shaped material 28 may be used for one of the branch pipes 22, 23 and the flow-regulating member composed of the rolled material 25 may be used for the other. The number of the flow-regulating members 19 to be disposed on each of the branch pipes 22, 23 is not limited to one or two but may be three or more. For the flow-regulating member 19, it is necessary to decide the coarseness of the mesh, the number of turns (in the case of the rolled material 25), and the thickness (in the case of the disk-shaped material 28) in consideration of its flow-regulating function and a pressure loss. In Fig. 2 and other figures, the flow-regulating member 19 is disposed in the vicinity of the inlet and/or outlet of the throttle passageway 18, namely, in the vicinity of an upstream end of the branch pipe 22 and/or in the vicinity of a downstream end of the branch pipe 23. However, the location where the flow-regulating member 19 is disposed may be in the vicinity of the capillary tube 17 or the central portion of the branch pipes 22, 23. In the throttle passageway having the muffler 27 as shown, for example, in Fig. 7, instead of disposing the muffler 27 at a central portion of the branch pipe 22, 23, the muffler 27 may be disposed in the vicinity of the upstream end or downstream end of the branch pipe.

Claims

1. An air conditioner in which a first heat exchanger (13) and a second heat exchanger (14) are connected to each other by a main passageway (16) having an on-off valve (15), the on-off valve (15) is bypassed by using a throttle passageway (18) having a capillary tube (17), and in a closed state of the on-off valve (15) , the first heat exchanger (13) functions as a condenser and the second heat exchanger (14) functions as an evaporator such that the air conditioner performs a reheat dehumidifying operation by which air of a room is cooled for moisture removal and then reheated and returned into the room,

   characterized in that:

   the throttle passageway (18) is provided with a flow-regulating member (19).

2. An air conditioner according to claim 1, wherein the flow-regulating member (19) is provided upstream and/or downstream of the capillary tube (17).

3. An air conditioner according to claim 1, wherein the throttle passageway (18) is connected to the main passageway (16) at a position where a gas-rich refrigerant flows preferentially.

4. An air conditioner according to claim 1, wherein the throttle passageway (18) is provided with a muffler (27), and the flow-regulating member (19) is accommodated inside the muffler (27).

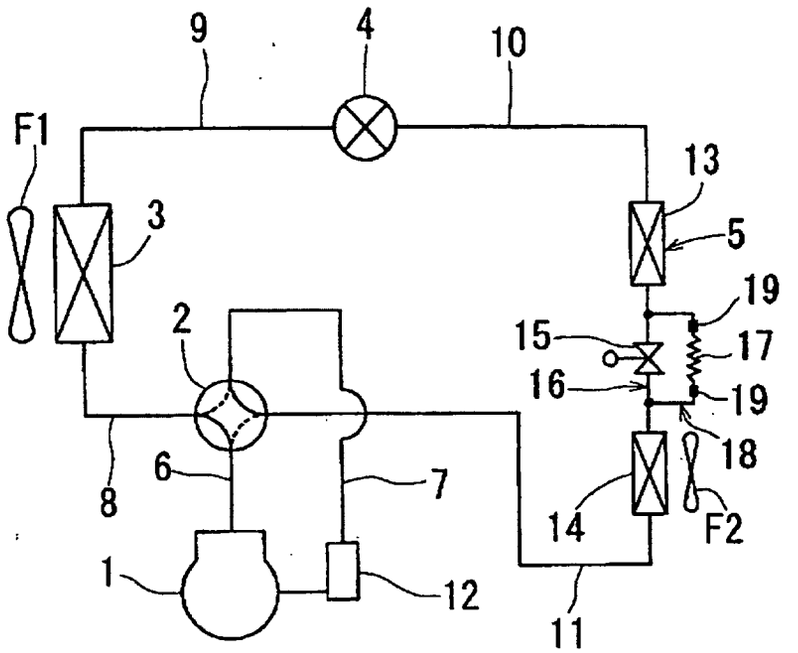
5. An air conditioner according to claim 1, wherein the flow-regulating member (19) is composed of a netted material (25, 28).

6. An air conditioner according to claim 5, wherein the flow-regulating member (19) is composed of a roll (25) of the netted material that is formed in a thin-plate shape, and the roll (25) is disposed with an axial direction thereof aligned with a flow direction of a refrigerant.

