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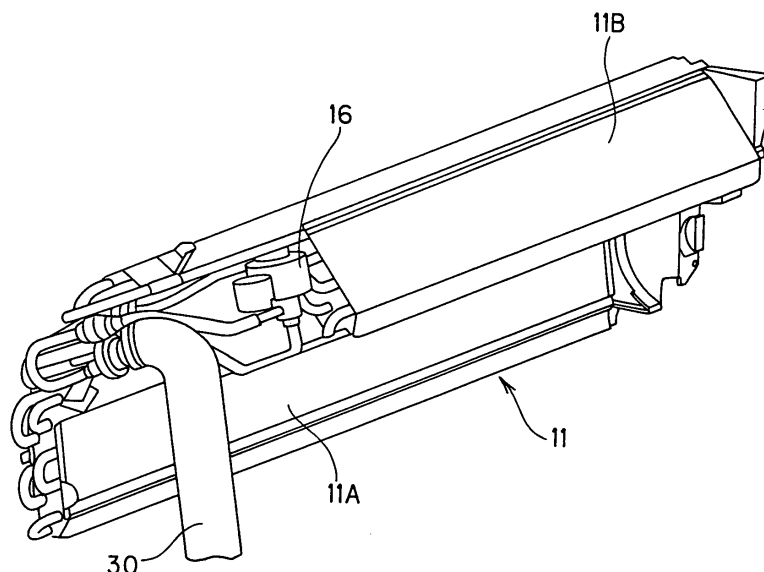
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(54) **Air conditioner**

(57) In an air conditioner having a heat exchanger 11 covering the front, back and upper sides of an air blowing fan 12 and an electrically-operated expansion valve in a housing 2A, 2B, 2C of an indoor unit 2a, 2b, a

cut-out portion 29 is provided to a part of the heat exchanger which is located at any one of right and left portions of the heat exchanger 11 and covers the back side of the air blowing fan, and the electrically-operated expansion valve 16 is disposed at the cut-out portion 29.

FIG.7



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a multiple type air conditioner using a plurality of wall-suspended indoor units.

2. Description of the Related Art

[0002] With respect to a wall-suspended type indoor unit, an indoor heat exchanger is disposed in the housing of the indoor unit so as to extend entirely in the width direction. Furthermore, the indoor heat exchanger is designed to be substantially J-shaped (specifically, inverted J-shape) so as to cover or surround the front, back and upper sides of an air blowing fan (see JP-A-2005-16830 and JP-A-2005-233484). Accordingly, indoor air sucked from an air suction port located at the upper side is passed through the indoor heat exchanger, and then heat-exchanged air is blown out from an air blow-out port located at the lower side into a room.

[0003] Furthermore, with respect to a so-called multiple type (multi-type) air conditioner comprising plural wall-suspended indoor units and an outdoor unit, an electrically-operated expansion valve for adjusting the flow rate of refrigerant is mounted in the housing of each indoor unit, and cooling and heating operations are performed individually by each indoor unit.

[0004] In order to secure the electrically-operated expansion valve in the housing of the indoor unit, the internal volume of the indoor unit must be increased and thus the outside dimension of the indoor unit is larger than that of an ordinary indoor unit. Furthermore, when the electrically-operated expansion valve is secured, a strainer for removing foreign materials and an orifice must be provided, so that the operation noise of the indoor unit during operation is also larger than that of the ordinary indoor unit.

SUMMARY OF THE INVENTION

[0005] The present invention has been implemented in view of the foregoing situation, and has an object to provide an air conditioner in which an indoor air can be prevented from being larger in shape (size) than an ordinary indoor unit containing no electrically-operated expansion valve and also operation noise during operation can be set to substantially the same level as the ordinary indoor unit containing no electrically-operated expansion valve.

[0006] In order to attain the above object, an air conditioner including an indoor unit (2) having a housing, an air blowing fan (12) for sucking indoor air, a heat exchanger (11) that extends in a right-and-left direction of the housing and is disposed so as to cover the front, back

and upper sides of the air blowing fan, and an electrically-operated expansion valve (16), the air blowing fan, the heat exchanger and the electrically-operated expansion valve being mounted in the housing, is characterized in that a cut-out portion (29) is formed at a part of the heat exchanger that is located at any one of the right and left end portions of the heat exchanger in the right-and-left direction so as to cover the back side of the air blowing fan, and the electrically-operated expansion valve is located at the cut-out portion.

[0007] In the air conditioner, the indoor unit may be equipped with a filter (7) that is detachable from and attachable to the indoor unit along the outer shape of the heat exchanger, and a cover member covering the outside of the electrically-operated expansion valve is provided to the cut-out portion.

[0008] In the air conditioner, a strainer may be disposed at the cut-out portion so as to be connected to the electrically-operated expansion valve.

[0009] In the air conditioner, an electrical component box (13) may be disposed at the end portion at which the cut-out portion is formed.

[0010] In the air conditioner, a refrigerant pipe through which the indoor unit and an outdoor unit (3) may be disposed so as to extend from the end portion side of the indoor unit at which the cut-out portion is formed.

[0011] In the air conditioner, the heat exchanger (11) may comprise a master heat exchanger 11A located so as to extend in the right-and-left direction and face the front side of the air blowing fan (12) and a slave heat exchanger 11B located so as to extend in the right-and-left direction and face the back side of the air blowing fan (12), the master heat exchanger 11A and the slave heat exchanger 11B being assembled each other so that the cross-sectional shape of the assembled master and slave heat exchangers 11A and 11B is an inverted J-shape, and the cut-out portion (29) is formed at one end portion of the slave heat exchanger 11B.

[0012] According to the air conditioner of the present invention, the electrically-operated expansion valve can be disposed in the indoor unit with securing an efficiency necessary for the heat exchanger.

[0013] Furthermore, the filter can be easily attached and detached without hooking the filter to the electrically-operated expansion valve. The strainer which emits large operation noise is disposed at the back side, and thus sound at the room side can be suppressed. The operation sound can be reduced by the cover member. Furthermore, the refrigerant pipe connected to the electrically-operated expansion valve can be shortened.

[0014] According to the present invention, in the air conditioner having the heat exchanger covering the front, back and upper sides of the air blowing fan and the electrically-operated expansion valve, the cut-out portion is provided at the portion of the heat exchanger which corresponds to any part of any one of the right and left end portions of the heat exchanger and covers the back side of the air blowing fan, and the electrically-operated ex-

pansion valve is disposed at the cut-out portion. Therefore, the electrically-operated expansion valve can be disposed with securing the efficiency required to the heat exchanger. Therefore, a space where the electrically-operated expansion valve is disposed is not required to be separately secured in the indoor unit. When the front case covering the front portion of the indoor unit is detached, the electrically-operated expansion valve is located at an unseeable position. Accordingly, even when the front case is detached, the appearance of the indoor unit is excellent. Furthermore, the indoor unit of the present invention can be designed to have the same level size as the ordinary indoor unit, and thus meal molds and parts being used in the manufacturing process can be made common.

