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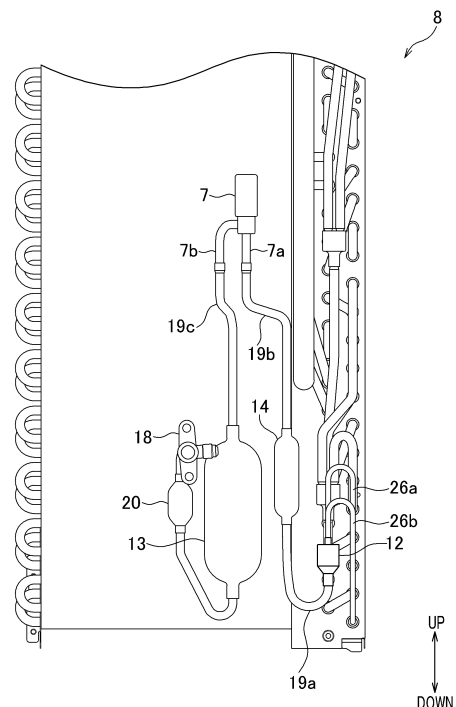
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(54) **AIR CONDITIONER**

(57) An air conditioner includes a first metal pipe 26a, 26b, a second metal pipe 19a with a higher electric potential than the first metal pipe, and a first component 12 made of stainless steel and including a first connecting part 12a, 12b and a second connecting part 12c. The first metal pipe 26a, 26b is connected to the first connecting part 12a, 12b of the first component 12 and the second metal pipe 19a is connected to the second connecting part 12c of the first component 12, so that a refrigerant passage is formed from the first metal pipe 26a, 26b to the second metal pipe 19a through the first component 12. The first component 12 is one of a filter a muffler, a decompression device, a refrigerant storage, and a diverter. With this arrangement, the number of components of the air conditioner is reduced.

FIG.4



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Description

[Technical Field]

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

[Background Art]

[0002] Refrigerant pipes of an air conditioner are typically made of copper or copper alloy. In this regard, in recent years, in order to achieve weight reduction and cost reduction, some of the refrigerant pipes are made of aluminum or aluminum alloy. However, aluminum has a greater tendency to ionize than copper, and when the two come into contact, corrosion (galvanic corrosion) may occur on the aluminum. In Patent Literature 1, in order to prevent corrosion of aluminum caused by condensation water adhering to a refrigerant pipe, a stainless steel joint refrigerant pipe is provided at the joint between an aluminum refrigerant pipe and a copper refrigerant pipe. The stainless steel joint refrigerant pipe is provided between an air blower and a connection pipe that is closest to the air blower among connection pipes connecting heat transfer pipes. This arrangement makes it possible to suppress water droplets that condense on other connection pipes from dropping onto the joint refrigerant pipe.

[Citation List]

[Patent Literatures]

[0003] [Patent Literature 1] International Publication No. 2016/038865

[Summary of Invention]

[Technical Problem]

[0004] According to the technology of Patent Literature 1, it is necessary to add a stainless steel joint refrigerant pipe as a new component, with the result that the number of components increases.

[0005] An object of the present disclosure is to provide an air conditioner with fewer components.

[Solution to Problem]

[0006] An air conditioner of the present disclosure includes a first metal pipe, a second metal pipe with a higher electric potential than the first metal pipe, and a first component made of stainless steel and including a first connecting part and a second connecting part. The first metal pipe is connected to the first connecting part of the first component and the second metal pipe is being connected to the second connecting part of the first component, so that a refrigerant passage is formed from the first metal

pipe to the second metal pipe through the first component, and the first component is one of a filter, a muffler, a decompression device, a refrigerant storage, and a diverter.

[0007] According to the present disclosure, by connecting functional component made of stainless steel such as a filter between the first metal and the second metal, it is no longer necessary to increase the number of components to suppress the galvanic corrosion, and manufacturing costs can be reduced.

[0008] Preferably, the first connecting part is located above the second connecting part. This makes it possible to suppress the corrosion of the second metal pipe due to condensation water including copper ions and dropping from the first metal pipe.

[0009] Preferably, an end portion of the first connecting part is inserted into the first metal pipe. With this arrangement, detachment due to cooling after the brazing is less likely to occur.

[0010] Preferably, the air conditioner further comprises: a second component connected to the opposite side of the first component of the first metal pipe; and a third component connected to the opposite side of the first component of the second metal pipe, each of the second component and the third component being one of a heat exchanger, a filter, a muffler, a decompression device, a refrigerant storage, a stop valve, and a diverter, the first metal pipe is a refrigerant pipe made of aluminum and the second metal pipe is a refrigerant pipe made of copper, and between the second component and the third component, the number of bended parts of the first metal pipe is smaller than the number of bended parts of the second metal pipe. The number of bended parts of aluminum that is inferior in processability is therefore small, which is advantageous in terms of manufacturing.

[0011] Preferably, the first component is a filter, the first metal pipe is a refrigerant pipe connected to a connection part of the filter on the heat exchanger side, and the first metal pipe includes: a first section connected to the first connecting part of the filter and extending upward from the first connecting part; a second section connected to an upper end portion of the first section, extending upward from the upper end portion, being bended, and extending downward; and a third section connected to a lower end portion of the second section and extending downward. This makes it possible to suppress the corrosion of the second metal pipe due to condensation water including copper ions and dropping from the first metal pipe.

[0012] The first component may be a decompression device, the first metal pipe may be made of aluminum, and the second metal pipe may be made of copper. This arrangement is cost-effective because the aluminum pipe is long, in a case in which the decompression device is preferably positioned as high as possible in order to shorten an electric wire of the air conditioner.

[0013] Preferably, the first component is a diverter, the first metal pipe is a refrigerant pipe connected to an out-

door heat exchanger and made of aluminum, and a decompression device and a stop valve are provided on the opposite side of the outdoor heat exchanger over the diverter, and a pipe between the diverter and the decompression device and a pipe between the decompression device and the stop valve are made of copper. This arrangement is cost-effective as a long refrigerant passage from the diverter to the stop valve through the decompression device is made of copper that excels in processability.

[Brief Description of Drawings]

[0014]

FIG. 1 is a schematic configuration diagram of an air conditioner related to First Embodiment of the present disclosure.

FIG. 2 is a perspective view of an outdoor heat exchanger and some refrigerant pipes included in the air conditioner shown in FIG. 1 and an enlarged view of a filter and its surroundings.

FIG. 3 is a front view of the outdoor heat exchanger and some of the refrigerant pipes shown in FIG. 2.

FIG. 4 is a partial side view of the outdoor heat exchanger and some of the refrigerant pipes shown in FIG. 2.

FIG. 5 is an enlarged cross section of a joint between a stainless steel filter and an aluminum refrigerant pipe.

FIG. 6 is a partial side view of an outdoor heat exchanger and some of refrigerant pipes included in an air conditioner of Second Embodiment of the present disclosure.

FIG. 7 is a partial side view of an outdoor heat exchanger and some of refrigerant pipes included in an air conditioner of Third Embodiment of the present disclosure.

FIG. 8 is a partial side view of an outdoor heat exchanger and some of refrigerant pipes included in an air conditioner of Fourth Embodiment of the present disclosure.

FIG. 9 is a partial side view of an outdoor heat exchanger and some of refrigerant pipes included in an air conditioner of Fifth Embodiment of the present disclosure.

FIG. 10 is a side view of the vicinity of a muffler included in an air conditioner of Sixth Embodiment of the present disclosure.

FIG. 11 is a side view of the vicinity of an accumulator included in an air conditioner of Seventh Embodiment of the present disclosure.

[Description of Embodiments]

<First Embodiment>

[0015] The following will describe an air conditioner 1

of First Embodiment of the present disclosure. The air conditioner 1 shown in FIG. 1 includes an indoor unit 2 provided indoors and an outdoor unit 3 provided outdoors. The indoor unit 2 and the outdoor unit 3 are connected to each other through a refrigerant pipe 19.

[0016] Inside the outdoor unit 3, there are a compressor 5 configured to compress refrigerant to generate high-temperature and high-pressure gas refrigerant, filters 14 and 20, a liquid receiver (a type of a refrigerant storage in the present disclosure) 13, an electric expansion valve 7 configured to reduce the pressure of the refrigerant, an outdoor heat exchanger 8, an accumulator (a type of the refrigerant storage in the present disclosure) 11, a muffler 15, a four-pass switching valve 16, a gas stop valve 17, and a liquid stop valve 18. Inside the indoor unit 2, an indoor heat exchanger 6 is provided. These components are connected by the refrigerant pipe 19 to form a refrigerant circuit 4. The electric expansion valve 7 is provided with a first connection pipe 7a and a second connection pipe 7b. The first connection pipe 7a and the second connection pipe 7b are attached to a main body portion of the electric expansion valve 7 (i.e., a portion excluding the first connection pipe 7a and the second connection pipe 7b) by brazing.

[0017] The indoor heat exchanger 6 performs heat exchange between the refrigerant and the room air. In the vicinity of the indoor heat exchanger 6, there is an indoor fan 9 that is configured to blow the room air to the indoor heat exchanger 6 and to send conditioned air into the room. The compressor 5 is configured to compress low-pressure gas refrigerant and to discharge high-pressure gas refrigerant. The compressor 5 includes an intake section 5a and a discharge section 5b. Low-pressure gas refrigerant is sucked in from the intake section 5a, and high-pressure gas refrigerant is discharged in a direction indicated by an arrow D from the discharge section 5b. The electric expansion valve 7 is placed between the outdoor heat exchanger 8 and the indoor heat exchanger 6 in the refrigerant pipe 19 of the refrigerant circuit 4, and is configured to expand and decompress the incoming refrigerant. The filters 14 and 20 remove fine dust particles from the refrigerant and transform gas bubbles into fine bubbles, and function as flow adjusters for adjusting the disturbance of the flow of the refrigerant. By transforming gas bubbles into fine bubbles, it is possible to reduce the noise generated by the electric expansion valve 7. The liquid receiver 13 stores refrigerant that has become surplus due to a change in heat load. The outdoor heat exchanger 8 performs heat exchange between the refrigerant and the outdoor air. An outdoor fan 10 is provided in the vicinity of the outdoor heat exchanger 8 to blow the outdoor air to the outdoor heat exchanger 8.