7. An air conditioner according to claim 5, wherein the netted material (28) is formed in a shape of a disk and disposed with an axial direction thereof aligned with a flow direction of a refrigerant.

8. An air conditioner according to claim 1, wherein the flow-regulating member (19) is disposed near an outlet and/or an inlet of the throttle passageway (18).

FIG. 1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4
10
F1
13
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17
16
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6
7
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14
F2
1
12
11

FIG. 2

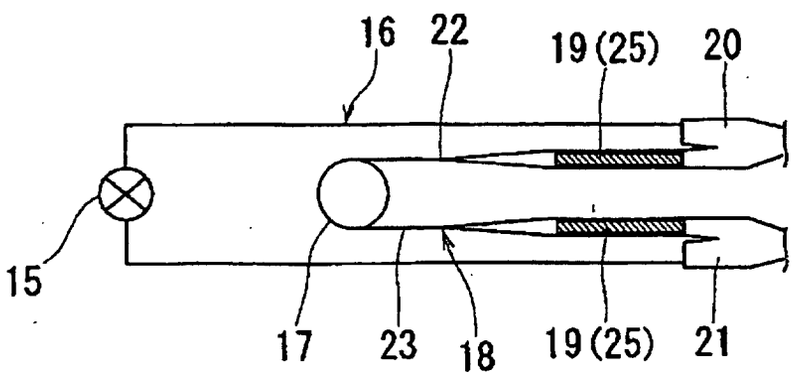

16
22
19 (25)
20
15
17
23
18
19 (25)
21

FIG. 3

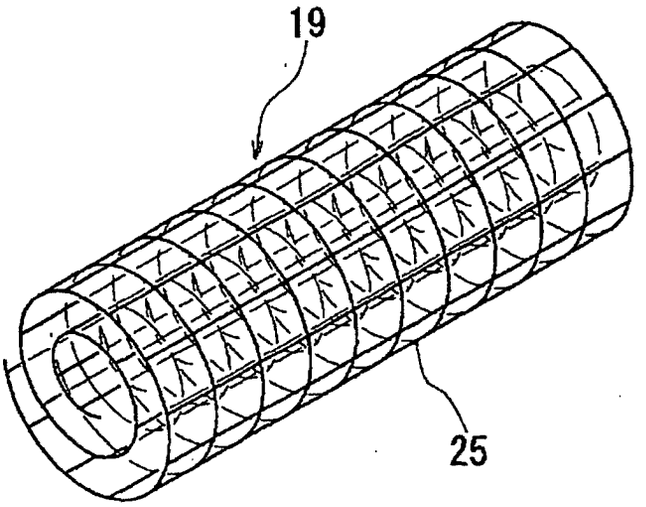


FIG. 4

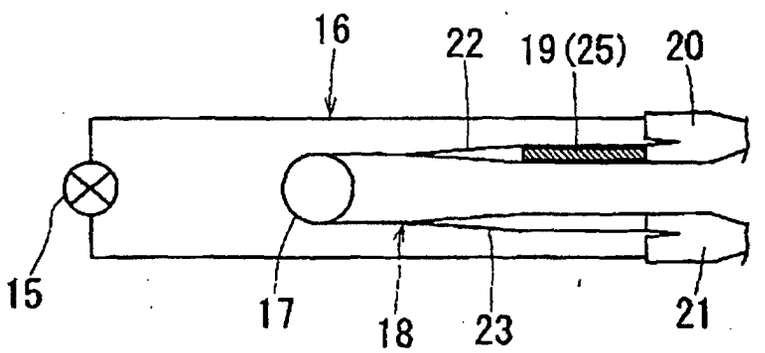