[0015] Furthermore, the cut-out portion is provided at the back side portion of the heat exchanger, and the electrically-operated expansion valve is disposed at the cut-out portion. Accordingly, the distance between the indoor side and the electrically-operated expansion valve can be as large as possible. As a result, the operation sound of the electrically-operated expansion valve can be reduced (eliminated) in the indoor side, so that the dwelling ability in the room can be kept excellent.

[0016] Still furthermore, the indoor unit is equipped with the filter which can be detached and attached along the outer shape of the heat exchanger, and the cover member covering the outside of the electrically-operated expansion valve is provided at the cut-out portion. Therefore, the filter can be easily attached or detached without hooking the filter to the electrically-operated expansion valve.

[0017] Still furthermore, the strainer connected to the electrically-operated expansion valve is disposed at the cut-out portion. Accordingly, the strainer which produces large operation sound is located at the back side, so that the sound at the indoor side can be suppressed. In addition, the operation sound can be reduced by the cover member. As a result, the dwelling ability of the room can be kept excellent.

[0018] Still furthermore, the electrical component box is disposed at the end portion side at which the cut-out portion is provided, and the refrigerant pipe to be connected to the outdoor unit is disposed so as to extend from the end portion side of the indoor unit at which the cut-out portion is provided, so that the wire and the refrigerant pipe can be shortened, and wiring (piping) can be easily performed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

Fig. 1 is a diagram showing an air conditioner according to an embodiment of the present invention; Fig. 2 is a side cross-sectional view of an indoor unit shown in Fig. 1; Fig. 3 is an exploded perspective view showing the

indoor unit shown in Fig. 1;

Fig. 4 is an exploded perspective view of a front panel and air filter of the indoor unit shown in Fig. 1;

Fig. 5 is a refrigerant circuit diagram of the air conditioner shown in Fig. 1;

Fig. 6 is a further exploded perspective view of an indoor heat exchanger shown in Fig. 3;

Fig. 7 is a perspective view when the indoor heat exchanger is viewed from an obliquely rear left side under the state that the indoor heat exchanger is fabricated; and

Fig. 8 is a perspective view when a cover member is secured under the state of Fig. 7.

15 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0020] A preferred embodiment according to the present invention will be described hereunder with reference to the accompanying drawings.

[0021] An air conditioner according to an embodiment of the present invention will be described with reference to the drawings.

[0022] Fig. 1 is a diagram showing a multiple type air conditioner. An air conditioner 1 has wall-suspended type indoor units 2 (two indoor units 2a, 2b in this embodiment) to be suspended on the wall of a room and an outdoor unit 3 disposed outdoors, and these indoor units and the outdoor unit are connected to one another through two refrigerant pipes 4 (a liquid pipe 4A and a gas pipe 4B). Each of the indoor units 2a, 2b can be remotely operated by a wireless remote controller 5. The number of the indoor units is not limited to two, and three or more indoor units 2a, 2b, .. may be connected to the outdoor unit 3 through the refrigerant pipes 4.

[0023] Fig. 2 is a cross-sectional view of the indoor unit 2a which is taken from one side of the indoor unit 2a. The left side of Fig. 2 corresponds to the wall side, and the right side of Fig. 2 corresponds to the indoor side (front side). Fig. 3 is an exploded perspective view of the indoor unit 2, and Fig. 4 is an exploded perspective view of the front portion of the indoor unit 2.

[0024] The indoor unit 2a and the indoor unit 2b have the same structure. Accordingly, only the indoor unit 2a will be described below and the description on the indoor unit 2b is omitted.

[0025] As shown in Fig. 2, the housing constituting the outer shape of the indoor unit 2a is constructed by a front case portion 2A at the front side, a rear case portion 2B at the back side and a louver portion 2C located at the lower side of the front case portion 2A. A front panel 2D is secured to the front side of the front case portion 2A, an air suction port 2f is provided at the top portion of the front case portion 2A, and an air blow-out port 9 is provided to the louver portion 2C. Furthermore, a fixing frame 14 (see Fig. 3) for fixing the indoor unit 2a to the wall of a room is provided to the rear side of the rear case portion 2B.

[0026] In the inner space surrounded by the front case portion 2A and the rear case portion 2B are mounted an indoor heat exchanger 11, an air blowing fan 12 located at the lower side of the indoor heat exchanger 11, a drain pan 6 that covers the lower portion of the indoor heat exchanger 11 and stocks drain water dropping from the indoor heat exchanger 11, an air filter 7 that can be detachably mounted between the front case portion 2A and the indoor heat exchanger 11 and removes relatively large dust, etc. from indoor air sucked into the indoor unit 2a, and an electrical component box 13 for controlling an electrically-operated expansion valve 16 described later, etc. (see Fig. 3) as shown in Fig. 2.

[0027] The indoor heat exchanger 11 heats/cools indoor air (adjusts indoor temperature). It acts as an evaporator during cooling/dry operation and thus functions as a cooler when refrigerant passes through the pipes of the indoor heat exchanger 11. Furthermore, during heating operation, the indoor heat exchanger 11 acts as a condenser and functions as a heater. The indoor heat exchanger 11 is designed so that the cross-sectional shape thereof is a substantially J-shape (specifically, inverted J-shape) as shown in Fig. 2, and covers the front and back sides and the top side of the air blowing fan 12. Accordingly, the indoor heat exchanger 11 is disposed so that indoor air W1 sucked from the upper side of the front case portion 2A is passed through the indoor heat exchanger 11.

[0028] Furthermore, the indoor heat exchanger 11 is disposed so as to extend entirely in the width direction of the indoor unit 2 (specifically, from the left end portion of the front case portion 2A till the electrical component box 13) as shown in Fig. 3. The details of the indoor heat exchanger 11 will be described later.

[0029] The air blowing fan 12 circulates indoor air W1 (see Fig. 2) so that the indoor air W1 (see Fig. 2) is sucked from the air suction port 2f and passed through the indoor heat exchanger 11, and then heated/cooled air W2 (see Fig. 2) is blown from the air blow-out port 9 into the room again. As shown in Fig. 3, the air blowing fan 12 is also disposed so as to extend entirely in the width direction of the indoor unit 2 (specifically, from the left end portion of the front case portion 2A till the electrical component box 13) as in the case of the indoor heat exchanger 11. Furthermore, the air blowing fan 12 is driven by an air blowing fan motor 12A (for example, cross flow fan) disposed at one side portion thereof.

[0030] An air cleaning filter 8 is also provided at the front portion of the air conditioner 1 between the air filter 7 and the indoor heat exchanger 11 as shown in Fig. 2. The air cleaning filter 8 is used to remove relatively small (minute) dust, etc. from the indoor air passing through the air filter 7.