[0018] A diverter 12 (a first component in the present embodiment) is placed at an end portion of the outdoor heat exchanger 8 on the electric expansion valve 7 side. The diverter 12 is a functional component in which branched passages are formed. The diverter 12 is connected to two refrigerant pipes 26a and 26b (first metal

pipes of the present embodiment) extending from the outdoor heat exchanger 8 (see FIGs. 2 and 4), and one refrigerant pipe 19a (second metal pipe of the present embodiment) connected to the filter 14. The filter 14 is connected to the first connection pipe 7a of the electric expansion valve 7 by a refrigerant pipe 19b. The second connection pipe 7b of the electric expansion valve 7 and the liquid receiver 13 are connected by a refrigerant pipe 19c. Furthermore, the liquid receiver 13, the filter 20, and the liquid stop valve 18 are also connected by the refrigerant pipe 19c. Furthermore, an accumulator 11 is connected to the refrigerant pipe 19d on the sucking side of the compressor 5 to prioritize sending of gas to the compressor 5 over sending of liquid. A muffler 15 is connected to the refrigerant pipe 19e on the discharging side of the compressor 5 to reduce pressure pulsation of the refrigerant discharged from the compressor 5.

[0019] The refrigerant pipe 19 is connected to the four-pass switching valve 16 for switching the refrigerant passage, the gas stop valve 17, and the liquid stop valve 18. By switching the four-pass switching valve 16, the flow of refrigerant is reversed, and the refrigerant discharged from the compressor 5 is supplied to either the outdoor heat exchanger 8 or the indoor heat exchanger 6 so as to switch between a cooling operation and a warming operation. The gas stop valve 17 and the liquid stop valve 18 are made of brass and are used to open or close the refrigerant passage.

[0020] During the warming operation of the air conditioner 1, the four-pass switching valve 16 is switched as indicated by solid lines in FIG. 1 to flow the refrigerant in directions indicated by solid arrows. As a result, the high-pressure gas refrigerant discharged from the compressor 5 in the direction indicated by the arrow D passes through the muffler 15 and the four-pass switching valve 16, then passes through the gas stop valve 17 and enters the indoor heat exchanger 6. The high-pressure gas refrigerant releases heat during the process of becoming high-pressure liquid refrigerant in the indoor heat exchanger 6. The high-pressure liquid refrigerant reaches the electric expansion valve 7 through the liquid stop valve 18 having been opened, and is decompressed by the electric expansion valve 7. The decompressed refrigerant reaches the outdoor heat exchanger 8, absorbs heat at the outdoor heat exchanger 8, and becomes low-pressure gas refrigerant. The low-pressure gas refrigerant is sucked into the compressor 5 through the four-pass switching valve 16 and the accumulator 11. During the warming operation, the indoor heat exchanger 6 functions as a heat radiator, and the outdoor heat exchanger 8 functions as a heat absorber.

[0021] On the other hand, during the cooling operation, the four-pass switching valve 16 is switched as indicated by dotted lines in FIG. 1 to reverse the flow of the refrigerant, with the result that the refrigerant flows in directions indicated by dotted arrows. Consequently, the high-pressure gas refrigerant discharged from the compressor 5 in the direction indicated by the arrow D passes through

the muffler 15 and the four-pass switching valve 16, and then enters the outdoor heat exchanger 8. The high-pressure gas refrigerant releases heat during the process of becoming high-pressure liquid refrigerant in the outdoor heat exchanger 8. The high-pressure liquid refrigerant reaches the electric expansion valve 7 and is decompressed by the electric expansion valve 7. The decompressed refrigerant reaches the indoor heat exchanger 6 through the liquid stop valve 18 having been opened, absorbs heat at the indoor heat exchanger 6, and becomes low-pressure gas refrigerant. The low-pressure gas refrigerant is sucked into the compressor 5 through the gas stop valve 17, the four-pass switching valve 16, and the accumulator 11. During the cooling operation, the indoor heat exchanger 6 functions as a heat absorber, and the outdoor heat exchanger 8 functions as a heat radiator.

[0022] As shown in FIGs. 2 and 3, the outdoor heat exchanger 8 includes a plurality of flat fins 21 stacked at predetermined intervals and a plurality of heat transfer pipes 22 inserted into multiple through holes provided in each fin 21 (only one of them is indicated by dotted lines in FIG. 3). Each heat transfer pipe 22 is bent to be L-shaped, and the outdoor heat exchanger 8 is substantially L-shaped when viewed from above. Except end portions functioning as (two) entrances and (two) exits of refrigerant to and from the outdoor heat exchanger 8, each end portion where an opening of the heat transfer pipe 22 is provided is connected by a U-bend 23 with an end portion where an opening of another heat transfer pipe 22 is provided. In this way, two passages through which the refrigerant passes are formed in the outdoor heat exchanger 8 of the present embodiment. The fins 21, the heat transfer pipes 22, and the U-bend 23 are made of aluminum or aluminum alloy (hereinafter, this will be simply referred to as "made of aluminum" in the present disclosure). The heat transfer pipes may be hair-pin tubes.

[0023] There is an end plate 25 constituted by a steel plate or the like on the outer side of the outermost fin 21. The heat transfer pipes 22 penetrate the end plate 25 and are connected to the U-bends 23 on the outer side of the end plate 25. An end portion of each heat transfer pipe 22, which is not connected to the U-bend 23, is connected to a refrigerant pipe connected to the above-described two passages formed in the outdoor heat exchanger 8. FIG. 2 and FIG. 4 show two refrigerant pipes 26a and 26b connected to the diverter 12, among the refrigerant pipes. In the following explanation, the up-down relationship will be described with reference to FIG. 4.

[0024] In the present embodiment, the refrigerant pipes 26a and 26b are made of aluminum, and the diverter 12 is made of stainless steel. The refrigerant pipes 19a, 19b, and 19c ahead of the diverter 12 are made of copper or copper alloy having a higher electric potential than aluminum (they will be simply referred to as "made of copper" in the present disclosure). The filter 14, the

liquid receiver 13, and the filter 20 are also made of copper, the electric expansion valve 7 has a main body portion made of stainless steel, and the first connection pipe 7a and the second connection pipe 7b are made of copper. With reference to FIG. 2, the diverter 12 includes two first connecting parts 12a and 12b and one second connecting part 12c. The first connecting parts 12a and 12b are joined with the refrigerant pipes 26a and 26b, respectively, by brazing. The second connecting unit 12c is joined with the refrigerant pipe 19a by brazing. With this arrangement, a refrigerant passage is formed from the refrigerant pipes 26a and 26b to the refrigerant pipe 19a through the diverter 12. In the diverter 12, a branching passage is formed to connect the first connecting parts 12a and 12b with the second connecting part 12c. In the present embodiment, the first connecting parts 12a and 12b are located above the second connecting part 12c.

[0025] As such, in the air conditioner 1 according to the present embodiment, the diverter 12 as a functional component is made of stainless steel, and the refrigerant pipes 26a and 26b made of aluminum and the refrigerant pipe 19a made of copper are joined with the diverter 12. With this arrangement, the refrigerant pipes 26a and 26b made of aluminum are not directly joined with the refrigerant pipe 19a made of copper, and hence the galvanic corrosion of the refrigerant pipes 26a and 26b is suppressed. Furthermore, because the diverter 12 that is a known functional component is made of stainless steel and interposed between the refrigerant pipes 26a and 26b and the refrigerant pipe 19a, it is unnecessary to add another component to suppress the galvanic corrosion of the refrigerant pipes 26a and 26b, so as to suppress the manufacturing cost. Moreover, because the first connecting parts 12a and 12b are located above the second connecting part 12c, even if condensation water containing copper ions adheres to the surface of the copper refrigerant pipe 19a and falls due to condensation, the condensation water will not adhere to the aluminum refrigerant pipes 26a and 26b. Therefore, it is possible to more effectively suppress the galvanic corrosion of the refrigerant pipes 26a and 26b.

[0026] In the air conditioner 1 according to the present embodiment, the refrigerant pipes 26a and 26b between the diverter 12 and the outdoor heat exchanger 8 are made of aluminum, whereas the long refrigerant pipes 19a, 19b, and 19c from the diverter 12 through the electric expansion valve 7 to the liquid stop valve 18 are made of copper. As such, in the present embodiment, most of the refrigerant pipes from the outdoor heat exchanger 8 to the liquid stop valve 18 are made of copper having excellent processability, which is advantageous in terms of manufacturing.

[0027] The details of the joining of the diverter 12 with the refrigerant pipes will be explained with reference to FIG. 5. While the following explanation deals with the joining of the first connecting part 12a with the refrigerant pipe 26a as an example, the same applies to the joining

of the first connecting part 12b with the refrigerant pipe 26b. As shown in FIG. 5, a lower end portion (right end portion in FIG. 5) of the refrigerant pipe 26a and its surroundings are expanded in diameter. The inner diameter of the expanded part is slightly larger than the outer diameter of the first connecting part 12a. The outer diameter and the inner diameter of the first connecting part 12a are identical with those of a non-expanded part of the refrigerant pipe 26a. An upper end portion (left end portion in Figure 5) of the first connecting part 12a and its surroundings are inserted into the expanded lower end portion and its surroundings of the refrigerant pipe 26a. The upper end portion of the first connecting part 12a and its surroundings and the expanded lower end portion of the refrigerant pipe 26a and its surroundings are joined together by brazing as described above, and a brazing material 28 is interposed between them.

[0028] Aluminum has a higher linear expansion coefficient than stainless steel. The solidification temperature of the brazing material 28 in the brazing process is a high temperature of about 580 degrees centigrade. The amount of contraction of the refrigerant pipe 26a inward is greater than the amount of contraction of the first connecting part 12a inward, during a process of cooling of the aluminum refrigerant pipe 26a and the stainless steel first connecting part 12a from the solidification temperature to a room temperature. In the present embodiment, because the upper end portion of the first connecting part 12a and its surroundings are inserted into the lower end portion of the refrigerant pipe 26a and its surroundings, the brazing material 28 sandwiched between (i) the upper end portion of the first connecting part 12a and its surroundings, which significantly contract inward, and (ii) the lower end portion of the refrigerant pipe 26a and its surroundings, which contract inward less than the upper end portion and its surroundings, receives a stress causing the brazing material 28 to contract in the radial direction, in the cooling process after the brazing process. Therefore, as compared to a case where the lower end portion of the refrigerant pipe 26a and its surroundings are inserted into the upper end portion of the first connecting part 12a and its surroundings, it is possible to reduce the occurrence of detachment at the brazing point and improve the reliability of the joining.