FIG. 5

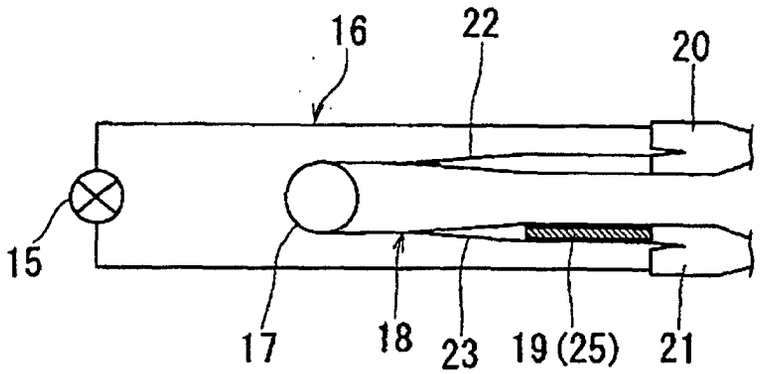


FIG. 6

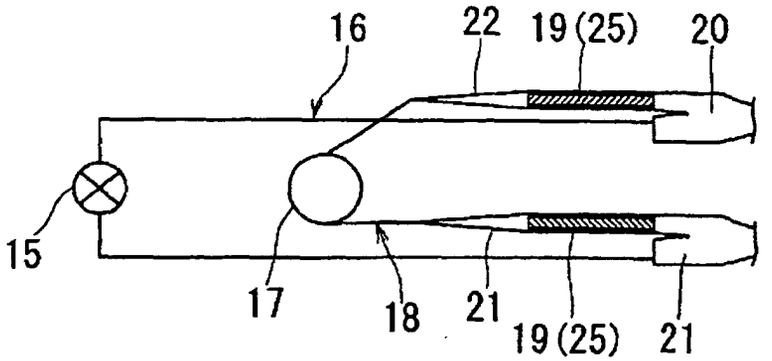


FIG. 7

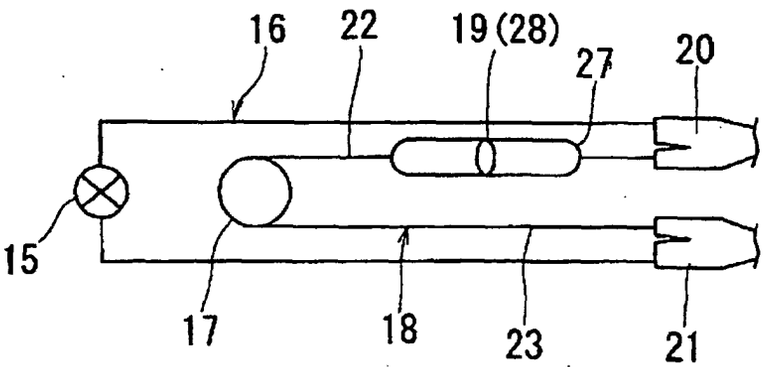


FIG. 8

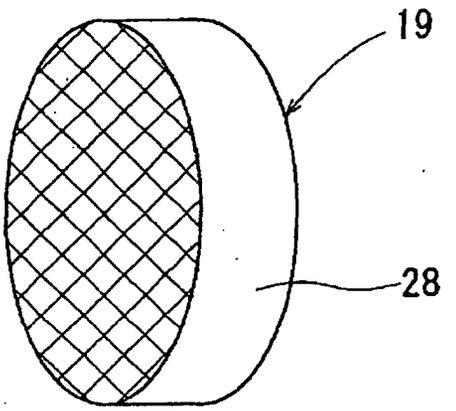


FIG. 9

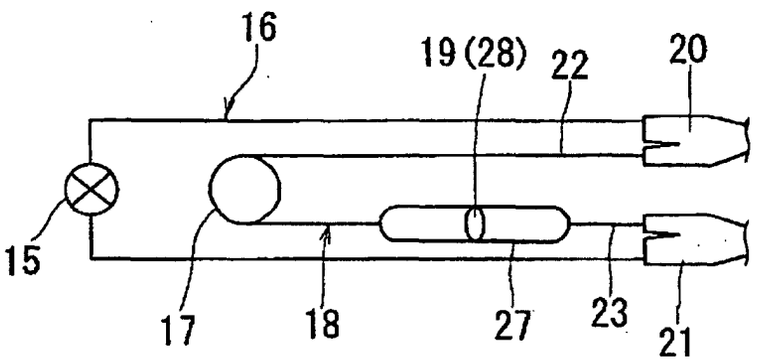


FIG. 10

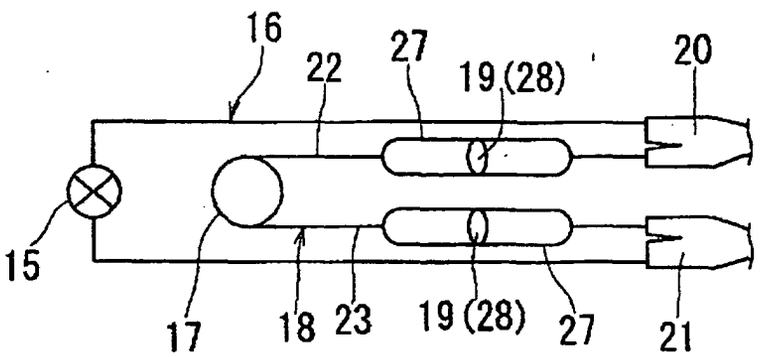


FIG. 11

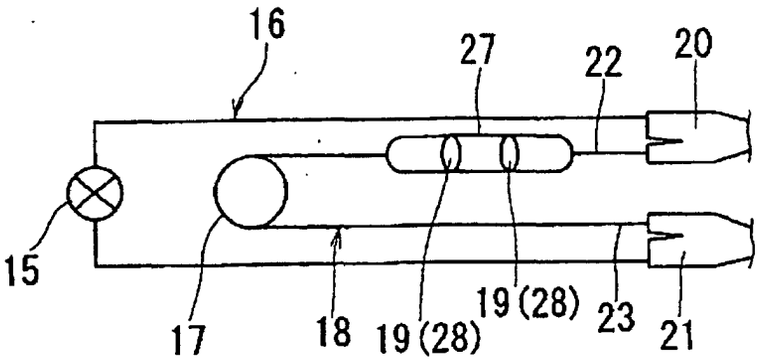


FIG. 12

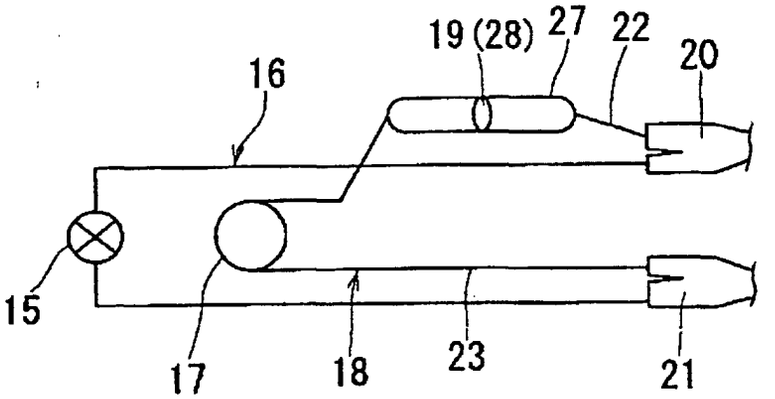


FIG. 13

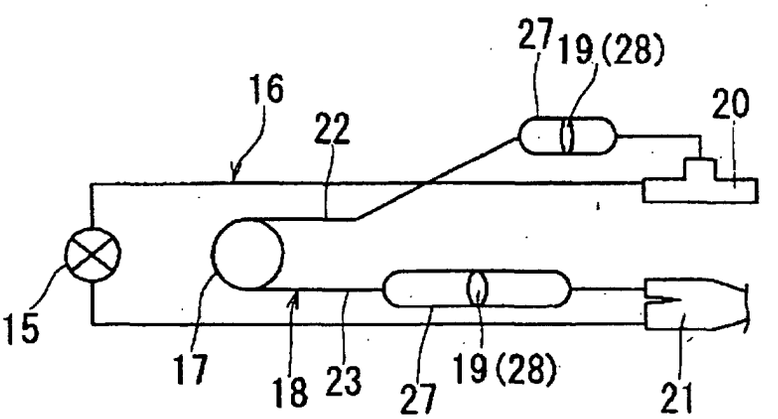


FIG. 14

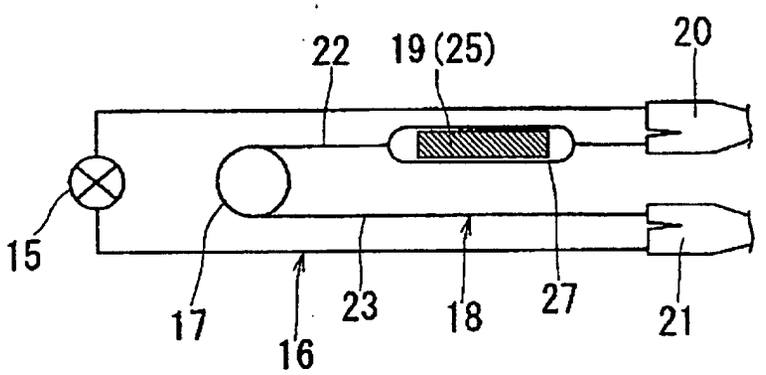
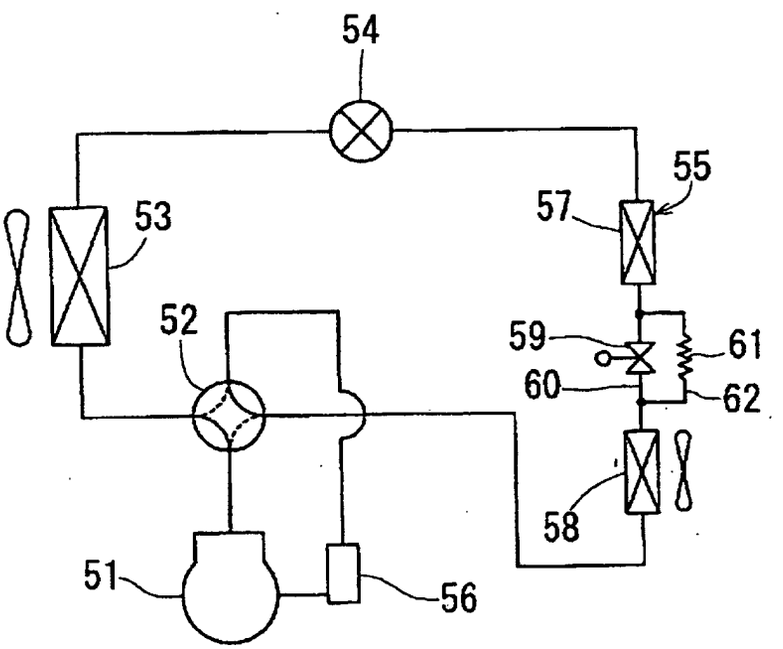


FIG. 15



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP02/09846

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] F25B41/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] F25B41/06, F01N1/00, F25B41/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1926-1996	Toroku Jitsuyo Shinan Koho	1994-2002