[0031] Furthermore, at the air blow-out port 9 are provided a flap 9A for controlling the up-and-down flow direction of warm air/cold air blown out from the air blow-out port 9, and plural vertical vanes 10 for controlling the right-and-left flow direction of warm air/cold air blown out

from the air blow-out port 9. A driving motor for adjusting the angle of the flap 9A is secured to the flap 9A, and the swing (rotation) of the flap 9A is freely controlled by operating the wireless remote controller 5.

5 **[0032]** Fig. 5 is a refrigerant circuit diagram of the air conditioner 1 according to the embodiment.

[0033] A branch pipe 15a branched from the liquid 4A and the gas pipe 4B is disposed in the indoor unit 2a, and a branch pipe 15b is likewise disposed in the indoor unit 2a. The indoor heat exchanger 11, the electrically-operated expansion valve 16 (described in detail later) and a strainer 17 for removing foreign materials (described in detail later) are connected to the indoor unit 2a, 2b through the branch pipe 15a, 15b.

10 **[0034]** The outdoor unit 3 is provided with a compressor 18 for compressing refrigerant, an outdoor heat exchanger 19 for heat-exchanging refrigerant with outside air, an electrically-operated expansion valve 21 as a pressure-reducing device, a four-way valve 22 for switching the refrigerant flow direction between cooling operation and heating operation, and a strainer 23 for removing foreign materials.

15 **[0035]** Furthermore, as shown in Fig. 5, a defrosting valve 24 and a receiver tank 25 may be interposed to provide a defrosting circuit 26 for making high-temperature refrigerant gas flow through the outdoor heat exchanger 19 and the indoor heat exchanger 11 during defrosting operation. The pipe connection between the outdoor unit 3 and the indoor unit 2 is carried out by service valves 27A and 27B.

20 **[0036]** As described above, two (or more) indoor units 2a, 2b, ... are connected to one outdoor unit 3. In the refrigeration cycle, by switching the four-way valve 22, the refrigerant is circulated in a direction indicated by a solid-line arrow during cooling operation while the refrigerant is circulated in a direction indicated by a broken-line arrow during heating operation.

25 **[0037]** Fig. 6 is an exploded perspective view showing the indoor heat exchanger 11 secured to the indoor unit 2a, 2b. In Fig. 6, the front side (indoor side) corresponds to the obliquely lower left side. Figs. 7 and 8 are perspective views of the indoor heat exchanger 11 which are taken from the obliquely rear left side, and show the state that the electrically-operated expansion valve 16 is secured to the indoor heat exchanger 11.

30 **[0038]** The indoor heat exchanger 11 comprises a master heat exchanger 11A located at the front side of the apex portion of the inverted J-shape (see Figs. 2, 7), and a slave heat exchanger 11B located at the back side of the apex portion of the inverted J-shape, and the master heat exchanger 11A and the slave heat exchanger 11B are constructed so that they can be separated from each other and assembled with each other. Furthermore, a drain pipe 28 for discharging drain water from the liquid pipe 4A, the gas pipe 4B and the drain pan 6 are assembled at the right end portion of the master heat exchanger 11A.

35 **[0039]** As shown in Fig. 6, the length L2 of the slave

heat exchanger 11B is set to be shorter than the length L1 in the width direction of the master heat exchanger 11A. More specifically, under the state that the master heat exchanger 11A and the slave heat exchanger 11B are assembled with each other so that the left end portions thereof are positionally coincident with each other, the right end portion of the slave heat exchanger 11B is apparently cut out (hereinafter referred to as "cut-out portion 29", see Figs. 7 and 8). The cut-out portion 29 is formed at one side of the indoor unit at which the electrical component box 13 is disposed as shown in Fig. 3.

[0040] As shown in Figs. 7 and 8, the electrically-operated expansion valve 16 is mounted at the cut-out portion 29. The liquid pipe 4A and the gas pipe 4B are installed in a flexible pipe 30 so as to extend to the outdoor unit 3, and the pipe 30 extends from the cut-out portion 29. The strainer 17 may be disposed at the cut-out portion 29. The electrically-operated expansion valve 16 is located at the rear side of the master heat exchanger 11A and also at the upper portion of the wall side of the indoor unit 2a as indicated by a two-dotted chain line in Fig. 2 when viewed from the side portion of the indoor unit 2a.

[0041] As shown in Fig. 8, a cover member 31 is disposed so as to be secured to or surround the outer periphery of the electrically-operated expansion valve 16. The right side portion (the left side in Fig. 8) of the master heat exchanger 11A is also covered by a cover member 32.

[0042] As shown in Fig. 8, the cover member 31 is formed by bending one steel plate vertically, and covers the whole body in the width direction of the electrically-operated expansion valve 16. A guide plane portion 31a is formed at the upper portion of the cover member 31 so that no step is formed between the surface of the master heat exchanger 11A and the surface of the cover member 31. Furthermore, after the cover member 31 is secured, sound insulating members 33a, 33b, 33c, 33d shown in Fig. 3 are secured so as to cover the right side surface of the master heat exchanger 11A and the front surface of the electrical component box 13.

[0043] The guide plane portion 31a is used to guide the air filter 7 when the air filter is attached to or detached from the indoor unit. More specifically, the air filter 7 is mounted in the indoor unit 2a as follows. The front panel 2D is detached from the indoor unit 2a, the upper portion 7a of the air filter 7 which is bent in the depth direction of the indoor unit 2a is inserted into an elongated hole 2e which is long in the width direction of the front case portion 2A as shown in Fig. 4. At this time, the upper portion 7a of the air filter 7 is guided along the shape (outer shape) of the upper portion of the indoor heat exchanger 11, and intrudes till the back of the indoor unit 2a. At the cut-out portion 29, the upper portion 7a of the air filter 7 is guided by the guide plane portion 31a of the cover member 31 because the slave heat exchanger 11B is cut out.

[0044] In the air conditioner 1 according to this embodiment, the cut-out portion 29 is formed at the slave heat

exchanger 11B of the indoor heat exchanger 11, and the electrically-operated expansion valve 16 is disposed at the cut-out portion 29. Therefore, the electrically-operated expansion valve 16 can be disposed in the indoor heat exchanger 11 with keeping a required efficiency. Therefore, a space in which the electrically-operated expansion valve 16 is disposed is not required to be separately secured in the indoor units 2a, 2b. Furthermore, the electrically-operated expansion valve 16 is disposed so that it is not viewed when the front case portion 2A or the front panel 2D covering the front portion of the indoor unit 2a, 2b is detached, and thus the appearance of the indoor unit is good even when the front case portion 2A or the front panel 2D is detached. Furthermore, the electrically-operated expansion valve 16 can be designed to have the same level size as the ordinary indoor unit having no electrically-operated expansion valve 16. Therefore, metal molds, parts to be used, etc. for the front case portion 2A and the rear case portion 2B in the manufacturing process can be commonly used.