[0029] Copper has a higher linear expansion coefficient than many types of stainless steel materials, but has a lower linear expansion coefficient than some types of stainless steel materials. Therefore, when the linear expansion coefficient of the stainless steel material of the diverter 12 is higher than the linear expansion coefficient of the copper material of the refrigerant pipe 19a, it is preferable that the refrigerant pipe 26a is inserted into the first connecting part 12a. Conversely, when the opposite is true, it is preferable that the first connecting part 12a is inserted into the refrigerant pipe 26a. In the embodiments described below, a brazed joint between a stainless steel functional component and an aluminum refrigerant pipe and a brazed joint between a stainless

steel functional component and a copper refrigerant pipe have the same structures as in the present embodiment.

<Second Embodiment>

[0030] The following will describe an air conditioner of Second Embodiment of the present disclosure. The air conditioner according to the present embodiment is identical with that of First Embodiment, except for the configuration related to the diverter and the adjacent filter. Therefore, the following will mainly explain the differences from First Embodiment.

[0031] In FIG. 6, a diverter 32 (the second component in the present embodiment) is made of aluminum, and a filter 34 (the first component in the present embodiment) is made of stainless steel. A refrigerant pipe 39a (the first metal pipe in the present embodiment) between the diverter 32 and the filter 34 is made of aluminum. A refrigerant pipe 19b (the second metal pipe in the present embodiment) between the filter 34 and an electric expansion valve 7 (the third component in the present embodiment) is made of copper in the same manner as in First Embodiment. The filter 34 includes one first connecting part 34a at the lower end and one second connecting part 34b at the upper end. The first connecting part 34a is joined with the refrigerant pipe 39a by brazing. The second connecting unit 34b is joined with the refrigerant pipe 19b by brazing. With this arrangement, a refrigerant passage is formed from the refrigerant pipe 39a to the refrigerant pipe 19b through the filter 34. In the filter 34, a mesh member with numerous fine holes is provided.

[0032] As such, in the air conditioner according to the present embodiment, the filter 34 as a functional component is made of stainless steel, and the refrigerant pipe 39a made of aluminum and the refrigerant pipe 19b made of copper are joined with the filter 34. With this arrangement, the refrigerant pipe 39a made of aluminum is not directly joined with the refrigerant pipe 19b made of copper, and hence the galvanic corrosion of the refrigerant pipe 39a is suppressed. Furthermore, because the filter 34 that is a known functional component is made of stainless steel and interposed between the refrigerant pipe 39a and the refrigerant pipe 19b, it is unnecessary to add another component to suppress the galvanic corrosion of the refrigerant pipe 39a, so as to suppress the manufacturing cost.

[0033] In the air conditioner according to the present embodiment, the aluminum refrigerant pipe 39a between the diverter 32 and the filter 34 is substantially U-shaped, with only one bended part. In contrast, as shown in FIG. 6, the refrigerant pipe 19b between the filter 34 and the electric expansion valve 7 is shaped to have a vertical section directly above the filter 34, an oblique section, and a vertical section directly below the electric expansion valve 7 which are connected with one another. As such, there are two bended parts. In this way, in the present embodiment, between the diverter 32 and the electric expansion valve 7, there are fewer processed

parts in the aluminum refrigerant pipe 39a that is made of aluminum and is poor in processability. On this account, the manufacturing can be easily done. Furthermore, between the outdoor heat exchanger 8 and the liquid stop valve 18, the number of bended parts of the aluminum refrigerant pipes 26a, 26b, and 39a between the filter 34 and the outdoor heat exchanger 8 is smaller than the number of bended parts of the copper refrigerant pipes 19a and 19c between the filter 34 and the liquid stop valve 18. On this account, the manufacturing can be easily done. Furthermore, the present embodiment is able to achieve at least part of the effect of First Embodiment described above.

<Third Embodiment>

[0034] The following will describe an air conditioner of Third Embodiment of the present disclosure. The air conditioner according to the present embodiment is identical with that of Second Embodiment, except for the configuration from the filter to the electric expansion valve. Therefore, the following will mainly explain the differences from Second Embodiment.

[0035] In FIG. 7, a filter 35 (the second component in the present embodiment) is made of aluminum, and an electric expansion valve 37 (the first component in the present embodiment) is arranged such that a main body portion is made of stainless steel, a first connection pipe 37a is made of aluminum, and a second connection pipe 37b is made of copper. A refrigerant pipe 39b (the first metal pipe in the present embodiment) between the filter 35 and the electric expansion valve 37 is made of aluminum. A refrigerant pipe 19c (the second metal pipe in the present embodiment) between the electric expansion valve 37 and a liquid receiver 13 (the third component in the present embodiment) is made of copper in the same manner as in First Embodiment. A first connecting part 37a of the electric expansion valve 37 is joined with the refrigerant pipe 39b by brazing. The second connecting unit 37b is joined with the refrigerant pipe 19c by brazing. With this arrangement, a refrigerant passage is formed from the refrigerant pipe 39b to the refrigerant pipe 19c through the electric expansion valve 37. In the electric expansion valve 37, a stepping motor that allows for almost stepless adjustment of the opening degree is provided.

[0036] As such, in the air conditioner according to the present embodiment, a main body portion of the electric expansion valve 37 as a functional component is made of stainless steel, and the refrigerant pipe 39b made of aluminum and the refrigerant pipe 19c made of copper are joined with the first connection pipe 37a made of aluminum and the second connection pipe 37b made of copper of the electric expansion valve 37, respectively. With this arrangement, the refrigerant pipe 39b made of aluminum is not directly joined with the refrigerant pipe 19c made of copper, and hence the galvanic corrosion of the refrigerant pipe 39b is suppressed. Furthermore, be-

cause the main body portion of the electric expansion valve 37 that is a known functional component is made of stainless steel and interposed between the refrigerant pipe 39b and the refrigerant pipe 19c, it is unnecessary to add another component to suppress the galvanic corrosion of the refrigerant pipe 39a, so as to suppress the manufacturing cost.

[0037] In the air conditioner according to the present embodiment, the electric expansion valve 37, which is a decompression device, is positioned to be higher than the functional components (a diverter 32, a filter 35, a liquid receiver 13, and a filter 20) located between an outdoor heat exchanger 8 and a liquid stop valve 18 shown in FIG. 7. An electronic board (not illustrated) connected to the electric expansion valve 37 by an electric wire tends to be placed at a relatively high position inside the outdoor unit 3. Therefore, when the electric expansion valve 37 is made of stainless steel and the refrigerant pipes 39a and 39b between the outdoor heat exchanger 8 and the first connection pipe 37a are made of aluminum, the electric wire between the electronic board and the electric expansion valve 37 is short, and this is advantageous in cost.

[0038] In the air conditioner of the present embodiment, furthermore, the refrigerant pipe 39b made of aluminum and provided between the filter 35 and the electric expansion valve 37 is shaped to have a vertical section directly above the filter 35, an oblique section, and a vertical section directly below the electric expansion valve 37 which are connected with one another, as shown in FIG. 7. As such, there are two bended parts. In contrast, the refrigerant pipe 19c which is made of copper and provided between the electric expansion valve 37 and the liquid receiver 13 is shaped to have a vertical section directly below the second connection pipe 37b, a section extending obliquely forward and downward, a section extending obliquely rearward and downward, and a vertical section directly above the liquid receiver 13 (see FIG. 3) which are connected with one another. As such, there are three bended parts. In this way, in the present embodiment, between the filter 35 and the liquid receiver 13, there are fewer processed parts in the aluminum refrigerant pipe 39b that is made of aluminum and is poor in processability. On this account, the manufacturing can be easily done. Furthermore, between the outdoor heat exchanger 8 and the liquid stop valve 18, the number of bended parts of the aluminum refrigerant pipes 26a, 26b, 39a, and 39b between the electric expansion valve 37 and the outdoor heat exchanger 8 is smaller than the number of bended parts of the copper refrigerant pipe 19c between the electric expansion valve 37 and the liquid stop valve 18. On this account, the manufacturing can be easily done. Furthermore, the present embodiment is able to achieve at least part of the effect of First Embodiment and Second Embodiment described above.

<Fourth Embodiment>

[0039] The following will describe an air conditioner of Fourth Embodiment of the present disclosure. The air conditioner according to the present embodiment is identical with that of Third Embodiment, except for the configuration related to the electric expansion valve. Therefore, the following will mainly explain the differences from Third Embodiment.

[0040] In FIG. 8, a filter 35 (the second component in the present embodiment) is made of aluminum, and an electric expansion valve 38 (the first component in the present embodiment) is arranged such that a main body portion, a first connection pipe 38a, and a second connection pipe 38b are made of stainless steel. A refrigerant pipe 39b (the first metal pipe in the present embodiment) between the filter 35 and the electric expansion valve 38 is made of aluminum. A refrigerant pipe 19c (the second metal pipe in the present embodiment) between the electric expansion valve 38 and a liquid receiver 13 (the third component in the present embodiment) is made of copper in the same manner as in First Embodiment. A first connecting part 38a of the electric expansion valve 38 is joined with the refrigerant pipe 39b by brazing. The second connecting unit 38b is joined with the refrigerant pipe 19c by brazing. With this arrangement, a refrigerant passage is formed from the refrigerant pipe 39b to the refrigerant pipe 19c through the electric expansion valve 38.

[0041] Also in the present embodiment, a main body portion of the electric expansion valve 38 as a functional component is made of stainless steel, and the refrigerant pipe 39b made of aluminum and the refrigerant pipe 19c made of copper are joined with the first connection pipe 38a made of aluminum and the second connection pipe 38b made of stainless steel of the electric expansion valve 37, respectively. With this arrangement, the galvanic corrosion of the refrigerant pipe 39b is suppressed. Furthermore, it is unnecessary to add another component to suppress the galvanic corrosion of the refrigerant pipe 39a, so as to suppress the manufacturing cost.

[0042] In the present embodiment, the main body portion of the electric expansion valve 38 is made of stainless steel, and the main body portion is joined with the first connection pipe 38a and the second connection pipe 38b, which are also made of stainless steel, by brazing. Therefore, brazing of both of the pipes can be performed at the same time, with the result that the manufacturing process of the electric expansion valve 38 is simplified. Furthermore, because the second connection pipe 38b is made of not copper but stainless steel, even if condensation water adhering to the surface of the second connection pipe 38b adheres to members such as the aluminum refrigerant pipe 39b, the galvanic corrosion is less likely to occur in the members such as the refrigerant pipe 39b, because this condensation water does not include copper ions. Furthermore, the present embodiment is able to achieve at least part of the effect of First Embodiment to Third Embodiment described above.