Kokai Jitsuyo Shinan Koho	1971-2002	Jitsuyo Shinan Toroku Koho	1996-2002

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	JP 2001-50615 A (Mitsubishi Electric Corp.), 23 February, 2001 (23.02.01), Page 12, left column, lines 5 to 40 (Family: none)	1,2,8 4-7 3
X Y A	JP 2001-50616 A (Mitsubishi Electric Corp.), 23 February, 2001 (23.02.01), Page 13, left column, line 19 to page 13, right column, line 4 (Family: none)	1,2,8 4-7 3
Y	JP 9-133434 A (MATSUSHITA ELECTRIC INDUSTRIAL CO.), 20 May, 1997 (20.05.97), Page 4, right column, line 21 to page 5, right column, line 17; page 6, left column, line 40 to page 6, right column, line 3 (Family: none)	4-8

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
17 December, 2002 (17.12.02)	14 January, 2003 (14.01.03)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP02/09846

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6148631 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., Ltd.), 21 November, 2000 (21.11.00), Column 5, line 17 to column 8, line 36 & JP 11-325655 A (Matsushita Seiko Co., Ltd.), 26 November, 1999 (26.11.99), Page 4, right column, line 21 to page 6, right column, line 5	4-8
Y	JP 5-264129 A (TGK Co., Ltd.), 12 October, 1993 (12.10.93), Page 2, right column, line 14 to page 3, right column, line 32 (Family: none)	5-8
Y	JP 2001-255041 A (Sanyo Electric Co., Ltd.), 21 September, 2001 (21.09.01), Page 2, right column, line 7 to page 3, left column, line 16 (Family: none)	5-8

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