[0045] In the side cross-sectional view of the indoor unit 2a, 2b (see Fig. 2), the electrically-operated expansion valve 16 is disposed at the upper portion of the wall side of the indoor unit 2a, 2b, and the distance from the indoor side to the electrically-operated expansion valve 16 can be set to be as long as possible. As a result, the operation noise of the electrically-operated expansion valve 16 at the room side can be reduced (sound is eliminated), and thus dwelling ability can be kept excellent.

[0046] Furthermore, the cover member 31 covering the outside of the electrically-operated expansion valve 16 is provided to the cut-out portion 29, and thus the upper portion 7a of the air filter 7 can be guided till the back side of the indoor unit 2a, 2b by the guide plane portion 31a of the cover member 31 when the air filter 7 is attached to or detached from the indoor unit. As a result, the upper portion 7a of the air filter 7 can be easily attached to or detached from the indoor unit without being hooked to the electrically-operated expansion valve 16. In addition, the cover member 31 also serves to shield the operation sound of the electrically-operated expansion valve 16 by covering the electrically-operated expansion valve 16. Accordingly, the operation sound of the electrically-operated expansion valve 16 can be further reduced, and the dwelling ability in the room can be made excellent.

[0047] Furthermore, the sound of the strainer 17 can be eliminated by disposing the strainer 17 together with the electrically-operated expansion valve 16. Therefore, the dwelling ability in the room can be maintained excellent.

[0048] Still furthermore, the cut-out portion 29 is disposed at the side where the electrical component box 13 is disposed, and thus the distance between the electrically-operated expansion valve 16 and the electrical component box 13 can be shortened. Therefore, the wire between the electrically-operated expansion valve 16 and the electrical component box 13 can be shortened,

so that the material cost can be reduced and the wiring work can be facilitated.

[0049] Still furthermore, the pipe 30 containing the liquid pipe 4A and the gas pipe 4B is disposed so as to extend from the cut-out portion 29. Therefore, the liquid pipe 4A and the gas pipe 4B can be shortened. Therefore, the material cost can be reduced, and also the piping work can be facilitated.

[0050] The present invention is not limited to the above embodiment, and various modifications may be made on the basis of the technical idea of the present invention.

[0051] In the above embodiment, the electrical component box 1 is disposed at the right end portion of the indoor unit 2a, 2b, and the cut-out portion 29 is formed in the neighborhood of the electrical component box 13. However, the same action and effect as the above embodiment can be achieved by replacing the disposing position of these elements between the right and left sides.

[0052] Furthermore, in the above embodiment, the cover member 31 is formed of a steel plate. However, it may be formed of material having a high sound insulating effect, or comprise a resin mold article if no problem occurs in the guiding performance (friction, abrasion performance) of the air filter 7.

4. The air conditioner according to any one of claim 1 to 3, wherein an electrical component box (13) is disposed at the end portion at which the cut-out portion is formed.

5. The air conditioner according to any one of claims 1 to 4, wherein a refrigerant pipe through which the indoor unit and an outdoor unit (3) is disposed so as to extend from the end portion side of the indoor unit at which the cut-out portion is formed.

6. The air conditioner according to claim 1, wherein the heat exchanger (11) comprises a master heat exchanger 11A located so as to extend in the right-and-left direction and face the front side of the air blowing fan (12) and a slave heat exchanger 11B located so as to extend in the right-and-left direction and face the back side of the air blowing fan (12), the master heat exchanger 11A and the slave heat exchanger 11B being assembled each other so that the cross-sectional shape of the assembled master and slave heat exchangers 11A and 11B is an inverted J-shape, and the cut-out portion (29) is formed at one end portion of the slave heat exchanger 11B.

Claims

1. An air conditioner including an indoor unit (2) having a housing, an air blowing fan (12) for sucking indoor air, a heat exchanger (11) that extends in a right-and-left direction of the housing and is disposed so as to cover the front, back and upper sides of the air blowing fan, and an electrically-operated expansion valve (16), the air blowing fan, the heat exchanger and the electrically-operated expansion valve being mounted in the housing, **characterized in that** a cut-out portion (29) is formed at a part of the heat exchanger that is located at any one of the right and left end portions of the heat exchanger in the right-and-left direction so as to cover the back side of the air blowing fan, and the electrically-operated expansion valve is located at the cut-out portion.
2. The air conditioner according to claim 1, wherein the indoor unit is equipped with a filter (7) that is detachable from and attachable to the indoor unit along the outer shape of the heat exchanger, and a cover member covering the outside of the electrically-operated expansion valve is provided to the cut-out portion.
3. The air conditioner according to claim 2, wherein a strainer is disposed at the cut-out portion so as to be connected to the electrically-operated expansion valve.