<Fifth Embodiment>

[0043] The following will describe an air conditioner of Fifth Embodiment of the present disclosure. The air conditioner according to the present embodiment is identical with that of Second Embodiment, except for the configuration from the diverter to the electric expansion valve. Therefore, the following will mainly explain the differences from Second Embodiment.

[0044] In FIG. 9, a filter 45 (the first component in the present embodiment) is made of stainless steel. A refrigerant pipe 49a (the first metal pipe in the present embodiment) between the filter 45 and a diverter 32 (the second component of the present embodiment) is made of aluminum. A refrigerant pipe 49b (the second metal pipe in the present embodiment) between the filter 45 and an electric expansion valve 7 (the third component in the present embodiment) is made of copper in the same manner as in First Embodiment. The filter 45 includes one first connecting part 45a at the upper end and one second connecting part 45b at the lower end. The first connecting part 45a is joined with the refrigerant pipe 49a by brazing. The second connecting unit 45b is joined with the refrigerant pipe 49c by brazing. With this arrangement, a refrigerant passage is formed from the refrigerant pipe 49a to the refrigerant pipe 49b through the filter 45.

[0045] As such, in the air conditioner according to the present embodiment, the filter 45 as a functional component is made of stainless steel, and the refrigerant pipe 49a made of aluminum and the refrigerant pipe 49b made of copper are joined with the filter 45. With this arrangement, the refrigerant pipe 49b made of aluminum is not directly joined with the refrigerant pipe 49c made of copper, and hence the galvanic corrosion of the refrigerant pipe 49a is suppressed. Furthermore, because the filter 45 that is a known functional component is made of stainless steel and interposed between the refrigerant pipe 49a and the refrigerant pipe 49b, it is unnecessary to add another component to suppress the galvanic corrosion of the refrigerant pipe 49a, so as to suppress the manufacturing cost.

[0046] Furthermore, in the present embodiment, the refrigerant pipe 49a which is on the outdoor heat exchanger 8 side of the filter 45 and connected to the first connection pipe 45a includes three sections that will be described below. A first section PA is connected to the first connecting part 45a of the filter 45 and extends upward from the first connecting part 45a. A second section PB is connected to an upper end portion of the first section PA, extends upward from the upper end portion, and is bended and extends downward. In other words, the second section PB is U-shaped. A third section PC is connected to a lower end portion of the second section PB and extends downward. By arranging the refrigerant pipe 49a to have the three sections PA, PB, and PC described above, even when the refrigerant pipes 26a and 26b and the diverter 32 are provided in the vicinity of the lower end of the outdoor heat exchanger 8, the junction with

the aluminum refrigerant pipe 49a is the upper end of the filter 45 and the junction with the copper refrigerant pipe 49b is the lower end of the filter 45. This makes it possible to suppress the corrosion of the refrigerant pipe 49a due to condensation water including copper ions and dropping from the refrigerant pipe 49b. In the example shown in FIG. 9, the first section PA and the third section PC extend in the vertical direction. However, the first section PA and the third section PC may not extend in the vertical direction, and may be inclined with respect to the vertical direction. Furthermore, the present embodiment is able to achieve at least part of the effect of First Embodiment to Fourth Embodiment described above.

<Sixth Embodiment>

[0047] The following will describe an air conditioner of Sixth Embodiment of the present disclosure. An air conditioner according to the present embodiment is identical with that of First Embodiment, except for the configuration from the outdoor heat exchanger 8 to a muffler (equivalent to the muffler 15 shown in FIG. 1). Therefore, the following will mainly explain the differences from First Embodiment.

[0048] In FIG. 10, a muffler 55 (the first component in the present embodiment) is made of stainless steel. The muffler 55 includes one first connecting part 55a at the upper end and one second connecting part 55b at the lower end. The first connecting part 55a is joined with a refrigerant pipe 59e (the first metal pipe of the present embodiment) by brazing. The second connecting part 55b is joined with a refrigerant pipe 57 (the second metal pipe of the present embodiment) by brazing. The refrigerant pipe 59e is made of aluminum and is connected to an outdoor heat exchanger 8 through a four-pass switching valve 16. The four-pass switching valve 16 is made of stainless steel. The refrigerant pipe 57 is made of copper and is connected to a compressor 5. With this arrangement, a refrigerant passage is formed from the refrigerant pipe 59e to the refrigerant pipe 57 through the muffler 55.

[0049] As such, in the air conditioner according to the present embodiment, the muffler 55 as a functional component is made of stainless steel, and the refrigerant pipe 59e made of aluminum and the refrigerant pipe 57 made of copper are joined with the muffler 55. With this arrangement, the refrigerant pipe 59e made of aluminum is not directly joined with the refrigerant pipe 57 made of copper, and hence the galvanic corrosion of the refrigerant pipe 59e is suppressed. Furthermore, because the muffler 55 that is a known functional component is made of stainless steel and interposed between the refrigerant pipe 59e and the refrigerant pipe 57, it is unnecessary to add another component to suppress the galvanic corrosion of the refrigerant pipe 59e, so as to suppress the manufacturing cost. Furthermore, the present embodiment is able to achieve at least part of the effect of First Embodiment to Fifth Embodiment described above.

<Seventh Embodiment>

[0050] The following will describe an air conditioner of Seventh Embodiment of the present disclosure. An air conditioner according to the present embodiment is identical with that of First Embodiment, except for the configuration from the outdoor heat exchanger 8 to an accumulator (equivalent to the accumulator 11 shown in FIG. 1). Therefore, the following will mainly explain the differences from First Embodiment.

[0051] In FIG. 11, an accumulator 61 (the first component in the present embodiment) is made of stainless steel. The accumulator 61 includes one first connecting part 61a at the upper end and one second connecting part 61b at the lower end. The first connecting part 61a is joined with a refrigerant pipe 69d (the first metal pipe of the present embodiment) by brazing. The second connecting part 61b is joined with a refrigerant pipe 67 (the second metal pipe of the present embodiment) by brazing. The refrigerant pipe 69d is made of aluminum and is connected to an outdoor heat exchanger 8 through a compressor 5, a muffler 15, and a four-pass switching valve 16. The compressor 5 and the muffler 15 may be made of aluminum or stainless steel. The four-pass switching valve 16 is made of stainless steel. The refrigerant pipe 67 is made of copper and is connected to the four-pass switching valve 16. With this arrangement, a refrigerant passage is formed from the refrigerant pipe 69d to the refrigerant pipe 67 through the accumulator 61.

[0052] As such, in the air conditioner according to the present embodiment, the accumulator 61 as a functional component is made of stainless steel, and the refrigerant pipe 69d made of aluminum and the refrigerant pipe 67 made of copper are joined with the accumulator 61. With this arrangement, the refrigerant pipe 69d made of aluminum is not directly joined with the refrigerant pipe 67 made of copper, and hence the galvanic corrosion of the refrigerant pipe 69d is suppressed. Furthermore, because the accumulator 61 that is a known functional component is made of stainless steel and interposed between the refrigerant pipe 69d and the refrigerant pipe 67, it is unnecessary to add another component to suppress the galvanic corrosion of the refrigerant pipe 69d, so as to suppress the manufacturing cost. Furthermore, the present embodiment is able to achieve at least part of the effect of First Embodiment to Sixth Embodiment described above.

<Modifications>

[0053] In First to Fifth Embodiments, the liquid receiver 13 may be made of stainless steel, the refrigerant pipe between the liquid receiver 13 and the outdoor heat exchanger 8 may be made of aluminum, and the refrigerant pipe between the liquid receiver 13 and the liquid stop valve 18 may be made of copper. In First to Fifth Embodiments, the filter 20 may be made of stainless steel, the refrigerant pipe between the filter 20 and the outdoor heat

exchanger 8 may be made of aluminum, and the refrigerant pipe between the filter 20 and the liquid stop valve 18 may be made of copper. While in the embodiments described above the first metal pipe is made of aluminum and the second metal pipe is made of copper, the first metal pipe may be made of a metal different from aluminum and the second metal pipe may be made of a metal different from copper, as long as the electric potential of the material of the second metal pipe is higher than the electric potential of the material of the first metal pipe.

[0054] While the embodiments described above relate to the functional components and the refrigerant pipes in the outdoor heat exchanger, the present disclosure may be applicable to functional components and refrigerant pipes in an indoor heat exchanger. For example, in the indoor unit, a heat transfer pipe of a front heat exchanger and a refrigerant pipe connected thereto may be made of aluminum, a heat transfer pipe of a rear heat exchanger and a refrigerant pipe connected thereto may be made of copper, and a stainless reheat dehumidification valve (decompression valve) may be connected between the heat transfer pipes.

[0055] In First to Fifth Embodiments, at least one of the components between the outdoor heat exchanger 8 and the liquid stop valve 18 may be omitted, except the electric expansion valve 7. A muffler may be provided between the outdoor heat exchanger 8 and the liquid stop valve 18, and a filter may be provided between the outdoor heat exchanger 8 and the gas stop valve 17. The joints formed by brazing in the embodiments described above may be formed by a method other than brazing, such as welding. The first component may be entirely made of stainless steel, or may be only partially made of stainless steel. For example, the first connecting part may be made of the same metal as the first metal pipe, the second connecting part may be made of the same metal as the second metal pipe, and a part connecting the first connecting part with the second connecting part may be made of stainless steel.

[0056] Although the embodiments have been described above, it will be understood that various changes in form and details are possible as long as the changes do not depart from the spirit and scope of the claims.

[Reference Signs List]

[0057]

- 1 air conditioner
- 2 indoor unit
- 3 outdoor unit
- 6 indoor heat exchanger
- 7 electric expansion valve
- 7a first connection pipe
- 7b Second connection pipe
- 8 outdoor heat exchanger
- 11 accumulator
- 12 diverter

12a, 12b first connecting part
 12c second connecting part
 13 liquid receiver
 14, 20 filter
 15 muffler
 16 four-pass switching valve
 17 gas stop valve
 18 liquid stop valve
 19 (19a, 19b, 19c) refrigerant pipe
 26a, 26b refrigerant pipe

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Claims

1. An air conditioner comprising:

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a first metal pipe (26a, 26b; 39a; 39b; 39b; 49a; 59e; 69d); a second metal pipe (19a; 19b; 19c; 19c; 49b; 57; 67) with a higher electric potential than the first metal pipe; and a first component (12; 34; 37; 38; 45; 55; 61) made of stainless steel and including a first connecting part (12a, 12b; 34a; 37a; 38a; 45a; 55a; 61a) and a second connecting part (12c; 34b; 37b; 38b; 45b; 55b; 61b),

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the first metal pipe being connected to the first connecting part of the first component and the second metal pipe being connected to the second connecting part of the first component, so that a refrigerant passage is formed from the first metal pipe to the second metal pipe through the first component, and the first component being one of a filter (34; 45), a muffler (55), a decompression device (37; 38), a refrigerant storage (61), and a diverter (12).

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2. The air conditioner according to claim 1, wherein, the first connecting part (12a, 12b; 45a; 55a) is located above the second connecting part (12c; 45b; 55b).

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3. The air conditioner according to claim 1 or 2, wherein an end portion of the first connecting part (12a, 12b; 34a; 37a; 38a; 45a; 55a; 61a) is inserted into the first metal pipe (26a, 26b; 39a; 39b; 39b; 49a; 59e; 69d).

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4. The air conditioner according to any one of claims 1 to 3, further comprising: a second component (32; 35; 35; 32) connected to the opposite side of the first component of the first metal pipe (39a; 39b; 39b; 49a); and a third component (7; 13; 13; 7) connected to the opposite side of the first component of the second metal pipe (19b; 19c; 19c; 49b),

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each of the second component and the third component being one of a heat exchanger, a filter, a muffler, a decompression device, a refrigerant storage, a stop valve, and a diverter,

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the first metal pipe (39a; 39b; 39b; 49a) being a refrigerant pipe made of aluminum and the second metal pipe (19b; 19c; 19c; 49b) being a refrigerant pipe made of copper, and between the second component (32; 35; 35; 32) and the third component (7; 13; 13; 7), the number of bended parts of the first metal pipe being smaller than the number of bended parts of the second metal pipe.

5. The air conditioner according to any one of claims 1 to 4, wherein,

the first component is a filter (45), the first metal pipe (49a) is a refrigerant pipe connected to a connection part of the filter on the heat exchanger side, and the first metal pipe (49a) includes: a first section (PA) connected to the first connecting part (45a) of the filter and extending upward from the first connecting part; a second section (PB) connected to an upper end portion of the first section, extending upward from the upper end portion, being bended, and extending downward; and a third section (PC) connected to a lower end portion of the second section and extending downward.

6. The air conditioner according to any one of claims 1 to 4, wherein, the first component is a decompression device (37; 38), the first metal pipe (39b; 39b) is made of aluminum, and the second metal pipe (19c; 19c) is made of copper.

7. The air conditioner according to any one of claims 1 to 4, wherein,

the first component is a diverter (12), the first metal pipe is a refrigerant pipe (26a, 26b) connected to an outdoor heat exchanger (8) and made of aluminum, and a decompression device (7) and a stop valve (18) are provided on the opposite side of the outdoor heat exchanger (8) over the diverter, and a pipe (19a, 19b) between the diverter (12) and the decompression device (7) and a pipe (19c) between the decompression device (7) and the stop valve (18) are made of copper.