FIG. 1

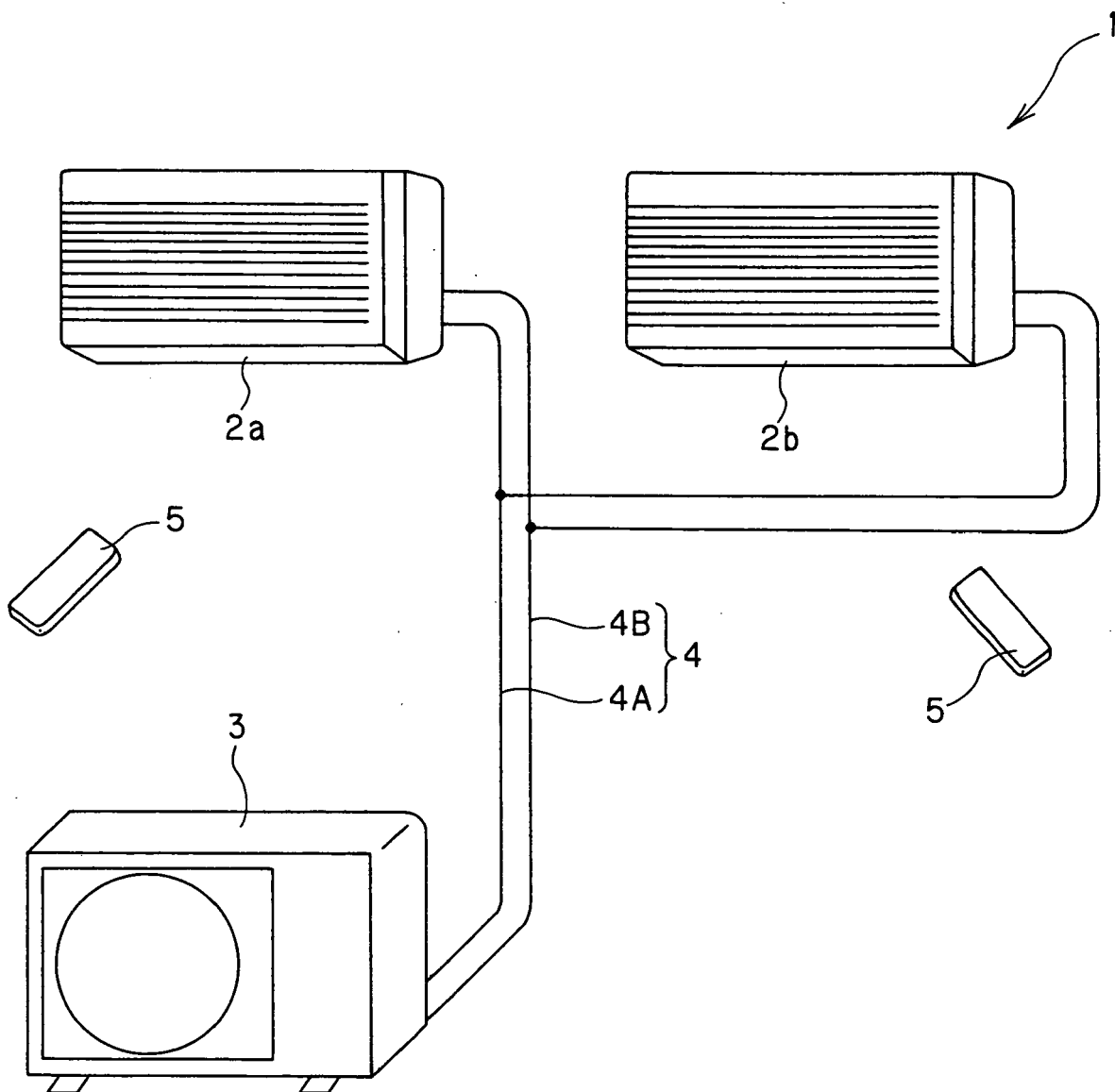


FIG.2

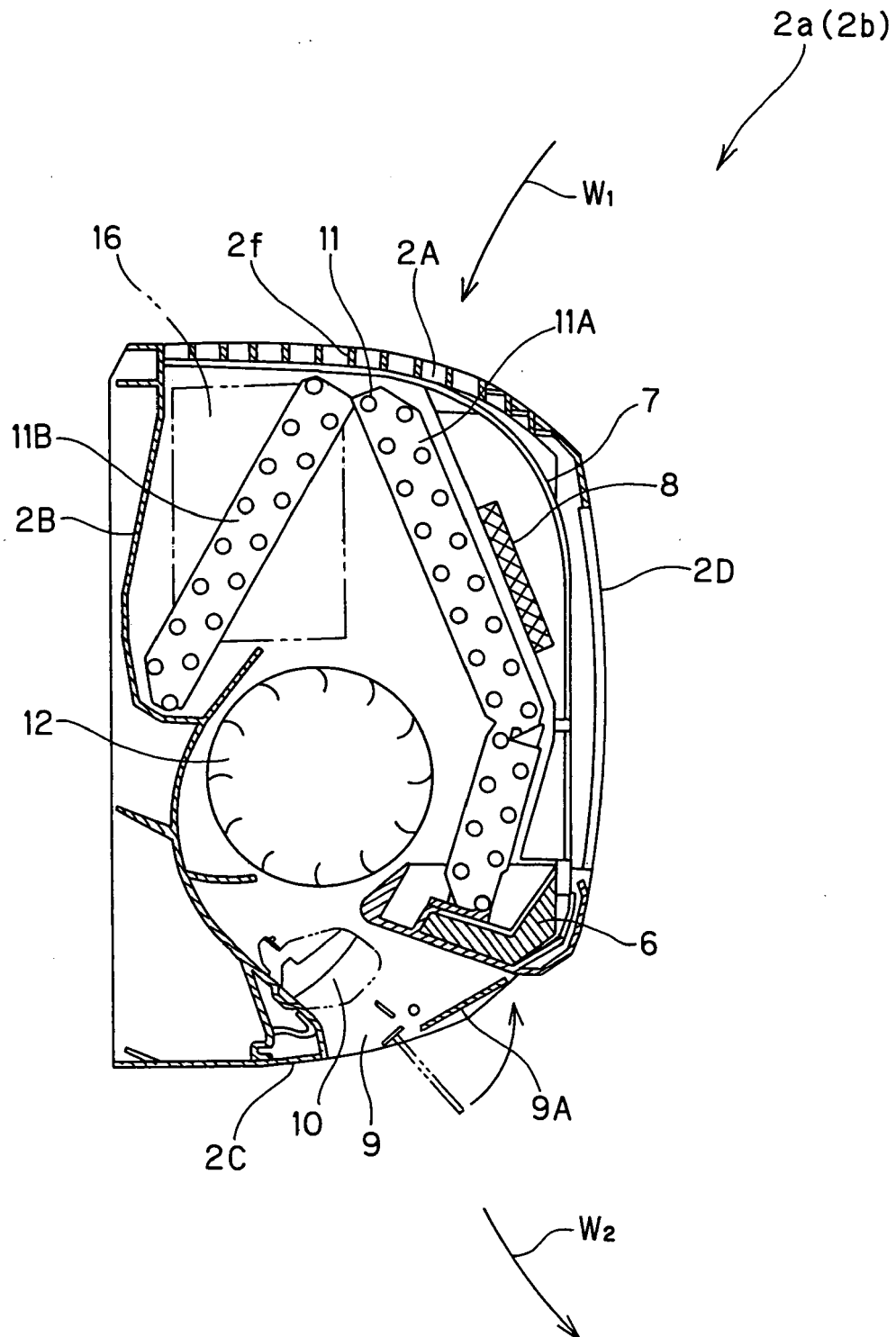


FIG. 3

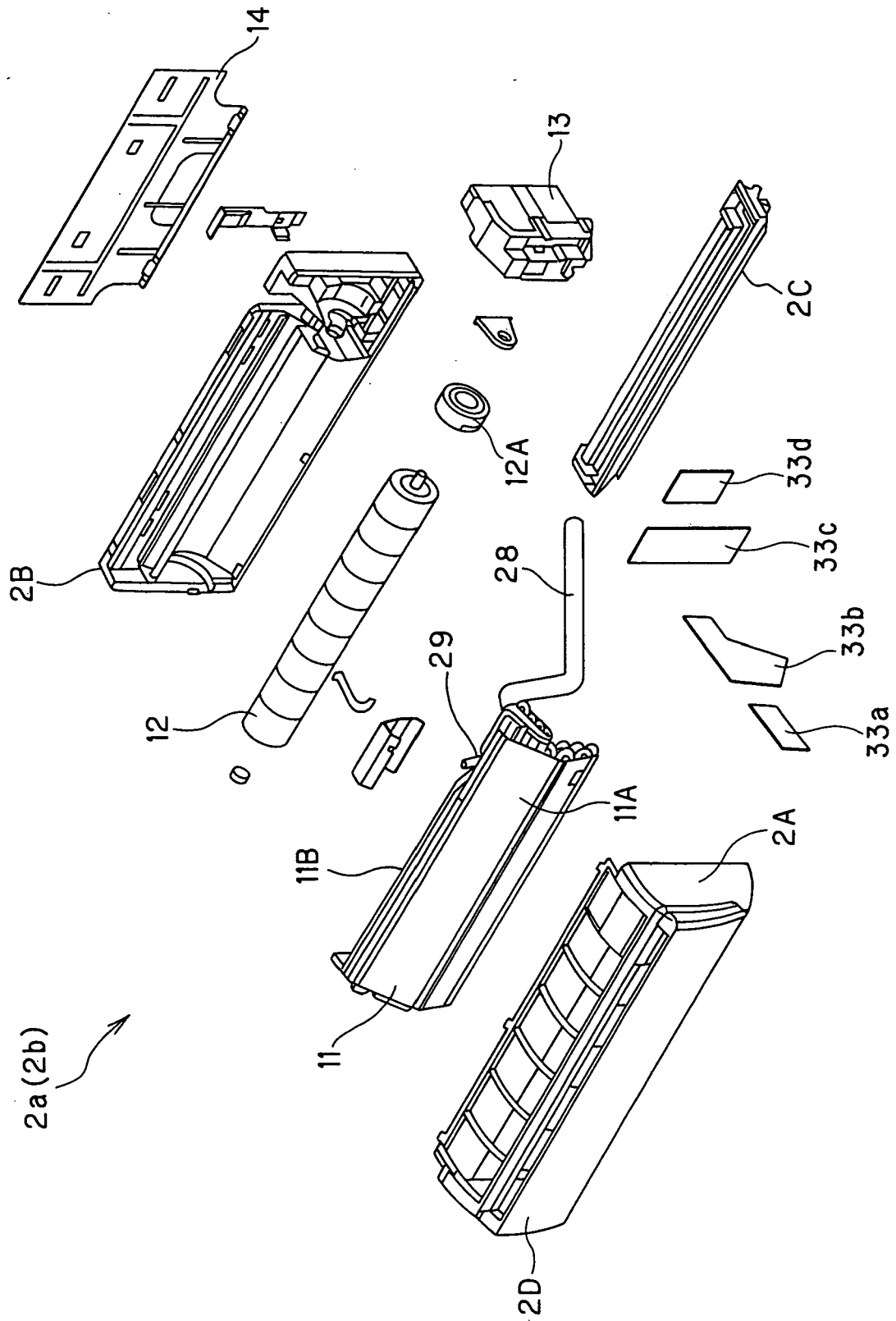


FIG.4

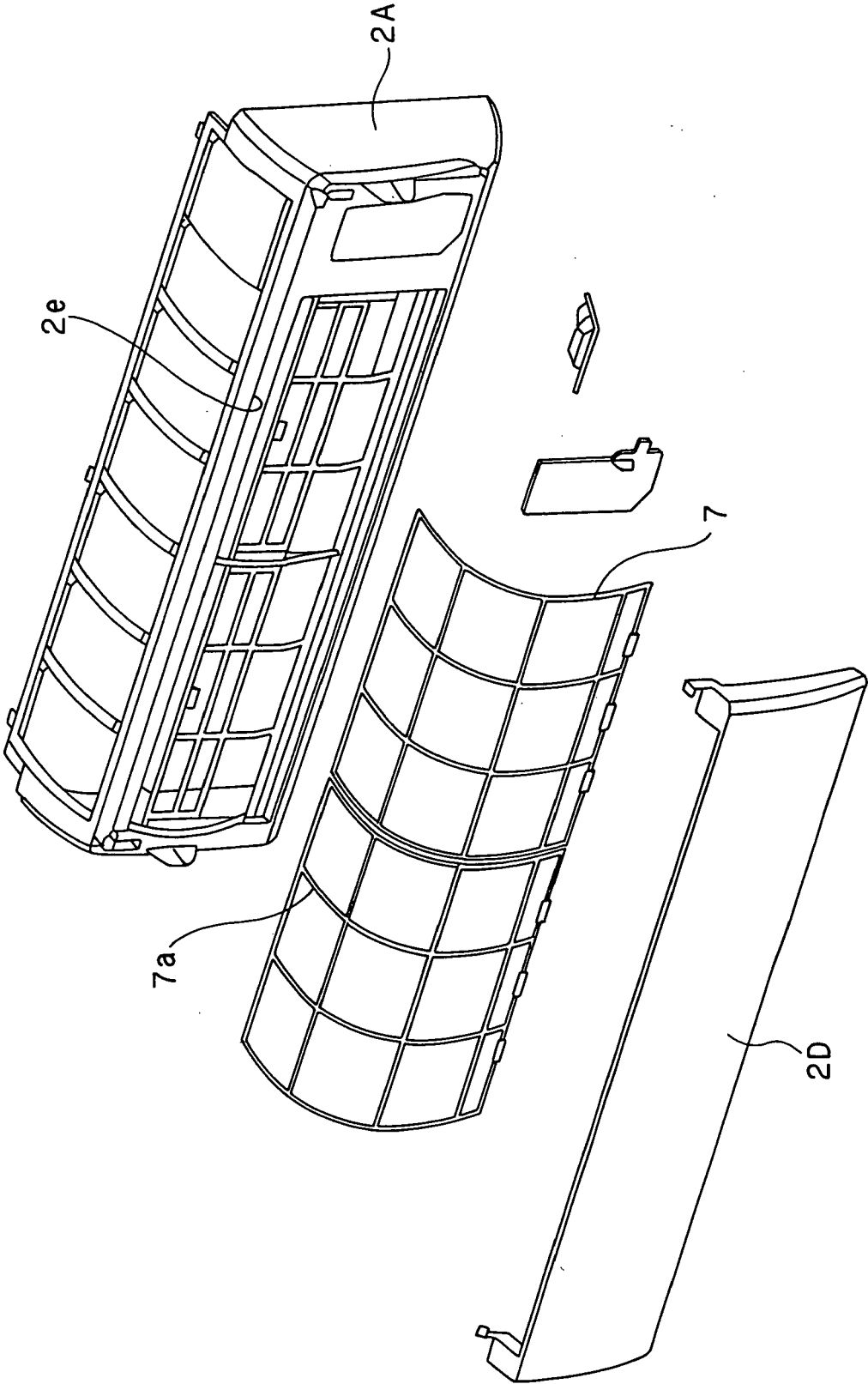