FIG.1

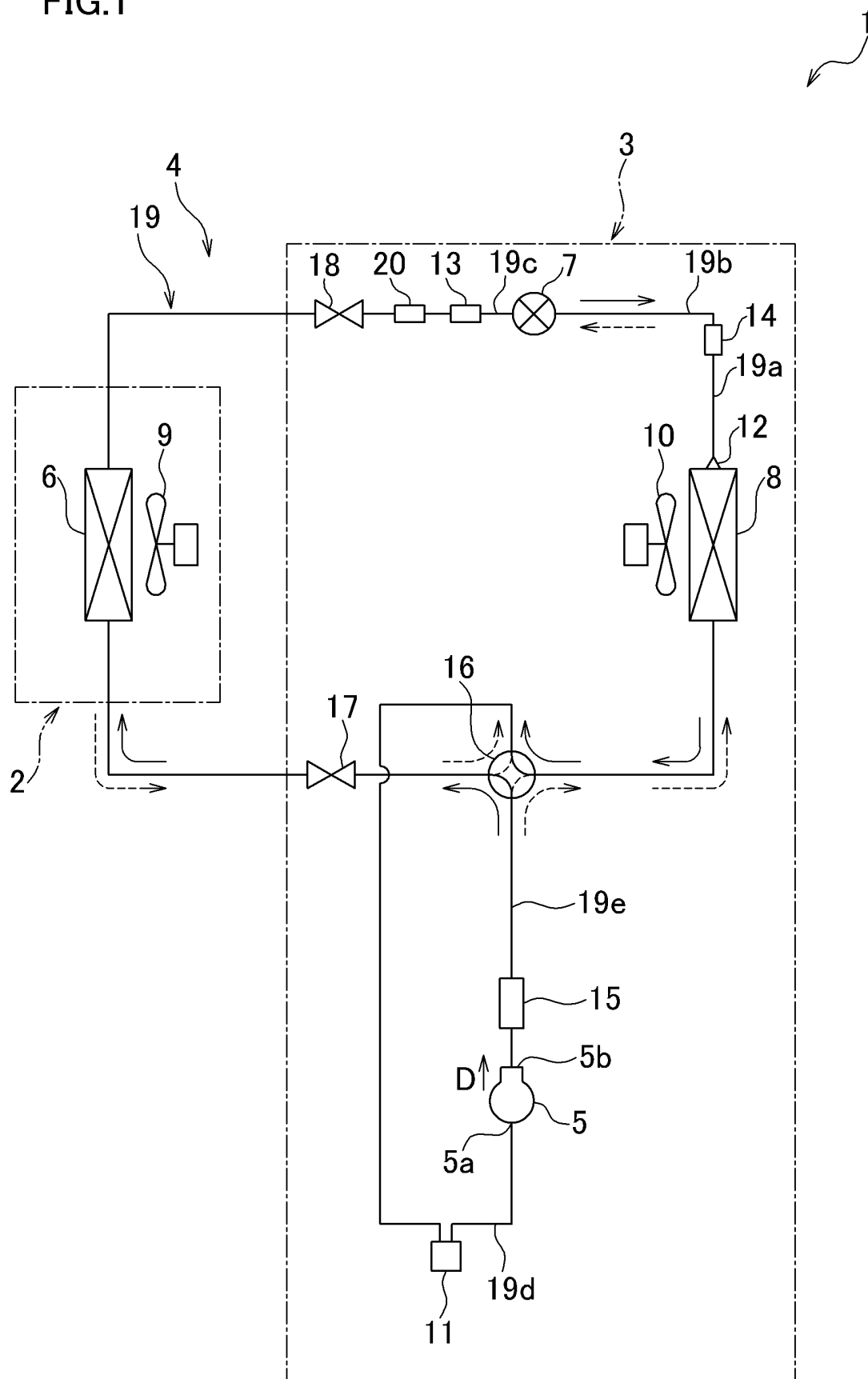


FIG.2

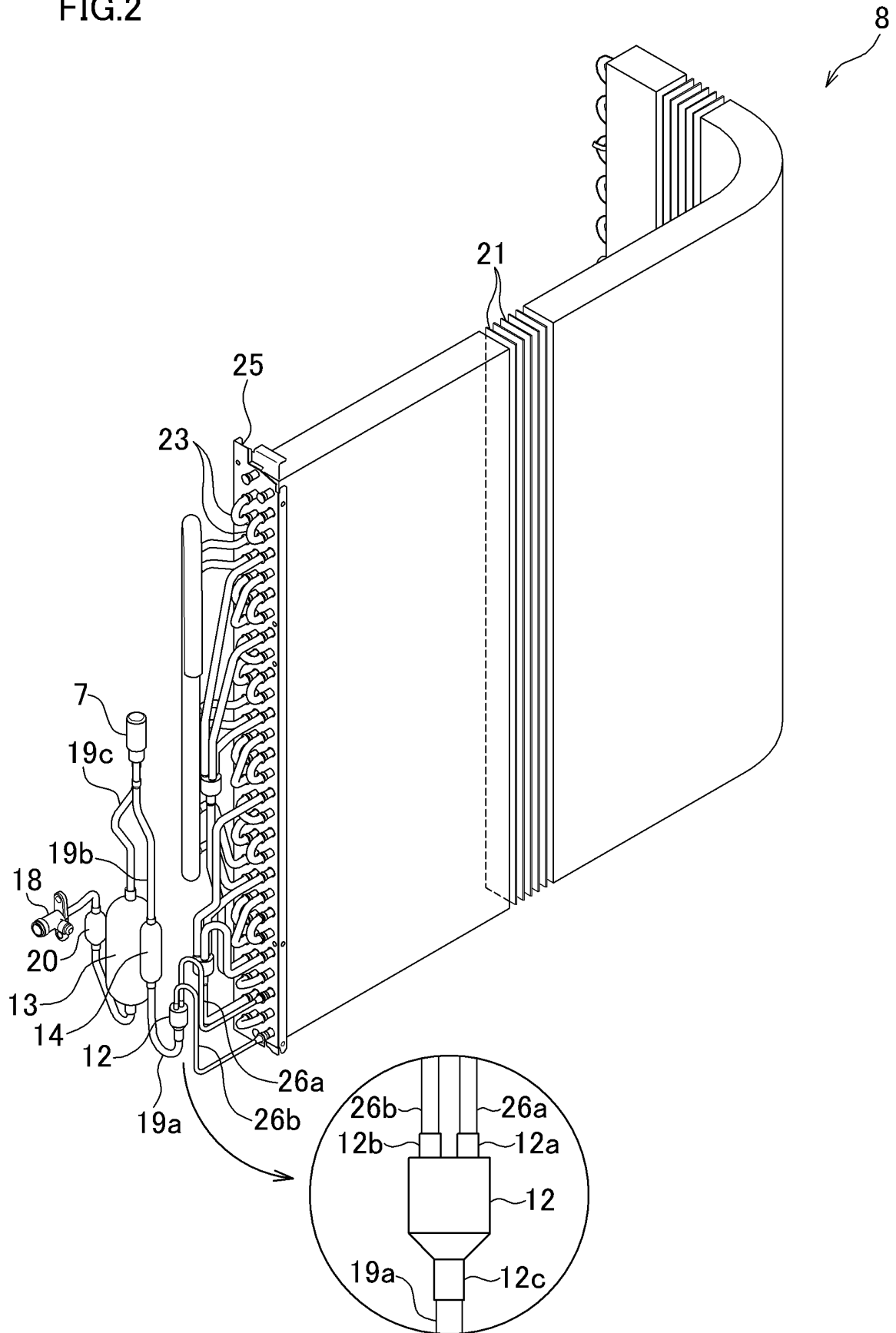


FIG.3

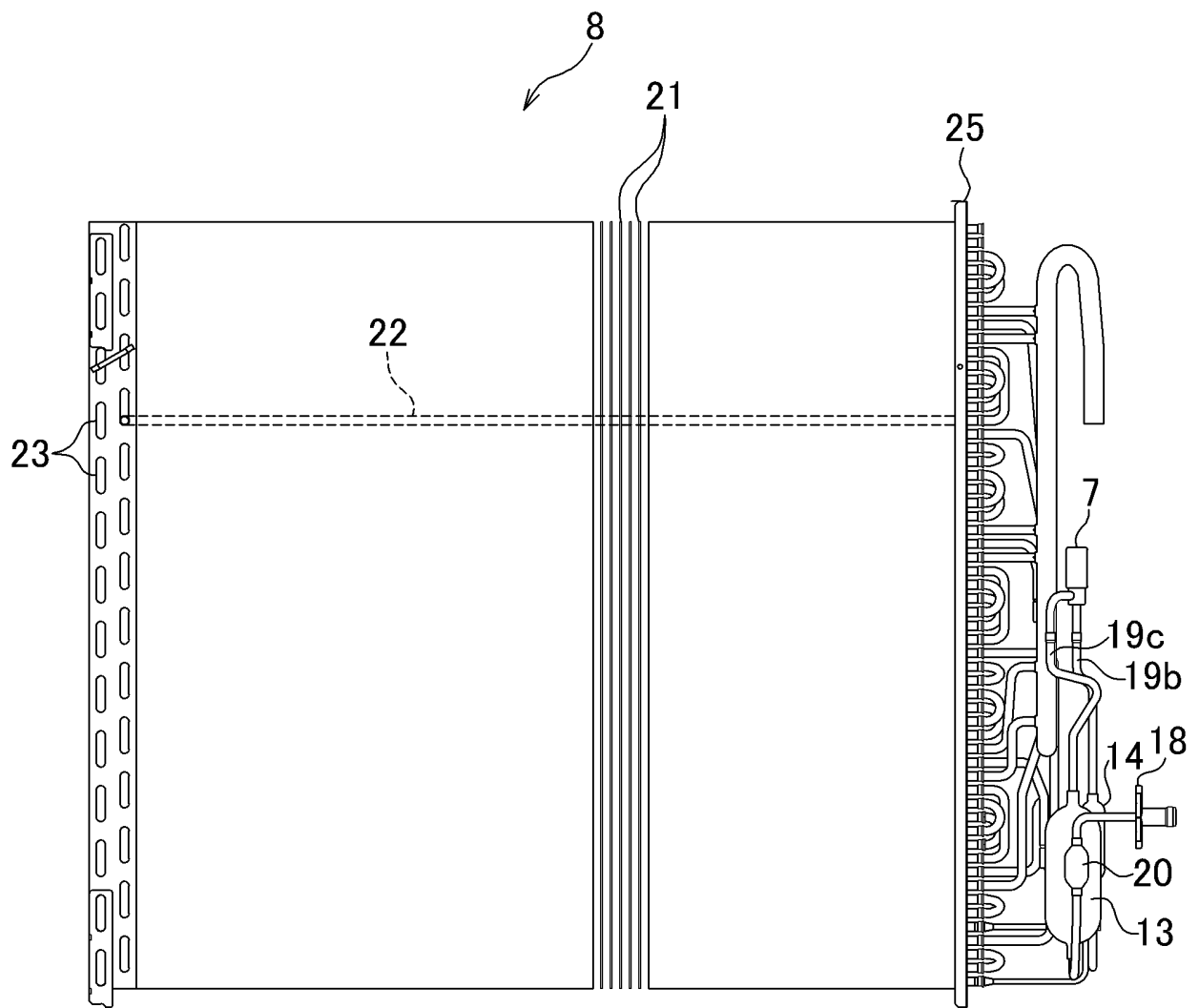


FIG.4

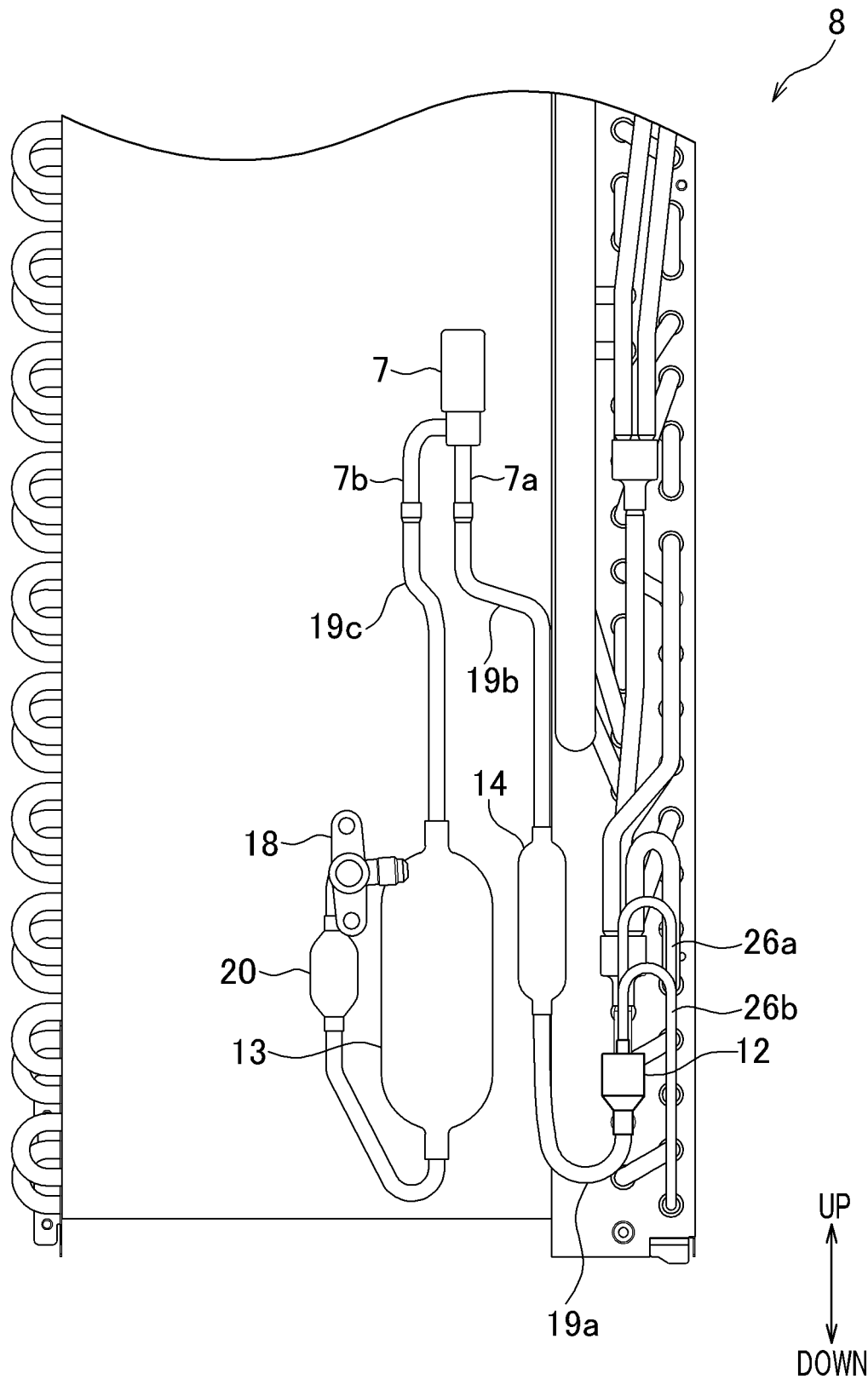


FIG.5

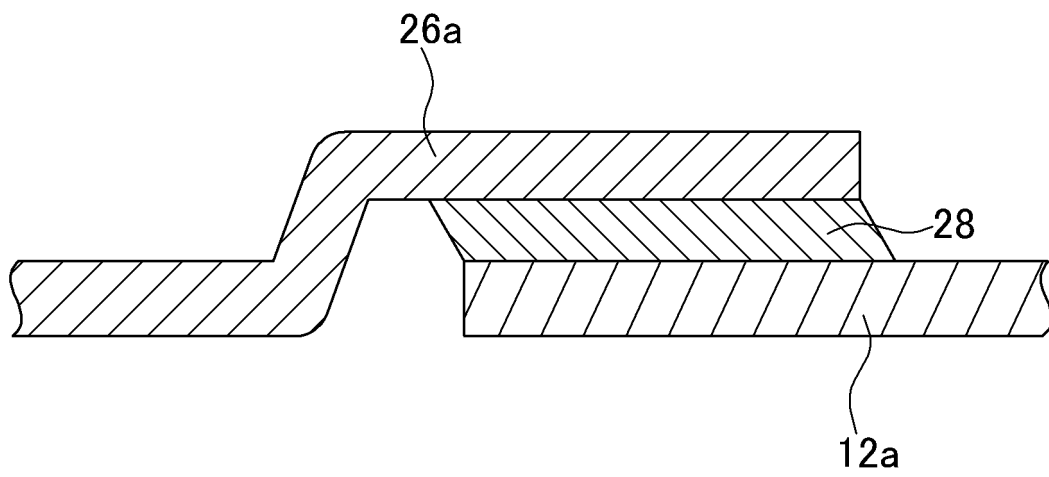


FIG.6

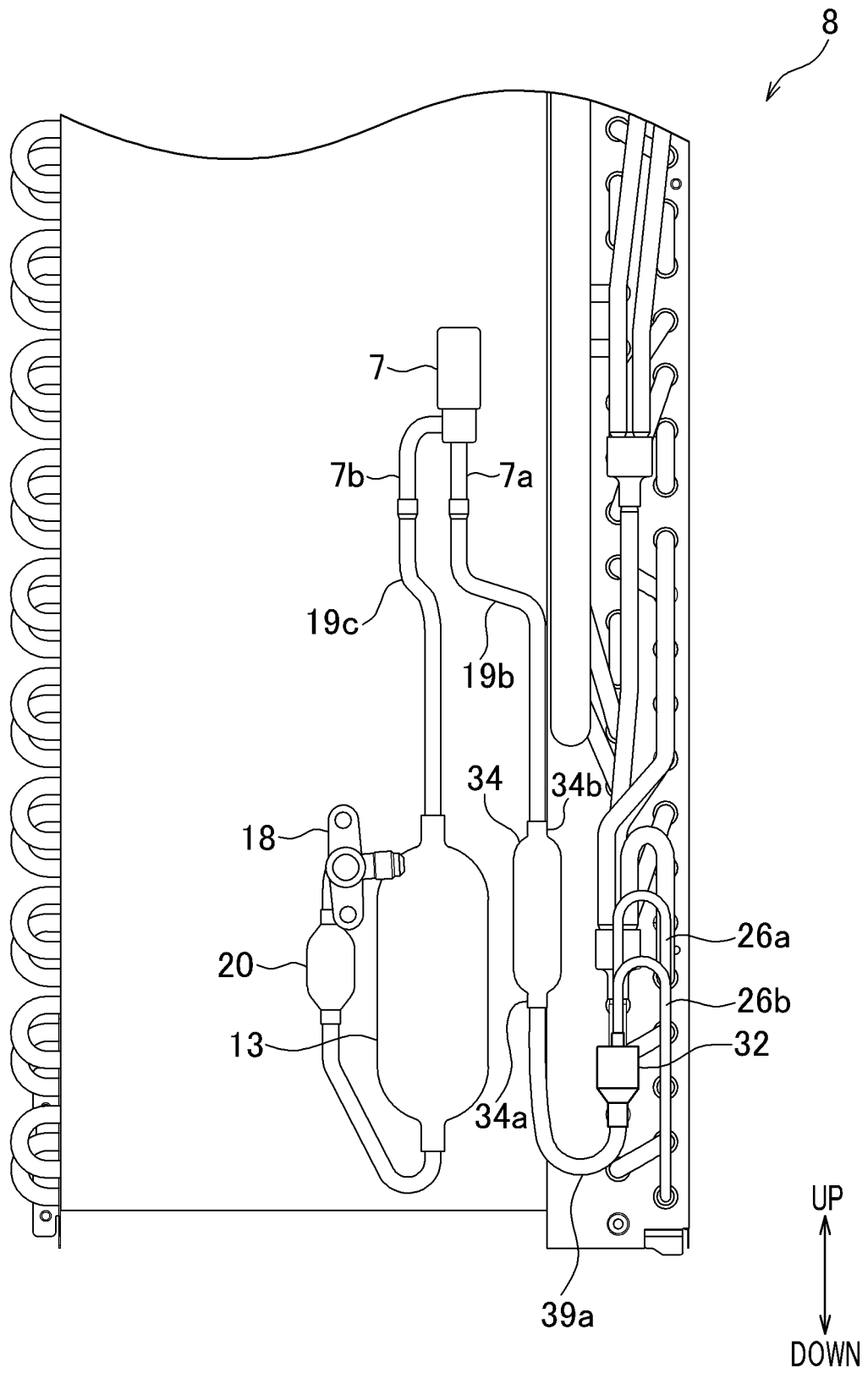


FIG.7

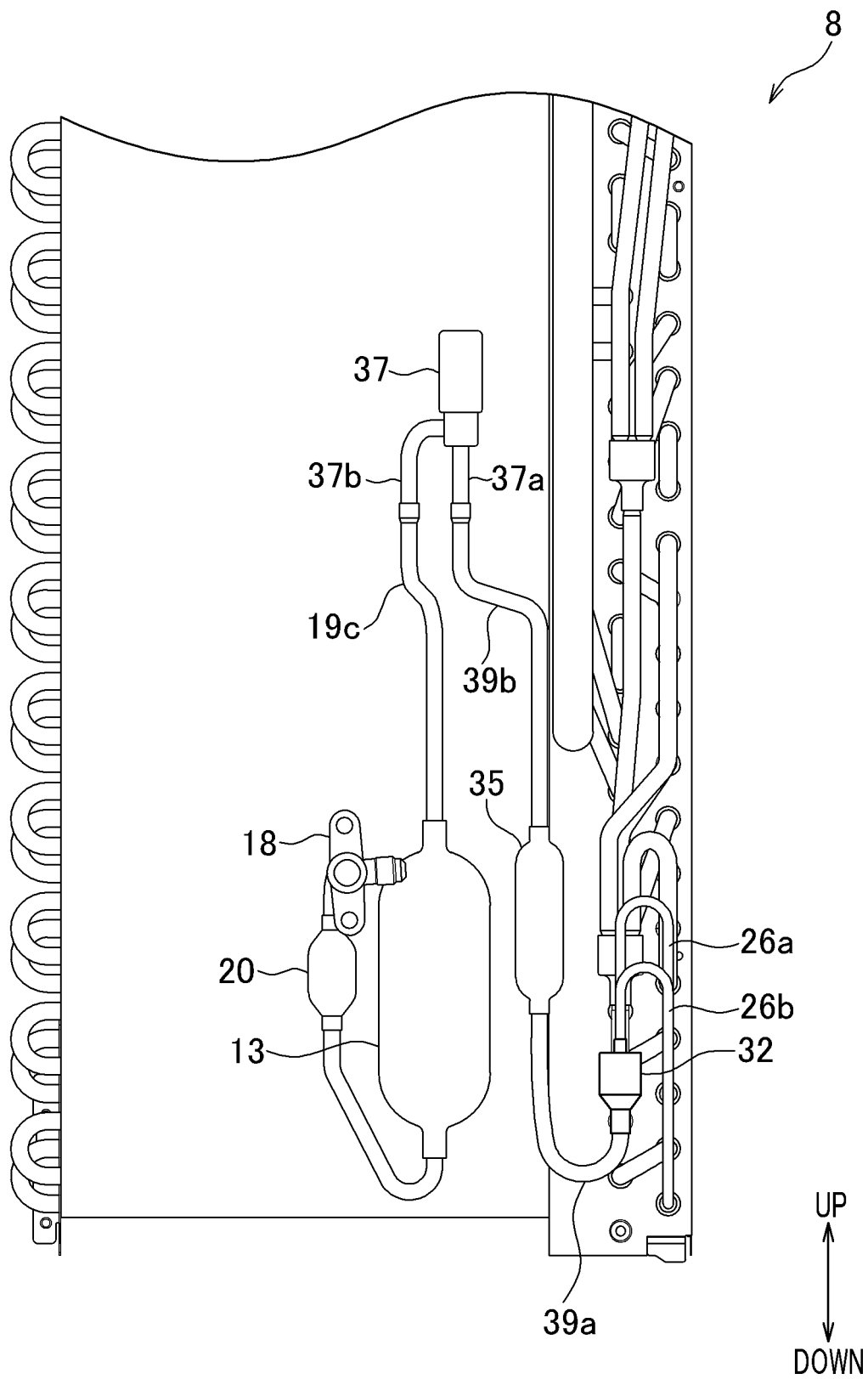


FIG.8

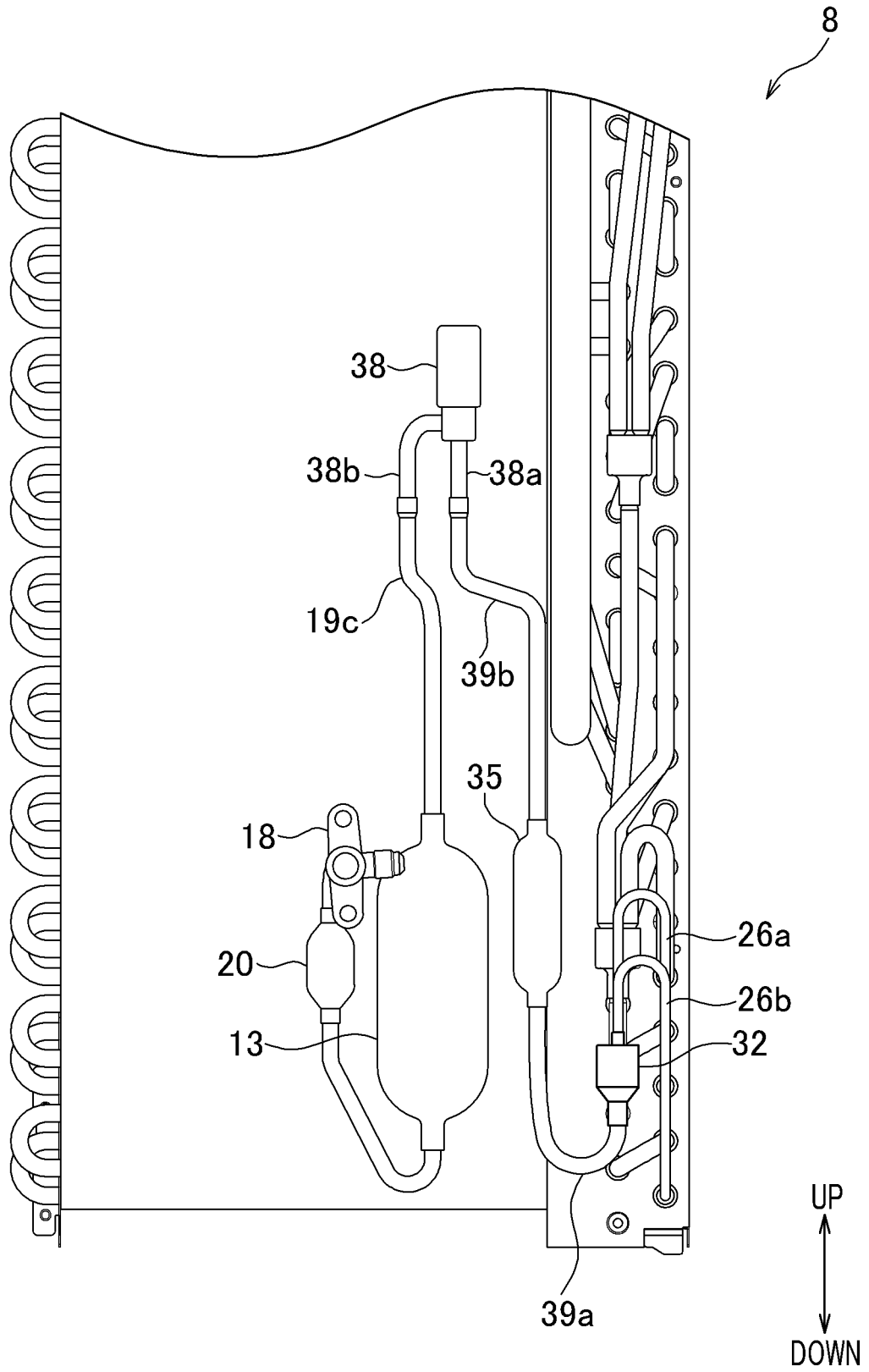


FIG.9

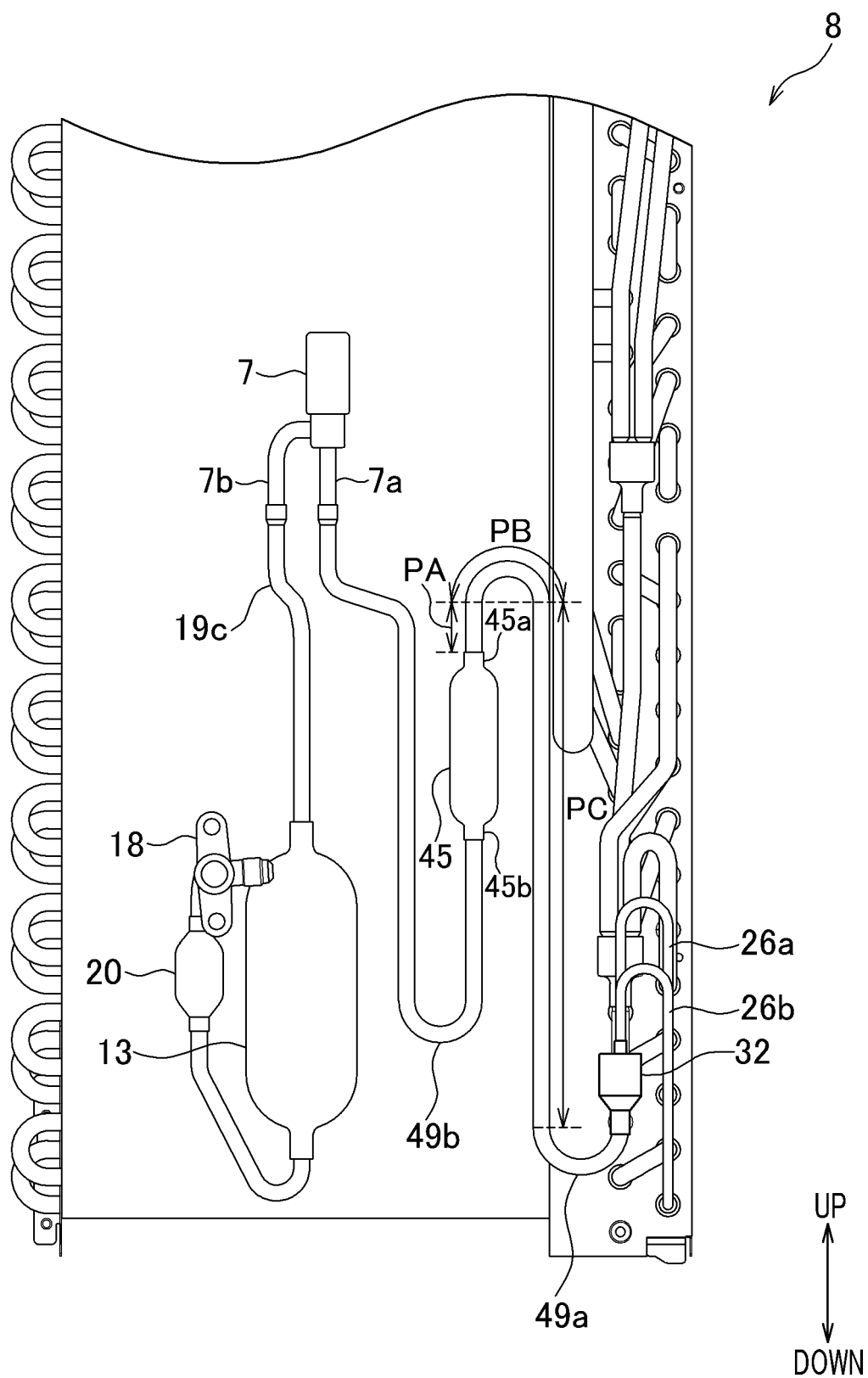


FIG.10

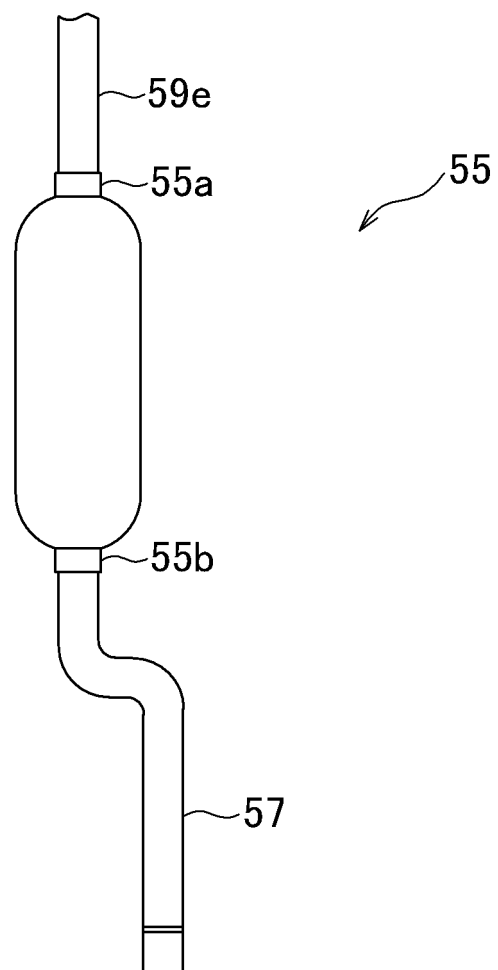
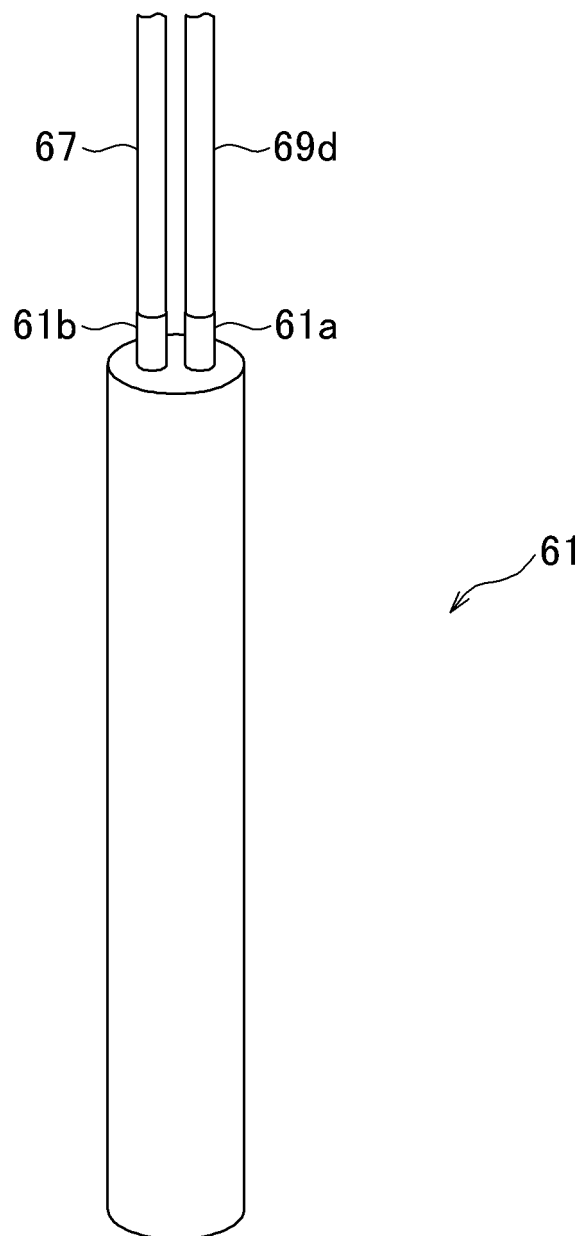


FIG.11



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2022/022162

A. CLASSIFICATION OF SUBJECT MATTER

F25B 47/00(2006.01)i; **F28F 19/00**(2006.01)i; **F25B 41/40**(2021.01)i
 FI: F25B47/00 A; F28F19/00 541; F25B41/40 B

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)
 F25B47/00; F28F19/00; F25B41/40