FIG. 5

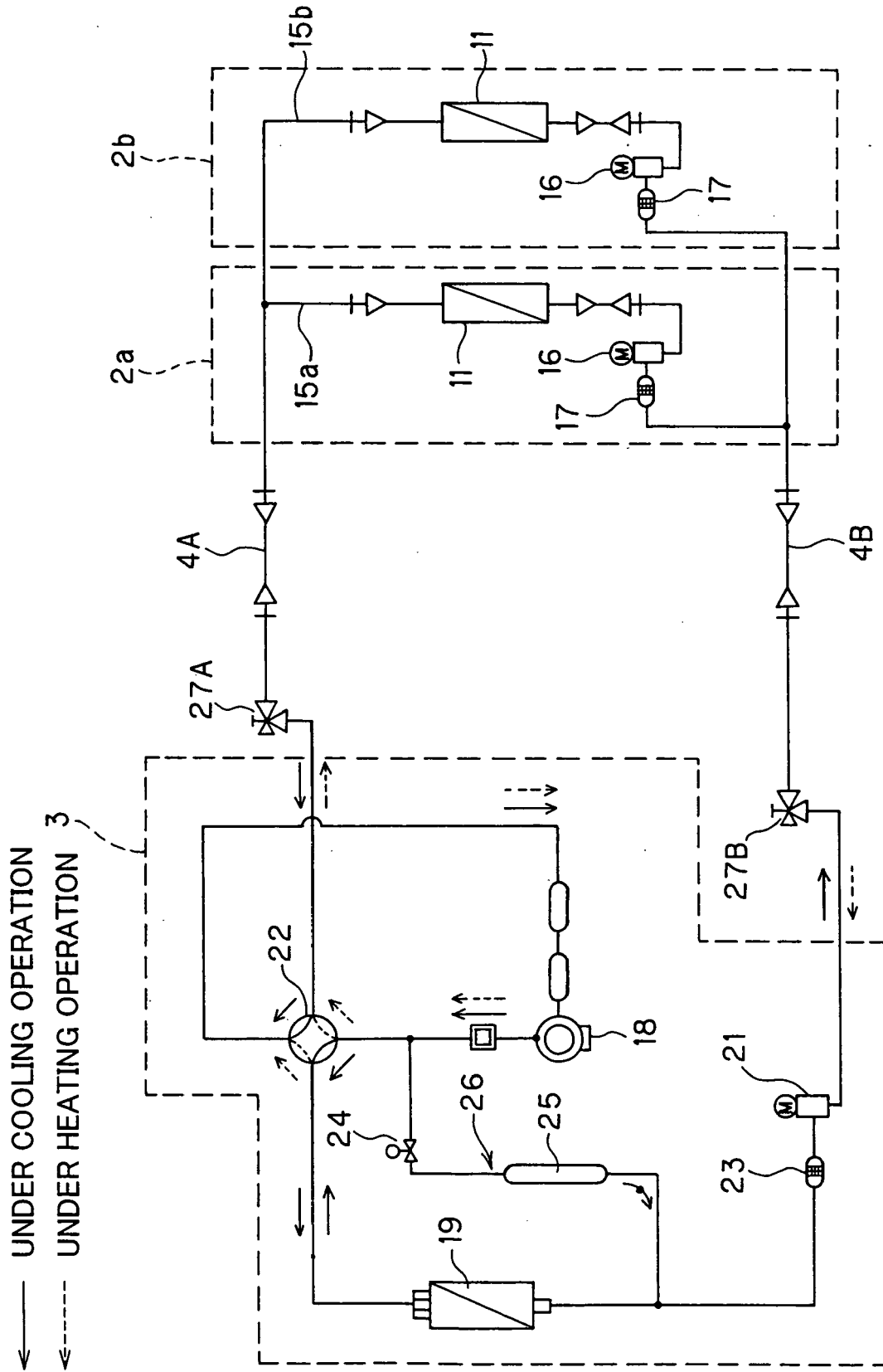


FIG.6

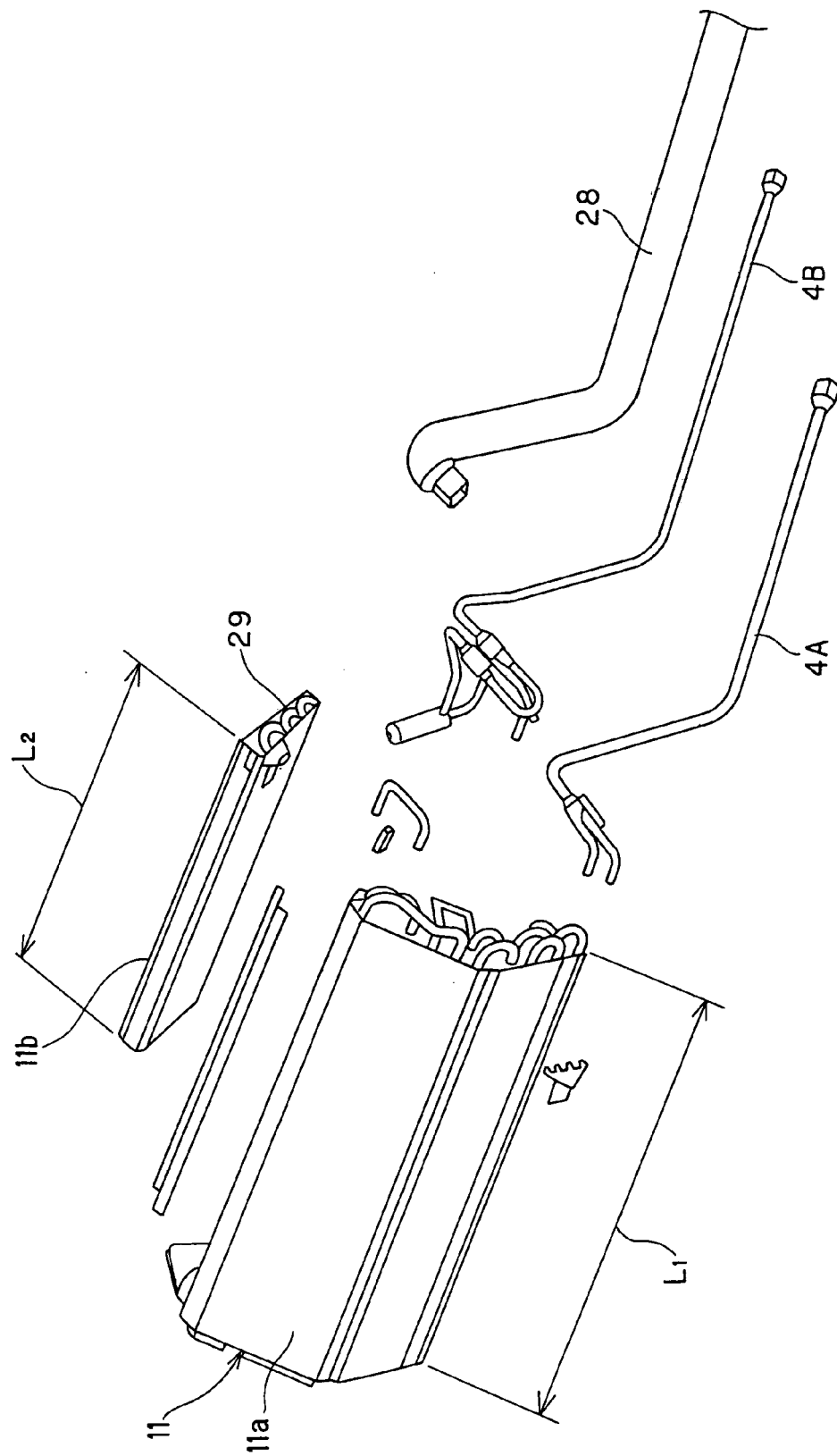


FIG. 7

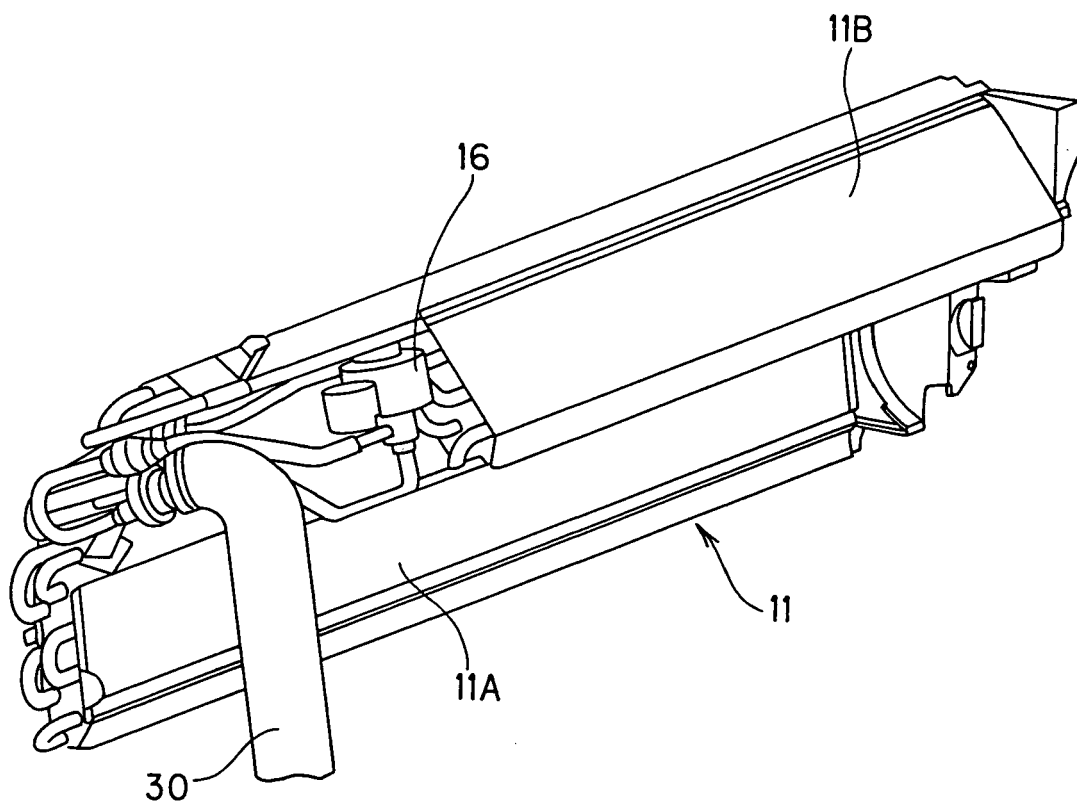
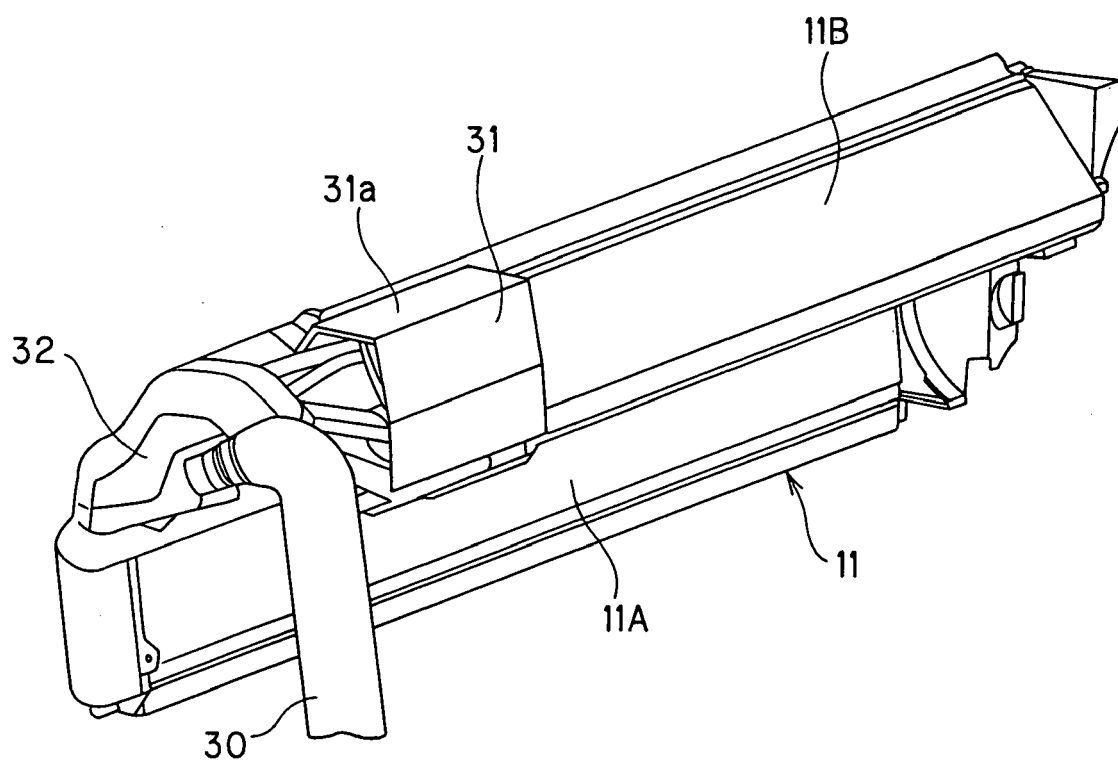


FIG.8





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 08 00 4698

DOCUMENTS CONSIDERED TO BE RELEVANT			
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 15 July 2008	Examiner Valenza, Davide
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 08 00 4698

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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