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

Published examined utility model applications of Japan 1922-1996
 Published unexamined utility model applications of Japan 1971-2022
 Registered utility model specifications of Japan 1996-2022
 Published registered utility model applications of Japan 1994-2022

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A		4-5, 7
Y	JP 2010-112667 A (MITSUBISHI ELECTRIC CORP.) 20 May 2010 (2010-05-20) paragraph [0042]	1-3, 6
A		4-5, 7
Y	WO 2015/155826 A1 (MITSUBISHI ELECTRIC CORP.) 15 October 2015 (2015-10-15) paragraphs [0042]-[0044]	1-3, 6
A		4-5, 7
Y	CN 210624987 U (JILIN PROVINCE BINGLUN REFRIGERATION ENGINEERING CO., LTD.) 26 May 2020 (2020-05-26) paragraph [0022]	1-3, 6
A		4-5, 7

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

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
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"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

26 July 2022

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Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2022/022162

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	paragraph [0060]	4-5, 7
Y	JP 2021-36193 A (DAIKIN INDUSTRIES, LTD.) 04 March 2021 (2021-03-04)	1-3, 6
A	paragraph [0063]	4-5, 7
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 177324/1985 (Laid-open No. 91768/1986) (DAIKIN INDUSTRIES, LTD.)	1-3, 6
A	14 June 1986 (1986-06-14), specification, p. 4, lines 18-20	4-5, 7

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/JP2022/022162

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WO 2015/155826 A1	15 October 2015	(Family: none)	
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JP 61-91768 U1	14 June 1986	(Family: none)	

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